Climate Change

Climate Change

- Climate change includes both global warming driven by human-induced emissions of greenhouse gases and the resulting large-scale shifts in weather patterns.
- Though there have been previous periods of climatic change, since the mid-20th century humans have had an unprecedented impact on Earth's climate system and caused change on a global scale.

Causes of Climate Change

- Climate Change is a periodic modification of Earth's climate brought about due to the changes in the atmosphere as well as the interactions between the atmosphere and various other geological, chemical, biological and geographical factors within the Earth's system.
- Climate change can make weather patterns less predictable. These unforeseen weather patterns can make it difficult to maintain and grow crops, making agriculture-dependent countries like India vulnerable.

Climate Change

- It is also causing damaging weather events like more frequent and intense hurricanes, floods, cyclones, flooding etc.
- Due to the rising temperature caused by climate change, the ice in the polar regions is melting at an accelerated rate, causing sea levels to rise. This is damaging the coastlines due to the increased flooding and erosion.
- The cause of the current rapid climate change is due to human activities and threatening the very survival of humankind.
- The largest driver of warming is the emission of gases that create a greenhouse effect, of which more than 90% are carbon dioxide (CO2) and methan.
- Fossil fuel burning (coal, oil, and natural gas) for energy consumption is the main source of these emissions, with additional contributions from agriculture, deforestation, and manufacturing.

Climate Change

- Temperature rise is accelerated or tempered by climate feedbacks, such as loss of sunlight-reflecting snow and ice cover, increased water vapour (a greenhouse gas itself), and changes to land and ocean carbon sinks.
- Temperature rise on land is about twice the global average increase, leading to desert expansion and more common heat waves and wildfires.
- Temperature rise is also amplified in the Arctic, where it has contributed to melting permafrost, glacial retreat and sea ice loss.
- Warmer temperatures are increasing rates of evaporation, causing more intense storms and weather extremes.
- Impacts on ecosystems include the relocation or extinction of many species as their environment changes, most immediately in coral reefs, mountains, and the Arctic.
- Climate change threatens people with food insecurity, water scarcity, flooding, infectious diseases, extreme heat, economic losses, and displacement.

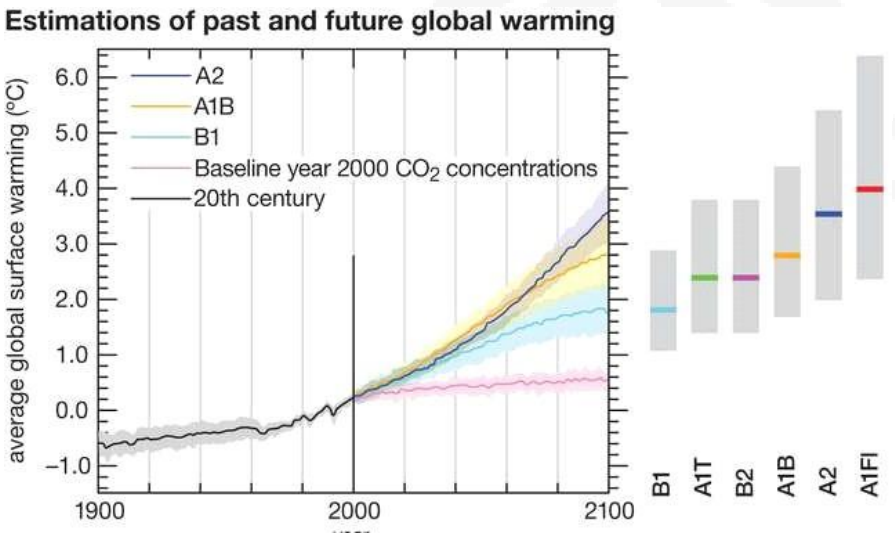
Climate Change

- These human impacts have led the World Health Organization to call climate change the greatest threat to global health in the 21st century.
- Even if efforts to minimise future warming are successful, some effects will continue for centuries, including rising sea levels, rising ocean temperatures, and ocean acidification.
- The Intergovernmental Panel on Climate Change (IPCC) has issued a series of reports that project significant increases in these impacts as warming continues to 1.5 °C (2.7 °F) and beyond. Additional warming also increases the risk of triggering critical thresholds called tipping points.
- Under the 2015 Paris Agreement, nations collectively agreed to keep warming "well under 2.0 °C (3.6 °F)" through mitigation efforts. However, with pledges made under the Agreement, global warming would still reach about 2.8 °C (5.0 °F) by the end of the century.

Climate Change

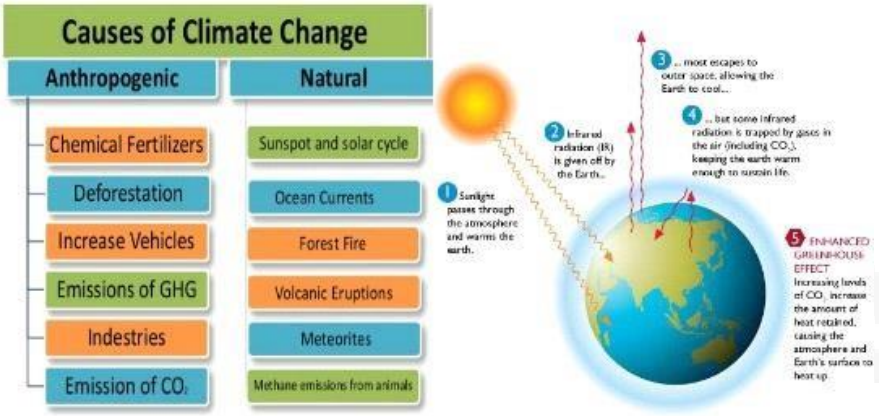
Global Warming

- Global warming occurs when carbon dioxide (CO2) and other air pollutants collect in the atmosphere and absorb sunlight and solar radiation that have bounced off the earth's surface.
- Normally this radiation would escape into space, but these pollutants, which can last for years to centuries in the atmosphere, trap the heat and cause the planet to get hotter.
- These heat-trapping pollutants—specifically carbon dioxide, methane, nitrous oxide, water vapor, and synthetic fluorinated gases—are known as greenhouse gases, and their impact is called the greenhouse effect.



Climate Change

Factors That Cause Climate Change



Natural Factors

- There are numerous natural factors that cause the Earth's climate to change. They affect the climate over a period of thousands to millions of years.

Continental Drift

- The present-day continents were not the same prior to 200 million years.
- They have formed millions of years ago when the landmass began to drift apart due to plate displacement.

Climate Change

- This movement had an impact on climate change due to the change on the landmass's physical features and position and the change in water bodies' position like the change in the follow of ocean currents and winds.
- The drifting of the landmass is continued today. The Himalayan range is rising approximately 1 millimetre every year as the Indian landmass is moving towards the Asian landmass.

Variation of the Earth's orbit

- The Earth's orbit has an impact on the sunlight's seasonal distribution that is reaching the Earth's surface.
- A slight change in the Earth's orbit can lead to variation in distribution across the world.
- There are very few changes to the average sunshine. However, it causes a high impact on the geographical and seasonal distribution.
- There are three types of orbital variations – variations in Earth's eccentricity, variations in the tilt angle of the Earth's axis of rotation and precession of Earth's axis.

Climate Change

- These together can cause Milankovitch cycles, which have a huge impact on climate and are well-known for their connection to the glacial and interglacial periods.
- The Intergovernmental Panel on Climate Change finding showed that the Milankovitch cycles had influenced the behaviour of ice formation.

Plate tectonics

- Due to the change in the temperature in the core of the Earth, the mantle plumes and convection currents forced the Earth's Plates to adjust leading to the rearrangement of the Earth Plate.
- This can influence the global and local patterns of climate and atmosphere.
- The oceans' geometry is determined by the continents' position. Therefore, the position of the continents influences the pattern of the ocean.
- The location of the sea also plays a crucial role in controlling the transfer of heat and moisture across the globe and determines the global climate.

Climate Change

- The recent example of the tectonic control on ocean circulation is the formation of the Isthmus of Panama about 5 million years ago, leading to the prevention of direct mixing of the Atlantic and Pacific oceans.

Volcanic Activity

- When a volcano erupts, it emits gases and dust particles, causing a partial block of the Sunrays. This can lead to the cooling of the weather.
- Though the volcanic activities last only for a few days, the gases and ashes released by it can last for a long period, leading to it influencing climate patterns.
- Sulphur oxide emitted by the volcanic activities can combine with water to form tiny droplets of sulphuric acid.
- These droplets are so small that many of them can stay in the air for several years.

Climate Change

Ocean Currents

- Ocean current is one of the major components of the climate system.
- It is driven by horizontal winds causing the movement of the water against the sea surface.
- The temperature differences of the water influence the climate of the region.

Anthropogenic Factors

- Scientists, since the beginning of the 20th century, have studied the impact of climate change caused by human activities.
- Global warming, the long-term rise in the average temperature of the Earth's climate system, is a major aspect of climate change.
- It is mainly a human-caused increase in global surface temperature. The anthropogenic factors causing climate change are as follows:

Climate Change

Greenhouse Gases

- The greenhouse gases absorb heat radiation from the sun. Following the initiation of the Industrial Revolution, the emission of greenhouse gases into the atmosphere has increased exponentially.
- This has led to more absorption and retaining the heat in the atmosphere. This resulted in an increase in Global Temperature.
- The greenhouse gases mostly do not absorb the solar radiation but absorb most of the infrared emitted by the Earth's surface.
- The main greenhouse gases include
    - water vapour (the majority of the GHG in the atmosphere but the impact is less)
    - Carbon dioxide released due to natural and anthropogenic factors spends more time in the atmosphere, leading to an increase in its impact.
    - There has been a 30% increase in the concentration of CO2 since the start of the industrial revolution. Apart from the industrial revolution, deforestation also contributes to the increase in the CO.

Climate Change

- Chlorofluorocarbons, used for industrial purposes, especially in refrigerants and air conditioning, is a man-made compound regulated under the Montreal Protocol due to their adverse effects on the Ozone layers.
- Methane is released due to decomposition of organic matter. It is stronger than CO2 because of its capacity to absorb more heat.
- Nitrous oxide is produced by the agricultural sector, especially in the production and use of organic fertilizers and while burning fossil fuels.

Change in the land use pattern

- Half of the land-use change is said to have happened during the industrial era.
- Most of the forests were replaced by agricultural cropping and grazing of lands.
- The increased albedo (reflectivity of an object in space) in the snow-covered high altitude regions due to deforestation led to the cooling of the planet's surface.

Climate Change

- The lower the albedo, the more of the Sun's radiation gets absorbed by the planet and the temperatures will rise.
- If the albedo is higher and the Earth is more reflective, the more of the radiation is returned to space, leading to the cooling of the planet.
- The tropical deforestation changes the evapotranspiration rates (the amount of water vapour put in the atmosphere through evaporation and transpiration from trees), causes desertification and affects soil moisture characteristics.
- From the satellite imagery, it is seen that the clearing of forest cover for agriculture and irrigated farming in arid and semi-arid lands can increase solar energy absorption and the amount of moisture evaporated into the atmosphere.

Climate Change

Atmospheric aerosols

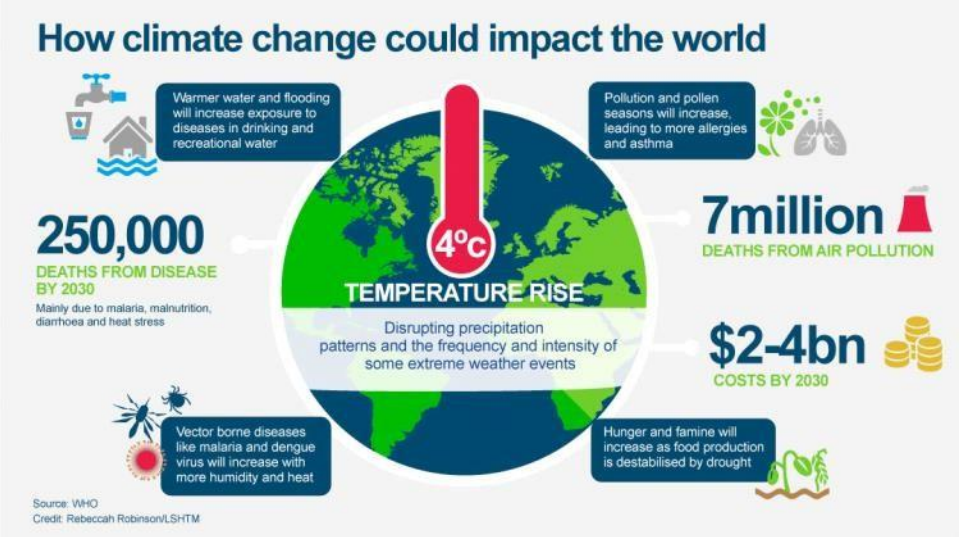
- Atmospheric aerosol can Scatter and absorb the solar and infrared radiation, change microphysical and chemical properties of the clouds, Solar radiation, when scattered, cools the planet.
- On the other hand, when the aerosols absorb solar radiation, it causes an increase in the temperature of the air instead of allowing the sunlight to be absorbed by the Earth's surface.
- Aerosols can directly affect climate change by absorbing or reflecting solar radiation. They can also produce indirect effects by modifying the cloud's formation and properties.
- They can even be transported thousands of kilometres away from its source through wind and upper-level circulation in the atmosphere.
- There are two types of aerosols – Natural aerosols and Anthropogenic aerosols.
    - The sources of natural aerosols include volcanic eruptions (produces sulphate aerosols) and biogenic sources like planktons (can produce dimethyl sulphide).

Climate Change

- The anthropogenic aerosols include: The ammonia used for fertilizers or released by the burning of plants and other organic materials forms a major source for Nitrate aerosols.
- Burning of coal and oil produces sulphur dioxide that forms a major source of sulphate aerosols. Burning of biomass can release a combination of organic droplets and soot particles.
- Industrial activities cause the release of wide-ranging aerosols into the atmosphere.
- Vehicle emissions can produce numerous pollutants that are aerosol from the beginning or becomes one due to chemical reactions in the atmosphere.
- It is found that the concentration of aerosols is about three times higher in the Northern Hemisphere than in the Southern Hemisphere, leading to the Northern Hemisphere's radiation concentration being 50% higher than that of the Southern Hemisphere.

Climate Change

Impacts of Climate Change



A rise in atmospheric temperature

- The greenhouse gases released due to human activities are increasing the temperature of the Earth.
- The last 6 years topped the list of hottest years ever recorded.
- The increase in temperature is the major cause of the current increase in heat-related deaths and illnesses, rise in sea levels and an increase in the intensity of natural disasters.

Climate Change

- The 20th century saw an increase in the Earth's average temperature by 1°F. This is believed to be the fastest rise in a thousand years.
- Research estimates predict that if the GHGs are not reduced, the average surface temperature could increase to 3-5°F by the end of this century.

Change in landscapes

- Increasing temperature and changing climate and weather patterns across the globe led to the shift of trees and plants towards Polar Regions and mountains.
- As the vegetation tries to adapt to climate change by moving towards colder regions, the animals that are dependent on them will be forced to follow them for survival. While some survive, many perish in the attempt.
- Other species like polar bears dependent on cold terrains will not have any habitat due to the melting of ice, causing a risk to their survival.
- Thus, the current hasty change in the landscape causes a considerable risk to the survival of many species, including the human population.

Climate Change

A risk to the ecosystem

- An increase in the temperature across the globe is changing the weather and vegetation patterns, causing the species to migrate to cooler areas for survival.
- This poses a threat to the survival of numerous species. It is projected that by 2050, one-fourth of the Earth's species may become extinct if the current trend continues.

Rising sea levels

- An increase in the temperature of the Earth leads to a rise in sea level due to the thermal expansion (a condition wherein the warm water takes up more area than cooler water). The melting of glaciers adds to this problem.
- The population living in under-lying areas, islands and coasts are threatened by the rising sea levels.
- It erodes shorelines, damages properties and destroys ecosystems like mangroves and wetlands that protect coasts from storms.
- In the last 100 years, the sea level has risen to 4-8 inches and will continue to rise between 4 and 36 inches in the next 100 years.

Climate Change

Ocean Acidification:

- The increase in the CO2 concentration in the atmosphere has increased the CO2 absorption in the ocean. This makes the ocean acidic.
- The increase in the acidification of the ocean can be harmful to many marine species like plankton, molluscs, etc. The corals are especially susceptible to this as they find it difficult to create and maintain the skeletal structures needed for their survival.

Increase in the risk of natural and manmade disasters

- The moisture from land and water is rapidly evaporating due to the high atmospheric temperature.
- This causes drought. Those areas that are affected by drought are highly susceptible to the negative effects of flooding.
- As this current condition, the droughts may become more frequent and more severe. This may lead to distressing consequences for agriculture, water security, and health.

Climate Change

- Countries in Asia and Africa are already facing this phenomenon, with droughts becoming longer and more intense.
- The increased temperature is not only causing droughts but also increasing the cases of forest fires across the globe.
- Climate change is also causing increased and intensified hurricanes and tropical storms, causing a devastating impact on human societies and the environment.
- The cause of this is the rise in the ocean temperature as warm waters influence the energies of hurricanes and tropical storms energies.
- The other factors that cause intensified hurricane and tropical storms are rising sea levels, disappearing wetlands and increased coastal development.

Climate Change

Health issues

- The high temperature across the globe can pose health risks and deaths.
- The increased heat waves caused by climate change have led to the deaths of many globally.
- For instance, in 2003, the extreme heat waves led to the death of more than 20,000 people in Europe and caused more than 1,500 deaths in India.
- Climate change increases the spreading of contagious diseases as the long-term warm weather allows disease-carrying insects, animals and microbes to survive longer.
- Disease and pests that were once confined to the tropics may find it habitable in the colder regions that were previously inhospitable.
- Currently, there is an increase in death due to extreme heat, natural disasters and diseases due to climate change.
- The World Health Organisation estimates that between 2030 and 2050, climate change may cause approximately 250,000 additional deaths per year due to malnutrition, malaria, diarrhoea and extreme heat.

Climate Change

Economic impacts

- It is estimated that if action is not taken to address the carbon emissions, climate change could cost about 5 to 20% of the annual global GDP.
- In contrast, the cost to lessen the most damaging effects of climate change is just 1% of the GDP.
- Climate change can alter shoreline habitats. This may lead to the need for relocation of ports and near-shore infrastructures and habitats, costing about millions of dollars.
- The increased hurricanes and other related natural disasters can bring forth extreme economic losses caused by damaged properties and infrastructures.
- Declining crop yields due to the lengthy droughts and high temperatures can lead to a risk of starvation of thousands of people.
- Coral reefs generate approximately $375 billion each year in goods and services. Their very survival is currently under threat.

Climate Change

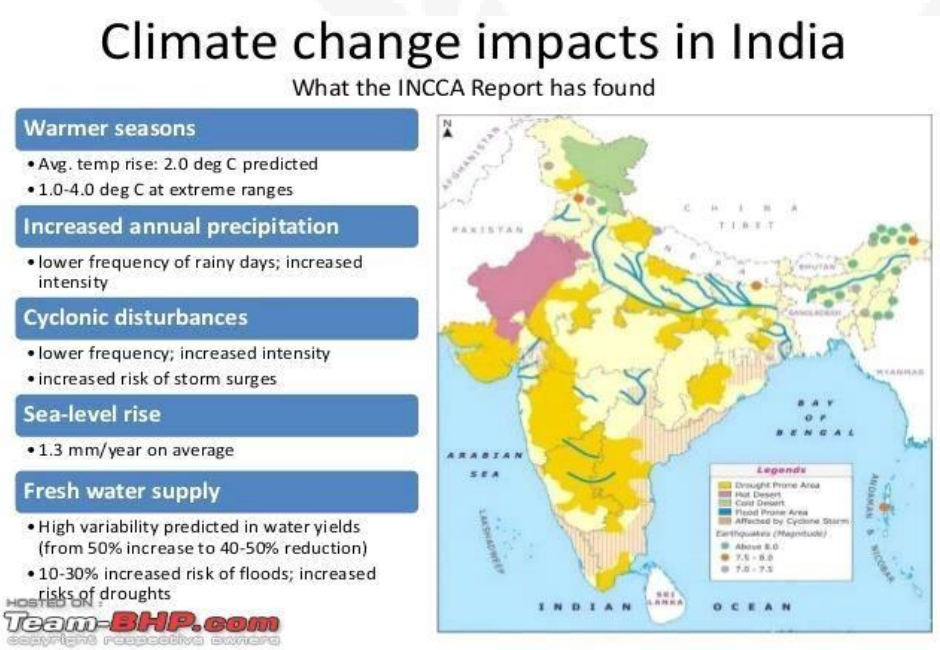
Agriculture productivity and food security

- The crop cultivation is dependent on solar radiation, favourable temperature and precipitation.
- Hence, agriculture has always been dependent on climate patterns.
- The current climate change
- has affected agricultural productivity, food supply and food security.
- These effects are biophysical, ecological and economic.
- They resulted in
- Climate and agricultural zones are moving towards poles
- There is a change in the agricultural production pattern due to increased atmospheric temperature
- Agricultural productivity has increased due to the rise in CO_2 in the atmosphere.
- Unpredictable precipitation patterns
- The vulnerability of the landless and the poor has increased.

Climate Change

Environment And Climate Change

Climate Change affecting India



Climate Change

India was the fifth most affected country by climate change

- It was not shocking when Germanwatch, an environmental non-profit think tank, reported in 2018, that India was the fifth most affected country by climate change, globally.
- In the last two years, the country has been hit by at least one extreme climate event every month.
- According to the World Risk Index 2020, India is the fourth-most-at-risk country in South Asia, after Bangladesh, Afghanistan and Pakistan.
- There is no doubt that climate change is real and its implications are disastrous.
- Historically, internal migration in India occurred due to factors like ethnicity, kinship, work opportunities, or access to better healthcare and education.
- More recently, climate disasters also contribute to displacement (involuntary and unplanned) and migration (voluntary and planned) in India.
- In 2018 alone, nearly 7 million Indians were either displaced or have migrated due to climate-induced distress.

Climate Change

- One of the major areas that will be extremely vulnerable to climate change in the future is South Asia.
- India especially will be vulnerable to climate change due to its diverse terrain, rapid use of natural resources due to the current trend of precipitous urbanisation, industrialisation and economic growth.
- Water and air quality are worsening each day due to environmental pollution.
- Those that are especially susceptible to climate change are the country's coastal ecosystems, biodiversity and agricultural productivity.
- The natural disasters' increasing frequency and intensity are causing negative effects to the already struggling Indian economy.
- The adverse effects of such disasters range from poverty, vulnerability to diseases, loss of income and livelihoods.
- According to the World Bank, an increase of 2°C in the world's average temperature in the next few decades will only make India's monsoon more unpredictable.

Climate Change

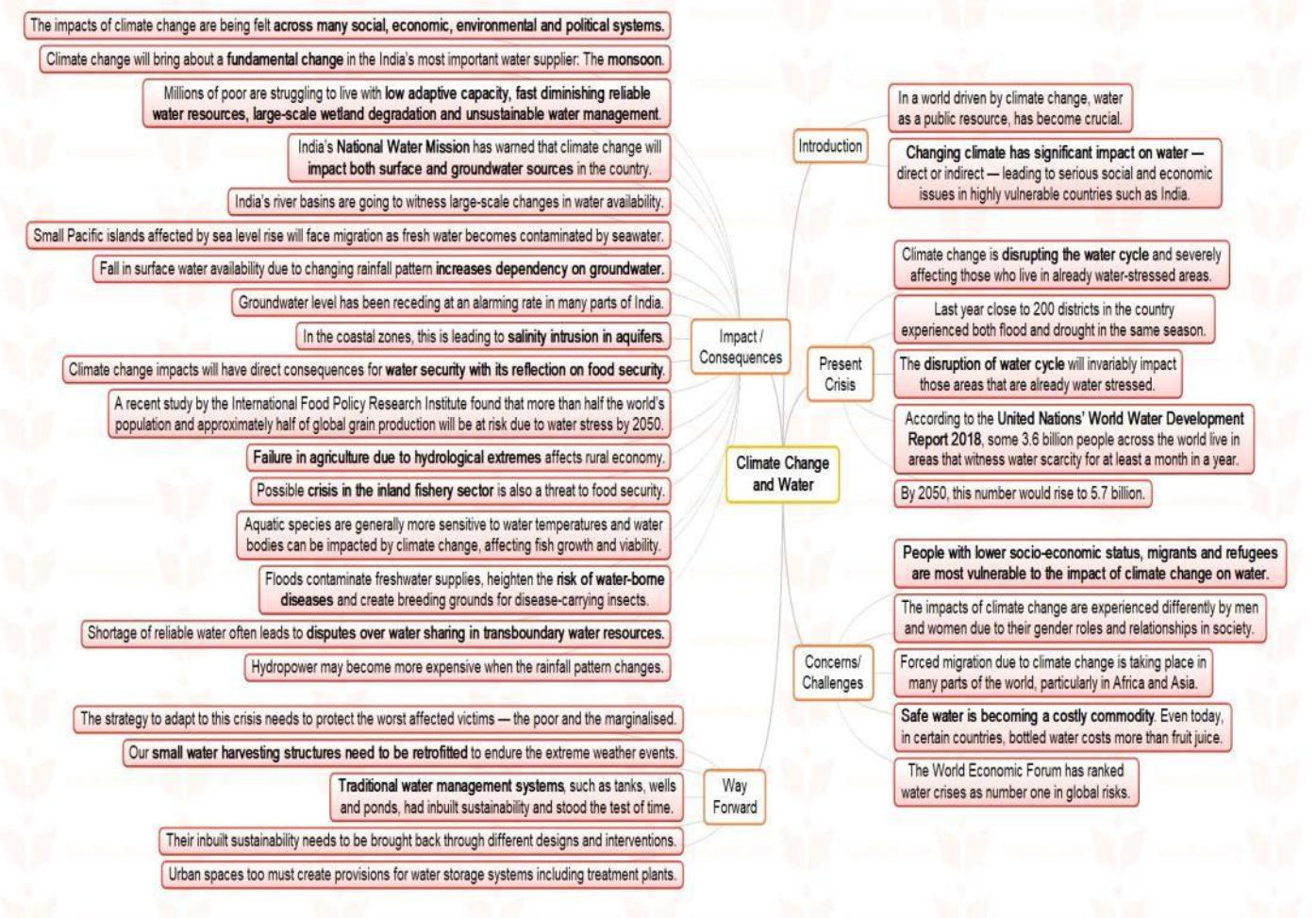
- The changing rain patterns in India are predicted to leave many areas flooded and others without water scarcity.
- More than 60% of India's agriculture is dependent on rain and the majority of the population are dependent on the agriculture sector for survival. This makes India more vulnerable to climate change.
- It is estimated that by the 2050s, with a temperature increase of 2-2.5°C, water in the river basins of Indus, Ganges and Brahmaputra will be reduced. This may threaten the food security of about 63 million people.
- Poor will be more vulnerable to climate change since many of them are dependent on the rain-dependent agriculture.
- An increase of 2°C by the 2040s is going to affect crop production and will reduce the crop output by 12%, requiring more imports to meet the domestic demands.
- The melting glaciers and loss of snow can pose a risk to reliable water resources in India.

Climate Change

- Main rivers like Ganges, Indus, and Brahmaputra mostly depend on snow and glacial meltwater. This makes them vulnerable to global warming.
- Climate change can further increase the risk of flooding of low areas and threatens agriculture.
- Intensity of cyclone to increase
- Sea surge height may increase to 7.46 metres
- Sea level rise will be higher than global average
- Sunderbans and Darjeeling hill to have more rain
- The Indian Himalayan region:-
  - The Himalayas, which represent about 16.2 per cent of the total area of the country, are not only a key watershed of India but also play a crucial role in the monsoon system. Climate change impacts on the mountain range can affect the entire sub-continent
  - The mean temperature of the Himalayas has gone up by 0.6°C in the past 30 years; the frequency of warmer days is also increasing
  - The northeastern states of India, particularly parts of Assam and Manipur, are vulnerable

Climate Change

- Flash flood due to glacial lake outbursts may lead to landslides and affect large-scale food security
- Himalayan glaciers melting faster than others elsewhere in the world
- Productivity of apple has decreased by 2-3% over the past few years. This will go down further
- Projected increase in intensity of rainy days is 2-12% in the Himalayan region



Climate Change

India's Efforts to Counter Climate Change

- India is the world's third largest economy and fifth largest greenhouse gas (GHG) emitter, accounting for about 5% of global emissions. India's emissions increased 65% between 1990 and 2005 and are projected to grow another 70% by 2020.
- By other measures, India's emissions are low compared to those of other major economies. India accounts for only 2% of cumulative energy-related emissions since 1850. On a per capita basis, India's emissions are 70% below the world average and 93% below those of the United States.
- India is also at the frontlines of facing the impacts of climate change. Shifting rainfall patterns, recurring floods, stronger cyclones and droughts or soil erosion are exacerbating the challenge of poverty eradication and necessitate the allocation of scarce national resources for preventing loss of human life.

Climate Change

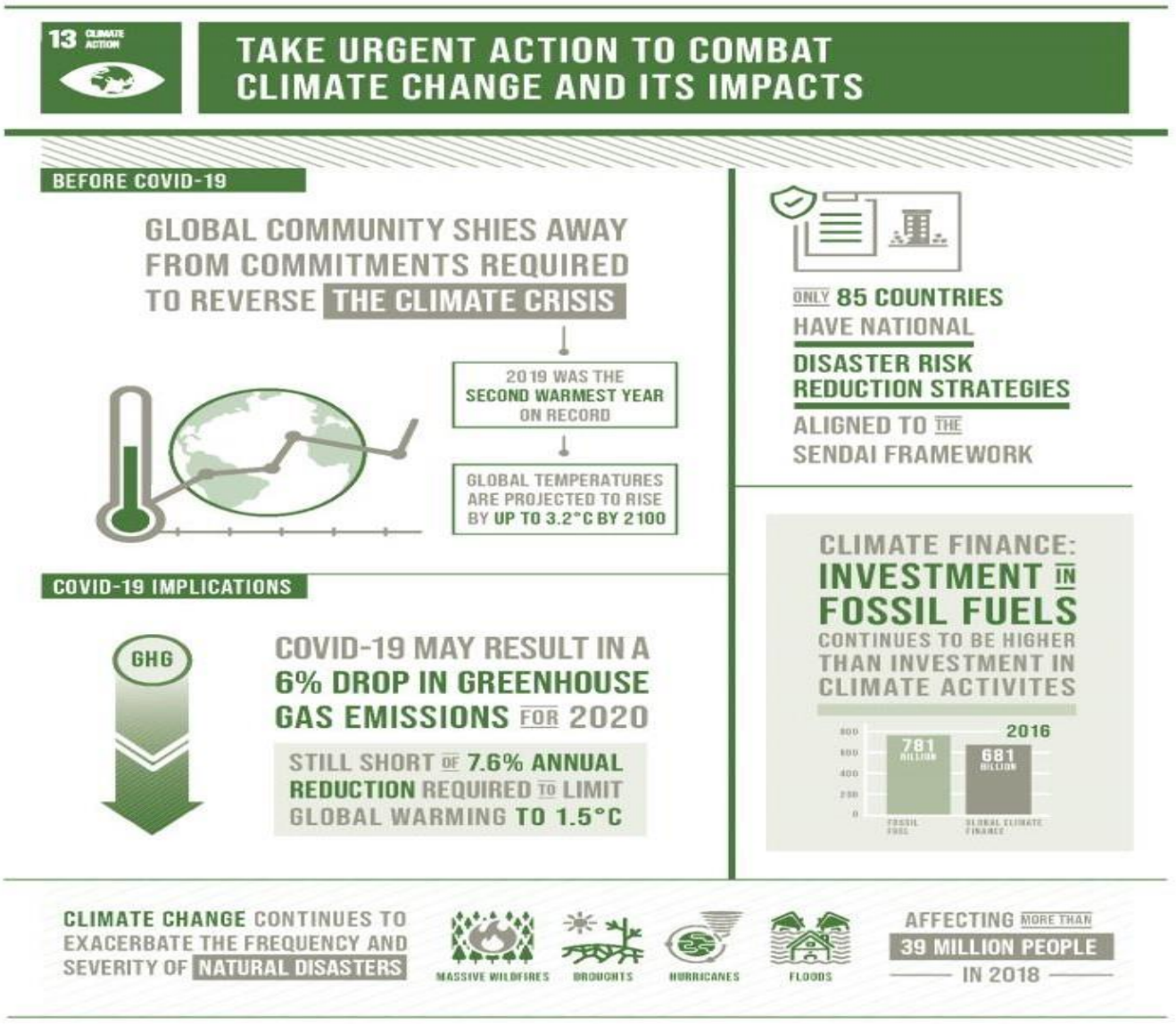
- Despite resource constraints, India is undertaking ambitious actions to undertake adaptation and mitigation actions, including thorough lowering of the energy intensity of our economic growth, increasing energy efficiency across sectors and making greater use of renewable.
- India has doubled the Clean Energy Cess on coal, which very few countries have, and the Clean Energy Fund already has over 3 billion US dollars to be used for promoting clean technologies India's National Solar Mission is being scaled up five-fold from 20,000 megawatts to 100,000 megawatts.
- This will mean an additional investment of 100 billion dollars and savings of about 165 million tonnes of CO2 emissions per year.
- India is releasing 6 billion US dollars in one go for intensive afforestation which will result in more carbon sinks.
- India has allocated about 200 million US dollars for the 'National Adaptation Fund', setting-up of Ultra Mega Solar Projects, Ultra-Modern Super Critical Coal Based Thermal Power Technology, and the development of Solar Parks on canals.

Climate Change

- Another initiative is "100 Smart Cities' with integrated policies for adaptation and mitigation to reduce the vulnerability and exposure of urban areas to climate change and also to improve their energy efficiency for which 1.2 billion US dollars have been allocated. India has put in place stringent norms for the cement industry.
- Our Action Plan for cleaning one of the longest rivers in the world, River Ganga will bring multiple benefits of pollution reduction and climate adaptation. We have also taken initiatives for protecting coastal, Himalayan, and forest areas.
- India has initiated preparations to develop a National Air Quality Index and have launched a National Air Quality Scheme. Setting-up of Ultra Mega Solar Projects in Tamil Nadu, Rajasthan, Gujarat, Andhra Pradesh and Ladakh to promote renewable energy.

Climate Change

Take Urgent Action To Combat Climate Change And Its Impact



Climate Change

Mission of NAPCC

- As a part of the NAPCC, the Indian government had launched 8 missions in focused areas. They are:

National Solar Mission

- The NAPCC aims to promote the development and use of solar energy for power generation and other uses with the ultimate objective of making solar competitive with fossil-based energy options.
- The plan includes: specific goals for increasing use of solar thermal technologies in urban areas, industry, and commercial establishments; a goal of increasing production of photovoltaic to 1000 MW/year; and a goal of deploying at least 1000 MW of solar thermal power generation.
- Other objectives include the establishment of a solar research centre, increased international collaboration on technology development, strengthening of domestic manufacturing capacity, and increased government funding and international support.

Climate Change

National Mission for Enhanced Energy Efficiency:

- Initiatives based on increasing the energy use efficiency were expected to yield savings of 10,000 MW by 2012. Building on the Energy Conservation Act 2001, the plan recommends:
  - Mandating specific energy consumption decreases in large energy-consuming industries, with a system for companies to trade energy-savings certificates;
  - Energy incentives, including reduced taxes on energy-efficient appliances; and
  - Financing for public-private partnerships to reduce energy consumption through demand-side management programs in the municipal, buildings and agricultural sectors.

Climate Change

National Mission on Sustainable Habitat

- To promote energy efficiency as a core component of urban planning, the plan calls for:
  - Extending the existing Energy Conservation Building Code;
  - A greater emphasis on urban waste management and recycling, including power production from waste;
  - Strengthening the enforcement of automotive fuel economy standards and using pricing measures to encourage the purchase of efficient vehicles;
  - Incentives for the use of public transportation.

National Water Mission

- With water scarcity projected to worsen as a result of climate change, the plan sets a goal of a 20% improvement in water use efficiency through pricing and other measures.

Climate Change

National Mission for Sustaining the Himalayan Ecosystem

- The plan aims to conserve biodiversity, forest cover, and other ecological values in the Himalayan region, where glaciers that are a major source of India's water supply are projected to recede as a result of global warming.

National Mission for a "Green India" Goals

- Goals include the afforestation of 6 million hectares of degraded forest lands and expanding forest cover from 23% to 33% of India's territory.

National Mission for Sustainable Agriculture

- The plan aims to support climate adaptation in agriculture through the development of climate-resilient crops, expansion of weather insurance mechanisms, and agricultural practices.

Climate Change

National Mission on Strategic Knowledge for Climate Change

- To gain a better understanding of climate science, impacts and challenges, the plan envisions a new Climate Science Research Fund, improved climate modelling, and increased international collaboration. It also encourages private sector initiatives to develop adaptation and mitigation technologies through venture capital funds.

International Solar Alliance (ISA)

State Action Plan on Climate Change (SAPCC)

- State governments have drafted climate strategies aligned with the eight National Missions under the NAPCC. The strategies focus on issues ranging from climate mitigation, energy efficiency, and resource conservation to climate adaptation.

Climate Change

FAME Scheme for E-mobility

- Union Government in April 2015 launched Faster Adoption and Manufacturing of Hybrid and Electric vehicles (FAME) – India Scheme with an aim to boost sales of eco-friendly vehicles in the country. It is a part of the National Mission for Electric Mobility.
- Atal Mission for Rejuvenation & Urban Transformation (AMRUT) for Smart Cities.

Pradhan Mantri Ujjwala Yojana

- The scheme provides LPG connections to five crore below-poverty-line beneficiaries. The connections are given in the name of women beneficiaries to reduce their dependence on fossil fuels and conventional fuel like cow dung for cooking food, thus reducing air pollution.

UJALA scheme

- The scheme was launched by the Prime Minister Narendra Modi in January 2015 with a target of replacing 77 crore incandescent lamps with LED bulbs. The usage of LED bulbs will not only result in reducing electricity bills but also help in environment protection.

Climate Change

India in the international forums on climate change

- India is currently setting up voluntary targets in the international forums to commit itself to the mission to combat climate change. It is also playing a major role in climate change mitigation.
- India's proactive role in mitigating climate change is due to the domestic compulsion of tackling issues like the need for poverty eradication, food and nutritional security, universalization of health and education, water security, sustainable energy, employment.
- India is of the opinion that the developing countries' need for inclusive growth, sustainable development, poverty eradication and universal access to energy must be made the fundamental differentiation between them and the developed nations. Currently, the Conventions recognise the historical emissions of the developed nations as the basis for differentiation between the developed and developing nations.

Climate Change

Efforts taken at the international level to combat climate change

- Intergovernmental Panel on Climate Change (IPCC)
- The World Meteorological Organisation (WMO) and the UN Environment Programme (UNEP) founded the IPCC to provide for a mechanism to study the effects of global warming at a governmental level.
- IPCC is a UN body that assesses the science related to climate change.
- It provides the policymakers with regular scientific assessments on climate change, its implications and potential future risks while also providing adaptation and mitigation options.
- It complements UNFCCC and vice versa.

United Nations Framework Convention on Climate Change (UNFCCC)

- It came to force on 21st March 1994.
- The 195 countries that have ratified it are called the Parties to the Convention.

Climate Change

- The UNFCC is a Rio Convention, one of the three adopted at the Rio Earth Summit in 1992. The others include the UN Convention on Biological Diversity and the UN Convention to Combat Desertification.
- The Joint Liaison Group was established to ensure cooperation among the three Conventions.
- Currently, it also consists of the Ramsar Convention on Wetlands.
- The ultimate aim of the Convention is to stabilize the greenhouse gas concentration "at a level that would prevent dangerous anthropogenic interference with the climate system".
- It also aims to achieve the said level within a specific period so that the ecosystem is allowed to adapt naturally to climate change while also ensuring food security and sustainable economic development.
- Following its establishment, the COP1 (first Conference of Parties) was held in Berlin, COP2 was held in Geneva and the COP3 was held in Kyoto to adopt the "Kyoto Protocol" that ensures the implementation of the UNFCCC's objective.

Climate Change

Kyoto Protocol

- Kyoto Protocols was adopted in Kyoto, Japan on 11th December 1997 and came to force on 16th February 2005
- Its signatories are committed towards the achievement of emission reduction targets.
- COP 7 held in Morocco in 2001 saw the adoption of the detailed rules for the implementation of the protocol. These are referred to as "Marrakesh Accords".
- This protocol holds the developed countries accountable for the current high levels of GHG emissions into the atmosphere due to their role in the industrial revolution.
- Kyoto Mechanism, also known as Flexible Mechanism, is defined under the Kyoto Protocol to lower the overall cost of achieving the emission targets. It includes Emission Trading, the Clean Development Mechanism and Joint Implementation.
- In December 2012, the Doha Amendment to the Kyoto Protocol was adopted. The changes made include.

Climate Change

- New commitments were made by Annex I Parties (developed nations and Economies in Transition) to be implemented between the period of 1st January 2013 and 31st December 2020.
- A revised list of GHG that is to be reported by the Parties during the second commitment period
- Amendments were made to update several articles of the Kyoto Protocol to be on par with the second commitment period.
- The Kyoto Protocol is a significant step towards the reduction of global emission regime that will allow the stabilisation of GHG emissions.

Paris Agreement

- Signed in 2016, it is considered to be the world's first comprehensive climate agreement.
- It aims to
- Keep the global temperature well below 2°C above pre industrial times and endeavour to limit them even more to 1.5°C.
- Strengthen the nations' ability to combat the adverse impacts of climate change.

Climate Change

- The Paris Accord calls for a reduction of the GHGs emitted due to human activities equal to that of the trees, soil and oceans so that they can be absorbed naturally.
- As per the Agreement, each country's contribution towards cutting emission must be reviewed every 5 years.
- It also states that rich countries must help the poorer nations by providing them with "Climate finances" to make them shift towards renewable energy usage.
- The agreement is binding in some elements like reporting requirements. Other elements of the agreement are non-binding like the emission targets of the individual nations.
- The Paris Agreement necessitates all Parties to put forth their best efforts through Nationally Determined Contributions (NDCs) and to strengthen these efforts in the future.
- This also includes the need for regular reporting emissions and implementation by the parties.

Climate Change

- India's Intended Nationally Determined Contribution (INDC) includes the reduction in the intensity of its GDP by 33 to 35% by 2030 from 2005 level. Additionally, it has pledged to increase the share of non-fossil fuel-based electricity by 40% by 2030. It has also agreed to enhance its forest cover, which will absorb 2.5 to 3 billion tonnes of CO2 by 2030.

REDD+

- Reducing Emissions from Deforestation and Forest Degradation (REDD+) is a mechanism developed by Parties of the UNFCCC.
- It creates financial value for the carbon stored in forests to offer incentives for the developing nations to reduce emissions from forested lands and invest in low-carbon paths.
- The developing nations will receive results-based payments for results-based actions.
- The REDD+ goes beyond simply deforestation and forest degradation by including the role of conservation, sustainable management of forests and enhancement of forest carbon stocks.

Climate Change

- It is estimated that the financial flows for the GHG emission reduction from REDD+ could reach up to $30 billion per year.
- This improved North-South flow of funds can ensure a significant reduction of carbon emissions and the promotion of inclusive development. It could also improve biodiversity conservation and secure vital ecosystem services.
- Forests are a vital carbon sink and thus, it is vital to increase its resilience to climate change.

Responses: mitigation and adaptation

- Climate change impacts can be mitigated by reducing greenhouse gas emissions and by enhancing sinks that absorb greenhouse gases from the atmosphere.
- In order to limit global warming to less than 1.5 °C with a high likelihood of success, global greenhouse gas emissions needs to be net-zero by 2050, or by 2070 with a 2 °C target.
- This requires far-reaching, systemic changes on an unprecedented scale in energy, land, cities, transport, buildings, and industry.

Climate Change

- Scenarios that limit global warming to 1.5 °C often describe reaching net negative emissions at some point.
- To make progress towards a goal of limiting warming to 2 °C, the United Nations Environment Programme estimates that, within the next decade, countries need to triple the amount of reductions they have committed to in their current Paris Agreements; an even greater level of reduction is required to meet the 1.5 °C goal.
- Although there is no single pathway to limit global warming to 1.5 or 2.0 °C (2.7 or 3.6 °F), most scenarios and strategies see a major increase in the use of renewable energy in combination with increased energy efficiency measures to generate the needed greenhouse gas reductions.
- To reduce pressures on ecosystems and enhance their carbon sequestration capabilities, changes would also be necessary in agriculture and forestry, such as restoring natural ecosystems by reforestation.

Climate Change

- Other approaches to mitigating climate change entail a higher level of risk. Scenarios that limit global warming to 1.5 °C typically project the large-scale use of carbon dioxide removal methods over the 21st century.

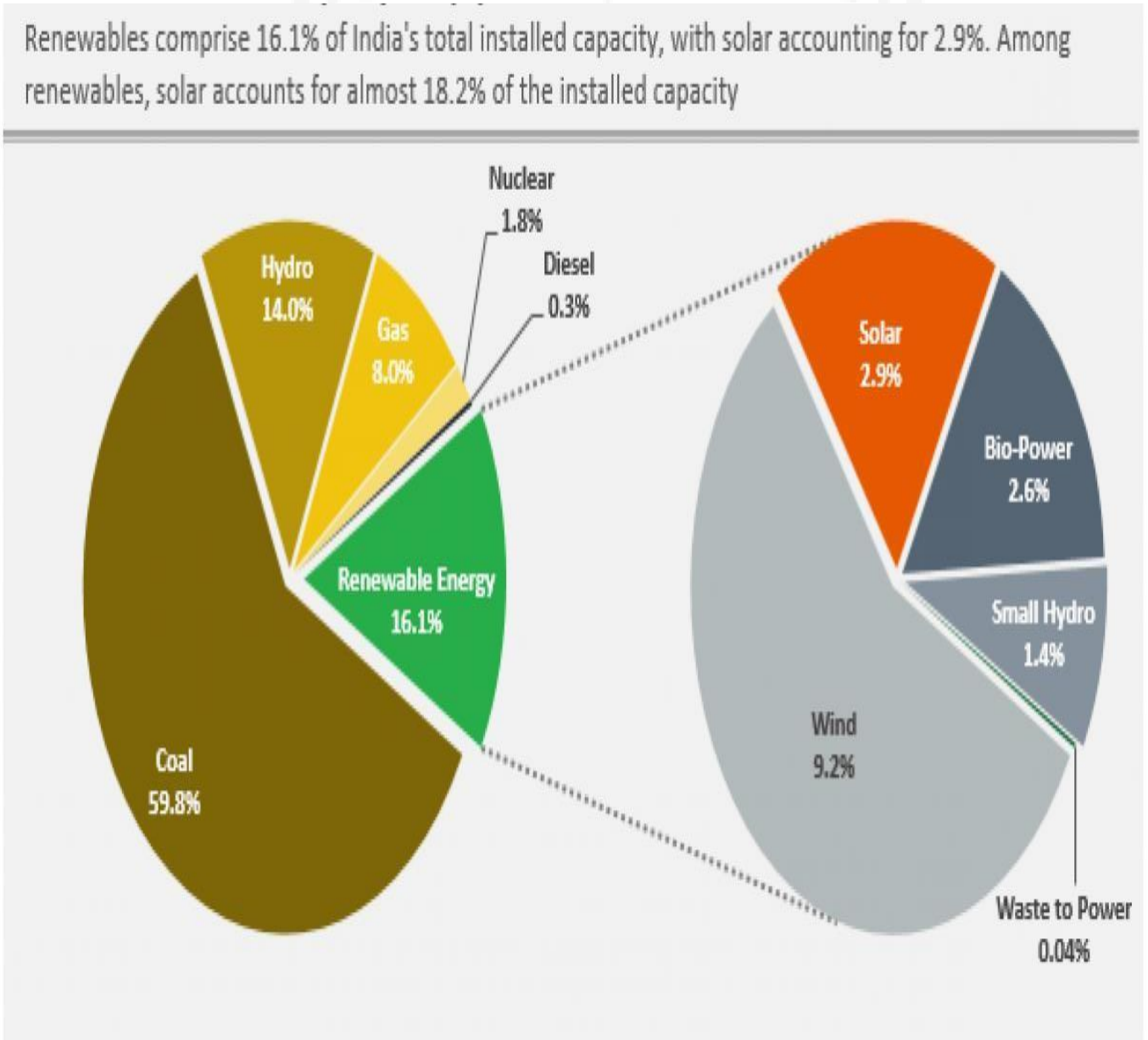
The Way Forward

- Wealthy nations like the U.S., and those of the EU argued that emissions from developing countries are consistently rising and they need to commit to more serious emission cuts. A consensus needs to be developed at the earliest.
- The immediate up-scaling of ambition in the second Commitment period of Kyoto Protocol and its early ratification by all Kyoto Protocol parties would be a step in the right direction.
- Concerning mitigation, distinction enshrined in the Convention between Annex I (Developed) and nonAnnex I (developing) Parties must be maintained in accordance with the principles of Equity, CBDR and other provisions of the UN Conventions.
- The 'developing versus developed country' schism needs to be diluted at the earliest and Developed Countries should avoid watering down the CBDR principle envisaged in earlier agreements.

Climate Change

Renewable Energy

- Renewable energy, often referred to as clean energy, comes from natural sources or processes that are constantly replenished. For example, sunlight or wind keep shining and blowing, even if their availability depends on time and weather.



Climate Change

Types of Renewable Energy Sources

- The most common renewable power technologies include

Wind

- This takes advantage of wind motion to generate electricity. Wind motion is brought about by the heat from the sun, and rotation of the earth, mainly via the Coriolis Effect.

Solar

- It taps heat from the sun to produce energy for the generation of electricity, heating, lighting homes and commercial buildings.

Hydropower

- Utilizes moving water to produce electricity. Moving water creates high energy that can be harnessed and turned into power.

Biomass

- Organic matter that constitutes plants is referred to as biomass, which can be utilized to generate electricity, chemicals or fuels to power vehicles.

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Ocean

- Takes advantage of rising and falling of tides to generate electricity

Geothermal

- Leverages heat from underneath the earth to generate electricity.

Key Points

- Dedicated Project Development Cells have been established to facilitate investors ensuring 'Ease of Doing Business'.
- India's renewable power capacity is the fourth largest in the world and is growing at the fastest speed among all major countries.
    - India is a big market and a lot of countries are attracted towards it in terms of One Sun, One World, One Grid and International Solar Alliance.

Climate Change

- The renewable energy capacity in India is currently 136 Giga Watts, which is about 36% of its total capacity.
  - Target for capacity increase is 450GW by 2030, increasing 25GW every year as we move forward.
- Per capita consumption of energy in India is quite low as compared globally.
- Power sector, being primarily dependent on fossil fuels, is one of prime sources of air pollution.

Why Renewable Energy

Sustainable

- Energy generated from renewable sources will be cleaner and greener and more sustainable.

Employment opportunities

- Inclusion of a newer technology simply means more employment opportunities for the working population of the country.

Climate Change

Market assurance

- From the economy point of view, renewable sources provide the market and revenue assurance which no other resources can provide.

Power supply

- Providing 24*7 power supply to 100% of the households, sustainable form of transports are some of the goals that can only be achieved through sustainable power that comes from renewables.

Government Initiatives

- As part of its commitment to create awareness about energy efficiency as a resource and also to develop an action plan for energy conservation initiatives, Bureau of Energy Efficiency (BEE) and Alliance for an Energy Efficient Economy (AEEE), had released the 'State Energy Efficiency Preparedness Index', which assesses state policies and programmes aimed at improving energy efficiency across various sectors.

Climate Change

- The National Mission for Enhanced Energy Efficiency (NMEEE) is one of the eight national missions under the National Action Plan on Climate Change (NAPCC).
- NMEEE has the following schemes:
  - Perform Achieve and Trade Scheme (PAT)
  - Market Transformation for Energy Efficiency (MTEE)
  - Energy Efficiency Financing Platform (EEFP)
  - Framework for Energy Efficient Economic Development (FEED)
- Other government initiatives include:
  - DeenDayal Upadhyaya Gram Jyoti Yojana (DDUGKY)
  - Integrated Power Development Scheme (IPDS)
  - UDAY
  - Soubhagya
  - Power for All 24*7
  - Ujala

Climate Change

- Other technological innovations and initiatives
  - Electric vehicles –No Licence required for charging stations
  - Smart Metering- Procurement of 50 lakh smart meters done
  - Energy efficiency- Energy Star labeling program
  - Energy Conservation Building Code for energy efficient buildings launched in June 2017
- Vidyut Pravah – The Mobile/Web App provides real-time information of current demand met, shortages if any, surplus power available and the prices in Power Exchange.
- UJALA (Unnat Jyoti by Affordable LEDs for All) – App provides real-time updates on the LED distribution happening across the country.
- UrjaMitra – monitoring of power availability and sending power cut information through SMS.
- MERIT-information pertaining to marginal variable cost and source wise purchase of electricity.
- URJA (Urban Jyoti Abhiyaan) – It is an informative App for Urban Distribution Sector. It captures Consumer-centric parameters from the IT systems created under IPDS.

Climate Change

- TARANG (Transmission App for real-time monitoring & Growth) – It is an IT Web/mobile-based platform to provide the status of both inter and intrastate Transmission Projects in the country. This platform also shows the prospective interstate as well as intrastate Transmission Projects.
- DEEP e-bidding (Discovery of Efficient Electricity Price) – The portal will provide a common e-bidding platform with e-reverse auction facility to facilitate nation-wide power procurement through a wider network so as to bring uniformity and transparency in the process of power procurement.
- Ash Track- linking fly ash users and power plants for better ash utilization.

Climate Change

Challenges In The Renewable Energy Sector For Sustainable Development

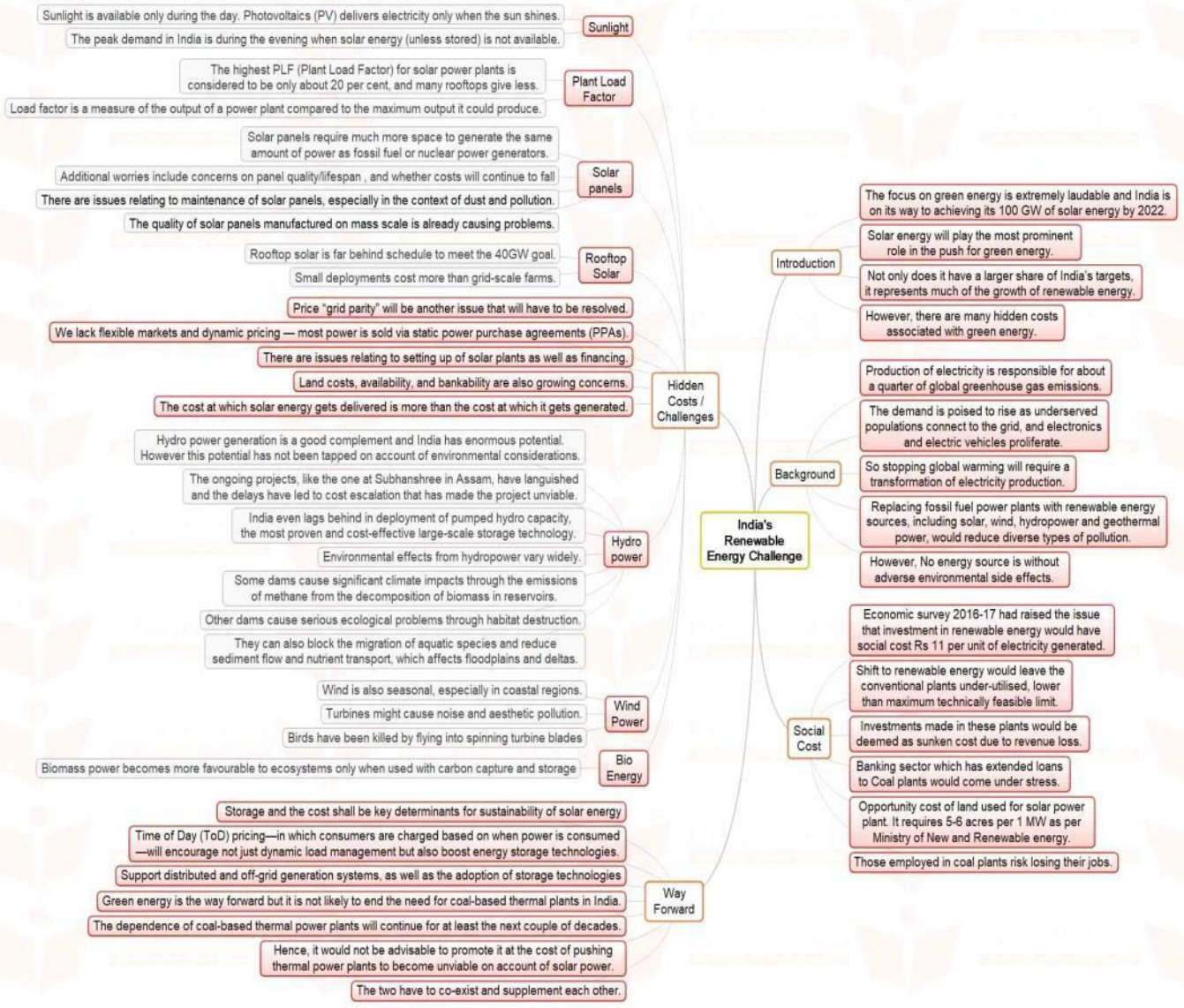
- Despite the progress India has made in developing the renewable energy sector, the country still faces barriers. Offtaker risk, lack of infrastructure, lack of financial intermediaries, and limited understanding from investors are the four main challenges to overcome.
- Offtaker risk. This refers to the risk that the buyer may not fulfill the contractual obligations or will delay or make incomplete payments.
- Offtakers are primarily state-owned public-sector distribution companies. Given the poor financial health of India's distribution companies, there is a risk of lagged or incomplete payments. In 2015 the total outstanding debt of distribution companies was approximately $64 billion.
- Offtaker risk increases the overall risk of the renewable energy projects.
- To address this issue, the government has implemented Ujwal DISCOM Assurance Yojana, which aims at reducing operational inefficiencies and improving the financial performance of distribution companies.

Climate Change

- The program mandates to take over 75% of distribution company debt and turn it into state-guaranteed bonds.
- Lack of infrastructure. Inefficiencies from the lack of infrastructure to generate and distribute electricity are a key barrier to foreign investment. Moreover, the time taken to obtain permits for building and operating the transmission evacuation infrastructure is very long.
- These delays increase project construction time, which postpones the commissioning of new projects and ultimately revenues and profits.
- Lack of financial intermediaries.
- Another barrier for Indian institutional investors is a shortage of financial intermediaries in the renewable energy sector.
- These actors are needed to provide proper information about investment opportunities.
- Limited understanding.

Climate Change

- Renewables lie outside traditional investments, and potential investors are often wary because of their limited understanding of the sector.
- Domestic institutional investors typically invest in less risky securities and prefer more liquid assets with good credit ratings, which are not available in renewable energy projects.



Climate Change

Pathways Forward

- According to a report by the Climate Policy Initiative, total investment needed for India to meet its renewable energy targets by 2022 is $189.15 billion, 27% of which is required to be invested in wind, 37% for utility-scale solar projects, 32% for solar rooftop projects, and 4% for biomass and small hydropower projects.
- Several pathways are available for India to overcome the four challenges outlined above and meet these investment needs.
- These include foreign direct investment (FDI), domestic investment, and financial incentives.
- FDI. According to data from the Department for Promotion of Industry and Internal Trade, cumulative FDI inflows in the power sector from 2000 to 2020 were around $15 billion, which is around 3% of total FDI inflows.
- The government allowed 100% of FDI under the automatic route to the power sector in 2012, easing the approval process.

Climate Change

- This included investment in the generation and transmission of electricity through hydroelectric dams, fossil fuel–based thermal power plants, renewable energy generation and distribution, distribution of electricity to households, industrial commercial users, and power trading.
- There has been an increase in penetration of nonconventional sources of energy in the Indian market, which have seen rising FDI participation.
- Domestic investment. As a result of economic reforms and liberalization policies across sectors implemented since the early 1990s, both the private and public sectors have shown a sharp growth in investments, especially in the power sector.
- The potential investments that are available for renewable projects amount to $411 billion, double the required investment target.
- Despite large government investments, India's energy sector relies on the private sector more than ever as public-sector resources are more directed toward public health and sustaining livelihoods.

Climate Change

- Therefore, to attract private investment, the government has encouraged the participation of nonfinancial banking companies, launched a new investment fund, initiated the rationalization of tariffs, released subsidies, and improved the bankability of power purchase agreements.
- Financial incentives. Alternative debt vehicles such as "green" asset-backed securities could be potential financial instruments for encouraging investment in sustainable energy infrastructure.
- By pooling renewable energy assets from different companies and geographies at various points in their operational lifecycles, banks and other financial institutions can hedge the risks associated with individual renewable energy projects.
- Green investment banks are government-funded entities that "crowd in" private investment in low-carbon assets, provide debt for projects with existing capital reserves, and raise funds through the issuance of bonds and creation of asset-backed securities.

Climate Change

- Governments can issue green bonds through private or public banks, the World Bank, or regional development banks to attract both domestic and international investors, which expands the investor base and incentivizes private players interested in cleaner energy.
- Indian green bonds are very much in demand overseas. With many countries aiming for a green recovery from the recession caused by the Covid-19 pandemic, central banks may induce liquidity in the markets, including through issuing green bonds.

What are Renewable Energy Certificates (RECs)

- Renewable Energy Certificates (RECs), also known as green energy certificates or tradable renewable certificates are proof that energy has been generated from renewable sources such as solar or wind power.
- Each REC represents the environmental benefits of 1MWh of renewable energy generation. When you purchase RECs, renewable energy is generated on your behalf.

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Significance

- It is a market based mechanism which will help the states meet their regulatory requirements (such as Renewable Purchase Obligations (RPOs)) by overcoming the geographical constraints on existing renewable potential in different states.
- RECs unbundle the electricity component (commodity) from the green/environmental attributes of the power generated from renewable sources. Both the components can then be traded separately.
- Thus, RECs help in incentivizing the production of renewable energy over and above the RPO state limit as tradable certificates are not constrained by the geographical limitations of commodity electricity.

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Need for removal of GST

- RECs are being charged GST, while bundled power (RECs plus electricity, irrespective of source) or even just electricity are devoid of the same.
  - Cost of electricity generation from renewable energy sources is classified as cost of electricity generation (equivalent to conventional energy sources) and the cost of environmental attributes.
  - REC is the environmental attribute of the electricity derived from RE.
  - As per regulations, RPO compliance through REC is at par with sourcing electricity directly from RE.
  - Therefore, GST applicable on the sale of RECs negatively affects its parity with similar electricity sale alternatives, be it conventional or renewable.
  - Moreover discoms, the major buyer of RECs (around 50-60 per cent), do not get GST credit; and the increase in their cost of RPO compliance will translate to increased tariff for the end consumer.

Climate Change

green hydrogen

- Hydrogen when produced by electrolysis using renewable energy is known as Green Hydrogen which has no carbon footprint.
  - The hydrogen that is in use today is produced using fossil fuels, which is the primary source.
  - Organic materials such as fossil fuels and biomass are used for releasing hydrogen through chemical processes.

Significance of Green Hydrogen:

- Green hydrogen energy is vital for India to meet its Nationally Determined Contribution (INDC) Targets and ensure regional and national energy security, access and availability.
- Green Hydrogen can act as an energy storage option, which would be essential to meet intermittencies (of renewable energy) in the future.
- In terms of mobility, for long distance mobilisations for either urban freight movement within cities and states or for passengers, Green Hydrogen can be used in railways, large ships, buses or trucks, etc.

Climate Change

Applications of green hydrogen:

- Green Chemicals like ammonia and methanol can directly be utilized in existing applications like fertilizers, mobility, power, chemicals, shipping etc.
- Green Hydrogen blending up to 10% may be adopted in CGD networks to gain widespread acceptance.

Benefits

- It is a clean-burning molecule, which can decarbonize a range of sectors including iron and steel, chemicals, and transportation.
- Renewable energy that cannot be stored or used by the grid can be channelled to produce hydrogen.

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Steps the Indian government has taken in the production of green hydrogen

- During the budget speech in February 2021, Finance Minister Nirmala Sitharaman announced the launch of the Hydrogen Energy Mission to produce hydrogen from renewable sources.
- In the same month, state-owned Indian Oil Corporation signed an agreement with Greenstat Norway for setting up a Centre of Excellence on Hydrogen (CoE-H). It will promote R&D projects for the production of green and blue hydrogen between Norwegian and Indian R&D institutions/universities.
- Recently, India and the US have set up a task force under the aegis of the Strategic Clean Energy Partnership (SCEP) to mobilise finance and speed up green energy development.

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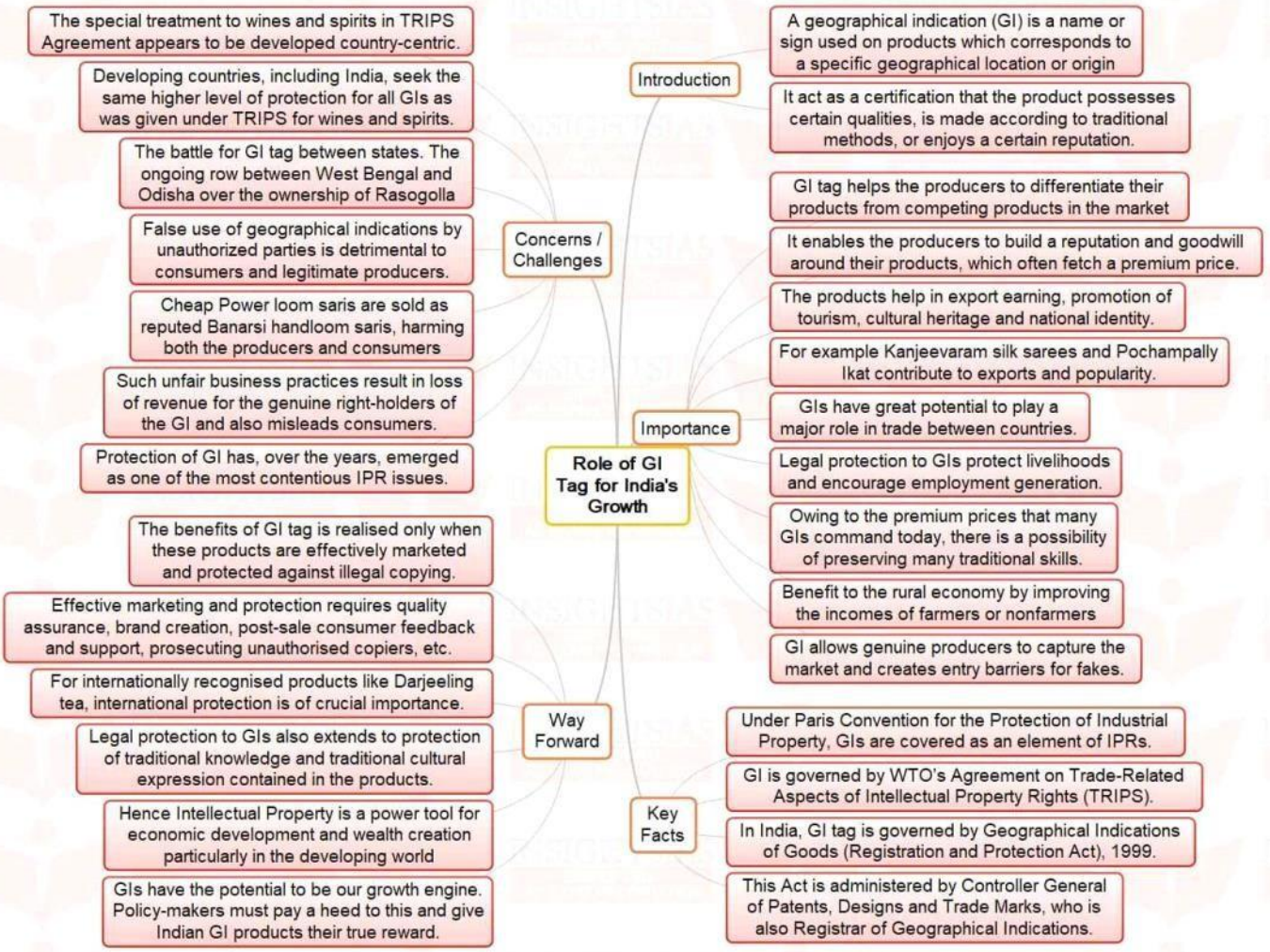

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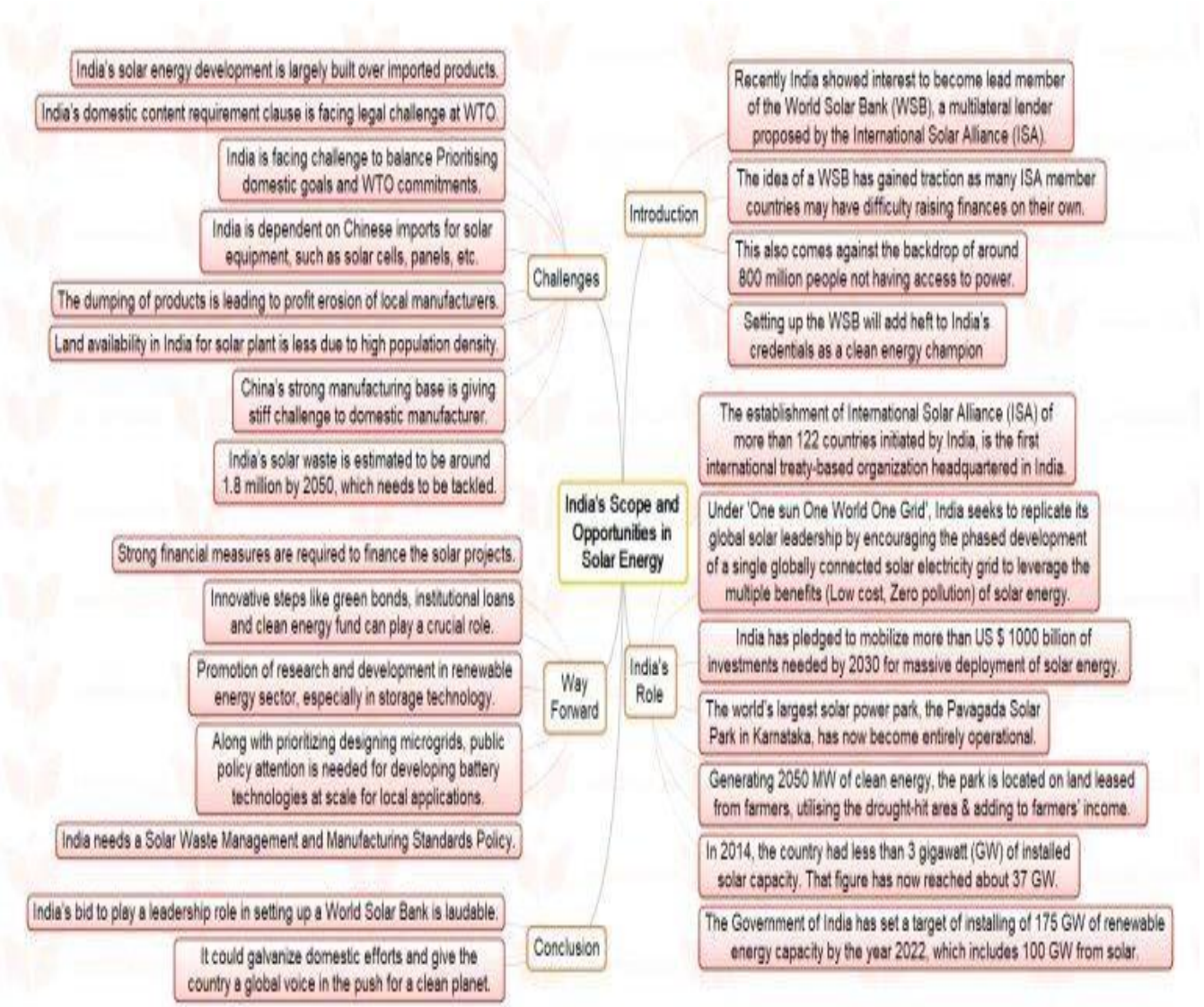

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India's Key Focus for Next Five Years

The Twin Challenge

- India has a twin challenge of providing more energy as well as cleaner energy to the masses in India.
  - It should focus on getting into the manufacturing of the solar panels under the Atma Nirbhar Bharat initiative as the demand is to create jobs as well as supply decentralised energy to all the households in India.
  - Look and develop the entire supply chain of all the components beside the manufacturing sector.

Methanol and Biomass

- Looking for other alternatives such as methanol based economy and biomass.
  - Bio-CNG vehicles with 20% blending in petrol is also a target the government has been chasing.
  - Conversion of energy from Biomass is a considerable option as it will clean the cities as well as reduce our energy dependence.

- Fuels produced from biomass have a high calorific value and are cleaner than traditional biomass.

Hydrogen based FCV

- Hydrogen in technology is likely to change the landscape of renewables, shifting towards Hydrogen Based Fuel Cells Vehicles (FCV) is another area of focus.

Grid Integration

- It is the practice of developing efficient ways to deliver variable renewable energy (RE) to the grid.
  - Identifying the demands which are in tune with the characteristics of the renewables, focussing on characteristics of renewables mainly solar and wind and considering their variability as strength rather than weakness.

Climate Change

Challenges with Renewable Energy

Integration with the Main Grid

- Integrating the renewables with the main grid is the area India needs to work upon.
  - To accelerate the uptake of renewables, storage and battery solutions is needed in large quantities.

Cost factor

- Renewable resources are slightly more expensive than conventional sources.

24*7 Power Supply

- Sustainable, round-the-clock power supply along with the storage system is a big challenge ahead.

Agricultural Sector

- Much power is consumed in the agricultural sector. The challenge is to provide sufficient power and energy to every household and to the agricultural sector as well.

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Way Forward

Identification of areas

- Renewable resources specially wind cannot be set up everywhere, they require specific location.
  - Identification of these specific locations, integrating them with the main grid and distribution of powers; A combination of these three is what will take India forward.

Exploration

- More storage solutions need to be explored.

Agriculture subsidy

- Agricultural subsidy should be rectified in order to ensure that only the required amount of energy is consumed.

Hydrogen fuel cell based vehicles and Electric vehicles

- These are the most suitable options when it comes to shifting towards renewable sources of energy, that's where we need to work upon.