# INDIA-NAMIBIA LINKAGES: PARTNERING IN URANIUM SECTOR

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## Abstract

*In light of India's growing nuclear energy program and changing internatio nal nuclear governance, this study explores the strategic aspects of IndiaNa mibia collaboration in the uranium sector. The article is structured into five main sections. The first section outlines India's nuclear energy trajectory, highlighting its three-stage nuclear programme, rising electricity demand, and the structural constraints imposed by limited domestic uranium reserves. It also discusses the historical impact of India's exclusion from the Nuclear Non-Proliferation Treaty (NPT) and international nuclear trade regimes on the growth of its civilian nuclear sector. The second section examines India's reintegration into the international nuclear order after the 2008 Nuclear Suppliers Group (NSG) waiver. It focuses on nuclear liability frameworks, safeguards agreements, and civil nuclear cooperation agreeme nts that continue to influence foreign involvement in India's nuclear industry . The third section provides a comprehensive overview of the uranium industry in Africa, mapping key producing regions, emerging mining frontiers, and the geopolitical significance of African uranium in the global nuclear fuel cycle. Particular attention is given to the political economy of uranium extraction and the strategic competition among external powers for secure supplies. The fourth section focuses specifically on Namibia's uranium sector, examining its production capacity, regulatory regime, environmental governance, and growing role as a major global supplier. The final section evaluates the prospects and limitations of India–Namibia uranium cooperation. It highlights strong political symmetry and historical ties while critically assessing legal constraints arising from Namibia's commitments under the Pelindaba Treaty and India's non-NPT status.*

**Keywords:** African Uranium Resources, Global Nuclear Governance, India–Namibia Relations, Non-Proliferation Regime, Nuclear Energy Policy, Uranium Sector.

India and Namibia share a deep-rooted relationship since the Independence of Namibia. India was among the first nations to raise the question of Namibian independence in the UN, way back in 1946. According to annual bulletin of Ministry of External Affair, Government of India on India – Namibia Bilateral Relationship (2021), the first SWAPO (which led Namibia's liberation struggle) Embassy abroad was established in New

Delhi in the year 1986. India has accorded full diplomatic status and support at NAM to Namibia; which was further accompanied by material assistance and military training. India and Namibia enjoy warm and cordial relations. The Namibian people and leadership view India as a dependable and trusted friend. Indian support during their liberation struggle is warmly recalled by Namibian leaders. The bulletin further mentioned, after Namibian independence, the Indian Observer Mission was upgraded to a full-fledged High Commission on 21 March 1990. Namibia opened a full-fledged resident Mission in New Delhi in March 1994. The bilateral trade has shown a steady growth in recent years. It was US$813 million in 2023-24 with India's exports amounting to US$ 453 million. In the year 2024-25, the two-way trade touched US$ 568. India's exports were at US$327 million and imports from Namibia amounted to US$241million.Sectors of mining, energy, infrastructure development, health, education, agriculture and trade and investment offer potential for bilateral cooperation. The recent visits by multi-sector business delegations from India to Namibia took place in May/June and October 2023. Virtual business session on engineering goods held in September 2023 attracted considerable interest. India and Namibia established a Joint Trade Committee in 1995. India and SACU with Namibia as coordinator are negotiating a Preferential Trade Arrangement.

Pardesi and Ganguly (2009) in the book *India and Energy Security: A Foreign Policy Priority* mentioned that the growing convergence between India Namibia in Uranium sector. India–Namibia cooperation in the uranium sector reflects the convergence of India's long-term energy security needs and Namibia's position as a major global uranium producer. India faces structural constraints due to limited domestic uranium reserves and its non-signatory status to the Nuclear Non-Proliferation Treaty, making external uranium access essential for sustaining its expanding nuclear power programme. India is, however, endowed with small reserves of poor quality uranium ores, though large reserves of thorium ore. Consequently, India's nuclear-generation programme is based on a three stage plan-(a) Pressurised Heavy Water Reactors, (b) Fast Breeder Reactors and (c) Reactors based on the Uranium 233-Thorium 232 cycle, towards eventual exploitation of the country's vast thorium reserve (Pardesi and Ganguly, 2009, p.99).As a non-signatory to the Nuclear Non-Proliferation Treaty (NPT) and following nuclear tests in 1974 and 1998, India faced prolonged international sanctions that limited its access to nuclear materials and technology. Although these constraints have gradually eased, India's nuclear energy expansion continues to depend on

civil nuclear cooperation. In this context, Namibia and Africa more broadly have emerged as important strategic partners, offering India opportunities for collaboration in the uranium sector.

## India's Nuclear Energy Programme

World Nuclear Association, (2021*) India Uranium Sector yearly Briefing* mentioned India possesses a well-developed and largely indigenous nuclear power programme and had projected an installed nuclear capacity of 14,600 MWe by 2020, with nuclear energy expected to contribute nearly 25 per cent of total electricity generation by 2050. However, because of its nuclear weapons programme and non-signatory status to the Nuclear Non-Proliferation Treaty (NPT), India remained excluded from international nuclear trade for nearly 34 years. This prolonged isolation significantly constrained the growth of its civilian nuclear sector until 2009, limiting access to external technology, fuel, and cooperation.

Restricted international engagement, combined with limited domestic uranium resources, compelled India to pursue a distinctive nuclear fuel cycle strategy centred on its abundant thorium reserves. This approach prioritised long-term energy security, strategic autonomy, and technological self-reliance. Ministry of Environment, Forest and Climate change in its Environment Impact Assessment Report (2021) highlights India consequently invested heavily in indigenous capabilities, particularly in fast breeder reactor technology and thorium-based fuel cycles. In recent years, renewed access to foreign nuclear fuel and advanced reactor technologies following the opening of international nuclear trade is expected to accelerate nuclear expansion while retaining a high degree of indigenous engineering content. Leveraging its expertise in advanced reactor systems, India aspires to position itself as a global leader in next-generation nuclear technologies India has a population of over 1.4 billion and a fast-growing economy. Energy demand is expected to grow more in India than any other country over the next decade. India's priorities are economic growth and to alleviate poverty. As such, coal is to remain the largest source of energy supply until at least the middle of the century. At COP26 India pledged to cut its emissions to net zero by 2070 – the first time it made such a commitment. Nuclear energy plays an important role in the country's long-term energy strategy. The country has developed an indigenous nuclear power programme, based on a fuel cycle which aims to utilize the country's vast thorium reserves. In March 2018, the government stated that nuclear capacity would be about 22.5 GWe by the year 2031. This revised target was reaffirmed by Minister of State Jitendra

Singh in December 2022 and by the Department of Atomic Energy (DAE) in February 2025.

World Nuclear Association (2021) also mentioned India's electricity demand has expanded rapidly alongside economic growth and rising population. Although total power generation reached approximately 900 billion kilowatt-hours in 2009, per capita electricity availability remained relatively low at around 750 kWh, further constrained by transmission and distribution losses .Coal continues to dominate the energy mix, while gas and hydropower each account for roughly 12 per cent. Long-term projections suggest per capita electricity consumption could increase to 5,000–6,000 kWh by 2050, implying annual demand approaching 8,000 TWh and underscoring the importance of reliable base-load power.

In 2011, nuclear energy contributed only 3.7 per cent of electricity generation from an installed capacity of 4.4 GWe. Although nuclear output has increased modestly with improved access to imported uranium and new reactor construction, it remains a marginal component of the energy mix. India nevertheless aims to meet around 25 per cent of its electricity demand through nuclear power by 2050, a target that will require substantial investment in generation capacity, transmission infrastructure, and grid modernisation. World Nuclear Association, (2021) *Uranium in India* report examines India's civilian nuclear programme is structured around achieving full autonomy across the nuclear fuel cycle—a strategy shaped by decades of technological isolation. This autonomy spans uranium mining, fuel fabrication, heavy water production, reactor construction, reprocessing, and waste management. Prolonged exclusion from international markets contributed to low reactor capacity factors in the mid-1990s. Operational performance improved significantly thereafter, with capacity factors rising to nearly 85 per cent by 2001–02, before declining again during 2008–10 due to uranium shortages.

India operates a fast breeder reactor and continues to develop larger breeder facilities while advancing research on thorium-based reactors. However, India's nuclear liability framework remains a significant constraint on foreign participation, as it diverges from international conventions by exposing suppliers to extended liability. World Nuclear Association, 2021 further highlights the Civil Liability for Nuclear Damage Act, enacted in August 2010 amid heightened public sensitivity following the 1984 Bhopal gas disaster, assigns primary responsibility for nuclear accidents to operators and sets an overall liability cap of 300 million Special Drawing Rights (approximately US$450 million).

Operator liability is capped at ₹1,500 crore, with the central government assuming responsibility beyond this limit Crucially, the Act permits operators to seek legal recourse against suppliers for up to 80 years after plant commissioning if a nuclear incident is attributed to supplier fault, including defective equipment or substandard services. These provisions diverge from international liability conventions, which typically channel liability exclusively to the operator. In response to industry concerns, the Department of Atomic Energy clarified in 2011 that supplier liability claims would not exceed the compensation paid by the operator.

Subsequent Civil Liability for Nuclear Damage Rules further limited supplier exposure by capping liability at the lower of the operator's liability or the contract value, and restricting the right of recourse to the duration of the operating licence or product liability period. Despite these clarifications, foreign suppliers remained cautious. Negotiations with Russia on additional reactors at Kudankulam continued, albeit amid concerns over increased costs linked to liability provisions. Similar reservations were expressed by US-based vendors such as GE-Hitachi, Westinghouse, and Areva, with Westinghouse indicating it would defer participation until India ratified the Convention on Supplementary Compensation for Nuclear Damage (CSC).

India signed the CSC in October 2010, as envisaged under the 2008 civil nuclear understanding with the United States. However, the legislation does not explicitly shield suppliers from legal action in their home jurisdictions. India also lacks a dedicated nuclear insurance pool, partly due to constraints related to international inspection requirements imposed by global insurers. Historically, India's civilian nuclear sector functioned largely outside comprehensive International Atomic Energy Agency (IAEA) safeguards. Until 2009, only four nuclear power plants were subject to facility-specific safeguards under the INFCIRC/66 agreement. This changed in October 2009, when India's safeguards agreement with the IAEA became operational. The government subsequently committed to placing 14 reactors under safeguards by 2014.

World Nuclear Association, (2021) further mentioned India's status as a nuclear-armed state outside the NPT, combined with the absence of full-scope safeguards, had long excluded it from international nuclear trade under Nuclear Suppliers Group (NSG) guidelines. This isolation ended in September 2008, when India received a clean waiver from the NSG, reflecting international recognition of its strong non-proliferation record. India has consistently maintained stringent export controls to prevent

diversion or illicit transfer of nuclear materials and technologies. As per Arms Control Association, 2007, following the 2005 civil nuclear understanding with the United States, several countries expressed support for expanded nuclear cooperation with India. The United Kingdom, France, and Canada endorsed engagement, while export controls were relaxed in line with NSG guidelines. In December 2006, the US Congress passed legislation enabling nuclear trade with India, culminating in a bilateral agreement in July 2007. This agreement granted India access to global nuclear markets, required civilian reactors to be placed under safeguards, mandated the shutdown of the CIRUS research reactor, and permitted reprocessing of foreign-origin fuel at safeguarded facilities

As per World Nuclear Association, (2021), the IAEA described this arrangement as a "creative break with the past." A comprehensive safeguards agreement was approved in July 2008, followed by the NSG waiver in September 2008. Subsequent agreements with the United States, Russia, and France effectively ended India's decades-long nuclear isolation, while subjecting it to enhanced international oversight In April 2012, India informed the United Nations Security Council that, given its adherence to non-proliferation norms and export control regimes, its inclusion in all four major multilateral export control frameworks—the NSG, Missile Technology Control Regime, Australia Group, and Wassenaar Arrangement—was a logical progression. India has also supported negotiations on a Fissile Material Cut-off Treaty, underscoring its aspiration to be recognised as a responsible stakeholder in the global nuclear order. In January 2011, reasonably assured uranium resources were estimated at about 102,600 tonnes (tU), with an additional 37,200 tU classified as inferred resources, while the Department of Atomic Energy revised total estimates to around 152,000 tU in 2012. Uranium deposits are geologically diverse, comprising vein-type, sandstone-hosted deposits in Meghalaya, unconformity-related deposits such as Lambapur–Peddagattu, and strata-bound deposits in the Cuddapah basin, including Tummalapalle. Given these constraints, India is expected to rely increasingly on imported uranium to meet its growing nuclear fuel requirements.

## Uranium Resource Acquisition

Uranium exploration is conducted by the Atomic Minerals Directorate for Exploration and Research, while mining and processing are undertaken by Uranium Corporation of India Limited in Jharkhand near Kolkata. Major processing facilities include mills at Jaduguda and Turamdih, with ore grades averaging 0.05–0.06 per cent uranium. Most operations are

underground, except at Banduhurang. In 2005–06, the government announced plans to invest nearly US$700 million to develop new mines in Jharkhand, Meghalaya, and Andhra Pradesh. India's principal nuclear fuel complex is located in Hyderabad. To support nuclear expansion and international safeguards, three additional fuel cycle complexes are planned: one at Kota in Rajasthan to supply PHWRs at Rawatbhata and Kakrapar, a second to fuel ten new PHWRs in Haryana, Karnataka, and Madhya Pradesh, and a third to serve light water reactors.

The Nuclear Fuel Complex (NFC) in Hyderabad is responsible for uranium refining, conversion, and fuel fabrication, processing uranium received as magnesium diuranate (yellowcake). Its main fabrication facility, with a capacity of about 400 tonnes per year, produces un-enriched fuel for pressurised heavy water reactors (PHWRs), while a smaller plant fabricates enriched fuel for the Tarapur reactors using imported uranium. The NFC also manufactures depleted uranium and thorium oxide pellets for PHWR fuel bundles. Mixed carbide fuel for the Fast Breeder Test Reactor was first produced by the Bhabha Atomic Research Centre in 1979. Heavy water supply is managed by the Heavy Water Board, whose plants are operating at full capacity. India's uranium enrichment capability is limited to a small centrifuge facility at Ratnahalli near Mysuru, operated primarily for strategic and research purposes and undergoing expansion. Additional centrifuge research is conducted at BARC. Fuel fabrication remains centred at the NFC, which is also establishing a new PHWR fuel plant at Rawatbhata to support 700 MWe reactors. India is exploring joint ventures with US, French, and Russian firms for future fuel production, while advancing capabilities in reprocessing, thorium fuel cycles, and waste management.

By late 2008, India had secured uranium supply agreements with Russia and France, followed by Kazakhstan. A major contract with Russia's TVEL and a long-term agreement with Kazatomprom enabled imported uranium use, with Rajasthan Atomic Power Station among the first facilities to operate on imported fuel. In September 2009, India signed uranium supply and civil nuclear cooperation agreements with Mongolia and Namibia. This was followed in March 2010 by Russia's offer to provide India with an equity stake in the Elkon uranium mining project in the Sakha Republic through a joint venture with ARMZ Uranium Holding Company. In July 2010, India reported uranium imports totalling 868 tonnes from France, Russia, and Kazakhstan, including supplies from Areva, TVEL, and Kazatomprom. By August 2010, seven nuclear reactors with a combined capacity of 1,400 MWe were operating at full capacity

using imported fuel, while nine reactors, totalling 2,630 MWe, continued to depend on domestically sourced uranium.

## Uranium Industry in Africa

Africa has long been a significant supplier of uranium for both civilian nuclear energy and military purposes, including material used in the atomic bomb dropped on Hiroshima. The continent re-emerged in global nuclear discourse in 2002, when claims by the United States regarding Iraq's alleged attempt to procure uranium from Africa—specifically "yellowcake" from Niger—drew international attention. This episode raised broader questions about whether uranium-producing states are recognised as part of the global nuclear order and whether uranium itself should be considered inherently "nuclear". These issues are explored by Gabrielle Hecht through the concept of *nuclearity*, which frames nuclear status as a contested techno-political process rather than a purely technical classification. By tracing uranium extraction in Africa and the development of the global uranium market, Hecht foregrounds the experiences of African mine workers and the often-unacknowledged health risks of radiation exposure. Her work challenges conventional narratives by firmly situating Africa within the global nuclear history.

World Nuclear Association, (2021) *Uranium in Africa* writes, Africa possesses substantial uranium reserves, and exploration has expanded into new producing countries. In Algeria, uranium exploration during the 1970s identified the Tahaggart deposit, with reasonably assured resources estimated at around 26,000 tonnes. Renewed interest was signalled in 2009 when exploration licences were offered in the Tamanrasset province In Morocco, uranium exploration is being promoted in regions such as Haute Moulouya and Sirwa, alongside feasibility studies on uranium recovery from phosphate mining, reflecting the country's significant resource potential (World Nuclear Association, 2021). In the Central African Republic, Areva, after acquiring UraMin Inc., proposed the development of the Bakouma uranium project, originally discovered by Cogema. Designed as an open-pit mine with a planned output of about 1,200 tonnes of uranium annually, the project faced delays despite substantial investment, primarily due to low uranium prices and the need for further metallurgical studies. Areva Resources Centrafrique reported uranium resources of approximately 32,000 tonnes across multiple deposits, with a 90 per cent company stake and a 10 per cent free-carried interest held by the government. Disputes related to the acquisition were resolved in 2008.

On the distribution of Uranium in Africa World Nuclear Association on yearly bulletin *Uranium in Africa, 2021* mentioned the Democratic Republic of Congo historically supplied uranium for the Manhattan Project, notably from the Shinkolobwe mine in Katanga province. Around 25,000 tonnes were produced before independence in 1960, after which the mine was sealed. Since the late 1990s, unregulated mining has raised international concerns over potential uranium diversion. Although Areva signed an exploration agreement in 2009, it has refrained from mining due to political instability. The DRC has been a signatory to the Nuclear Non-Proliferation Treaty since 1970. In West Africa, Mali's Falea copper–silver deposit in the south-west is being explored by Rockgate Capital Corporation of Canada, building on earlier investigations by Cogema. Uranium is envisaged as a by-product, with NI 43-101–compliant measured and indicated resources estimated at about 11,400 tonnes and inferred resources at around 6,050 tonnes. The sandstone-hosted deposit lies approximately 20 kilometres north of the Guinean border.

The bulletin further mentioned different region. In Mauritania, Forte Energy NL reported JORC-compliant inferred uranium resources of roughly 9,000 tonnes at its A238 prospect near Bir Moghrein, with additional resources at the Bir En Nar deposit. Aura Energy has also identified around 19,000 tonnes of uranium in a shallow calcrete deposit on the Reguibat Craton. Areva holds an equity stake in Forte and has expressed interest in future development. In Nigeria, Russia signed cooperation agreements in 2009 covering uranium exploration and the possible construction of nuclear and research reactors, reflecting Nigeria's emerging nuclear ambitions. In Gabon, uranium mining has ceased, though exploration continues. Uranium production at Mounana between 1960 and 1999 yielded nearly 28,000 tonnes, including significant output from the Oklo deposit, known for its natural fossil nuclear reactors. Mining ended due to reserve depletion, and the site is undergoing environmental rehabilitation.

Hecht, G. (2009) in the book Africa And The Nuclear World: Labor, Occupational Health, and the Transnational Production of Uranium. *Comparative Studies in Society and History*, *mentioned* Uranium mining at Mounana began with open-pit operations between 1960 and 1975, followed by extraction at Oklo from 1970 to 1985. Underground mining was subsequently undertaken at Mounana and later expanded to Oklo between 1977 and 1997, as well as to Boyindzi from 1980 to 1991. In the final phase of production, the Mikouloungou open pit, situated around 60 kilometres from Mounana, was mined between 1997 and 1999.

Prior to 1975, approximately two million tonnes of tailings and mill effluents were discharged into the Ngamaboungou creek and the Mitembe–Likedi river system. Thereafter, nearly four million tonnes of tailings were deposited in the exhausted Mounana pit, and a tailings dam was constructed across the Ngamaboungou creek in 1990 to manage remaining waste. Environmental rehabilitation commenced in 1985, with COMUF reinforcing the creek channel and covering valley tailings with compacted lateritic material. Tailings in the former open pit were sealed with rock and laterite, while contaminated processing zones were capped with a minimum of 0.7 metres of lateritic soil. The rehabilitation programme concluded in July 2004 at an estimated cost of €10.7 million, partly financed by the European Union. Although Gabon is a signatory to the Nuclear Non-Proliferation Treaty and concluded a safeguards agreement in 1979, it does not currently operate a comprehensive safeguards regime.

World Nuclear Association (2021) further mentioned, in Guinea, uranium exploration is ongoing, with Forte Energy NL reporting JORC-compliant inferred resources of approximately 4,470 tonnes at the Firawa prospect, located about 600 kilometres east of Conakry, alongside potential rare earth element by-products. Additional exploration licences are held by Toro Energy and Contico. In Equatorial Guinea, the government has launched airborne geophysical surveys and introduced a revised mining code to support uranium exploration and development .In Southern Africa, Botswana hosts several significant uranium prospects. A-Cap Resources' Letlhakane project in the north-east comprises the Gojwane and Serule deposits and contains an estimated 61,000 tonnes of uranium within shallow calcrete-hosted deposits. Gojwane accounts for a substantial share of the indicated resources, while Serule contributes most of the inferred resources. Mineralisation occurs as carnotite and is suitable for heap-leach processing, with planned production of around 1,350 tonnes per year and exports via Namibia. The project, valued at approximately US$200 million, has attracted equity participation from Polo Resources and China Growth Minerals, while further exploration is ongoing in eastern Botswana.

In Malawi, Paladin Energy operates the Kayelekera uranium mine, which holds proven reserves of about 11,265 tonnes within measured and indicated resources of roughly 15,000 tonnes. Commercial production began in 2009 following an investment of US$220 million, with output rising from 670 tonnes in 2010 to 842 tonnes in 2011. World Nuclear Association in its yearly bulletin on Uranium in Africa (2021) mentioned

the open-pit mine uses conventional acid-leach processing and was projected to expand production further, while nearby prospects remain under exploration. In Zambia, Denison Mines is advancing the Mutanga uranium project, which holds NI 43-101–compliant resources across the Mutanga and Dibwe deposits. The project is planned as an open-pit, heap-leach operation and holds long-term mining and environmental approvals, pending improvement in uranium market conditions.

According to World Nuclear Association (2021) updates Near the Zimbabwean border, the Chirundu project encompasses the Njame and Gwabe deposits, with combined uranium resources of approximately 4,300 tonnes. African Energy Resources holds full ownership and obtained a mining licence in 2009 for a proposed acid heap-leach operation, though development has been delayed due to low uranium prices. Zambia has updated its mining framework to include uranium development, issues uranium mining licences, and remains a signatory to the Nuclear Non-Proliferation Treaty and a member of the International Atomic Energy Agency.

World Uranium Association in its yearly bulletin further mentioned the additional uranium projects are under way in Tanzania, including Uranex's Bahi project near Manyoni, East Africa Resources' Madaba–Mkuju deposits, and Uranium Resources Inc.'s Mtonya project. The Tanzanian government has supported these developments through regulatory reforms and has indicated longer-term interest in nuclear power generation. The expansion of uranium mining in Africa is largely driven by expectations of future demand. Forecasts of declining uranium stockpiles, combined with climate change concerns and the prospect of a global "nuclear renaissance," have encouraged several African states to consider nuclear energy as a strategic response to rising energy needs.

Global expectations of rapid nuclear expansion have reinforced competition for uranium resources. Under President Nicolas Sarkozy, nuclear energy became a key element of France's foreign policy, resulting in nuclear cooperation agreements with countries such as China, Libya, Morocco, Turkey, and Saudi Arabia. Concurrently, China's large-scale nuclear power expansion has driven growing demand for uranium, with estimates suggesting a requirement of nearly 10,000 tonnes of uranium oxide by 2020. To secure supplies, Chinese firms have expanded exploration and investments in uranium-rich regions, particularly in Niger, Namibia, and Zimbabwe, as well as in Central Asia and Mongolia. This increased Chinese engagement has challenged France's traditional

economic influence in Francophone Africa, prompting references to a shift from *la Françafrique* to *la ChinAfrique*. Other countries, including India, Japan, and Canada, have also intensified their investments in African uranium projects. For many African governments, this heightened competition among external powers is viewed as an opportunity for economic and strategic leverage, while simultaneously raising concerns related to governance, sustainability, and Africa's role within the global nuclear order.

## Uranium Sector in Namibia

During the Cold War, when Namibia was under apartheid South African control, the country occupied a strategic position in the global uranium market supplying capitalist economies. Namibian uranium supported nuclear weapons programmes in Britain and fuelled reactors across Europe and Asia, while apartheid politics and colonial control shaped the ability of international firms to participate in transnational uranium trade. Uranium extraction during this period also generated sustained international opposition and anti-apartheid activism. Nuclear Power Daily, (2010) in the news briefing mentioned that the Namibia's uranium sector underwent a major transformation after its Independence. The post-independence government rapidly expanded uranium mining and articulated ambitions to develop a domestic nuclear power plant. International mining companies adapted their strategies to align with new political and social expectations, while Namibia diversified its policy approach to uranium development In 2010, Namibia and Russia agreed on a proposed uranium investment programme valued at up to US$1 billion, invoking historical Soviet support for SWAPO as a basis for contemporary economic cooperation.

Namibia hosts two major uranium mines with the potential to supply nearly 10 per cent of global uranium output. Commercial production began in 1976 following exploration at Rössing, with subsequent discoveries at Trekkopje and Langer Heinrich (Hecht, 2010). In 2011, the government announced that Epangelo Mining would hold exclusive rights to future uranium developments without nationalising existing operations. To manage cumulative environmental impacts, a Strategic Environmental Assessment covering the uranium province near Swakopmund and Walvis Bay was conducted in 2011–12.Rössing Uranium Ltd, established in 1970, is operated as a large open-pit mine and is owned by Rio Tinto (68.6 per cent), the Iranian Foreign Investment Company (15 per cent), the Industrial Development Corporation of South Africa (10 per cent), and the Namibian government (3 per cent). Commercial production began in 1976,

and by the end of 2011 cumulative output had reached over 101,000 tonnes of uranium. The mine has a nominal capacity of about 4,000 tonnes per year, although annual production has varied, including output of 2,293 tonnes in 2012. Proven and probable reserves at the end of 2009 were estimated at nearly 59,000 tonnes at an average grade of 0.031 per cent uranium, with exports primarily serving utilities in Europe, North America, and Asia, including China.

According to World Uranium Limited in yearly briefing on *Uranium in Namibia*, (2021) In 2005, a US$112 million investment was approved to extend mine life and increase capacity, followed by further expansion plans proposed in 2007. Development phases included satellite ore bodies, ore-sorting technologies, and the commissioning of a sulfur-burning acid plant generating both processing capacity and electricity. Rising production costs accompanied these expansions. In 2011, the Namibian government entered negotiations regarding Iran's ownership stake due to international sanctions.Paladin Energy's Langer Heinrich mine, located south-east of Rössing, began production in 2006 as an open-pit operation with initial capacity of around 1,000 tonnes per year. The carnotite-hosted ore body is processed using alkaline leaching.Production at the Langer Heinrich mine increased steadily, reaching 1,960 tonnes of uranium in 2012, up from 1,437 tonnes in 2011 and 1,108 tonnes in 2009. Capacity expansions were implemented in stages: Stage 2 raised capacity to about 1,430 tonnes per year in 2009, while Stage 3, completed in 2011 at a cost of roughly US$100 million, increased capacity to around 2,000 tonnes annually. A proposed Stage 4 heap-leach development aims to recover about 400 tonnes per year from low-grade ore, potentially raising total output to nearly 3,850 tonnes per year, subject to feasibility assessment.

Proven and probable reserves at Langer Heinrich are estimated at approximately 46,500 tonnes of uranium, with an additional 5,100 tonnes in stockpiles. World Uranium Limited in yearly briefing on Uranium in Namibia, (2021) highlights that the resource upgrades followed extensive drilling in 2010, and around 12,000 tonnes of uranium may remain in low-grade stockpiles for possible future recovery.The Husab uranium project entered a new phase following its acquisition by Taurus Minerals, a subsidiary of China Guangdong Nuclear Power Group. Development was scheduled to begin in late 2012, with production projected to reach about 5,700 tonnes per year between 2015 and 2017. The Rössing South deposit, part of the Husab project, lies south of the Rössing mine near Walvis Bay. A definitive feasibility study by Extract Resources confirmed the viability of mining Zones 1 and 2 of the Husab deposit, identifying measured

resources of about 32,000 tonnes of uranium and indicated resources of approximately 105,500 tonnes, with inferred resources across the wider deposit estimated at around 50,000 tonnes. By mid-2011, total uranium resources stood at roughly 188,000 tonnes at an average grade of 0.035 per cent, making Husab the highest-grade granite-hosted uranium resource in Namibia and a stratigraphic extension of the Rössing system. The deposit remains open along strike and at depth.

World Uranium Limited, (2021) further mentioned that the feasibility study projected operating costs of around US$32 per pound of $U_3O_8$ and capital expenditure of approximately US$1.66 billion. Planned operations involve open-pit mining of about 15 million tonnes of ore annually to supply a processing plant capable of producing roughly 5,700 tonnes of uranium per year. Mining and environmental approvals were granted in 2011, and following acquisition by Taurus Minerals and CGN-URC, construction was scheduled to begin in late 2012, with full production targeted by 2017. Ownership restructuring between 2010 and 2012 resulted in Taurus Minerals acquiring control of both Kalahari Minerals and Extract Resources, backed by China Guangdong Nuclear Power Group. The Namibian state-owned Epangelo Mining later secured a 10 per cent stake in Swakop Uranium, reinforcing state participation in the project. Nearby, Deep Yellow Ltd is advancing the Omahola (Tubas) project, comprising the Inca, Ongolo, and MS7 deposits. Combined JORC-compliant resources across these deposits total approximately 17,400 tonnes of uranium at an average grade of 0.036 per cent, with development plans centred on shallow open-pit mining and a central acid-leach processing facility.

In November 2011, Deep Yellow submitted an environmental assessment for the Inca deposit, proposing an open-pit mine producing up to 2.5 million tonnes of uranium- and iron-bearing ore annually, with potential output of up to 960 tonnes of uranium per year depending on economic conditions. A mining licence application has been lodged, and environmental assessment for the Ongolo–MS7 area was scheduled for completion in 2012. Initial production was tentatively projected for 2015.South of Inca, the shallow aeolian Tubas Red Sand (TRS) deposit hosts indicated and inferred resources of approximately 10,900 tonnes of uranium at an average grade of 0.0125 per cent as carnotite. Beneficiation trials using hydrocyclone technology have demonstrated the potential to upgrade ore grades to around 0.05 per cent uranium, leading to a reassessment of cut-off grades and the likelihood of increased JORC-compliant resources. The TRS deposit is now considered a potential standalone operation.

The broader Tubas–Tumas palaeochannel system extends roughly 30 kilometres south and southeast of Inca and contains extensive secondary calcrete-hosted mineralisation. This includes inferred resources of about 2,350 tonnes at Tubas Calcrete and indicated resources of approximately 4,470 tonnes at Tumas, located around 25 kilometres southeast of Tubas, both averaging grades of 0.03 per cent uranium. Further south, Reptile's Aussinanis palaeochannel project, located near the coast about 60 kilometres from the main Omahola cluster, contains approximately 6,976 tonnes of indicated and inferred uranium resources at an average grade of 0.02 per cent. Beneficiation techniques tested at the TRS deposit may also be applicable at Aussinanis. In January 2013, Deep Yellow entered into an agreement with Epangelo to transfer the Aussinanis and Ripnes projects into a new joint venture, Yellow Dune Uranium Resources Ltd. Under this arrangement, Epangelo acquired a five per cent stake to fund beneficiation test work, while Reptile retained 85 per cent ownership and Oponona Investments held the remaining 10 per cent.

If test work at Aussinanis proves successful, Epangelo Mining Ltd would assume operatorship and could increase its equity stake to up to 70 per cent by financing the project through a bankable feasibility study, reducing Reptile Uranium Namibia's shareholding to 20 per cent. Reptile also maintains a joint venture with a Namibian subsidiary of Toro Energy over contiguous exploration licences, while Paladin Energy holds a 20 per cent equity stake in Deep Yellow Ltd.Areva's Trekkopje uranium project is located about 80 kilometres northeast of Swakopmund and 35 kilometres north of Rössing. World Uranium Limited in yearly briefing on Uranium in Namibia (2021) mentioned that in the year 2007, UraMin Inc. announced a significant upgrade of resources at Trekkopje, which comprises two adjacent palaeochannel deposits—principally Klein Trekkopje—extending over approximately 16 kilometres. Following Areva's acquisition of UraMin, the project was advanced by Areva Resources Southern Africa through its Namibian subsidiary

World Uranium Limited, (2021) further mention the Trekkopje development, with an estimated capital cost of around US$1 billion, was designed as a shallow open-pit operation using a sodium carbonate–bicarbonate heap-leach process. Approximately 80 per cent of the ore occurs at depths of less than 15 metres but is characterised by very low grades of 0.012–0.015 per cent uranium. From 2010, water was supplied by a coastal desalination plant with a planned capacity of about 55,000 cubic metres per day, drawing 16 MWe from the national grid. Around one-third of the output was made available to other mining operations, and

the facility has continued operating despite the suspension of mining. Drilling campaigns in 2006–07 converted much of the inferred resource into measured and indicated categories, raising resources in the main deposit to about 42,000 tonnes of uranium. Areva reported total resources of 45,600 tonnes in 2008 but revised this downward to around 26,000 tonnes in 2011 at lower grades, coinciding with a €1.8 billion write-down. The project also envisaged recovery of more than 9,000 tonnes of vanadium pentoxide as a by-product and planned uranium production of approximately 3,200 tonnes per year from 2013.

Although a mining licence was granted in June 2008 and the first concentrate from pilot operations was produced in January 2011, development slowed in October 2011 due to persistently low uranium prices. Areva stated that the pause would allow optimisation of technical and economic parameters and exploration of alternative development options. Despite commissioning a second-stage pilot plant in mid-2010 and plans to begin large-scale ore stacking in early 2012, the project was placed under care-and-maintenance in October 2012, citing weak uranium prices and the scale of remaining capital investment. Forsys Metals Corp, headquartered in Toronto, is developing the Valencia uranium project located approximately 25 kilometres northeast of Rössing within a similar alaskite geological setting. Environmental approval was granted in June 2008, followed by a mining licence in August 2008 to Valencia Uranium (Pty) Ltd. Measured and indicated resources are estimated at about 23,320 tonnes of uranium at an average grade of 0.016 per cent, including reserves of roughly 19,000 tonnes. The proposed open pit would extend to a depth of approximately 375 metres.

Further drilling from 2010 at the nearby Namibplaas area, now wholly owned by Forsys, resulted in indicated resources of about 12,870 tonnes and inferred resources of approximately 4,250 tonnes at similar grades. Forsys has proposed a combined development of Valencia and Namibplaas, targeting annual production of around 1,900 tonnes of uranium from 2015, subject to a definitive feasibility study that may include heap-leaching options.In October 2010, Bannerman Resources Ltd announced measured and indicated resources of approximately 57,330 tonnes of uranium at an average grade of 0.019 per cent for its Etango project, located southwest of Rössing. Inferred resources of about 24,600 tonnes are associated mainly with the Ondjamba and Hyena ore bodies. The alaskite-hosted mineralisation resembles that at Rössing and extends to depths of up to 400 metres, with roughly two-thirds within 200 metres of the surface. Heap leaching has been identified as the preferred processing method.

Environmental approval for Etango was obtained in 2010, followed by approval for infrastructure in 2011, though a mining licence remains pending. A definitive feasibility study completed in March 2012 estimated capital costs at around US$870 million and converted approximately 80 per cent of measured and indicated resources into proven and probable reserves of about 46,000 tonnes, supporting a minimum mine life of 16 years. Planned production is estimated at roughly 2,700 tonnes per year, with operating costs of about US$41 per pound of $U_3O_8$ in the initial years. Bannerman, holding an 80 per cent stake in Etango, has sought strategic partners. A conditional takeover bid by China's Sichuan Hanlong Group in 2011 did not proceed. In April 2012, Namibia's state-owned Epangelo Mining Ltd agreed to acquire a five per cent interest, with an option to increase its stake, but the arrangement was later abandoned due to contractual disagreements.

Marenica Energy (formerly West Australian Metals) announced a JORC-compliant inferred resource at its Marenica palaeochannel deposit in 2008. By December 2011, this was revised to an indicated resource of approximately 2,500 tonnes and an inferred resource of about 19,600 tonnes of uranium at low grades. Test work demonstrated strong potential for grade upgrading through beneficiation, leading to a shift from heap leaching to tank leaching of beneficiated material. Marenica Energy holds an 80 per cent interest in the project. Areva NC acquired a 9.5 per cent stake in early 2010, followed by a 5.82 per cent investment by Hanlong Energy later that year. Meanwhile, Xemplar Energy Corp has been exploring the Cape Cross uranium project within Namibia's coastal uranium corridor. Overall, Namibia possesses around five per cent of global known uranium resources, estimated at approximately 275,000 tonnes recoverable at costs below US$130 per kilogram, of which about 176,000 tonnes are classified as reasonably assured resources, largely suitable for open-pit mining.

Namibia generates roughly three billion kilowatt-hours of electricity annually, with nearly half imported from South Africa. Although a coal-fired power plant has been proposed at Walvis Bay and the government has expressed interest in nuclear power generation, progress has been limited and power shortages persist. World Uranium Limited, (2021) highlights that the Uranium mining is regulated under the Atomic Energy Act (2005) and the Environmental Management Act (2007). Oversight has been strengthened through the creation of an Atomic Energy Board and a National Radiation Protection Authority. Finland's Radiation and Nuclear Safety Authority (STUK) has supported Namibia in developing

uranium mining policy and safeguards, although this cooperation did not extend to nuclear power regulation as of 2011. In terms of non-proliferation commitments, Namibia is a signatory to the Nuclear Non-Proliferation Treaty and has maintained a comprehensive safeguards agreement with the International Atomic Energy Agency since 1998. Namibia has also ratified the 1996 African Nuclear Weapon Free Zone Treaty, also known as the Pelindaba Treaty, which came into force in 2009 and precludes export of uranium to India. The country further strengthened its non-proliferation credentials by signing the IAEA Additional Protocol in 2000.

World Energy Association (2026) mention Namibia's uranium sector illustrates the converging interests of China, Iran, and Canada, reflecting how global geopolitics, energy security, and foreign investment intersect in a resource-rich African state. At the core is Rössing Uranium Limited, established in 1970, which has long been one of the world's largest open-pit uranium mines. While the mine has supplied over 112,000 tU since production began in 1976, its ownership history reveals shifting geopolitical dynamics. Iran's 15% equity stake, held through the Iranian Foreign Investment Company, became politically sensitive after UN sanctions, prompting Namibia in 2011 to consider holding the stake in trust or transferring it to the state mining company, Epangelo. This episode highlights how international sanctions regimes directly shape resource governance in Namibia. China's involvement has been both deep and strategic. Through China National Uranium Corporation Limited and subsidiaries of China National Nuclear Corporation, China has progressively consolidated control over Namibia's uranium assets. The 2018 acquisition of Rio Tinto's majority stake in Rössing, combined with the development of the Husab mine by Swakop Uranium (largely owned by Chinese state-linked entities), positions Namibia as a critical pillar in China's long-term nuclear fuel supply chain. Much of the output is earmarked for China, though a portion is traded internationally via UK-based marketing firms. Canada's role is more exploratory but still significant. Xemplar Energy Corp has been active in the Cape Cross Uranium Project within Namibia's "uranium corridor," while Uranium One, through its Headspring Investments arm, has investigated in-situ leach potential in the Omaheke region. Together, these engagements demonstrate how Namibia's uranium sector operates as a global arena, where Chinese state capital, Iranian legacy interests, and Canadian exploration coexist within a single national resource landscape.

## India–Namibia Partnership on Uranium

During the state visit of Namibian President Hifikepunye Pohamba to India in August–September 2009, the two countries concluded several memoranda of understanding, including agreements on cooperation in geology and mineral resources and on the peaceful uses of nuclear energy. These instruments signalled an intention to deepen engagement in strategic sectors such as uranium and civil nuclear cooperation. Among the world's leading uranium producers—Kazakhstan, Canada, Australia, Namibia, and Niger—India currently sources uranium only from Kazakhstan. Although India and Namibia have signed a civil nuclear cooperation agreement, Namibia is legally constrained from supplying uranium to India due to India's non-signatory status to the Nuclear Non-Proliferation Treaty (NPT). Namibia is a party to the African Nuclear-Weapon-Free Zone (Pelindaba) Treaty, which prohibits the transfer of nuclear materials to non-NPT states. Namibia ratified the treaty in February 2012, formally reinforcing this legal limitation.

## Political Symmetry

India and Namibia share historically close relations rooted in anti-colonial solidarity. India played a pioneering role in international advocacy for Namibia's independence, raising the issue at the United Nations from 1946 onward and providing sustained diplomatic and moral support to the liberation movement. The first overseas office of SWAPO was established in New Delhi in 1986. India- Namibia Relation: An Analysis Based on Ministry of External Affairs, Government of India highlights diplomatic relations were formalised immediately after Namibia's independence in 1990, with India upgrading its mission to a High Commission, followed by Namibia's establishment of its mission in New Delhi in 1994.Bilateral political cooperation has remained strong, encompassing defence training, capacity building, and sustained high-level exchanges. Namibia has consistently supported India's bid for permanent membership of an expanded UN Security Council and India's candidatures in multilateral bodies. President Pohamba's 2009 visit further expanded cooperation through agreements on defence collaboration and visa waivers for diplomatic and official passport holders.

## Cultural Symmetry

A Cultural Agreement between the Government of the Republic of India and the Government of the Republic of Namibia was concluded on 25 January 1991, with the objective of promoting cooperation in the fields of art and culture and enhancing mutual understanding of each other's cultural traditions and activities. As part of this framework, the Indian Council for Cultural Relations (ICCR) offers scholarships to Namibian students under the Africa Scholarship Scheme for undergraduate, postgraduate, and research programmes at Indian universities. The Indian community in Namibia remains small, numbering approximately 200 Indians, NRIs, and persons of Indian origin, engaged primarily in professions such as healthcare, academia, religious service, commerce, transport, and the service sector. Although limited in size, the Indian diaspora in Namibia is gradually expanding and contributes to strengthening people-to-people ties between the two countries.

## Economic Symmetry

India and Namibia share a post-colonial economic trajectory marked by resource dependence and import substitution. India's rapid economic growth and rising energy demand have intensified its pursuit of overseas resource partnerships as part of a broader resource security strategy. Namibia's mineral endowment—particularly uranium, diamonds, and non-ferrous metals—aligns closely with India's external resource requirements. Although bilateral trade volumes remain modest, they have shown steady growth. According to the report published by Ministry of External Affairs, India Namibia Relations (2021) India exports pharmaceuticals, machinery, automobiles, and manufactured goods to Namibia, while imports consist largely of minerals and metal products. Official trade statistics understate actual volumes due to indirect trade routes via South Africa and third-country diamond hubs. A notable milestone was achieved in 2009 with the first direct sale of Namibian rough diamonds to India. Trade data indicate that Indian imports from Namibia declined from US$41.88 million in 2009–10 to US$9.95 million in 2011–12, while exports from India remained higher but similarly modest. Despite this, growing entrepreneurial engagement and the proposed India–SACU Preferential

Trade Agreement suggest substantial untapped potential for deeper economic cooperation, particularly in energy, mining, and agriculture.

## Policy Calibration

President Pohamba's 2009 visit established new pillars of cooperation, including Indian commitments to support mining and IT education at the University of Namibia, implement the Pan-African e-Network project, expand ITEC and scholarship allocations, and provide development grants for education, health, and rural electrification. Namibia is now a partner country under the ITEC programme, with over 700 Namibians trained in India to date.To maximise long-term strategic benefits, greater alignment is required between India's capacity-building initiatives and its resource-based partnerships with Namibia. Prioritising uranium-related technical and managerial training within scholarship and ITEC programmes would strengthen local expertise and facilitate sustained cooperation. The Indian High Commission, which exercises discretion over a significant share of ITEC slots, can play a key role in ensuring sectoral relevance and broad representation. Facilitating post-training industry exposure with Indian energy and uranium-related enterprises would further help translate educational cooperation into durable strategic partnerships in the uranium sector.

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