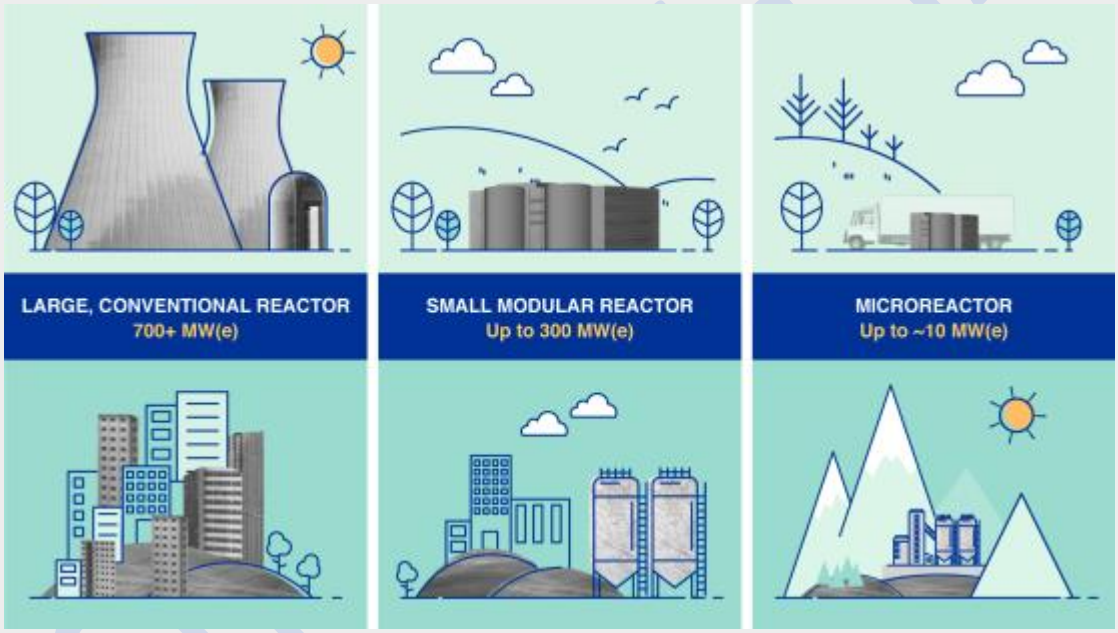
1. Union Budget 2025-26 push towards Civil nuclear energy

Introduction

The Union Budget 2025-26 outlines a significant push towards nuclear energy as part of India's long-term energy transition strategy. The government has set an ambitious target of 100 GW nuclear power capacity by 2047, positioning nuclear energy as a major pillar in India's energy mix. As of January 30, 2025, India's nuclear capacity is 8180 MW.

Small Modular Reactors (SMRs)

A key highlight of the Union Budget 2025-26 is the launch of a Nuclear Energy Mission, which is focused on research and development (R&D) of Small Modular Reactors (SMRs). The government has allocated ₹20,000 crore for this initiative, aiming to develop at least five indigenously designed and operational SMRs by 2033.



Small modular reactors (SMRs) are advanced nuclear reactors that have a power capacity of up to 300 MW(e) per unit, which is about one-third of the generating capacity of traditional nuclear power reactors. SMRs, which can produce a large amount of low-carbon electricity, are:

- **Small** – physically a fraction of the size of a conventional nuclear power reactor.
- **Modular** – making it possible for systems and components to be factory-assembled and transported as a unit to a location for installation.
- **Reactors** – harnessing nuclear fission to generate heat to produce energy.

Bhabha Atomic Research Centre (BARC) is developing Small Modular Reactors (SMRs) in India.

Bharat Small Reactors

The government is also actively expanding its nuclear energy sector by developing Bharat Small Reactors (BSRs) and exploring partnerships with the private sector. BSRs are 220 MW

Pressurized Heavy Water Reactors (PHWRs). These reactors are being upgraded to reduce land requirements, making them suitable for deployment near industries such as steel, aluminium, and metals, serving as captive power plants to aid in decarbonization efforts.

The plan involves private entities providing land, cooling water, and capital, while the Nuclear Power Corporation of India Limited (NPCIL) handles design, quality assurance, and operation and maintenance, all within the existing legal framework.

Relevance: GS Prelims; International Relations
Source: PIB

2. International Big Cat Alliance (IBCA) officially comes into force

Introduction

In a major development, the Framework Agreement on establishment of the International Big Cat Alliance (IBCA) has officially come into force. From 23rd January, 2025, the IBCA and its Secretariat have become a full-fledged treaty based inter-governmental international organization and international legal entity.

Member Countries

As of now, 27 countries including India have consented to join IBCA. The five countries namely Nicaragua, Eswatini, India, Somalia and Liberia have signed the Framework Agreement to formally become members of the IBCA.

About the IBCA

The IBCA was launched in 2023, during the event 'Commemorating 50 years of Project Tiger'. The headquarters of IBCA are in India. It was launched with the aim of conservation of seven big cats - Tiger, Lion, Leopard, Snow Leopard, Cheetah, Jaguar and Puma – with membership

of all UN countries/the range countries harbouring the said species and non-range countries where historically these species are not found but interested to support big cat conservation. The IBCA was established by Government of India, through the nodal organisation viz., National Tiger Conservation Authority (NTCA), Ministry of Environment, Forest & Climate Change (MoEFCC).

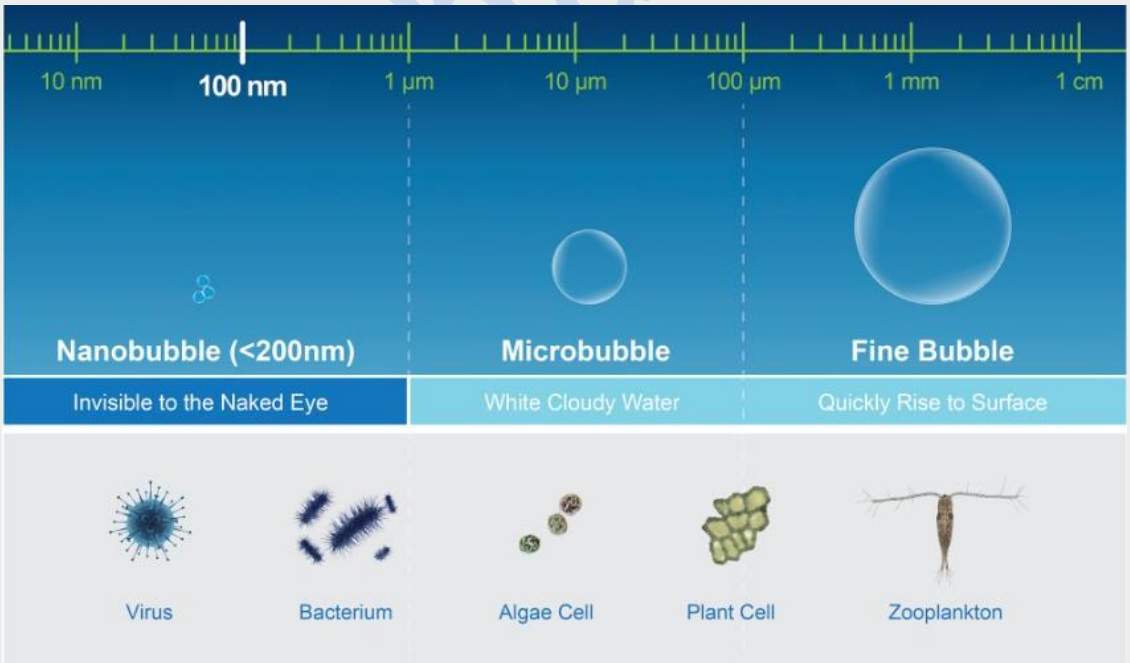
The IBCA will facilitate collaboration and synergy among stakeholders, consolidating successful conservation practices and expertise to achieve a common goal of conservation of big cats at global level. This unified approach, bolstered by financial support, aims to halt the decline in big cat populations, and reverse current trends.

Relevance: GS Prelims & Mains Paper III; Environment
Source: PIB

3. Nano Bubble Technology: A Breakthrough in Water and Gas Transfer

Why in News?
Union Minister of State for Environment, Forest and Climate Change gave reply on Nano Bubble Technology in Lok Sabha.

What Are Nanobubbles?
Nanobubbles are microscopic gas bubbles, only 70-120 nanometers in size—about 2,500 times smaller than a grain of salt. Unlike larger bubbles, which quickly rise to the surface and burst, nanobubbles remain suspended in liquids for long periods. They can be created using any gas, such as oxygen or nitrogen, and injected into any liquid, making them highly versatile.



Key Properties of Nanobubbles
1. Large Surface Area

Because nanobubbles are so small, they have a much higher surface area compared to their volume. This means more gas is exposed to the surrounding liquid, allowing for efficient gas exchange.

This property is especially useful in applications like oxygenation, where a higher surface area increases the amount of dissolved oxygen in water.

2. Brownian Motion
Nanobubbles do not rise to the surface like regular bubbles. Instead, they move randomly due to a phenomenon called Brownian motion. Brownian motion is the random movement of tiny particles in a liquid or gas, first observed in 1827 by Scottish botanist Robert Brown. This phenomenon occurs because molecules in a fluid are constantly moving and colliding with each other.

This random motion helps distribute oxygen and other gases evenly throughout a liquid, preventing oxygen loss and ensuring dissolved oxygen levels remain stable for long periods.

3. High Oxygen Transfer Efficiency
Traditional aeration methods, like air pumps or diffusers, lose much of the oxygen they inject because large bubbles rise and escape into the air.

Nanobubbles, however, stay in the water longer due to their small size and high stability, allowing up to 90% of the oxygen to be absorbed into the liquid. This makes nanobubbles much more efficient than conventional methods.

4. Surface Charge
Nanobubbles carry a strong negative charge, which repels other negatively charged particles in water. This property enhances the separation of suspended impurities in processes like wastewater treatment, making it easier to remove contaminants.

In industries such as oil and gas, nanobubbles improve separation efficiency, reducing the need for additional chemicals.

Uses
Nanobubbles offer superior performance compared to traditional aeration or gas transfer methods, making them useful in various industries:

1. Water Treatment
Their ability to efficiently dissolve oxygen helps break down organic pollutants, kill bacteria, and remove contaminants without requiring harmful chemicals.

2. Cleaning
Nanobubbles can penetrate tiny pores and crevices, effectively dislodging stubborn dirt and biofilms that traditional cleaning methods may miss.

3. Agriculture & Aquaculture

Supplying oxygen-rich nanobubbles to crops or aquatic life improves their growth, health, and resilience. Higher oxygen levels lead to better root development in plants, stronger immune systems in fish, and improved nutrient absorption. Nanobubbles also reduce the need for fertilizers, pesticides, and antibiotics, making farming more sustainable.

4. Oil & Gas Industry
In oil extraction, nanobubbles improve the flow of fluids in underground reservoirs, reducing the need for excessive chemicals and increasing oil recovery efficiency.

5. Skin & Hair Care
Nanobubbles help skincare products absorb more effectively into the skin, promoting hydration and improving overall skin health. Their deep-cleaning ability also makes them useful in hair treatments, helping remove residues and improving scalp health.

Relevance: GS Prelims & Mains Paper III; Science & Technology
Source: PIB