सत्यमेव जयते

Samanvay

Harmonizing Traditions and Modernity

Ministry of Environment, Forest and Climate Change
Government of India
2017

सत्यमेव जयते

SAMANVAY

समन्वय

HARMONIZING TRADITIONS AND MODERNITY FOR SUSTAINABLE LOW-CARBON ECONOMIC GROWTH

Ministry of Environment, Forest and Climate Change
Government of India
2017

SAMANVAY

Harmonizing Traditions and Modernity for Sustainable Low-Carbon Economic Growth

Citation:
MoEFCC. (2017). *Samanvay: Harmonizing traditions and modernity for sustainable low-carbon economic growth*.
Ministry of Environment, Forest and Climate Change, New Delhi, pp 56

ISBN: 978-81-927373-9-3

Disclaimer:
The views expressed in this publication do not necessarily reflect the views of the Ministry of Environment, Forest and Climate Change (MoEFCC) or its representatives. The examples cited in this book are only illustrative and indicative and not exhaustive, nor have they been chosen based on priority. The designation of geographical entities in this book, and presentation of the material, do not imply the expression of any opinion whatsoever on the part of MoEFCC concerning the legal status of any country, territory, or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries. Citing of trade names or commercial processes does not constitute endorsement.

For further details, please contact:
Dr. J.R. Bhatt
Scientist-G,
Ministry of Environment, Forest and Climate Change
Government of India, New Delhi – 110003
Tele-Fax: 011-24695293
Email: jrbhatt@nic.in

डॉ. हर्ष वर्धन
Dr. Harsh Vardhan

सत्यमेव जयते

भारत सरकार
पर्यावरण, वन एवं जलवायु परिवर्तन मंत्री
GOVERNMENT OF INDIA
MINISTER OF ENVIRONMENT, FOREST
& CLIMATE CHANGE

MESSAGE

The problem of climate change has been precipitated primarily because of excessive consumption patterns and profligate lifestyles of the developed countries. It is this overconsumption which has been depleting our natural resources at a rate faster than their natural replenishment, and is damaging our planet's life and life support systems.

Due to various reasons, largely shrouded in history, the nations of the world are at different stages of development since the dawn of Industrial Revolution in the 1760s. While one cannot roll back the tide of history, one can moderate its flow. Climate change was identified way back in the late 18th century as one of the most important global challenges. Crafted with adequate thought and care by the world leaders at the historic Earth Summit in 1992, the United Nations Framework Convention on Climate Change (UNFCCC) recognizes the principle of 'common but differentiated responsibilities' and the 'precautionary approach' to tackle the intimidating threat of climate change, by categorizing the countries of the world as least developed, developing and developed, and gauging their respective capacities to cope with the challenges of climate change.

Since the challenges that we are facing today are essentially a result of consumption patterns and lifestyles, education and awareness are and will be, important and integral components of any global strategy to contain over consumption, before it reaches the tipping point.

The Paris Agreement on Climate Change has unequivocally established the role of sustainable patterns of consumption and production and sustainable lifestyles in addressing climate change. Traditional practices contribute to making lifestyles more sustainable. Through the 'Parampara' Catalogue released at COP 21 in Paris, India showcased the customary Indian climate-friendly practices. India's comparatively greener consumption patterns are the outcome of its culture, ethos, and traditions. As reflected in its Nationally Determined Contributions (NDCs), India is committed to pursue and propagate a healthy and sustainable way of living, based on traditional values of conservation and optimal utilization of resources.

The present book focuses on the need to balance heritage and modernity. It discusses consumption patterns and greenhouse gas emissions in the global context, along with India's actions and initiatives for sustainable development taken at the local, regional and national levels across various sectors. The book also provides details of various strategies and practices to address climate change.

The book is written in a language that can be understood both by a lay person and an informed reader. The examples presented are practical and easy to adopt. It is also an effort to underline the importance of sustainable traditional practices, which are not only climate-friendly but also result in a low carbon footprint.

I take this opportunity to urge all nations to also share their climate-friendly sustainable lifestyle practices so that we can learn, understand, introspect, share and emulate such practices towards a sustainable future.

Date: 10.11.2017

(Dr. Harsh Vardhan)

Paryavaran Bhawan, Jor Bagh Road, New Delhi-110 003
Tel.: 011-24695136, 24695132, Fax: 011-24695329

सत्यमेव जयते

डॉ. महेश शर्मा
Dr. Mahesh Sharma

संस्कृति राज्य मंत्री (स्वतंत्र प्रभार)
पर्यावरण, वन एवं जलवायु परिवर्तन राज्य मंत्री
भारत सरकार
MINISTER OF STATE (I/C) OF CULTURE
MINISTER OF STATE FOR
ENVIRONMENT, FOREST AND CLIMATE CHANGE
GOVERNMENT OF INDIA

MESSAGE

Respect and reverence for nature are an integral part of our ethos and traditions. We treat nature and natural resources as life supportive and sacred. We are aware of Mahatma Gandhi's idea of Trusteeship, following which the present generation has the responsibility to act as trustees of our rich natural wealth for the future generations.

Climate change is both a pressing and complex global challenge. It calls for considered collective human action as part of a comprehensive global response. We must make the most use of our wisdom; the strength of all concerned institutions and their innovations, and the emerging power of science and technology to address the looming threat of climate change.

Unsustainable consumption creates pressure on natural resources and leads to long-term impacts on the environment. While many developing regions of the world face lack of basic necessities, the high consumption and unsustainable lifestyles of the affluent societies place immense stress on the environmental resources. As the world faces a severe environmental crisis, it is both crucial and important that we find ways to combat it through a blend of modern technologies, complementing our collective wisdom and extant cultural traditions.

In India, traditional practices that are sustainable and environment-friendly continue to be a part of peoples' lives and livelihoods. India has a long, evolving history of low carbon footprint and climate-friendly lifestyles. These need to be encouraged, rather than replaced by more modern or fashionable, unsustainable practices and technologies. Pursuing sustainable lifestyles and creating awareness and consciousness can address climate change and other maladies of the 21st century and help build a more balanced world. Celebrating International Yoga Day reflects humanity's collective ability and resolve to think out of the box and search for solutions to pressing challenges.

With the above backdrop, it gives me great pleasure to present 'Samanvay: Harmonizing Traditions and Modernity', a document that depicts the sustainable consumption patterns of India in comparison to other major and developed economies. Some climate-friendly practices and technologies across the country are also showcased giving evidence of India's sustainability-oriented perspective. During COP 21 in Paris, the Honorable Prime Minister released 'Parampara' Catalogue showcasing our traditional climate-friendly practices and roots of India's frugal lifestyles. The present document 'Samanvay' is a further step in that direction.

It focuses on the possibilities of leapfrogging, to achieve sustainable development, prosperity, and well-being, without treading on the path of reckless consumption. It doesn't mean that economic development will be compromised; it only means that our economic development will take a different character. At this historic moment, our generation must rise to meet the imminent challenges and reaffirm its commitment to sustainable development. I congratulate all those who were involved in the preparation of this document.

(Dr. Mahesh Sharma)

पंचम तल, आकाश विंग, इंदिरा पर्यावरण भवन, जोर बाग रोड़, नई दिल्ली-110 003, फोन : 011-24621921, 24621922, फैक्स : 011-24695313,
कैम्प कार्यालय : एच-33, सैक्टर-27, नोएडा-201301 (उ.प्र.) दूरभाष : 0120-2444444, 2466666, फैक्स : 0120-2544488

5th Floor, Aakash Wing, Indira Paryavaran Bhawan, Jor Bagh Road, New Delhi-110 003, Ph. : 011-24621921, 24621922, Fax : 011-24695313
Camp Office : H-33, Sector-27, Noida - 201301 (U.P) Tel. : 0120-2444444, 2466666, Fax :0120-2544488
E-mail : dr.mahesh@sansad.nic.in, drmahesh3333@gmail.com

Table of Contents

1	**APPROACH TO *SAMANVAY***	8
1.1	CONSUMPTION – THE DRIVING FORCE	8
1.2	ROOTS OF INDIA'S FRUGAL LIFESTYLE	9
2	**NEED TO BALANCE HERITAGE AND MODERNITY**	12
3	***SAMANVAY* THROUGH LEAPFROGGING**	16
4	**UNEQUAL CONSUMPTION PATTERN**	19
4.1	THE BACKGROUND	19
4.2	CONSUMPTION OF GROUPS OF COUNTRIES	19
5	**CONSUMPTION OF RESOURCES THROUGH IMPORTS**	27
6	**EMISSIONS**	29
7	**STRATEGIES AND PRACTICES TO ADDRESS CLIMATE CHANGE**	32
7.1	LEAPFROGGING: WITH LED LIGHTS	32
7.2	ENERGY EFFICIENT APPLIANCES LABELING PROGRAM	33
7.3	PUSHING RENEWABLE POWER THROUGH INNOVATIVE APPROACH	34
7.4	LESS ENERGY INTENSIVE TRANSPORT	34
7.5	NATIONAL ELECTRIC MOBILITY MISSION PLAN 2020	37
7.6	BUILDINGS WHERE TRADITIONS MET WITH MODERNITY	38
7.7	CLIMATE RESILIENT VILLAGES UNDER NICRA	41
7.8	SUSTAINABLE SUGARCANE INITIATIVE	43
7.9	COMMUNITY CONSERVED AREAS	44
7.10	SACRED GROVES	46
7.11	BAMBOO AND *SAMANVAY*	46
7.12	RECYCLING OF WASTES	47
7.13	GREEN STARTUPS IN INDIA	49
8	**CHALLENGES FOR INDIA AND WAY AHEAD**	52
	REFERENCES	54

1

APPROACH TO *SAMANVAY*

1.1 CONSUMPTION – THE DRIVING FORCE

The levels and patterns of consumption are the main driving forces of greenhouse gas emissions and the related change in climate. All economic activities are geared to fulfilling the demand for consumption. Global material use is on the rise. Such growth in material consumption is reflective of the increase in the material well-being of the growing population on the planet. On the other hand, this is an outcome of the lifestyle of the affluent and growth world over, of the middle-class which aspires to follow the lifestyle of the affluent, with accompanying shifts in consumption behaviour and aspirations.

The investments made in infrastructure and public services indirectly support consumption. Over the last few decades, India has made significant progress in achieving economic growth along with improvements in key human development indicators. It is therefore important to look at how consumption levels and patterns affect emissions, resource use and environment.

According to 2014 Greendex Report

- Indians - 1st
- Chinese - 2nd
- South Koreans - 3rd
- Brazilians - 4th
- Argentineans - 5th
- Mexicans - 6th
- Hungarians - 7th
- Russians - 8th
- South Africans - 9th
- Germans - 10th
- Spanish - 11th
- Swedish - 12th
- Australians - 13th
- Britons - 14th
- French - 15th
- Japanese - 16th
- Canadians - 17th
- Americans - 18th

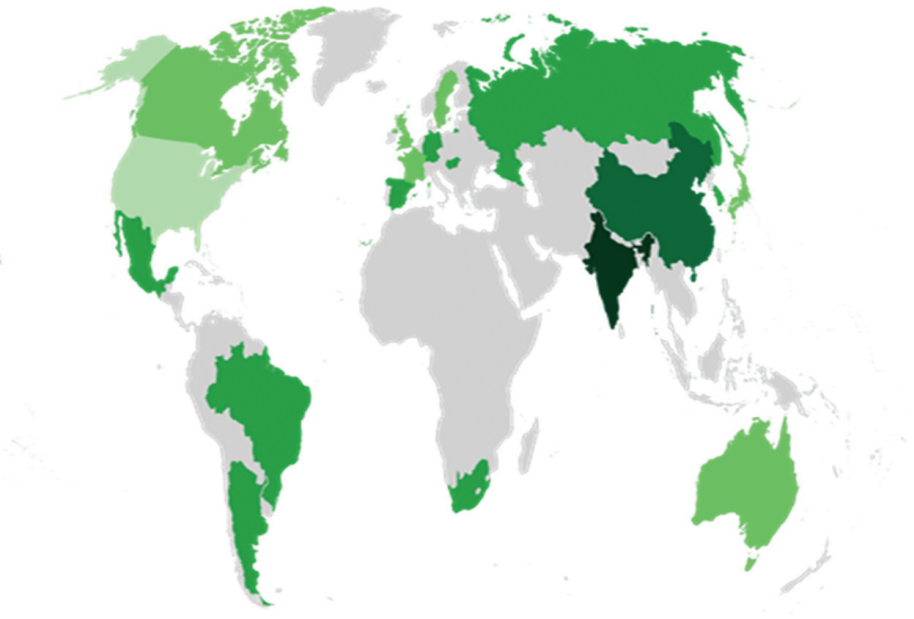

Figure 1.1: India's consumption pattern is the greenest.
(Adapted from Greendex 2014)

The 'Greendex' computed by National Geographic assesses the environmental sustainability of consumer choice of different countries. The index puts India's consumption as the greenest (Figure 1.1). Consumer choice in housing, transport, food and goods of everyday consumption as well as big-ticket items are assessed for this index. According to the report, environment friendly behaviour among consumers has increased since 2012 in India. India's comparatively greener consumption pattern is the outcome of its culture, ethics, traditions and development.

1.2 ROOTS OF INDIA'S FRUGAL LIFESTYLE

India, being a secular country has nurtured different religions, all of which preach that contentment is the key to happiness rather than greed and unlimited consumption. Small behavioural practices such as not wasting food and worshipping nature in everyday life are rooted in the lifestyle of every Indian, which will stay for years to come.

Hindu sages, with their ideas concerning nature and rights of all living beings, have recognized the limitations of human nature. Some of these have an important bearing on Sustainable Development. It is recognized that desire for consumption and greed for possession are limitless. The more you consume, the more you want to consume, and not that it increases satisfaction. As is observed in *Vayupurana*:

Desire is not satisfied by consumption. Just as a hungry fire fed with butter becomes even stronger, so does one's desire for consumption grows with consumption.

Hindu philosophers have emphasized contentment, giving, and having limits and discipline in consumption. Thus, *Bhagwat Mahapurana says* –

One is entitled to only that amount of wealth, which is enough for one's upkeep; the rest has to be shared and if one does not do so, the same can be taken away.

Similarly, *Ishavasyopanishad* says:

Enjoy it by giving it up – don't grab what you see.

This idea that one should not take more than one needs is also in Jain philosophy, defined as *Aparigraha*. Mahatma Gandhi's simple lifestyle and behaviour have shown what it means. At a river, Gandhi took just a small tumbler of water to wash his face. Someone said to him, why is he so miserly when the river has all the water that he can take and is free. Gandhi said, "I should not take anything more than what I need, someone else may need it."

Apart from the notions of 'aparigraha' and "enjoy it by giving it up", a third idea that has affected many in India is that of all living things, humans and animals, having a soul that is a part of the cosmic soul. Thus '*Ahimsa*'– non-violence – and vegetarianism have a strong influence on diets and consumption patterns in India. Some examples of practices shaped by these ideas are as follows:

- Locally grown food (vegetables and fruits) sourced from nearby rural areas is readily available in local markets, thereby reducing transportation and packaging requirements. As of now, fresh food is more widely consumed as compared to processed, packaged and artificially preserved food.
- The per capita food waste by consumers in South/South-east Asia and sub-Saharan Africa is only 6-11 kg/year. The per capita food waste by consumers in Europe and North America is 95-115 kg/year.
- About 42% of the households in India are vegetarian (they do not eat fish, meat or eggs). The per capita meat consumption in India for the period 2011-13 was 3.3 kg, that is one-tenth of the global average, which was 33.8 kg.

- Non Motorised Transport (NMT) dominates the modal share of Indian cities. Even in mega cities, with a population of over eight million, the modal share of NMT (walking and bicycling) ranges from 40-50%.
- Traditionally, Indian house construction utilizes local materials like bamboo, stones and clay. The use of traditional materials is not only suitable for local climates but also contributes to GHG mitigation by reducing cement consumption and material transport.
- The culture of repair/recycle and reuse is a part and parcel of Indian lifestyle. There exists a thriving informal recycling network that has a strong door-to-door collection system, as well as forward linkages to the recycling industry. Newspapers, plastics, metals, woolens, cartons and electronic products are recycled extensively.
- Almost 70% of the population in India uses traditional systems of medicines for primary healthcare needs.
- In India, forests are revered and trees worshipped by many.
- Sacred Groves and Landscapes for ecological conservation of sacred species, groves, forests and landscapes has been an important aspect of the ethics of Indian culture. They have a role in stabilizing soil and water resources. Forests neutralize approximately 12% of India's GHG emissions.

It is this background that sustains *khadi* and its variants like *malkha* (see box 1) and brings together people to work for ecological conservation (see box 2). Some of these characteristics are likely to change with the growth of Indian economy and urbanization. It is therefore, important to promote the confluence—*Samanvay*, of traditional and modern lifestyles.

BOX 1: *Malkha* - The Sustainable Fabric

Malkha is a word created by joining the words *Malmal* and *Khadi*, the handspun and handwoven cloth promoted by Mahatma Gandhi, also known as 'freedom fabric'. It is a decentralised, sustainable, field-to-fabric cotton textile, collectively owned and managed by the primary producers — the farmers, the ginners, the spinners, the dyers and the weavers.

A low-carbon weaving technology, present in all parts of the country, it is an industry that can be owned by producer collectives and it suits an energy-stressed future.

(Source: Sahapedia)

BOX 2: Community-Based Ecological Conservation in Himalayan Region

Himalaya Consortium for Himalaya Conservation (HIMCON), a community-based grassroots effort aims to protect and conserve Himalayan environment while taking up activities and programmes along with the mountain communities that support development. It constructed 64 small ponds/water recharge pits through participative community efforts in the project area. The communities have successfully organized plantation of around 16,975 saplings of Oak, Guriyal, Bhimal and Bamboo covering 17 hectares of land through active community participation under this programme. The women Self Help Groups (SHGs) in the villages not only actively participated in the plantation drive but also were involved in the care of the saplings.

(Source: HIMCON)

2

NEED TO BALANCE HERITAGE AND MODERNITY

The traditional practices contribute to making Indian lifestyles more sustainable. In addition to these practices, India is open to adopting new technologies which allow for levels of energy efficiency which countries at similar levels of growth did not have in the past.

Although the consumption pattern of Indians is inherently linked with their traditions and older practices, it may change with economic growth and will depend on the way the Indian economy grows.

Table 2.1: Well-Being Indicators for India

Brief description of the well-being indicator	Value (India)	Value (Developed countries)	Gap
Human Development Index (HDI)[a] (2015)	0.624	0.887	0. 263
Life expectancy in years at birth[a] (2015)	68.3	80.3	12
Mean years of schooling[a] (2015)	6.3	11.9	5.6
Percentage of households with access to improved water source[b] (World Bank, 2015)	94.1	100	5.9
Percentage of households with access to improved sanitation facilities[b] (World Bank, 2015)	39.6	100	60.4
Percentage of rural households with access to clean cooking fuels[c]	11.9	100	88.1
Percentage of urban households with access to clean cooking fuels[c]	65.5	100	34.5
Percentage of urban households living in durable houses[c]	68	100	32
Percentage of rural households with access to electricity[c]	55.3	100	44.7
Percentage of urban households with access to electricity[c]	92.7	100	7.3
Poverty headcount ratio[d] (Planning Commission, 2012)	21.9	0	-21.9

Source: a-UNDP, 2016 (http://hdr.undp.org/sites/default/files/2016_human_development_report.pdf)
b-World Bank, 2015 (http://data.worldbank.org/indicator); c-Census of India, 2011; d-Planning Commission, 2012

Although there have been considerable improvements in education, health and other socio-economic indicators nationally, India's need for development is obvious when we look at the large deficit in human well-being. India lags behind many other developing countries as well and has a long way to go in human development. There are several challenges which remain, specifically relating to improving the socio-economic well-being of those sections of the populations which have not benefitted much from gains in economic growth. Table 2.1 compares India's achievements in some of the indicators with those of developed countries. Local scale sustainable practices in the rural areas tend to improve the important indicators (see boxes 3 and 4). Because of seasonality of rains, Indian farmers have to depend on groundwater for irrigation which requires consumption of electricity or diesel. Use of solar energy for pumping groundwater reduces the cost and pollution associated with irrigation (see boxes 5 and 6).

BOX 3: Sustainable Practices for Wasteland Development, Water Harvesting and Livelihoods

Society for Environment & Social Awareness (SESA) has been working in Jharkhand to provide low cost vermicomposting options in two villages which saves them the cost of chemical fertilizers every season. Communities have been sharing the earthworms. Setting up of biogas plants has led to savings of fuelwood. A preliminary study suggests a saving of 30-50% on wood and nearly ¾ of an hour for women every day. Other impacts of the activities include increased productivity of private land holdings, increased income generation, *in-situ* rainwater conservation and reduced surface run-off, increased plantation on unutilized community land and reduced pressure on forest.

(Source: GEF Small Grants Programme and MoEFCC)

India's population increased from 1.02 billion to 1.21 billion from 2001 to 2011. Urban population was 286 million in 2001 and was 377 million in 2011. To keep up with the rising population and with growing share of urban population, Indian economy has to grow. Growth is also needed to meet the well-being requirements and aspirations of millions of people in rural and urban areas. Increasing population and economic growth have stressed India's resources and environment. Water quality of particular stretches of some rivers of India's populated states is poor (CPCB, 2011).

BOX 4: Promoting Renewable Energy Alternatives: Through Community Led Approches

The Centre for Tribal and Rural Development Trust (CTRD), an NGO, worked in 30 tribal villages of Nilgiris, Tamil Nadu to enhance and balance the well-being, livelihood capabilities, equity and sustainable actions in the villages with participation of local people. Under their project 'Promoting the Adaptation of Renewable Energy by installation of Biogas Units in Tribal and other Deprived Villages of Gudalur Block of Nilgiris District', they aim to develop 70 Biogas units jointly through MoEFCC GoI-GoTN, and GEF/UNDP. They are also working to develop smokeless *chulas* (500), livestock sheds (50), fodder plots (50-70) through Self-Help Groups in the villages.

(Source: GEF Small Grants Programme and MoEFCC)

Resource scarcity manifests in many ways. India's energy imports are also increasing. Land prices have increased manyfold in the past decades. While speculative activities have contributed to it, growing scarcity of land exacerbates it. A number of countries with lower per capita incomes have higher Human Development Index (HDI) than India (UNDP, 2016).

Can one be happy with limited amount of material goods? Mahatma Gandhi's idea of self-sufficient villages faces the challenge of a mass consumption-based modern, technology-driven society. The society is now aware and is moving ahead towards a blend of the old traditional and the modern lifestyles. Sector-wise blend and case studies that are presented in this document show how *Samanvay* (synthesis) of the two is leading India towards a green, clean and sustainable society.

BOX 5: Solar Energy-Based Water for Communities - Reducing Carbon Footprint

Susceptible to frequent droughts, Bundelkhand region of central India experiences acute water stress. Even villages that use electric or diesel pumps to supply water through taps in the villages cannot guarantee regular supply of water owing to erratic power supply and high costs of fuels. The scarcity of drinking water has significant ramifications.

An NGO, Development Alternatives, implemented programmes to ensure water supply for drinking and irrigation through solar energy-based pumping systems. Renewable energy-based drinking water systems are set up at the doorstep of over 550 households across 5 villages.

(Source: Development Alternatives)

BOX 6: Solar Power as a Remunerative Crop (SPaRC) - Promise of Dhundi Solar Pump Irrigators' Cooperative

In June 2016, the world's first Solar Pump Irrigators' Cooperative Enterprise (SPICE) commenced operations in the village of Dhundi in central Gujarat. In India, the number of solar pumps has grown from less than 7,500 in 2010 to over 66,250 in 2014-15. But Dhundi Solar Cooperative is the first of its kind. Its members will use solar energy to run irrigation pumps. Six solar pumps, with a total of capacity of 56.4 kW, are expected to generate some 85,000 kWh/year of solar energy. Their owners will use around 40,000 kWh/year for irrigation, and inject the remaining 45,000 kWh/year to the grid and earn INR 3,00,000 /year in net cash income from power sales.

(Source: Tushar Shah, IWMI)

3

SAMANVAY THROUGH LEAPFROGGING

Fortunately, India has the late starter advantage and a number of modern technologies can be adopted, leapfrogging over the emission intensive intermediate stages. The economist Simon Kuznets (1955) had shown that income inequality worsens in the initial stages of development and then improves with higher income. Later on, it was stipulated (Grossman and Kreuger, 1991; World Bank, 1992; Panayatu, 1997 among others) that there is also an 'Environmental Kuznets Curve', showing that environmental indicators worsen in initial stages of development but improve thereafter. The common sense behind this is that as incomes increase, people's preference for environment quality becomes stronger (Ruttan, 1971). The experience in USA and European countries supports such a stipulation. In the 1960s and 1970s, air quality in many USA cities was bad but has been cleaned up subsequently. Similarly, the Rhine river that was termed as the sewage canal in the 1980s, is now clean and aquatic life has returned. Figure 3.1 after Yandle, Bhattarai and Vijayaraghavan (2004) shows the hypothesized relationship between economic development and environmental quality. While such a relationship is observed for local environmental pollution in a number of countries, GHG emissions do not seem to follow such a trend. However, with the growing concern for climate change, one hopes that many developed countries would recognize that they have long ago reached the turning point.

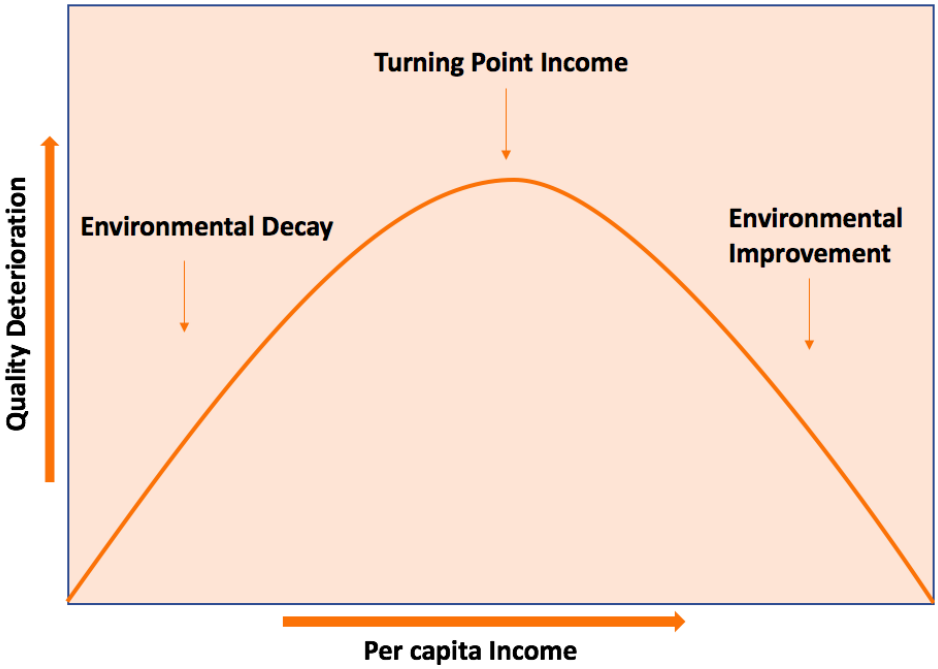

Figure 3.1: A schematic diagram of Environmental Kuznets Curve (EKC).

However, the Environment Kuznets Curve is not cast in stone. It is possible to leapfrog over the mountain or to tunnel through it with much flatter trajectory. India has the late-mover advantage and the technological development of cleaner options. One of the reasons for the turning point in Environment Kuznets Curve

is that once people get to a certain level of income, they demand better quality of environment. In India, rapid economic growth, increasing population and accelerating urbanization have led to deterioration of air quality in some cities. The demand for better air and water quality has grown considerably. This has created a momentum for cleaner and more sustainable ways of development. See for example eco-construction with low-carbon cement in box 7 (see also box 8). This makes it possible for India to pursue a path that minimizes adverse environmental impact. There are treasures that once lost in the phase of development, never return to their original state. One such treasure is biodiversity. Global South is presently the storehouse of biodiversity and India being a megadiverse country has taken several initiatives and has launched many projects to safeguard the adaptive capacity of millions who are directly dependent on forest resources and their diversity. The Government of India, therefore, is pushing development in cleaner and better ways.

BOX 7: Eco-construction and Low-carbon cement

Development Alternatives has promoted affordable eco-construction techniques and technologies and it has trained construction workers and masons at various capacities to mainstream eco-construction techniques in rural areas. Some of the benefits of eco-construction techniques are as follows:

- A potential reduction of 16.8 metric tonne of carbon dioxide per year.
- Potential savings to the tune of INR 24,000 million (20% cost reduction over 40 million sq. m of construction at Rs. 3,000 per sq. m).

To address the twin issues of reducing CO_2 emissions and saving natural resources, a new cement blend has also been developed by a consortium of EPFL, IIT-Delhi, IIT-Madras, IIT-Bombay, TARA and CIDem through a project funded by Swiss Agency for Development and Cooperation (SDC). The cement blend uses 50% clinker, 15% non-cement grade (waste) limestone, 30% waste china clay (overburden) from mines and 5% gypsum. The produced cement is named as Limestone Calcined Clay Cement (LC3).

(Source: Development Alternatives)

India is determined to take further initiatives to leapfrog in the struggle to protect its resources despite development. In the fourth chapter, India's comparative consumption patterns are discussed in the global context. In chapter 5, the consumption of resources embodied in imports are discussed and in chapter 6, GHG emissions of different countries and groups of countries are compared. In the seventh chapter, India's actions and initiatives for sustainable development taken at the local to state to national level in various sectors are discussed.

BOX 8: The Eco Kiln technology

The annual brick production in India is at around 200 to 220 billion bricks, consuming 45-50 million tonnes of coal. The emissions from these kilns have negative impacts on the environment. The introduction of Eco kiln is based on vertical shaft brick kiln principles developed by Development Alternatives. It has now been adopted in many countries in South East Asia and in Africa, especially South Africa and Malawi. Advantages include high energy efficiency, environment-friendliness, economic viability, round the year production and consistent quality.

(Source: Development Alternatives)

4

UNEQUAL CONSUMPTION PATTERN

4.1 THE BACKGROUND

Unequal consumption pattern continues to be a major driving force of climate change. In a study done for the secretariat of the 1992 UN Conference on Environment and Development (UNCED) at Rio-de-Janeiro, Parikh *et al.* (1991) have shown that unequal consumption pattern around the world was the driving force of environmental stress. In the late 1980s, the developed countries having only 24% of global population had shares ranging from 50 to 90% in the global consumption of various commodities. Even for the products that fulfill basic needs like cereals, milk and meat, the consumption of developed countries constituted 48 to 72%. The consumption share of energy of developed countries was 75%, and share of total CO_2 emissions was 70%. Since then, things have changed. Most developing countries are growing rapidly. The next section shows how the shares of consumption of countries have evolved.

4.2 CONSUMPTION OF GROUPS OF COUNTRIES

The consumption pattern of two sets of commodities, agriculture products and energy sources, is examined. The CO_2 and GHG emissions are looked at. The analysis has been done based on UNFCCC grouping into Annex I and non-Annex I countries. Data for USA, EU28, China and India (four top emitters in terms of total emissions) has been shown separately for comparison.The per capita GDP and populations of these groups are shown in Table 4.1.

Table 4.1 GDP Per Capita and Population of Groups of Countries.

Indicators	Year	USA	EU(28)	Annex I	China	India	non-Annex I
GDP/Capita (PPP, Intl$, 2011)*	2012	50586	34367	35726	10756	4967	8586
Population in 2012 (in millions)	2012	314	506	1295	1351	1237	5519
Shares of Population in World (%)	2012	4.61	7.42	19.00	19.82	18.15	81.00

*GDP per capita based on purchasing power parity (PPP) is gross domestic product converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States. Data are in constant international dollars based on the 2011 International Comparison Project (ICP).

(Source: World Bank)

FOOD AND WOOD

Table 4.2 presents the per capita use of some items of food and wood in different countries. The data clearly shows the disparity in consumption per capita. Even for food items, Annex I countries consume twice as much cereals, 3.4 times as much milk and twice as much meat and fish in per capita terms than non-Annex 1 countries. Consumption of sawn wood is 6 times as much and of round wood it is 2.5 times (figure 4.3).The

persistence of disparity in per capita consumptions can be seen by comparing the ratio of per capita use of different commodities in different countries and group of countries for 1992 and 2011. These are shown in figure 4.1 (a, b, c, d). The ratio of per capita use between USA or EU (28) and India is much larger. The shares in total consumption of food items are shown in figure 4.2, and those of wood in figure 4.3.

Table 4.2 Per Capita Supply (Production + Imports – Exports – Addition to Stocks).

Indicators	Year	USA	EU(28)	All Annex I	China	India	All non-Annex I	Annex I/ non Annex I Ratio	USA / India Ratio	EU(28)/ India ratio	China/ India ratio
Cereals (kg/ person)	1992	743	445	549	289	165	211	2.6	4.5	2.7	1.8
	2011	1041	554	645	391	213	309	2.1	4.9	2.6	1.8
Milk- Excluding Butter (kg/ person)	1992	231	283	254	7	46	35	7.2	5.0	6.2	0.2
	2011	277	278	250	35	104	74	3.4	2.7	2.7	0.3
Meat and Fish (kg/person)	1992	74	44	50	13	4	13	3.8	16.9	11.0	3.3
	2011	95	48	60	41	8	31	2.0	12.3	6.0	5.1
Sawn wood (m^3/1000 persons)	1992	323	161	232	16	14	19	12.4	22.8	11.5	1.1
	2011	235	175	176	50	6	29	6.1	39.0	29.2	8.3
Round wood (m3/1000 persons)	1992	1488	650	1012	277	259	353	2.9	5.7	2.5	1.1
	2011	1217	880	980	288	295	400	2.5	4.1	3.0	1.0

Calculation done by IRADe based on data from FAOSTAT (2016a)

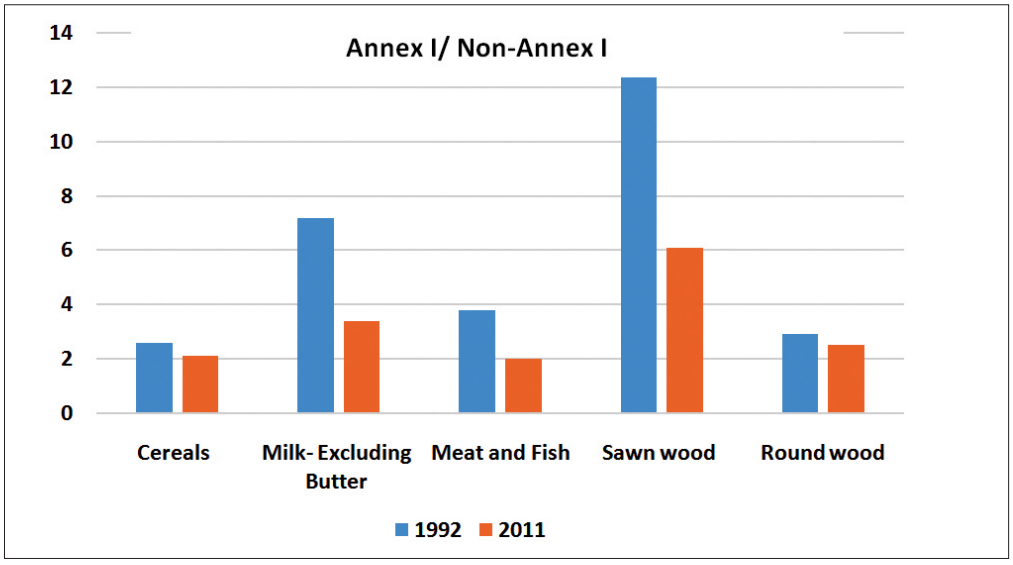

Figure 4.1 (a): Ratios of per capita consumptions of different commodities in Annex I over non-Annex I in 1992 and 2011

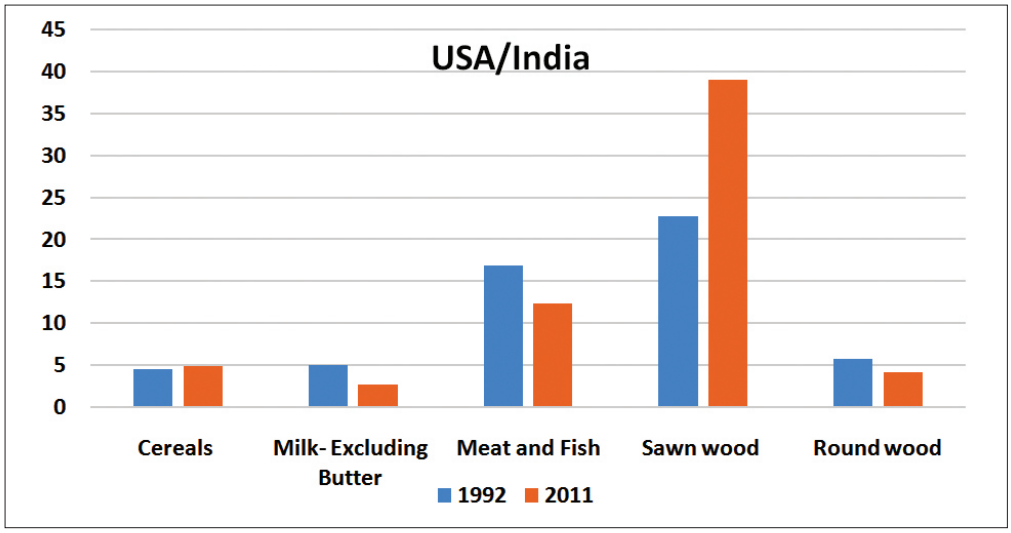

Figure 4.1 (b): Ratios of per capita consumptions of different commodities in USA over India in 1992 and 2011

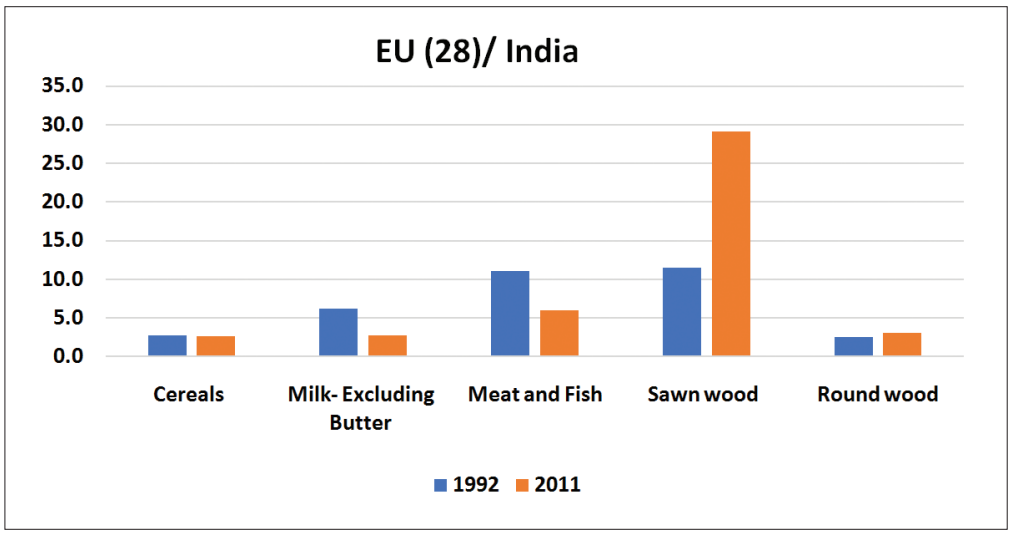

Figure 4.1 (c): Ratios of per capita consumptions of different commodities in EU over India in 1992 and 2011

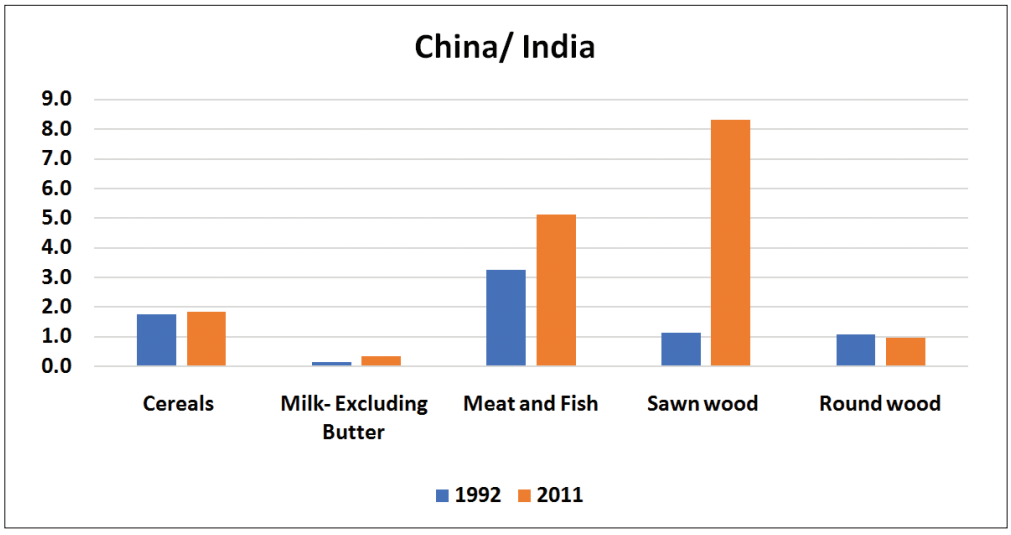

Figure 4.1 (d): Ratios of per capita consumptions of different commodities in China over India in 1992 and 2011

Dietary habits in India are such that a significant portion of the population is vegetarian. According to the National Sample Survey Organization (NSSO), approximately 42% of households are vegetarian. This includes those who consume dairy products, but not fish, meat or eggs. The remaining 58% are either non-vegetarians or vegetarians who occasionally eat fish, meat or eggs (FAO, 2016b). In terms of total meat consumption, the global average is 115 grams per person per day, while in India it stands at 12 grams per person per day (UNEP, 2012). Even amongst those who eat animal protein, there is a preference for dairy, eggs and poultry meat. This may be attributed to high mutton prices, religious prohibition on beef and pork, and the lower availability of fish in non-coastal regions (Mehta and Nambiar, 2013).

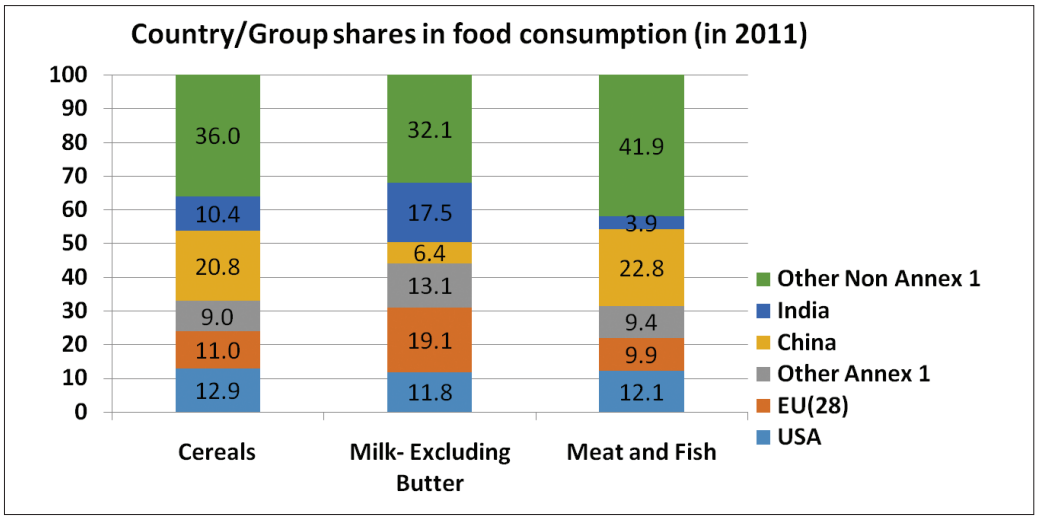

Figure 4.2: Country Group Shares in Food Consumption

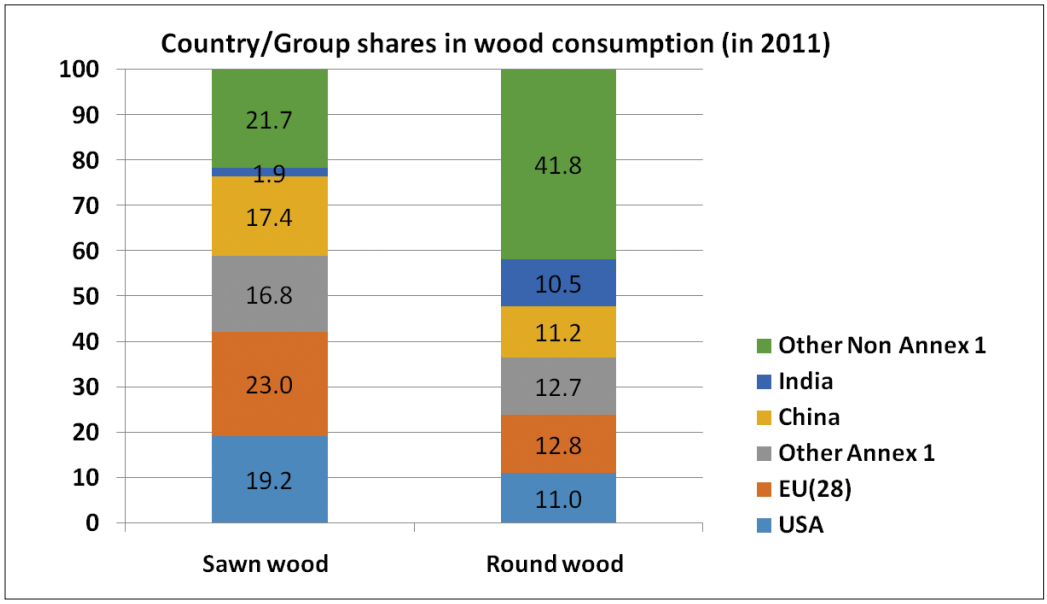

Figure 4.3: Country Group Shares in Wood Consumption

Studies have shown that emissions from poultry meat and dairy are lower than other forms of meat, especially red meat because of higher requirements of land and water (Lesschen *et al*., 2011). In this context, it may be useful to encourage the traditional food habits in the face of increasing preference for meat consumption.

In 2011, with a population share of 19%, Annex I countries used 32.9% cereals, 44.3% milk and 31.4% meat and fish. Similarly, the shares of Annex I countries in wood consumption are 59.9% for sawn wood and 35.5% for round wood.

ENERGY

In case of energy, the disparity in consumption is even more glaring. The per capita consumption of Annex-I countries was much larger than those of non-Annex I countries even in 2012. For example, that of USA was 15 times for primary energy, 18 times for electricity and 19 times for petroleum products compared to India. Table 4.3 shows the per capita use of energy sources and figure 4.4 (a,b,c,d) and figure 4.5 show the disparity ratios in different countries and groups of countries for the years 1992 and 2012.

Table 4.3: Per Capita Consumption Energy Sources

Indicators	Year	USA	EU(28)	Annex I	China	India	non-Annex I	Annex I/non Annex I Ratio	USA / India Ratio	EU (28)/ India Ratio	China/ India Ratio
Primary Coal (kg per person)	1992	2623	1685	1879	739	203	293	6	13	8.3	0.7
	2012	2570	1296	1761	2852	626	963	2	4	2.1	0.7
Electricity (kWh per person)	1992	9230	4583	6146	493	207	447	14	45	22.1	0.5
	2012	12209	5724	7638	3295	670	1674	5	18	8.5	0.4
Refined Petroleum (Litres/person)	1992	2394	807	1420	94	49	170	8	49	16.5	0.3
	2012	2565	763	1382	345	133	353	4	19	5.7	0.4
Hydrocarbon Gas Liquids (bbl/person/ year)	1992	NA	1	1	0	0	0	5	NA	NA	NA
	2012	3	1	1	0	0	0	4	18	NA	NA
Primary Energy (TOE/person)*	1992	69	34	46	5	2	4	10	39	17.0	0.5
	2012	76	36	49	21	5	12	4	15	7.2	0.4
Dry Natural Gas (1000 cf/ person)	1992	64	25	46	0	0	3	18	167	NA	NA
	2012	81	33	56	4	2	8	7	48	16.5	0.3

*Primary energy includes primary fuels such as coal, oil, gas, biomass, nuclear and electricity generated from renewable sources such as water for hydroelectricity, solar, and wind.

(Source of data: U.S. Energy Information Administration & BP Statistical Review of World Energy, June 2016)

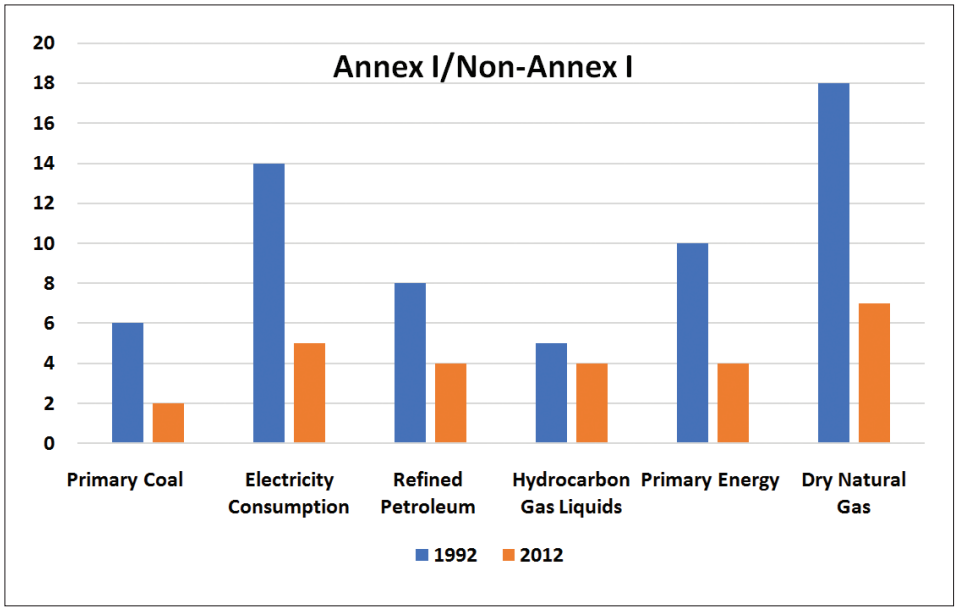

Figure 4.4 (a): Disparity ratio of per capita consumption of energy resources for Annex I/ non-Annex I for the years 1992 and 2012.

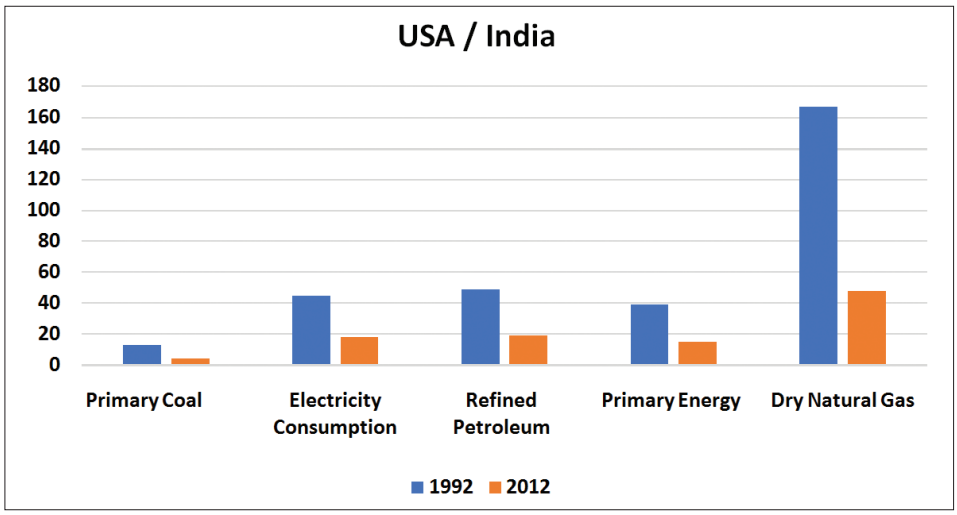

Figure 4.4 (b): Disparity ratio of per capita consumption of energy resources for USA/ India for the years 1992 and 2012.

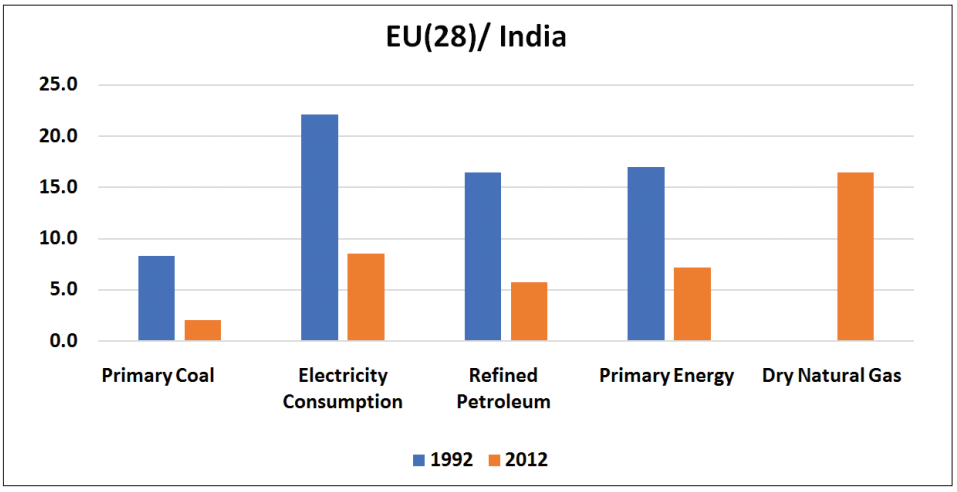

Figure 4.4 (c): Disparity ratio of per capita consumption of energy resources for EU-28/ India for the years 1992 and 2012.

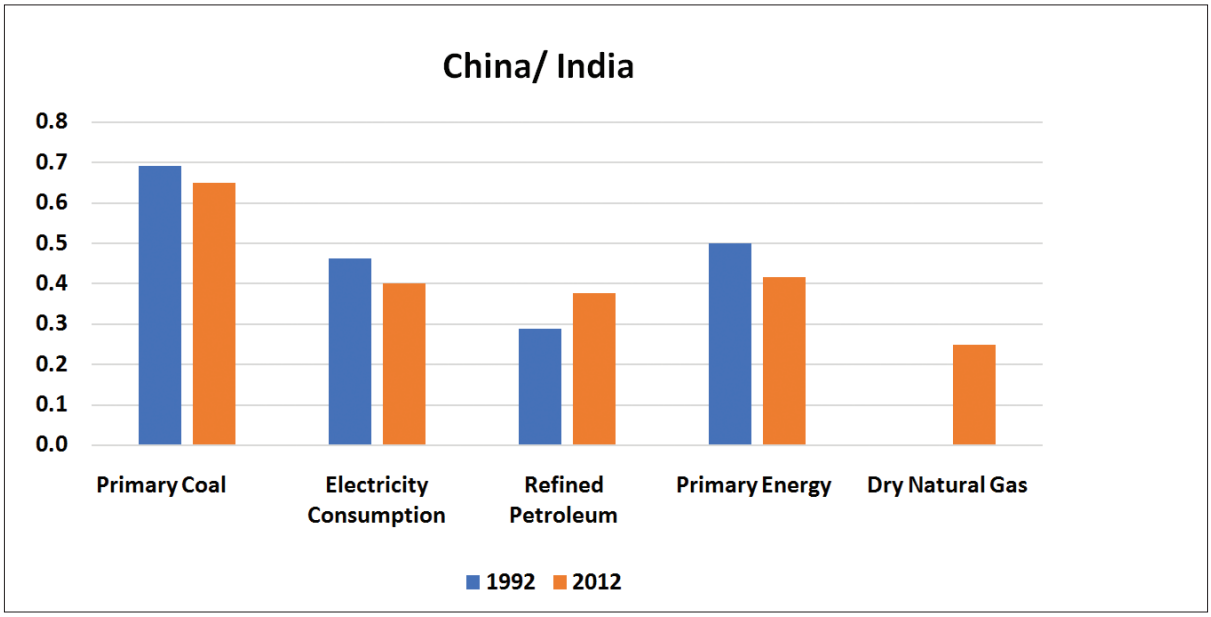

Figure 4.4 (d): Disparity ratio of per capita consumption of energy resources for China/India for the years 1992 and 2012.

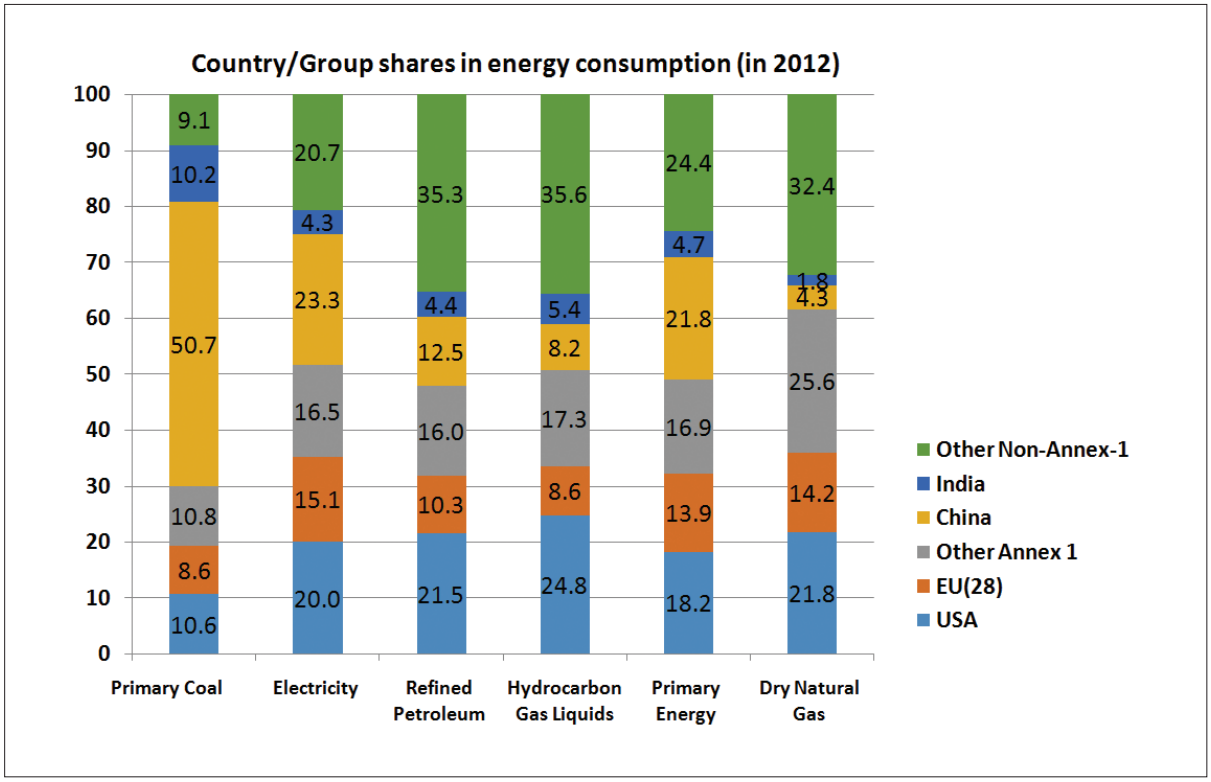

Figure 4.5: Country Group Shares in Energy Consumption

The shares of total consumption of Annex I countries in global consumption is 30% for coal, 52% for electricity, 48% for petroleum products and 49% for primary energy. As far as India is concerned, not only that the present consumption is much lower than the developed world, the energy intensity of the Indian economy has reduced from 18.16 goe (grams of oil equivalent) per rupee of GDP in 2005 to 15.02 goe per rupee

of GDP in 2012. This is a decrease of roughly 2.5% per annum. This has been made possible because of successful promotion of energy efficient appliances and practices and of industrial efficiency through the Energy Conservation Act, 2001.There are also important changes on the supply side. Between 2002 and 2015, the share of renewable power generation in the grid capacity increased from 2 to 13%. In particular, installed capacity of solar power has increased from 3.7 MW in 2005 to 4,060 MW in 2015. By 2022, it is planned to have installed capacity of 100 GW for solar power (MoSPI, 2015).

It is also interesting to note that India has been able to achieve an HDI of 0.59 (rank 135) with an average annual energy consumption of 0.6 tonnes of oil (toe) per capita in 2011 (as opposed to the world average of 1.88 toe per capita). No country has been able to achieve an HDI of 0.9 or more without an average annual energy consumption of at least 4 toe per capita (INDC, 2015).

5

CONSUMPTION OF RESOURCES THROUGH IMPORTS

The consumption figures given in the previous chapter are of consumption of the goods and services produced in the country. However, resource consumption embodied in the trade of a country may be quite different. For example, China manufactures many products which are exported. However, the consumption of resources and related emissions caused for manufacturing products for export presently falls in the account of the exporter rather than in that of the importing countries who are actual users of the products.

A country manufacturing a particular product that it exports, will raise its consumption of the embodied resources (i.e. resources used in producing it). If the importing country was to manufacture these products itself, its emissions would go up significantly. The calculation of the resource consumption by selected countries embodied in their net imports, assuming that they manufacture these domestically, shows the difference. These embodied resources are in addition to the directly imported products. Thus, for example, a country may import steel for manufacturing other products which is accounted in the direct use. If in addition the country imports cars, then the steel required to manufacture the cars has to be added to get import adjusted use of steel. That is the resource consumption that can be attributed to the country's consumption pattern.

Figures 5.1, 5.2 and 5.3 show the ratio of net import adjusted use in the country and its net domestic use (production + imports - exports) for selected products. These have been worked out on the basis of the input-output tables and trade levels of the countries selected. The data was obtained from the GTAP modeling group of Purdue University. A ratio greater than one suggests the country is importing that product, and a ratio less than one suggests it is exporting.

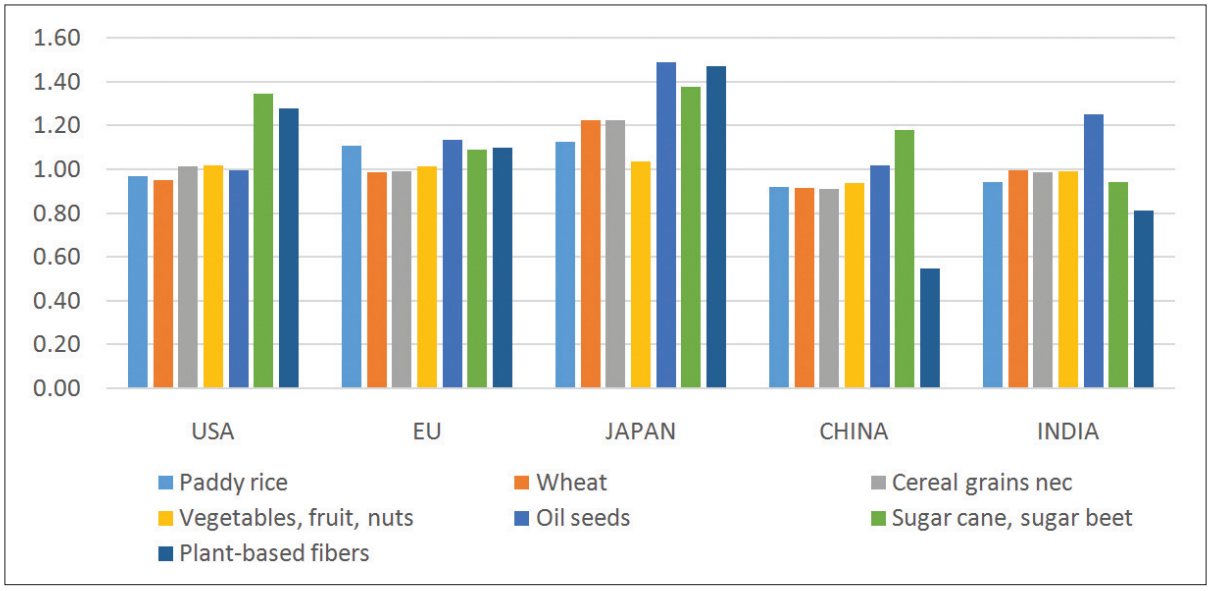

Figure 5.1: Use including Commodity Embodied in Net Imports of Food Items / Net Domestic Use

Figure 5.1 shows this ratio for selected agricultural products. It is seen that USA imports substantial amount of sugarcane (not as cane but as embodied in its sugar imports) and plant-based fibres (again as embodied in the textiles that it imports). Japan imports most of the agricultural products. EU also imports significant amounts of sugarcane, oil seeds and plant-based fibres.

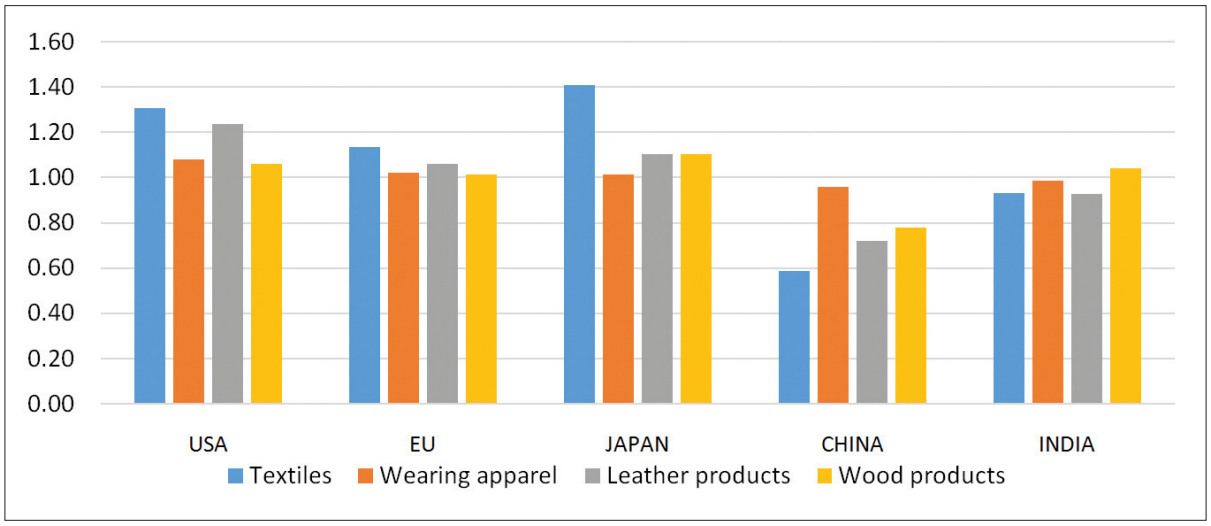

Figure 5.2: Use including Commodity Embodied in Net Imports of Textiles, Leather and Wood Products / Net Domestic Use

Figure 5.2 shows that US, EU and Japan, all consume substantial amount of textiles and leather products. The textile embodied imports may be embodied in garments and are over and above the textiles directly imported. China exports substantial quantities of these goods through its exports that use these goods. India also exports textiles and leather products this way.

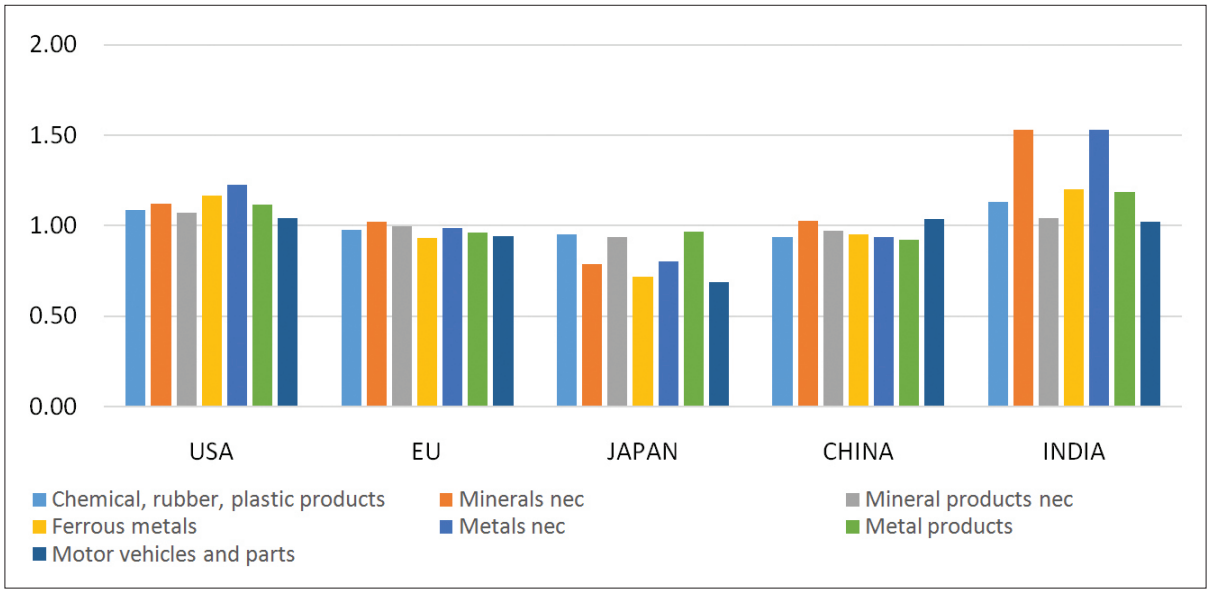

Figure 5.3: Use including Commodity Embodied in Net Imports of Metals, Minerals and Manufactured Products / Net Domestic Use

In Figure 5.3, it is seen that India imports minerals, metals and manufactured products. USA also imports these products, whereas Japan and China export these.

6

EMISSIONS

A large part of the Indian population may be classified as 'under-consumers' since it does not have access to basic essential goods and services such as water, sanitation, education, healthcare, shelter, transport, and electricity. It is seen that in 2012 with only 19% of global population, Annex I countries emitted 0.7 times as much CO_2 as non-Annex I countries. In per capita terms, however, they emit 3.1 times as much as non-Annex I countries. USA, with only one-fourth the population of India, emitted 2.6 times as much CO_2 as India in 2012, and emitted 10.6 times more than India in per capita terms. Table 6.1 shows the CO_2 emissions per capita for different groups and Figure 6.1 shows the disparity ratios.

Table 6.1: CO_2 Emissions of Different Groups.

Parameters	Year	USA	EU(28)	Annex I	China	India	Non-Annex I	Annex I/non-Annex I	USA / India	EU(28)/ India ratio	China/ India ratio
CO_2 emissions ($MtCO_2$) excluding LULUCF	1990	4846	4144	14012	2181	565	6435	2.2	8.6	7.3	3.9
	2000	5692	3910	13820	3384	942	9187	1.5	6.0	4.2	3.6
	2012	5081	3514	13171	9722	1927	19124	0.7	2.6	1.8	5.0
CO_2 per capita (tCO_2 per capita)	1990	19.4	8.7	11.9	1.9	0.6	1.6	7.5	29.9	13.4	3.0
	2000	20.2	8.0	11.2	2.7	0.9	1.9	5.9	22.6	9.0	3.0
	2012	16.2	7.0	10.2	7.2	1.5	3.3	3.1	10.6	4.6	4.7
Population (in million)	1990	250	478	1175	1135	870	4068	0.29	0.3	0.5	1.3
	2000	282	488	1232	1263	1053	4839	0.25	0.3	0.5	1.2
	2012	314	505	1295	1351	1263	5744	0.23	0.2	0.4	1.1
CO_2 Cumulative emissions ($MtCO_2$)	1990-2012	123386	90207	314620	111319	24473	257239	1.22	5.0	3.7	4.5

(Source of data: WRI CAIT)

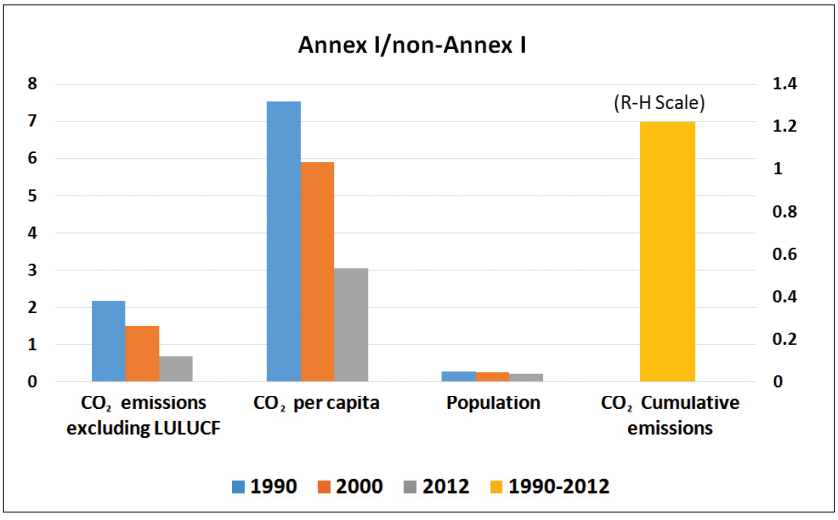

Figure 6.1: Disparity ratio: CO_2 emissions

Figure 6.2 shows the shares of different groups of countries in global CO_2 emissions, and figure 6.3 shows per capita emissions. While EU's per capita emissions have come down steadily from 1990 to 2012, USA's per capita emissions were on the rise from 1990 to 2000 and were reduced only after that.

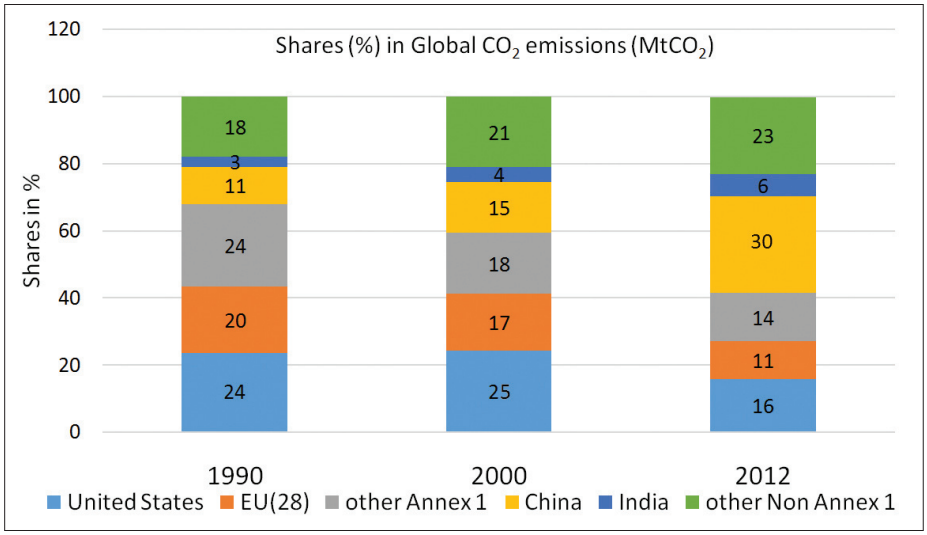

Figure 6.2: Shares of Different Groups of Countries in Global CO_2 Emissions

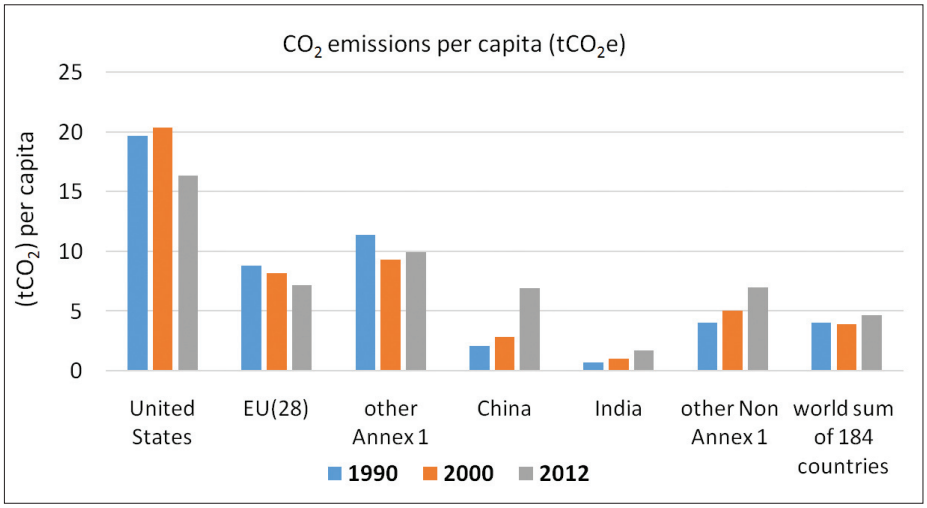

Figure 6.3: Per Capita CO_2 Emissions of Different Groups of Countries

China's emissions have grown dramatically, and even in per capita terms it has exceeded significantly the world average per capita emissions. In fact, if Annex I countries and China are taken together, the share of remaining non-Annex I countries has hardly changed. India's per capita emissions has increased steadily and slightly but it is still much below the global average. It has remained so over the years as can be seen in figure 6.4 and even in 2012 it was only one-fourth as much. While part of the reason for low per capita emissions stems from low access to goods and services as a result of poverty, there are also lessons that India can

offer the world in the way of traditional and contemporary practices which contribute to relatively low levels of consumption across sectors. These practices need to be encouraged and sustained, rather than be replaced by unsustainable patterns of consumption seen in the developed countries.

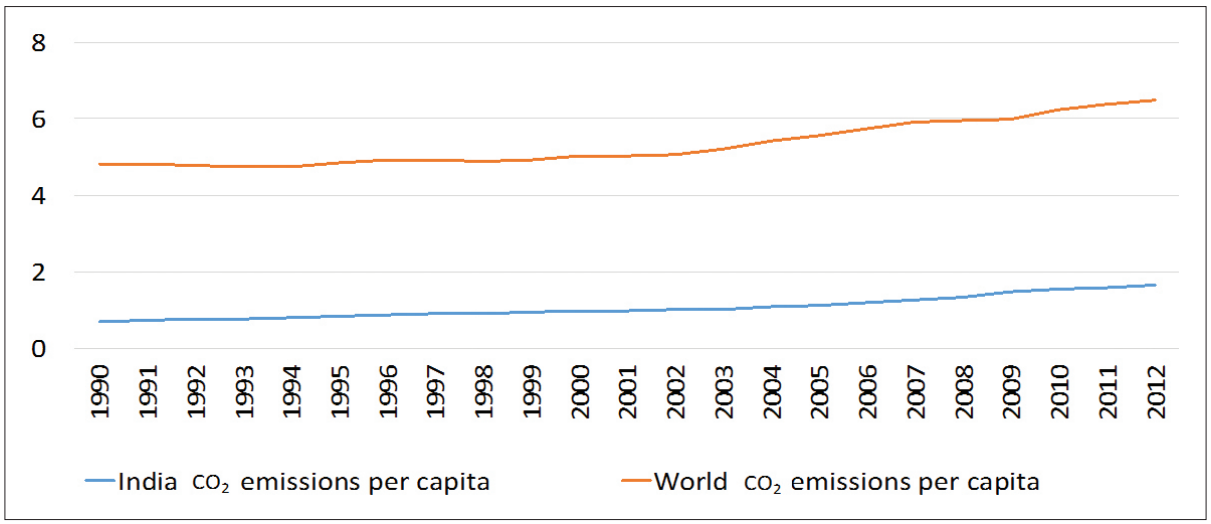

Figure 6.4: India's and World's Per Capita CO_2 Emissions (in tonnes).
(Source of data: WRI CAIT)

However, India's economy will grow and as its per capita income increases, the emissions will also grow. As seen in figure 6.5, emissions increase with per capita GDP. Also, there are differences in emissions for the same level of income. India's ambition is to beat this curve and moderate its growth of emissions even as its GDP grows.

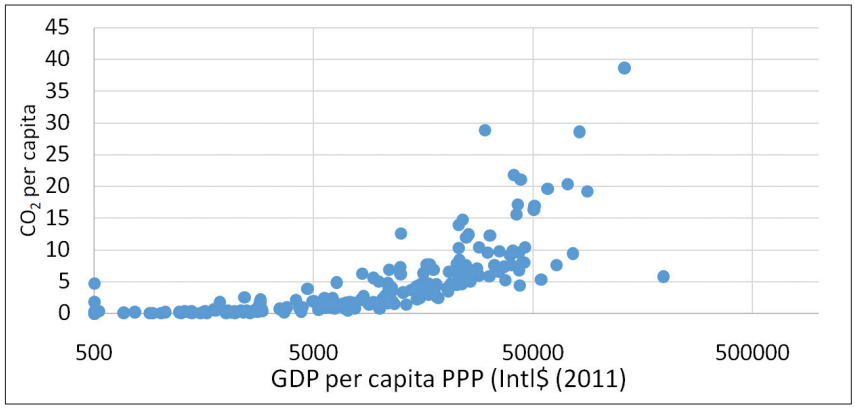

Figure 6.5: CO_2 per Capita vs GDP per Capita (in tonnes of CO_2).
(Source of data: WRI CAIT)

Inequality in per capita consumption and emissions across nations persists and may remain so for decades to come. However, climate change and the increased frequency of its impacts are already being felt around the world. The need for action to reduce the threat of climate change is urgent. This poses a huge challenge to developing countries who have to grow in a climate constrained world. This is particularly so for less income countries who are generally short of resources, and thus have a lower adaptive capacity to deal with the changes.

7

STRATEGIES AND PRACTICES TO ADDRESS CLIMATE CHANGE

India needs to grow at 8 to 10% per year at least for couple of decades to take care of its human development, to eliminate poverty, to provide energy access, to expand education and health care, to provide *pucca* (solid and permanent) houses, to eliminate nutritional deficit and to create an environment which generates hope that tomorrow will be still better. For this, it needs to expand its energy use.

As population and incomes increase, consumption levels and patterns will change and demand for resources will increase. However, India has taken and is taking many steps to reduce the need for resources to make a transition from its traditional lifestyle to a modern one in a way that leapfrogs to a low-carbon lifestyle and one that preserves the essence of its traditions. In this chapter, we look at some specific examples for different sectors of the economy.

7.1 LEAPFROGGING: WITH LED LIGHTS

India's approach to reduction in electricity required for lighting is a striking example of leapfrogging and an innovative approach to achieving it. The goal to move directly to the most energy efficient LED bulbs skips the compact fluorescent lamps (CFL) stage to go straight to LED devices.

To achieve this, government decided to procure LED bulbs and distribute it to people at a low cost. The innovative approach of bulk procurement by the government brought down the price from more than INR 300 per bulb to INR 85 per bulb over a period of 14 months (See figure 7.1). This had made LED bulbs economically attractive even for those who do not need subsidized bulbs. As of 2 November, 2017, the government has distributed 272 million bulbs. The government plans to procure and distribute 770 million LED bulbs. It saved 35,433 million kWh per year, INR 14,0170 million and led to an estimated annual reduction of 28 million tonnes of CO_2(Table 7.1).

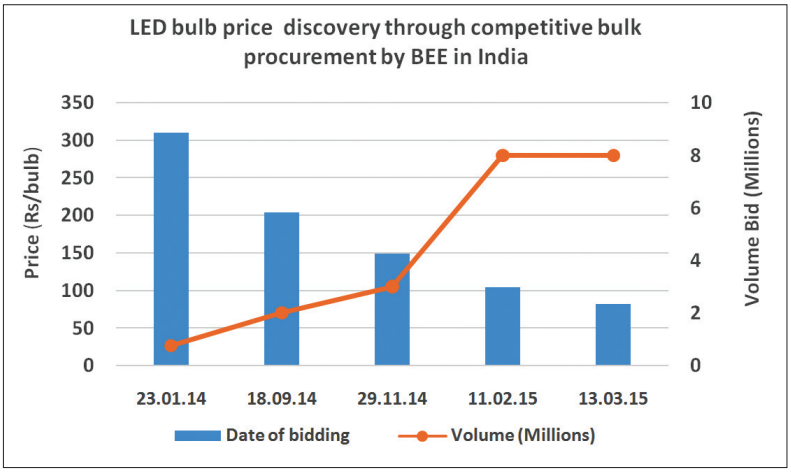

Figure 7.1: Price Reduction of LED Bulbs through Bulk Procurement by Government.
(Source: BEE)

Table 7.1 Leapfrogging with LED Lights

Type	Watts	Units/year	Peak load Reduction (MW)	Emissions $MtCO_2$
Incandescent Bulb (I B)	60W			
CFL	14W			
LED	7W			
Saving per LED bulb compared to I B		~130		~110 kg CO_2
Saving from 272 million bulbs as of Nov 2017		35,053 MU	7,015	28 Mt CO_2
Saving from 770 million bulbs planned		105,000 MU	20,000	79 Mt CO_2

Along with efficient lighting for homes, the Government has also launched a programme in January 2015 named Street Lighting National Programme (SLNP) to install LED street lights. Table 7.2 shows the savings achieved due to the implementation of the programme.

Table 7.2 Savings from LED street lights

LED Street Lights (Million)	Energy Savings/day (MU)	Avoided Emissions (tCO_2/day)	Avoided Capacity (MW)
3.8	1.48	1231	134

7.2 ENERGY EFFICIENT APPLIANCES LABELING PROGRAM

The Standards & Labeling Program of Bureau of Energy Efficiency in India provides the consumer an informed choice about the energy saving and thereby the cost saving potential of the marketed household and other equipment. This is expected to impact the energy savings in the medium and long run while at the same time it will position domestic industry to compete in such markets where norms for energy efficiency are mandatory. Mandatory labelling is ongoing for the following: Frost Free (No-Frost) Refrigerator, Tubular Fluorescent Lamps, Room Air Conditioner, Distribution Transformer, RAC (Cassette, Floor Standing Tower, Ceiling, Corner AC), Direct Cool Refrigerator, Electric Geyser and Color TV. Voluntary labelling has been introduced for Induction Motor, Agricultural Pump Set, Ceiling Fan, domestic Liquefied Petroleum Gas (LPG) stove, Washing Machine, Computer (Notebook /Laptops), Ballast (Electronic/Magnetic), Printer, Copier, Scanner, MFD's, Diesel Engine Driven Monoset Pump, Solid State Inverter, Diesel Generator, Variable Capacity Air-conditioner, and LED Lamps (BEE, n.d).

With clear and informative labelling, the consumers on their own are buying more energy efficient star-rated appliances without any subsidy. It has been estimated that the electricity savings in household consumption for major appliances by 2030 could be as a high as 40% with facilitating finance (Parikh and Parikh, 2016).

7.3 PUSHING RENEWABLE POWER THROUGH INNOVATIVE APPROACH

The Prime Minister of India launched the solar mission in January 2010. The target was to set up 20,000 MW of solar capacity by 2022. Such a target was considered necessary to realize economics of scale and to create capacity building for solar sector. It was also recognized that subsidy would be required and feed-in-tariff (FIT) was considered an efficient way as it is linked to outcome. At the same time, in order to provide incentives for cost reduction and efficiency, a process of competitive bidding was used under which firms were asked to bid for the FIT they required for the next 25 years. The lowest bidder got the contract. In the first bidding in 2010, bids were invited for 50 MW. However, to promote competition a bidder or her associates were restricted to a bid of 5 MW (+ 5%). A bid for INR 15/kWh was expected but the lowest bid came to INR 13.5/kwh. The FIT has come down from bid to bid and the bid for Bhadla Solar Plant in Rajasthan in May, 2017 came to INR 2.44/kWh. Based on the encouraging response, Prime Minister Mr. Narendra Modi has stepped up the target of Solar Power to 100,000 MW by 2022.

7.4 LESS ENERGY INTENSIVE TRANSPORT

Public transport by buses and metros is far more fuel efficient compared to private motorized vehicles. The development of public transport infrastructure is promoted by Central funding through the Jawaharlal Nehru National Urban Renewal Mission (JnNURM). India has currently seven operational metro systems in the cities of Kolkata, Delhi (NCR), Gurugram, Bengaluru, Mumbai, Jaipur and Chennai. Mumbai already has around 400 km of suburban railway network. A number of cities are planning or constructing metro rail projects. The experience of Delhi Metro is described in box 9.

India has also undertaken development of BRTS (bus rapid transit system) in many cities. BRT systems exist in Pune, Ahmedabad and Rajkot, and new BRT systems are being developed in Kolkata, Visakhapatnam, Vijayawada, Surat, Naya Raipur and Hubli-Dharwad. Cities of Amritsar, Ludhiana, Pimpri Chinchwad, Hubli Dharwad, Bengaluru, Kolkata, Bhubaneswar, Visakhapatnam, Vijaywada, and Chennai are also planning BRTS systems. How Ahmedabad BRTS has increased the use of public transport as well as quantified benefits of Delhi Metro Phase-I and II are described in this section.

Table 7.3 Quantified Benefits of Delhi Metro for Phase I & II

Descriptors	Phase - I 2007	Phase - I & II 2011	Phase - I & II 2014
No. of vehicles off the road daily	16895	117249	390971
Annual reduction in fuel consumption (t)	24691	106493	276000
Annual reduction in pollutants (t)	31520	179613	577148
Savings in time per trip (minutes)	31	28	32
Annual reduction in fatal accidents (No.)	21	111	125
Annual reduction in all accidents (No.)	93	591	937

Source: DELHI METRO

BOX 9: Delhi Metro

Delhi Metro operates the largest metro of India transporting more than 2.6 million passengers daily. The total length of Delhi metro currently is 213 km. Delhi metro has set an ambitious target of increasing its line length to more than 400 km in next few years thereby accommodating many more commuters to use a less GHG intensive mode of transport.

Delhi Metro Rail Corporation (DMRC) Ltd. is also installing Solar Panels in its station buildings, depots and colonies. As per DMRC Solar Policy, DMRC has to increase the share of renewable energy by 20 MW and 50 MW up to 2017 and 2021 respectively. The power generated by these plants will be used for DMRC's operational requirements, which include station lighting and other loads.

(Source: DMRC, 2013)

AHMEDABAD BRTS

Ahmedabad, located in the state of Gujarat, with a population of 5.5 million (Census, 2011), is one of the rapidly growing metropolitan cities in India. The city is one of the important economic and industrial hubs in the country. The city has a well-developed ring-radial road network and urban transportation in the city is road based with a mix of private vehicles, public transport buses and informal modes. The public buses have been run in the city since 1945 by Ahmedabad Municipal Transport System (AMTS). However, private vehicles, especially two wheelers, are dominant in the city (Swamy, 2010).

The need for an efficient public transport system was highlighted in the Integrated Public Transit Plan developed for the city by the municipal and state government and the concept of a Bus Rapid Transit System (BRTS) was born in 2005. The Ahmedabad BRTS system called "Janmarg" or "the people's way", began operation in October 2009, and has grown from 12 km of route to 97 km with 250 buses and about 1,30,000 average passengers per day. A total network of 129 km has been planned for the BRTS system. Currently the Phase 1 and Phase 2 of the system have been completed and are operational. A further addition of 37 km has been planned under Phase 3.

(Source: UNFCCC, 2014)

The BRTS network links the central city areas with transit terminals, markets, industries and institutions and has led to promoting higher densities along the corridors by raising Floor Space Index (FSI) up to 4. The system is a closed system (except at certain road stretches and roundabouts) with raised island/ median bus stations which allowed for easy transfer of passengers. Janmarg is designed as a strategic intervention, to attract latent transit demand, improve air quality and help the city remain compact. Its salient features are: a closed BRT system with median bus stations; specially designed buses with right hand side doors, matching bus floor and bus station platform heights; a complete revamp of the right of way to include cycle tracks and pedestrian facilities; a commercial speed of 25 kp/h enabling faster commuting; and off board fare collection.

Janmarg has made several innovations in the planning and designing of the system including a fully 'pedestrian and transit' only street section at one location and a one-way bus lane to manage narrow right of way. At a larger level, Janmarg has demonstrated that BRT system can work in India. The activity has become the backbone of public transportation in the city. Janmarg looked at other BRTS in cities around the world and adapted their best practices in the context of Ahmedabad (UNFCCC, 2014). There have been significant reductions in NOx, SOx and CO levels and there has been a 122-170% reduction in PM2.5 levels in the BRT corridors as compared to non-BRT corridors (Solanki, 2013).

7.5 NATIONAL ELECTRIC MOBILITY MISSION PLAN 2020

Government of India approved the National Mission on Electric Mobility in 2011 and subsequently National Mission on Electric Mobility Plan 2020 (NEMMP 2020) was unveiled in 2013. This plan is one of the most important and ambitious initiatives undertaken by the Government of India that has the potential to bring about a transformational paradigm shift in the automotive and transportation industry in the country. This is a culmination of a comprehensive collaborative planning for promotion of hybrid and electric mobility in India through a combination of policies aimed at gradually ensuring a vehicle population of about 6-7 million electric/ hybrid vehicles in India by the year 2020 along with a certain level of indigenisation of technology ensuring India's global leadership in some vehicle segments. It aims to achieve national fuel security by promoting hybrid and electric vehicles in the country. Government aims to provide fiscal and monetary incentives to kick start this nascent technology. The government is preparing a road map to ensure that only electric vehicles will be sold in the country by 2030 (FAME-India).

As part of this mission, Department of Heavy Industry formulated a scheme namely FAME – India [Faster Adoption and Manufacturing of (Hybrid&) Electric Vehicles in India] to promote hybrid/electric technology in transportation so as to reduce dependence on fossil fuel. The overall scheme was proposed to be implemented over a period of 6 years, till 2020, wherein it is intended to support the hybrid / electric vehicles market development and its manufacturing eco-system to achieve self-sustenance at the end of the stipulated period. At present, the Phase-1 of the scheme is under implementation, which was originally for a period of 2 years commencing from 1st April 2015 i.e. FY 2015-16 and FY 2016-17, and has since been extended now till 31st March 2018.The scheme has four focus areas i.e. Technology Development, Demand Creation, Pilot Project and Charging Infrastructure. The scheme will provide a major push for early adoption and market creation of both hybrid and electric technologies vehicles in the country. The scheme will allow hybrid and electric vehicles to become the first choice for the purchasers so that these vehicles can replace the conventional petroleum products-based vehicles. It is envisaged that early market creation through demand incentive, in-house technology development and domestic production will help industry reach self-sufficient economies of scale in the long run. Market creation through demand incentives is aimed at incentivising all vehicle segments i.e. 2-Wheelers, 3-Wheeler Autos, Passenger 4-Wheeler vehicles, Light Commercial Vehicles and Buses. The demand incentive is available to buyers (end users/consumers) in the form of an upfront reduced purchase price to enable wider adoption. Through this scheme, about 1,69,914 EVs have been (as on 21/11/2017) given direct support by way of demand incentives amounting to approximately INR 2030 million since its launch on 1st April 2015.The status of Fund Allocation and Utilization of FAME Scheme is summarised Table 7.4:-

Table 7.4: Fund Allocation under the FAME Scheme

Financial Year	Fund Allocation (INR)	Fund Utilization (INR)
2015-16	750 Million	750 Million
2016-17	1440 Million	1440 Million
2017-18	1750 Million	INR 854.9 Million (Till 30/09/2017)

A similar approach of bulk procurement as was used for LED bulb is being used to achieve the government's ambitious target to have all vehicles sold in India

in 2030 to be EVs. As a first step, bids for 10000 vehicles were invited in 2017. Two companies bid for it, Tata Motors and Mahindra & Mahindra. As the second bidder, Mahindra & Mahindra agreed to match the price of the lowest bidder, the contract is split among the two. In the first phase, 500 vehicles are to be supplied in 2017 of which 150 will be supplied by Mahindra & Mahindra. In the second phase, 9500 vehicles will be procured of which Mahindra & Mahindra can supply up to 40%.

7.6 BUILDINGS WHERE TRADITIONS MET WITH MODERNITY

There are examples where Indian buildings demonstrate that modern technology can be combined effectively with traditional design elements and principles to achieve the highest standard of energy and environmental design. Traditional designs have emphasized orientation, natural ventilation, passive heating and cooling, use of sunlight and grills or *jaalis* to protect buildings from heat. One such example is the building of the Confederation of Indian Industry's (CII) Sohrabji Godrej Green Business Center (CII-Godrej GBC) in Hyderabad that received the prestigious 'Platinum' Leadership in Energy and Environmental Design (LEED) rating from the United States Green Building Council (USGBC).

Another example is the Pearl Academy of Jaipur which used a number of old technologies to create an environmentally responsive passive habitat. The building is protected from the environment by a double skin which is derived from a traditional building element called the 'Jaali' which is prevalent in Rajasthani architecture. The double skin acts as a thermal buffer between the building and the surroundings. Infosys, the premier Indian IT company, is trying out an underfloor water cooling system at its Pocharam campus in Hyderabad, one of the hottest cities in India. Infosys has divided the building perfectly in half. One half is conventionally cooled, and the other half is cooled using in-slab radiant cooling (piping cool water through the floors of each office). Another example is that of Druk White Lotus School, Ladakh where the building is oriented 30° towards the south-east so that all buildings within it can gain maximum benefit from the morning sun. The National Institute of Immunology (1984-2006), New Delhi comprises laboratories and

Sohrabji Godrej Green Business Center

Infosys building at Pocharam

housing clusters that are influenced by traditional havelis. The manner in which the havelis counter intense heat by building around a courtyard was incorporated within the framework of current norms and functional requirements.

In India, architect Charles Correa has used the traditional cluster concept and typology, and has added new colours and details to create his successful Belapur housing project in Navi Mumbai. Apart from their accomplishment in sustainability, these buildings also demonstrate that aesthetics need not be sacrificed in order to combine traditional and cultural methods with elements of modern technology.

Backed by environmental regulations and rising awareness, green buildings in India are expected to grow from the current 1.7 billion sq. feet to 3 billion sq. feet by 2020. New high-rise residential complexes, schools, offices and mixed-use development are expected to be the top sectors driving the demand for green buildings. India ranked third among the top 10 countries for LEED green buildings and in 2016, nearly 650 Indian building projects had earned LEED certification. The size of the green building materials market too is estimated to reach $234 billion by 2019. Green building programmes such as LEED have been significant drivers of market transformation across the globe (Menon, 2017).

TRADITIONAL ELEMENTS IN INDIAN BUILDINGS

Traditional Indian buildings consisted of specific characteristics that naturally kept the buildings cool in summers and warm in winters. These specific features included ventilation options, cooling, and humidity regulation. Options for natural ventilation were ingrained in traditional buildings. Examples of passive cooling are Hawa Mahal in Jaipur, Rajasthan which used 'Venturi Effect' to cool the air and Panchmahal at Fatehpur Sikri in Uttar Pradesh. *Jaali* is also used frequently as it controls the airflow and lowers the temperature of internal spaces.

Jaali in Rajasthan

Courtyard at Jahangiri Mahal, Agra

In the Kerala state of India, the Nalukettu is a popular traditional domestic architecture. The buildings are planned around a courtyard and rooms are positioned according to *Vaastu Mandala*. This method of courtyard planning brings climatic comfort in warm and humid climate. Slope of the roof responds to heavy rain and the use of wood regulates humidity. The use of terracotta roof tiles accommodates infiltration of air.

Nalukettu veedu exterior

Nalukettu veedu interior

Likewise, many other states and cities in India have a particular architecture that is best suited for their type of climatic condition. In Hyderabad, *badgirs*, or windscoops stand as an excellent example of providing natural solution to combat dry and humid conditions. Made of stretched fabric on a thin board on a wooden frame, the *badgir* channels wind down to the lower parts of a dwelling.

A traditional way of cooling in India was the Stepwell, a pond dug into the ground or surrounded by walls above ground so that the air is cooled by evaporating water in an enclosed, shaded zone. Here the earth acts as a natural heat sink, having access to water and with a pavilion, it remains comfortable throughout the year.

Winds Coop In Hyderabad

Stepwell in Adalaj, Gujarat

For natural air conditioning in Rajasthan, ancient kings demonstrated nice applications of hydrology and thermodynamics, capturing rainwater across their territory and building hundreds of kilometers of pipes, eventually piping water underneath their floors. This cool water running underneath the floors created a massive thermal mass, storing and radiating coolness within the structures. High ceilings and very thick walls were also important features.

With the arrival of Mughals in India, the merger of local and immigrated architectural techniques resulted in an astounding style providing new ways to cope with climate extremes. The technology supported the use

of local materials. For example, the buildings at Fatehpur Sikri were constructed in red sandstone procured from quarries near the site, and were erected by indigenous technology with the help of local artisans. The micro-climate in these indigenous buildings was controlled by vegetation in outer spaces and water bodies (still and moving) and fountains inside the buildings to improve the quality and humidity of air, as also seen in Red Fort of Delhi.

The outer space/*verandah* in these buildings acted as buffer for inner spaces to protect people from prickly heat in summer. Depending upon seasons, grass mats with sprinkled water, heavy quilts, and bamboo screens were used to control the sun's penetration.

Panchmahal at Fatehpur Sikri

Nahar-i- Bahisht at Red fort, Delhi

7.7 CLIMATE RESILIENT VILLAGES UNDER NICRA

Climate resilient agriculture involves integration of adaptation, mitigation and other practices in agriculture aiming at enhancing the capacity of the system to respond to various climate related disturbances by resisting or tolerating the damage and recovering quickly. Such perturbations and disturbances can include events such as drought, flooding, heat/cold wave, erratic rainfall pattern, long dry spells, pest population explosions and other perceived threats caused by change.

Climate resilient agricultural practices require a synthesis of traditional sustainable practices giving relatively low yields with modern practices that provide high productivity. These are crop and location specific and need to be tailored to fit into the agro-ecological and socio-economic conditions and priorities of farmers. The National Initiative on Climate Resilient Agriculture (NICRA) was organized in February 2011 to enhance resilience of Indian agriculture to climate change and climate variability through strategic research and technology demonstration.

As a part of NICRA, 151 Climate Resilient Villages (CRVs) were established in various climatically vulnerable regions of the country (see figure 7.6). Location-specific integrated action plans, including demonstration of resilient technologies, management practices, and institutional and policy interventions, have shown

promising results at several locations, increasing the productivity significantly and enhancing the cropping intensity up to 125% (see figure 7.7).

CRVs have become model villages for gradual expansion horizontally in the cluster of villages. They have brought the element of resilience in overall Indian agriculture. The dual benefits envisaged in the strategy of climate resilient agriculture in India are to improve and sustain the country's food security by adapting agriculture sector to weather aberrations and extreme climatic events along with environmental services in terms of reducing greenhouse gas emissions.

Some of the successful technologies and practices that promoted resilience to climatic stresses are being mainstreamed through National Mission on Sustainable Agriculture (NMSA) in many national and state government programmes for their up-scaling in applicable domains.

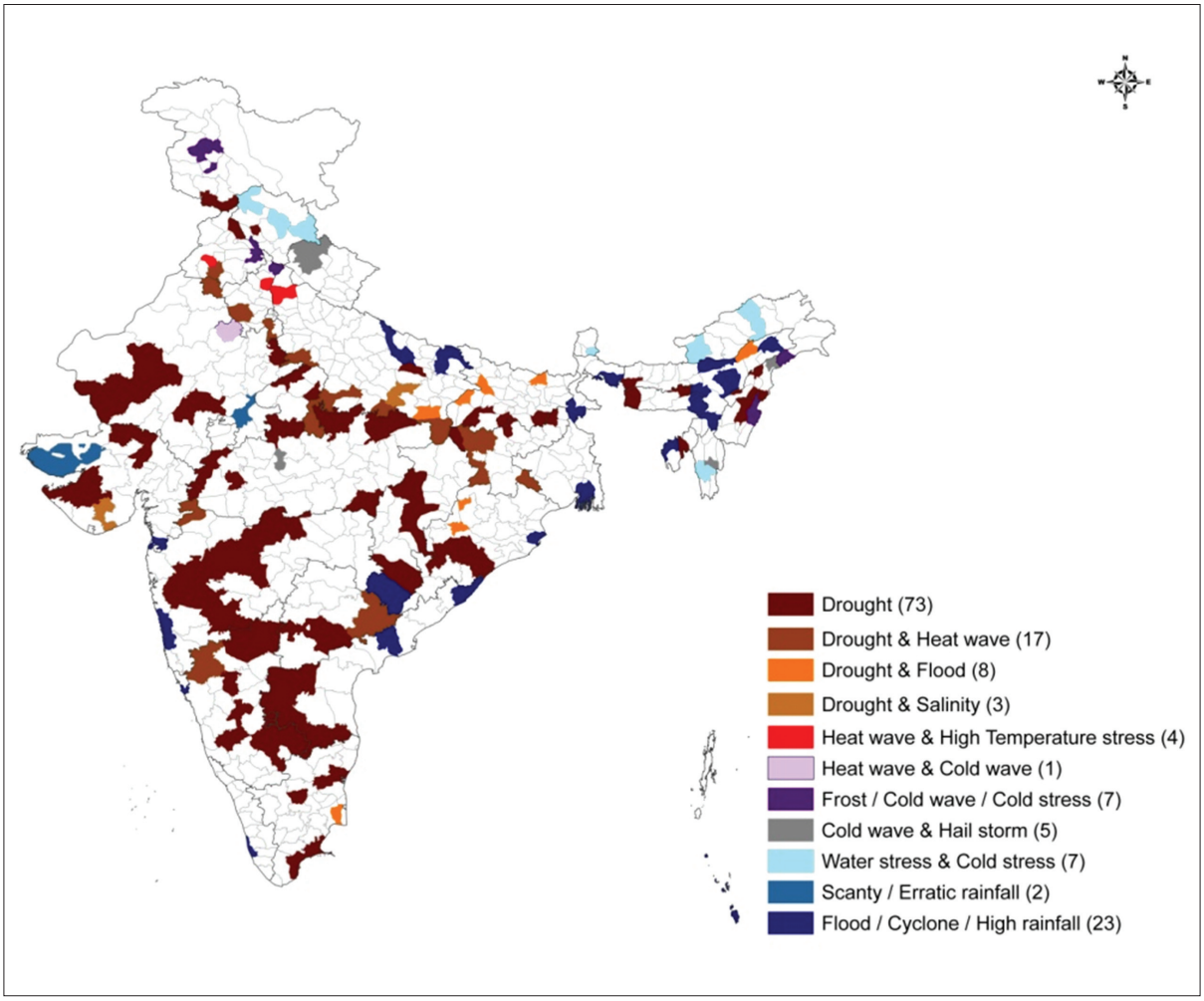

Figure 7.6: Districts where 151 climate resilient villages are established in India under NICRA programme of Indian Council of Agricultural Research (ICAR)

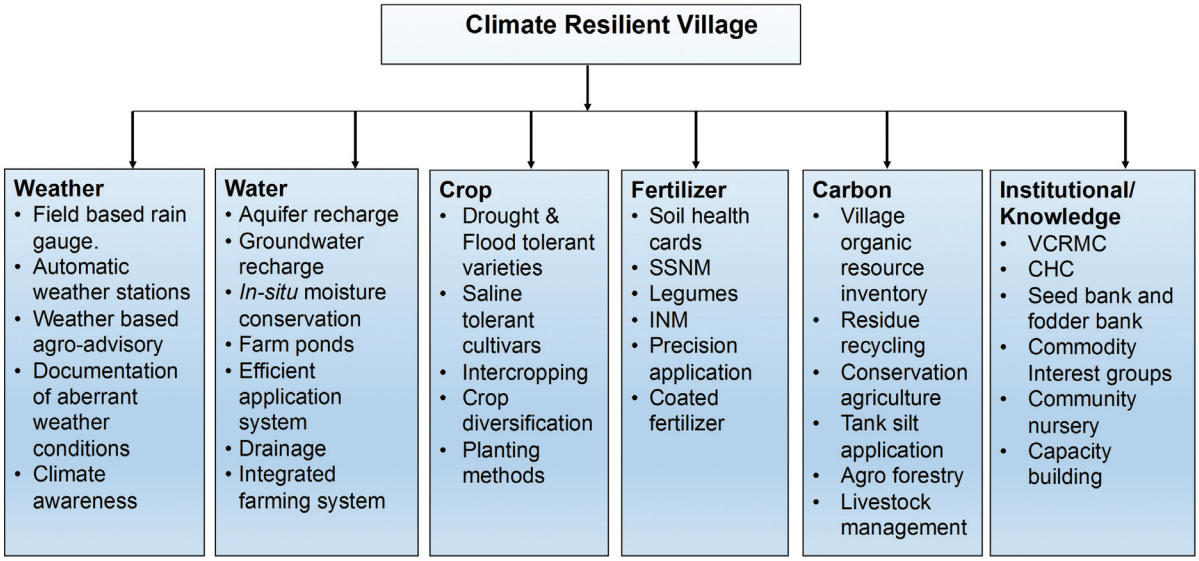

Figure 7.7: Components and technology framework of Climate Resilient Villages (CRV)

Note: SSNM— Site specific nutrient management; INM— Integrated nutrient management; VCRMC— Village climate risk management committee; CHC— Custom hiring center

7.8 SUSTAINABLE SUGARCANE INITIATIVE

After successful experiences in System of Rice Intensification (SRI), the approach has now been extended to the sugarcane crops through Sustainable Sugarcane Initiative (SSI). The highly successful methods and practices will increase the profitability of the farmers significantly while reducing the inputs — water, fertilizer, seed material — and improving the productivity of water, land and labour.

Director General William Dar of International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad released the SSI manual 'Sustainable Sugarcane Initiative (SSI): Improving Sugarcane Cultivation in India' in 2009. The Sustainable Sugarcane Initiative (SSI) aims to provide practical options to farmers for improving the productivity of land, water and labour, reducing crop duration, providing factories a longer crushing season and increased employment opportunities for workers, and reducing the overall pressure on water resources and ecosystems. It stresses on a practical approach that originates from farmers and civil society to improve productivity while reducing pressures on natural resources (SSI-India). It is estimated that by adopting SSI, a farmer will be able to produce at least 20% more sugarcane while reducing water inputs by 30% and chemical inputs by 25% (ICRISAT-WWF, 2009).

(Source: SSI-India)

7.9 COMMUNITY CONSERVED AREAS

India has a rich history of community-based conservation with thousands of small and large areas where traditional forms of conservation exist or new forms of conservation have evolved. The conservation processes at these sites are deeply interlinked with the local culture, lifestyles and needs. Conventionally, conservation around the world is generally viewed as a formal process within government designated Protected Areas where any form of human intervention is normally considered harmful for the ecosystem/species being conserved. This form of conservation may lead to various conflicts between local communities that use natural resources, and government officials/conservationists and designated managers of these sites.

Indigenous and Community-Conserved Areas (ICCAs) are areas that are governed by local communities/ tribes, leading to conservation of cultural traditions and biodiversity. As per the IUCN definition, Community-Conserved Areas can be described as, "natural and/or modified ecosystems containing significant biodiversity values and ecological services, voluntarily conserved by (sedentary and mobile) indigenous and local communities, through customary laws or other effective means. CCAs may represent the continuation of traditional conservation practices or ones where ancient practices have been revived, modified or even newly created to protect nature. These CCAs seek to address threats to natural ecosystems and cultural values from changing socio-cultural, economic and developmental imperatives and mores, as well as unsustainable resource extraction practices, e.g. hunting and poaching or shifting cultivation practices on a reduced fallow

cycle. Both exogenous and endogenous factors may exert an influence on cultural and resource conservation practices, and work alone or in tandem to strengthen or weaken these CCAs.

Figure 7.8: Signs in CCA

In Nagaland, India customary rights are protected under Article 371 A of the Constitution and nearly 93% of natural habitats (largely forests) are owned by individual clans, village/district councils and other traditional community institutions. Hence customary land ownership and management practices characterize forest management in Nagaland, as also elsewhere in the North East India. However, in the absence of alternative livelihood options, most of the economic activities in the villages are based upon utilization of natural resources. Still, there is a silver lining in the form of an age-old practice of conserving areas/forests being followed since many decades. In Nagaland, traditional conservation practices have helped protect biodiversity, and there are records of Community Conservation Areas being declared in the early 1800s, especially in response to forest degradation and loss of wildlife.

Figure 7.9: Sema Tribe of Nagaland

As many as 84% of the CCAs include areas with primary forests that have never been *jhummed* (a form of slash and burn agriculture), and of secondary forests that have not been *jhummed* for more than 25 years. This suggests that a significant number of CCAs include either primary forest or old-growth forests although the area under each is not known. A significant percentage of CCAs (33%) also include abandoned *jhums* and/or plantations (20%) within their territories.

7.10 SACRED GROVES

The traditional practice in South Asia as well as in other parts of the world of conserving a part of the ecosystem as inviolable to human influences has led to the conservation of several species. The First Inspector General of Forests in India, Dietrich Brandis, discovered a network of such Sacred Groves all over India in later half of the nineteenth century. This practice continues to exist to this date, especially in rural India, and is a key contributor to extremely valuable ecosystem services. Sacred groves are scattered all over India and are referred to by different names in different parts of the country.

Sacred groves exist in other parts of the world too. In ancient Greece and Rome, stone walls usually enclosed these forests. Initially these forests began as open-air temples but even after huge temples were built they continued to be protected. Many of them contained streams and lakes that were also considered sacred, and no one was allowed to fish in them or pollute them. Such groves also exist in countries such as Ghana, Syria, and Turkey. The survival of these groves depends entirely on the control of the community over the forest and the people. Usually these areas are designated as holy and dedicated to a god or a goddess.

7.11 BAMBOO AND *SAMANVAY*

India is the second largest producer of bamboo in the world and the bamboo-based communities have huge traditional knowledge about bamboo. There are more than 135 species of bamboo that occur in India. These are distributed across various climatic zones and each part of the country has its own abundance and diversity of bamboo species. Use of bamboo for buildings is part of age-old tradition in India. There exists a variety of bamboo based-buildings across the country, depending on the climatic zone and the species found in the particular part of the country.

Bamboo is part of traditional lifestyle in India, especially in the north-eastern part of the country. With use of modern technologies, bamboo is now being used as construction material for contemporary housing, for making furniture and handicraft and as laminated panels. With a view to harness the potential of bamboo resources of the country, Ministry of Agriculture, Government of India is implementing National Bamboo Mission. Similarly, Department of Science and Technology is executing National Mission on Bamboo Applications. These missions have promoted sustainable cultivation and utilization of bamboo, while providing livelihood and climate change mitigation as co-benefits. Bamboo based structures have been designed and installed at various places in the country.

Owing to their fast growth rate, most bamboo species have excellent potential of carbon sequestration. In addition to serving as carbon sink, bamboo can be used for other activities that mitigate climate change (figure 7.10). Given its versatility, bamboo, 'the poor man's timber' also presents promising potential for adaptation to climate change.

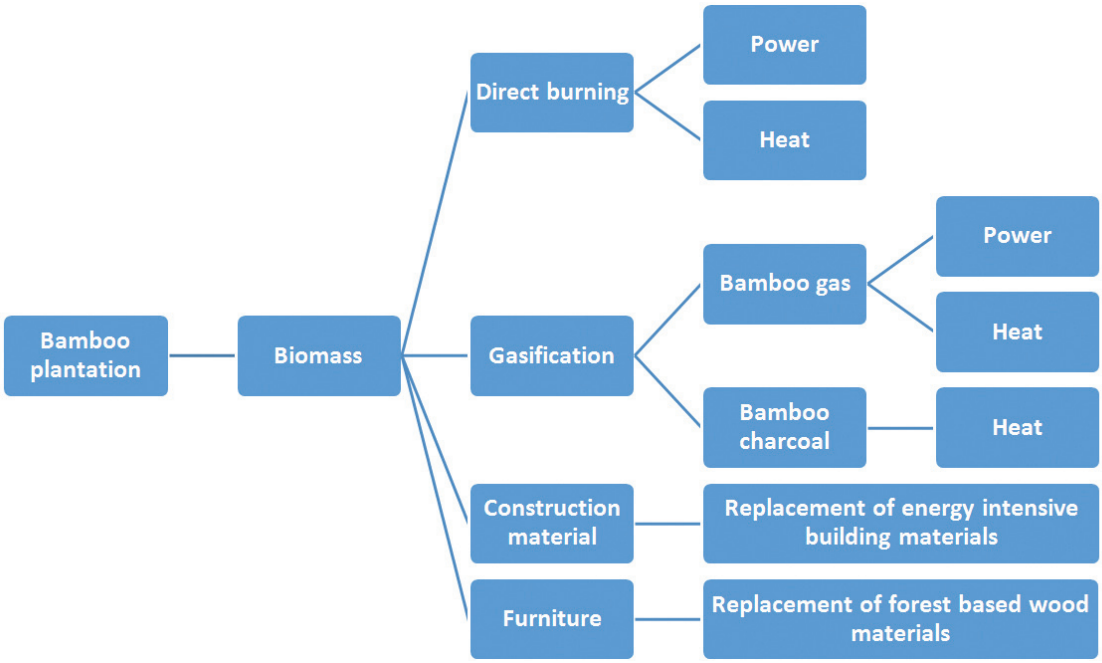

Figure 7.10: Bamboo Applications for Climate Benefits
(Source: Dube, 2008)

7.12 RECYCLING OF WASTES

An important aspect of sustainability is minimizing the use of resources. Recycling provides an important option to reduce consumption of resources in modern lifestyle. Recycling of waste materials in India is entirely undertaken by the informal sector. The informal sector comprises of rag-pickers, itinerant waste buyers, dealers and recycling units. Rag-pickers constitute a large population in the informal sector.

Generally, recyclables are collected in two ways: paper, glass and metals are collected before they enter the municipal solid waste (MSW) stream from households on an instant payment basis, by a special group of people called 'Kabadiwala' (itinerant waste buyers) and plastics are generally collected by rag-pickers

from litter on streets or from heaps of waste in landfills. Shopkeepers as well as households sell recyclable items, such as newspaper, cardboard, glass containers, and tin cans to itinerant waste buyers too. Waste pickers retrieve recyclable materials like milk bags, plastic cups and containers, and glass bottles from what is discarded by households, commercial establishments and industries. Larger commercial establishments and industries sell the recyclable waste (source separated or otherwise) to waste dealers in bulk, who then sell it to recycling units.

The recyclables collected are separated by pickers and collectors on a daily basis and transferred to small, medium and large dealers. Usually, the pickers and collectors sell to small dealers in the slums, near their residence. The small dealers sell the waste to medium or large dealers and finally the waste is sold to the recycling units. There are some 2,000 known plastic recycling units in India. Most of these known units are located in Tamil Nadu (588), Gujarat (365), Karnataka (302), Kerala (193) and Madhya Pradesh (179) (Annepu, 2012).

Figure 7.11: Waste collection
(Source: Swachh Bharat Mission website)

Annepu (2012) estimated that the informal sector recycles 20.7% of recyclables from the formal system, which compares fairly well with the best recycling percentages achieved around the world. It has to be observed that this number excludes the amount of wastes this sector recycles from Municipal Solid Waste (MSW) prior to collection, which is generally not accounted for and can be as much as four times the quantity recycled from formally collected waste.

7.13 GREEN STARTUPS IN INDIA

Sustainability of lifestyles can be improved by using renewable resources as far as possible. Such green lifestyles require innovative development of products and services based on renewables and their adoption by people. The Government of India is promoting the setting up of startup entrepreneurs through the Start Up Mission. Some of the innovative startups focusing on green technologies that contribute to sustainable development of business models and also aid in the adoption of sustainable lifestyles are described below.

ENERGY FROM BIODEGRADABLE WASTE

Startups in India are working on promoting biogas production from kitchen waste. For example, a firm, Carbonlites, is providing biogas plants in refurbished old shipping containers for use in schools, office canteens etc. that can provide piped biogas for use in kitchen or involve bottling of biogas for use in transportation or other applications (Carbonlites, 2017). Small household level biogas plants have also been developed by certain startups like Biotech Renewable Energy Private Limited (Biotech-Renewable Energy) which can be used by individual households to produce biogas from kitchen waste that can reduce the need for LPG.

Household Level Biogas plant
(*Source: Biotech Renewable Energy)*

WASTE MANAGEMENT

Individuals can contribute significantly to waste management through practices like segregation of waste at source. Startups like Daily Dump and Hasirudala are taking this to the next level by promoting household level composting of the organic fraction of the domestic waste through small composters and composting accelerators along with odour neutralizers. This can help reduce the waste going to landfills and also provide organic manure.

These home composting options are ideal for individual homes and tight spaces. One of these models consist of pots stacked upon each other and depending upon the type of model, it can handle the entire kitchen waste of a family of four or five (see picture below). As in August 2017, Daily Dump initiative saves 37,029 kg of organic waste daily.

Home Composters
(*Source: Daily Dump)*

SOLAR ROOFTOP AND SOLAR OFF-GRID STARTUPS IN INDIA

Decentralised renewable sources of energy offer low-cost options for enhancing energy access even at the bottom of the pyramid. The national government as well as several state governments are currently promoting solar rooftop as well as offering incentives for decentralised renewable energy. Several startups have entered this space as the business case now exists for such entrepreneurial ventures. Boond Engineering, Cygni Energy, Mera Gao Power, Picoenergy, Gram Power are startups providing electricity to low income or remote households using solar-powered smart microgrids or off-grid systems.

Solar Rooftop
(*Source: BOOND)*

Sunvest, and Oorjan Cleantech are among startups focusing on commercial or residential and small scale rooftop market in urban and semi-urban areas of India. In some cases, the entrepreneur sets up rooftop solar panels in a number of buildings, integrates the power and feeds in to the grid. The building owners get a share in the revenue from sale of power to the grid.

8

CHALLENGES FOR INDIA AND WAY AHEAD

With a share of nearly 18% of global population, India's GHG emissions are only around 4.12% of global emissions and its per capita emission is only 1.56 tonnes compared to global average of 6.62 tonnes (in 2010). However, India's population as well as its per capita incomes are rising, and consequently emissions may also rise. India's GDP grew at 7.7% from 2004-05 to 2016-17 and aspires to grow at more than 8% per year over the coming decades.

The challenge India faces is how to improve well being of its people and meet their growing aspirations. This requires economic growth, ensuring energy access to all its citizens, good housing for all and a resilient economy that can withstand the impact of climate change, while at the same time reducing energy and emission intensities. According to UNEP gap report (UNEP, 2017), India is on track to meet its Cancun pledge of 20-25% reduction in emission intensity of its GDP by 2020, and its NDC target of 33-35% reduction in emission intensity by 2030 as compared to 2005 levels. The emission intensity of India's GDP has already declined by 12% from 2005 to 2010 (India, 2015).

Currently, Indians are amongst the lowest emitters of CO_2 across sectors. As millions of people move out of poverty, an increase in consumption levels is inevitable, and also desirable. The United Nations Development Programme (UNDP, 1998) points out, "Development and consumption patterns that perpetuate today's inequities are neither sustainable nor worth sustaining". In this context, an increase in consumption can contribute to human development, where it enlarges the capabilities of people without adversely affecting the well-being of others, when it is as fair to future generations as to the present ones, when it respects the carrying capacity of the planet and when it encourages the emergence of lively and creative communities.

However, it is also understood that an increase in consumption can have negative effects as well. At a societal level, unsustainable consumption can have deleterious effects on the environment and exclude individuals who do not have access to materials widely used by the rest of the society from participating – socially, economically, and politically.

In India, the growing middle classes, as in the rest of Asia, are projected to be future drivers of global demand growth. This presents both an opportunity and a challenge. This is because while on the one hand, the middle class in India could be a key driver of global growth, the consumption patterns of the middle class could lead to economic growth which may be unsustainable. The trajectory that this growth takes should therefore be one which is based on the lessons of developed countries, as well as the rich tradition of sustainable practices which India has access to.

As the middle class grows, aspirational consumption of lifestyle products will increase. Greater use of

[2] http://environment.nationalgeographic.com/environment/greendex
Based on data sourced from India's First Biennial Update Report, WRI CAIT and UN Database.

appliances, increased leisure travel and use of personal motorized vehicles will take place. Also, reliance on comfort increasing applicances like ACs, washing machines and driers will grow. The challenge for India is to provide alternatives that consume less energy and resources. It will need to provide more energy efficient environment, create climate for eco-tourism, and provide infrastructure that makes walking, cycling and using public transport more preferable than private vehicles. These challenges are huge but surmountable. The rapid spread of five star rated appliances, large scale adoption of LED lighting, and construction of metro systems in a number of cities are indicators of India's firm determination for cleaner sustainable development.

Newer challenges such as increasing scarcity of natural resources due to either depletion or contamination, and new vulnerabilities as a result of climate change mean that a 'business as usual' scenario is no longer possible as India endeavours to meet the basic needs of its population. India is committed to achieving growth which is equitable, inclusive, and sustainable. Sustainable growth is envisaged as one which involves sustainable consumption and production, including sustainable lifestyles.

While technological innovation and availability of finance can play a role in this movement towards sustainable lifestyles, habits and values play an equally important role. In this regard, India has access to a rich tradition of values which promote frugality and moderation in consumption. As part of India's Intended Nationally Determined Contributions (INDCs) made in response to the 21st Conference of Parties (COP 21) of the United Nations Framework Convention on Climate Change (UNFCCC), India stated its intention to "put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation." Further, it is open to adopting new technologies which allow for levels of energy efficiency which countries at similar levels of growth did not have in the past.

In addition to supporting existing traditional and contemporary practices, India has initiated a number of policies at the national and state levels to forge a pathway to low-carbon development based on sustainable consumption. These include community conservation of biodiversity rich areas, afforestation and reforestation programmes, promotion of sustainable agricultural practices such as micro-irrigation, system of rice intensification, organic agriculture and energy efficient pumps, energy efficient practices in specific industries such as the promotion of divided blast cupolas in iron foundries, solar driers for income generation, co-processing of waste in cement kilns in India, low-carbon initiatives under the smart cities mission, and various initiatives to promote public transport such as the Bus Rapid Transit System and the Metro system in urban areas. Details about these practices and policies are provided in this book. India, thus, aims to moderate its emerging consumption pattern with a *Samanvay* of its heritage and modernity.

REFERENCES

Annepu, Ranjith. (2012). Recycling in India-The Informal Sector. Retrieved from swmindia.blogspot.in

BEE. (n.d). Star-labelled appliances. Retrieved from https://beestarlabel.com

BP. (2016). *BP Statistical Review of World Energy*, June 2016 http://www.bp.com/statisticalreview

Biotech-Renewable Energy. (n.d). Retrieved from http://www.biotech-india.org/Domestic_Biogas.aspx

Carbonlites. (2017). Carbonlites- From Waste to Renewable Energy. Retrieved from http://carbonlites.com/index.html

Census of India. (2011). Office of the Register General and Census Commissioner, Ministry of Home Affairs, Government of India. New Delhi, India.

Census. (2011). Ahmedabad City Census (2011), Available at http://www.census2011.co.in/census/city/314-ahmedabad.html

CPCB. (2011). *Basin wise water quality data*, *2011*, Environmental Data Statistics, Central Pollution Control Board, Ministry of Environment and Forests, Government of India

Dube, Lokesh Chandra. (2008). *Climate Change Mitigation Opportunities in Bamboo and Bamboo applications*. Cane and Bamboo Technology Centre's Technical Papers-III; edited by Dr. M L Choudhary and Kamesh Salam. pp 205-213.

DMRC. (2013). Annual Report 2013 – 2014, Delhi Metro Rail Corporation Ltd. (http://www.delhimetrorail.com)

FAME-India. (n.d). National Automotive Board, Government of India.

FAO. (2016a). *FAOSTAT*, Retrieved September 30, 2016, from http://faostat3.fao.org/home/E

FAO. (2016b). *Food and Agriculture Organization*, Retrieved October 19, 2016 from http://www.fao.org/WAIRDOCS/LEAD/X6170E/x6170e09.htm#bm09

Greendex. (2014). Consumer Choice and the Environment: A Worldwide Tracking Survey. National Geographic and Globescan.

Grossman, Gene M. and Krueger, Alan B. (1991). Environmental Impact of a North American Free Trade Agreement. Working paper 3914, National Bureau of Economic Research, Cambridge, MA.

ICRISAT-WWF. (2009). Sustainable Sugarcane Initiative. Improving Sugarcane Cultivation in India, Training Manual.

INDC. (2015). *India's Intended Nationally Determined Contribution: Working Towards Climate Justice,* Government of India.

India. (2015). *India: First Biennial Update Report.* Ministry of Environment, Forest and Climate Change, Government of India.

Lesschen *et. al*. (2011). Greenhouse gas emission profiles of European livestock sectors. *Animal Feed Science and Technology*, 166-167.

Mehta and Nambiar. (2013). The poultry industry in India, http://www.fao.org/WAICENT/FAOINFO/AGRICULT/againfo/home/events/bangkok2007/docs/part1/1_5.pdf (accessed October 18, 2016)

Menon. (2017). Demand for green buildings grows as health, environmental concerns rise. The Hindu Business Line.

MoSPI. (2015). Statistics Related to Climate Change, *Ministry of Statistics and Programme Implementation*, Government of India, http://mospi.nic.in/Mospi_New/upload/climateChangeStat2015.pdf

National Geographic. (2015). 2014 *Greendex Reports*. Available at: http://environment.nationalgeographic.com/environment/greendex

Panayatu, T. (1997). Demystifying the Environmental Kuznets Curve: Turning a Black Box into a Policy Tool. *Environment and Development Economics* 2: 465–84.

Parikh, Jyoti., Parikh, Kirit., Gokarn, Subir., Painuly, J.P., Saha, Bibhas and Shukla, Vibhooti. (1991). Consumption Patterns: The Driving Force of Environmental Stress, report prepared for UNCED, Indira Gandhi Institute of Development Research, Mumbai, http://www.irade.org/Consumption%20Patterns_JPKP.pdf

Parikh, Kirit and Parikh, Jyoti. (2016). Realizing potential savings of energy and emissions from efficient household appliances in India. *Energy Policy*, Vol 97. Pp. 102-111

PIB. (2015). National Electric Mobility Mission Plan, Ministry of Heavy Industries and Public Enterprises, Press Information Bureau, Government of India.

Planning Commission. (2012). *Twelfth Five Year Plan (2012–2017) Faster, More Inclusive and Sustainable Growth Volume I*, Planning Commission. Government of India, New Delhi, India. http://planningcommission.gov.in/plans/planrel/12thplan/pdf/vol_1.pdf

Ruttan, Vernon W. (1971). Technology and the Environment. *American Journal of Agricultural Economics* 53: 707–17

Solanki, Harshadray. (2013). Presentation by Harshadray Solanki at India International CleanTech Summit 2013 held at FICCI Federation House New Delhi.

SSI-India. (n.d). Sustainable Sugarcane Initiative. Retrieved from http://sri-india.net/ssi_website/index.html

Swamy, P. H. M. S. (2010). 'Janmarg – Bus rapid transit in Ahmedabad', Symposium on Public Transportation, UITP, 20 January, New Delhi

UNEP. (2012). *Growing greenhouse gas emissions due to meat production*, United Nations Environment Programme. Retrieved from http://www.unep.org/pdf/unep-geas_oct_2012.pdf.

UNFCCC. (2014). United Nations Framework Convention on Climate Change, Ahmedabad BRTS Janmarg, Available at http://unfccc.int/secretariat/momentum_for_change/items/7098.php

UNDP. (1998). *Human Development Report 1998*, United Nations Development Programme, Oxford University Press, New York.

UNDP. (2016). *Human Development Report 2016*. Retrieved from http://hdr.undp.org/sites/default/files/2016_human_development_report.pdf

UNEP. (2017). *The Emissions Gap Report 2017*. United Nations Environment Programme (UNEP), Nairobi

U.S. Energy Information Administration. (2016). Retrieved September 26, 2016, from http://www.eia.gov/beta/international/

World Bank. (1992). *World Development Report, 1992*. New York: Oxford University Press

World Bank. (2015). Retrieved from http://data.worldbank.org/indicator

WRI. (2015). CAIT Climate Data Explorer 2015, Retrieved September 30, 2016 from http://cait.wri.org/faq.html#q07

Yandle, Bruce., Bhattarai, Madhusudan and Vijayaraghavan, Maya. (2004). "Environmental Kuznets Curves: A Review of Findings, Methods, and Policy Implications", Research Study 02-1 UPDATE • April 2004

CONTRIBUTORS

Prof. Kirit Parikh (IRADe)
Dr. J. R. Bhatt (Adviser, MoEFCC)
Dr. Himangana Gupta (NATCOM, MoEFCC)
Mr. Lokesh Chandra Dube (NATCOM, MoEFCC)
Dr. Jyoti Parikh (IRADe)
Dr. Ashutosh Sharma (IRADe)
Mr. Rajat Puri (IRADe)

COMMENTS RECEIVED FROM

Dr. Arun Kumar Mehta (MoEFCC)
Dr. Sujata Arora (MoEFCC)
Prof. A.K. Bhatnagar (DU)
Dr. Navroz Dubash (CPR)
Dr. Ashish Chaturvedi (GIZ)
Prof. Amit Garg (IIMA)
Dr. Probal Pratap Ghosh (IRADe)
Dr. Rahul Majumdar (IRADe)
Dr. T.S. Nayar
Mr. Ajay Raghava
Ms. Abha Tewary

CASE STUDY CONTRIBUTORS

Integrated Research for Action and Development (IRADe)
The Energy and Resources Institute (TERI)
Development Alternatives (DA)
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), India
International Water Management Institute (IWMI)
Sahapedia

Photo Credits

Front Cover: UJALA Photogallery (EESL website),Wind Power Programme Photogallery (MNRE website), RMZ Ecospace, SLNP Photogallery (EESL website), Mr. Tushar Shah (IWMI), Mr. S. Suresh

Back Cover: Mr. Shyam Ghate, Mr. S. Suresh

This book is an effort to highlight comparative consumption patterns of India and other countries and India's tradition of sustainable consumption. It showcases the harmonisation of India's traditional practices with the modern ones leapfrogging the rapid development phase for a low-carbon growth. Drawing from the experiences and trends resulting from conventional consumption patterns, the document reinforces the need to follow a sustainable lifestyle at the individual and community level by stressing upon the traditional practices that are rooted in our culture and can easily find a way to our modern lifestyle making it more sustainable and environment-friendly. It discusses relevant national and local level strategies in context of Samanvay to address climate change.

ॐ द्यौः शान्तिरन्तरिक्षꣳ शान्तिः
पृथिवी शान्तिरापः शान्तिरोषधयः शान्तिः ।

"Om dyauh śāntir antariksam śāntih prithvi śāntih āpah śāntih osadhayah śāntih" -- Yajur Veda 36.17

Unto Heaven be Peace, Unto the Sky and the Earth be Peace,
Peace be unto the Water, Unto the Herbs and Trees be Peace.

ISBN 81-927373-9-X
9 788192 737393