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INDUSTRY OUTLOOK

RENEWABLE ENERGY IN INDIA: CHALLENGES AND PROSPECTS

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Introduction

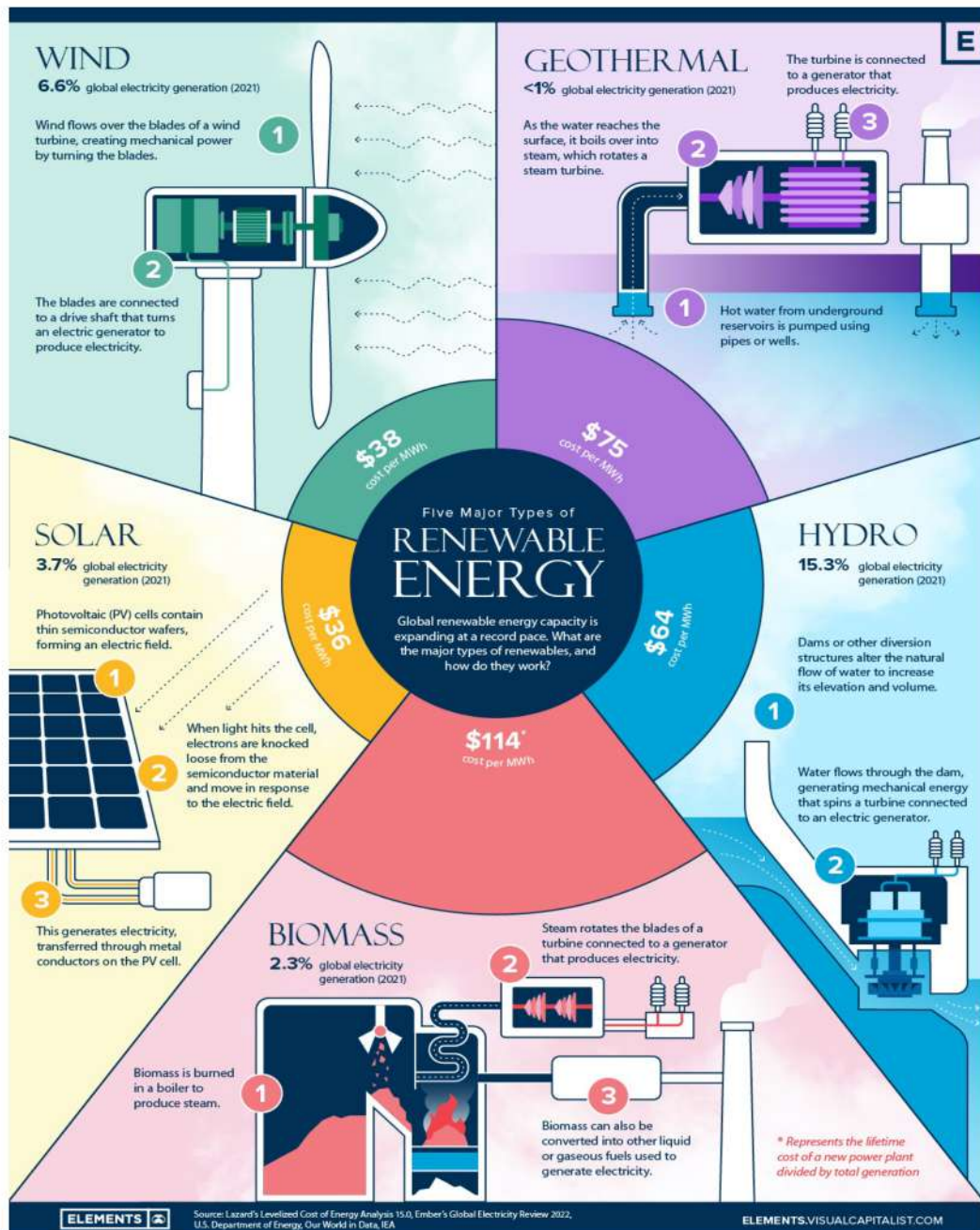
Compelling cross-country experiences have brought into sharp focus accelerating environmental changes, rapidly depleting potential economic value of finite resources and their attendant implications. The issues of environmental preservation, uncertainty and irreversibility necessitate an accent on renewable energy (RE) for life, biodiversity, climate variability, environmental sustainability, inter-generational and distributive equity.

The rising environmental concerns, climate change and global warming have provided a sense of immediacy in exploring more viable and sustainable sources of energy by nations. Renewable sources of energy can be harnessed from natural sources and help to move towards a safer and cleaner environment. The Brundtland Commission set up by the United Nations in 1987 defined the term sustainable development as “development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs”. [1] The enhancement of value for the stakeholder necessitates profound change – away from a society obsessed with growth and consumption to one that does not blow away finite resources.



Given the sway of materialistic thinking all over the world, this requires addressing needs and factoring environmental, societal and economic values through products and services. Hence, the concept of sustainable development does not merely imply “a concern for the progeny” but requires intermeshing of economic, social and environmental policies ‘to ensure a better quality of life for everyone, now and for generations to come’. Growth is no longer the unquestioned Holy Grail. Hence the strategy of sustainable development encompasses four basic themes of social progress that recognizes the need of everyone, effective protection of the environment, prudent use of natural resources and maintenance of high and stable levels of economic growth and employment.

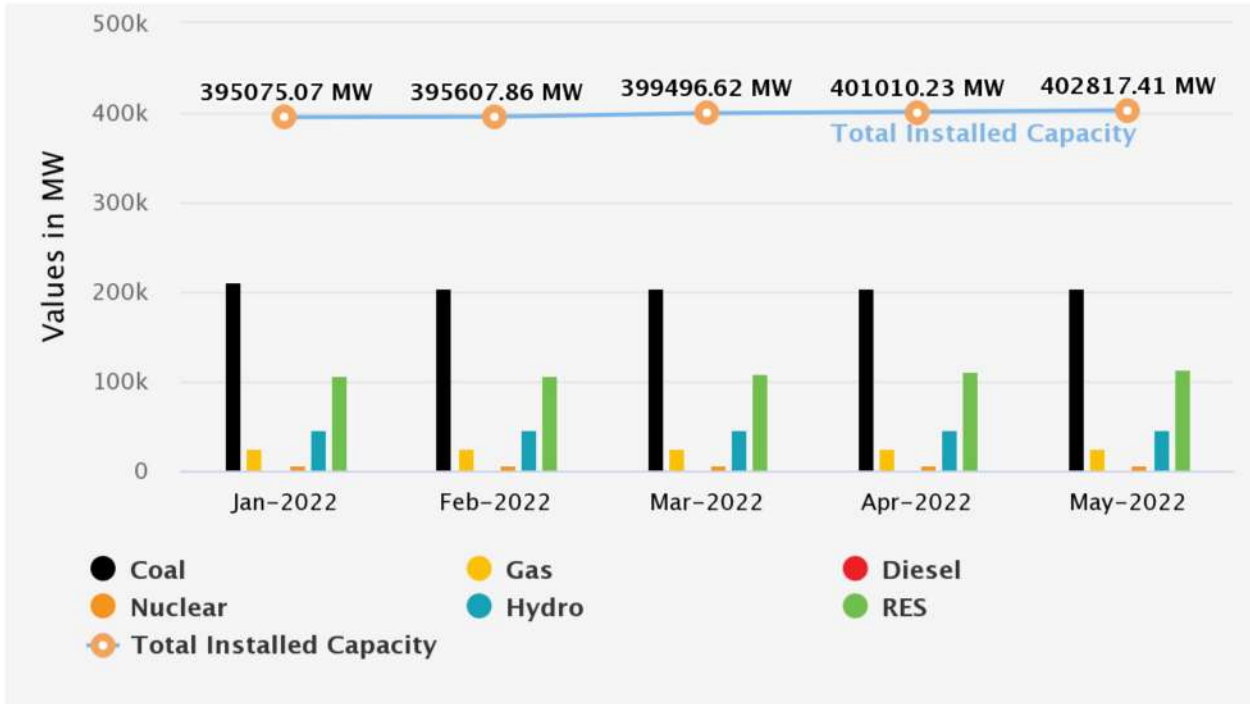
The United Nation (UN) has defined ‘renewable energy as the energy derived from natural sources that are replenished at a higher rate than they are consumed’.[2] There is plentiful availability of renewable energy sources, such as, wind and sunlight. Globally, India is at the 4th position in overall installed renewable energy capacity with a share of 26.53 per cent in total installed generation capacity in the country. In the last 7.5 years, the installed capacity has increased by 286 per cent.



Source: <https://elements.visualcapitalist.com/what-are-the-five-major-types-of-renewable-energy/>

Until May 2022, the total installed capacity of renewable energy (excluding from hydro sources) was 113226.47 MW (Mega Watt), which constituted 28.10 per cent of the total installed capacity [3] (See Chart 1).

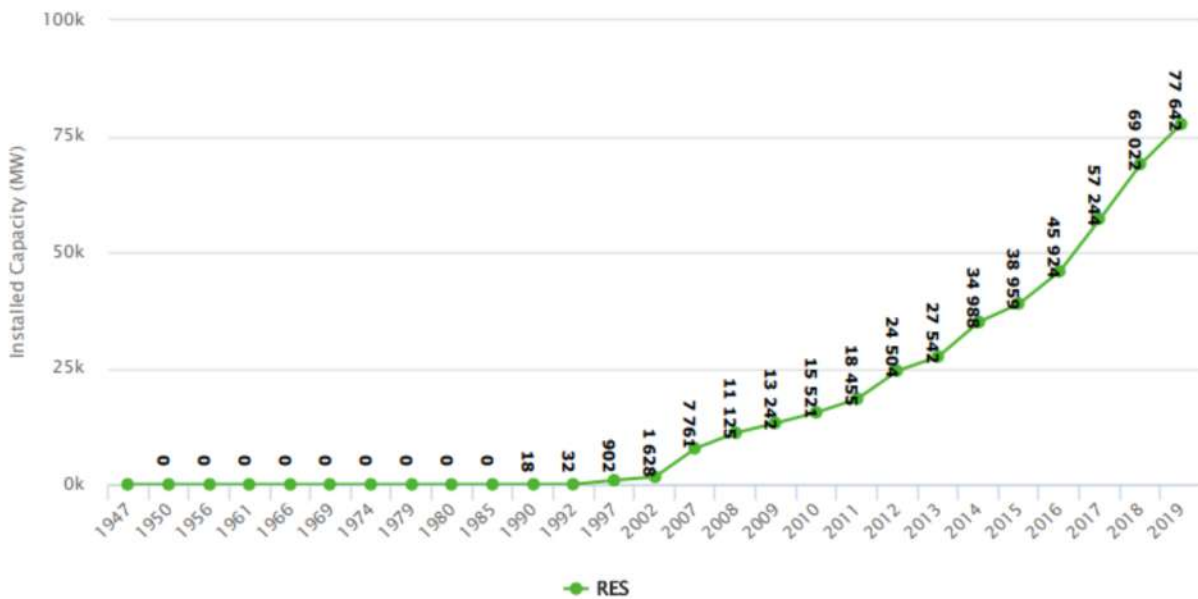
Chart 1: Installed Capacity – Resource-wise installed capacity of All India



Source: CEA, Ministry of Power, Government of India

The growth of renewable energy sources occurred from 2002 onwards when the government’s focus to shift towards generating power out of renewable sources of energy. In January 2010, the government had launched the Jawaharlal Nehru National Solar Mission (JNNSM), or the National Solar Mission to promote renewable energy in the country through solar power.

Chart 2: Renewable Energy Sources (RES) Installed Capacity Trend



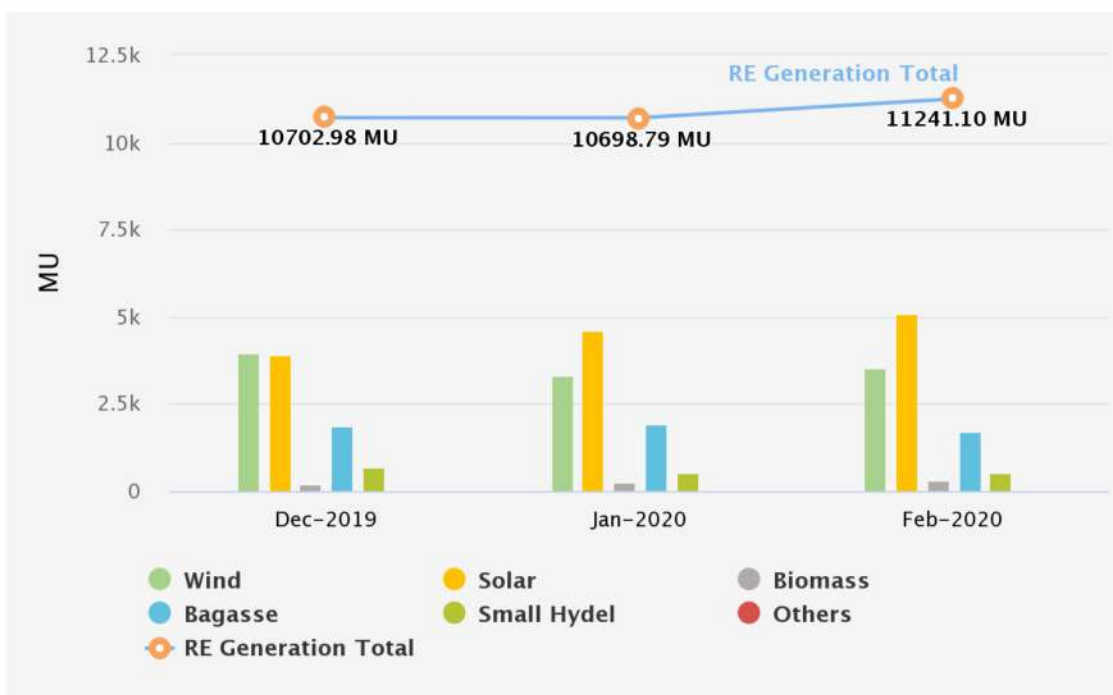
In 2010, India had installed capacity of 15,521 MW from renewable energy sources, which increased five-folds to 77,642 in 2019 (See Chart 2). While the total installed capacity of Hydro power is 46722.52 MW and 40706.38 MW by Wind Power. The breakup of renewable energy sources is given below (See Table 1):

Table 1: Break up of RES all India as on May 31, 2022

Small Hydro Power	Wind Power	Bio Power		Solar Power	Total Capacity
		BM Power/ Cogeneration	Waste to Energy		
4886.40	40706.38	10205.61	476.75	56951.33	113226.47

Out of the total renewable energy generation of 11241.10 MU, energy generation from the solar sources has been the highest followed by wind, bagasse, and small hydel projects.[4] Until, February 2020, the 5085.17 million units (MU) was generated from the solar power sources while 3518.88 MU and 1735.14 MU were generated respectively from wind and bagasse sources of renewable energy generation (See Chart 3).

Chart 3: All India Renewable Generation



Source: CEA, Ministry of Power, Government of India

Sustainable development has implications for life, biodiversity, climate variability, environmental sustainability, inter-generational and distributive equity. The sustainability of fossil fuels is worked out by Reserves-to-production ratio (R/P), i.e., the extrapolation on the basis of the reserves at their present rate of consumption. Estimated global R/P ratios for the main conventional fuels are – Oil-46 years, Natural Gas-58 years and Coal-118 years. This highlights the concepts of interrelatedness, of a shared planet, of global citizenship, and of 'spaceship earth'. Sustainable development in a globalizing world stresses the mutuality of activities.

We cannot, however, be oblivious to the principles of equity and “common but differentiated responsibility and respective capabilities (CBDR-RC)”, wherein all nations must try and save planet but skewed distribution of income and wealth necessitate greater financial burden on rich countries than poor nations.

The unsustainable consumption and production patterns jeopardizing the natural life-support system require improved design and establishment of effective institutional and associated legal and regulatory frameworks; improved policy measures; modernized forestry approaches; improved data collection and associated biomass energy planning; the provision of adequate financial and technical resources and effective mechanisms for transfer of technology. Accordingly, environmental concerns need to be dovetailed into development planning as indicated below to formulate a coherent strategy for environment-friendly development (See Table 2).

Table 2: Formulation of Coherent Strategy for Environment-friendly Development

Level	Integration of Environmental Policies and Procedures	Environmental Assessment Planning or Management Techniques Used
National	Environmental policy included in national action plan	<ul style="list-style-type: none"> • Environmental profiles • International Assistance Agency Country Programming.
Regional	Economic-cum-environmental development	<ul style="list-style-type: none"> • Integrated regional development planning. • Land use planning • Environmental master plans.
Sectoral	Sectoral review linked with other economic sectors	<ul style="list-style-type: none"> • Sector environmental guidelines. • Sector review strategy.
Project	Environmental review of project activities EIA procedures.	<ul style="list-style-type: none"> • EIA • Environmental guidelines

In view of the inherent limitations of the conventional approach, the focus of environmental issues now covers problems, such as, water shortage, crop failures, tropical diseases, flooding and extreme weather events condition. Going forward, all these problems could be exacerbated because of increased concentration of greenhouse gases (GHGs) emitted by a vast number of highly heterogeneous sources.

Perspective of the Developing Countries

According to the Asian Environmental Outlook 2001, “environmental degradation in (Asia and the Pacific) is pervasive, accelerating and unabated. At risk are people’s health and livelihoods, the survival of species and eco-system services that are the basis for long-term economic development”[5] (ADB 2001). While developing countries saddled with three times more population than the developed countries, have been far less responsible for “polluting” the global atmosphere with GHGs, the contribution of developing countries to the worsening of environmental problems is increasing rapidly. An asymmetric and ‘dualistic society’, wherein environmental problems originate from the greed of the rich and the poverty of the poor characterize most developing countries.

Three rapidly accelerating trends are agricultural intensification, fast paced industrialization and rising energy use, particularly, greater use of fossil fuels. Consequently, a slew of environmental interventions, from local to international, are needed to safeguard both environmental quality and human health. The strategy of effective environmental management, inter-alia, requires expanding water and sanitation coverage, tackling indoor air pollution, controlling disease vectors in the local environment, eco-friendly industrialization by pollution abatement measures, reducing exposure to the worst offenders and cleaner production in the future, etc. Holistic and transparent development of developing countries requires the integration of the agricultural, economic, social, and environmental sectors of the economy with a judicious mix of practical, applied, and theoretical perspectives.

Institutional Initiatives

The Government of India has been driving a vibrant renewable energy programme aimed at achieving energy security, energy access and reducing the carbon footprints of the national economy. Government is making vigorous efforts to promote and develop the infrastructure required for generating power from renewable energy sources. At the COP-26 Summit held in Glasgow in November 2021, the Prime Minister Shri Narendra Modi promised to enhance India’s renewable energy generation capacity to 500 GW and meet 50 per cent of India’s energy needs through renewable means by the year 2030.

Recently, the Government of India (GoI) has implemented a financial assistance scheme for setting up of 50 Solar Parks of aggregate capacity of 40,000 MW in the country. These parks are meant to provide developed infrastructure to facilitate installation of solar power projects. Also, for promoting solar energy in the residential sector, the Ministry of New and Renewable Energy is implementing Rooftop Solar Programme Phase-II which is a Central Financial Assistance (CFA) programme with a target of adding 4000 MW rooftop solar (RTS) capacity. Under this scheme, 40 per cent of the benchmark cost is to be given in the form of Central Financial Assistance to RTS project up to 3 kW capacity and up to 20 per cent for RTS system capacity beyond 3 kW and up to 10 kW for individual households. While for Group Housing Societies/Residential Welfare Associations (GHS/RWA), CFA is limited to 20 per cent for RTS plants for supply of power to common facilities maximum 500 kW capacity.

The renewable expansion in the country on the projected scale requires creation of an investor friendly ecosystem with timely reform measures by the government. In the wake of this development, the GoI has allowed Foreign Direct Investment (FDI) up to 100 percent under the automatic route that will attract more investments and essential source of non-debt finance for the economic expansion in the solar power sector. Solar sector has been amongst the focus area of government shifting towards renewable energy. In annual budget 2021, government had announced custom duty hike on solar invertors from 5 per cent to 20 per cent and solar lantern 5 per cent to 15 per cent with a motive to promote indigenous manufacturing of solar invertors and attract the foreign players to invest in India. Apart from the financial based schemes, government is also supporting projects at academic and research institutions and industry for development of hydrogen technologies.

Industry Risks

India is the third-largest global emitter of CO₂, despite low per capita CO₂ emissions. The carbon intensity of its power sector exceeds the global average. Further, particulate matter emissions are a major contributor to air pollution, which has emerged as one of India's most sensitive social and environmental issues. In 2019, there were well over one million premature deaths related to ambient and household air pollution. This is going to be a big challenge for the policy makers making it necessary to shift their focus to most efficient and sustainable energy sources. Strategic measures include

- (i) improving the efficiency of supply and consumption of energy;
- (ii) expanding the proportion of natural gas, and hydropower in the fuel mix; and
- (iii) reducing energy intensity in the transport sector.

India has the target to increase its non-fossil energy capacity 175 GW by 2022 and 500 GW by 2030 .[6] But unfortunately, India is far behind the target with many States are lagging on this front. While Telangana under-achieved the target of increasing renewable energy sources, Rajasthan achieved more than the targeted level.

The lack of required infrastructure is one of the major hurdles of the renewable energy sector. Most of the available infrastructure is suitable to produce fossil-based and thermal-based fuels. Also, most of the electric transmission and distribution lines were developed long back, and therefore, need to be renovated and reconstructed in conformity with the emerging sources of energy in power generation system.

The lack of power storage is another risk because power generation through solar energy is possible only in daytime while the peak demand of power is mostly in night. Also, there might be inconsistency in power generation through solar and wind energy because of unpredictable weather system. Therefore, there must be an affordable and efficient battery storage system to store up the surplus energy than can be used to meet peak hour demands.

Another risk to the stakeholders is the high cost of installation of a solar power system. It costs around \$2,000 per kilowatt. For small-scale system for the household purpose, it costs around \$3,700 while for a new gas-fire plant, it cost around \$1,000 per kW.[7] Therefore, the high cost of installation makes investors and lenders think of renewables as high risk whereas they find fossil fuel plants more acceptable due to their low installation costs. Hence, the government policy should back the investors and lenders financially and promote use of renewable energy by giving up fossils-based fuels.

The renewable industry is in its nascent stage. Accordingly, several government initiatives are in place to develop the industry and other key players are also actively participating in developing the sector. But the industry is facing efficiency risk, which needs to be eliminated to survive in the industry. At this juncture, the major challenge for the producers is to reduce the cost of per unit production of renewable energy. Therefore, there is immense need to adopt innovative approach and technologies to increase efficient in the process of production of renewable energy in India.

There is a need for effective policy interventions from the policymakers in the sector so that the delays in renewable projects can be significantly reduced. However, the government has come up with 'Green Open Access Rules, 2022' recently which majorly promotes generation, purchase and consumption of green energy including the energy from Waste-to-Energy plants. The government should provide a shield to the industry so that the stakeholders can avert the financial risks in installation of power generation of renewable energy projects.

Financing Issues

Interactive and mutually reinforcing strategies, viz., strengthened institutional capacity, public-private partnerships and synchronized relationship between government agencies, UN bodies, business and industry, non-governmental organizations and academia reduce ubiquitous risks. Given the humungous investment requirements in RE, we need to identify financing issues, viz., their higher capital-intensive nature with lower organization and management (O&M) cost, exposure limit of banks to sectors, inadequate sector-specific risks awareness among financial institutions and solar project viability apprehensions.

An attempt also needs to be made to briefly examine sources of financing, viz., debt finance, equity finance, multilateral funding, clean energy funds and role of Development Finance Institutions (DFIs).

The survival of species and eco-system requires making sustainable development a credo by designing both appropriate energy programmes and appropriate energy delivery systems. The market for energy efficient products and services in India stems both from regulatory impetus and commercial incentives for industrial process efficiency. Some of the basic drivers of RE are energy security, energy deficit, abundant renewable supply and potential, climate change, government support, energy access and increased competitiveness of the sector.

Basic issues hampering the growth of the sector relate inter-alia to high cost and short-term debt, low availability of debt for RE sector because of non-conducive bank policies, restricted foreign borrowings and inadequate equity for new projects. Accordingly, action-oriented, time-bound outcomes approach requires transfer of energy technologies, enabling policy environments, greater private sector involvement and proper appraisal mechanisms. All stakeholders, viz., government, financial community, RE developers and distribution companies need to work in a coordinated and concerted manner with a sense of immediacy.

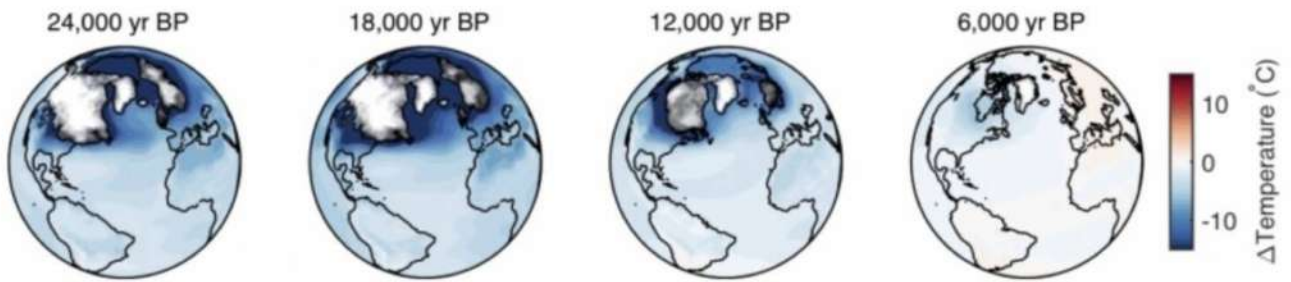
This requires strengthening of schemes to improve access to domestic and foreign debt; amend existing lending policies; enhanced capacity building; greater understanding of viability of financing energy efficient projects, type, and size of projects; and replicating best practices across geographies. There is also a compelling need to assess and mitigate technical risk, commissioning risk and performance risk and Energy Service Company (ESCO) Appraisal by credit line to an ESCO and energy efficiency project specific financing.

Climate Change

The RBI's Annual Report emphasized increasing vulnerability of the Indian economy to climate change, particularly agriculture [8] (RBI, 2021). Hence Central bankers need to popularize Environment, Social and Governance (ESG) principles. While focused attention is needed for sustainable development in all forms and manifestations, climate change adaptation requires altering behavior, systems, and even ways of life to protect families, economies, and the environment. The more we reduce emissions now, the easier it will be to adapt to the inexorable process of change.

The concept of climatic change goes back to the seminal work of Wallace Broecker in 1975. Subsequently, "the apocalyptic vision of ecologists" has acquired not just a terrifying ecological dimension but also a health problem, a social problem, a political problem and an economic one.

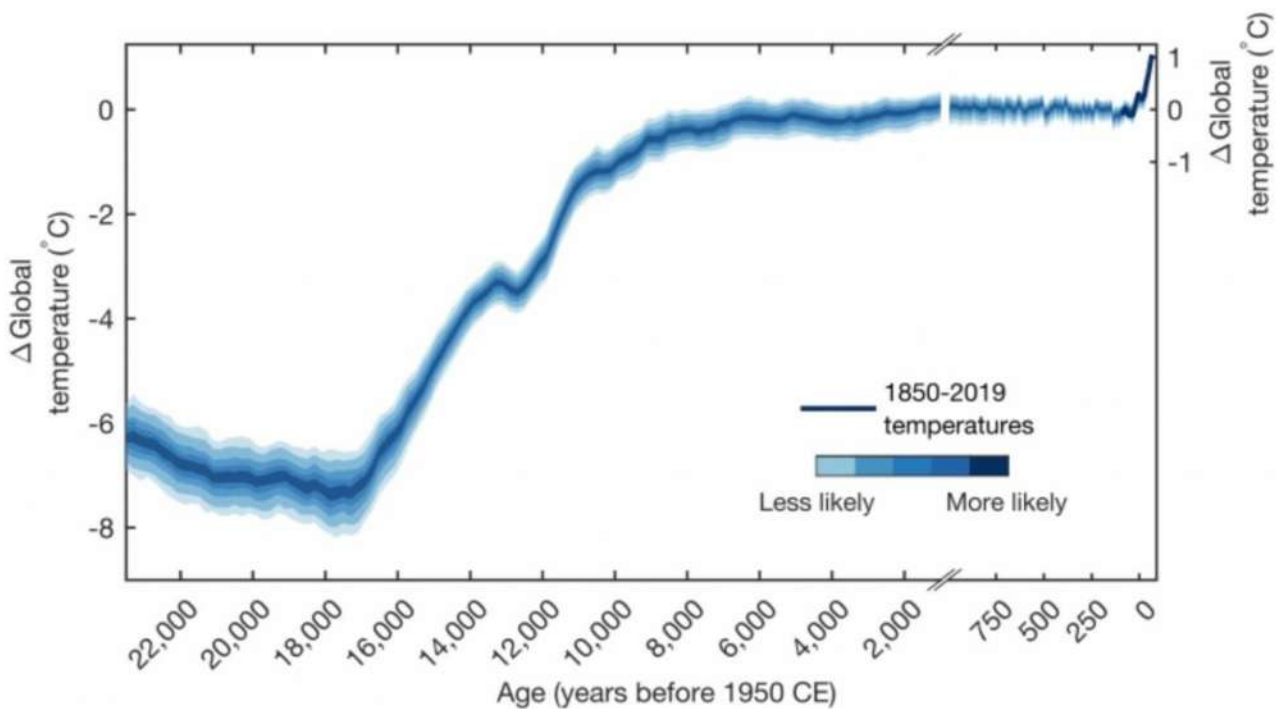
Chart 4 (1): Periodic Change of Global Average Surface Temperature at Different Periods



Source: Matthew Osma and University of Arizona

The above map shows global average surface temperature at different periods in earth's history going back 24,000 years. The darker the shade of blue, the colder the temperature compared to today.[9]

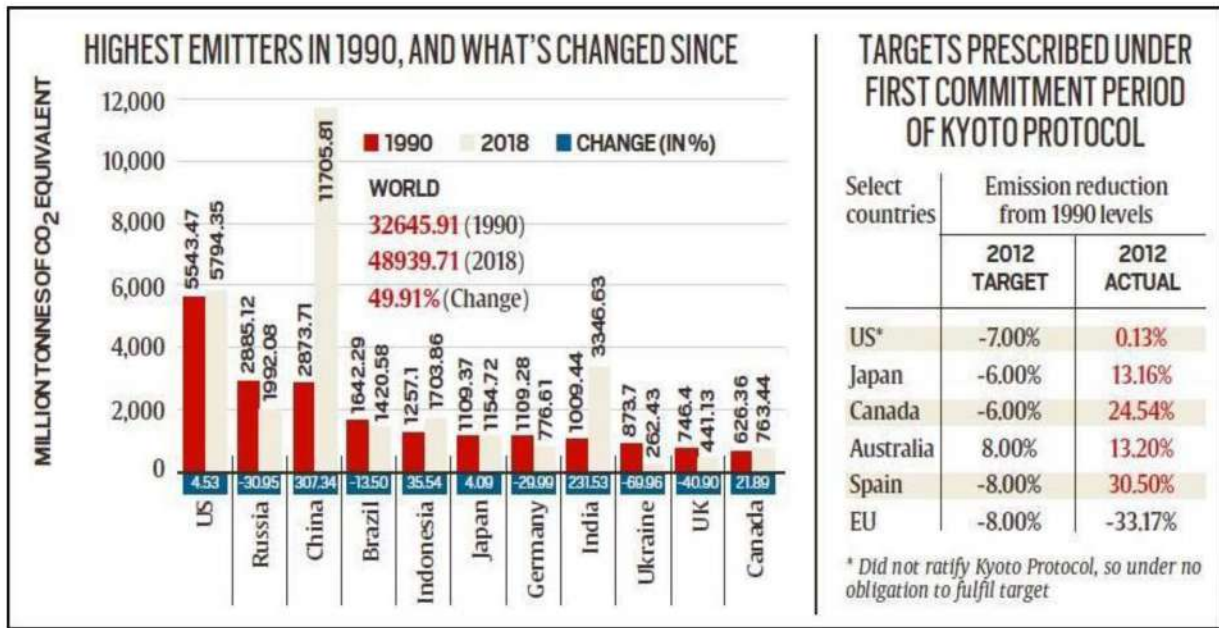
Chart 4 (2)



Source: Matthew Osma and University of Arizona

Three basic elements of climate change are the estimated damage of climate change; the discount rate and the weight on the future well-being; and the costs partially mitigating climate change. [10][11][12][13][14]

Chart 5: Highest Emitters in 1990 and in 2018



Source: Climate Watch, World Resources Institute (WRI)

Chart 6: Emission Reduction: Targets and Progress

COUNTRY	EMISSION REDUCTION TARGET	STATUS IN 2018
US	26-28% by 2025 from 2005 levels	10% reduction from 2005
EU (27)	40% by 2030 from 1990 levels	22% reduction from 1990
Australia	26-28% by 2030 from 2005 levels	3.48% above 2005
Japan	25.4% by 2030 from 2005 levels	2.66% reduction from 2005
Canada	30% by 2030 from 2005 levels	24.16% reduction from 2005
Russia	25-30% reduction by 2030 from 1990	30.95% reduction from 1990
China	Peak emissions in 2030	70.57% above 2005
Brazil	37% by 2025 from 2005 levels, 43% by 2030	29.13% below 2005
Indonesia	29% by 2030 from business-as-usual scenario	37.11% above 2005
Iran	4% by 2030 from business-as-usual scenario	45.58% above 2005

Source: Climate Watch, World Resources Institute (WRI)

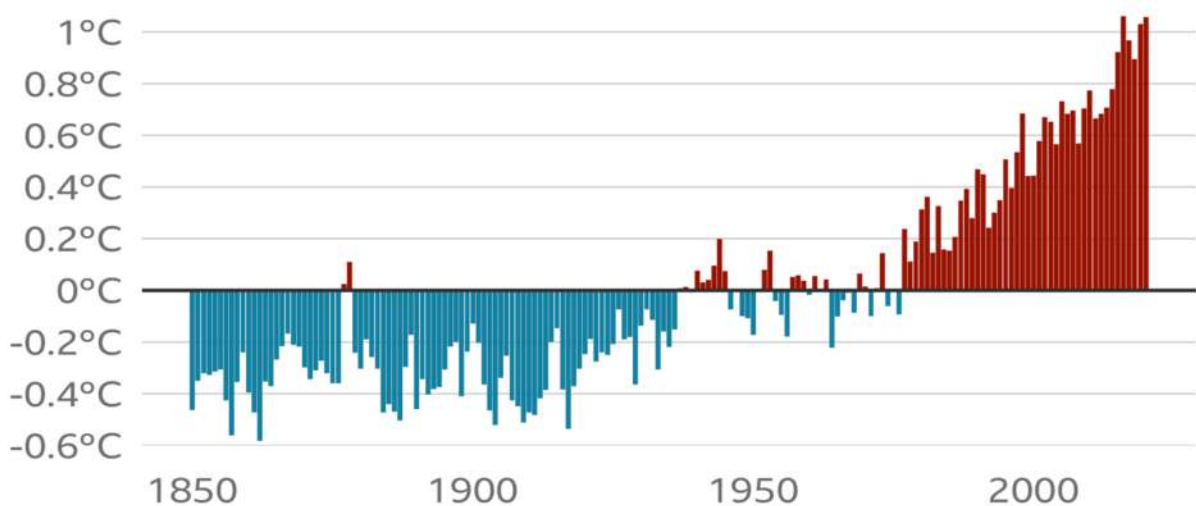
India is greatly susceptible to climate change because of extensive poverty, high population density, high reliance on natural resources, and a stressed environment. There is a battle outside and a war within. India requires USD 2.5 trillion (at 2014-15 prices) for mitigation and adaptation measures upto 2030. This requires domestic public budgets, international public finance and private sector resources. Preparation of India's National Action Plan on Climate Change (NAPCC) includes eight critical sectors namely Water, Solar, Enhanced Energy Efficiency, Sustainable agriculture, sustainable habitat, Strategic Knowledge for Climate Change, Himalayan Ecosystem.

State Action Plans on Climate Change (SAPCC) helps to profile climate challenge at State level, assess vulnerable areas and sectors for prioritization of climate actions, develop climate action pathways and strategies.

India's agreement to a "net zero" climate target depends on developed nations not renegeing on their clear commitments, viz., an annual \$100 billion to developing countries for mitigating climate change, facilitating technology transfer and implementing a tangible market-based mechanism to resuscitate the moribund carbon credit markets. A net-zero emissions future in terms of not just de-carbonization but also a whole new model for low-carbon development need not be a zero-sum game but could propel India to a higher growth orbit [15] (Kelkar, 2021).

The net-zero drive has also been associated with the targets of reaching 500 GW of non-fossil electricity capacity, renewables forming 50 per cent of the energy-mix and to slash projected carbon emissions by 1 billion tonnes by 2030. These targets are, by any standards, stiff targets, particularly, since India's over 80 per cent energy needs are met by coal, oil and traditional solid biomass.

Chart 7: Annual mean land and Ocean temperature above or below average, 1850 to 2020



Note: Average calculated from 1951 to 1980 data

The sixth report of the Intergovernmental Panel on Climate Change (IPCC) demonstrates that during 2015-2021, each subsequent year has been hotter than the previous one and the year 2021 is the sixth hottest year ever recorded. Global warming has constantly increased during the previous four decades compared to the last eighty years.

While acknowledging China and India are incorporating more renewable and low-carbon sources into their energy mix, displacement of coal is limited by sunk costs and political factors. Most developing countries almost continue to submit conditional targets because of inadequate financial assistance, technology transfers, and aid in capacity building by developed countries.

Developed countries' failure to mobilize \$100 billion a year starting 2020 has hampered their ability to take serious action necessitating new ways to leverage private investment while boosting and better aligning government spending. For leveraging the adaptation / resilience finance the key challenge remains

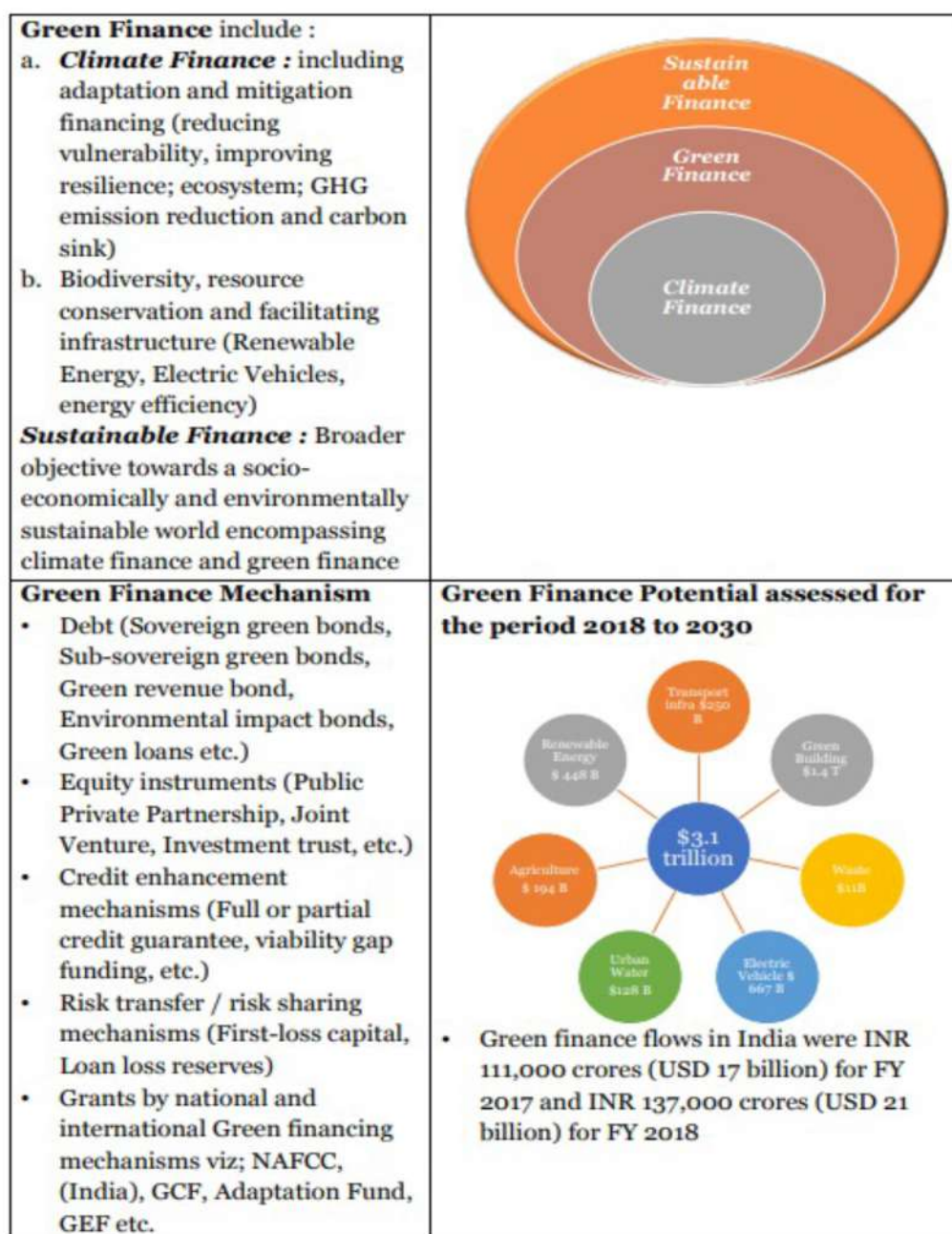
- (i) proper assessment of vulnerability,
- (ii) development of tools for quicker assessment,
- (iii) identification of location specific sustainable interventions
- (iv) ensuring Stakeholder Engagements/Peoples Participation
- (v) technical support & capacity building support of Stakeholders
- (vi) mainstreaming of through involvement of financial institutions through appropriate project finance approaches.

The report identifies 11 countries, including India, Pakistan, and Afghanistan as "Select Countries of Concern". These countries are likely to face warming temperatures, more extreme weather, and disruption to ocean patterns threatening their energy, food, water, and health security. Hence, we can no longer be oblivious to the vision of a common good, a shared future, the role of public goods, the divergence between social and private costs and benefits, and externalities in production and consumption.

Five elements of a robust climate change strategy are macroeconomic context, analytical framework, sectoral transitional mapping, technology, and financial mapping and institutional. [16] There has to be coherence between them to manage short-term dips and long-term recovery with an accent on climate change. Global Risks Report 2021 stresses managing risks, building resilience, and leveraging new opportunities with an integrated approach.

In the ultimate analysis, innovation in institutions, understanding, technology, and leadership are pre-requisites to addressing "the economics and politics of climate change". [17]

Chart 8: Green Finance Opportunities in India



Source: University of California, Berkeley

Conference of the Parties to the United Nations Framework Convention on Climate Change (CoOP26)

Almost all the world's negotiators gathered in Glasgow for the 26th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP26) to facilitate a broad agreement on slashing global warming and accelerating the transition to a cleaner economy. The case for holding this geopolitically significant Convention stemmed from the need to revisit climate pledges made by countries in terms of the historic 2015 Paris Agreement. The goal is to slash emissions – across air, water, and ground travel and logistics-till they reach net zero by mid-century. While not legally binding, this agreement will set the tone of climate change because what gets measured, improves.

The United States and China would work together in areas including methane emissions and shift to clean energy to slow global warming and bring out meaningful results. This is significant because these two countries are the top greenhouse gas emitting nations, together producing roughly 40 per cent of global emissions in 2019. This is why though the Glasgow Climate Pact had its faults, it did mark a headway ahead inasmuch as this was the first time that coal and fossil fuels were included in a final decision of the COP even though the initial aim to “accelerate the phasing-out of coal and subsidies for fossil fuel” was watered down to “phase-down unabated coal,” rather than “phase out.” The pact requires countries to “intensify their efforts” to phase down “unabated coal power”, meaning power plants lacking technology to check carbon dioxide emissions.

It called for an end to “inefficient” fossil fuel subsidies, without specifying a timetable for removing such subsidies. The provisions also “recognize” the need to support workers in these industries in finding alternative employment. It also allows for “different national circumstances”.

A UN agency will commit to providing “technical assistance” to vulnerable countries to help avoid and cope with the consequences of climate change. A proposal by developing countries to set up an independent fund to help pay for losses and harm was rejected by wealthy nations including the US, European countries and Australia.

The agreement notes with “deep regret” that rich countries have failed to meet their target of providing \$100bn a year to help developing countries by 2020. The agreement calls for them to raise at least \$100 billion a year until 2025. Rich countries are required to “at least double” their support for adaptation measures by 2025, compared with 2019 levels, which will help developing countries prepare for climate change.

Carbon market is a fundamental part of the “Paris rulebook”, a programme to implement the provisions of the Paris Agreement. The rules would create a market for the emissions reduction’s countries can trade. While many developing countries argue for a mandatory tax on all “carbon credits” to finance adaptation to climate change, rich countries oppose it. The final agreement included voluntary pledges by countries to contribute to the fund.

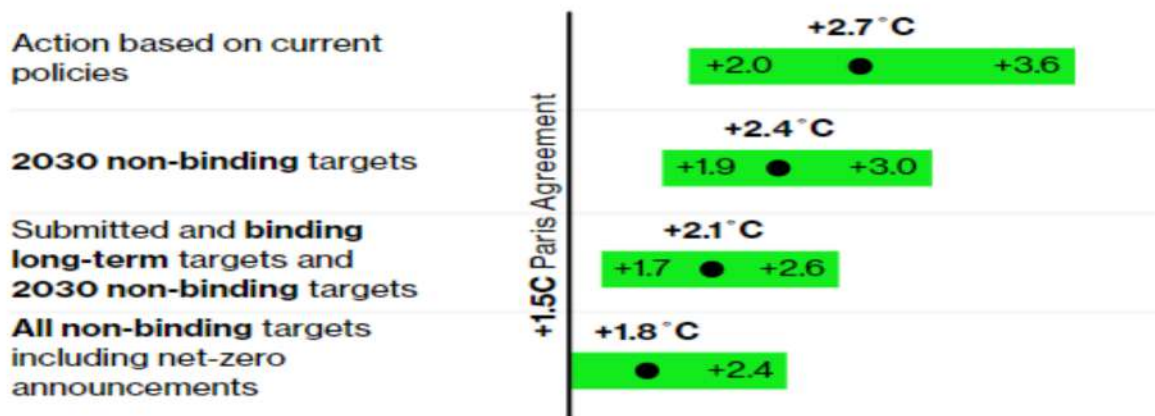
By the end of next year, countries need to raise their 2030 national climate targets. Commitments are now on track to raise global temperatures by 2.5C to 2.7C by the end of the century, which falls far short of the Paris Agreement target.

Parties also approved rules for the establishment of a global carbon market framework. Article 6, which provides a framework to help countries to work together to reach emissions-reduction goals, works primarily by trading credits that count toward their targets and sharing the burden of the climate fight. This issue is, however, tricky because of disagreement on how to account for emissions credits sold in the global market, avoiding double counting of carbon offsets, the demand of use old, unused credits from the 1997 Kyoto Protocol’s defunct CDM, etc.

The agreement pledged to significantly increase money to help poor countries cope with the effects of climate change and make the switch to clean energy. There is also the prospect of a trillion dollar a year fund from 2025 - after a previous pledge for richer countries to provide \$100 billion (£72 billion) a year by 2020 was missed. The issue of loss and damage was not addressed, i.e., developing countries pledging to pay for the damage already happening which cannot be avoided through adaptation. Developing countries wanted a facility to be set up but this did not fructify.

Phasing out coal was proposed as the main action to keep us below 1.5 degrees C. above pre-industrial level. But countries agreed to a weaker commitment to “phase down” rather than “phase out” coal after a late intervention by China and India. However, no firm date has been set.

Chart 9: Projections for Global Temperature increase by 2100 based on targets and announcements from COP26 (Still a Gap to 1.5oC above pre-industrial)

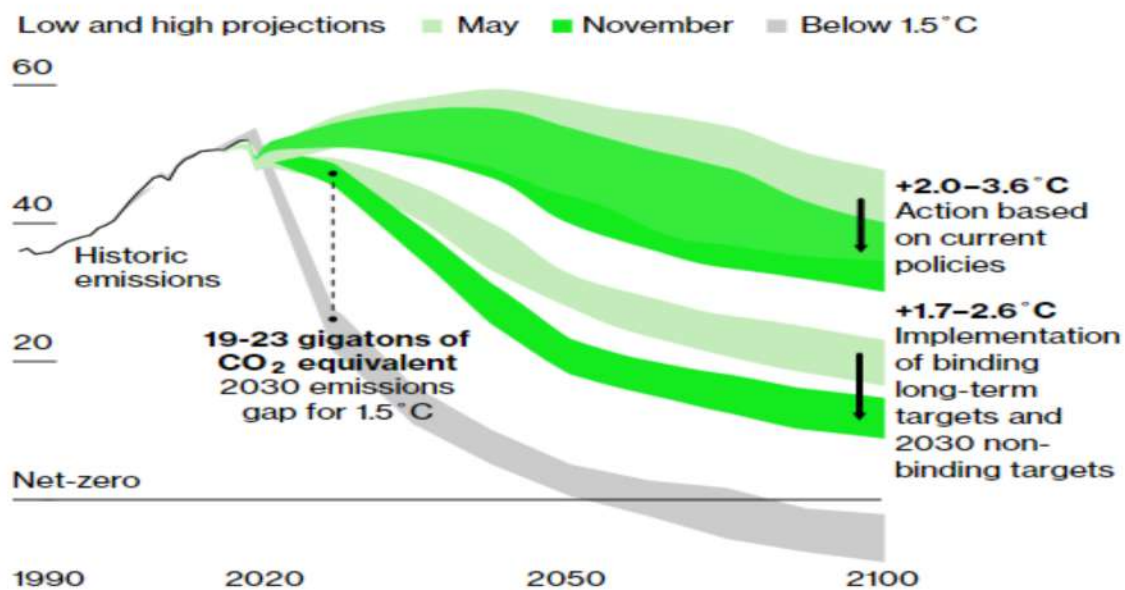


Note: November 2021 update
Source: Climate Action Tracker

Source: Climate Action Tracker

Several coalitions were made on saving forests, and cutting methane, although it seems most of the focus is on methane from fossils. Countries were asked to come back next year with stronger commitments for mitigation because these measures are clearly inadequate to prevent a “climate catastrophe”. Current pledges, if met, will only limit global warming to about 2.4oC.

Chart 10: Impact of COP26 on Emissions Pathways (New Targets could reduce emission by 2100 in line with 1.7-2.6oC warming)



Note: November 2021 update
Source: Climate Action Tracker

Source: Climate Action Tracker

Leaders from more than 100 countries - with about 85 per cent of the world's forests -promised to stop deforestation by 2030. This is crucial because trees absorb vast amounts of CO2. Given the unhappy experience of earlier initiatives, there have been some doubts about its success and the manner of its implementation and monitoring. A scheme to cut 30 per cent of methane emissions by 2030 was agreed by more than 100 countries. Methane is currently responsible for a third of human-generated warming. But China, Russia and India were conspicuous by their absence.

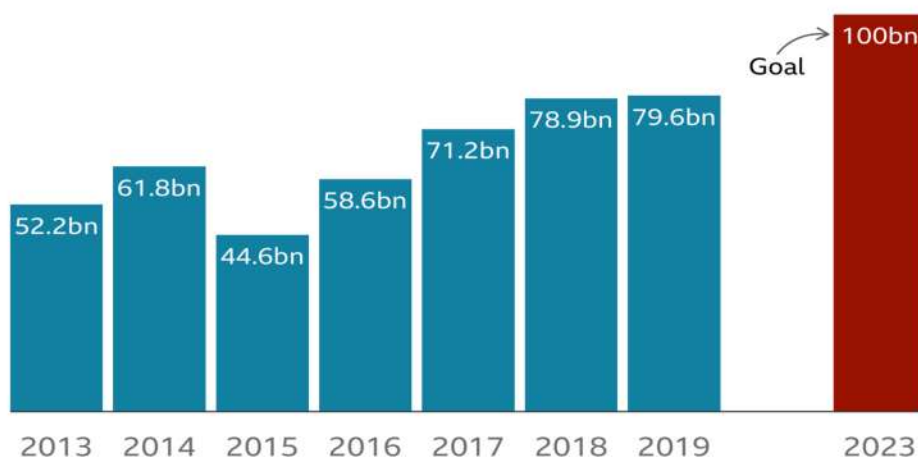
Financial organisations with around \$130 trillion in assets pledged to assign their business with the net-zero goal with thrust on “clean” technology, such as, renewable energy, and direct finance away from fossil fuel-burning industries. The initiative is an attempt to involve private companies in meeting net zero targets by effective action, enhancing low-carbon technologies and plug existing and potential new sources of emissions. However, without a greater commitment to ending support for fossil-fuels, this measure could be too little, too late.

Impact of COP26 on Emission Pathways

There is no mechanism of ensuring that the countries meet their pledges. Most commitments made at COP will have to be self-policed. Only a few countries are making their pledges legally binding. To be sure, it is uneasy for rich countries to eliminate fossil fuels and carbon and insulate their economies. This issue of effectively tackling climate change gets exacerbated in the case of developing nations, who are confronted with a serious resource crunch hampering their attempt to pay for new infrastructure and technology necessitating immediate grants, loans, and private investment to bolster efforts to adapt to climate change and mitigate its effects and move to renewable energy sources, such as, solar, wind and hydro power. What makes it worse is that climate finance has largely focused on loans rather than grants, which are bedeviled with repayment issues. Hence both the quality and the quantity of funding are important.

Despite agreement among countries to submit long-term strategies in conformity with 1.5 degree C, there is a clear skew in terms of timelines, an accent political and technical thrust, and the financial resources necessary to achieve the avowed goals of development. The implementation of individual and joint commitments is fraught with difficulties because the final version of the convention retains controversial proposals, including provisions to reduce coal and fossil fuel subsidies and proposed new climate targets by next year. Financial modeling needs to be supplemented by an understanding of complex ecosystem dynamics and principles of ecosystem valuation to discernibly alter the ground realities.

Chart 11: Climate Finance: Amount provided & mobilized by developed countries (US\$)



Source: OECD

The Way Forward

Apparently, the problem is enormous to be amenable to an easy solution because of its scale and magnitude. Accordingly, a judicious mix of programmes for each area by considering cost, environment and convenience needs to be worked out urgently. The commonality of interest requires equitable allocation of resources, attention to quality of economic growth, new technologies for efficient resource use and need-oriented economic and ecological development. In the Indian context, empowering local government and people, increasing afforestation and preventing swamping of traditional social and cultural systems would also help promote a more eco-friendly pattern of development.

What is called for is the broad basing of the development process - different programmes ought to be looked at not in isolation but as part of an organic whole. Some of the basic elements of the resuscitation strategy relate to vigorous efforts to promote and facilitate industry action for environmental improvement and management, dissemination of business-related information on climate change, energy efficiency and climate friendly technology and providing technology intermediation and business to business match making services to support the environmental initiative of industry, Government and international agencies.

Sustainable development implies integration of environmental, economic, and social needs in bringing about an enhanced standard of living in the short-term and a net gain or equilibrium among human, natural and economic resources to support future generations.

In the context of developing countries like India preoccupied with the task of attaining higher growth rates, it is important to consider the concerns of ecologically productive and sensitive areas of the country. Sustainability requires alleviation of poverty, a decline in fertility, the substitution of human capital for natural resources, effective demand for environmental quality and a responsive supply. The process of development itself also generates considerable environmental degradation. Ineffective action on environmental issues emanates from the prevailing mind set, which emphasizes development at the cost of environment. This could be attributed to the myopic short-term perspective that a transition from an agricultural or rural economy to an industrialized and urban economy invariably causes a rise in pollution.

However, the pollution levels might fall later. Recognition of inherent complementarity in the long run needs to replace the misplaced notion that the roles of environment and development are essentially conflicting and adversarial, and the self-sustaining regime of preconceived and unexamined expectations needs to be expelled forthwith.

The short-term costs of implementing eco-friendly policies are much lower than the potentially much higher costs caused by natural disasters in the mid- and long-term. There ought, therefore, to be a priori recognition that in the ultimate analysis, eco-friendly development is often the best, sometimes the only method, of enhancing economic development. There is no unavoidable trade-off between environment and development objectives and a synergistic relationship exists between growth and employment, employment and environment and environment and growth. Meticulously planned and flawlessly executed national emission mitigation strategy across diverse sectors could facilitate a robust economy and a healthier population.

This thesis can be substantiated by the declaration of net-zero emission targets by 58 countries. These countries attempt to slash their climate change-causing carbon dioxide emissions and other GHGs by measures, such as, planting trees, use of advanced technologies, etc. over the next three decades. These countries cumulatively make up for more than half the world's current GHG emissions.

The International Energy Agency forecasts that most of India's future emissions will emanate from transport infrastructure, industry, and buildings. A national net-zero target would foster economic growth in both quantitative and qualitative terms, e.g., use scarce freshwater for cooling thermal power plants, promotion of electric vehicles along with cleaner electricity and hydrogen electrolysis. Environmentally unsustainable practices turn out to be more expensive in the long run in terms of human and health costs and loss of capability. It has been demonstrated [18] that a net-zero emissions future need not be a zero-sum game but could propel India in a higher growth orbit.

The advantageous aspects of renewable energy sources include its extensive use in meeting the industrial need of energy with minimum costs, increasing efficiency and reliability. India needs to increase financial support for renewable energy to reach its goals for Aatmanirbhar Bharat.

Meeting the goal of 50 per cent of its energy requirements through non-fossil based renewable energy by 2030 is a huge challenge. India needs to enhance its capacity building in generation of power through energy sources. India needs to install at least 42 GW of renewable energy every year so as to achieve the target faster. As per the Central Electricity Authority (CEA) estimates, by 2029-30, the share of renewable energy generation would increase from 18 per cent to 44 per cent while that of thermal is expected to reduce from 78 per cent to 52 per cent.

Xinhua news agency has reported that most technologies were cheaper in 2021-22 as compared to 2020-21 and this could get further cheaper in the next 12 months as global supply chains recover from the disruptions caused by the COVID-19 pandemic. [19] The government's priority should be to navigate India's renewable energy transition efforts to boost industry to generate cheaper renewable energy generation.

The Government of India wants to develop a 'green city' in every state of the country, powered by renewable energy. The 'green city' will mainstream environment-friendly power through solar rooftop systems on all its houses, solar parks on the city's outskirts, waste to energy plants and electric mobility-enabled public transport systems.

Low-carbon hydrogen from the green sources is a fuel of the future which is storable, and it can be transported over long-distances. At present it costs \$5-\$6 per kilogram production of green hydrogen, which is quite high relative to the production cost in other countries in terms of per kilogram production cost. Therefore, to reduce the production of green hydrogen is a big challenge for both government and other industry players. The Government should incentivise producers of green hydrogen so that the commitment of achieving the goal of 500 GW by 2050 could be achieved collectively. Also, subsidies in the energy sector can help drive positive changes by helping consumers afford modern energy, bringing down the costs of new technologies, and encouraging investors to take risks in new markets in the pursuit of robust long-term planning, appraisal, monitoring, and evaluation mechanisms.

ENDNOTES

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