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Issue Brief

Building, Not Buying: India's HALEU Decision

Kavya Wadhwa

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Summary

Committing India to dedicated HALEU production is not yet warranted on demand grounds. Foreclosing the option, whether through enrichment capacity designed without margin or through a safeguards determination taken by default rather than deliberately, could however require a decade or more to reverse.

The investment approvals and fuel-cycle decisions before the Government of India will determine whether India's advanced-reactor ambitions of the 2040s are fuelled at all. Indian discussion of high-assay low-enriched uranium (HALEU), uranium enriched above 5 and below 20 per cent U-235 and the enabling fuel for a majority of advanced reactor designs under development worldwide, has nonetheless settled into a procurement framing.

The question is posed as one of access: which non-Russian producers are dependable, what offtake terms are achievable, and how soon agreements can be concluded. That framing misdirects attention towards negotiations that may not deliver on India's timetable, while deferring industrial decisions whose lead times can run to a decade or more. HALEU scarcity is not a market condition India can contract around. It is an industrial-capacity condition, and India's response must preserve the ability to build rather than assume it can buy.

What India Has, and What It Lacks

India's position is unusual and frequently misread. It is neither a newcomer nor a state that can purchase its way into the advanced fuel cycle. India possesses centrifuge competence, developed principally for strategic purposes, and a fuel-cycle industrial base covering conversion, fabrication and reprocessing that is deeper than that of almost any state outside the original nuclear suppliers. It also possesses a stated civil rationale for enrichment independent of HALEU. The Special Material Enrichment Facility at Chitradurga has been publicly framed for civilian applications, with slightly enriched uranium intended to raise burn-up in India's pressurised heavy water reactors.[1]

What India lacks is civil-scale capacity, and the distinction is not semantic. Enrichment for strategic requirements and enrichment for a commercial reactor fleet differ by orders of magnitude in separative work. Beyond the cascade, HALEU requires deconversion capability, fabrication lines matched to specific advanced-reactor fuel chemistries, and transport containers certified against a materially different criticality envelope. None of these is a marginal extension of existing pressurised heavy water reactor fuel work.

The legal architecture compounds rather than relieves this. The SHANTI Act, 2025 opens the construction, ownership and operation of nuclear power plants to private

[1] **"Countries: India"**, International Panel on Fissile Materials, 22 May 2026. It has been noted that India is planning an enrichment facility at Chitradurga for civilian applications. On the slightly enriched uranium and burn-up rationale, see the 2011 statement of the Chairman, Atomic Energy Commission, discussed in Mansoor Ahmed, **"Reactors, Reprocessing and Centrifuges: India's Enduring Embrace of Fissile Material"**, *South Asian Voices*, 26 June 2014.

and joint-venture participation under licence, but reserves enrichment and other core fuel-cycle functions to the state unless otherwise notified; it also permits selected private fuel-cycle activities up to thresholds set by government.[2]

The implication for HALEU is direct and insufficiently discussed: the private capital unlocked for reactor projects cannot automatically own or finance the enrichment bottleneck. Direct enrichment investment must still be sanctioned and anchored by the state, although private suppliers can participate in manufacturing, construction and services. Fuel-cycle capacity therefore remains a sovereign investment decision even as reactor capacity is opened to the market. Meanwhile, the Atomic Energy Regulatory Board, which the Act finally endows with statutory recognition, would need to develop safety cases, licence facilities, and certify transport packages for a much larger criticality envelope.

Nor is Indian demand yet established. The indigenous roadmap points towards thorium utilisation and fast reactors, while the lead small modular reactor designs are to operate on slightly enriched uranium within the existing architecture.[3] The high-temperature gas-cooled reactor being developed for hydrogen production is the indigenous design most likely to create demand in the HALEU band. However, its final fuel requirement has not been established publicly. Imported or collaborative advanced designs would bring their own requirements. The demand case is therefore real but contingent, which is an argument for preserving optionality cheaply rather than committing to either option.

Safeguards Is the First Gating Decision

The first consequential choice is not technical. India's enrichment competence resides on the unsafeguarded side of the separation plan, while Chitradurga has been publicly framed for civilian applications. Placing future HALEU-capable civil capacity under safeguards determines what forms of foreign partnership, downstream cooperation and eventual export participation are even feasible. It is necessary but not sufficient.

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[2] **"The Sustainable Harnessing and Advancement of Nuclear Energy for Transforming India (SHANTI) Bill, 2025"**, Press Information Bureau, Backgrounder, Government of India, 19 December 2025. On the reservation of enrichment, heavy water production and spent fuel management to the state notwithstanding private participation in plant ownership and operation, see Kavya Wadhwa, **"The SHANTI Bill: India's Nuclear Reforms and the Execution Challenge Ahead"**, Observer Research Foundation, 23 December 2025. The Act nevertheless permits exceptions by government notification and private activity up to notified thresholds. On the separate conditions governing transfers of enrichment facilities, equipment and technology, see **"Guidelines for Nuclear Transfers"**, paras 6–7, Nuclear Suppliers Group, July 2023.

[3] **"Minister Updates Parliament on Indian SMR Project"**, *World Nuclear News*, 7 August 2025. It reports the written answer of the Minister of State to the Lok Sabha that the BSMR-200 will use slightly enriched uranium fuel.

Nuclear Suppliers Group guidelines impose separate restrictions on transfers of enrichment facilities, equipment and enabling technology, including criteria India does not presently meet as a state outside the Nuclear Non-Proliferation Treaty (NPT). Safeguards could facilitate cooperation in non-sensitive components, deconversion, fabrication, transport and safeguards-by-design; they would not, by themselves, unlock centrifuge technology.

A HALEU line outside the civil sphere would sharply narrow collaboration; one inside it would constrain strategic flexibility. This is a Cabinet-level determination with implications across the Department of Atomic Energy, the Ministry of External Affairs, and the strategic establishment, and it logically precedes questions of the plant, cascade and licence beneath it. Deferring it does not preserve options. It delays the industrial decisions that depend on it.

The American Illustration

The assumption that partnership can substitute for capacity deserves testing against the experience of the state best placed to have proven it. The United States is a nuclear-weapon state under the NPT with no separation plan to negotiate, has legislated protection for domestic producers, holds surplus material available for downblending, operates the only licensed HALEU enrichment facility in the Western world, and has appropriated capital at scale. It remains short of fuel.

The arithmetic is unforgiving. Centrus closed out its Piketon demonstration contract in June 2026 with cumulative output slightly above 1,900 kilogrammes,[4] under two tonnes across roughly three years from a sixteen-machine cascade, against reactor first cores measured in tonnes. The successor commercial contract combines milestone payments for deploying commercial-scale capacity with a base obligation to deliver one metric tonne of HALEU by March 2032; Centrus says its initial build-out targets 12 tonnes of annual HALEU capacity, with first new capacity expected in 2029.[5]

Washington's near-term commitment of 21 tonnes, mandated by Congress, was to be met principally by drawing surplus material from federal stockpiles at Y-12, Savannah River and Idaho, supplemented by a downblending campaign that converted some 2.2 tonnes of highly enriched uranium into roughly 3.1 tonnes of

[4] **"Centrus Signs Contract with Department of Energy for $900 Million Award; Intends to Transition HALEU Production Cascade to Commercial Operation"**, Centrus Energy Corp., 1 July 2026.

[5] **"Centrus Signs $900M DOE Contract, Pivots Sole U.S. HALEU Cascade to Commercial Operation"**, *POWER Magazine*, 1 July 2026. It reports the terms disclosed in the Form 8-K filing.

HALEU over two to four years.[6] That is stockpile liquidation rather than supply-chain formation. Capital has not yet closed the gap either: the US$ 2.7 billion committed across three enrichment providers in January 2026[7] comprises milestone-based awards rather than immediately available plant and remains below the company estimate for Orano's single Oak Ridge facility.[8]

The reasons are instructive for Indian planning. Higher enrichment is a discontinuity rather than a simple increment. Producing HALEU towards the top of the band normally requires reconfigured or dedicated finishing cascades, process redesign for criticality-limited equipment sizes and a Category II security environment. Existing LEU facilities can be modified or augmented—as Urenco's sub-10-per-cent US expansion demonstrates—but near-20-per-cent commercial production is not a marginal increase in output assay.[9]

The binding physical constraint then shifts to centrifuge manufacturing and supply chain qualification. Domestic enrichers report lead times of three to four years for new cascades,[10] and centrifuges now being built in Tennessee are expected to come online in Ohio only in 2029.[11] This is why the substantive American announcements in 2026 focused on centrifuge factories rather than on fuel.[12]

The downstream is in worse condition than enrichment itself. There is no commercial-scale HALEU deconversion line in the United States. One commercial-quantity uranium hexafluoride transport package design has been approved for assays above 5 per cent, but it has not yet been manufactured at scale or become commercially available; fabrication remains fragmented by reactor chemistry, with each developer's fuel specification effectively bespoke.[13] Most pointedly for a debate

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[6] **"High-Assay Low-Enriched Uranium (HALEU)"**, World Nuclear Association, 11 February 2026.

[7] **"U.S. Department of Energy Awards $2.7 Billion to Restore American Uranium Enrichment"**, U.S. Department of Energy, 5 January 2026; See also **"DOE Awards USD2.7 Billion to Strengthen US Uranium Enrichment"**, *World Nuclear News*, 6 January 2026.

[8] **"US Department of Energy Selects Companies to Expand Domestic Enrichment Capacity"**, International Panel on Fissile Materials Blog, January 2026.

[9] **"Advanced Fuel Cycle Cost Basis Report: Module C3"**, Idaho National Laboratory, 2023. It notes that for HALEU uranium hexafluoride towards 19.95 per cent U-235, the process must be redesigned for criticality-limited equipment sizes and a Category II operating environment. On modification or augmentation of existing enrichment facilities, see **"Final HALEU Environmental Impact Statement"**, U.S. Department of Energy, October 2024.

[10] **"Landscape of U.S. Domestic Advanced Nuclear Energy Supply Chain"**, Nuclear Scaling Initiative and Solestiss, March 2026. It reports domestic enrichers' stated three to four year lead time for new cascades.

[11] **"Centrus to Expand Oak Ridge Centrifuge Manufacturing Plant to Facilitate Large-Scale Deployment"**, Centrus Energy Corp., 23 January 2026. It states that the first new centrifuges produced in Tennessee are expected to come online in Ohio in 2029.

[12] **"Two Companies Expand Centrifuge Development Centers at Oak Ridge"**, International Panel on Fissile Materials Blog, 26 January 2026. See also **"BWXT's Centrifuge Manufacturing Development Facility Opens in Oak Ridge"**, American Nuclear Society, 27 January 2026.

[13] **"Landscape of U.S. Domestic Advanced Nuclear Energy Supply Chain"**, no. 10. It reports on the absence of a commercial-scale HALEU deconversion line and the bespoke character of developers' fuel

in New Delhi that instinctively reaches for regulatory reform, enrichment industry participants describe the American regulator as predictable and not a barrier.[14] The constraint is industrial base, not statute.

Two Bridges India Cannot Use

Two mechanisms are currently masking Western scarcity, and neither is available to India. The first is downblending. States that reduced their arsenals after the Cold War declared quantities of highly enriched uranium in excess of defence requirements, and that this material now provides a near-term HALEU bridge, as the American drawdown from federal sites illustrates. India occupies a different position. Under a declared posture of credible minimum deterrence,[15] with a sea-based leg still maturing and naval propulsion requirements continuing to grow, no publicly available evidence establishes a surplus suitable for civil downblending.

Material committed to deterrence and propulsion is not a reserve that planners can assume is awaiting civil repurposing. India's only plausible domestic production route is therefore up-enrichment. The bridge currently softening Western scarcity cannot be assumed for India, making the industrial timeline the whole domestic timeline. This removes the buffer that allows others to defer industrial decisions while appearing to hold fuel.

The second is administrative allocation. Scarce American HALEU is distributed to domestic developers under a statutory allocation process, tied to pilot programmes established by executive order and conditioned on progress towards criticality.[16] Allocation is an instrument of industrial policy rather than a commercial market. India, as a state outside the NPT operating under a negotiated waiver, has no stated standing in that queue and cannot expect priority over domestic requirements. Supply assurance from a producer unable to satisfy its own developers is an option on a surplus that does not exist.

specifications. On transport, the NRC reported in April 2026 that one commercial-quantity UF6 package design for assays above five per cent had been approved, but manufacturing and commercial availability remained unresolved. See **"Federal Register"**, Vol. 91, No. 72, National Archives and Records Administration, United States of America.

[14] Ibid., recording an interviewee active in the enrichment sector describing the Nuclear Regulatory Commission as not a barrier, and the licensing process as clear and predictable.

[15] **"Cabinet Committee on Security Reviews Progress in Operationalizing India's Nuclear Doctrine"**, Press Information Bureau, Prime Minister's Office, Government of India, 4 January 2003.

[16] **"High-Assay Low-Enriched Uranium (HALEU)"**, no. 6. On the pilot programmes, see **"Reactor Pilot Program (established under Executive Order 14301)"**, U.S. Department of Energy; and **"Fuel Line Pilot Program (established under Executive Order 14299)"**. Both were expanded into the Nuclear Energy Launch Pad in March 2026.

The National Industrial Dividend

There is a further consideration that ought to weigh in the investment-approval calculus, and it argues for treating enrichment expansion as national industrial policy rather than a departmental energy project. India's naval propulsion trajectory, comprising the existing SSBN fleet, the projected SSN programme and any future decision on nuclear propulsion for an aircraft carrier, rests on the same underlying industrial competences that a civil enrichment expansion would develop.

Precision component manufacture at nuclear-grade, a qualified and audited vendor ecosystem, metallurgical and non-destructive inspection capabilities, specialist project management, and a trained technical workforce are not programme-specific assets. They are the shared foundation on which every reactor-related endeavour in the country draws, and they have historically paced Indian strategic timelines more than any scientific question has.

The point requires precision, because a loose version would be both analytically weak and diplomatically damaging. Capacity placed under safeguards to enable partnership is not available to the strategic programme. The separation plan governs facilities and material, and India's credibility with suppliers depends on that governance being observed rather than blurred.

The dividend, therefore, lies in the wider industrial base, not in shared plant, equipment, technical data, licences, or materials. A deliberately sequenced civil expansion can indirectly deepen the supplier pool, skilled workforce, high-precision manufacturing capability, regulatory practice and quality-assurance systems on which all reactor-related programmes draw. That is a substantial national return, and it is available without compromising the separation architecture, provided the sequencing is designed for it rather than arrived at by accident.

Sequencing India's Decision

Three propositions follow. First, resolve safeguards status early, as a political determination rather than a departmental one, because everything downstream waits on it. Second, measure progress in manufacturing throughput, vendor qualification and certified transport-package availability rather than in separative work units or enrichment know-how, since India already possesses the latter and the former is what binds. Third, and most usefully, recognise that a no-regrets option exists. India's near-term expansion of enrichment capacity for slightly enriched uranium is justified on conventional-fleet burn-up grounds, regardless of the HALEU question.

Designing that capacity with deliberate space and interfaces for reconfigured cascades, a segregated security envelope, deconversion capability and transport certification is likely to cost less than retrofitting later. However, the premium should be quantified before approval. Given that the demonstration unit of the Bharat Small Modular Reactor is expected to require six years from financial approval to erection and start-up, and a seventh before regular operation,[17] fuel availability in the 2040s is being determined by approvals issued now, largely without being recognised as such.

Conclusion

Committing India to dedicated HALEU production is not yet warranted on demand grounds. Foreclosing the option, whether through enrichment capacity designed without margin or through a safeguards determination taken by default rather than deliberately, could require a decade or more to reverse. The American case sets the benchmark against which Indian assumptions should be calibrated: legislation, appropriations and a cooperative regulator have not yet produced fuel at commercial scale.

India faces the same industrial constraint without the stockpile bridge that has softened it elsewhere, without stated standing in the queues through which scarce material is currently rationed, and without automatic access to the private capital being mobilised for reactor projects. The only HALEU India will be able to rely upon is HALEU India has built, or has deliberately preserved the capacity to build. The industrial base that decision creates will serve considerably more than the civil programme. That choice sits in the investment approvals and fuel-cycle files currently before government, not in the 2033 reactor milestone.

[17] **"Parliament Question: Progress of the Bharat Small Modular Reactor"**, Press Information Bureau, Department of Atomic Energy, Government of India, 3 April 2025.

About the Author

Mr. Kavya Wadhwa is a nuclear energy policy analyst working at the intersection of nuclear technology, strategic security, and energy policy.

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Manohar Parrikar Institute for Defence Studies and Analyses
1, Development Enclave, Rao Tula Ram Marg
New Delhi 110 010 India
T +91-11-2671 7983 F +91-11-2615 4191
www.idsa.in
Twitter @IDSAIndia
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