

Fourth Report

INAE Forum on Technology Foresight and Management for Addressing National Challenges

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Indian National Academy of Engineering
November 2020

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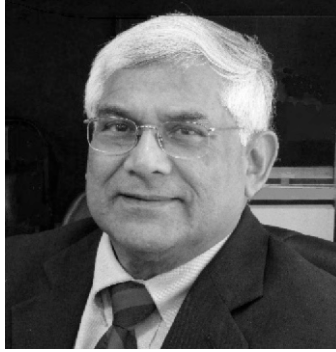
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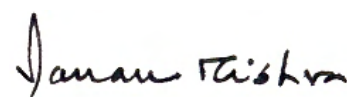


Foreword

The Indian National Academy of Engineering (INAE), founded in 1987 comprises India's most distinguished engineers, engineer-scientists and technologists covering the entire spectrum of engineering disciplines. INAE functions as an apex body and promotes the practice of engineering & technology and the related sciences for their application to solving problems of national importance. The Academy also provides a forum for futuristic planning for country's development requiring engineering and technological inputs and brings together specialists from such fields as may be necessary for comprehensive solutions to the needs of the country. Towards this end, INAE Forum on Technology Foresight and Management for addressing National Challenges has been constituted under the Chairmanship of Mr VK Agarwal, FNAE. I am delighted that the INAE Forum on Technology, Foresight and Management for addressing national challenges has brought out the fourth Report with the mandate to evolve solutions keeping in view the issues of Environment, Climate Change, Sustainability, Rail-based Infrastructure and Improving the Operating Ratio of Indian Railways in focus and suggest appropriate technologies accordingly.

At the national level, technology foresight has always been a key area assuming greater importance and I am happy that the INAE Forum on Technology, Foresight and Management for addressing national challenges has taken cognizance of application of technology foresight to pertinent issues of topical interest such as Environment, Climate Change, Sustainability, Rail-based Infrastructure and Improving the Operating Ratio of Indian Railways and have focused the studies on these areas with the objective of arriving at actionable recommendations.

I am confident that this report shall be of immense benefit to all stakeholders from Government, industry and R&D organizations in addressing these challenges and suggesting an action plan for growth of these sectors and shall be well accepted by the engineering community in domains of interest.



Dr. Sanak Mishra

President

INAE

Preface

1. A proposal to constitute a **Technology Foresight and Management Forum for addressing National Challenges**, composed as under, was discussed during the Governing Council meeting of the Academy held on July 27, 2012 at New Delhi and approval conveyed vide Indian National Academy of Engineering (INAE)'s Letter No. INAE/413/TFMF dt. 22nd August 2012:
 - (i) Mr. V. K. Agarwal Fellow INAE – Chairman
 - (ii) Dr. Y. P. Anand Fellow INAE
 - (iii) Dr. Prem Vrat Fellow INAE
 - (iv) Dr. C. R. Prasad Fellow INAE
 - (iv) Mr. A. K. Anand Fellow INAE
 - (v) Mr. K. P. Singh Ex MD RITES & Ex. MD Tata Projects
 - (vi) Mr. S. C. Gupta Ex. Member Electrical, Railway Board
 - (vii) Mr. V. N. Mathur Ex. Member Traffic, Railway Board
 - (ix) Mr. A. K. Gupta Ex. CAO Railways & currently Editor, RITES
 - (x) Mr. Pradeep Chaturvedi Fellow INAE (Joined the Group later viz. May 2017)
2. The broad **Terms of Reference for the Forum** were as under:
 - 2.1 Domain of National Challenges is very wide and also keeps on changing from time to time. However, this Forum would address the following as a broad guide but could suitably modify the list as required:
 - (a) Food Production and Utilisation and Conservation of Water.
 - (b) Energy Generation and Utilities.
 - (c) Manufacturing Technologies.
 - (d) Mass Transit Systems.
 - (e) Building and Construction Technologies.
 - 2.2 This Forum will evolve solutions keeping in view the issues of sustainable development, poverty reduction, and climate change in focus and suggest appropriate technologies accordingly. Further, suitable Engineering Management techniques will be employed to find cost effective and optimal solutions.
 - 2.3 For formulation of the Recommendations / Solutions the Forum could also invite Specialists as required and / or conduct Workshops as found desirable.
 - 2.4 Meetings of the Forum can be held at a frequency of say once in two months anywhere in the country as desired by Chairman of the Forum. Logistic support will be provided by INAE.
3. The Members of Forum (Group in short) during the initial meetings decided the line of action to be followed for effectively and speedily handling this daunting task. Even though the Forum will be working on the various National Challenges on a continuous basis it was thought prudent to select some priority areas for directed attention in the first

instance. Since the domain of National Challenges is very wide and keeps on changing with time, it was felt that use of expertise of domain 'experts' may be difficult and may cause avoidable delays in formulating recommendations. It was, therefore, the view of the Group to make use of the available data (published literature, reports, media information, INAE literature, data from internet, etc.) and contacts/knowledge of the Group Members with occasional interaction with the experts. The option to invite Specialists as required and/or conduct Workshops as found necessary was kept open.

4. To achieve commonality of approach and to have a common understanding of the various technical terms/issues, some of the areas, as discussed by the Group, are mentioned below:

- Solutions for addressing the National Challenges have to keep in focus issues concerning Sustainable Development, Climate Change, and Poverty-reduction / Inclusive Growth.
- Boundaries between Science, Technology, and Engineering have to be made more explicit. This is all the more necessary because of the growing role of Engineering and its close interface with Society/Nature.
- For Technology Foresight exercises to be more useful / effective it was necessary to bring together expertise in social affairs, business management, financial issues, and policy with the scientific, technological, and engineering issues.
- Too much emphasis on the authenticity of Data / Source was not a practical reality as the challenge was many a times to venture into new areas not only Scientific / Technological / Engineering but also areas concerning Social affairs / Business management / Finance / Policy and their inter-relationships.
- Dimensions of Project Management were becoming more and more complex and diverse and needed special attention. Our poor track record in Project Implementation amply testified this need.
- Expanding definitions of Growth / Progress / Development need to be taken into account (Gross Domestic Product – Human Development Index – Gross National Happiness).
- Ethical issues especially concerning the Environment needed to be addressed.
- Innovations needed to be such so as to achieve More from Less for More people (MLM) for sustainability and equity.
- Role of Technology was not only to be seen from the point of view of achieving the desired objectives but also from the point of view of its consequences.
- Many of the Challenges / Risks have Global dimensions and this had to be kept in view.

- Necessary inputs for Skill development and Training were needed to match the futuristic technologies. Quality of Engineering education especially for Tier II, III & IV colleges needed special inputs.
- Policy frame work will have to be in place to improve the 'image' and 'role' of Engineering to make it more effective especially in tackling social and economic development and for provision of commensurate infrastructure.

5. After discussions, the Forum Members selected some Areas for examination & the **First Report** (March 2014) was published. The Report had Four Chapters as given under:

Chapter	Title
1.	Introductory / Explanatory Notes
2.	Waste Management
3.	Water – Meeting the Future Challenges
4.	Transport – Making it Greener

6. The **Second Report** (March 2016) covered the following three Areas:

Chapter	Title
1.	Agriculture – Waste Reduction and its Use
2.	Energy – Major Thrust on Solar
3.	Mass Transit Systems

7. The **Third Report** (October 2018) covered the following two Areas:

1. **Challenges of Rural Urban Continuum**
2. **High Speed Rail for India**

8. The **Fourth Report** (November 2020) covers the following three Areas:

1. **Issues of Environment / Climate Change / Sustainability**
2. **Rail-based Infrastructure Urgently Needs Four Major Interventions at the Level of Government of India**
3. **Improving the Operating Ratio of Indian Railways – A Way Forward**

9. The Group is currently working on Issues of “Logistics”, “Municipal Solid Waste Management”, “Energy Sector with special reference to Solar and Coal Power”, “Engineering Focus for Future Development in India” and “Boost to Rail in MSME Sector”.

10. It is hoped that Suggestions / Recommendations of the Forum will be helpful to Society / Nature / Policy-makers / Engineers / Administrators in addressing the Challenges in the studied / examined areas.

V. K. Agarwal
Chairman of the Forum

November 2020

CHAPTER 1

ISSUES OF ENVIRONMENT / CLIMATE CHANGE / SUSTAINABILITY

1.1 Introduction

Since man's emergence on earth the evolution of living conditions has been driven largely by sustenance and transportation needs. Inventions of wheel and computer are considered the most important developments by mankind and environmental pollution is now considered civilization's greatest sin.

1.2 ENVIRONMENT & ECOLOGY

- 1.2.1 The 'heat' from global warming is being felt by everyone now and environment is a 'hot' topic all over the world. There is almost a universal awareness that our world is faced with serious threats like sea-level rises, melting glaciers, climatic changes, recurrent food shortages, increased frequency of extreme conditions of floods/droughts, migration of population from coastal areas etc. This is largely due to human activity causing changes in global carbon cycle due to increasing emissions of Carbon dioxide (CO₂) and Methane (CH₄). Sulphur, nitrogen and phosphorous cycles have been seriously disrupted and impediments in the natural flow of rivers is interfering in the water cycle.
- 1.2.2 By one assessment it has been estimated that humankind contributes more than 30 billion tonnes of CO₂ equivalent emissions every year. Of these, transport emissions are around 13%, energy generation - 26%, industry - 19%, agriculture - 14%, deforestation - 17%, waste - 3% and residential / commercial activities - 8%. In fact, Earth's inherent capacity to tackle such extreme situations is being over-stressed and is almost at its limit.
- 1.2.3 The global community took a small step towards collective action at Rio de Janeiro Conference and subsequently followed up with the Kyoto Protocol in 1997 which set legally binding targets for the stake-holders based on the principles of equity and collective differentiated responsibilities. Although all countries did not agree initially, but it was an encouraging start.
- 1.2.4 Subsequently numerous conferences, discussions, negotiations and agreements from COP 1 (1995) in Berlin to COP 24 (2018) in Katowice have been held.
- 1.2.5 With the warming of the planet, changing rainfall patterns, the Himalayan glaciers are melting, there is increased frequency of extreme conditions of

floods/droughts, sea-levels have been rising, & food shortages becoming more frequent. Millions of people in densely populated coastal areas and in island countries could lose their habitat. Impoverished population, particularly in Africa and Asia would be and are, getting adversely affected.

- 1.2.6 If the 'tipping point' is to be avoided, there is an immediate global need for a collective action-plan, otherwise the consequences could be very serious. Since the transport sector would continue to be a major contributor to environmental pollution, urgent mitigating actions are needed.

1.3 CLIMATE CHANGE

- 1.3.1 Climate Change is now unambiguously accepted as the biggest challenge facing mankind. Humans contribute more than 30 billion tons of carbon dioxide equivalent emissions annually. The adverse impact could be very serious and immediate action needs to be taken globally and collectively.
- 1.3.2 Prior to the global conference (in the year 2015), 146 national climate panels had apprised draft national climate contributions (called 'Intended Nationally Determined Contributions', INDCs). These suggested that the commitments may limit global warming to 2.7°Celsius by the end of 2100.
- 1.3.3 A global agreement, known as the Paris Agreement, was negotiated which represented a consensus of the 196 parties attending it. For it to become legally binding, it had to be ratified and signed by at least 55 countries within one year from 22 April 2016 (Earth Day). Each country that ratified the Agreement was required to set an emission reduction target.
- 1.3.4 This year Earth Day was celebrated on 22nd April 2019 & the emphasis was on education, climate change & what is being done globally.
- 1.3.5 A goal of limiting global warming to less than 2°C, compared to pre-industrial levels, was agreed. Efforts would also be made to limit the temperature rise to 1.5°C only. Interestingly, the 1.5 °C goal would mean zero emissions sometime between 2030 and 2050. Surprisingly, there would be no enforcement mechanism for not advising targets in time or for non-achievement of targets.
- 1.3.6 Tackling the multidimensional challenge of climate change needs extraordinary ingenuity and cooperation. The greenhouse gases that are being emitted trap the heat in the atmosphere for decades or even centuries. A 'climate-smart' world is feasible in the foreseeable future, but effecting such a transformation requires action. This must be now since what is done today determines both the climate of tomorrow and the options that decide the future.

- 1.3.7 Further, the action must be together, since climate change is a crisis which concerns everyone. Climate change cannot be tackled without countries cooperating on a global scale to improve energy efficiencies, develop and deploy clean technologies, and expand natural 'sinks' for absorbing gases. There is need to protect human (and all) life and ecological resources. The action must be together in a differentiated and equitable way. Developed countries have been largely responsible for most of the past emissions and their per-capita emissions are still high. These countries should lead the way by reducing their carbon footprints substantially and stimulate research in 'green' areas.
- 1.3.8 The World Bank Group, in their Strategic Framework for Development and Climate Change, has formulated a number of funding/financing initiatives to help nations tackle climate change. Amongst these are carbon funds for financing for energy efficiency and new renewable energy areas. The World Bank is working on incentives for avoided deforestation, on lower carbon growth models and other adaptation and mitigation incentives. It is supporting the United Nations Framework Convention on Climate Change (UNFCCC) process in a number of other similar ways.
- 1.3.9 Prior to the Paris conference the members advised their Nationally Determined Contributions (NDC) which would (after ratification) serve as the initial greenhouse gas targets. At the Paris conference the signatories promised to reduce emissions 'as soon as possible' and do their best to keep global warming to well below 2°C. Of course, issues of funding, legal enforceability, time-frame, ratification etc. are 'works-in-progress'.
- 1.4 **India & United Nations Framework Convention on Climate Change (UNFCCC)**
- 1.4.1 India signed the UNFCCC in June 1992 and ratified it in November 1993. Under the UNFCCC, developing countries such as India do not have binding GHG mitigation commitments in recognition of their small contribution to the greenhouse problem as well as low financial and technical capacities. The Ministry of Environment and Forests is the nodal agency for climate change issues. It has constituted Working Groups on the UNFCCC and Kyoto Protocol and work is in progress on priority.
- 1.4.2 The Kyoto Protocol to the UNFCCC was adopted in 1997 and requires developed countries and economies in transition listed in Annex B of the Protocol, to reduce their GHG emissions by an average of 5.2% below 1990 levels. Article 12 of the Kyoto Protocol provides for the Clean Development Mechanism (CDM)
- 1.4.3 India acceded to the Kyoto Protocol on August 2002.

1.4.4 Current initiatives in India to further improve understanding of climate change, and comply with the requirements of the UNFCCC include:

- Preparation of the country's initial National Communication to the UNFCCC by the Government. All Parties were to communicate a national inventory of GHGs, The GHG inventory for the country (base year 1994), was for five sectors: energy, industrial processes, agriculture, forestry, and waste.
- Support of the Asian Least-cost Greenhouse Gas Abatement Strategy (ALGAS) study, by the Government. The study developed a national inventory of GHG sources and sinks, and identified potential mitigation options. Country-specific emission factors have been developed for methane emissions from paddy cultivation, carbon dioxide emissions from Indian coal, etc.
- Several measures being undertaken in the country, which contribute to GHG mitigation.
- Establishment of the Technology Information, Forecasting and Assessment Council under the Department of Science and Technology, which facilitates the transfer of environmentally sound technology.
- Extensive efforts in conservation of forests and biodiversity. The Participatory Forest Management Strategy of the Government of India secures rehabilitation of degraded areas, conservation of biodiversity, along with sharing of benefits with local people. In situ conservation has been undertaken through a system of protected areas, including more than 75 national parks and 421 wildlife sanctuaries, covering around 146,000 square km. The work is continuing.
- Coastal zone management plans by all coastal states and Union Territories as per the Coastal Zone Regulation Notification of 1991 by all coastal states and Union Territories are on. The Government has set up Standing Committees for monitoring development in such fragile ecosystems as islands.
- Generation of much-needed information about the vulnerability to climate change under the ongoing Indo-UK Climate Change Impacts Programme supported by the Ministry of Environment and Forests, Government of India. Several research organizations and academic institutions in the country are also engaged in research on climate change impacts. The Indian Institute of Tropical Meteorology, Pune, and the Indian Institute of Technology, Delhi, amongst a host of others, are engaged in developing climate change scenarios for India.

- Involvement of a number of governmental and independent agencies in climate change research in India. The India Meteorological Department (IMD) observes climatic parameters at surface and upper air observatories throughout the country. IMD's network includes 559 surface observatories, more than 8000 rainfall monitoring stations, 100 satellite-based data collection platforms in remote areas, more than 200 voluntary observing ships, 10 cyclone detection radars, and 17 storm detection radars. Since 1983, IMD has maintained a meteorological observatory at the Indian Antarctic station. This data is scrutinized and archived at the National Data Centre, Pune, and used to study, predict, and determine the effects of climate change.
- Use of state-of-art Doppler Weather Radars in a phased manner. The cities of Kolkata and Chennai have been the first ones to use them.
- Using satellite data received from INSAT to provide cloud imageries which are used to derive cloud motion vectors, sea surface temperatures, and outgoing long-wave radiation etc.
- Key role played by Indian scientists in national and international climate research efforts such as the IIOE (International Indian Ocean Expedition), MONEX (Monsoon Experiment), INDOEX (Indian Ocean Experiment), World Climate Research Programme, Global Observing System, and International Geosphere-Biosphere Programme.

1.5 **United Nations Framework Convention on Climate Change (UNFCCC)**

- 1.5.1 The **United Nations Framework Convention on Climate Change (UNFCCC)** is an international environmental treaty adopted on 9 May 1992 and opened for signature at the Earth Summit in Rio de Janeiro from 3 to 14 June 1992. It then entered into force on 21 March 1994, after a sufficient number of countries had ratified it. The UNFCCC objective is to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". The framework sets non-binding limits on greenhouse gas emissions for individual countries and contains no enforcement mechanisms. Instead, the framework outlines how specific international treaties (called "protocols" or "Agreements") may be negotiated to specify further action towards the objective of the UNFCCC.
- 1.5.2 Initially, an Intergovernmental Negotiating Committee (INC) produced the text of the Framework Convention during its meeting in New York from 30 April to 9 May 1992. The UNFCCC was adopted on 9 May 1992, and opened for signature on 4 June 1992. The UNFCCC has 197 parties as of

December 2015. The convention enjoys broad legitimacy, largely due to its nearly universal membership.

1.5.3 As also mentioned earlier, the parties to the convention have met annually from 1995 in Conferences of the Parties (COP) to assess the progress in dealing with climate change. In 2015 the Paris Agreement was adopted, governing emission reductions from 2020 onwards through commitments of countries in ambitious Nationally Determined Contributions. The Paris Agreement entered into force on November 4, 2016.

1.5.4 One of the first tasks set by the UNFCCC was for signatory nations to establish national greenhouse gas inventories of greenhouse gas (GHG) emissions and removals, which were used to create the 1990 benchmark levels for accession of Annex I countries to the Kyoto Protocol and for the commitment of those countries to GHG reductions. Updated inventories must be submitted annually by Annex I countries.

1.5.5 ***India's Initiatives***

India has undertaken numerous response measures that are contributing to the objectives of the United Nations Framework Convention on Climate Change (UNFCCC). India's development plans balance economic development and environmental concerns. The planning process is guided by the principles of sustainable development. Reforms in the energy and power sector have accelerated economic growth and enhance the efficiency of energy use. These have been complemented by notable initiatives taken by the private sector.

1.5.6 ***History of Conferences of the Parties (COPs)***

1.5.6.1 The Conference of the Parties is the governing body of the Convention, and advances implementation of the Convention through the decisions it takes at its periodic meetings.

1.5.6.2 The COP is the apex decision-making body of the Convention. All States that are Parties to the Convention are represented at the COP, at which they review the implementation of the Convention and any other legal instruments that the COP adopts and take decisions necessary to promote the effective implementation of the Convention, including institutional and administrative arrangements.

1.5.6.3 The Conference of Parties, with an aim of mitigating the effects of climate change, started to hold meetings annually from 1995 in order to prepare a global stage to set targets and monitor the same. A brief description of each COP is highlighted in the following paras:

I. COP-1: Berlin 1995

The major challenge which was to be addressed in the first COP was to find out what has to be done by each nation individually to curb the emissions of green house gases. The first COP resulted in the “Berlin Mandate”, where a two year time was allotted to analyse and evaluate the green house emission data which was further to be used to formulate a catalogue of measures from which individual parties could choose and plan their own initiatives to curb the GHG emissions.

II. COP-2: Geneva 1996

This COP resulted in creating some major decisions which formed the roadmap for future COPs. One major decision was that instead of following a uniform solution, each country was to have the freedom of planning its own solutions to address the problem of GHG emissions best suited to its interests.

III. COP-3: Kyoto 1997

This was the first COP in which the knowledge from earlier assessments, discussions and reports culminated into an action plan. Kyoto Protocol, a set of mechanisms and binding targets for GHG emissions in 37 industrialised countries from 2008 to 2012, was adopted in this COP. It was a long-term plan and it actually came into force on 16th February, 2005 after several rounds of amendments resulting from the negotiations in the subsequent COPs.

IV. COP-4: Buenos Aires 1998

This COP allotted a two year time frame to clarify the measures suggested in the Kyoto Protocol and the required details for the implementation of the Protocol.

V. COP 5: Bonn 1999

This conference was marked by the technical discussions regarding the mechanisms concurred in the Kyoto Protocol.

VI. COP 6 (I): The Hague 2000

This COP initiated with a proposal from the USA to consider agricultural and forest areas be included in carbon sinks. There was

considerable debate concerning USA and Europe and a mechanism for imposing sanctions on countries failing to meet their emission reduction obligations. In view of non-consensus, it was decided by UNFCCC to take up this proposal in an out of turn COP.

COP 6 (ii): Bonn July 2001

This meeting was the continuation of the Sixth COP. The USA rejected the Kyoto Protocol and took on a role of an observer. However, this COP took some historic decisions like the scope for inclusion of forest and other carbon sinks in a nation's budget and the principles of sanctions on countries which fail to meet the obligations.

VII. COP 7: Marrakesh 2001

This was the regular COP of 2001, which marked the culmination of negotiations on Kyoto Protocol.

VIII. COP 8: Delhi 2002

In this COP the members of European Union proposed for more stringent actions on the parties under UNFCCC but the proposal was not accepted.

IX. COP 9: Milan 2003

This COP marked the discussion regarding finalisations of last set of technical details concerning the Kyoto Protocol.

X. COP 10: Buenos Aires 2004

This meeting initiated the planning of road map ahead of Kyoto Protocol, at its expiry in 2012.

XI. COP 11: Montreal 2005

The main focus of discussion was planning the road map ahead of Kyoto Protocol. This was the first conference after the Kyoto Protocol came into force; hence there was a regular conference of all the parties, in addition to the conference of the parties which ratified the Kyoto Protocol. The parties which did not accept the Kyoto Protocol were having an observer status at the Conference of Parties to the Kyoto Protocol.

XII. COP 12: Nairobi 2006

The member parties worked collectively towards the formation of the new agreement which was to succeed the Kyoto Protocol.

XIII. COP 13: BALI 2007

In this COP the assessment report of the IPCC was the main focus. The report concluded that the signs of global warming are visible and clear now. There was an increased sense of urgency and resulted in adoption of the Bali Action Plan with modifications. This was the stringent successor of the Kyoto Protocol.

XIV. COP 14: Poznan 2008

This COP marks the beginning of an era where something substantial was done for the first time to strengthen the commitments of least developed countries by creating a fund called as Adaptation Fund. Basically, the focus of this COP was to decide (in the next COP) the negotiation process.

XV. COP 15: Copenhagen 2009

A Copenhagen accord was evolved but was neither adopted nor was it legally binding. Nevertheless, an important aspect of the Copenhagen Accord was a greater commitment of the developed countries in new and additional funding to the developing countries. Towards this end a Green Climate fund was also created.

XVI. COP 16: Cancun 2010

The Cancun conference worked to formalise the Copenhagen Accord under the ambit of UNFCCC. There were many of decisions over the delivery of long-term financial assistance and adaptation of the Green Climate Fund in which the developed countries formalised the agreements to deliver US\$ 100 Billion. Apart from this, a mechanism was also established to assess the needs and policies for the transfer of technologies for clean energy, thus further bridging the gap between the developing and developed nations.

The most historically significant decision of this conference was the adoption of the limit to increase of global temperatures under which the parties agreed unanimously to restrict the global temperature rise below an average of 2°C over the pre-industrial level.

XVII. COP 17: Durban 2011

This conference accelerated the negotiations regarding the acceptance of a global legally binding agreement on climate change by forming the Durban Platform for Enhanced Action. A new working ad-hoc group was formed to make sure that such an agreement comes into being latest by 2015, and shall be enforced by 2020. India, at this conference voiced its concern over the balance between right to development and restrictions on development due to climate change agenda for developing countries. These concerns further led to organisation of workshops by the adhoc working group to consider the issue of equitable access to sustainable development. Also, a second commitment period of Kyoto Protocol was considered but, even the economies which were parties to the earlier phase of Kyoto Protocol backed out.

A framework for the reporting of emission reductions for both developed and developing countries was also agreed, taking into account the common but differentiated responsibilities of different countries. The Green Climate Fund (GCF) was operationalized and the COP approved the governing instrument of the GCF but there was no progress on long-term financing sources.

XVIII. COP 18: Doha 2012

The major work of this COP could be considered procedural in nature. However, a major milestone was achieved in terms of finalising two work streams initiated in Bali in 2007 namely the Ad hoc working group on the Kyoto Protocol and the Ad hoc working group on long term cooperative action (LCA).

This COP was also unique in terms of bringing the anthropological aspects of empowerment of vulnerable people, in particular women. This COP marked the first ever discussions highlighting the hardships faced by uncountable men and women because of the climate change. A decision over strengthening the representation of women in COP was taken.

XIX. COP 19: Warsaw 2013

This conference began with three clear priority issues for the 195 member parties, viz, the elaboration of a timeline to secure a new international climate agreement at COP21 in Paris in 2015; the establishment of a mechanism on loss and damage; and the provision of long-term finance.

Further, a voluntary action plan was called under the name of “nationally determined contributions”, for emission reduction targets. It was a new step which helped in understanding the difference between initial collective offers and the emissions reductions needed to stay within the temperature rise of 2°C. However, this step was neither binding nor had any time limit. One of the major achievements of this COP was the completion of the “reducing emissions from deforestation and forest degradation” (REDD+) program which had the commitments of financing US\$ 280 million (from US, Norway and UK).

XX. COP 20: LIMA 2014

This COP created a sense of urgency of climate change in the backdrop of national development goals. This conference focused over the advances in the Ad Hoc Working Group on the Durban Platform for Enhanced Action (ADP), the additional body responsible for the adoption of new climate program at COP 21 in Paris. Furthermore, the draft of Paris agreement (COP 21) was prepared during this conference.

Concurrently, the Ad-Hoc group of the Doha Action Plan focused on the submission of voluntary nationally determined contributions, called the Intended Nationally Determined Contributions (INDCs) as earlier decided in the previous COP held at Warsaw.

The Parties also agreed on the up-front information that would make up the INDCs submitted by Parties, viz. Mitigation reference points (base year), implementation time frame including scope and coverage and the planning process; assumptions and methodological approaches for estimating emissions; fairness of INDCs taking into account national circumstances of individual parties etc.

XXI. COP 21: PARIS 2015

The **2015 United Nations Climate Change Conference, COP 21** or **CMP 11** was held in Paris, France, from 30 November to 12 December 2015. It was the 21st yearly session of the Conference of the Parties (COP) to the 1992 United Nations Framework Convention on Climate Change (UNFCCC) and the 11th session of the Meeting of the Parties (CMP) to the 1997 Kyoto Protocol.

The conference negotiated the Paris Agreement, a global agreement on the reduction of climate change, the text of which

represented a consensus of the representatives of the 196 parties attending it. The agreement will enter into force when joined by at least 55 countries which together represent at least 55 percent of global greenhouse emissions. On 22 April 2016 (Earth Day), 174 countries signed the agreement in New York, and began adopting it within their own legal systems (through ratification, acceptance, approval, or accession).

According to the organizing committee at the outset of the talks, he expected key result was an agreement to set a goal of limiting global warming to "well below 2 °C" Celsius compared to pre-industrial levels. The agreement calls for zero net anthropogenic greenhouse gas emissions to be reached during the second half of the 21st century. In the adopted version of the Paris Agreement, the parties will also "pursue efforts to" limit the temperature increase to 1.5 °C. The 1.5 °C goal will require zero emissions sometime between 2030 and 2050, according to some scientists.^[2]

XXII. COP 22: Marrakech 2016

The **2016 United Nations Climate Change Conference** was an international meeting of political leaders and activists to discuss environmental issues. It was held in Marrakech, Morocco, on 7-18 November 2016. The conference incorporated the twenty-second Conference of the Parties (COP22), the twelfth meeting of the parties for the Kyoto Protocol (CMP12), and the first meeting of the parties for the Paris Agreement (CMA1). The purpose of the conference was to discuss and implement plans about combatting climate change and to "[demonstrate] to the world that the implementation of the Paris Agreement is underway".^[1] Participants work together to come up with global solutions to climate change.

The conference was presided over by Salaheddine Mezouar, the Moroccan Minister for Foreign Affairs and Cooperation. Approximately 20,000 participants were expected to attend.

On 2 May 2016, events firm GL Events signed the service contract. The Food and Agriculture Organization of the United Nations also lent its support to the preparation for COP 22".

XXIII. COP 23: Bonn 2017

COP 23 was held on 6–17 November 2017. On Friday, 18 November 2016, the end of COP 22, the Chairperson of COP 23 from Fiji announced that it will be held in Bonn, Germany. (COP 23/CMP 13).

Fijian Prime Minister and incoming President of COP 23, Frank Bainimarama, on 13 April launched the logo for this year's United Nations Climate Change Conference, to be held at UN Campus, Bonn in November.

XXIV. COP 24: Katowice 2018 (3rd December onwards)

COP 24 was held on 3–14 December 2018 in Katowice, Poland.

COP 24 has agreed for new admissions as 'observers' in COP 24. Eight new inter-governmental organisations and 137 new non-governmental organisations have been approved by COP.

XXV. **COP25/CMP15/CMA2 are planned to be held in Madrid, Spain in Dec. 2019.**

1.6 **Paris Agreement and COP 21**

- 1.6.1 The most important aspect of the COP held in Paris, was that all the member parties had a sense of urgency about the climate changes. In the entire journey of COPs the major portion was dedicated to planning and discussion over the path which could limit the global temperature rise by the end of the year 2100 to 2°C, even though the 2°C rise does not necessarily guarantee a no damage situation but there would be hope that at least the damage could be managed, i.e. the changes will not be irreversible in nature. In the COP 21, the parties had firmly agreed to make even more stringent efforts & restrict the global temperature rise to 1.5°C.
- 1.6.2 In COP 21, the participating 195 countries agreed by consensus to the final global pact, the Paris Agreement to curb emissions. The United States of America and China, the leading emitters of greenhouse gases were totally committed to make the deal 'ambitious'; also with Brazil joining hands with the European Union, the United Nations and 79 other countries in a so called 'high-ambition coalition' with a shared ambition of reaching a legally binding agreement gives out a positive signal in crossing the diplomatic hurdle. Further, as a procedural strength of the agreement the country that ratifies the agreement will set a target for emission reduction of voluntary amount, as the measure decided under the head INDC in the previous COP-20 held in Lima. This is further reinforced by the fact that there will be mechanism to force the countries to set target by specific date but there is no mechanism to check the implementation of the declared target.
- 1.6.3 ***Paris Agreement***
 - 1.6.3.1 The Paris Agreement is unique in the context of calling the member parties

for a greater co-operation, even though the agreement is still not legally binding for the parties. The Agreement and its recommendations, however, binds the parties diplomatically defining a new relationship between a nation's diplomatic credibility and its policy decision in accordance with the Paris Agreement.

1.6.3.2 The importance of Paris Agreement can be summarized under the key aspects of the agreement as follows:

1. Long-term goal: The Paris Agreement reiterates the commitment of restricting the global temperature rise to a point well below 2°C, and also commits to make efforts towards restricting the same to 1.5°C. It would be worth noting that the temperature rise has already reached 1°C above pre-industrial times. It has been decided in the conference that by the year 2050, the man-made emissions should be cut down to a level which can be absorbed in the natural carbon sinks, viz. forests and oceans.
2. Emission Targets: Member parties have agreed to submit targets in line with the long-term goals of curbing emissions every five years. More than 180 countries have already submitted their targets for the first cycle beginning 2020 onwards. However, only developed countries have the liability to reach the targets in 'absolute terms'. The developing countries have been charged with the responsibility of capacity-building in order to enable them to strike a balance between their right to development and obligation to fight climate change.
3. Mechanism of Reviewing Targets: The initial emission targets set by the countries are not good enough. The agreement seeks governments to review their targets of emission cuts submitted by them in the next four years. There is also a mechanism for review of INDCs every five years. The idea is that as the science and technology will advance in tapping the potential of renewable energy, the targets can be reviewed, revised and made even tougher.
4. Transparency: Even though the long standing demand of several countries for issuing sanctions against countries not standing by their commitment on their targets was not fulfilled, the agreement sets transparency rules which encourage nations to meet their own commitments, specially the developing nations.
5. Financial Support: The agreement says that the developed world should continue to offer financial aid to help their developing and underdeveloped counterparts overcome the financial hurdles in mitigating the effects of climate change and cutting down emission. Further, the agreement motivates other countries to voluntarily donate. Such an attempt will help

generating financial resources from the wealthier developing countries, like China also.

6. Loss and Damage: the concerns of the small island countries, threatened by rising seas, were addressed by including a section in the agreement recognizing “Loss and damage” associated with climate related disasters. But, in the end a foot note stated that loss and damage does not involve liability or compensation, in order to address the concern of some other nations.

1.6.4 **The US has recently withdrawn from global climate change discussions.**

1.7 **India's Lead Role**

- 1.7.1 In the last few years several measures relating to environmental issues have been introduced. They have targeted increasing significantly, the capacity of renewable energy installations; improving the air quality in major cities (the world's largest fleet of vehicles fuelled by compressed natural gas has been introduced in New Delhi); and enhancing afforestation. Other similar measures have been implemented by committing additional resources and realigning new investments, thus putting economic development on a climate-friendly path.

- 1.7.2 **Prime Minister of India has taken a leading global role and important initiatives on issues relating to climate change and mitigation giving primacy to the country's growth and development needs.**

1.8 **Initiatives & Measures**

1.8.1 ***Modeling Studies***

- 1.8.1.1 In order to create and strengthen the scientific and analytical capacity for assessment of climate change in the country, different studies have been initiated under the Climate Change Action Programme (CCAP), including National Carbonaceous Aerosols Programme (NCAP), Long Term Ecological Observatories (LTEO) Programme, and GHG.

1.8.2 ***National Communication and Biennial Update Report (BUR)***

- 1.8.2.1 National Communication and Biennial Update Report (BUR) are furnished periodically to the UNFCCC. These include information on National Circumstances, National Greenhouse Gas Inventory, Mitigation Actions, Domestic Monitoring, Reporting and Verification (MRV) arrangements, Finance, Technology & Capacity Building Needs, and Support Received.

1.8.2.2 **BUR-1 (India's first BUR) highlighted that 12% of India's GHG emissions were offset by carbon sink action of forests & croplands. It also highlighted that India's per capita GHG emission in 2010 was 1.56 tCO₂ equivalent which is less than one third of the world's per capita emissions & far below than many developed & developing countries. The Reports were submitted to UNFCCC and discussion held.**

1.8.3 ***National Action Plan on Climate Change (NAPCC)***

1.8.3.1 Government of India is implementing the National Action Plan on Climate Change (NAPCC) with a focus on promoting the understanding of climate change and establishing linkage between adaptation and mitigation consistent with the national priority for achieving sustainable development. It comprises of eight national missions representing multipronged, long-term and integrated strategies for achieving key goals in the context of climate change. These missions focus on specific areas of Solar Energy, Enhanced Energy Efficiency, Sustainable Habitat, Water, Sustaining the Himalayan Ecosystem, Green India, Sustainable Agriculture and Strategic knowledge for Climate Change.

1.8.4 ***State Action Plan on Climate Change (SAPCC)***

1.8.4.1 The Government had encouraged the states to provide state-level action plan for climate change and also provided financial support.

1.8.5 ***National Adaptation Fund on Climate Change (NAFCC)***

1.8.5.1 National Adaptation Fund on Climate Change (NAFCC) was launched in 2015 with an initial outlay of Rs. 350 Crore to meet the cost of adaptation to climate change for the State and Union Territories of India that are particularly vulnerable to the adverse effects of climate change.

1.8.6 ***Climate Change Action Programme (CCAP)***

1.8.6.1 Climate Change Action Programme (CCAP) is a central scheme which was approved by the Cabinet in January 2014 at a total cost of Rs. 290 Crore for duration of five years. Its objective is to create and strengthen the scientific and analytical capacity for assessment of climate change in the country.

1.8.6.2 Some of the components of the CCAP scheme include the National Carbonaceous Aerosols Programme (NCAP), Long Term Ecological Observatories (LTEO), and Coordinated Studies on Climate Change for North-East Region (CSCCNER).

1.8.6.3 The Science Plan of LTEO was released by Hon'ble Minister, EF&CC on the sideline of the 21st Conference of the Parties (COP-21) to the United Nations Framework Convention on Climate Change (UNFCCC) at Paris, France in 2015. Under the project, it is proposed to establish 31 weather stations across all the LTEO field sites for recording bioclimatic variable etc.

1.8.7 ***India's post-2020 Climate Goals***

1.8.7.1 For post-2020 period, in response to the decisions of the Conference to the Parties, India submitted its Nationally Determined Contribution (NDC) to the UNFCCC in October, 2015, outlining the climate actions intended to be taken under the Paris Agreement. The eight goals put forth by India in its NDC are --:

1. To put forward and further propagate a healthy and sustainable way of living based on traditions and values of conservation and moderation.
2. To adopt a climate friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development.
3. To reduce the emissions intensity of its GDP by 33 to 35 percent by 2030 from 2005
4. To achieve about 40 percent cumulative electric power installed capacity from non-fossil fuel based energy resources by 2030 with the help of transfer of technology and low cost international finance including from Green Climate Fund (GCF).
5. To create an additional carbon sink of 2.5 to 3 billion tonnes of CO₂ equivalent through additional forest and tree cover by 2030.
6. To better adapt to climate change by enhancing investments in development programmes in sectors vulnerable to climate change, particularly agriculture, water resources, Himalayan region, coastal regions, health and disaster management.
7. To mobilize domestic and new & additional funds from developed countries to implement the above mitigation and adaptation actions in view of the resource required and the resource gap.
8. To build capacities, create domestic framework and international architecture for quick diffusion of cutting edge climate technology in India and for joint collaborative R&D for such future.

1.8.7.2 For preparing the roadmap for implementation of India's NDC in post-2020 period, the MoEF&CC has constituted an NDC Implementation committee. With India's target of a US\$ 5 trillion economy by 2024, New India will be undertaking massive infrastructure development before the first global stock taking (under the Paris Agreement). For the present, India will elaborate its post 2020 climate actions pledged in its NDC.

1.8.8.8 **India has participated in the Conferences with a constructive and positive approach and emphasized its aim to protect and give primacy to India's long-term interests and its developmental priorities.**

1.8.9 ***Climate Change Innovation Programme (CCIP)***

1.8.9.1 Through Climate Change Innovation Programme (CCIP), the State Governments are being provided with technical assistance in preparing and refining SAPCCs. It also assists in preparing sectoral action plans and projects to address climate change adaptation in thematic areas such as water, urban flooding, agriculture, forestry, coastal vulnerability, health as well as securing finance for implementing the plans

1.8.10 ***Clean Development Mechanism (CDM)***

1.8.10.1 The Clean Development Mechanism (CDM) has been a flagship programme addressing climate change mitigation and simultaneously giving an opportunity to developing countries in meeting their sustainable development objectives. CDM allows emission reduction or removal projects in developing countries to generate carbon offset credit, each equivalent to one tonne of carbon dioxide. These certified emission reduction credits (CERs) could be traded, sold and used by industrialized countries to meet part of their emission reduction targets under Kyoto Protocol.

1.8.10.2 The Government of India had set up a National CDM Authority (NCDMA). Some notable measures under CDMA are:

- Till November, 2017, 1653 out of total 7788 projects registered by the CDM Executive Board were from India, which is the second highest in the world.
- As on date, Certified Emission Reductions (CERs) issued to Indian projects is 235 million (12.6%) of the total 1869 million CERs issued.
- The National CDM Authority (NCDMA) in the Ministry has accorded Host Country Approval to 3028 projects. These projects are in the sectors of energy efficiency, fuel switching, industrial processes, municipal solid waste, renewable energy and forestry spread across the country (covering all states in India).
- About 90% of the CDM projects are developed by private sectors which has facilitated huge private sector investments in the country.

1.8.11 ***World Bank Partnership for Market Readiness (PMR)***

- 1.8.11.1 The PMR Project aims to support and incentivize a market and piloting new approaches that allow emission reductions in a cost effective manner, while also addressing other priorities such as incentivizing waste, energy security, growth and development in the country.
- 1.8.11.2 The 8 million US Dollar grant allotted to India under the PMR Project will be utilised to develop voluntary carbon market in waste management and Micro, Small and Medium Scale Enterprises (MSME) sectors with carbon credits. These sectors have been identified to have significant mitigation potential and the ability to contribute to India achieving its NDCs targets. The Project is aimed to be completed in 2020.

1.8.12 ***Ozone Layer Protection***

- 1.8.12.1 India is a Party to the Vienna Convention for the Protection of the Ozone Layer and the Montreal Protocol on Substances that Deplete the Ozone Layer and its amendments / adjustments.
- 1.8.12.2 India has set up the Ozone Cell as a National Ozone Unit (NOU) to render necessary services for effective and timely implementation of the Protocol and its ODS phase-out program in India.
- 1.8.12.3 The Montreal Protocol is to phase out the production and consumption of the Ozone Depleting Substances (ODSs). With the extraordinary international cooperation under this agreement it is estimated that with continued, full implementation of the Montreal Protocol's provisions, the global ozone layer should return to pre-1980 levels by around the middle of this century which will give substantial climate benefits.

1.8.13 ***Kigali Amendment / Montreal Protocol***

- The negotiations for phasing down of HFCs under the Montreal Protocol were initiated way back in 2009, but these negotiations gathered momentum only after India submitted an amendment proposal for phase down of HFCs under the Montreal Protocol in April, 2015.
- **India has been a strong advocate of the principle of Common but Differentiated Responsibility and relevance of national circumstances in the matter of global actions to protect environment.**
- In the Kigali Amendment, it has been agreed that the developing countries will have two set of baselines – one for the early movers in which case it will be 2020, 2021, and 2022 and the other for those whose national circumstances were different and the manufacturing of HFCs and consumption in whose case was still rising in the absence of

clear alternative technologies. In case of such countries the agreed baseline years are 2024, 2025 and 2026.

- The developed countries will have baseline years of 2011-2013 with separate reduction schedule starting 10% in 2019.
- India piloted a realistic baseline of 2024-2026 for production and consumption of HFCs in developing countries for phase-down of HFCs.

1.8.13.1 This agreement facilitates adequate carbon Space for growth on domestic industry while minimizing the cost to the economy during the transition period.

1.8.13.2 On India's initiative, it was agreed in Kigali that the Multilateral Fund under the Montreal Protocol will provide funds for maintaining or increasing the energy efficiency with new technology. Funding for R&D and servicing sector in developing countries has also been included in the agreed solutions on finance.

- India has been able to secure an agreement that provides adequate space for growth of our economy, while providing adequate time for industry to shift to sustainable alternatives in the interest of environment. The agreed arrangements will minimize the cost to consumers in transitioning away from HFCs and provide for domestic innovation to develop in the sector of new generation refrigerants, etc.

1.9 ***Awareness Programme***

1.9.1 Countrywide awareness programme regarding importance of measures needed, mitigation steps, amongst all sections of the population, were taken.

1.10 **Sea Level Rise**

1.10.1 Since at least the start of the 20th century, the average global sea level has been rising. Between 1900 and 2016, the sea level rose by 16–21 cm (6.3–8.3 in). More precise data gathered from satellite radar measurements reveal an accelerating rise of 7.5 cm (3.0 in) from 1993 to 2017, which is a trend of roughly 30 cm (12 in) per century. This acceleration is due mostly to human-caused global warming, which is driving thermal expansion of seawater and melting of land-based ice sheets and glaciers. Between 1993 and 2018, thermal expansion of the oceans contributed 42% to **sea level rise**; the melting of temperate glaciers, 21%; Greenland, 15%; and Antarctica, 8%. Climate scientists expect the rate to further accelerate during the 21st century.

1.10.2 A conservative estimate of the long-term projections is that each Celsius

degree of temperature rise triggers a sea level rise of approximately 2.3 meters (4.2 ft/degree Fahrenheit) over a period of two millennia: an example of climate inertia.

- 1.10.3 The sea level will not rise uniformly everywhere on Earth, and it will even drop in some locations. Local factors include tectonic effects and subsidence of the land, tides, currents and storms. Sea level rises can influence human populations considerably in coastal and island regions. Widespread coastal flooding is expected with several degrees of warming sustained for millennia. Further effects are higher storm-surges and more dangerous tsunamis, displacement of populations, loss and degradation of agricultural land and damage in cities. Natural environments like marine ecosystems are also affected, with fish, birds and plants losing parts of their habitat.

1.10.4 **Regional Sea Level Change**

- 1.10.4.1 Sea level rise is not uniform around the globe. Some land masses are moving up or down as a consequence of subsidence (land sinking or settling) or post-glacial rebound (land rising due to the loss of the weight of ice after melting), so that local sea level rise may be higher or lower than the global average.
- 1.10.4.2 Many ports, urban conglomerations, and agricultural regions are built on river deltas, where subsidence of land contributes to a substantially increased relative sea level rise. This is caused by both unsustainable extraction of groundwater (in some places also by extraction of oil and gas), and by levees and other flood management practices that prevent accumulation of sediments from compensating for the natural settling of deltaic soils.
- 1.10.4.3 The Atlantic is set to warm at a faster pace than the Pacific. This has consequences for Europe and the U.S. East Coast, which underwent a sea level rise 3-4 times the global average. The downturn of the Atlantic meridional overturning circulation (AMOC) has been also tied to extreme regional sea level rise on the US Northeast Coast.
- 1.10.4.5 Current and future sea level rise is set to have a number of impacts, particularly on coastal systems. Such impacts include increased coastal erosion, higher storm-surge flooding, inhibition of primary production processes, more extensive coastal inundation, changes in surface water quality and groundwater characteristics, increased loss of property and coastal habitats, increased flood risk and potential loss of life, loss of non-monetary cultural resources and values, impacts on agriculture and aquaculture through decline in soil and water quality, and loss of tourism,

recreation, and transportation functions. Many of these impacts are detrimental. Owing to the great diversity of coastal environments; regional and local differences in projected relative sea level and climate changes; and differences in the resilience and adaptive capacity of ecosystems, sectors, and countries, the impacts will be highly variable in time and space. River deltas in Africa and Asia and small island states are particularly vulnerable to sea-level rise.

- 1.10.4.6 Globally, tens of millions of people will be displaced in the latter decades of the century if greenhouse gases are not reduced drastically. Many coastal areas have large population growth, which results in more people at risk from sea level rise.
- 1.10.4.7 Several days after, United Nations Secretary General António Guterres cited the report calling to Asian countries to implement a carbon tax, stop building new coal plants and stop subsidies to fossil fuels.
- 1.10.4.8 Rising seas has also been tied to an increased risk from tsunamis, potentially affecting coastal cities in the Pacific and Atlantic Oceans.
- 1.10.4.9 Food production in coastal areas is affected by the rising sea levels. Due to flooding and salt water intrusion into the soil, the salinity of agricultural lands near the sea increases, posing problems for crops that are not salt-resistant. Furthermore, salt intrusion in fresh irrigation water poses a problem for crops that are irrigated. Newly developed salt-resistant crop variants are currently more expensive than the crops they are set to replace.
- 1.10.4.10 With an expected rise in the frequency and intensity of storms, they may become more significant in determining island shape and size than sea level rise. The Island nation of Fiji is being impacted by sea level rise. Five of the Solomon Islands have disappeared due to the combined effects of sea level rise and stronger trade winds that were pushing water into the Western Pacific.
- 1.10.4.11 Coastal ecosystems are facing drastic changes as a consequence of rising sea levels. Many systems might ultimately be lost when sea levels rise too much or too fast. Some ecosystems can move land inward with the high-water mark, but many are prevented from migrating due to natural or artificial barriers. This coastal narrowing, sometimes called 'coastal squeeze' when considering human-made barriers, could result in the loss of habitats such as mudflats and marshes. Mangroves and tidal marshes adjust to rising sea levels by building vertically using accumulated sediment and organic matter. If sea level rise is too rapid, they will not be able to keep up and will instead be submerged.

- 1.10.4.12 Scientists keep refining their models of sea-level changes. They also point out that the extent to which countries work together to limit release of more greenhouse gases may have a significant impact on how quickly seas rise, and how much.

1.11 Desertification

- 1.11.1 According to Wikipedia, *“Desertification is a type of land degradation in which a relatively dry land region becomes increasingly arid, typically losing its bodies of water as well as vegetation and wildlife. It is caused by a variety of factors, such as climate change and human activities. Desertification is a significant global ecological and environmental problem.”*

- 1.11.2 According to UNESCO, one third of world's land surface is threatened by desertification and across the world it affects livelihood of millions of people who depend on the benefits of ecosystems that drylands provides. Desertification is a major environmental concern and a major barrier to meeting human basic needs in drylands and are being constantly threatened by increases in human pressures and climatic variability.

- 1.11.3 Desertification can be defined as a process of land degradation in arid, semi-arid and sub-humid areas due to various factors including climatic variations and human activities. It results in persistent degradation of dryland and fragile ecosystems due to man-made activities and variations in climate.

1.11.4 ***Reason for Desertification***

- Climate change plays a huge role in desertification and unless it is not slowed down, huge areas of land could become desert.
- Deforestation: Due to urbanisation and population pressures.
- Overgrazing: If there are too many animals that are overgrazing in certain spots, it makes it difficult for the plants to grow back.
- Farming Practices: Due to stripping of the soil of its nutrients.
- Stripping the land of resources. If an area of land has precious natural resources like natural gas, oil, or minerals and people mine it, the soil gets stripped of nutrients, which kills plant life.
- Natural Disasters like drought.

1.11.5 ***Impact of Desertification***

- Poor Water Quality: If an area becomes a desert, water does not remain potable since plant life is instrumental in keeping the water clean and clear.
- Farming becomes very difficult.
- Hunger: Without farms food becomes scarce; Animals are also affected.
- Overpopulation can lead to poverty & make harder for people to subsist.

1.11.6 ***Corrective Action***

- Policy Changes to land-use to get natural resources. The policies that govern them should be such that will help the land to thrive.
- Policy Reforms for Farming. Policy change related to how often people can farm and how much they can farm on certain areas.
- Education: Education is an important tool especially in developing countries to help people to understand the best way to use the land that they are farming on. By educating them on sustainable practices, more land could be saved from becoming a desert.
- Technology Advances. In some cases, it's difficult to try and prevent desertification from happening. In those cases, there needs to be research and advancements in technology that push the limits.
- By Rehabilitation Efforts. There are some ways that one can go back and rehabilitate the land that has undergone desertification.

1.11.7 Desertification is a serious issue that needs to be addressed on priority.

Later may be 'too Late'.

1.11.7.1 The Conference held in India in early September 2019 is a follow-up in the right direction. The Declaration at the end of the Conference (**see Appendix**) is perhaps very timely.

1.12 ***Adaptation to Climate Change***

1.12.1 In his Book “Ten Technologies to Save the Planet”, Goodall (2008) shows considerable optimism and mentions that each of the ten Chapters of the

Book looks at a technology or technique that could reduce CO₂ emissions by at least 10% of the annual world total. All these technologies are comfortably within our scientific and technological reach and so the Author argues that we should be able to 'decarbonise the economy' at an affordable price. The Ten Technologies mentioned are:

i. **Capturing the Wind**

ii. **Solar Energy:** The sunlight hitting the earth's surface every day contains around 7,000 times more energy than the fossil fuels that humanity consumes.

iii. **Electricity from the Oceans:** Tapping tides, waves and currents.

iv. **Combined Heat and Power (CHP):** (a) Use of fuel cells powered by hydrogen created from renewable sources for individual buildings, and (b) Use of small power stations close to homes or offices fired by wood or other biomass and piping the 'waste' heat to where it is needed.

v. **Super-efficient Homes.**

vi. **Electric Cars.**

vii. **Motor Fuels from Cellulose:** Second-generation biofuels.

viii. **Capturing Carbon:** Clean coal, algae and scrubbing the air.

ix. **Biochar:** Sequestering carbon as charcoal.

x. **Soil and Forests:** Improving the planet's carbon sinks.

1.12.2 **Sun uses hydrogen fusion to generate energy. Our research activities must be directed with a much greater vigour to use the energy from the Sun and also towards generating energy from 'hydrogen fusion'.**

1.12.3 **Sachs (2008) observes that the challenges of sustainable development – protecting the environment, stabilizing the world population, narrowing the gaps between the rich and the poor, and ending extreme poverty – will need global cooperation.**

1.12.4. Four goals have been suggested by Sachs (2008) to overcome these challenges of sustainable development:

- **Sustainable systems of energy, land, and resource use that avert**

the most dangerous trends of climate change, species extinction, and destruction of ecosystems.

- Stabilization of the world population at eight billion or below by 2050 through a voluntary reduction of fertility rates.
- The end of extreme poverty by 2025 and improved economic security within the rich countries as well.
- A new approach to global problem solving based on cooperation among nations & the dynamism and creativity of the non-governmental sector.

1.12.5 We need agreements at the global level and attitudes throughout the world that are compatible with meeting the global challenges.

1.12.6 To give a thrust to this vital issue of addressing the Climate Change, **National Action Plan on Climate Change (NAPCC)** has been prepared and was released in June 2008 by the Prime Minister. The **eight core missions** and the Broad Goals of NAPCC can be seen in the Box below.

National Action Plan on Climate Change: Eight Core Missions

No.	National Mission	Goals
1	National Solar Mission	Specific goals for increasing the use of solar thermal technologies in urban areas, industry, and commercial establishments; Long term aim is to make solar competitive with fossil based energy.
2	National Mission for Enhanced Energy Efficiency	Initiatives based on the Energy Conservation Act 2001.
3	National Mission on Sustainable Habitat	Extending the existing Energy Conservation Building Code; Emphasis on urban waste management and recycling, including power production from waste; in the Transport Sector it calls for stronger enforcement of automotive fuel economy standards, using pricing measures to encourage the purchase of efficient vehicles, and providing incentives for use of public transport.

No.	National Mission	Goals
4	National Water Mission	20% improvement in water use efficiency through pricing and other measures.
5	National Mission for Sustaining the Himalayan Ecosystem	Conservation of biodiversity, forest cover, and other ecological values in the Himalayan region, where glaciers are likely to recede.
6	National Mission for a "Green India"	Expanding forest cover from 23% to 33%.
7	National Mission for Sustainable Agriculture	Promotion of sustainable agricultural practices.
8	National Mission on strategic Knowledge for Climate Change	The plan envisions a new Climate Science Research Fund that supports activities like climate modeling, & increased international collaboration; It also seeks to encourage private sector initiatives to develop adaptation and mitigation technologies.

1.12.7 ***Action Plan to tackle Climate Change***

- Conscious realization must be made by the World Community that Climate Change is a major problem afflicting the whole Planet and while presently it may be affecting the poorer nations more, but has the potential to affect all the nations. Current cyclones and floods in USA / Japan / Europe are ample testimony to this fact. A cooperative approach to problem solving is thus called for and any isolated detractors have to be suitably tackled (by coercion and / or International Law / Covenants).
- All nations should develop suitable action plans on Climate Change within the overall guiding principles of the World community.
- We have to re-look our 'growth model' so that it puts lesser emphasis on resource-intensive growth and greater emphasis on Human Development / Happiness.
- Austerity in all walks of life as preached by Gandhi / Mahavira, by one and all, appears to be the only way out.

- Development of poorer nations cannot be ignored. Firstly, because 'severe income disparity' is a major Global Risk (2013) and Secondly, if they grow following the highly polluting resource intensive development model of West they will greatly add to environmental pollution. The only viable option appears that the West provides them with efficient sustainable technologies of the future for their growth.
- New generation of technologies have to be developed and made more sensitive to environment. Here, heavy reliance on 'solar power' and producing energy using 'hydrogen fusion' can be mentioned which will need specially directed R&D inputs / efforts.
- We need an economic system that can provide for World's population without destroying the environment. Our global footprint is already 140% and ecological security is the need of the hour. The Classical Economics has to give way to '**Sustainable Economics**'.
- Educating and empowering the World citizens to effectively and ethically handle the Climate Change issues is essential. For long term sustainability, the solutions have to consider oneness of all life and its thorough interconnectedness with the Nature.
- **The Journey is difficult but it is related to our wellbeing and survival.**

1.13 Stubble Burning

- 1.13.1 **Stubble burning** is intentionally setting fire to the straw stubble that remains after grains, like paddy, wheat, etc., have been harvested. The practice was widespread until the 1990s, when governments increasingly restricted its use.



- 1.13.2 Wheat stubble burning is comparatively a newer issue which started with mechanised harvesting using combine harvesters.

1.13.3 The practice of stubble burning is being largely carried out at locations since 1980's, where combine machines replaced manual labour for harvesting and threshing their paddy. In northern India, there is a ban by the Punjab Pollution Control Board. Stubble burning is however still practiced at locations. Authorities are now enforcing the ban more proactively.

1.13.3.1 Harvesting paddy manually does not result in stubble burning.

1.13.4 ***Other Countries***

- Stubble burning has been largely prohibited since 1993 in England and Wales. A perceived increase in blackgrass, particularly herbicide resistant blackgrass, has led to a campaign by some arable farmers for its return.
- In Australia stubble burning is "not the preferred option for the majority of farmers" but is permitted and recommended in some circumstances. Farmers are advised to rake and burn windrows, leaving a fire break around any burn off.
- In US, such burning is done in some mid-western states and a number of states regulate the practice.
- In the European Union, the Common Agricultural Policy strongly discourages stubble burning.
- In China, there is a government ban on stubble burning; through the practice is in use at some locations.
- Stubble burning is allowed by permit in some Canadian provinces.

1.13.5 ***Impacts***

1.13.5.1 ***Detrimental Effects***

- Loss of nutrients
- Pollution from smoke
- Damage to electrical and electronic equipment from floating threads of conducting waste
- Risk of fires spreading out of control.

1.13.5.1.1 In addition to wheat and paddy, sugarcane leaves are most commonly burnt. According to an official report, more than 500 million tonnes of parali (crop residues) is produced annually in the country; cereal crops (rice, wheat, maize and millets) account for 70 per cent of the total crop

residue. Of this, around 34 per cent comes from rice and about 22 per cent from wheat crops, most of which is burnt on the farm. According to an estimate, almost 80 per cent of this is burnt.

- 1.13.5.1.2 It has been estimated, that one tonne of stubble burning leads to a loss of 5.5 kilogram nitrogen, 2.3 kg phosphorus, 25 kg potassium & more than 1 kg of **sulfur**—all of which are soil nutrients, besides organic carbon.
- 1.13.5.1.3 The heat from burning paddy straw penetrates 1 centimetre into the soil, elevating the temperature to 34 to 42 degree Celsius. This kills the bacterial and fungal populations critical for a fertile soil.
- 1.13.5.1.4 Burning of crop residue causes damage to other micro-organisms present in the upper layer of the soil as well as its organic quality. Due to the loss of 'friendly' pests, the wrath of 'enemy' pests increases and as a result, crops are more prone to disease. The solubility capacity of the upper layers of soil also reduces.

1.13.5.2 *Beneficial Impact*

- Kills slugs and other pests.
- Can reduce nitrogen tie-up.

- 1.13.5.2.1 The well known Agriculture scientist M S Swaminathan has pointed out that stubble is not burnt in southern India, as it holds an economic value as animal feed. “For years, I pointed out many economic uses of rice straw. We should adopt a do-ecology approach with farmers to convert rice stubble into income rather than making them agents of eco-disaster”.
- 1.13.5.2.2 Instead of burning of the stubble, it can be used in different ways like cattle feed, compost manure, roofing in rural areas, biomass energy, mushroom cultivation, packing materials, fuel, paper, bio-ethanol and industrial production, etc.

1.13.6 **Measures**

- 1.13.6.1 In 2014, the government enacted the National Policy for Management of Crop Residue. Since then, crop residue management has helped make the soil more fertile, thereby resulting in savings in farmers manure costs. The Government has introduced promotional schemes for agricultural mechanization for In-Situ management of crop residue in northern states, establishment of Custom Hiring Centres (CHCs), awareness programmes, use of biomass pellets (with coal) in thermal power plants

etc. Zero tillage farming has also been encouraged. The results have had a positive impact and the satellite data has also shown substantial improvements (25-30%).

1.13.6.2 Farmers can also manage crop residues effectively by employing agricultural machines like:

- Happy Seeder (used for sowing of crop in standing stubble)
- Rotavator (used for land preparation and incorporation of crop stubble in the soil).
- Zero till seed drill (used for land preparations directly sowing of seeds in the previous crop stubble)
- Baler (used for collection of straw & making bales of the paddy stubble)
- Paddy Straw Chopper (cutting of paddy stubble for easily mixing with the soil)
- Reaper Binder (used for harvesting paddy stubble and making into bundles)

1.13.6.3 A top court bench ordered that all farmers be given a Rs 100 per quintal incentive to prevent them from setting their fields on fire in preparation for the next crop, and provide them free machines to get rid of the agriculture residue. The bench has also demanded an action plan on top priority within three weeks to deal with the problem from the Centre and the states in and around the National Capital Region.

1.14 Conclusions

1.14.1 It is recalled that prior to the conference, 146 national climate panels had apprised draft national climate contributions (called 'Intended Nationally Determined Contributions', INDCs). These suggested that the commitments may limit global warming to 2.7°C by 2100.

1.14.2 A global agreement, the **Paris Agreement**, was negotiated which represented a consensus of the 196 parties attending it. For it to become legally binding, it was to be ratified and signed by at least 55 countries within one year from 22 April 2016 (Earth Day). Each country that ratified the Agreement would need to set an emission reduction target.

1.14.3 A goal of limiting global warming to less than 2°C, compared to pre-industrial levels, was agreed. Efforts had also to be made to limit the temperature rise to 1.5°C only. Interestingly, the 1.5 °C goal would mean zero emissions sometime between 2030 and 2050. There would be no enforcement mechanism for not advising targets in time or for non-achievement of targets. This is at variance from the earlier methodology discussed at Kyoto.

- 1.14.4 The progress, however, appears to be not fast enough. The clock continues to tick and the world has little time left and unless newer agreements are arrived at quickly, humankind may have to pay a heavy price for complacency.

1.15 **SUSTAINABILITY**

- 1.15.1 At present the most widely and accepted definition of Sustainable Development is the one that was adopted at the Rio Summit – “Meeting the needs of the present without compromising the ability of future generations to meet their own needs”. This would involve an all-encompassing cooperation between all global stakeholders, industry, businesses etc., to tackle the challenges of poverty, health, food, environmental degradation and promote development in a sustainable manner. Interestingly, India has 2.4% of earth's land with about 1% of world's forest cover, about 4% of the fresh water and is home to one-sixth of world's population.

- 1.15.1.1 The sustainable development challenge calls for uplifting such mass of humanity without adversely impacting the environment, or affecting earth's regenerative ability, or depleting earth's natural resources, apart from combating numerous other limitations. An important aspect of sustainable development is inclusive or participatory growth. Nevertheless, globally, there is an urgent need for a paradigm shift for promoting environmentally sustainable development. Unless this is done, mankind would be seriously compromising the ability of future generations to meet their needs.

1.15.2 ***Development Sustainability***

- 1.15.2.1 Sustainable development is the process/methodology/road-map for utilizing the finite planetary resources in a manner that the necessary needs of the present and future generations are taken care of in perpetuity, in a manner that the stability and integrity of the natural systems are not adversely impacted.

- 1.15.2.2 The definition of Sustainable Development universally accepted was the one largely based on the Brundtland Report (1987). It defines Sustainable Development as — “Meeting the needs of the present without compromising the ability of future generations to meet their own needs”. This would involve all-encompassing cooperation and efforts between all global stakeholders, businesses and industry, etc, to tackle the challenges of poverty, food, health, environmental degradation and promote development in a sustainable manner.

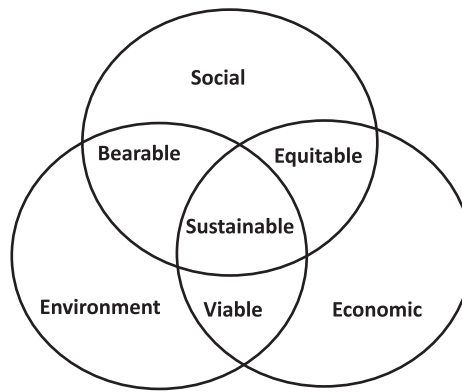
- 1.15.2.3 This refers, as the name also suggests, to an all encompassing growth for

all sections of the population, particularly the marginalized, under-privileged, BPL segments etc.

- 1.15.2.4 Economic growth provides income enhancing activities and if it is in a sustainable manner covering the under-privileged, farmers, myriads of small businessmen, it would result in upliftment of all concerned, especially the needy.
- 1.15.2.5 The PMJDY (Pradhan Mantri Jan-Dhan Yojana) launched in August 2014 and the RuPay Card, (which is a payment solution), are important new measures taken by the Govt. for financial inclusion. Besides, the government has restructured a number of on-going programmes based on field experience to make them need based. Further, to facilitate coordinated functioning of the various social infrastructure and human development programmes, the Sansad Adarsh Gram Yojna (SAGY) has been launched which will be implemented through convergence of existing programmes. Another scheme launched is the Vanbandhu Kalyan Yojna that is being implemented in specified blocks in identified States.
- 1.15.2.6 **The recent opening of Bank accounts for a wide spectrum of the population is also greatly facilitating implementation of the sustainable development process.**
- 1.15.2.7 Sustainability requires the reconciliation of environmental, social equity, and economic needs. Sustainable development, environmental (climate change: mitigation and adaptation) and social equity (inclusive growth) issues are being suitably addressed in our country with **primacy** being given to economic growth and development objectives.

1.15.3 ***Sustainability: Some Dimensions***

- 1.15.3.1 Sustainability is the capacity to endure. In ecology the word describes how biological systems remain diverse and productive over time. Long-lived and healthy wetlands and forests are examples of sustainable biological systems. For humans, sustainability is the potential for long-term maintenance of well-being, which has ecological, economic, political, and cultural dimensions. Sustainability requires the reconciliation of environmental, social equity and economic demands – also referred to as the “three pillars” of sustainability.



Three Pillars of Sustainability

- 1.15.3.2 Dictionaries provide several meanings for the word sustain, the main ones being to “maintain”, “support”, or “endure”. However, since the 1980s, sustainability has been used more in the sense of human sustainability on planet Earth and this has resulted in the most widely quoted definition of sustainability as a part of the concept of sustainable development, that of the **Brundtland Commission of the United Nations (1987)** : As brought out earlier **“Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs”**.
- 1.15.3.3 A universally accepted definition of sustainability remains elusive because it needs to be factual and scientific, a clear statement of a specific “destination”. The simple definition “sustainability is improving the quality of human life while living within the carrying capacity of supporting eco-systems”, though vague, conveys the idea of sustainability having quantifiable limits. Sustainability is also a call to action, a task in progress or “journey” and some definitions set out common goals and values. The Earth Charter talks of “a sustainable global society founded on respect for nature, universal human rights, economic justice, and a culture of peace.”
- 1.15.3.4 Sustainability interfaces with economics through the social and environmental consequences of economic activity. Sustainability economics involves ecological economics where social aspects including cultural, health-related and monetary/financial aspects are integrated. Moving towards sustainability is also a social challenge that entails international & national law, urban planning & transport, local & individual lifestyles & ethical consumerism. Ways of living more sustainably can take many forms, from reorganising living conditions (e.g., eco-villages, eco-municipalities & sustainable cities), reappraising economic sectors (permaculture, green building, sustainable agriculture), or work practices (sustainable architecture), using science to develop new technologies, green technologies, renewable energy & sustainable Fission & Fusion

power, to adjustments in individual lifestyles that conserve natural resources.

1.15.4 ***Millennium Development Goals (MDGs)***

1.15.4.1 At the start of the new millennium almost all stakeholder nations had agreed on a set of goals for mankind – the Millennium development Goals (MDGs). These were — Eradicate Extreme Poverty and Hunger, Achieve Universal Primary Education, Promote Gender Equality and Empower Women, Reduce Child Mortality, Improve Maternal Health, Combat HIV/AIDS, Malaria and other Diseases, Ensure Environmental Sustainability and Develop a Global Partnership for Development.

1.15.5 ***India's Further Initiatives***

1.15.5.1 ***India's Commitment to 35% Cut in Emission Rate***

1.15.5.1.1 India, announced Post-2020 'Climate Action Plan', promises to reduce emission intensity by 33-35% by 2030 over 2005 levels; boost clean energy in electricity generation to 40% while adding carbon sinks – tree and forest cover to remove CO₂ from the atmosphere – amounting to 2.5-3 billion tonnes of CO₂.

1.15.5.1.2 In keeping with its position that India's development needs cannot be delayed, there is no commitment to a 'peaking year' when emissions will be capped and there are no sector-specific targets. Instead, India has outlined a plan to reduce emission intensity which is the ratio of greenhouse gases to GDP or emission per unit GDP.

1.15.5.1.3 The Indian Government decided to enter Global Solar Alliance, IASPA (International Agency for Solar Policy and Application), of all countries located between the tropics of Cancer and Capricorn; the membership is now opened to all countries.

1.15.5.1.4 India has argued that it cannot be compared to China, despite roughly similar population sizes, as its per capita emissions are much lower. According to the World Resources Institute, India's per capita emissions are 2.44 metric tonnes and our northern neighbour's is 8.13 metric tonnes. India accounts for less than 7% of greenhouse gases. While US and China have agreed to converge at 12 tonnes of CO₂ per capita by 2030, India is still far lower than these emission levels.

1.15.5.1.5 India NDC has focused on eradicating poverty, reducing unemployment and ensuring energy sufficiency. Over one million medium and small enterprises in India will be involved in the “zero effect” and “zero defect”

scheme. India's ambitious solar expansion programme seeks to enhance capacity to 100 GW by 2022, which is expected to be scaled up further. Efforts will include scaling up efforts to increase the share of non-fossil fuel based energy resources in total electricity mix including wind power, solar, hydro-power, biomass, waste to energy, and nuclear power.

- 1.15.5.1.6 India has focused on adopting energy efficiency route and move on a low carbon growth path to combat climate change.
- 1.15.5.1.7 India decided that it will raise the share of clean energy in its energy mix by about 40% by the year 2030 and take several other mitigation and adaptation measures. India has stressed that its Post – 2020 Climate Action Plan does not bind it to any sector specific mitigation obligation or action, including in important sectors like agriculture. India's declaration is intended to insulate the country from pressure from developed countries.

1.15.6 ***India to add 150 GW of Power from Non-fossil Fuel Mix in 15 Years***

- 1.15.6.1 India's commitment on increasing its non-fossil fuel component of power generation to 40% by 2030 is impressive. Given India's 10% increase in power demand year on year, the nation may have to more than double its installed capacity to 550 GW by 2030. The 40% commitment would mean adding another 150 GW of non-fossil power plants in the next 15 years.
- 1.15.6.2 India's Pledge document talked about increasing nuclear power from 5 GW to 63 GW by 2032 and doubling wind capacity to 60 GW by 2022.
- 1.15.6.3 The government recently raised the target for renewable energy sources to 175 GW by 2022. Of this, solar power target has been set at 100 GW, wind energy will contribute 60 GW, biomass will contribute 10 GW and hydro power at 5 GW.
- 1.15.6.4 In short, the issues mentioned above can be summarized as –
 - a. The country plans to propagate a healthy and sustainable way of living based on traditions, growth needs and values of conservation and moderation.
 - b. India has promised to reduce emission intensity of its GDP by 33-35% by 2030, from 2005 levels.
 - c. India seeks to achieve this by generating 40% of electricity through non-fossil fuel sources such as solar, wind, hydro, biomass and nuclear.

- d. It also seeks to create additional carbon sink of 2.5 to 3 billion tonnes of CO₂ by increasing forest and tree cover.
- e. India would also raise investment in programmes to adapt to climate change in agriculture, water resources, Himalayas, coastal regions, health and disaster management.
- f. It will cost \$2.5 trillion from 2015 to 2030, part of which India will seek from the West/developed nations.
- g. In absolute emissions, India is one the largest polluters, after US and China. Nevertheless, our per-capita additions are only one-eighth of that of the US and less than one-third of China's.

1.15.7 ***Climate Action is expected to cost around \$2.5 Trillion***

- 1.15.7.1 It seeks assistance of developed nations (with a historical responsibility for global warming) to help with technology and finance to meet the estimated \$2.5 trillion needed to support climate change actions from now to 2030.

1.15.8 ***What Government would do to Achieve its Target?***

- 1.15.8.1 Government has considered various approaches that can be broadly classified into the following groups:
 - a. Introduce new, more efficient and cleaner technologies in thermal power generation (by adopting Advanced Ultra Supercritical Power Technologies).
 - b. Reduce emissions from transportation sector.
 - c. Promote energy efficiency in the economy, notably in industry, transportation, buildings and appliances.
 - d. Reduce emissions from waste.
 - e. Develop climate resilient infrastructures.
 - f. Full implementation of Green India Mission and other programmes.
 - g. Build capacities, create domestic framework and international architecture for quick diffusion of cutting edge climate technology in India and for joint collaborative R&D for such future technologies.

1.15.9 ***Measures***

1.15.9.1 ***Rising Levels of Carbon Dioxide Mean***

- 1.15.9.1.1 With increasing emissions, the rising levels of CO₂ lead to greenhouse effect. More heat is trapped in the atmosphere and the planet gets warmer than it should naturally be.

1.15.9.2 ***Need to cut emissions***

- 1.15.9.2.1 ***Protecting Biodiversity:*** India has 7-8% of all recorded species and 4 out of 34 biodiversity hot spots.
- 1.15.9.2.2 ***Conserving the Himalayan Eco System:*** It forms the most important concentration of snow-covered region outside the polar region.
- 1.15.9.2.3 ***Disaster Prone:*** Indian subcontinent among most disaster prone areas. Almost 85% of its areas is vulnerable to hazards.
- 1.15.9.2.4 ***Coastal Impact:*** 14.2% of its population inhabits its 7,517km coastline which is most vulnerable to rising sea level. 1,238 islands are in danger.
- 1.15.9.2.5 ***Agriculture:*** Drought and floods are frequent and the sector is already facing high degree of climate variability.

1.15.10 ***Measures Till Now***

- 1.15.10.1 ***Power Sector:*** Using renewable like solar, wind and biomass energy, hydro and nuclear reactors to generate power. Efficient use through policies like National Mission for Enhanced Energy Efficiency like promoting use of LED bulbs, labeling electrical appliances on power consumption.
- 1.15.10.2 ***Smart Cities:*** Smart Cities Mission to transform urban areas. Develop new-generation cities that promise clean and sustainable environment.

1.15.11 ***UNFCCC Discussions in Bangkok***

- 1.15.11.1 In May 2018, UNFCCC agreed to an additional meeting in Bangkok to ensure the work programmes, timely completion by COP 24 in December 2018. To enable this work, the parties met in Bangkok during 4-9 September, 2018. Negotiations on the early 20 substantive agenda items took place throughout the week.
- 1.15.11.2 The conference realized that differentiation and finance have long been

the wrenches in the gears of global climate action. Developing countries continue to call for new, additional, and predictable finance that will enable them to undertake sustainable development. Developed countries continue to demand broader participation in the mitigation effort and transparency of all countries' action. Currently, these differing perceptions between the developed and the developing countries are holding up discussions and have little possibility of agreement. All stakes in these negotiations is the degree to which all major emitters, including key emerging economies, will continue mitigation efforts.

1.15.12 **IPCC Report – Global Warming of 1.5°C and Linkages between Mitigation Options and Sustainable Development using SDGs**

1.15.12.1 UNFCCC requested IPCC “to provide a special report in 2018 on impacts of global warming of 1.5°C above clean-industrial levels and related global greenhouse gas emission pathway contained in the decision of the 21st COP of UNFCCC to adopt the Paris Agreement.” The IPCC accepted the invitation in April 2016 to prepare a special report in the context of strengthening the global response to the threat of climate change, sustainable development, and effort to eradicate poverty.

1.15.12.2 Recent information published in mass media indicates the following important outcomes:-

- Human activities are estimated to have caused approximately 1.0°C of global warming above pre-industrial levels, with a likely range of 0.8°C to 1.2°C. Global warming is likely to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate.

1.15.13 ***Linkages between Mitigation Options and Sustainable Development using SDGs***

1.15.13.1 Mitigation options deployed in each sector can be associated with potential positive effects (synergies) or negative effects (trade-offs) with the sustainable development goals. The linkage which this potential has realized will depend on the selected portfolio of mitigation options, mitigation policy design, and local circumstances in context. Particularly in the energy-demand sector, the potential for synergies is larger than for trade-offs. The Bars Group individually assessed options by level of confidence and takes into account the relative strength of the assessed mitigation-SDG connections. Information about the net impacts of mitigation on sustainable development in 1.5°C pathways is available only for limited number of SDGs and

mitigation options. Only a limited number of studies have assessed the benefits of avoiding climate change impacts of 1.5°C pathways for the SDGs, and the co-effects of adaptation for mitigation and the SDGs.

- 1.15.13.2 Limiting the risks from global warming of 1.5°C in the context of sustainable development and poverty eradication implies system transitions that can be enabled by an increase of adaptation and mitigation investments, policy instruments, the acceleration of technological innovation and behaviour changes.
- 1.15.13.3 Directing finance towards investment in infrastructure for mitigation and adaptation could provide additional sources. This could involve the mobilization of private funds by institutional investors, asset managers and development or investment banks, as well as the provision of public funds. Government policy that lowers the risk of low-emission and adaptation investments can facilitate the mobilization of private funds and enhance the effectiveness of other public policies. Studies indicate a number of challenges including access to finance and mobilization of funds.
- 1.15.13.4 Adaptation needs have typically being supported by public sector sources such as national and sub-national government budgets, and in developing countries together with support from development assistance, multi-lateral development banks, and UNFCCC channels. More recently there is a growing understanding of the scale and increase in NGO and private funding in some regions. Barriers including the scale of adaptation financing, limited capacity and access to adaptation finance.
- 1.15.13.5 Global model pathways limiting global warming to 1.5°C are projected to involve the annual average investment needs in the energy system of around 2.4 trillion USD between 2016 and 2035 representing about 2.5% of the world GDP. Quality tools can help mobilize incremental resources, including through shifting global investments and savings and through market and non-market based instruments as well as accompanying measures.
- 1.15.13.6 The systems transitions consistent with adapting to and limiting global warming to 1.5°C include the widespread adoption of new and possibly disruptive technologies and practices and enhance climate driven innovation. These imply enhanced technological innovation capabilities, including in industry and finance. Both national innovation policies and international cooperation can contribute to the development, commercialization and widespread adaption of mitigation and adaptation technology. Innovation policies may be more

effective when they combine public support for research and development with policy mixes that provide incentives for technology diffusion.

- 1.15.13.7 Sustainable development supports, and often enables, the fundamental societal and systems transitions and transformations that help limit global warming to 1.5°C. Such changes facilitate the pursuit of climate-resilient development pathways that achieve ambitious mitigation and adaptation in conjunction with poverty eradication and efforts to reduce inequalities.

Strengthening the capacities for climate action of national and sub-national authorities, civil society, the private sector, indigenous peoples and local communities can support the implementation of ambitious actions implied by limiting global warming to 1.5°C. International cooperation can provide an enabling environment for this to be achieved in all countries and for all people, in the context of sustainable development. International cooperation is a critical enabler for developing countries and vulnerable regions.

1.15.14 **Circular Economy and Sustainable Development Goals**

- 1.15.14.1 The Second World Circular Economy Forum 2018 took place during 22-24 October, 2018 at Yokohama, Japan to discuss the role of Circular Economy. To have a proper understanding the concept of Circular Economy is being explained initially in the first three paragraphs.
- 1.15.14.2 Against a background of global population growth, the current economic model of ever increasing production and consumption, which is also associated with an acute pattern of unequal distribution & social exclusion, is presenting substantial challenges. These include scarcity of an unequal access for natural resources & energy, as well as climate, social and geopolitical disruption. The Earth community has already crashed through four out of nine critical “planetary boundaries” or risk thresholds (climate change, species extinction, deforestation and land use change, nutrient loads) identified by the Stockholm Resilience Centre. The role of circular economy as the “industrial leg” of efforts to combat climate disruption was underlined by a Sitra-commissioned study on the role that the circular economy can make to keeping global warming below 2°C. The study, *'Re-configure: The Circular Economy – A Powerful Force for Climate Mitigation'*, shows that switching to the circular use of the four materials (steel, plastics, aluminum, and cement) responsible for the largest GHG emissions could help reduce EU industrial emissions by 56% (300 MT) annually by 2050, more than half the amount necessary to achieve net zero emissions.

- 1.15.14.3 In response to the emergence of these converging crises, the concept of “circular economy” has been coined to inform the design of an alternative economic model based on entirely different principles. The circular economy decouples virgin and non-renewable resource use from economic growth and seeks to put an end to an era of overconsumption – an era that has caused climate change, alarming loss of biodiversity and the over-use of natural resources.
- 1.15.14.4 The outcome of the Yokohama Forum on Circular Economy has focused on the following actions --.
- a) The global thrust on sustainable development is focusing on consideration of the role that a circular economy can play as a vehicle for de-coupling economic growth from the ecological impact of natural resource consumption and as an important means to meet the challenges of the Sustainable Development Goals and the UN Framework Convention on Climate Change, Paris Agreement on Climate Change.
 - b) Natural resource conservation is considered the most important element in promoting circular economy; and challenges of plastic waste and marine pollution, climate change and biodiversity are important issues.
 - c) Circular economy is seen as the industrial approach of fighting climate change. There is a close link between the circular economy and the fourth industrial revolution “Industry 4.0”, food systems, finance and investment, business solutions, life styles and consumptions, plastics, education, climate change, research and development, rural development, and value chains.
 - d) SDGs are excellent basis to build a global circular economy's strategy which defines a trajectory for advancement by 2030, and beyond and how to get there. The G-20 and UN meetings were identified as ideal decision-making tools to build a global circular economy strategy and together tackle global challenges of climate change, polluted environments and unemployment. It is important to note that issues of poverty and unemployment are linked with climate change issues.
 - e) Circular Economy is also considered important for limiting the global warming to well below 2°C, as there is growing recognition that renewable energy and energy efficiency measures alone will not suffice.

- f) Circular Economy is considered good for business, trade and job creation. There is a need for shared global vision for a circular economy that can correct current political emphasis on national interest and help remove and prevent harmful obstacles to international trade and collaboration such as trade tariffs and protectionism. Increase in trade of knowledge and services combined with local production close to markets are identified as contributions to lowering environmental impact through less required transportation and more efficient supply chain. Product and service solutions that enable the circular economy need to be spread across global markets freely.
- g) There is an urgent need for stronger leadership and international collaboration to help build a global circular economy by 2050 and create a planet where the economy and environment are no longer in contradiction. This calls for strong political and business leadership to shift away from a linear economic paradigm, which was described as the root cause of global challenges, such as climate change, polluted environments and unemployment.

1.15.14.5 The following steps can play an important role in effective implementation of Circular Economy and meeting the challenges of climate change in the SDGs.

- The era of mass consumption and production is not sustainable;
- The circular economy must play a role in meeting the challenges of climate change and the SDGs;
- Every entity, from governments to individuals, can set and share actions to help create a circular economy movement;
- Japan has experience on resource productivity and is playing a leadership role on Circular Economy and is expected to focus on the outcomes at various important international forums including the UN General Assembly.
- A transition to a circular economy is underway and is the only way to preserve life on Earth within planetary boundaries;
- Alongside climate change, biodiversity loss & over-use of natural resources, the global sustainability crises include social inequality too.

- The root causes of over consumption of natural resources and energy must be addressed.

1.15.14.4 The concept of Circular Economy for Sustainable Development is expected to play an important role in future course of mitigation and adaptation in climate change and ensuring growth at appropriate levels.

1.15.15 The **Sustainable Development Goals (SDGs)**, officially known as **Transforming our World: the 2030 Agenda for Sustainable Development**, are an intergovernmental set of seventeen aspiration Goals and are:

1. **No Poverty** - End poverty in all its forms everywhere.
2. **Zero Hunger** - End hunger, achieve food security and improved nutrition and promote sustainable agriculture.
3. **Good Health and Well-being** - Ensure healthy lives and promote well-being for all at all ages.
4. **Quality Education** - Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
5. **Gender Equality** - Achieve gender equality & empower all women & girls.
6. **Clean Water and Sanitation** - Ensure availability and sustainable management of water and sanitation for all.
7. **Affordable and Clean Energy** - Ensure access to affordable, reliable, sustainable and clean energy for all.
8. **Decent Work and Economic Growth** - Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.
9. **Industry, Innovation and Infrastructure** - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.
10. **Reduced Inequalities** - Reduce inequality within & among countries.
11. **Sustainable Cities and Communities** - Make cities and human settlements inclusive, safe, resilient and sustainable.

12. **Responsible Consumption and Production** - Ensure sustainable consumption and production patterns.
13. **Climate Action** - Take urgent action to combat climate change and its impacts.
14. **Life Below Water** - Conserve and sustainably use the oceans, seas and marine resources for sustainable development.
15. **Life on Land** - Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.
16. **Peace, Justice and Strong Institutions** - Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.
17. **Partnerships for the Goals** - Strengthen the means of implementation and revitalize the global partnership for sustainable development.

1.16 **INAE's Earlier Efforts**

- The Study on 'Engineering Intervention necessary for Achieving 175 GW of renewable power by 2022' conducted by the Energy Section was released in February 2017. The objective of the research study was to bridge the gap of “what is perceived as achievable” and “what India must achieve” in order to realize the targets envisaged. To provide an effective framework of action, the following topics were covered under the study.
- Evolving Business Models for renewable power supply, manufacturing renewable energy systems, installation and integration by studying and globally emerging business models.
- Advancement in systems technology development for cost-effective solutions for project execution, operation and maintenance.
- Strategy and solution for grid integration and balancing power – including cost of balancing power.
- Policy interventions to support achieving the target cost-effectively.

- Creating manufacturing capacity of poly-silicon solar cells, modules and inverters of required quality of globally competitive price.

1.16.1 The key recommendations of the study were presented in the following thrust areas:

- Technology focus and R&D focus including increase in R&D spending
- Building an integrated manufacturing eco-system and promoting competitiveness; and enhanced capacity in terms of testing centres and labs.
- Standardization and adoption of new technologies/techniques (and tools) to enhance efficiency and reduce cost for renewable energy projects.
- Automation and data analytics to be leveraged to reduce cost, and skill development.
- Renewable energy integration including forecasting capability, grid integration and cost of balancing.
- Power market interventions support penetration of higher level of renewable power.
- Regulatory mechanism and incentives.

1.16.2 The utility of the Report was seen when NITI Aayog, various ministries and the agencies of central government, state governments and the solar industry associations took note of the recommendations of the Report. These reflect in government's thrust in policy to promote a manufacturing eco-system by supporting infrastructure facilities and promoting financing to MSMEs. The R&D spending has also been on the rise. Renewable energy grid integration and cost of balancing have now been focused. There is a new thrust on electric vehicles and its components of cost-effective battery and electric charging stations (mainly based on solar energy). These steps had been given an outline framework by the INAE Report.

1.16.3 INAE is also preparing a '**Report on Clean and Green Energy in Urban Development**'.

1.17 Conclusion

- 1.17.1 Time is running out for the World. One fervently hopes that global collective wisdom would show greater urgency if the 'tipping point' is to be avoided, failing which, the consequences would be disastrous and truly frightening and the future of mankind itself would be at stake.

1.18 Some Points to Ponder

1.18.1 ***Gandhian Thesis of Environmental-Ecological Sustainability*** (Ref.: Anand – 2013)

- 1.18.1.1 Gandhiji held a holistic view of human existence in its environmental contexts. As he said, all life is one. He was also very conscious of the inherently limited nature of natural resources and, hence, insisted that humankind adjusts its needs and wants accordingly. He always went to the heart of the matter and following (of his oft-quoted statements) **would sum up the modern ecological debate:**

- Earth provides enough to satisfy every man's needs but not for every man's greed.'
- - - it is the fundamental law of Nature, without exception, that Nature produces enough for our wants from day to day, and if everybody only took enough for himself and nothing more, there would be no pauperism in this world, there would be no man dying of starvation in this world. But so long as we have got this inequality, so long we are thieving. - -'
- If we knew all the laws of nature or having known, had the power to obey them in thought, word and deed, we would be God Himself - -. - - It is, therefore, enough for us to realize that every illness is but a breach of some unknown law of nature and to strive to know the laws and pray for power to obey.'
- He summed it up thus: '**Simplicity is the essence of universality**'.

1.18.2 ***Ecological Capacity: Ecological Footprint*** (Ref.: State of the World – 2006)

- 1.18.2.1 Beyond possible limits to energy and food output, the global community will need to grapple with a more fundamental constraint: the ability of Earth's ecological systems to support a continually growing global economy while absorbing the vast quantities of pollution it produces. Environmental analyst Mathis Wackernagel has developed a concept known as **ecological footprint** to measure the ecological capacity, both at

the global and national levels. Footprint analysis measures what an economy needs from nature: the inputs that fuel it and the wastes that emerge from it. It does so using a single matrix – the number of global hectares of land and water needed by the economy. Global hectares are the area of biologically productive space (land and water with significant photosynthetic activity and biomass accumulation) with world-average of productivity. Where a nation's footprint is larger than its bio-capacity, it indicates that its economy is consuming more forests, croplands and other resources than the country can supply and thus it is overtaxing the domestic environment's capacity to absorb wastes.

1.18.2.2 According to Mathis Wackernagel, the global footprint now exceeds global bio-capacity by 40 per cent (World footprint is thus 140 per cent). By importing resources and exporting wastes, particularly carbon dioxide, the United States, Europe, Japan, India and China all live well beyond their ecological means with footprints ranging from 200 per cent to nearly 600 per cent. Footprints tend to grow larger as countries industrialise, but the bulk of footprint growth typically comes from a single source: the increase in area needed to absorb carbon dioxide. With per capita carbon emissions still modest compared with Japan and Western Industrial Nations, the carbon component of China and India's footprints is likely to grow dramatically in view of their faster growth and development.

1.18.3 **Environmental Ethics** (Ref.: Jardins – 1997)

1.18.3.1 Environmental ethics is a systematic account of the moral relations between human beings and their natural environment. It assumes that moral norms can and do govern human behaviour towards natural world. A theory of environmental ethics, then, must go on to explain what these norms are, and to whom or to what humans have responsibilities, and to show how these responsibilities are justified. **Different theories of environmental ethics offer different answers to these questions:**

- Some philosophers argue that our responsibilities to the natural environment are only indirect, that the responsibility to preserve resources, for example, is best understood in terms of the responsibilities that we owe to other humans. **Anthropocentric (human centered) ethics** holds that only human beings have moral value. Thus, although we may be said to have responsibilities regarding the natural world, we do not have direct responsibilities to the natural world.
- An extension of anthropocentric ethics occurs by considering **future generations of human beings as objects of our moral responsibilities**. Such an approach basically remains anthropocentric but it extends our responsibilities to include

some of the humans who do not yet exist.

- Other philosophers argue that we also have direct responsibilities to natural objects other than human beings. This **Non-anthropocentric ethics** grants moral standing to such natural objects as animals and plants, and consequently requires further extensions and revisions of standard ethical principles.
- Further development of environmental ethics occurs by shifting from a focus on individual living things to focus on collections or “wholes” such as species, populations, or ecosystems. **Holistic ethics** holds that we have moral responsibilities to collection of individual living things rather than (or in addition to) those individual living things who constitute the whole.
- The **Ethics of Deep Ecology** propagated by Arne Naess focuses on two ultimate norms. These norms are ultimate in the sense that they are not derived from any further or more basic principles or values. They are the point at which ethical justification ends. **These two ultimate norms of deep ecology are self-realization and bio-centric equality.** Self-realization is a process through which people come to understand themselves as existing in a thorough interconnectedness with the rest of nature. Bio-centric equality is the recognition that all organisms and beings are equally members of an interrelated whole and therefore have equal intrinsic worth.

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The New Delhi Declaration: Investing in Land and Unlocking Opportunities

We, the Ministers and Representatives gathered for the high-level segment at the fourteenth session of the Conference of the Parties to the United Nations Convention to Combat Desertification (UNCCD), held on 9–10 September 2019 in New Delhi at the invitation of the Government of the Republic of India,

Expressing our sincere appreciation to the Government of the Republic of India for its hospitality and to the UNCCD secretariat for the organization of the high-level segment,

Recognizing that desertification/land degradation and drought undermines health, development and prosperity in all regions and acknowledging that dryland ecosystems are areas of special focus,

Deeply concerned that the impacts of desertification/land degradation and drought are felt most keenly by vulnerable people,

Recalling the 2030 Agenda for Sustainable Development and the UNCCD 2018–2030 Strategic Framework and looking forward to comprehensively reviewing and monitoring progress with the aim of accelerating the implementation of both,

Recalling also that striving to achieve land degradation neutrality has the potential to act as an accelerator for achieving a number of the Sustainable Development Goals and as a catalyst for attracting sustainable development financing to implement the Convention,

Acknowledging those practices which conserve and restore land and soil affected by desertification/land degradation, drought and floods, contribute towards achieving land degradation neutrality and can also have long-term multiple benefits for the health, well-being and socioeconomic development of the entire society, especially for the livelihoods of the rural poor,

Noting the link between the restoration and sustainable management of land and the creation of decent jobs, including green jobs initiatives and other employment-generating opportunities, for vulnerable communities in degraded areas,

Recalling that the Sharm El-Sheikh Declaration, recognized by the Conference of the Parties to the Convention on Biological Diversity at its fourteenth session, called for synergies in addressing environmental degradation, biodiversity loss and climate change,

Noting the findings of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services Land Degradation and Restoration Assessment and its Global Assessment Report on Biodiversity and Ecosystem Services, as well as the Intergovernmental Panel on Climate Change Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems, which recognize the role of the land-use sector,

Recognizing the contribution of effective and responsible governance and stewardship of natural resources, especially land and water, for combating desertification/land degradation and drought and for the sustainable development of current and future generations,

Convinced that diverse multi-stakeholder participation, as appropriate, at local, subnational, national and regional levels and from all sectors of society, including civil society organizations, local government and the private sector, will be crucial to achieving the objectives of the UNCCD,

Contd.

Renewing our commitment to concerted international cooperation for the effective implementation of the Convention,

1. *Encourage* the development of community-driven transformative projects and programmes that are gender-responsive, at local, national and regional level, to drive the implementation of the Convention;
2. *Also encourage*, in the context of projects aimed at combating desertification/land degradation and drought and achieving land degradation neutrality and resilience-building, inter alia and as appropriate, the transition and increased access to energy in rural and urban communities, within the scope of the UNCCD;
3. *Further encourage* a proactive approach to reducing the risks and impacts of desertification/land degradation and drought through the implementation of drought preparedness plans and increased risk mitigation for drought and sand and dust storms;
4. *Invite* development partners, international financial mechanisms, the private sector and other stakeholders to boost investments and technical support for the implementation of the Convention and the achievement of land degradation neutrality, create green jobs and establish sustainable value chains for products sourced from the land;
5. *Promote* opportunities that support, as appropriate and applicable, the long-term goals of the Paris Agreement and the development of an ambitious post-2020 global biodiversity framework, taking into consideration land-based solutions for climate action and biodiversity conservation and the mutually supportive implementation of the three Rio conventions;
6. *Welcome* the United Nations Decade on Ecosystem Restoration (2021–2030), commit to adopting an integrated, best-practice approach to land restoration based on scientific evidence and traditional knowledge that offers hope to vulnerable communities and invite Parties, observers and other relevant UNCCD stakeholders, including the private sector, to accelerate and scale up relevant initiatives at all levels;
7. *Take note* of the benefits brought to participating countries by the accelerated implementation of initiatives that support a transformative narrative in the Sahel through, inter alia, the Great Green Wall of the Sahara and the Sahel Initiative and the Initiative on Sustainability, Stability and Security;
8. *Also take* note of the launch of the Peace Forest Initiative and its potential contribution to increasing cooperation on land degradation neutrality, including land restoration and reforestation in transborder areas in participating countries, where appropriate;
9. *Reaffirm* the relevance of the Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security for better access, control and stewardship over land and equitable tenure security, in accordance with relevant national legislation, for the implementation of the Convention and the promotion of sustainable land management;
10. *Encourage* local governments to adopt integrated land use management and enhanced land governance to rehabilitate the natural resource base that makes cities sustainable, taking into consideration the New Urban Agenda, including by reducing rates of land consumption and soil sealing along with biodiversity and ecosystem loss;

11. *Welcome* the various initiatives targeting land degradation neutrality by India such as Har Khet Ko Pani, More Crop Per Drop, the National Afforestation Program, the National Rural Employment Guarantee Scheme, Pradhan Mantri Krishi Sinchayee Yojna, Rashtriya Krishi Vikas Yojana and the Soil Health Card Scheme;
12. *Also welcome* the proposed adoption of a voluntary land degradation neutrality target by India that includes the restoration of degraded land and the legacy programme announced to support South–South cooperation following this Conference of Parties.

ABBREVIATIONS

ADP	Ad Hoc Working Group on the Durban Platform for Enhanced Action
ALGAS	Asian Least-cost Greenhouse Gas Abatement Strategy
AMOC	Atlantic Meridional Overturning Circulation
BUR	Biennial Update Report
CCAP	Climate Change Action Programme
CCIP	Climate Change Innovation Programme
CDM	Clean Development Mechanism
CERs	Certified Emission Reduction Credits
CHCs	Custom Hiring Centres
CHP	Combined Heat and Power
CMP	Meeting of the Parties
COPs	Conferences of the Parties
EU	European Union
GCF	Green Climate Fund
GHG	Green House Gas
GOS	Global Observing System
GSA	Global Solar Alliance
HFCs	Hydrofluorocarbons
IASPA	International Agency for Solar Policy and Application
IGBP	International Geosphere-Biosphere Programme
IIOE	International Indian Ocean Expedition,
IMD	India Meteorological Department
INC	Intergovernmental Negotiating Committee
INDCs	Intended Nationally Determined Contributions
INDOEX	Indian Ocean Experiment
IPCC	Intergovernmental Panel on Climate Change
LCA	Long-Term Cooperative Action
LTEO	Long Term Ecological Observatories
MDGs	Millennium Development Goals

ABBREVIATIONS

MoEF&CC	Ministry of Environment, Forest and Climate Change
MONEX	Monsoon Experiment
MRV	Monitoring, Reporting and Verification
NAFCC	National Adaptation Fund on Climate Change
NCAP	National Carbonaceous Aerosols Programme
NCDMA	National CDM Authority
MSME	Micro, Small and Medium Scale Enterprises
NDC	Nationally Determined Contributions
NGO	Non-Governmental Organisation
ODSs	Ozone Depleting Substances
PMR	Partnership for Market Readiness
REDD+	Reducing Emissions from Deforestation and Forest Degradation
SAPCC	State Action Plan on Climate Change
SDGs	Sustainable Development Goals
UNCCD	United Nations Convention to Combat Desertification
UNFCCC	United Nations Framework Convention on Climate Change
WCRP	World Climate Research Programme

CHAPTER 2

Rail-based Infrastructure Urgently Needs Four Major Interventions at the Level of Government of India

2.1 Introduction

- 2.1.1 In a VUCA world, forecasting the mid-term future (say 20-30 years) of a Technology is a difficult task. However, when a **Technology Foresight** exercise is done by considering social, economic, climate change, employment generation and other connected factors, prediction of a likely future Technology becomes a herculean task.
- 2.1.2 Broader definition of Technology as proposed by Dr. A. P. J. Abdul Kalam (2001) has been kept in focus. He has mentioned that Technology includes techniques as well as the machines that may or may not be necessary to apply them. It includes ways to make chemical reactions occur, ways to breed fish, eradicate weeds, light theatres, treat patients, teach history, fight wars or even prevent them.
- 2.1.3 Various Transport Modes viz. Air, Water (Inland & Coastal), Road, Rail (Long distance, Suburban, Metros) and Pipelines have been examined. The IR White Paper (Dec. 2009) indicates mode-wise share of existing Freight Traffic as Rail (30%), Road (61%) Coastal shipping (2.3%), Inland Water Transport (2.2%), Pipelines (4.5%) with Air sharing a very small percentage (It is mostly passenger traffic). While all transport modes are being given inputs but the Rail and Road modes will dominate the Transport Scenario and have been examined in detail.

2.2 Growth of Transport Modes

- 2.2.1 Growth of transport infrastructure has to consciously keep in view the need for using a mode which is least polluting and hence more environment friendly. Further, besides fuel and systems efficiency measures, integrated and optimum use of various transport modes is essential.
- 2.2.2 One European Study (Soft Mobility Paper 2006) details carbon dioxide (CO₂) emissions for various transport modes as under:

Freight Transport (gms / tonne km)

Road	158
Water Transport	31
Rail	29

Passenger Transport (gms / passenger km)

Air	229
Road (Car)	175
Rail	75

The Study suggests various methods to make Transport Greener like (i) Planned shift to Non-motorised Transport (ii) Encouraging shift of commuters from use of Road to Rail and from personalised vehicles to Public Mass Transport Systems but the main emphasis is on (iii) **Improving the share of Rail in overall transport scenario.**

2.2.3 For our country, faster growth of Rail has also been envisaged in several Studies:

- (i) National Transport Development Policy Committee (NTDPC) Report (2014)
 - Growth of market share in freight traffic from existing 30% to 50% by 2032.
 - Growth of investment from 0.8% of GDP in 12th Plan (2012-17) to 1.1 to 1.2% of GDP in next three Plans (2017-2032)
- (ii) Report on “Low Carbon Strategies for Inclusive Growth” of the Planning Commission (April 2014), highlights the need for completing the Dedicated Freight Corridors (DFCs) on the Golden Quadrilateral and its two Diagonals by 2030 for improving the market share of Rail to 50%.
- (iii) India has committed to increase the market share of freight traffic by Rail to 45% by 2030 in the INDC document which was discussed in the 21st Conference of Parties (CoP 21) organised by the UNFCCC in Paris, in November 2015. (Ref.: Indian Railways: Environment Sustainability Annual Report 2017-18).

2.3 Rail Needs Faster Growth

- 2.3.1 Need for faster growth of Rail vis-à-vis Road was also emphasised in a Study conducted by the Balance Research Institute (1999) which mentioned that while the World Transport in next 100 years will increase by 4 times, the Roads will not be able to carry more than 2 times, and the balance will have to be carried by Rail.
- 2.3.2 The Study further highlighted that including all known Costs and Revenues perhaps rail freight is 80% commercial at present, whereas road freight is perhaps 50%. If both had to pay 100% of the economical and societal costs, then the modal split would change towards Rail.
- 2.3.3 With growing concerns for Climate Change, the present day **differential cost** can be taken as $30+10 = 40\%$. Further, a study is needed to

realistically evaluate the economical, societal and environmental costs for Rail and Road projects.

2.4 **Special Features of Indian Railways**

- 2.4.1 It is essential to keep in focus the special features of an organisation of the size and complexity of IR.
- 2.4.2 Unlike the Road systems, which, apart from Central control also have complementing organisations at the State level, the IR is a monolith due to the need for seamless operations. Its Huge Work-force and Complex Working, round the clock, can only be compared with Defence Organisation during a wartime situation.
- 2.4.3 The need for uniformity on the entire system coupled with need for speedy action at the grass-root levels calls for a system and management approach which can rightly be termed **controlled-decentralisation**.
- 2.4.4 Changes are difficult to effect on the IR and have to be meticulously planned. To give an example, if a new rolling stock is introduced, the whole length of the concerned network has to have maintenance staff and facilities for it. Unless these are developed, end-to-end running will not be possible.
- 2.4.5 Prevention of accidents needs Zero failures of men, materials, machines & systems. Developing a culture towards 'zero failure' is an inescapable need.

2.5 **Four Major Interventions for Rail based Infrastructure at the Level of Government of India**

A. Need for Ministry of Urban, Sub-urban and Metro Rail Systems

- Heavy investments are being made by Central / State Governments in this vital area to increase share of Rail primarily for passenger traffic, reduce road congestion, reduce air pollution, etc. Several Metros and other Cities are being covered. **The Work is being co-ordinated by the Ministry of Urban Development and the concerned State Governments.**
- **Since the volume of activity is huge and is likely to gain further momentum, coordinated efforts are the need of the hour. Formation of this new Ministry will help in standardisation, help in 'Make in India' effort, is likely to benefit MSME sector and also in significant employment generation. Further, directed R&D inputs will be possible in this vital area.**

B. Inputs for Accelerated Development of Indian Railways – Pradhan Mantri Rail Vikas Yojna – Two Projects

- While IR is doing exceedingly well, within the constraints of available resources, need for accelerated development of Rail infrastructure is evident. To effect this accelerated development, GOI could assist IR for a period of about 10 years for the following two projects so that IR could concentrate on other locations:
 - (i) **New lines @ 1,000 km / yr according to a planned blue print for 10 yrs.** These will, inter alia, develop new areas, increase market share of Rail and generate employment. Some high altitude rail lines needed for Defence purposes could also be included. Since the high altitude rail lines will be financially not viable, full cost could be borne by GOI. The IR could continue at the existing pace constructing New Railways lines in other areas.
 - (ii) **Completion of DFCs on the Golden Quadrilateral and its two diagonals connecting Delhi, Mumbai, Chennai and Kolkata in next 10 years.** The IR has more or less completed Delhi-Mumbai and Delhi-Kolkata legs. Balance 6000 km or so could be covered in next 10 years. Work could be executed by IR with 40% of cost subsidised by the GOI by way of **Viability Gap cum Accelerated Development Fund**.

C. Need for Ministry of High Speed Rail Systems as and when New Projects are Sanctioned

- The UIC (International Union of Railways) defines speeds of 200 kmph or more when achieved on existing tracks as **High Speed Travel** while for new lines constructed for the purpose, speeds have to be more than 250 kmph for being classified as **High Speed Travel**. In such cases, however, speeds higher than 250 kmph are invariably planned.
- The IR will be completing the DFCs on the Golden Quadrilateral connecting Delhi, Mumbai, Chennai and Kolkata and its two Diagonals in next 10 years and plans are afoot to upgrade the passenger system for **160 kmph speeds (Semi High Speeds)** as the freight traffic shifts to DFCs.
- **The whole of the Golden Quadrilateral and its two Diagonals could be made fit to run some selected tilt-body or similar trains at speeds of 200 kmph. This will bring about 10,000 km IR network on the World High Speed Rail Map. Input costs will not be very high.**
- **Conventional High-Speed Trains of 300-350 kmph speeds could be planned on sections like**

- (i) **Mumbai-Ahmedabad (Work in progress)**
 - (ii) **Delhi-Chandigarh**
 - (iii) **Chennai-Bangalore**
- **This new Ministry could undertake execution of these projects, lay down standardisation norms for fixed and moving infrastructure, plan R&D also including new High-Speed systems like Magnetic Levitation, Hyperloop, etc.**

D. Need for a High Level Transport Authority

- **Co-ordinated development of various Transport Modes is not only needed for **maximising** the output but to ensure necessary **optimisation** so that scarce resources are used in the best possible manner.**
- **A **System** is needed to coordinate the MoR and the two new Ministries suggested above as also the various Ministries connected with Road, Water, Air and Pipeline sectors.**
- **Further, studies to evaluate the Social costs, Environmental costs, Financial costs etc need to be undertaken for various transport modes. An on-line system also needs to be put in place to measure the modal share of various transport modes, on a regular basis, with passage of time.**
- **The MoR with its vast expanse & experience could assist & coordinate.**
- **Earlier efforts made by having a Unified Ministry of Transport for the purpose were not successful, most probably because of enormous size of operating needs of the various Ministries. Present proposal will primarily concentrate the efforts for coordination and optimisation, and will not dwell into the operational requirements, and hence is likely to succeed.**

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Some Abbreviations Used

DFCs	Dedicated Freight Corridors
GOI	Government of India
IEM	Independent External Monitor
INAE	Indian National Academy of Engineering
INDC	Intended Nationally Determined Contribution
IOCL	Indian Oil Corporation Limited
IR	Indian Railways
MoR	Ministry of Railways
MCMEs	Micro, Small & Medium Enterprises
NHAI	National Highways Authority of India
NHPC	National Hydroelectric Power Corporation
NTDPC	National Transport Development Policy Committee
ONGC	Oil and Natural Gas Corporation
UTES	Rail India Technical & Economic Services
SAIL	Steel Authority of India Limited
UIC	International Union of Railways (HQ – Paris)
UNFCCC	United Nation's Framework Convention on Climate Change
VUCA	Volatility, Uncertainty, Complexity, Ambiguity

CHAPTER 3

Improving the Operating Ratio of Indian Railways – A Way Forward

3.1 Brief Overview

- 3.1.1 Transport is an essential pre-requisite for development / growth. In addition, transport by itself also accelerates growth. Integrated development of various transport modes is essential for optimum utilization of the resources. One major factor which has come to the fore in recent years is the need for **making transport 'greener' that is, basically, reducing the Green House Gas (GHG) emissions. The transport mode selection has to keep this vital aspect also in view.**
- 3.1.2 About 90% of the traffic in our Country is carried by Rail / Road modes. Rail is 4-6 times fuel-efficient vis-à-vis Road and therefore reduction in the market share of Rail vis-à-vis Road is a serious concern for environment too. **It may not be out of place to mention that the market share of Rail in freight traffic has gone down from 89% to 30% and for the passenger traffic from 69% to 15%, since 1950-51.**
- 3.1.3 Planning Commission and other recommendatory bodies like the recent National Transport Development Policy Committee (NTDPC - 2014) have all been proposing a growth in the market share of Rail Freight to a value of around 50%.
- 3.1.4 **Growth of rail traffic, and that too at an accelerated pace to make up for the lost market share, is not possible only by doing some system improvements. The rail infrastructure needs major capacity expansion inputs.** The capacity expansion on Indian Railways (IR) has lagged behind largely due to paucity of resources. To give an example, the rate of construction of New Railway lines in the pre-independence era was around **Three times faster** than that after Independence. **The rail network has grown by about 23% while the traffic has grown by more than 1400 per cent, since 1950-51.**
- 3.1.5 The Golden Quadrilateral and its two Diagonals connecting the metro cities of Delhi, Mumbai, Chennai and Kolkata (Delhi-Kolkata; Delhi-Mumbai; Delhi-Chennai; Mumbai-Kolkata; Mumbai-Chennai; Chennai-Kolkata) **constitute about 16% of the Route kms of IR but carry around 60% of traffic and are having severe capacity constraints.**
- 3.1.6 To relieve the traffic congestion, **Dedicated Freight Corridors (DFCs)** are planned for the Golden Quadrilateral and its two Diagonals. Work on Delhi-

Kolkata and Delhi-Mumbai Corridors is already in progress and is likely to be completed by 1920-21. However, the speed at which the work is being done needs special inputs and efforts so that all the six DFCs are available for use, say in a period of next 10 years.

- 3.1.7 Construction of these DFCs which are being built more or less parallel to the existing double line tracks **will release the congestion on the existing tracks as these will then be carrying only Passenger traffic as the Freight traffic will shift to the newly constructed DFCs. Average speeds of travel both for passenger & freight trains will also improve.**
- 3.1.8 One more issue which is intimately related to environment is to provide a mechanism so that some Road traffic could shift on to Rail and for that **Construction of New Railway Lines** in the areas where road traffic is currently taking major share is essential. In addition, some entirely new Railway lines are also needed from Social / Economic considerations. As has already been mentioned, our New Line construction has been very slow and there is an urgent need to boost it. While the Railway Vision Document of 2009 indicated construction of New Railway lines at the rate of 2500 km per year but at least 1000 to 1500 km per year appears essential.
- 3.1.9 Appreciating the need for faster growth of Rail Infrastructure, the National Transport Development Policy Committee (NTDPC) headed by Dr. Rakesh Mohan in its recent Report (2014) has proposed an increase in investment in Railways from about 0.4% of GDP in the last two decades to around 0.8% in the 12th Plan (2012-2017) and then rising to around 1.1 to 1.2 per cent of GDP in the following three Plans (2017 to 2032). It will be seen that the proposed increase is 2 to 3 times more than the currently prevailing levels.

In the Budget Speech (26th Feb. 2015) an investment of Rs. 8.5 lac crore in the next five years on the IR i.e. an average of Rs. 1.7 lac crore / year was suggested. For this level of funding, innovative financing models / strategies will be required coupled with a significant support from the Government of India.

3.1.10 **Needed Interventions by Government of India for Accelerated Development of Rail Infrastructure**

Government of India (GOI) could support the following two projects by declaring them as National Projects:

A. New Railway Lines

Construction of New Railway Lines at the rate of 1000 km/year according to a ten year blue-print made for the purpose. This can be done on the same pattern as the Pradhan Mantri Gram Sadak Yojana (PMGSY) for Road

projects & full funding provided for the purpose by the GOI. Approximate support needed would be Rs.10,000 cr/yr @ Rs.10 cr/km of Newline.

B. Dedicated Freight Corridor (DFCs)

All the six legs of Golden Quadrilateral connecting Delhi, Mumbai, Chennai and Kolkata and its two Diagonals should be provided with Dedicated Freight Corridors (DFCs) **wherein 40% grant could come from Government of India as a Viability Gap-cum-Accelerated Development Fund**. This will be more or less on the pattern of National Highways Development Program (NHDP) for the Road sector.

The IR has more or less completed Delhi-Mumbai & Delhi-Kolkata legs & these would be operational in phases by 2020-21. The remaining four legs, about 6000 kms (double line), will need to be taken up in the next 10 years @ 600 kms per yr. Approximate support needed would be Rs. 7,800 cr / yr.

Cost of 1 km of DFC (Double Line Track) has been taken as Rs. 25 cr which, inter-alia, includes cost of provision of ROBs / RUBs for grade separation and cost of 'Land' especially in areas where the DFC is not running parallel to the existing network. Further, Rs. 7.5 cr / km has been added towards raising the speeds to 160 kmph. The total thus works out to Rs. 32.5 cr/km and 40% thereof as Rs. 13 cr/km of DFC.

3.1.11 Expansion of Rail Network – Action by IR

3.1.11.1 For any Transport organisation basically three broad areas viz. Maintenance of assets, Operations, and Expansion of capacity are very relevant. On the IR all the three areas have suffered, primarily due to paucity of resources, but the major casualty has been the expansion of network / capacity. This has caused severe traffic congestion especially on the busy routes. The average point-to-point speeds of trains which should be 70-75% of maximum speeds are much lower, being about 33% for Goods / Freight trains and less than 50% for most of the Passenger trains. Expansion of network (New Lines / Doublings) will greatly reduce traffic congestion, **permit much higher point-to-point speeds**, and enhance capacity of the System.

3.1.11.2 With the suggested intervention by the GOI in two National Projects, the Indian Railways can now concentrate on Doubling of other busy routes, and on financially viable / strategic New Line Projects. Presently, IR undertakes construction of about 700 km of Doublings and about 500 km of New Lines every year. This pace of construction could then be continued in a planned manner, based on a ten year blue-print made for the purpose with defined priorities, completion schedules, and assured funds.

3.1.12 **Loss Making Passenger Traffic to be made Self Sustaining**

- 3.1.12.1 Indian Railways earn about Rs. 1,40,000 Crores in a year (2013-14) out of which contribution by the Goods / Freight traffic is 67% and by the Passenger traffic 26%. The IR bears Social Service Obligations of about Rs. 25,000 crore per year by carrying Passenger services below the stipulated ticket price, making the Passenger traffic a loss making segment and needing subsidisation from the Goods segment. If this money was available to the System it could have been gainfully utilised for network expansion and capacity augmentation.
- 3.1.12.2 **It may not be out of place to mention that loss making Passenger traffic occupies more than 60% of IR's Capacity while generating less than 30% of IR's Revenue. The growing needs of having more and more Passenger trains compels IR to increase their numbers with consequent increase in traffic congestion and also in revenue loss.**
- 3.1.12.3 Passenger fares on IR were deliberately kept low since inception and in the year 1950-51 the value of **Tariff Ratio** (Ratio between the average passenger fare per km to the average freight rate per km) was 0.5 (Financially desirable value for the Tariff Ratio is around 1.0; on Chinese Railways its value is 1.2). However, over the years the Tariff Ratio has further declined to 0.3 resulting in loss in the Passenger segment of traffic. If the Tariff Ratio is restored to its original value of 0.5, the Passenger traffic will no more remain a loss making segment.
- 3.1.12.4 The argument that subsidised passenger fares benefit the 'poor' is also not entirely true. The Economic Survey 2014-15, page 55 (Feb. 27th, 2015) clearly highlights that the subsidised fares on IR benefit the wealthy Households more as in non-suburban passenger segment only 28.1% are from the bottom 80% of the Households. (From this it can be inferred that this percentage from "below the poverty line" Households will even be lower.) It may be desirable to enhance the passenger fares gradually to make the Passenger segment financially self sustaining. Further, in consonance with the DBT (Direct Benefit Transfer) approach, subsidy could be targeted to the 'poor' through the Concession route (say 30-50% concession on the tickets purchased) to cover all those "below the poverty line".
- 3.1.12.5 **To make the system of fare fixation more rational, transparent, and acceptable to the general public it may be desirable to link it to some national index like the Consumer Price Index (CPI). Changes can then be done automatically say once or twice a year.**

3.2 Several Studies Support the Need for Faster Growth of Rail

3.2.1 A European Study (Soft Mobility Paper 2006) details carbon dioxide (CO₂) emissions for various transport modes as under:

Freight Transport (gms / tonne km)		Passenger Transport (gms / passenger km)	
Road	158	Air	229
Water Transport	31	Road (Car)	175
Rail	29	Rail	75

The Study suggests various methods to make Transport Greener like (i) Planned shift to Non-motorised Transport (ii) Encouraging shift of commuters from use of Road to Rail and from personalised vehicles to Public Mass Transport Systems but the main emphasis is on (iii) **Improving the share of Rail in overall transport scenario.**

3.2.2 For our country, faster growth of Rail has also been envisaged in several Studies:

- (i) National Transport Development Policy Committee (NTDPC) Report (2014)
 - Growth of market share in freight traffic from existing 30% to 50% by 2032.
 - Growth of investment from 0.8% of GDP in 12th Plan (2012-17) to 1.1 to 1.2% of GDP in the next three Plans (2017-2032)
- (ii) Report on “Low Carbon Strategies for Inclusive Growth” of the Planning Commission (April 2014), highlights the need for completing the Dedicated Freight Corridors (DFCs) on the Golden Quadrilateral and its two Diagonals by 2030 for improving the market share of Rail to 50%.
- (iii) India has committed to increase the market share of freight traffic by Rail to 45% by 2030 in the INDC document which was discussed in the 21st Conference of Parties (CoP 21) organised by the UNFCCC in Paris, in November 2015. (Ref.: Indian Railways: Environment Sustainability Annual Report 2017-18).

3.2.3 Need for faster growth of Rail vis-à-vis Road was also emphasised in a Study conducted by the Balance Research Institute (1999) which mentioned that while the World Transport in next 100 years will increase by

4 times, the Roads will not be able to carry more than 2 times, and the balance will have to be carried by Rail.

The Study further highlighted that, including all known Costs and Revenues, perhaps rail freight is 80% commercial at present, whereas road freight is perhaps 50%. If both had to pay 100% of the economical and societal costs, then the modal split would change towards Rail. **(Differential cost works out to 30%)**

With growing concerns for Climate Change, the present day **differential cost** can be taken as $30+10 = 40\%$. **Further, a detailed study is needed to realistically evaluate the economical, societal and environmental costs for Rail and Road projects.**

3.3 Some special Features of an Organisation, of the size and complexity of Indian Railways

- 3.3.1 Unlike the Road systems, which, apart from Central control, also have complementing organisations at the State level, the IR is a monolith due to the need for seamless operations. Its Huge Work-force and Complex Working, round the clock, can only be compared with Defence Organisation during a wartime situation.
- 3.3.2 The need for uniformity on the entire system coupled with need for speedy action at the grass-root levels calls for a system and management approach which can rightly be termed **controlled-decentralisation**.
- 3.3.3 Changes are difficult to effect on the IR and have to be meticulously planned. To give an example, if a new rolling stock is introduced, the whole length of the concerned network has to have maintenance staff & facilities for it. Unless these are developed, end-to-end running will not be possible.
- 3.3.4 Prevention of accidents on an Organisation **running 19,000 trains daily** essentially needs Zero failures of men, materials, machines and systems. Developing a culture towards 'zero failure' is an inescapable need.
- 3.3.5 Indian Railways have 13 lac employees and with an average family size of 4, about 1 in 250 in our country is railwayman or his family member. An elaborate system of staff training coupled with 'Ethics and Values' very favourably affects not only the IR but all the rail users. With a little more directed efforts and inputs the benefits could be multiplied **manifolds**.
- 3.3.6 Low passenger fares on IR, while affecting adversely the Organisation, also convey a message of its deep concern for the poor. Any change in the passenger fare pricing pattern has also to keep this aspect in view.

3.4 Action Plan for improving the Operating Ratio of Indian Railways

- 3.4.1 A recent Report, in the Economic Times of 2nd February 2019, has quoted Hon'ble Railway Minister Piyush Goyal that the Operating Ratio of IR is expected to improve to 95% for the year 2019-20 vis-à-vis earlier values of 96.2% in 2018-19 and 98.4% in 2017-18. It will be appreciated that for a dynamic organisation like the IR, and that too under one of the best Political and Managerial leadership, financial situation could perhaps have been better. **It clearly indicates presence of severe organisational constraints which basically are 'lack of capacity on busy routes due to under-investments in the past' and 'loss making passenger traffic needing subsidy'.**
- 3.4.2 To take care of lack of capacity on busy routes DFCs are planned for the Golden Quadrilateral and its two diagonals connecting Delhi, Mumbai, Chennai and Kolkata. **Work on Delhi-Mumbai and Delhi-Kolkata routes is nearing completion and major growth of both Freight and Passenger Traffic (Capacities are likely to double) could be planned on these routes duly supplementing the feeder routes in advance.** The balance four legs of DFC should be completed in next 10 yrs. with the partial assistance (40% Viability Gap cum Accelerated Development Fund) from the GOI.
- 3.4.3 Indian railways should also embark on a phased programme to eliminate loss-making passenger traffic subsidy (only people below the poverty line could be subsidised) as discussed earlier in this Note (**Ref. Para 3.1.12**).
- 3.4.4 **Growth of Freight and Passenger traffic on the two completed legs of DFCs in a big way also by supplementing the concerned Feeder routes should be the main stay for enhanced financial performance.** It has been noted that recently there has been lot of activity proposing introduction of new passenger private trains and further plans for the Freight trains could be considered. This opportunity could also be taken to plan some point to point Time Tabled freight trains as also Roll-on Roll-off trains to carry road trucks to reduce road traffic and air pollution.
- 3.4.5 Other area like the Station Development, Outsourcing of Some Activities, Improving the Logistics, etc could continue but these can only make a marginal contribution towards financial enhancement. **It has always to be kept in focus that market share of Rail based systems has to be improved for a significant enhancement in National Transport Infrastructure, keeping in view the Environmental considerations.**
- 3.4.6 **A system also needs to be put in place to monitor the market share of Rail vis-à-vis other Transport modes on a regular basis.**

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Some Abbreviations / Terms Explained

DBT	Direct Benefit Transfer
DFCs	Dedicated Freight Corridors
GOI	Government of India
IEM	Independent External Monitor
INAE	Indian National Academy of Engineering
INDC	Intended Nationally Determined Contribution
IOCL	Indian Oil Corporation Limited
IR	Indian Railways
MoR	Ministry of Railways
MCMEs	Micro, Small & Medium Enterprises
NHAI	National Highways Authority of India
NHPC	National Hydroelectric Power Corporation
NTDPC	National Transport Development Policy Committee
ONGC	Oil and Natural Gas Corporation
MEoR	Measure of Expenditure over Revenue
PMGSY	Pradhan Mantri Gram Sadak Yojna
UTES	Rail India Technical & Economic Services
OB	Road Over Bridge
RUB	Road Under Bridge
SAIL	Steel Authority of India Limited
Tariff Ratio	Ratio Between the Average Passenger Fare per Km to the Average Freight Rate per Tonne Km
UIC	International Union of Railways (HQ – Paris)
UNFCCC	United Nation's Framework Convention on Climate Change

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