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Issue Brief

A Helium Shock to India's Quantum Technology Ambitions

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Summary

The disruption of the Qatari helium supply resulting from the war in Iran has exposed a structural vulnerability. Beyond helium-4 price volatility, the bigger risk lies in helium-3, which is irreplaceable in the dilution refrigerators that power leading quantum computing architectures. India has no secure, quantified domestic supply of Helium-3. The near-term priority is research support for alternative cooling techniques and shared cryogenic-enabling infrastructure.

Helium spot prices in India surged 70–100 per cent in March 2026 after Iranian drone strikes forced the shutdown of a key LNG processing facility in Qatar, the same infrastructure where Helium is captured as a by-product of natural gas and oil extraction.[1] Currently, Qatar accounts for a third of global helium production and supplies over 50 per cent of India's helium.[2] Repair timelines mean Qatar's output is projected to fall 14 per cent over the next five years, compressing global supply precisely when global demand is rising.[3] For India, with no domestic helium production, this is not merely a price shock, it is a structural supply vulnerability with direct consequences for India's ability to develop and operate quantum technologies.

Helium's unique chemical and physical properties, such as inertness and high thermal conductivity, make it irreplaceable in semiconductor and optical-fibre manufacturing, drug discovery, leak detection, neutron detectors for nuclear security and weapons detection, and in advanced process tools and medical devices such as MRIs.[4] The helium shortage has already prompted China, Taiwan, South Korea and Japan to seek policy solutions and alternative sources.[5] Tightening supply is creating real constraints on the infrastructure that underpins quantum technology development.[6]

Helium for Quantum: The Two Isotopes

Helium gas is scarce on Earth and difficult to store in gaseous form because it readily leaks into the atmosphere and escapes into space. It is difficult to transport and store, requiring specialised million-dollar containers to maintain it in liquid form at temperatures below -269°C.[7] Helium-based cryogenic systems are the foundational

[1] Shivanghi Payal, **"Up, Up and Away: Is the World Running Out of Helium Gas?"**, *The Times of India*, 29 March 2026.

[2] Mini Tejaswi, **"India is 100 per cent Import-Dependent for Helium, Making Many Industries Acutely Vulnerable to Global Disruptions"**, *The Hindu*, 3 April 2026.

[3] Jinjoo Lee, **"Helium Disruption Spells Opportunity for Some Suppliers of the Gas"**, *The Wall Street Journal*, 2 April 2026.

[4] Timothy Rooks, **"Iran War: Helium Shortage Could Hit Semiconductor, Oil, EVs & Smartphone Supply Chains"**, *Deutsche Welle* (DW), 18 March 2026; Constanza M. Vidal Bustamante and John Burke, ***Quantum's Industrial Moment: Strengthening U.S. Quantum Supply Chains for Scalable Advantage***, Washington, DC, Center for a New American Security, March 2026.

[5] Carol Yang, **"From Semiconductors to Medical Tech, Iran War Puts Helium Users on Edge"**, *South China Morning Post*, 27 March 2026; Prateek Tripathi, **"Has the Iran War Triggered Another Semiconductor Crisis?"**, Observer Research Foundation, 13 April 2026; John Liu, **"China Faces Helium Fallout from Iran War Disruption"**, *CNN*, 15 April 2026; **"Helium: The Lesser Known Necessity – Helium Shortage Global Supply Chain Risks"**, Kotak Mahindra Mutual Fund Blog, 16 April 2026.

[6] Zack Savitsky, **"As Helium-3 Runs Scarce, Researchers Seek New Ways to Chill Quantum Computers"**, *Science*, 16 April 2026; Lara Williams, **"US Iran War: Will Helium Shortages Risk Major Disruption to Quantum Computing Companies?"**, *Verdict*, 10 March 2026.

[7] **"Helium: The Lesser Known Necessity – Helium Shortage Global Supply Chain Risks"**, no. 5.

infrastructure that enables the ultra-low temperatures required for the operation of quantum technologies. Two distinct helium-based systems are relevant: dilution refrigerators, which use a circulating mixture of two helium isotopes, helium-3 and helium-4, to reach sub-kelvin temperatures (below −272°C), and cryocoolers, which use helium-4 alone to reach the few-kelvin range (2–10K).

A dilution refrigerator is a helium-based cryogenic system that resembles a human-sized golden chandelier, with stacked gold-plated copper plates and intricate wiring used to cool hardware to almost the lowest attainable temperature in the universe. It is the standard system for reaching the base temperature required for quantum computing, since many qubits operate reliably only when thermal noise is nearly eliminated. This requires extremely precise engineering, because even a single misplaced wire can introduce enough heat to disrupt the system.[8] Each dilution fridge requires 10-100 litres of helium-3 gas, priced at US$ 2,500–3,000 per litre with lead times of 6 to 12 months. Helium-3 alone can constitute up to a quarter of the total acquisition cost of a dilution refrigerator, which can exceed US$ 600,000.[9]

Helium-4, while subject to the price volatility described above, is naturally occurring in recoverable quantities, whereas helium-3, about a million times rarer than helium-4 on Earth,[10] is produced almost exclusively as a decay product of tritium, a radioactive hydrogen isotope generated in nuclear weapons programmes and select nuclear energy reactors.[11] Helium-3 is extremely scarce, expensive, and tightly regulated. Helium-3 supply is dominated by the US, Russia and Canada, with production capped at 22,000–30,000 litres per year, a figure dwarfed by projected quantum-sector demand as the technology scales.[12] In India, helium-3 is extracted from heavy-water nuclear reactors, but no public data exists on extraction volumes or rates.[13]

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[8] Zack Savitsky, **"As Helium-3 Runs Scarce, Researchers Seek New Ways to Chill Quantum Computers"**, no. 6.

[9] Constanza M. Vidal Bustamante and John Burke, ***Quantum's Industrial Moment: Strengthening U.S. Quantum Supply Chains for Scalable Advantage***, no. 4; Lara Williams, **"US Iran War: Will Helium Shortages Risk Major Disruption to Quantum Computing Companies?"**, no. 6.

[10] Leonid B. Krivdin, **"An Overview of Helium-3 NMR: Recent Developments and Applications"**, *Progress in Nuclear Magnetic Resonance Spectroscopy*, Vol. 136–137, August–October 2023, pp. 83–109.

[11] Stuart Clarke, **"The 7 Most Expensive Substances Ever Found on Planet Earth"**, *BBC ScienceFocus*, 6 March 2026; Prineha Narang and Joshua Levine, **"The Supply Chain Chokepoints in Quantum"**, *War on the Rocks*, 20 October 2025; Helium-3 is produced in a very limited number of civilian sites such as Laurentis Energy Partners in Canada. For more details, see Sebastian Moss, **"DARPA to Research Modular Sub-Kelvin Cryocoolers That Don't Use Helium-3"**, *DataCenterDynamics*, 11 March 2026.

[12] Nimra Javed, **"The Real Battle for the Moon's Resources Is Here on Earth"**, *The Interpreter*, Lowy Institute, 24 September 2025; Kasha Patel, **"Moon Helium Deal is Biggest Purchase of Natural Resources From Space"**, *The Washington Post*, 16 September 2025; Constanza M. Vidal Bustamante and John Burke, ***Quantum's Industrial Moment: Strengthening U.S. Quantum Supply Chains for Scalable Advantage***, no. 4.

[13] M. Coleman and M. Kovari, **"Global Supply of Tritium for Fusion R&D from Heavy Water Reactors"**, Technical Report IAEA-CN-258, International Atomic Energy Agency, 2018; Sarah Newbury,

Not all quantum architectures and technologies are equally exposed to Helium supply constraints. Photonic quantum computers and quantum communication devices (including single-photon detectors and quantum memory) operate at the less demanding few-Kelvin range using closed-cycle helium-4 cryo-coolers, making them less vulnerable to helium-3 scarcity, though not insulated from helium-4 price shocks. Quantum sensing applications, notably SQUID magnetometers and bolometers used in defence and medical contexts, span both temperature regimes depending on sensitivity requirements.[14] The most exposed architectures are also the most strategically significant: superconducting quantum computers—the modality pursued by leading tech companies such as IBM, Google, and most national quantum programmes—and semiconductor spin-qubit systems both require dilution refrigerators, making them dependent on both isotopes.

Without helium-3, many quantum machines cannot run, and most companies and countries lack secure, continuous access to it. Scaling quantum computers from current cryogenics to fault-tolerant quantum computers with millions of superconducting or semiconductor spin qubits will require dozens, or even hundreds, of interconnected dilution refrigerators.[15] NATO and the EU have flagged helium-3 as a high-priority supply chain risk in the context of quantum technology scaling.[16] To scale practical quantum system deployment with current cryogenics and avoid helium-3 becoming both a dominant per-qubit cost and a potential supply bottleneck, new helium-3 sources need to be secured.[17]

Lunar Gamble and Promise of Helium-3

Lunar samples collected from Apollo-era space missions identified the presence of deposited helium-3 on the moon's surface. It is estimated that lunar helium-3 reserves, accumulated over billions of years of solar wind bombardment, amount to over a million metric tonnes.[18] Although lunar mining is still technologically nascent and untested, with its feasibility disputed, companies such as Maybell Quantum and

Samuel Cohen and Charles Gentile, **"Evaluating Earth's Helium--3 Supply"**, 2016, pp. 3–7; Dana A. Shea and Daniel Morgan, **"Helium: U.S. Resources, Supply, and Demand"**, Congressional Research Service Report R41419, Washington, DC, Library of Congress, 2012.

[14] Constanza M. Vidal Bustamante and John Burke, ***Quantum's Industrial Moment: Strengthening U.S. Quantum Supply Chains for Scalable Advantage***, no. 4.

[15] Ibid.

[16] Matt Swayne, **"Kiutra Secures €13 Million to Strengthen Quantum Supply Chains With Helium-3 Free Cooling"**, *The Quantum Insider*, 2 October 2025.

[17] Prineha Narang and Joshua Levine, **"The Supply Chain Chokepoints in Quantum"**, no. 11.

[18] **"Bluefors to Source Helium-3 from the Moon with Interlune to Power Next Phase of Quantum Industry Growth"**, Press Release, Interlune, 16 September 2025; **"Bluefors to Source Helium-3 From the Moon With Interlune to Power Next Phase of Quantum Industry Growth"**, Press Release, Bluefors, 16 September 2025.

Bluefors have already signed agreements to secure helium-3 extracted helium-3.[19] Bluefors, the world's leading cryogenic manufacturer for quantum technologies, has signed an agreement with Interlune for a decade-long delivery scheduled from 2028, for 10,000 litres of helium-3 annually, and even the US Department of Energy's Isotope Program has bought a token three litres, marking the first government purchase of a natural resource from space.[20]

India, China, Russia and Japan are also investing in the potential procurement of helium-3 from the Moon.[21] India's ambition to secure helium-3 is riddled with regulatory, economic and technological challenges. India is a signatory to the Artemis Accords, which critics say enable de facto territorial carve-outs.[22] State-of-the-art lunar excavators are untested, and, technologically, India cannot excavate, load, and transport helium-3 or lunar rocks to Earth. Economically, investments in lunar mining are more likely to yield returns from the retrieval of 'low-volume-high-value' assets, such as rare earth elements, rather than helium-3.[23] Despite the promise, lunar mining would not be a near-term solution to the helium-3 supply issue; near-term policy must be built on earth-bound options.

India's Early Moves: Infrastructure Support

Over the last year, India has made significant strides. Oil and Natural Gas Corporation of India (ONGC) has partnered with Engineers India to set up India's first indigenous helium recovery demonstration plant at ONGC's gas collection station to recover helium with 99.995 per cent purity from natural gas.[24] Researchers are also exploring helium extraction from geothermal springs and natural gas fields, although the economic viability remains questionable.[25]

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[19] Nimra Javed, **"The Real Battle for the Moon's Resources Is Here on Earth"**, no. 12; Stuart Clarke, **"The 7 Most Expensive Substances Ever Found on Planet Earth"**, no. 11; **"Bluefors to Source Helium-3 From the Moon With Interlune to Power Next Phase of Quantum Industry Growth"**, no. 18.

[20] Ibid.

[21] **"Indian Scientists Work Tirelessly to Mine the Moon for Helium-3"**, Vellore Institute of Technology; Ajey Lele, **"Space Race for Minerals on the Moon, Helium-3"**, *The Print*, 13 April 2026.

[22] Artemis Accords are a set of non-binding, voluntary principles put forth by NASA and US Department of State. For more information, see Nimra Javed, **"The Real Battle for the Moon's Resources Is Here on Earth"**, no. 12; Ajey Lele, **"Space Race for Minerals on the Moon, Helium-3"**, no. 21.

[23] Ajey Lele, **"Space Race for Minerals on the Moon, Helium-3"**, no. 21.

[24] **"India Launches Its First Helium Recovery Facility in Collaboration With ONGC and EIL"**, *The Economic Times*, 19 August 2025; Kusum Kumari, **"ONGC and Engineers India to Build ₹39.42 Crore Helium Recovery Plant in Tamil Nadu"**, *Angel One*, 19 August 2025.

[25] Shivanghi Payal, **"Up, Up and Away: Is the World Running Out of Helium Gas?"**, no. 1; Mini Tejaswi, **"India is 100 per cent Import-Dependent for Helium, Making Many Industries Acutely Vulnerable to Global Disruptions"**, no. 2.

India’s Department of Energy is working on recovering helium from purge gas generated by fertiliser plants.[26] To further support the cryogenic ecosystem, the Liquid Helium Cryogenic Facility was established at IIT Bombay in 2025. The facility is open for use by the larger ecosystem. Moving away from traditional designs, the facility adopts modern closed-loop systems that store and recycle helium, mitigating supply pressures and reducing experimental costs by a factor of 10.[27] India has taken initial steps to strengthen the underlying cryogenic infrastructure by indigenising components and providing government funding to quantum-enabling cryogenic component start-ups developing CMOS cryogenic controller chips and cryogenic coaxial cables.[28]

From Vulnerability to Strategy

As the Minister of State for Science and Technology, Dr Jitendra Singh, highlighted, with the rising global demand for quantum technology, there is a need to strengthen the current cryogenic infrastructure and to foster greater collaboration to scale up indigenous capabilities.[29] A troubling continuity sharpens the stakes. A 1996 UNESCO report found that India's cryogenic capabilities had not meaningfully advanced since 1973, with helium remaining fully import-dependent.[30] Thirty years on, the structural vulnerability remains the same—while the consequences of inaction are considerably larger. India has the scientific intent; what it needs now is the policy architecture to match.[31]

Dilution refrigerators, the current hidden workhorse of quantum computing, are not built to scale. There is a need to encourage research and development of alternative cooling techniques. Current cryogenics can cool a single device to the lowest

[26] **“About HWBF Mumbai”**, Heavy Water Board, Department of Atomic Energy, Government of India.

[27] **“Liquid Helium Plant Inaugurated at IIT Bombay”**, IIT Bombay, 14 October 2025; **“Dr Jitendra Singh Lauds Quantum Sensing Breakthroughs by IIT Bombay, Inaugurates India’s First Liquid Helium Cryogenic Facility”**, Press Information Bureau, Ministry of Science and Technology, Government of India, 24 November 2025; Prineha Narang and Joshua Levine, **“The Supply Chain Chokepoints in Quantum”**, no. 11.

[28] Mustafijur Rahman, **“It’s my pleasure to announce that I have been awarded research grant worth USD 1.5 million (INR 14 crores) as PI at IIT Delhi…”**, LinkedIn, 25 April 2026; Sweta Akundi, **“Quantum Jump”**, *IIT Madras Shaastra Magazine*, Vol. 5, No. 4, April 2026; **“Cryogenic Infrastructure for Indus Accelerators: SCCCS”**, Raja Ramanna Centre for Advanced Technology (RRCAT); Nisith Kr. Das, Jedidiah Pradhan, Bidhan Ch Mondal, Anindya Roy, Z. A. Naser and Pradeep Kumar, **“Indigenous Development of a Millikelvin Refrigerator at VECC, Kolkata”**, *Current Science*, Vol. 112, No. 5, 10 March 2017, pp. 1022–1024.

[29] **“Dr Jitendra Singh Lauds Quantum Sensing Breakthroughs by IIT Bombay, Inaugurates India’s First Liquid Helium Cryogenic Facility”**, no. 27.

[30] **“Strategies for Developing India’s National Capabilities in Cryogenics Science and Promoting Its Applications in Agriculture, Medicine and Industry”**, UNESCO New Delhi, 1996.

[31] Ibid.

temperature stage. Large-scale quantum computers envisioned would require multiple interconnected devices operating at disparate temperatures. For each device, these temperatures must be optimised. Dilution refrigerators do not scale up appropriately to meet the future helium-3 and technical requirements for quantum computing. Countries are funding the development and commercialisation of alternative modular, interconnected cryocoolers that can reach sub-kelvin temperatures without helium-3.[32]

Photonic, magnetocaloric and on-chip cooling techniques are maturing as promising alternatives that reduce or eliminate helium-3 dependency. On-chip cooling can significantly reduce the size and power requirements of current dilution refrigerators, potentially miniaturising quantum computers. Magnetocaloric cooling prevents expensive accidental cryogenic gas releases and is being commercially deployed by companies such as Kiutra and used in labs, offering easier control.[33] These alternative cooling platforms currently lack the power to sufficiently cool the bulky samples required to operate a full-stack quantum computer. However, they are still good enough for quantum chip fabrication and testing.[34]

Although some Indian scientists are conducting fundamental research, no well-documented, dedicated Indian research group is specifically focused on developing alternative cooling modalities at scale.[35] India should fund a small, dedicated programme to evaluate and pilot at least one of these alternative cooling modalities, positioned explicitly as a hedge against long-term helium-3 scarcity. This is not a replacement for near-term cryogenic investment, but a necessary parallel track—one that positions India ahead of a transition the broader quantum sector is only beginning to act on.

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[32] Sebastian Moss, **"DARPA to Research Modular Sub-Kelvin Cryocoolers That Don't Use Helium-3"**, no. 11.

[33] Zack Savitsky, **"As Helium-3 Runs Scarce, Researchers Seek New Ways to Chill Quantum Computers"**, no. 6; **"Solving Quantum Computing's Helium Crisis With kiutra's Alexander Regnat"**, *Infinite Frontiers*, 23 October 2025.

[34] Ibid.

[35] M. Patra, S. Majumdar, S. Giri, Y. Xiao and T. Chatterji, **"Magnetocaloric Effect in RAl_2 (R = Nd, Sm, and Tm): Promising for Cryogenic Refrigeration Close to Liquid Helium Temperature"**, *Journal of Alloys and Compounds*, Vol. 536, 2012; U. Arjun, K. M. Ranjith, Anton Jesche, Fabian Hirschberger, D. D. Sarma and Philipp Gegenwart, **"Efficient Adiabatic Demagnetization Refrigeration to below 50 mK With UHV-Compatible Ytterbium Diphosphates $AYbP_2O_7$ (A = Na, K)"**, *Physical Review Applied*, Vol. 20, No. 014013, 2023; Sharath Kumar Channarayappa, Poorvisha C, Dheeraj Ranaut, M. P. Saravanan and D. Jaiswal-Nagar, **"Enhanced Adiabatic Demagnetization Cooling Performance in Exchange Frustrated Gd_2CrTiO_5"**, *Physical Review Applied*, Vol. 23, No. 014041, 2025.

The Path Forward: Collective Response and Strategic Preparedness

Stabilising India's helium supply chain, across both helium-4 and the far scarcer helium-3, requires collective action. Life sciences and chemistry R&D laboratories, quantum technology labs and start-ups, the National Quantum Mission, the National Critical Mineral Mission, and the Indian Cryogenic Council must move beyond isolated institutional efforts and be supported by policy instruments that treat helium as a strategic necessity rather than a sectoral convenience.

The near-term priority should be two-fold: research and development support for alternative sub-kelvin cooling techniques, and sustained investment in the cryogenic-enabling infrastructure shared by all techniques. Cryogenic-enabling infrastructure spanning specialised materials, components, cables and engineering solutions that reduce helium use is a common requirement for control and operation across all sub-kelvin cooling techniques.[36] Investment in this cryogenic-enabling infrastructure will yield returns not only for emerging quantum technologies but also for the life sciences and energy sectors.

With no domestic production, India's helium imports cost over Rs 55,154.4 crores annually (as per a 2020 report), a figure expected to rise given India's expanding presence in semiconductor and electronics manufacturing and quantum technologies.[37] In the near- to medium-term, India needs to diversify its supply through multi-origin contracts, including those from Russia, the US, Algeria, Canada, and emerging suppliers such as South Africa and Tanzania. The Ministry of Mines should further explore non-conventional sources, such as hydrothermal gases and hot springs, which are more productive and cost-effective in the Indian context, and consider integrating them with geothermal power plants.[38]

Helium is difficult to stockpile with conventional storage lasting at most weeks or months and requiring transportation in specialised containers. Long-term storage requires geological reservoirs, pipelines and specialised infrastructure.[39] While the US government officially sold off the last of its National Helium Reserve in 2024, which once accounted for 30 per cent of the world's helium, the US maintains large

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[36] Lara Williams, "**US Iran War: Will Helium Shortages Risk Major Disruption to Quantum Computing Companies?**", no. 6.

[37] Subhro Niyogi, "**Scientists Want Centre to Expedite Helium Recovery in Bengal, Jharkhand**", *The Times of India*, 23 July 2020; Prateek Tripathi, "**Has the Iran War Triggered Another Semiconductor Crisis?**", no. 5.

[38] Hirok Chaudhuri, Kankana Seal, Chiranjit Maji, Supriya Pal and Mrinal Kanti Mandal, "**The Unrevealed Facts on Helium Resources of India**", *Arabian Journal of Geosciences*, Vol. 12, Article No. 216, 15 March 2019.

[39] Robert Z. Lawrence, "**Bring Back the Helium Reserve—Before the Next Shock Hits**", Peterson Institute for International Economics (PIIE), 21 April 2026.

reserves through privately held suppliers. The EU and Russia categorise helium as a strategic and critical material, recognising its economic and strategic value.[40] India typically maintains a 7–10 day helium inventory.[41] In the medium- to long-term, there is a need for India's Ministry of Mines, Ministry of External Affairs, and Ministry of Science and Technology to explore establishing a national helium reserve and categorising helium as a critical mineral to mitigate supply disruptions.[42]

At the current stage of quantum computing development, platform choices are primarily driven by performance and engineering trade-offs, and each approach has its own infrastructure dependencies.[43] The quantum computing platform supply chain is diverse yet nascent, with limited visibility and a concentration of suppliers.[44] Even with a restored helium supply, the challenge India faces is ensuring that the cryogenic infrastructure, which enables quantum technologies, scales to support the required quantum-computer modality.

The disruption to Qatari Helium supply caused by the Iran war is a sobering reminder of how geopolitical shocks can expose the economic and strategic fragility of a single-source dependency within the quantum supply chain, and of the impact on India's quantum ambitions if this vulnerability is left unaddressed. Near-term helium demand for quantum technologies is not scaling exponentially, and current requirements remain relatively manageable. But that window will not stay open indefinitely. What India needs now is clear, coordinated, and calibrated support meeting today's research needs while building the foundation for the quantum computers and applications India expects to deploy in the medium- to long-term.

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[40] Jiayi Zhou and André Månberger, "**Critical Minerals and Great Power Competition: An Overview**", sStockholm International Peace Research Institute (SIPRI), 2024, pp. 6–13; Suman D'Silva, "**Inside India's Response to the Global Helium Shortage**", *Finshots*, 29 April 2026.

[41] Suman D'Silva, "**Inside India's Response to the Global Helium Shortage**", no. 40.

[42] "**India's Critical Mineral Mission: Securing the Minerals of Tomorrow**", Press Information Bureau, Energy & Environment, Government of India, 6 September 2025; Robert Z. Lawrence, "**Bring Back the Helium Reserve—Before the Next Shock Hits**", no. 39.

[43] Ibid.

[44] Manoj Harjani and Shantanu Sharma, "**Will Quantum Supply Chains Fall Victim to Geopolitics?**", S. Rajaratnam School of International Studies (IDSS Paper), 18 August 2022.

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