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The Name Associated with Excellence

PT TRICKS 2023

Environment Current-FEB

Covering: Basic concepts- current- terms and application

NOTE: **FOR ALL EXAMINATIONS**

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Dholes

- Presence of dholes or Asiatic wild dogs in the high mountains of Central Asia was recenelty reported
- Historically, dholes occurred throughout southern Russia, all across central Asia, south Asia and southeast Asia. They are also known as Asian wild dogs
- In India, they are found in three clusters across India namely the Western and Eastern Ghats, central Indian landscape and North East India.
- Dholes play an important role as apex predators in forest ecosystems

IUCN List of Threatened Species: Endangered
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES): Appendix II
Wildlife Protection Act, 1972 : Schedule II

Golden Langur

- The Assam Forest Department is converting a patch of forest into the Kajoijana Bamuni Hill Wildlife Sanctuary.
- Kakoijana Reserve Forest is one of the better-known homes of the golden langur
- The villagers demand that the "conventional idea of wildlife sanctuary" be dropped and the reserve forest converted into a community forest resource using Forest Rights Act, 2006, to ensure community co-managed system of participation for sustainable conservation.

What is the Difference between Wildlife Sanctuary, Reserve Forest and Community Forest Resource?

Wildlife Sanctuary: It is the place that is reserved exclusively for wildlife use, which includes animals, reptiles, insects, birds, etc. wild animals, especially those in danger of extinction and the rare ones, so that they can live in peace for a lifetime and keep their population viable. ☐
The Wildlife Protection Act, 1972 empowers the central and state governments to declare any area a wildlife sanctuary, national park or closed area.
Reserve forests: They are the most restricted forests and are constituted by the State Government on any forest land or wasteland which is the property of the Government. In reserved forests, local people are prohibited, unless specifically allowed by a Forest Officer in the course of the settlement.
Community Forest Resource: According to Section 2(a) of the Forest Rights Act, it is the customary common forest land within the traditional or customary boundaries of the village or seasonal use of landscape in the case of pastoral communities, including reserved forests, protected forests and protected areas such as sanctuaries and national parks to which the community had traditional access.

- Golden langurs can be most easily recognized by the color of their fur, after which they are named. They are highly dependent on trees, living in the upper canopy of forests. They are also known as leaf monkeys.
- It is endemic to western Assam, India, and southern Bhutan. Their habitat in Assam has fragmented drastically especially after a thrust on rural electrification and massive deforestation
- Protection Status: ☐
    - IUCN List of Threatened Species: Endangered ☐
    - Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES): Appendix I ☐

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- Wildlife Protection Act, 1972 : Schedule I

Sovereign Green Bonds

- The government proposes to issue sovereign green bonds to mobilise resources for green infrastructure.

Green bonds are issued by companies, countries and multilateral organisations to exclusively fund projects that have positive environmental or climate benefits and provide investors with fixed income payments

Proceeds from these bonds are earmarked for green projects. This is unlike standard bonds, the proceeds of which can be utilised for various purposes at the discretion of the issuer.

- It will catalyze domestic market development and provides impetus to institutional investors.
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Other Measures on Climate Action announced in the Budget?

The budget included several measures on climate action such as: ☐ Battery swapping policy. ☐ Additional allocation under the PLI scheme for manufacturing high efficiency solar modules. ☐ The government is introducing a new bill that aims to provide a regulatory framework for Carbon Trading in India to encourage penetration of renewables in the energy mix

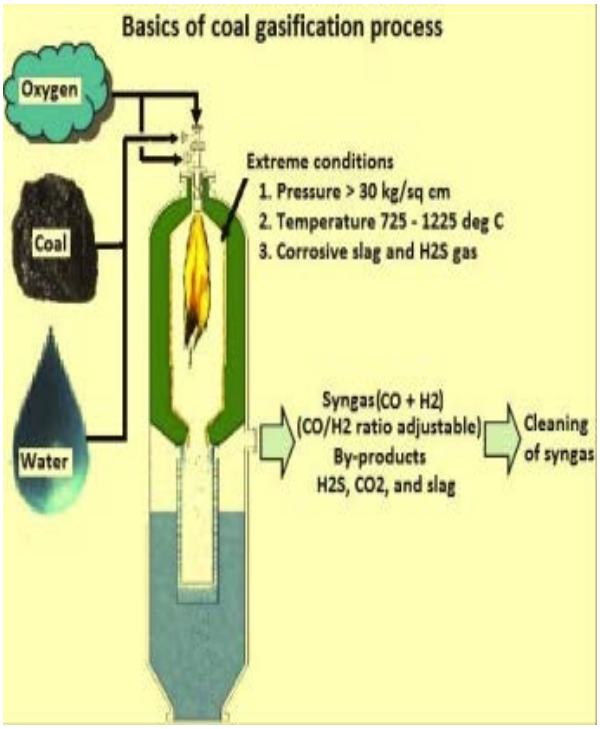
Coal Gasification

- The budget proposed four pilot projects for coal gasification and conversion of coal into chemicals required for the industry.
- This gas is then used instead of piped natural gas, methane and others for deriving energy.

It produces Syngas which is a mixture consisting primarily of methane (CH4), carbon monoxide (CO), hydrogen (H2), carbon dioxide (CO2) and water vapour (H2 O).

Syngas can be used to produce a wide range of fertilizers, fuels, solvent and synthetic materials

- Steel companies typically use coking coal in their manufacturing process.
- Most of the coking coal is imported and is expensive. The hydrogen obtained from coal gasification can be used for various purposes such as making ammonia, powering a hydrogen economy.



Koalas as Endangered Species: Australia

- Koala is an arboreal (lives in trees) marsupial.

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A marsupial is born in a very incomplete state. They are minute, hairless and with hind limbs only partially formed.
Instead of the placenta, the mother's milk nourishes the young and allows it to grow and develop.

- Recently, Australia has officially classified koalas as 'endangered'.
- During the 2019 bushfires in Australia, now known as the 'Black Summer', an estimated 60,000 koalas were impacted, with vast swathes of their habitat being blackened and rendered unliveable. ☐
- Another major threat is the spread of chlamydia, a sexually transmitted disease known to cause blindness and cysts in the koalas reproductive tract.

The typical habitat for Koalas is open eucalypt woodlands, and the leaves of these trees make up most of their diet. In terms of societal behavior, Koalas are asocial animals and typically emotional bonding is seen only between mothers and dependent offspring. ☐
They are endemic to Australia

World Wetlands Day

- It is celebrated on the 2nd of February & "National Wetland Decadal Change Atlas" was prepared by the Space Applications Center of ISRO (Ahmedabad).

The Ramsar Convention is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. ☐
The countries with the most Ramsar Sites are the United Kingdom (175) and Mexico (142), as per the Ramsar List.
Bolivia has the largest area with 148,000 sq km under the Convention protection. It was first celebrated in 1997.
Theme for 2022: Wetlands Action for People and Nature
Ramsar tag makes it incumbent upon authority to strengthen the protection regime there and also creates defenses against encroachment
It is like an ISO certification. They can take it off the list as well if it doesn't meet their standards continuously.

- Two new Ramsar sites (Wetlands of International Importance), Khijadia Wildlife Sanctuary in Gujarat and Bakhira Wildlife Sanctuary in UP were also announced
- Wetlands are ecosystems saturated with water, either seasonally or permanently. They include mangroves, marshes, rivers, lakes, deltas, floodplains and flooded forests, rice-fields, coral reefs, marine areas no deeper than 6 meters at low tide, as well as human-made wetlands such as waste-water treatment ponds and reservoirs

According to UNESCO, the threat to wetlands will have an adverse impact on 40% of the world's flora and fauna that live or breed in wetlands

Status in India:

- India has a network of 49 Ramsar sites, highest in South Asia, comprising 4.63% of the total geographical area.
- Gujarat is at the top (17.56% of total geographical area of the state or 22.7% of total wetlands areas of the country.
- It is followed by Andhra Pradesh, Uttar Pradesh, and West Bengal.

Volatile Organic Molecules

- VOCs are carbon-containing chemicals released by petrol and diesel vehicles. They impact air quality and human health.

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- VOCs can have a natural origin, too. ☐ Plants emit these chemicals to attract pollinators, defend themselves from pests and predators and adapt to environmental stress

a study conducted by Indian Institute of Science Education and Research revealed that India can slash emissions of Volatile Organic Molecules (VOC) by 76% in the next eight years by swapping all two- and three-wheelers with electric vehicles and all diesel-fuelled ones with Compressed Natural Gas (CNG).

- India is home to 14 out of the top 20 most polluted cities globally.
- VOCs can irritate the eyes, nose and throat, damage body organs and cause cancer.
- They react with sunlight and nitrogen dioxide to form ground-level ozone and are also instrumental in formation of Particulate matter.

An EV operates on an electric motor instead of an internal combustion engine and has a battery instead of a fuel tank

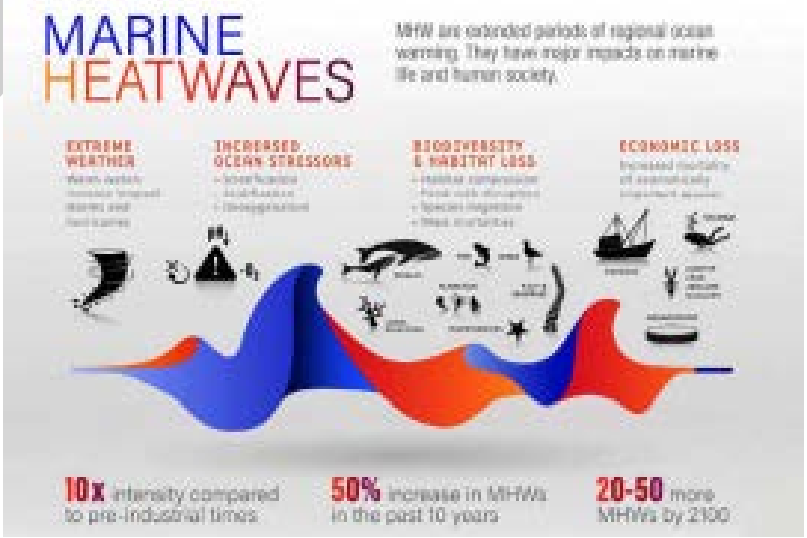
Government has set a target of EV making up 30% of new sales of cars and two-wheelers by 2030

There is an ambitious target to achieve 6-7 million sales of hybrid and EVs year on year from 2020 onwards under National Electric Mobility Mission Plan (NEMMP)

FAME India was launched in 2015 with the objective to support hybrid/EV market development and manufacturing ecosystem.

Marine Heatwaves

- Marine heatwaves are periods of extremely high temperatures in the ocean.
- The most common drivers of marine heatwaves include ocean currents which can build up areas of warm water
- These events are linked to coral bleaching, seagrass destruction, and loss of kelp forests, affecting the fisheries sector adversely.



According to a study, marine heatwaves have been on the rise in the waters around India

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- The Western Indian Ocean region experienced the largest increase in marine heatwaves (1.5 events per decade) compared to 0.5 Events per decade in Bay of Bengal
- The marine heatwaves in the Western Indian Ocean and the Bay of Bengal increased drying conditions over the central Indian subcontinent.
- Correspondingly, there is a significant increase in the rainfall over south peninsular India in response to the heatwaves in the north Bay of Bengal.

Impacts of Heat-Waves:

- It has been associated with the mass mortality of marine invertebrates, and may force species to change behaviour in a way that puts wildlife at increased risk of harm.
- Marine heatwaves can change the habitat ranges of certain species, such as the spiny sea urchin off southeastern Australia which has been expanding southward into Tasmania at the expense of kelp forests which it feeds upon
- In 2016, marine heatwaves across northern Australia led to severe bleaching of the Great Barrier Reef
- Often they occur alongside other stressors such as ocean acidification, deoxygenation, and overfishing.

Greater One-Horned Rhino

- There are five species of rhino – white and black rhinos in Africa, and the greater one-horned, Javan and Sumatran rhino species in Asia.
- Only the Great One-Horned Rhino is found in India (largest among all)
- In India, rhinos are mainly found in Assam, West Bengal and Uttar Pradesh.

IUCN Red List Status:
Black Rhino: Critically endangered. Smaller of the two African species.
White Rhino: Near Threatened. Researchers have created an embryo of the northern white rhino by using In Vitro Fertilization (IVF) process.
One-Horned Rhino: Vulnerable
Javan: Critically Endangered
Sumatran Rhino: Critically Endangered. It has gone extinct in Malaysia.

Conservation Efforts

- The New Delhi Declaration on Asian Rhinos 2019- five rhino range nations (India, Bhutan, Nepal, Indonesia and Malaysia) have signed a declaration for conservation efforts.
- Indian Rhino Vision 2020: Launched in 2005, it was an ambitious effort to attain a wild population of at least 3,000 greater one-horned rhinos spread over seven protected areas in the Indian state of Assam by the year 2020.

Draft Policy Framework for Distributed Renewable Energy

- Ministry of New and Renewable Energy (MNRE) released a draft policy framework on Distributed Renewable Energy
- The aim is to achieve the objective of a decentralised and distributed renewable energy supply in the country, particularly for rural populations.

Provisions:

- MNRE proposed forming a committee to monitor the progress of DRE projects, which will meet at least once every six months.
- Within the committee, each member ministry shall nominate the main point of contact for interministerial collaboration.

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- Within the committee, each member ministry shall nominate the main point of contact for interministerial collaboration.

Objectives and Significance Outlined:

- Enabling a market-oriented ecosystem.
- Increasing the adoption of DRE-based livelihood solutions by enabling easy finance for the end-user.
- Using applications powered by mini / micro-grids operating in hybrid mode along with the main grid
- Establishing energy-efficiency standards for highpotential livelihood products
- DRE and its downstream applications offer an opportunity to not only meet India's climate and energy access targets, but also provide attractive returns to financial investors.
- It also provides pathways for India to reduce importdependence on crude oil as well as create economic growth and jobs in the long run.

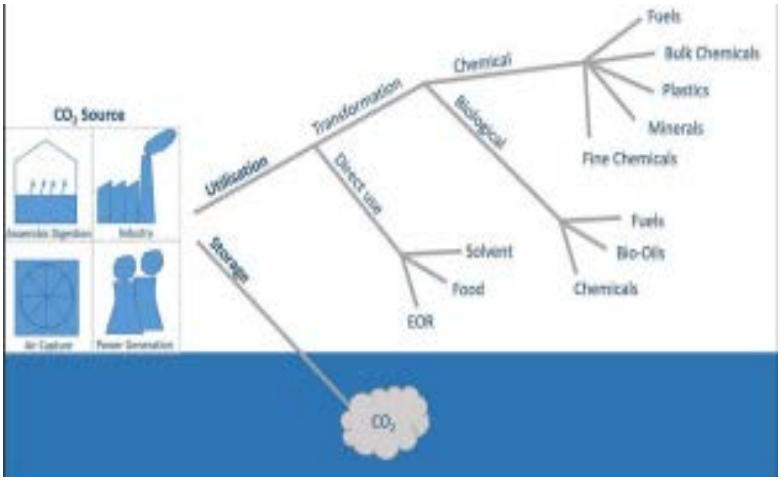
Sustainable Cities India Program

- The 'Sustainable Cities India' intends to enable cities to decarbonise in a systematic and sustainable way that will reduce emissions and deliver resilient and equitable urban ecosystems.
- The MoU has been signed by World Economic Forum & National Institute for Urban Affairs.
- This initiative is in synergy with India's commitment to turn net zero by 2070 as a climate mitigation response at COP26.
- WEF and NIUA will adapt the Forum's City Sprint process and Toolbox of Solutions for decarbonization in the context of five to seven Indian cities across two years.

The City Sprint process is a series of multi-sectoral, multi-stakeholder workshops involving business, government, and civil society leaders to enable decarbonization, especially through clean electrification and circularity

Toolbox of Solutions: It provides a digital platform containing over 200 examples of clean electrification, efficiency and smart infrastructure best practices and case studies across buildings, energy systems and mobility from over 110 cities around the world.

Carbon Capture and Utilisation & Storage Technologies (CCUS)



- Carbon Capture, Utilization, and Storage (CCUS) encompasses methods and technologies to remove CO2 from the flue gas and from the atmosphere, followed by recycling the CO2 for utilization and determining safe and permanent storage options.
- CO2 captured using CCUS technologies is converted into fuel (methane and methanol), refrigerants and building materials.
- The captured gas is used directly in fire extinguishers, pharma, food and beverage industries as well as the agricultural sector

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As per a study, the available technology might fail to help the world reach Net Zero emissions by 2050.

- The study noted that a majority of these systems are energy intensive and the resultant product can also release CO2 into the atmosphere

Applications of CCUS

- Capturing CO2 from biogenic sources such as plants and soil to boost crop growth in a greenhouse could work.
- Combining CO2 with steel slag - an industrial byproduct of the steel manufacturing process — to make construction materials compatible with the Paris Agreement goals
- Oil and Natural Gas Corporation signed a MoU with Indian Oil Corporation Limited (IOCL) for Enhanced Oil Recovery (EOR) by injecting CO2

Saltwater Crocodile

- Largest of the 23 species of 'extant' or living crocodilians. Now extinct in Vietnam due to human activity.
- also called the 'estuarine crocodile' and as the name suggests, is typically found in the brackish water
- today found in three locations in India — the Sundarbans, Bhitarkanika National Park and the Andaman and Nicobar Islands.

native to the Indian Subcontinent, along with the mugger crocodile (Crocodylus palustris) and the gharial but also found in South East Asian countries of Phillipines, Malaysia etc.

- IUCN List of Threatened Species: Least Concern
- CITES: Appendix I (except the populations of Australia, Indonesia and Papua New Guinea, which are included in Appendix II).
- Wildlife Protection Act, 1972: Schedule I

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Army Tag for New Gecko

- Geckos are reptiles and are found on all the continents except Antarctica.
- These colorful lizards have adapted to habitats from rainforests, to deserts, to cold mountain slopes.

a team of herpetologists have recorded a new species of bent-toed gecko from a wooded part of the Umroi Military Station in Meghalaya

- Gecko tails serve many purposes. They help balance their weight as they climb branches, they act as fuel tanks to store fat, and as camouflage to help them disappear into their environment. □
- Geckos are also able to shed their tails if a predator grabs them.
- Most geckos are nocturnal, which means they are active at night, but day geckos are active during the day and nibble on insects.

Plastic Waste Management (Amendment) Rules, 2022

Plastic Waste Management Rules 2016 has been amended to fast-track the elimination of single-use plastics and promote alternatives.

Plastic Waste Management Rules 2016?

It mandates the generators of plastic waste to take steps to minimize generation of plastic waste, prevent littering of plastic waste, and ensure segregated storage of waste at source among other measures.

The rules also mandate the responsibilities of local bodies, gram panchayats, waste generators, retailers and street vendors to manage plastic waste

New Provisions

Classification of Plastics:

- Category 1: Rigid plastic packaging
- Category 2: Flexible plastic packaging of single layer or multilayer, plastic sheets and covers made of plastic sheet, carry bags, plastic sachet or pouches
- Category 3: Multi-layered plastic packaging
- Category 4: Plastic sheet used for packaging as well as carry bags made of compostable plastics

Reuse of rigid plastic packaging material has been mandated in the guidelines to reduce the use of fresh plastic material for packaging.

- The guidelines allow for sale and purchase of surplus extended producer responsibility certificates which allows for a market mechanism for plastic waste management.
- Centralised Online Portal to act as the single point data repository with respect to orders and guidelines related to implementation of EPR for plastic packaging under Plastic Waste Management Rule, 2016.
- Environmental compensation will be levied based upon polluter pays principle, with respect to nonfulfilment of EPR targets by producers, importers and brand owner.
- A committee constituted by the CPCB under the chairmanship of CPCB chairman will recommend measures to the environment ministry for effective implementation of EPR
- State Pollution Control Board (SPCBs) or Pollution Control Committees (PCCs) have been tasked to submit an annual report on EPR portal with respect to its fulfillment by producers, importers and brand-owners and plastic waste processors in the state/Union Territory to the CPCB.

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- The United Nations Environment Programme (UNEP) has released its Annual Frontiers Report named Noise, Blazes and Mismatches.

The Frontiers report identifies and offers solutions to three environmental issues: urban noise pollution, wildfires and phenological shifts to address the triple planetary crisis of climate change, pollution and biodiversity loss.

Key Highlights

- Urban Noise Pollution- Chronic annoyance and sleep disturbance caused by traffic can result in severe heart diseases and metabolic disorders
- Wildfires- The trends towards more dangerous fire-weather conditions are likely to increase due to rising concentrations of atmospheric greenhouse gasses
- Phenological Shifts:- Phenology is the timing of recurring life cycle stages, driven by environmental forces, and how species interacting within an ecosystem respond to changing conditions.

Plants and animals in terrestrial, aquatic and marine ecosystems use temperature, day length or rainfall as cues for when to bear fruit, migrate or transform in other ways.

climate change disrupts these natural rhythms as plants and animals are being pushed out of sync with their natural rhythms, leading to mismatches, such as when plants shift life cycle stages faster than herbivores.

Recommendations:

- adopting indigenous fire management techniques
- preventive approach, rather than reactive approach by engaging vulnerable groups
- focus on long-range weather forecasting
- Focus on remote-sensing capabilities such as satellites, ground-based radar, lightning detection as well as data handling

ONE OCEAN SUMMIT

- At One Ocean Summit (OOS), UNESCO has announced that at least 80% of the seabed will be mapped by 2030, compared to 20% currently.

One Ocean Summit

• OOS was organised by France (as part of French presidency of Council of the European Union) in cooperation with United Nations and World Bank.

• Its objective is to mobilise international community to take tangible action towards preserving and supporting healthy and sustainable ocean ecosystems

- Bathymetric survey measures the depth and map the underwater features of water body
- In 2017, UNESCO joined with Nippon Foundation, Japan's private foundation to launch Seabed 2030 Project.
- It is carried out in collaboration with General Bathymetric Chart of the Oceans, the only intergovernmental organisation with a mandate to map the entire ocean floor.
- The study will help in understanding location of ocean faults, workings of ocean currents and tides, and the transport of sediments. and Protecting populations by anticipating seismic and tsunami risks.

KEN-BETWA LINK PROJECT AUTHORITY (KLBPA)

- Centre has constituted a KBLPA and a national steering committee for interlinking the two rivers.
- KBLPA has been constituted as a vertical of National Water Development Agency comprising of secretaries from ministries of environment, power and tribal affairs

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- All central funds for the project will be routed through KBLPA.
- Steering committee will be chaired by Jal Shakti Ministry secretary & it will approve fundamental administrative policies, byelaws and norms for KBLPA; and also approve annual budget and financial statements.
- It has to meet at least twice a year, with a quorum of 2/3 of total members

KAZIRANGA NATIONAL PARK- A NET CARBON EMITTER

- According to research conducted by Indian Institute of Tropical Meteorology and Tezpur University, KNP is releasing more carbon than it is absorbing.
- The unique soil of the KNP's deciduous forest is home to a large population of bacteria that release CO2 as they breathe
- ability of forest to absorb CO2 decreases as the photosynthetic activity of trees during the monsoon decreases due to increased cloud cover

OTHER EFFECTIVE AREA-BASED CONSERVATION MEASURES (OECM) SITE

- Aravali Biodiversity Park in Gurugram was declared as India's first OECM site. It was once a mining site.
- OECM tag is conferred upon areas of rich biodiversity, outside of protected areas like national parks and sanctuaries, for effective in-situ conservation.
- It is issued by International Union for Conservation of Nature (IUCN)

WHITE CHEEKED MACAQUE

- Scientists from Zoological Survey of India have recorded presence of White-Cheeked Macaque from Arunachal Pradesh
- They have distinct white cheeks, long and thick hair on neck and longer tail than other Macaque species.
- They have not been yet included in the Wildlife (Protection) Act, 1972 of India.

POLA VATTA

- Central Marine Fisheries Research Institute has identified a new species of fish carangid (Vatta) species from the Indian coast.
- Locally known as polavatta, fish belongs to 'queen fish' group and is available across coasts in the country.
- There are over 60 species of carangids in the Indian seas and four of them belong to the 'queen fish' category

TONGA VOLCANO

- It lies along Pacific 'Ring of fire', and is just over 60 kilometres from island nation of Tonga.
- In case of Tonga, Pacific Plate was pushed down below the Indo-Australian Plate and Tonga plate
- The plums from the recently volcanic eruption in Tonga has reached to mesosphere. it was the biggest volcanic event recorded anywhere in the world in over three decades.

Impacts:

- Alter the local weather, shade sunlight & temporary cooling, triggered a Tsunami, Release large amounts of greenhouse gases such as water vapor and carbon dioxide increasing the warming effect.

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GREEN HIGHWAY POLICY, 2015

- 244.68 lakh plants have been planted upto December, 2021 across 869 NH projects
- Green Highways (Plantation, Transplantation, Beautification & Maintenance) Policy 2015 aims to promote greening of corridors across all the National Highways of the country.

It also aims:

- Making India pollution free
- Help in curtailing the number of road accidents,
- Help local communities, and generate employment.

REJUVENATING WATERSHEDS FOR AGRICULTURAL RESILIENCE THROUGH INNOVATIVE DEVELOPMENT PROGRAMME (REWARD) PROJECT

- REWARD is a $115 million project signed by Central government, Karnataka, Odisha, and World Bank
- It is proposed as a 6 years Project.
- It will help in the adoption of improved watershed management practices that further help increase farmers' resilience to climate change, promote higher productivity and better incomes.

Watershed management refers to implementing land use practices and water management practices to protect and improve the quality of the water and other natural resources within a watershed.

LAKSHYA ZERO DUMPSITES (LZD)

- Ministry of Housing and Urban Affairs approved Legacy Waste Remediation Proposal of Andhra Pradesh with goal of LZD.
- LZD under SBM-U 2.0 seeks to remediate 16 crore metric tonnes (MT) of legacy waste dumpsites that occupy nearly 15,000 acres of city land.
- Legacy dumpsites pose a major threat to the environment and contribute to air pollution and water pollution

NANOPLASTIC

- A study conducted at Alps to determine the amount of plastic falling to Earth from the atmosphere concluded that plastic nanoparticles travel over 1,200 miles through air before settling.
- Nanoplastics are particles resulting from the degradation of plastics. They present colloidal behavior within the size range from 1 to 1000 nm.
- Sources of nanoplastics: Densely populated and urban areas; oceans (plastics entering the air via spray of waves) etc.
- Impact: Unlike micro-particles, they are likely capable of crossing the cell-blood barrier after respiration into the lungs and eventually entering the bloodstream.

MUMBAI POLLUTION INCREASES AS DUST STORMS HIT

- Sand and dust storms (SDS) are natural events caused by strong, turbulent winds blowing over dry land surfaces that have little or no protection from vegetation cover.

Causes of Dust storm in India

- Temperature in Middle East was warm, leading to the lifting of dust in the air.

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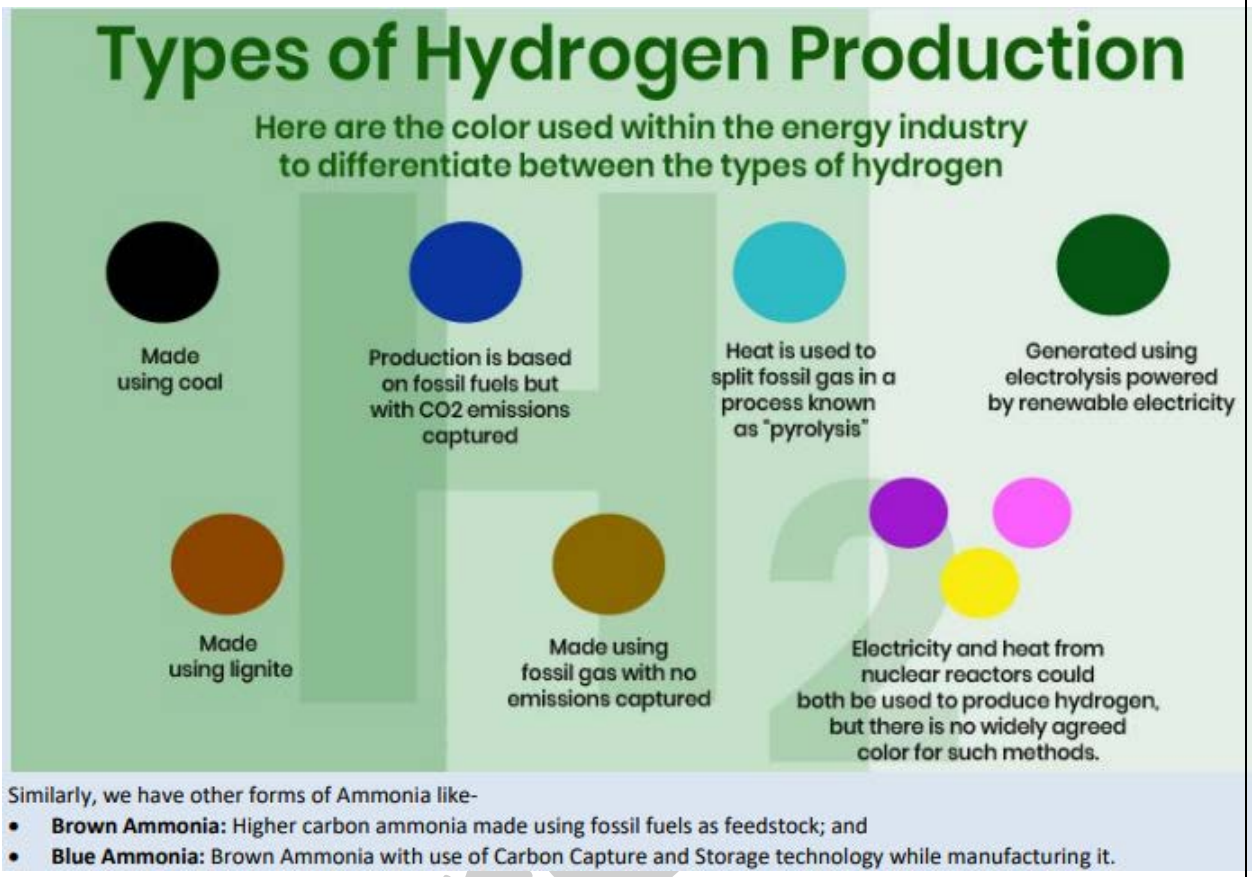
- As temperature in western parts of India towards the Arabian Sea is warmer, it was favourable for storms to enter the country.



Similarly, we have other forms of Ammonia like-
- **Brown Ammonia:** Higher carbon ammonia made using fossil fuels as feedstock; and
- **Blue Ammonia:** Brown Ammonia with use of Carbon Capture and Storage technology while manufacturing it.

Impacts of dust storms

- They are a transboundary meteorological hazard that affect agriculture, energy, environment, aviation, and human health.
- Deposition of dust on glaciers induces a warming effect.
- Reduces crop yields by burying seedlings, causing loss of plant tissue etc.
- Larger particles can cause skin and eye irritations or infections, while smaller particles may trigger respiratory disorders like asthma.
- Also, Increase the nutrient content in the areas of deposition and benefit vegetation.

Feature	Hydrogen	Ammonia
About	**Hydrogen (H_2)** is a clean-burning molecule with water as its by-product.	**Ammonia (NH_3)** is the basic building block of all nitrogen fertilizer.
Production	Primarily through **Steam Methane Reforming** (producing H_2 from natural gas), along with other methods like **Methane Pyrolysis, Coal Gasification, Electrolysis of water** etc.	Primarily through the **Haber-Bosch Process**, i.e. ammonia production from hydrogen (H_2) and nitrogen (N_2) through a high pressure (150-300 bar) exothermic catalytic reaction at 350-500 °C.
When they are produced using **power from renewable energy (RE)**, it is termed as **Green Hydrogen** and **Green Ammonia.**		

GREEN HYDROGEN/GREEN AMMONIA

- Ministry of Power notified the Green Hydrogen/Green Ammonia Policy to enable production of Green Hydrogen/Green Ammonia using Renewable Sources of Energy.

Properties of Hydrogen and Ammonia as Fuel

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	Advantages	Disadvantages
Hydrogen	• Very **high energy density (120 MJ/Kg),** almost 3 times of hydrocarbons, making it an **efficient source of energy.** • **Easy availability and lower cost** (when produced at mass scale) as it can be produced from gas, coal, wind, water, biomass etc. • **Colorless and odorless fuel** and light in weight. • Multiple production pathways (as given earlier). • **Reduced carbon footprints** as no release of any toxic by-product or GHG. ○ As per IEA, green hydrogen would save the world from **830 million tonnes of CO_2** emitted annually when produced using fossil fuels.	• **High initial cost** due to use of metals like **Platinum** in production. • **Lack of existing storage and transport infrastructure.** • **Highly flammable fuel**.
Ammonia	• **Flexibility of use as a transport fuel** or to **store thermal and chemical energy**. • **Lower cost to produce, store, and deliver hydrogen** as NH_3 than as compressed and/or cryogenic hydrogen. • **Existing safe storage** and transportation infrastructure. • **Reduced Carbon footprints**. E.g., present ammonia production consumes 1.8% of global energy output, producing around 500 million tonnes of CO2.	• **Energy density** (22.5 MJ/Kg) is **half of typical hydrocarbons.** • **Toxic to humans.** • **Risk of Alteration of the Global Nitrogen Cycle** by humans which might lead to loss of biodiversity, poor air quality etc.

Features of Green Hydrogen/Green Ammonia (GH/GA) Policy

Operational

- **Manufacturers** of GH/GA may purchase renewable power from the **power exchange or set up RE capacity** themselves or through any other developer, anywhere.
- **Open access** will be granted within **15 days of receipt of application**.
- Manufacturers can **bank his unconsumed renewable power**, up to **30 days**, with distribution company and take it back when required.
- **Manufacturers** of GH/GA and the RE plant shall be **given connectivity** to the **grid on priority basis** to avoid any procedural delays.
- **To ensure ease of doing business** MNRE will set up a single portal for carrying out all the activities including **statutory clearances** in a time bound manner.
- **Connectivity**, at the **generation end** and the GH/GA manufacturing end, to the **ISTS for RE capacity** set up for the purpose of manufacturing GH/GA shall be granted on priority.
- Manufacturers of GH/GA shall be allowed to **set up bunkers** near **Ports for storage** of GA for export / use by shipping. The land for the storage for this purpose shall be provided by the **respective Port Authorities** at applicable charges.

Financial

- **Distribution licensees** can procure and supply RE to the **manufacturers of GH/GA** in their States at **concessional prices** which will only include the cost of procurement, wheeling charges and a small margin as determined by the State Commission.
- **Waiver of inter-state transmission charges** for a period of **25 years** will be allowed to the manufacturers of GH/GA for the projects commissioned before **30th June 2025**.
- Benefit of **Renewable Purchase Obligation (RPO)** will be granted incentive to the hydrogen/Ammonia **manufacturer and the Distribution licensee** for consumption of RE.

Advantages and disadvantages of Green Hydrogen and Ammonia as fuel

UNEP'S FIRE READY FORMULA FOR WILDFIRES

- Formula envisages 66% of spending to be devoted to planning, prevention, preparedness, and recovery and the remaining 34% to be spent on response.

Significance of the formula

- Investing effectively as current government responses to wildfires put money in the wrong place.

Wildfire vs Forest Fire

- National Institute of Disaster Management (NIDM) defines Forest fire as **an unclosed and freely spreading fire that consumes the natural fuels**.
- When a **fire burns out of control it is known as Wildfire.**

Forest fires in India

- India has a **strong legal and institutional arrangement** for forest fire prevention and management.
  - As per**, Indian Forest Act of 1927** it is a criminal offense to burn or to allow a fire to remain burning in reserved and protected forests.
  - **Wildlife (Protection) Act, 1972** further prohibits setting fire in wildlife sanctuaries.
  - **Ministry of Environment, Forest, and Climate Change** (MoEFCC) is the nodal ministry.
- **National Action Plan on Forest Fires (NAPFF), 2018** has been formulated to minimize forest fires. It includes:
  - Performing Fire Risk Zonation and Mapping
  - **Involving communities**
  - **Increasing Resilience through biomass management and weed management.**
  - **Using Satellite based** Forest Fire Alerts
  - **Post Fire Management**
- **Forest Fire Prevention and Management (FPM) Scheme:** It is a centrally sponsored scheme launched in 2017 which is **specifically dedicated to assist the states in dealing with forest fires**.

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- Focus on prevention as true cost of wildfires i.e. financial, social, and environmental is extremely high.
- Development of international standard for wildfire management which will help countries build capacity for domestic application and international assistance

Impact of Wildfires/forest fire

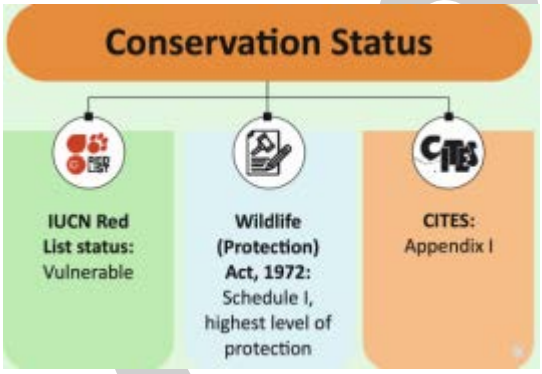
- Wildfires in ecosystems like peatlands and rainforests, which store large amounts of irrecoverable terrestrial carbon, release vast quantities of CO2 into the atmosphere, exacerbating global warming.
- due to mortality during the fire and, for some animals and post-fire habitat changes such as impact on vegetation, landscape, and individual plants.
- Contaminants, increased soil erosion, changed soil composition, and slope stability affect both yield and quality for extensive periods.
- Wildfires result in long term impacts on individuals, communities, and nations.

About seagrass

- Seagrasses are **underwater plants that evolved from land plants**.
- They are like **terrestrial plants in that they have leaves, flowers, seeds, roots, and connective tissues**, and they make their food through photosynthesis.
- Unlike terrestrial plants, however, they **do not have strong stems to hold themselves up**. Instead they're **supported by the buoyancy of the water that surrounds them**.
- Seagrasses are a **very important food source and habitat** for wildlife, supporting a diverse community of organisms including fish, octopuses, sea turtles, shrimp, blue crabs, oysters, sponges, sea urchins, anemones, clams, and squid.
- Seagrasses have been called '**the lungs of the sea**' because they release oxygen into the water through the process of photosynthesis.
- Seagrasses can reproduce sexually or asexually. They are flowering plants that produce seeds. Seagrasses are not true grasses. They are more closely related to terrestrial lilies and gingers than grasses.

DUGONG

- Tamil Nadu has declared India's first dugong conservation reserve in the Gulf of Mannar.
- The dugong is a species of sea cow found throughout the warm latitudes of the Indian and western Pacific Oceans.
- They can tolerate the brackish waters found in coastal wetlands, and large numbers are also found in wide and shallow mangrove channels and around leeward sides of large inshore islands, where seagrass beds are common.
- Dugong play an important ecological role in coastal marine ecosystems, and dugong populations in an area can be used as an indicator of general ecosystem health



IUCN GREEN LIST OF PROTECTED AND CONSERVED AREAS

- In 2021, 10 protected areas in Switzerland, France and Italy entered IUCN Green List of Protected and Conserved Areas.
- It is the first global standard of best practice for area-based conservation.
- Its objective is to provide a global benchmark to assess whether protected and conserved areas are achieving successful conservation outcomes through effective and equitable governance and management

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- It aims to increase the number of natural areas delivering long-lasting conservation results for people and nature.
- The sites admitted to the IUCN Green List have distinguished themselves through exemplary management, fair governance, and a long-term commitment to successful conservation
- Presently, 59 sites in 16 countries have made it to the list.
- No Indian site is currently part of this list

The IUCN Green List Standard is organized into 4 components of successful nature conservation in protected and conserved areas.

- The baseline components concern: Good Governance; Sound Design & Planning; and Effective Management.

About Green Status of Species

- **Prepared by:** IUCN.
- It is a global standard for **measuring species recovery and assessing conservation impact.**
- The Green Status **assesses species against three essential facets of recovery -**
  - A species is fully recovered if it **is present in all parts of its range**, even those that are no longer occupied but were occupied prior to major human impacts/disruption; AND
  - **It is viable** (i.e., not threatened with extinction) in all parts of the range; AND
  - **It is performing its ecological functions in all parts of the range.**
- These factors contribute towards a **"Green Score" ranging from 0–100%, which shows how far a species is from its "fully recovered" state.**
  - A value of **0% means the species is Extinct or Extinct in the Wild, and 100% means it is Fully Recovered**.
- **The significance of the Green Status** is its **potential to tell the story of a species** by calculating Green Scores at different time intervals.
- Green Status assessments are **not an alternative to extinction risk assessments through the IUCN Red List,** but provide complementary information.
  - Red List is the **global standard for assessing the risk of extinction that individual species of animal, fungus, and plant faces.**
  - It consists of **Nine categories - Not evaluated, Data deficient, least concern, near threatened, vulnerable, endangered, critically endangered, extinct in wild, extinct.**

Down to Earth Special

PT Points:

Agrivoltaics: It refers to the **practice of using the farmland for solar power generation,** along with planting of crops.

- The practice is **beneficial for renewable energy generation** as it increases the area under solar power generation and increases the efficiency of panels due to cooling effects of crops.
- It is also a **boon for agriculture**, as the panels provide shade to the farmland, leading to a decrease in evapo-transpiration and resulting water loss.

Sohrai Murals: These are the **vibrant, attractive tribal paintings drawn by Santhal communities of Odisha, West Bengal and Jharkhand** on the walls of their dwellings.

- They are famous for the **geometric symmetry** in the architecture.
- The murals are usually painted to mark **Sohrai, a harvest festival coinciding with Diwali or Kali Puja.**

Arab Spring: It was a series of p**ro-democracy revolutions** which began and swept many of the countries in the Middle East.

- It **started in Tunisia** and led to an **overthrow of the governments in Libya and Egypt**.

- The main **cause** of the revolution was **economic stagnation and prevalence of corruption** in the respective countries.

Karewas: they are plateau-like landforms formed by the deposition of alluvial soils and sediments like sandstone and mudstone.

- They are famous for the cultivation of various crops like kashmir saffron (gi tag in 2020), almonds and apples. kashmir saffron is famous for its longer and thicker stigmas, deep-red colour, high aroma and bitter flavor.
- They mainly exist around pir panjal range and were formed during the pleistocene period (2.6 million to 11,700 years ago).

Mulching: It refers to the practice of covering the field with crop residue. It has multiple benefits like:

- Protection from loss of water through evaporation.
- Conservation of soil moisture.
- Control soil erosion.
- Protection of roots from excessive heat or cold.
- Suppress weeds and pests.
- Enhancement in the nutrient levels of the crops.

An Unusual Contest

Apart from directly encroaching the forest lands, India is also seeing a **loss of bio-diverse areas due to its zeal to achieve the renewable energy targets.**

- The article covers the desert area of **Jaisalmer which is home to Great Indian Bustard.** But has not been as comfortable for the bird due to the web of transmission lines laid to distribute electricity from the large scale solar and wind energy generation projects.

Impact of Renewable Energy on Man-Animal Conflict

- **Encroachments**: India has committed to achieve **450 GW of renewable energy as a part of Nationally Determined Contributions (NDCs)** under the Paris Climate Agreement. This has led to a huge sprawl of solar and wind energy generation projects, including in bio-diverse areas. Environmentalists have flagged such projects as a threat to biodiversity.
  - **Orans in Jaisalmer:** In Rajasthan, **Orans are biodiversity-rich, sacred groves, which are traditionally protected by the local communities** of the area. For e.g., Orans in **Jaisalmer boast of 122 Great Indian Bustards (GIBs) out of a total population of 150** in the wild. Considering GIBs are 'Critically Endangered', these Orans assume a great significance. But they have been victims of encroachments of solar and wind energy plants.
  - **Suitability for renewable energy:** The area surrounding Orans in Rajasthan is ideally suited for renewable energy **due to long sunlight hours as well as existence of large plains with unhindered winds**. This makes the areas conducive to both solar energy generation and wind energy generation respectively.
- **Lack of Stringent Regulations:** Unlike thermal power plants and various other industrial projects, solar and wind energy generation plants are **not subject to 'Environmental Impact Assessment' (EIA).** This may lead to deterioration in biodiversity of a region on the installation of such projects. In contrast, the countries like USA conduct comprehensive EIA and Avian Path Studies to ascertain the impact of such projects on wildlife.

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- **Underground Wiring:** On a petition filed by environment conservationists, Supreme Court had directed underground wiring in the region, to protect GIBs and other birds from electrocution. The **Centre has set up a three-member committee** to look into the different aspects of underground wiring. However, it is difficult to comply with SC order due to various reasons:
    - **Prohibitive Costs:** According to the proponents of the Renewable Energy projects, an attempt to lay underground wiring may lead to a four to ten-fold **increase in the costs** of the project, rendering it unviable. This would hinder the progress of renewable energy generation in the country.
    - **Right of Way:** Unlike overhead wiring, the land needs to be dug to lay underground wiring. This might be difficult considering the **land acquisition problems** which have plagued the development of highways and other infrastructure projects in the country.
    - **Technical Limitations:** Experts have contended that no company around the world manufactures underground cables which have the capacity to transmit 765 KV of current, which is suitable for the project.
    - **Safety Issues:** The project may lead to **electrocutions and loss of life in case of any fault** exposing the high tension cable under the ground.

Steps Required to Resolve the Issue

- **Technology-based Initiatives:** (This part is taken from another article in the same edition – Good Riddance): There is a need to harness the power of technology to reduce man-animal conflict and protect the animals while still preventing them from destroying the property. For e.g. a startup **Katidhan Tech has tied up with various NGOs to install devices that deter animals**. It has designed two devices:
    - **Parabraksh:** It is a **smart light which repels animals**. The light is solar-powered and has usb-charging system for cloudy days. It is a smart light which switches on at night and switches off during the day. It has various patterns of LED lighting to keep the animal away from the intended location.
    - **Kapilkaat:** This device has 2 speakers and it **uses predator sounds to scare monkeys away**. It has built-in sensors to detect the movement of monkeys and plays sounds of tigers and lions to scare them off. Since monkeys are known to be highly adaptable, the device uses different sounds every time monkeys approach an area.
    - **Humane in application:** The major advantage of the devices is that despite being tremendously effective, they are **not cruel in nature** like electric fences, which give electric shocks, sometimes killing the young animals.
- **Protecting the Area:** Due to its rich biodiversity, there is a need to declare areas like Jaisalmer Orans protected areas. **In 2018, Supreme Court directed such areas to be deemed forests** as they are open natural ecosystems. This would also be in the spirit of Article 25 of the Constitution of India, as Orans have spiritual significance for the local communities.
- **Tapping the potential of Renewable Energy:** Despite its proven rich biodiversity, Orans in Jaisalmer hold huge energy potential. According to the Ministry of New and Renewable Energy (MNRE), **the area has potential to generate renewable energy to the tune of 263 GW. Out of this, only 3% of the total potential has been realized till now.**
    - **Phasing out Fossil Fuel:** Proponents of renewable energy have contended that if the renewable energy potential of the area is not tapped, it would mean continuing to

use thermal power and could only be **offset by an additional capacity of 93 GW of coal-based projects.** This would lead a huge blow to Indian efforts at lowering its fossil fuel based energy intensity.

- **Decentralized Power Generation:** Environmentalists suggest innovative practices like **agri-voltaics (see inset) and roof-top power generation** to decrease the use of power transmission lines. They have additional benefit of lower power losses due to transmission and distribution losses.

- **Conservation of Wildlife:** There is a need to balance the country's objectives of tapping into renewable energy as well as conserving biodiversity. For e.g., as already mentioned, Great Indian Bustard (GIB) is a 'critically endangered' bird. Therefore, the **forest department in Rajasthan and Wildlife Institute of India, Dehradun have set up a GBI breeding centre in the Desert National Park**. In the centre, the eggs of GIB are collected and hatched in captivity to protect them from being eaten or destroyed in the open.

Conclusion

- Solar and wind energy hold immense potential in a tropical country like India. However, there is a need to ensure that any attempt to harness renewable energy is not at the cost of loss of biodiversity in the country. Innovation is required to **balance the need for harnessing the renewable energy, while still maintaining the natural areas in pristine condition.**

NATURAL OPTION

What is organic and Natural Farming

- **Chemical Free:** Organic farming refers to the type of agriculture in which the use of chemicals like pesticides, fertilizers, growth regulators, food additives, genetically modified organisms and other such **inputs are used in a minimum quantity or are entirely shunned.**
- **Use of Alternatives Systems:** In place of chemical based inputs, organic farming utilizes methods like crop rotation, use of green manures and compost, biological pest control and mechanical cultivation.
- **Bio-inputs:** Under organic farming, there is a focus on the use of organic and bio-inputs like farmyard manure, vermicompost, poultry manure, green manure, liquid bio-fertilizers, Jeevamrutha, Beejamritha, Ghanajeevamritha, Panchagavya and fish-protein hydrolysate.
- **Additional Practices:** Organic farming system can be complemented with practices like crop rotation (planting different crops sequentially), mulching (see inset), intercropping (planting different crops simultaneously in a field) and seed soaking with liquid manure, to increase the yields in a field.
- **State of Organic Farming in India:** As per the reports, in India, hardly 2.7% or 3.8 million hectares (ha) of the net sown area is under organic and natural farming.

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Benefits of Organic Farming

- **Crop Yield:** As per the report titled 'Evidence (2004-20) on Holistic Benefits of Organic and Natural Farming in India', published by Centre for Science and Environment (CSE), a Delhi-based NGO, organic farming is more productive as compared to chemical-based farming. Out of the total studies, organic farming led to an **increase in the crop yield 41%** of the times it was used, while integrated approach (a mix of organic and inorganic approaches) led to an increase 33% of the times.
- **Cost of Cultivation:** The CSE study takes into account 89 scientific studies conducted in the last decade and also, Government of India's All India Network Project on Organic Farming (AI-NPOF), which has been going on in 16 states since 2004. It says that the **cost of cultivation is higher in organic farming** as compared to the chemical-based farming
- **Reduction in the Costs:** However, this increase in the cost of farming is **attributed to market-based inputs like bio-fertilizers**. If, on the other hand, the inputs are produced by the farmers on the farm itself, the costs would be decreased substantially.
- **Income and Livelihood:** From the studies, it is well established that **net returns are higher** in the organic approach than the inorganic or mixed approaches. Organic approaches not only lead to minimized cost of cultivation (if inputs are produced on-field), they also **fetch premium price** for the produce. This is true for sale of crops even without obtaining certification of being organic.
- **Soil Health:** Organic farming leads to better soil health as it **does not deplete the macro-nutrients** (nitrogen, phosphorus and potassium) and micro-nutrients (iron, managanese, zinc and copper), organic carbon as well as rhizosphere microbiome in the soil, unlike the conventional chemical-based practices.
- **Environment:** Organic farming leads to **lesser carbon emissions**, in addition to promoting carbon sequestration. It also promotes soil respiration, growth of beneficial organisms like earthworms, soil enzymes and microbial biomass increase.
- **Climate-resilience:** Organic farming leads to an increase in overall resilience of the crops against climatic disasters like droughts and frost.
- **Water-use efficiency:** Use of organic methods of farming leads to more **efficient use of soil moisture, leading to an increase in the levels of water table, prevents over-extraction of groundwater and promotes aquifer recharge**.
- **Food Quality:** As per the study, organic farming has a pronounced effect on the **quality of food** in parameters like total carotenoids, total soluble solids, vitamin C, total sugars, lycopene and cancer-fighting antioxidants. It also **promotes the growth of nutrient content and improves the physical attributes** of vegetables like tomato, cabbage and cowpea, fetching better prices in the market.

Government Steps

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- **Policy on Organic Farming 2005:** The policy was **launched in 2005 under the aegis of Ministry of Agriculture and Farmers' Welfare**. It seeks to promote organic farming and conserve bio-resources, resulting in strengthening of rural economy, promotion of value addition, sustaining soil fertility and accelerate growth of agri-businesses in the country.
- **Paramparagat Krishi Vikas Yojana:** It is a **sub-component of Soil Health Management under National Mission of Sustainable Agriculture**. It primarily aims at developing healthy agriculture models through a mix of traditional wisdom and modern scientific advancements. It also seeks to promote soil fertility buildup, resource conservation and climate change mitigation
- **Mass movement:** Recently, **PM Modi has made an appeal** to the farmers of the nation, to make organic farming a mass movement in the country. At the same time, he also highlighted the ill effects of chemical-based farming.

Challenges to Organic Farming

- **Conviction among Policy Makers:** As of now, policy makers fear for the food security of the nation and are non-committal on any major changes in the agriculture sector. Despite its proven benefits, organic farming is yet to take off due to the need for higher production to feed the increasing population in the country.
- **Lack of Consensus among the Scientific community:** Though agreeing to its health and environmental benefits, scientific community is divided on the impact of organic agriculture on crop yields. Again, the scientific community is more focused on the questions surrounding technological challenges like genetically modified crops.
- **Resistance by the Chemical inputs-based industry:** Again, the chemical-based farming has a strong backing in the form of multi-million dollar agro-chemical industry, which has fought tooth and nail to sustain the application of chemicals in agriculture. It is **tough to find their deep pockets and information blitzkrieg** unleashed by such companies on innocent farmers.

Way forward

- **Time Lag:** It is critical to understand that switching to organic farming will take some time to produce the desired results and **expectations of instant benefits are futile**. For e.g. crops like wheat, rice, maize may take a few years to produce comparable results, while in the potato crop, better results can be obtained within a year.
- **Influencing Policymakers:** There is a need to understand that the benefits of technology are not limited to increasing production, but also transcends to increase in the quality of final product and its effect on the environment. Therefore, the decision-makers need to formulate appropriate policy in the direction, keeping the holistic benefits in mind.
- **Support during Transition:** During the transition period from chemical-based farming to organic farming, farmers may need **support in the form of financial and other resources**. It is imperative to ensure that they are adequately supported not only in terms of funds, but also creation of a vibrant market, encouraging farmers to invest in organic and natural farming in the hope of better remuneration.
- **Farmer-friendly Processes:** Not all farmers have the resources or even literacy to understand the **complex processes involved in getting certification** for their organic crops. Therefore, it is critical to ensure that such farmers do not lose out on the benefits offered by organic crops, out of ignorance and lack of knowledge.
- **Roadmap for Implementation:** Organic farming needs a definite roadmap for its implementation in the country in the wake of its holistic benefits. At the same time, the farmers also need **handholding in terms of technical support and extension**

services (like creation of value chains) to support the process of transition as well as sustaining the growth of organically grown crops.

CHARGED UP

Indian companies are investing in new technologies related to chemical compositions of batteries for the upgradation of storage technologies. At the same time, various types of batteries based on sodium, metals like Aluminium, as well as vanadium are being explored as more efficient ways of storing energy.

Current state of Battery Technology

- Factors determining the usefulness of battery technology: There are four major factors which may disrupt the storage market:
- **Energy Density:** It refers to the **amount of charge per unit area**.
- **Cost:** The cheaper, the better.
- **Safety:** It includes the **health impacts, flammability and explosiveness** of the battery technology.
- **Sustainability:** It includes the **availability of raw materials** and capability to produce the battery in a sustainable manner.

Types of Battery Technology

As of now, four types of batteries are prevalent around the world:

- Lead Acid Batteries: Lead Acid batteries have had a long history of usage in the world. They are economical in nature and are easily available in the market due to strong supply chains, which are in place.

Problems with Lead Acid Batteries:

- **Lead acid batteries have slowly become obsolete** due to various reasons including
- **Health issues:** If improperly discarded, the lead acid batteries have the capability to harm living beings due to **toxic nature of lead**. Inhalation or ingestion of lead fumes in large quantities may result in anemia, brain damage to the extent of causing death.
- **Impact on Environment:** Lead is also considered a harmful pollutant and can cause air, soil and water pollution on improper disposal.
- **Low Energy Density:** Lead acid batteries are bulky in nature as they produce lesser energy per unit area (almost 50-80 Watt-hour per kg), thereby, requiring a bigger system for the production of same amount of energy, as compared to other battery systems.
- **Lithium-ion Batteries (including variants):** Lithium ion batteries are considered a cleaner source of energy than the lead acid batteries. In fact, a leading research firm states that lithium-ion batteries account for almost 85.6% of deployed energy storage systems in the year 2015, for which the data is available.
- **Suitable for Electric Vehicles:** At the same time, they have **a higher energy density** (equivalent to 100-265 Watt-hour per kg) with a capability to produce more energy per unit area. Therefore, they can be installed in the **electric vehicles which have a requirement of compact and lighter batteries** to better assist mobility.

Issues with Lithium-ion battery:

- It is **expensive to produce Lithium,** thereby imposing prohibitive costs on the manufacturing of Lithium-ion batteries. Also, the reserves of Lithium are localized in countries like China, Chile, Australia and Argentina.
    - **Chinese Dominance:** As per a report by Bloomberg-NEF, **China controls 80% of global Lithium refining and 77% of global cell capacity**. This has led to an over-dependence of the companies on China in the field of storage systems.

- **Nickel-metal hydride:** These are rechargeable batteries using nickel oxide hydroxide. They have a lesser energy density than Lithium ion batteries.
- **Vanadium ion Batteries:** Vanadium based batteries have a limitation of not being useful for mobility systems. But it is a preferred choice in case of stationary storage, due to its safety, scalability and longer life span of 15-20 years, as compared to four-five years of Lithium-based batteries. It is also available in plenty as it is naturally found in almost 65 different minerals.

Future Technology

- Various Technologies like **Vanadium redox, metal-air, metal-ion and liquid metal batteries are currently in different stages of exploration**. At the same time, there are other technologies in pipeline which have seen large investments
- **Sodium-ion Batteries:** They work on the principle of **flow of electrons from cathode (positively charged cathode constituted by sodium-containing layered materials) to anode (negatively charged, constituting hard carbon)** in the external circuit. They have seen huge investments from Indian companies like Reliance and CSIR-CECRI as well as Chinese companies like Contemporary Amperex Technologies.
- **Advantages of Sodium-ion Batteries:** Unlike Lithium, which is a mere 0.01% of Earth's crust, Sodium is abundant in nature, comprising almost 2.9% of the Earth's crust. It is found in Seawater in the form of salts as well as extractable from soda ash. US, Turkey and Botswana have abundant reserves of soda ash
    - **Cost:** At the same time, Sodium-ion based batteries are cheaper as the cost of extracting sodium is 20% lower than extraction of Lithium. Similarly, Sodium is considered safer than Lithium, with research focused on making it safer for on-the-ground usage.
- **Challenges with Sodium-ion Batteries:** A major challenge associated with Sodium-ion batteries is their low energy density (140-160 Watt hour per kg). This makes it unsuitable for electric vehicles, until the energy density is improved by investments in Research and Development.
- **Aluminium-air Batteries:** India is interested in this type of batteries as they have Aluminium as the major raw material, which is abundantly found in the form of its ore **Bauxite (5th largest reserves in the world) in India.** Aluminium-air batteries also have an advantage of a **higher energy density than Lithium.** However, they suffer from the limitation of **not being rechargeable, therefore, requiring constant change.**
- **Multi-ion Batteries:** They have an energy density of 170 Watt hour per kg and are cheaper than Lithium-ion batteries. They also have the added advantage of **faster recharge as they require hardly 15 minutes for a full charge**. They use negative ions like hexafluorophosphate or tetrachloroaluminate, along with positive ions like sodium, potassium and magnesium.
- **Liquid Metal Battery Technology:** This technology has been patented by a US-based startup, Ambri, in which Reliance has invested. It has a **liquid calcium-alloy anode, a cathode comprising solid antimony particles and an electrolyte of molten salt.** It produces energy on heating to a temperature of 500 degrees Celsius.

Way Forward

- **Investments:** Energy storage systems are going to be in a huge requirement given the underlying shift towards cleaner energy and electric mobility. Therefore, it is critical to stay ahead of the curve by investing in the Research and Development of the sector. In fact, in 2021, the Government of India came up with a **Production linked Incentive scheme,**

promoting manufacture, export and storage of lithium-ion cells, with an outlay of Rs 18,100 Crore.

- **Shift of Focus on Stationary Energy Systems:** At the same time, focus needs to shift from electric vehicle storage systems to stationary storage systems as **they do not necessarily suffer from space constraints** like the electric mobility systems. Such systems may focus their research on being cost-effective, scalable and safer as they are allowed to compromise on the energy intensity.
- **Storing Renewable Energy:** Stationery energy systems can harness the power of the country's installed energy capacity in renewable energy, which is already undergoing huge expansion. Solar power and wind power have a **limitation of not being available round the clock and throughout the year**. They will get a huge boost if they can be stored and used at the time of requirement.
- **Application based Research:** Many technologies which are undergoing research seem promising. However, it is important to keep in mind that they are effective only when they are able to **prove their effectiveness in real-life situations**. They also need to be compatible with the grid and must respond well to signal changes such as charge or discharge.
- **Recycling:** Due to its generally hazardous nature, a comprehensive ecosystem, aimed at maximum recycling of battery systems is the need of the hour in the country. Also, since the storage systems require use of Lithium and other rare-earth elements, it would be highly cost-effective to put these systems to reuse. In fact, a study points out that **one-third of India's future needs can be met by recycling Lithium-based gadgets**.

Conclusion

- Solar and wind energy hold immense potential in a tropical country like India. However, there is a need to ensure that any attempt to harness renewable energy is not at the cost of loss of biodiversity in the country. Innovation is required to **balance the need for harnessing the renewable energy, while still maintaining the natural areas in pristine condition.**
- The need for energy storage systems would continue to grow in the coming years. In such a situation, it is critical to **be an early mover and seize the opportunity**, which is going to dominate the upcoming future. The government needs to move fast to **provide funding and promote research** in the new technologies to help in the progress of energy efficiency in the country.

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All the Best to all my students...
Hope this material will help you.
God bless...
Jai Hind