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India-Canada Uranium Deal and India's Nuclear Programme

Mains: *GS III – Energy*

Why in News?

Recently, India signed a CAD 2.6 billion uranium supply agreement with Canadian uranium giant Cameco and The deal will ensure the supply of approximately 10,000 tonnes of uranium between 2027 and 2035.

What is India's uranium resources, stockpiles and imports?

- **Reserves & stockpiles** – India possesses both domestic uranium reserves and imported stockpiles to meet the requirements of its nuclear energy programme.
- Domestically, India has 4.2–4.3 lakh tonnes of uranium ore, primarily located in mining regions such as Jaduguda, Turamdih in Jharkhand, and Tummalapalle in Andhra Pradesh.
- **Issues with Indian uranium** – The extractable uranium metal from these ores is estimated to be only 76,000–92,000 tonnes.
- The significant difference between ore quantity and extractable metal arises from the low grade of Indian uranium deposits, which contain only 0.02–0.45% uranium concentration.
- In contrast, uranium deposits in Canada are much richer, with concentrations 10 to 100 times higher.
- Because of this limitation, India has increasingly turned to uranium imports, which currently meet about three-fourths of its civilian nuclear fuel requirements.

- **India's Uranium Import Strategy** – To ensure stable fuel supply, India has diversified its uranium import partners.
- **Leading partners** – Besides the Cameco agreement with Canada, India has supply arrangements with several uranium-producing countries.
- One key partner is Kazatomprom of Kazakhstan, one of the world's largest uranium producers.
- India also maintains supply agreements with Uzbekistan and Russia, both of which export low- to medium-grade uranium ore.
- **Strategic reserve** – In addition to diversifying supply sources, the Indian government is building a strategic uranium reserve capable of meeting five years of nuclear fuel requirements.
- This reserve is intended to shield the country from potential supply chain disruptions or geopolitical shocks.
- **Import vs extraction** – While importing uranium is economically cheaper than

domestic extraction, international regulations stipulate that imported uranium can only be used for civilian nuclear energy purposes and not for nuclear weapons.

- Consequently, India continues to mine uranium domestically to support its strategic nuclear deterrent.
- **Legal framework of the india-canada nuclear cooperation agreement** – The Cameco deal operates under the India–Canada Civil Nuclear Cooperation Agreement (NCA) signed in 2010.
- This agreement came after the Nuclear Suppliers Group granted India a waiver allowing it to participate in global nuclear trade despite not being a signatory to the Nuclear Non-Proliferation Treaty.
- The NCA includes provisions requiring India to provide "fissionable material accounts" to Canada.
- These reports track the use of imported nuclear materials to ensure they are used solely for civilian purposes.
- Critics have argued that this requirement represents a minor infringement on India's strategic autonomy.
- However, the agreement has also drawn criticism from another perspective.
- Some analysts contend that importing uranium for civilian reactors indirectly frees up India's domestic uranium resources, which can then be allocated for strategic or military purposes.

What are the uses of uranium in India?

- **Diverse role** – Uranium plays a central role in India's nuclear energy generation, research, and strategic programmes.
- **Present capacity** – Currently, India operates 24 nuclear reactors with a total installed capacity of around 9 gigawatts (GW).
- **PHWR** – A major portion of this capacity comes from 700 MW Pressurised Heavy Water Reactors (PHWRs), which use natural uranium as fuel.
- These reactors generate 6–7 GW of electricity, contributing roughly 3% of India's total electricity production.
- **Future goals** – The government has set an ambitious goal of expanding nuclear power capacity to 100 GW by 2047, aligning with India's long-term climate and energy security objectives.
- However, expansion has often faced challenges such as land acquisition issues, environmental concerns, and local protests.
- **Medical uses** – Uranium is also crucial for research reactors such as Dhruva reactor at Trombay, which produce medical isotopes like technetium-99m and iodine-131 used in diagnostic imaging and cancer treatment.
- These reactors also support advanced research in materials science and nuclear technology.
- **Small Modular Reactors** – India is also investing in next-generation nuclear technologies to diversify its nuclear power portfolio.
- In the Union Budget 2025–26, Finance Minister Nirmala Sitharaman allocated ₹20,000 crore for the development of Small Modular Reactors (SMRs).
- SMRs are compact nuclear reactors that typically use 3–5% enriched uranium and can be deployed more flexibly than conventional large reactors.

- They offer advantages such as lower upfront costs, enhanced safety features, and suitability for remote areas or industrial clusters.
- These reactors could play a significant role in India's strategy to expand nuclear energy while minimizing land use and public opposition.
- **Strategic and Military Applications** – Domestic uranium resources are also essential for India's strategic nuclear deterrent.
- India is estimated to possess around 170 nuclear warheads, which rely partly on domestically sourced uranium.
- Uranium is also used to fuel nuclear-powered submarines, including the Arihant-class submarine of the Indian Navy.
- These submarines form a crucial component of India's nuclear triad, ensuring a credible second-strike capability.

What is India's Three-Stage Nuclear Power Programme?

- **3 stage** – India's nuclear energy strategy is based on the three-stage nuclear power programme conceptualised by Homi J. Bhabha.
- This programme was designed to maximise the use of India's abundant thorium reserves, which constitute about 20–25% of the world's deposits.
- **Stage I** – Pressurised Heavy Water Reactors use natural uranium-235 as fuel to generate electricity. During this process, plutonium-239 is produced as a byproduct.
- **Stage II** – Fast Breeder Reactors use a mixed oxide fuel made of uranium-238 and plutonium-239.
- These reactors are called "breeders" because they produce more fissile material than they consume, generating additional plutonium and uranium-233.
- India's Prototype Fast Breeder Reactor at Kalpakkam is currently in an advanced stage of commissioning.
- **Stage III** – Advanced Heavy Water Reactors will use plutonium-239 and thorium-232 to produce electricity while generating uranium-233, which can sustain future nuclear fuel cycles.

What are the challenges and delays in the nuclear programme?

- **Delay & Cost issues** – Despite its strategic vision, India's three-stage nuclear programme has faced significant delays and cost overruns.
- The Fast Breeder Test Reactor at Kalpakkam was established in 1977, but approval for the Prototype Fast Breeder Reactor came only in the early 2000s, partly due to international sanctions imposed after India's nuclear tests.
- Moreover, the cost of the PFBR increased from ₹3,492 crore at the design stage to over ₹6,800 crore by 2019.
- **Structural challenges** – Experts, including former Department of Atomic Energy chairman Anil Kakodkar, have highlighted another structural challenge:
- The doubling time of fast breeder reactors, which refers to the time required for one reactor to generate enough fissile material to start another reactor.
- Currently, this period is estimated to be 15–20 years.
- Because multiple doubling cycles are needed to scale up nuclear power to 100 GW, India must secure large and stable uranium supplies, explaining its growing emphasis

on international uranium agreements.

What lies ahead?

- The India–Canada uranium deal represents an important step in securing the fuel supply required for India's expanding nuclear energy programme.
- By diversifying import partners while continuing domestic mining, India aims to balance energy security, strategic autonomy, and environmental sustainability.
- At the same time, the agreement underscores the complexities of nuclear diplomacy, non-proliferation commitments, and domestic technological challenges.
- As India transitions through the stages of its ambitious nuclear power programme, reliable uranium supply and technological innovation will remain critical to achieving the country's long-term goal of 100 GW nuclear power capacity by 2047.

Reference

The Hindu| Indian – Canada Uranium Deal