SCIENCE AND TECHNOLOGY

❖ **Understanding the fusion energy breakthrough announced by US scientists**

➢ **CONTEXT: Scientists in the United States have, for the first time, achieved a net gain in energy from a nuclear fusion reaction, seen as a big step forward in the decades-old endeavour to master a technology that is considered the most dependable source of energy in future.**

- Fusion is a different, but more powerful, way of harnessing the immense energy trapped in the nucleus of an atom. This is the process that makes the Sun and all other stars shine and radiate energy.
- Attempts to master the fusion process have been going on at least since the 1950s, but it is incredibly difficult and is still at an experimental stage.
- The nuclear energy currently in use across the world comes from the fission process, in which the nucleus of a heavier element is split into those of lighter elements in a controlled manner.
- In fusion, nuclei of two lighter elements are made to fuse together to form the nucleus of a heavier atom.
- A large amount of energy is released in both these processes, but substantially more in fusion than fission.
- For example, the fusion of two nuclei of a heavier isotope of hydrogen, called tritium, produces at least four times as much energy as the fission of a uranium atom which is the normal process of generating electricity in a nuclear reactor.
- Besides greater energy yield, fusion is also a carbon-free source of energy, and has negligible radiation risks.
- Fusion reactions happen only at very high temperatures, 10 times the temperature that exists at the core of the Sun, and creating such an extreme environment in a laboratory requires huge amounts of energy.
- So far, the energy released in such experimental fusion reactions have been lower than what is consumed to create the enabling high temperatures. At best, some of these reactions have produced 'near break-even' energies.
- That is why the latest experiment conducted at the Lawrence Livermore National Laboratory in California is being considered a big deal.

➢ **Fusion still far from reality**

- Significant though the achievement is, it does little to bring the goal of producing electricity from fusion reactions any closer to reality. By all estimates, use of the fusion process for generating electricity at a commercial scale is still two to three decades away. The technology used in the US experiment might take even longer to get deployed.
- There are at least two different ways in which fusion reactions are being experimented with. These differ mainly in the way the input energy is supplied to create the extreme heat to enable fusion, but that also results in differences in design and capabilities.
- At the Lawrence Livermore facility, scientists use high-energy laser beams to achieve those temperatures, also called 'inertial fusion'. At some other places, including the international collaborative project in southern France called ITER in which India is a partner, very strong magnetic fields are used for the same purpose.
- According to ITER India "It is relatively easier to attain break-even energy levels through inertial fusion compared to magnetic fusion. Obtaining net energy gain is a very important step, but we are still far away from reactor grade fusion reactions. There are many challenges to be overcome before the potential of fusion reaction is realised.
- According to current timelines, the ITER project is expected to demonstrate the viability of a commercially scalable nuclear fusion reactor between 2035 and 2040. The actual deployment of a fusion reactor for generating electricity could take another decade after that.
- Several countries, like China, Japan, UK and South Korea, are working on this technology separately as well, apart from collaborating at ITER. it is the magnetic fusion that is expected to deliver the fusion reactors first.
- Still, the United States, also a partner at ITER, and some other countries including China, are trying the laser-based inertial fusion as well. This is mainly because this technology can also be used to develop fusion-based nuclear weapons that would be far more powerful and devastating than the current nuclear weapons.

➢ **Incremental progress**

- In December 2021, UK-based JET laboratory, which uses magnetic fusion, had improved its own previous record for the amount of energy produced from a fusion reaction. The reaction had run for five seconds and produced 59 megajoules of energy, more than double the previous record.
- The fusion reactions currently being run in labs last for barely a few seconds.
- Those based on laser beams run for even shorter times. It is difficult to sustain such extreme high temperatures for prolonged periods. The ITER project was being designed to run for 3,000 seconds. At its

Plot-1441, Opp. IOCL Petrol Pump, CRP Square, Bhubaneswar-751015
Ph.: 8984111101, 8093083555. Web: www.vanikias.com, E-mail: vaniksias@gmail.com

full power, it was expected to produce five times more energy than it would consume. However, when run for shorter time periods, about 300-500 seconds, it could release10 times the energy consumed.

- According To experts it is not that there is any physical limit to how long a fusion reactor can run. Magnetic fusion reactions can run for hours. But there are lots of engineering challenges right now.
- ITER, when operational, would become the biggest machine anywhere in the world, more complex than the Large Hadron Collider at CERN, or the LIGO project to detect gravitational waves. Right now, the ITER reactor is in the machine assembly phase. Over 10 million parts, being manufactured and tested in the seven member countries, have to be transported, assembled and integrated.
- India joined the ITER project in 2005. The Institute for Plasma Research in Ahmadabad, a laboratory under the Department of Atomic Energy, is the lead institution from the Indian side participating in the project. As a member country, India is building several components of the ITER reactor, while also carrying out a number of experiments and R&D activities related to the project.

PRELIMS

1. 'Futuristic' Energy Conservation Bill

➢ **CONTEXT: Recently, the Rajya Sabha passed the Energy Conservation (Amendment) Bill, 2022, clearing the decks for "mandate use of non-fossil sources", including green hydrogen, green ammonia, biomass, and ethanol for energy and feedstock and establishing carbon markets in the country.**

- The Bill aimed to bring large residential buildings, with a minimum connected load of 100 kilowatt (kW) or contract demand of 120 Kilovolt Ampere (kVA), within the fold of the Energy Conservation regime.

➢ **Provisions**

- Minimum share of consumption of non-fossil: Specify minimum share of consumption of non-fossil sources by designated consumers as energy or feedstock;
- Carbon credit trading scheme: Carbon credit certificates shall be issued by the central government or any authorized agency to the entities that would need to comply under the scheme. These organizations have the option to buy and sell certificates depending on their needs.
- Large residential buildings: Coverage of large residential buildings within the fold of the Energy Conservation regime; and Enhance the scope of the Energy Conservation Building Code to include sustainability aspects.
- The allotment of regulatory powers of State Electricity Regulatory Commissions.
- Amendments in the governing council of the Bureau of Energy Efficiency (BEE).
- The scope has been expanded to include Vehicles (Motor Vehicles Act 1988) and Vessels (ships and boats), according to the bill.
- Penalty: A penalty of up to Rs 10 lakh in case of failure of compliance.
- It will attract an additional penalty of twice the price of the oil equivalent of energy consumed above the prescribed norm.

➢ **Impact**

- Meet Energy standards: The new regulations would give the government the authority to impose import or manufacturing restrictions on any automobiles or vessels that do not meet the required energy standards.
- Reduced consumption of fossil fuels: Buildings would have to make sure that at least a portion of its overall energy usage is derived from non-fossil fuels or renewable resources.
- This would increase demand for renewable or other non-fossil fuels and assist in reducing the amount of energy based on fossil fuels consumed in the economy.

➢ **Concerns**

- The Opposition said that the Bill was ultra vires of the Energy Conservation Act, 2001.
- The current Bill deals with protecting the environment and preventing climate change caused by using fossil and non-fossil fuels to generate electricity, whereas the Energy Conservation Act of 2001 deals with saving energy.
- The purpose and object of the current Bill are not included in the original Acts scope and objective.
- Lack of coordination: The State Governments have been granted authority under the Act to discharge a different set of tasks from those that the Central Government does.
- A coordinated strategy between the Central Government and the State Government is missing, each State Government will operate independently hampering coordination.
- Centralization: With only five proposed State delegates, the Bureau of Energy Efficiency would be unable to receive the majority of the states' opinions.
- R&D: The government needs to enable some successful research and development and pilots on the ground before setting targets of such fuels for industries. This will bring about a clear picture of their technical and financial feasibility.

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Ph.: 8984111101, 8093083555. Web: www.vanikias.com, E-mail: vaniksias@gmail.com

2. SVAMITVA scheme

➢ **CONTEXT: Dr Jitendra Singh said, under the Modi Government's SVAMITVA scheme, geospatial technology along with Drones will survey all the over 6 lakh Indian villages and at the same time, pan-India 3D Maps will be prepared for 100 Indian cities.**

- Survey of Villages And Mapping with Improvised Technology in Village Areas (SVAMITVA) is a Central Sector Scheme.
- It was launched on the National Panchayati Raj Day in 2020.
- It is being implemented with the collaborative efforts of the Ministry of Panchayati Raj, State Revenue Department, State Panchayati Raj Department, National Informatics Centre and Survey of India (SoI).
- It has been approved for implementation at an outlay of Rs. 566.23 crore across the country in a phased manner over five years (2020-2025).

➢ **Aim:** To demarcate inhabited lands in rural areas through the latest surveying drone technology.

- To provide the 'Record of Rights' to village household owners possessing houses in inhabited areas in villages with the issuance of legal ownership rights (Property cards/Title deeds).
- To facilitate monetization of properties of the citizens of rural India by enabling them to use their property as a financial asset by taking loans and other financial benefits

➢ **Significance:** It has the potential to transform rural India and will ensure streamlined planning, revenue collection and provide clarity over property rights in rural areas.

- The scheme has also provided a boost to the ecosystem of drone manufacturing in the country.

3. Rashtriya Gokul Mission

➢ **CONTEXT: The Department of Animal Husbandry & Dairying, under Rashtriya Gokul Mission has released funds for setting up of 16 "Gokul Grams" with the aim of conservation and development of indigenous bovine breeds in a scientific and holistic manner.**

- The Rashtriya Gokul Mission focuses on the conservation of the indigenous bovine breeds for improving milk production and productivity in the country. This mission was launched in December 2014.

➢ **Objectives**

- To Conserve and develop the indigenous breeds.
- The mission focuses on the improvement of the breed, which also results in improving the genetic makeup.
- To increase and improve milk productivity and production.
- Use of elite indigenous breeds like Rathi, Deoni, Gir, Sahiwal, Tharparkar, Red Sindhi for upgrading nondescript cattle.
- To distribute high genetic disease, free merit bulls for natural service.

➢ **Initiatives under Rashtriya Gokul Mission**

- Several cattle development centres were established to develop indigenous breeds with proper health. These development centres were known as Gokul Grams.
- The government initiated many different awards for the farmers to encourage them to work hard and to rear these indigenous breeds.
- The Gopal Ratna was awarded to the farmers for the best management of their Indigenous Breed and maintenance of them. Kamdhenu was awarded for the trustor NGO which best managed Indigenous herds.
- A centre was established for the development and conservation of indigenous breeds in a scientific way known as the National Kamdhenu Breeding Centre (NKBC).
- The government decided to launch it in the e-markets, a portal for connecting the breeders and farmers. This e-market portal was known as 'E-Pashu Haat – Nakul Prajnan Bazaar'.
- To Use advanced reproductive technology to get free from female bovine disease. This technology includes an In-vitro Fertilization (IVF) and Multiple Ovulation Embryo Transfer (MOET) which is useful for the female cattle.
- The government decided to Establish the National Bovine Genomic Center for Indigenous Breeds (NBGC-IB).

➢ **What are Gokul Grams?**

- The Rashtriya Gokul Mission focuses on the development of integrated indigenous cattle centres. These cattle centres are known as Gokul Grams. Where, 14.5% of India houses the world cattle population, out of which 83% of the population is indigenous.

➢ **Objectives of Gokul Gram:**

- Gokul gram aims at promoting indigenous cattle rearing and also their conservation, but all this is done scientifically.
- It is propagating the Usage of indigenous breeds for high genetic merit bulls.
- Promoting standard resource management along with Development of the modern farm management practices,

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- To economically use animal waste.
- Setting up of Biogas Plant was also included as one of the component under Gokul Grams

➢ **What are the Roles and responsibilities of Gokul Grams?**

- The Gokul grams have to be development centres for Indigenous Breeds and a source that supplies high genetic breeding stock to the farmers in the breeding tract.
- The Gokul grams will be self-sufficient and will also generate economic resources from the sale of A2 milk, from organic manure, vermicomposting, urine distillates, and production of their own electricity from biogas for in consumption within the Gokul gram and sale of animal products.
- The Gokul grams will be used as a situ training centre for Farmers, Breeders, and MAITRI.
- The gram will contain milch and unproductive animals and will have a maximum capacity of 1000 animals, whereas the milch and unproductive animals will be in the ratio of 60:40. All the animals will get all their Nutritional requirements by fodder production in the Gokul Gram.
- Gokul grams in the Metropolitan areas will focus on genetic up-gradation and the quality of urban cattle.

4. <u>Pradhan Mantri Kisan Sampada Yojana (PMKSY)</u>

➢ **CONTEXT: Minister of State for Food Processing Industries, gave data on the scheme to Loksbha by written reply**

- The Ministry of Food Processing Industries (MoFPI) has been implementing an umbrella scheme, namely, Pradhan Mantri Kisan Sampada Yojana (PMKSY) since 2017-18 across the country.
- PM Kisan SAMPADA Yojana focuses on developing the country's food processing industry to provide better payback to farmers.
- It is a global aim to manufacture the latest and modern infrastructure with proper management from farms to retail outlets.
- The Pradhan Mantri Kisan Sampada Yojana will help in creating many job opportunities in the rural areas, doubling the farmers' income, increasing the processing level, reducing wastage of agricultural produce, and enhancing the export of processed foods
- PMKSY is a comprehensive package of sub-schemes viz.
    - ✓ Mega Food Parks
    - ✓ Integrated Cold Chain and Value Addition Infrastructure
    - ✓ Food Safety & Quality Assurance Infrastructure
    - ✓ Creation/ Expansion of Food Processing and Preservation Capacities
    - ✓ Creation of Infrastructure Development for Agro Processing Cluster
    - ✓ Creation of Backward and Forward Linkage
    - ✓ Human Resource and Institutions, which results in creation of modern infrastructure with efficient supply chain management from farm gate to retail outlet.

➢ **Implementation**

- The Ministry has approved nearly 42 Mega Food Parks and 236 Integrated Cold Chains of Food Processing Industries to create a modern infrastructure for the food processing to value it.
- The government is initiating things to enhance the food processing sector to reduce and bring down post-harvest waste.
- The Pradhan Mantri Kisan Sampada Yojana intends to spot the agro clusters and give them subsidies for the easy transfer of food products from the manufacturer to the market.
- SAMPADA focuses on linking and removing the gaps between the supply chains so that they can function normally. It also focuses on the expansion and spread of the existing food processing unit.
- This yojana will help the farmers by increasing their wages and income, new employment opportunities, reviving the export of processed food, and reducing food wastage.
- The scheme aims to create processing units as it includes all the necessary things and will boost the food processing sector in India.
- The Indian government has also taken other important steps by allowing 100% FDI in e-commerce of food products manufactured in India to boost the food processing sector.

ANSWER WRITTING

Q. Discuss the role of the Election Commission of India in the light of the evolution of the Model Code of Conduct.

The Election Commission of India (ECI) is an autonomous constitutional body responsible for administering Union and State election processes in India. In the context of free and fair elections, Model Code of Conduct (MCC) plays a crucial role.

The Model Code of Conduct is a set of guidelines issued by the Election Commission to regulate political parties and candidates prior to elections. MCC is operational from the date on which the election schedule is announced until the date of result announcement.

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Evolution of Model Code of Conduct

- The origins of the Model Code of Conduct lie in the Assembly elections of Kerala in 1960, when the State administration prepared a 'Code of Conduct' for political factors.
- In the Lok Sabha elections of 1962, the Election Commission of India circulated the code to all recognized political parties and State Governments, and it was followed.
- In 1991, the Election Commission decided to enforce the Model Code of Conduct more strictly because of repeated flouting of the election norms and continued corruption.

Role of ECI in the Enforcement of MCC

- As part of its mandate to conduct free and fair elections under Article 324 of the Constitution, the Election Commission ensures that ruling parties at the Centre and in States adhere to the code.
- In case of electoral offences, malpractices, and corrupt practices like inducements to voters, bribery, intimidation or any undue influence, the Election Commission acts against violators.
- The Election Commission has devised several mechanisms for efficient enforcement of MCC such as:
    - Joint task forces of enforcement agencies and flying squads.
    - Introduction of the c-VIGIL mobile app through which audio-visual evidence of malpractices can be reported.

Model Code of Conduct does not have any statutory backing, it has come to acquire strength in the past decade because of its strict enforcement by the Election Commission. The various technological advancement has presented new challenges in the path of ensuring fair elections, but initiatives took by the Election Commission regarding the enforcement of model code of conduct seem to have been fruitful.

MCQs

1. Consider the following statements related to Pradhan Mantri Kisan SAMPADA Scheme Yojana:
    1. The Scheme is under Union Minister of Agriculture
    2. It is a Central Sponsored Scheme.
    3. The Scheme aims to reduce agricultural waste.
    4. Operation Greens is a sub-component of this scheme.

Which of the above statement/s is/are correct?

a) 1 and 2 only
b) 2 and 3 only
c) 2 and 4 only
d) 3 and 4 only

2. Consider the following statements about the "Rashtriya Gokul Mission":
    1. It is a sub-mission under the National Livestock Mission
    2. The mission aims to support cattle breeding in the country through technical & non-technical manpower.
    3. The mission is being implemented through National Livestock Development Board

Which of the above statements is/are correct?

a) 1 and 2 only
b) 2 only
c) 2 and 3 only
d) 3 only

3. Consider the statement in regard to the SVAMITVA scheme.
    1. The aim of this scheme is to update rural land records, providing a record of rights to village households and issue property cards.
    2. SVAMITVA is a central scheme of the Ministry of Panchayati Raj and Rural Development.
    3. This scheme to be implemented across the country in a phased manner over a period of six years (2020-2026).

Which of the above statement/s is/are not correct?

a) 1 and 2 only
b) 2 and 3 only
c) 1 and 3 only
d) 3 only

4. With reference to Nuclear energy, consider the following statements:
    1. Fission generates several times greater energy than Fusion.
    2. Fusion doesn't produce highly radioactive fission products.

Which of the following statements given above is/are correct?

a) 1 only
b) 2 only
c) Both 1 and 2

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d) Neither 1 nor 2

5. Consider the following statements regarding Bureau of Energy Efficiency (BEE).
   1. Bureau of Energy Efficiency (BEE) is a statutory body whose primary objective is to reduce the Indian economy's energy intensity.
   2. BEE gives financial assistance to institutions for promoting efficient use of energy and its conservation.
   3. The items covered under the Star Labeling Programme includes Deep Freezers, Light Commercial Air Conditioners, Domestic Gas Stove, Ballast and Microwave Oven.

Which of the above statements is/are correct?
   a) 1 and 2 only
   b) 1 and 3 only
   c) 2 and 3 only
   d) 1, 2, 3

6. Which of the following schemes was launched to quickly help the oppressed women victims of domestic and other violence?
   a) One stop centre was established.
   b) Manodhairya scheme was started.
   c) Provision of Nirbhaya funds.
   d) Started the scheme of Swadhar Gruha Yojana.

7. With reference to National Energy Conservation Day consider the followings
   1. India celebrates National Energy Conservation Day on December 14.
   2. The date December 14 was chosen because Bureau of Energy Efficiency (BEE) was established on that day.
   3. National Energy Conservation Day is commemorated to raise awareness of the value of energy and the need to conserve it by using less of it.

Which of the above statement/s is/are not correct?
   a) 1 and 2 only
   b) 2 only
   c) 2 and 3 only
   d) 3 only

8. Consider the following statements with respect to Central Ground Water Authority (CGWA)
   1. It was constituted under the Environment (Protection) Act, 1986.
   2. It is the only agency to issue No Objection Certificates (NOC) for ground water withdrawal in India.

Which of the statement/s given above is/are correct?
   a) 1 only
   b) 2 only
   c) Both 1 and 2
   d) Neither 1 nor 2

9. "Piezometer" is an instrument recently seen in news, used to measure which of the following?
   a) Atmospheric pressure
   b) Liquid pressure
   c) Infra-red radiation
   d) Salinity of solutions

10. Consider the following statements:
   1. Energy Intensity is calculated by taking the ratio of energy use (or energy supply) to gross domestic product (GDP).
   2. The smaller the energy intensity ratio is, the lower the energy intensity of a particular nation.

Which of the above statements is/are correct?
   a) 1 only
   b) 2 only
   c) Both 1 and 2
   d) Neither 1 nor 2

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