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ENERGY SECURITY FOR DEFENCE FORCES: STRATEGIC IMPERATIVES FOR INDIA

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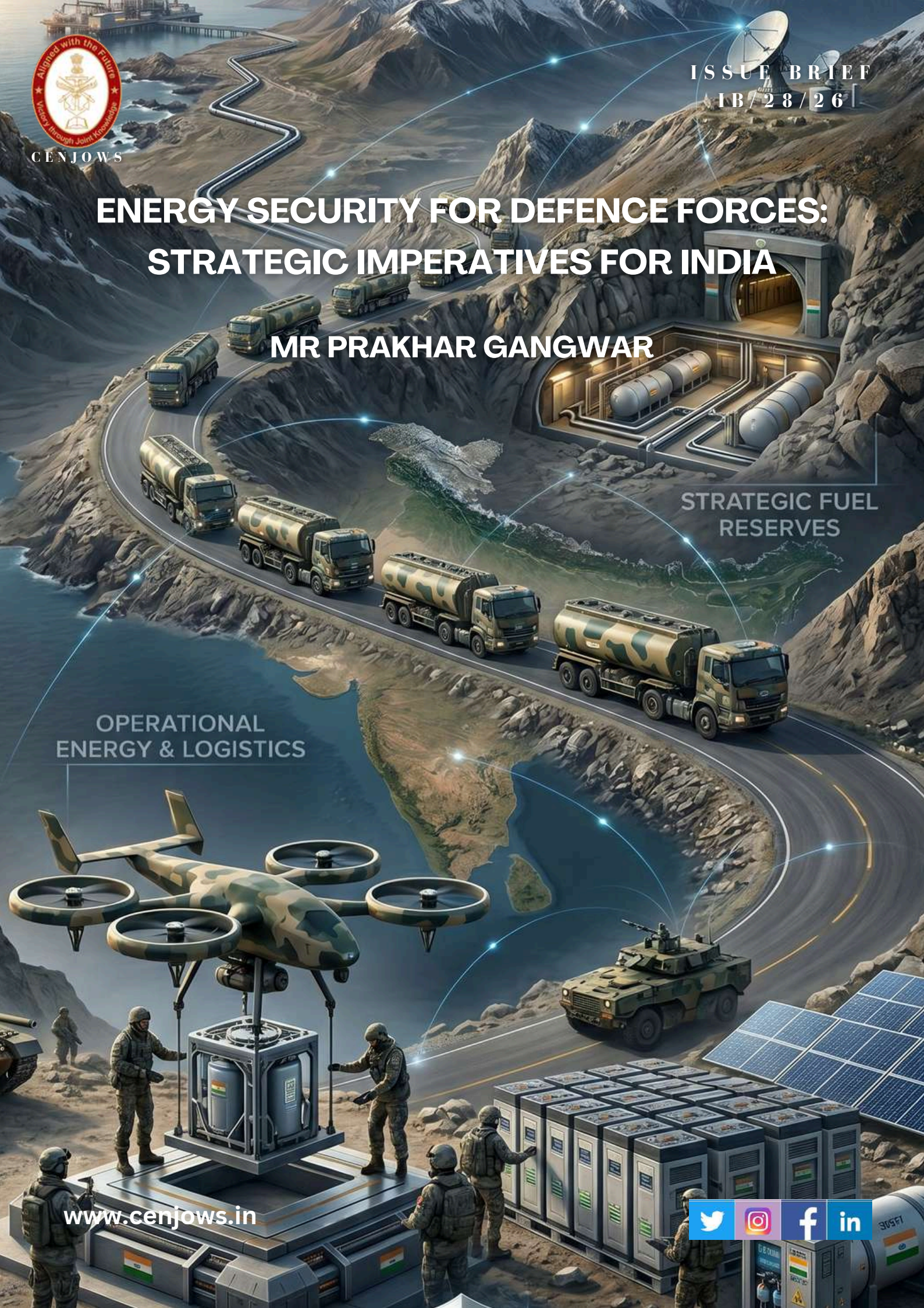

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Energy Security for Defence Forces: Strategic Imperatives for India

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Introduction: A New Era for Military Power

The way battles are fought and won has undergone a fundamental transformation. Whoever commands more troops or has more land is no longer the only factor. Energy is becoming an increasingly important aspect, as is who possesses it, who manages it, and who can keep it flowing when everything else fails. India cannot afford to overlook the effects of this change. Consider what the contemporary military truly depends on. Satellite networks, encrypted communication links, gigantic data centres humming with intelligence feeds, fifth-generation fighter jets, and swarms of unmanned drones, in short, none of it functions without a steady, massive, and uninterrupted source of power. Even the world's most technologically advanced fighting force can go black in a matter of hours if you pull the plug. Energy is now both a weapon and a vulnerability, turning what was formerly a back-office issue handled discreetly by supply officers into a front-line strategic reality.[1]

Military strategists used to think about energy security in very specific terms: if you had enough diesel for the tanks and enough aviation turbine fuel for the jets, you were pretty much protected. That world has vanished. These days, the discussion covers everything

from tactical microgrids that can withstand cyberattacks to solid-state batteries that power autonomous surveillance drones to the electricity required to maintain digital command-and-control backbones. The distinction between national security and energy security has virtually vanished as conflict becomes increasingly networked and digital. An adversary does not even need to fire a missile anymore; shutting down a power grid or choking off a fuel supply route can achieve the same strategic effect.[2]

For India, these realities land with particular force. The country is the world's third-largest energy consumer, yet it buys roughly 87 percent of its crude oil from abroad, a share that the International Energy Agency expects to climb to 92 percent by 2035. That level of import dependence leaves New Delhi exposed to wild price swings, geopolitical arm-twisting, and the ever-present risk that someone could block the narrow sea lanes through which the oil must travel.[3] On top of that, India's military operates in some of the most punishing geography on the planet, from the oxygen-thin heights of Siachen and Ladakh, where every litre of fuel must be hauled up the mountains at enormous cost, to the vast stretches of the Indian Ocean, where the Navy's expanding blue-water ambitions demand ever-longer and ever-more-vulnerable supply lines.[4, 5]

The strategic takeaway is blunt: India's armed forces need to stop thinking of themselves as mere fuel consumers but need to start building self-sustaining energy systems. That means embedding resilience, redundancy, and homegrown technology into the very core of military planning. If the country fails to make this shift, it risks fielding forces that look formidable on paper but could be starved into paralysis during a prolonged fight. Getting military energy right is not just about running things more efficiently; it is, quite literally, the foundation on which modern deterrence stands.

How the World’s Militaries Are Tackling Energy

India is not the only country wrestling with an energy crisis. Across the globe, major military powers have arrived at the same uncomfortable conclusion: the force that runs out of energy first tends to lose. What they are doing about it is both instructive and, in some cases, alarming.

- **The United States: Going Nuclear at the Base Level**

  No organisation on earth burns more fuel than the U.S. Department of Defence. In fiscal year 2022 alone, it went through more than 73 million barrels, nearly half of it bought on foreign soil. Washington has learned the hard way about the exposure costs.[6] The 2022 National Defence Strategy now explicitly calls for cutting energy demand, hardening supply chains, and giving commanders real-time visibility of their energy picture throughout multi-domain operations.[7]

  The most eye-catching moves involve nuclear power. Under the Janus Program, the army plans to install commercially owned, military-regulated nuclear microreactors at domestic installations by the end of September 2028. Nine bases, including Fort Bragg, Fort Hood, and Joint Base Lewis-McChord, are already undergoing site assessments.[8] Running in parallel, Project Pele is building a transportable microreactor prototype designed to fit inside standard shipping containers, with potential operation at the Idaho National Laboratory as early as 2026.[9] The logic is simple: a small reactor sitting inside your base gives you power that no cyberattack, no missile strike, and no supply-chain disruption can easily take away.[10]

- **China: Building Energy Fortresses on the Roof of the World**

  Beijing has a clear strategy: make its military as self-sufficient on energy as possible, particularly where it borders India. The People's Liberation Army (PLA)'s Western Theatre Command is quietly constructing renewable-powered bases across the Tibetan Plateau and Xinjiang’s terrain so punishing that trucking diesel up mountain passes is not just difficult; it is a tactical liability.[11]

  China kicked off its first national-level on-site military energy demonstration project at the Zhurihe Training Base in Inner Mongolia, combining wind and solar generation with smart grids, battery storage, and diesel backup. By rolling out solar microgrids across its high-altitude outposts, the PLA slashes the convoy traffic that Indian artillery or aircraft could target, while simultaneously powering electronic

warfare and surveillance systems without the telltale heat and noise of diesel generators.[12] Beyond the mountains, China is expanding its network of dual-use port facilities from its established base in Djibouti to potential nodes strung across the Indo-Pacific; it is fundamentally about securing fuel stops for its navy, enabling the PLA Navy to project power far from home without constantly running back to the mainland for a refill.[13, 14, 15]

- **The North Atlantic Treaty Organization (NATO): Fuel Convoys as the Weakest Link**

  If any single event jolted the Western alliance into rethinking energy, it was Russia's invasion of Ukraine. The war made painfully clear that fuel trucks and centralised power plants are among the easiest and most rewarding targets on a modern battlefield. NATO's response has been the "Smart Energy" programme, which pushes renewable generation and energy-efficient kit out to deployed forces. It's not because Brussels suddenly became an environmental advocacy group but because cutting fossil-fuel dependence means fewer vulnerable convoys, more tactical freedom, and one less lever for an adversary to pull. Russia's weaponisation of gas exports to Europe only reinforced the point: energy independence is not a climate slogan for militaries; it is a survival strategy.[16,17]

India's Military Energy Architecture Today

India's defence apparatus has an enormous fuel appetite. Look closely at how each service actually keeps itself running, and a troubling picture emerges, one of deep dependencies and supply bottlenecks that could prove crippling the moment a real conflict begins.

- **The Army: Fighting Gravity, Cold, and Distance**

  For the Indian Army, the defining energy challenge is geography. The Northern and Eastern borders sit in some of the highest, coldest, and most inhospitable terrain on earth, and nearly everything runs on diesel and kerosene.

Consider the Siachen Glacier, often called the highest battlefield in the world. At altitudes where temperatures regularly drop below minus fifty degrees Celsius, kerosene is not a convenience; it is survival. Soldiers use it to heat their shelters, cook their food, and melt ice into drinking water. A single outpost of fifteen men goes through roughly 112 litres every month, which adds up to about 1,350 litres per year.[18] Multiply that across the estimated 150 posts scattered along the glacier, and the annual consumption tops 202,500 litres of kerosene, and it's just to keep people alive. Getting it there is a feat of endurance in itself: a 67-kilometre pipeline laid by Indian Army engineers, relentless helicopter shuttle flights, and human porters threading their way through crevasse fields where avalanches are a daily hazard.[19, 20]

Further West, the annual advanced winter stocking operation in Ladakh is another logistical marathon. Before the high passes like Zojila and Rohtang shut for winter, the Indian Oil Corporation has to push more than 100,000 kilolitres of petroleum products across 1,600 to 2,000 kilometres of hostile terrain, with each round trip swallowing seven to eight days. And then there is the sheer thirst of heavy armour. The T-90 Bhishma, at 46 tonnes with a thousand-horsepower engine, and the indigenous Arjun MBT, tipping the scales at 68 tonnes in its Mk1A form and guzzling roughly seven litres of diesel for every kilometre it covers, act as enormous logistical anchors the moment they start moving.[21, 22, 23, 24, 25]

Platform / Theatre	**Energy Consumption**	**Strategic Context**
Siachen Glacier	~202,500 litres kerosene/ year	Survival fuel for 150 high-altitude posts at extreme temperatures
Ladakh Winter Stocking	>100,000 kilolitres (mixed fuels)	Pre-winter stockpile for XIV Corps moving over 1,600 km of vulnerable routes

Arjun MBT	~7 litres diesel per km	1,400 HP powerplant demands a continuous, nearby supply during manoeuvres
Su-30MKI	~10,200 litres ATF per hour	Twin-engine fighters dictating massive airbase fuel reserves
INS Vikramaditya	100 tonnes steam per hour (LSHSD)	180,000 HP carrier needing vast fuel logistics for blue-water operations

- **The Air Force: Burning Fuel at Supersonic Rates**

  Aviation turbine fuel is the IAF's lifeblood, and it gets expensive fast. Its primary air superiority platform, the Sukhoi Su-30MKI, burns roughly 10,200 litres per hour of flight. Multiply that across dozens of aircraft flying combat sorties, and the numbers become staggering.[26] Cut the fuel flow through a strike on a refinery, a bombed-out pipeline, or a cratered apron blocking tanker trucks, and the aircraft do not fly. Air superiority, so carefully built up over years, evaporates in days, and that is before accounting for the power-hungry side of airbase life: early-warning radars, SAM batteries, simulators, and encrypted communication networks all need electricity, continuously.

- **The Navy: Powering a Blue-Water Ambition**

  The further the Navy sails, the longer its fuel tail grows. Warships burn high-grade fuel continuously, and replenishment tankers must follow them through seas that are increasingly contested. INS Vikramaditya, the fleet's flagship carrier, generates a hundred tonnes of steam every hour through its high-pressure boilers, producing 180,000 horsepower worth of propulsion at speeds above thirty knots.[27, 28] Sustaining an entire Carrier Battle Group at sea for weeks is a logistics puzzle of the first order.

To be fair, the Navy has done more than the other services on green energy. It has commissioned 15.87 megawatts of solar capacity at shore facilities, with another sixteen megawatts under development. Transport fleets run on a B-7 biodiesel blend, and engineers have retrofitted diesel generators at several stations with indigenous emission-control systems.[29, 30] But these are peacetime, shore-based measures. A carrier battle group operating three thousand kilometres from Visakhapatnam runs on an entirely different calculus.

- **The Achilles' Heel: Grid Dependence and Missing Doctrine**
  India's sprawling military cantonments draw the bulk of their electricity from civilian power grids, grids that were never designed to be defended against a determined attacker. The Army's Southern Command has made encouraging strides, targeting "Net Zero" emissions by 2047 through AI-driven carbon mapping, solar expansion, smart metering, and green construction standards. But these remain isolated bright spots.[31] The overarching problem is structural: India sources 87 percent of its crude oil from foreign suppliers, and there is still no unified, tri-service operational energy doctrine. Without one, the forces cannot coherently plan, manage, or protect their energy supply when a crisis erupts.[32] That gap leaves the entire military architecture exposed to physical strikes and to the increasingly real threat of digital sabotage on the civilian grid it depends upon.

What Recent Wars Have Taught Us

Recent battlefields have confirmed what theorists long argued. Energy infrastructure is no longer a secondary target that commanders hit when they run out of better options; it is now the primary objective. Knock it out, and everything else follows.

- **Ukraine: A Masterclass in Energy Warfare**
  Russia's campaign against Ukraine has featured a deliberate, systematic assault on civilian and dual-use power systems. In just the five months between March and August 2024, coordinated waves of missiles, loitering munitions, and drones wiped out roughly nine gigawatts of Ukraine's electricity generation, knocking out

thermal plants, hydroelectric dams, and solar installations alike.[33, 34] The military consequences were severe: stable power is not optional when you need to run command-and-control networks, communications, intelligence processing, and logistics coordination.

Even before the first bombs fell, Russian-linked cyber units had been softening the ground. Groups like Sandworm deployed sophisticated malware —BlackEnergy 3, CRASHOVERRIDE, and KillDisk -to infiltrate and shut down Ukrainian power substations. And once the conventional fighting started, fuel convoys became priority targets: slow-moving, easily spotted by ever-present drones, and devastated by precision artillery.[35] The lesson was clear: if you depend on centralised power and long fuel supply lines, your adversary will make you pay for it.[36]

- **The Middle East: One Strike, Total Exposure**

  January 2020 brought a stark reality check. Iranian ballistic missiles rained down on Al-Asad airbase in Iraq, with warheads exceeding a thousand pounds slamming into a base where over 2,000 American troops were sheltering, relying on exposed diesel generators and centralised fuel storage. The attack illustrated with horrible clarity how bulk fuel depots and standalone generators transform a forward operating base into a sitting target.[37] That event more than any other drove the Pentagon's rapid shift toward distributed tactical microgrids -spreading power generation across multiple nodes so that destroying one does not plunge the whole installation into darkness.[38]

- **China's Himalayan Playbook**

  For Indian defence planners, the PLA's Himalayan energy adaptation is the most immediately relevant and disturbing case study of all. The Chinese military recognised early that sustaining massive diesel logistics across the Tibetan Plateau through winter was practically impossible. Solar microgrids were the answer. Fewer trucks mean a smaller convoy footprint for Indian artillery to hit.[39]

Silent photovoltaic power means no rumbling generators advertising positions to surveillance systems. No diesel means no thermal plume for infrared sensors to lock onto. At extreme altitudes, energy independence does not just reduce logistical strain; it translates directly into combat superiority.

The Challenges India Must Overcome

India's path to military energy security is not blocked by one problem; it is blocked by several, each making the others worse.

- **Geography That Fights Back**

  India's borders are zones of extreme operational friction. The Himalayan environment savage's internal combustion engines; thin air means worse fuel efficiency and lower power output - and punishes the human body in equal measure. High-altitude outposts devour heating fuel, and keeping them supplied ties up thousands of troops, porters, and helicopter crews in purely logistical roles, diverting them from combat duties. Meanwhile, the Navy faces the opposite kind of vastness: an oceanic domain stretching from the Strait of Hormuz to the Malacca Strait, requiring enormous reserves of marine diesel and aviation fuel to maintain persistent patrols and safeguard the sea routes that India's economy depends on.[40, 41, 42]

- **The Imported Oil Trap**

  Buying 87 percent of crude oil from other countries is more than just an economic inconvenience; it is also a national security threat. All of that oil has to go via chokepoints, where interruptions are commonplace rather than hypothetical. Insurance rates for oil tankers skyrocketed by over 40% nearly overnight when Houthi rebels started assaulting shipping in the Red Sea. This is a striking example of how warring countries and non-state actors may pinch India's energy lifeline. Opponent naval blockades or more stringent international sanctions may completely cut off the oil supplies in a full-scale conflict. In that case, mechanized

land troops would be stopped in their tracks, the Air Force would be grounded, and the Navy would be restricted to coastal seas.

- **The Digital Danger: Cyber Threats to the Grid**
  Military facilities are becoming increasingly vulnerable to hacking as they grow more intelligent and networked. Cyberattacks that could spread far beyond their source are made possible by the expanding interconnection between military installations and civilian smart grids. A targeted attack on grid management centres, Supervisory Control and Data Acquisition (SCADA) control systems, or smart inverters might result in rolling blackouts throughout large areas.[43, 44]

  This isn't conjecture. Mumbai experienced a significant power outage in October 2020 that severely damaged trains and interfered with the city's economic operations. The event was later linked by cybersecurity specialists to an intrusion effort by RedEcho, a Chinese state-affiliated threat group that had penetrated India's power industry. More generally, advanced persistent threat groups like Salt Typhoon and Volt Typhoon have demonstrated their ability to infiltrate vital infrastructure with the very express goal of impeding or delaying military mobilization in the event of a crisis. The Western Command of the Indian Navy has taken this danger seriously enough to conduct frequent "energy-cyber war games," which mimic attacks on LNG terminals and oil refineries. This is an admission that cyberattacks on energy facilities will most likely occur before any traditional military action.[45, 46, 47]

Cyber Threat Vector	How It Works	What It Means for the Military
SCADA System Infiltration	Phishing and credential theft (e.g., BlackEnergy 3) to seize remote control of substations	Base power goes down; radars go blind, & C4ISR networks collapse
Smart Inverter Manipulation	Botnet-driven DDoS attacks (e.g., Mirai) swamping distributed energy resources	Local microgrids fail in a chain reaction, forcing fallback to exposed diesel backups

Telephony Denial of Service (TDoS)	Flooding phone lines during an active grid failure	Military logistics commands cannot coordinate with civilian grid operators for recovery
Data Wiper Malware	Destructive code (e.g., KillDisk) that erases system logs and operational data	Extended paralysis; digital command infrastructure must be physically rebuilt from scratch

- **Climate Change: The Threat No One Can Sanction Away**
  Climate change is not a distant policy debate for the Indian military; it is a physical, operational reality hitting today. Himalayan glaciers are retreating, threatening not only regional hydropower but also the basic water supplies for remote bases, which means the military may soon have to truck in water alongside fuel, further loading already groaning supply chains. Extreme weather events, the flash floods and landslides that routinely wreck stretches of National Highway 44 in Jammu and Kashmir, periodically sever the very roads that winter fuel stocking depends on.[48] Along the coasts, rising sea levels and intensifying cyclones pose a creeping but relentless threat to naval bases in Kochi, Visakhapatnam, and the Andaman Islands.[49, 50]

Technologies That Will Reshape Military Energy

Combustion engines will not power the next generation of warfare. The forces that understand this earliest - and invest accordingly - will hold major operational advantages within a decade. Several technologies are already close enough to reshape thinking.

- **Nuclear Microreactors and Small Modular Reactors**
  If there is a silver bullet technology for remote military bases, it will be small modular reactors. These compact nuclear systems can churn out continuous, high-yield electricity for years without needing an external fuel delivery. The United

States is chasing this through Project Pele and the Janus Program. India is not sitting still either: the Bhabha Atomic Research Centre, under the Department of Atomic Energy, is actively developing the 200 MWe Bharat Small Modular Reactor (BSMR-200) and the 55 MWe SMR-55, with the latter specifically designed for off-grid service in remote locations and earmarked for initial deployment at the Tarapur Atomic Power Station.[51] [52] The Bhabha Atomic Research Centre (BARC) is also working on a 5 MWt high-temperature gas-cooled reactor at its Vizag research campus aimed at producing hydrogen, potentially a clean fuel source for transport fleets. These reactors are natural candidates for powering strategic military hubs in the Himalayas and on island territories, where conventional fuel delivery is a perpetual headache.[53]

- **Solid-State Batteries for the Drone Age**

  Drones, loitering munitions, and autonomous sensor networks have changed the battery equation for good. Lithium-ion cells, the current standard, are heavy, have limited cycle life, and their flammable liquid electrolytes make them a fire hazard in high-temperature battle environments. Solid-state batteries fix all three problems at once, swapping the liquid electrolyte for a solid material. Companies like ESOX Group are already fitting them into defence interceptor drones and achieving extended flight time with virtually no thermal runaway risk.[54, 55, 56, 57] For India, developing this technology domestically is not merely about better drones; it is about breaking a dangerous structural dependence on Chinese-controlled lithium and rare-earth supply chains before that dependence becomes a strategic choke point.

- **Hybrid Propulsion and Air-Independent Power**

  Military vehicles and ships are shifting toward hybrid-electric drivetrains, near-silent operation, reduced heat signatures, and lower fuel burn. In the submarine world, this trend has produced a genuinely game-changing capability: air-independent propulsion. DRDO and Larsen & Toubro have developed an Air-Independent Propulsion (AIP) system that uses phosphoric acid fuel cells to

generate hydrogen on demand inside the vessel.[58, 59, 60] The result is a dramatic extension in the Kalvari-class's submerged endurance and acoustic stealth, without the serious hazards of physically storing liquid hydrogen onboard. It is evident that the Navy is persuaded because the MoD has already committed contracts totalling about $335 million to retrofit the class with this capacity.[61, 62]

Strategic Moves for India

A structural issue of this magnitude cannot be resolved by half-measures. The following five policy changes have the potential to significantly alter India's military and energy stance within the current planning horizon, not over decades.

- **Build Self-Sufficient Military Microgrids—Do It Fast**.
  Construct Self-Sufficient Military Microgrids Quickly. Forward operating bases, military cantonments, and radar stations need to become independent of the civilian power system. The deployment of intelligent, tactical microgrids with solar panels, sophisticated battery storage, and a diesel backup for real crises should be accelerated in India. The proof of concept is operational and already in place: At 4,400 meters above sea level in Chushul, Ladakh, National Thermal Power Corporation Limited (NTPC) and the Indian Army have established a solar-hydrogen microgrid. Electricity is produced by solar panels, and any extra power is used to electrolyze water to create green hydrogen, which serves as a dependable energy source at night and during cloudy conditions. The base receives 200 kWh continuously. Diesel generators, which are costly, dirty, and a logistical nightmare at that height, are no longer required by the army. India should improve that model and apply it to all crucial points along the Line of Actual Control.

- **Chart a Clear Path Toward Sustainable Aviation Fuel**.
  A significant portion of the military's overall fuel expenditure is used for aviation. Reducing the nation's whole reliance on imported petroleum requires increasing domestic production capacity for sustainable aviation fuel. One percent SAF in international flights by 2027, two percent by 2028, and five percent by 2030 are

the blending targets established by the government. The Air Force has already run trial flights using an indigenous SAF blend developed by Indian Oil Corporation and Praj Industries, demonstrating both technical feasibility and institutional willingness.[63] With India generating an estimated 230 million tonnes of surplus agricultural waste each year, the alcohol-to-jet production pathway holds genuine promise.[64] But reaching the projected eight to ten million tonnes of SAF output will not come cheap: industry estimates put the required investment at somewhere between 70 and 85 billion dollars, which makes deep public-private partnerships not just desirable but essential.[65, 66]

- **Turn the Andaman and Nicobar Islands into an Energy Fortress**.
  To project power credibly across the Indo-Pacific, counter China's growing string of dual-use bases, and protect vital sea lanes, India must transform the Andaman and Nicobar Islands into a fully self-sustaining maritime stronghold. The roughly ninety-thousand-crore Great Nicobar Development Project is the centrepiece of this effort. Alongside a sixteen-million-TEU transshipment port and a dual-use military airport, the project includes a 450 MVA gas-and-solar hybrid power plant engineered to guarantee total energy reliability for the tri-services command based there.[67, 68, 69, 70] The administration has already floated a tender for a 20 MWh battery energy storage system at Dollygunj in the Andamans, a tangible step toward marrying renewable energy with grid stability on isolated islands.[71,72] Once complete, these fortified, self-sustaining facilities will let the Navy refuel, repair, and sustain carrier battle groups without depending on painfully long logistics chains from the mainland.

- **Expand and Lock Down the Strategic Petroleum Reserve**.
  Renewables and nuclear represent the long game; for now, liquid fuel remains the lifeblood of every major military platform India fields. The Phase I Strategic Petroleum Reserve currently holds 5 million metric tonnes of crude oil in underground rock caverns at Visakhapatnam, Mangaluru, and Padur.[73, 74] That sounds like a lot until you compare it to peers: China's combined strategic and

commercial stockpiles cover at least 96 days of crude imports, and IEA member nations are required to maintain a minimum of 90 days' worth.[75, 76] India needs to move urgently on Phase II, which will add another 6 million metric tonnes at Chandikhol in Odisha and an expanded Padur facility, funded through a public-private partnership model.[77, 78, 79, 80, 81] Critically, the military must be guaranteed prioritised, no-questions-asked access to these reserves the moment a national emergency is declared.

SPR Phase	Locations	Capacity	Status
Phase I	Visakhapatnam, Mangaluru, Padur	5.33 MMT	Fully operational; filled during low-price windows
Phase II	Chandikhol, Padur II	6.50 MMT	Approved; proceeding under the Design-Build-Finance-Operate-Transfer model

- **Indigenise Military Energy Tech Through iDEX**.

  Swapping a dependence on Middle Eastern oil for a dependence on Chinese lithium and rare-earth minerals would be trading one strategic vulnerability for another, and probably a worse one. The Ministry of Defence needs to drive the Innovations for Defence Excellence (iDEX) framework hard toward domestic energy startups, MSMEs, and university labs. Targeted schemes like ADITI, offering grants of up to twenty-five crore rupees, and iDEX Prime, at up to ten crores, can seed the homegrown development of solid-state batteries, portable micro-turbines, military-grade SCADA cybersecurity tools, and power management software.[82, 83, 84] The payoff is not just hardware. It is an indigenous intellectual property foundation for defence energy systems that is impervious to embargoes and sanctions.

RECOMMENDATIONS

Filing drawers are filled with strategy papers. Here are specific procedures to incorporate energy thinking into the troops' real planning, training, and combat.

- **Create a Tri-Service Energy Command Cell**

  India now requires a special unified entity for energy, just as it formed the Defence Cyber Agency and the Defence Space Agency. This unit would standardize the acquisition of battery systems and microgrids, develop tri-service operational energy doctrine, coordinate cross-service fuel logistics during emergencies, and fortify every military electrical grid against cyberattacks. Energy needs to be managed service by service in distinct silos because it is extremely crucial and cross-cutting.

- **Build a Professional Energy Operations Cadre**

  The Indian Armed Forces should develop a specialized cadre of Energy Operations Officers—professionals with advanced training in energy logistics, smart-grid management, thermodynamics, and power-system resilience—inspired by the U.S. Department of Defence. Instead of being viewed as an administrative task best left to conventional supply corps, energy must be viewed as a smart, tactical weapon system in and of itself.[85, 86]

- **Put Energy Failure into Every Wargame**

  Scenarios including complete power outages and the actual cutting of gasoline supply lines must be regularly included in future military drills, tabletop wargames, and operations plans. The army and air force should be included in the "energy-cyber war games" that the Western Naval Command now holds. Because a skilled foe will force them to battle in severely degraded energy situations, commanders at all levels must practice fighting—and winning—in such environments.[87]

- **Fast-Track a Military Small Modular Reactor**

  To modify the SMR-55 microreactor for military uses, the Department of Atomic Energy and the Ministry of Defence should establish a direct and expedited relationship. By 2030, a functional prototype that provides years of continuous electricity without a single fuel truck might be put at a secure naval base or at a

high-altitude logistical hub in Ladakh or the Northeast, completely redefining what is feasible for India's strategic basing.[88]

- **Scale the 'Net Zero' Cantonment Programme Nationwide**
  The Southern Command's AI-powered energy auditing and carbon mapping initiatives are a perfect example, but they shouldn't be limited to a single command. Every regional command should be instructed to implement SCADA-based energy monitoring throughout all installations, aggressively increase rooftop and ground-mounted solar capacity, and embrace Green Rating for Integrated Habitat Assessment (GRIHA) green building standards. In addition to freeing up national energy resources, reducing the military's reliance on the civilian grid makes it much more difficult to take any base offline.[89]

Conclusion

The necessities of combat in the twenty-first century are clear. Energy is not a logistics afterthought; it is the primary vulnerability that a capable adversary will exploit and the primary enabler that a prepared force will defend. The conflicts ahead will not necessarily go to the side with the longest weapons catalogue. They will go to the force that keeps its microgrids running, its sensors powered, its data centres cooled, and its trucks moving even after the civilian grid fails and the oil stops coming.

India's current military energy model, weighed down by the physical extremes of Himalayan and Indian Ocean operations and structurally shackled to imported fossil fuels leaves dangerous gaps in the nation's strategic autonomy. However, none of these gaps will last forever. The Indian Armed Forces can radically alter their strategic position by making a firm move toward decentralized microgrids, locally produced sustainable aviation fuels, solid-state energy storage, and eventually tiny nuclear reactors at the tactical edge.

The objective is simple to articulate but challenging to construct: a force capable of maintaining high-intensity, multi-domain operations without relying on foreign oil or an

unprotected civilian grid. When you get to that point, the deterrence calculation shifts. An adversary contemplating escalation is aware that it cannot shut down India by destroying a power infrastructure, damaging a refinery, or obstructing a sea passage. More valuable than any one weapon system is the assurance that India will fight no matter what. When done correctly, energy resilience is a deterrent.

DISCLAIMER

The paper is the author's individual scholastic articulation and does not necessarily reflect the views of CENJOWS, the Defence forces, or the Government of India. The author certifies that the article is original in content, unpublished, and it has not been submitted for publication/ web upload elsewhere and that the facts and figures quoted are duly referenced, as needed and are believed to be correct.

ENDNOTES

[1] Energy Affairs, Security and Defence: India's Strategic Balancing in 2025, accessed on February 24, 2026, https://moderndiplomacy.eu/2025/09/30/energy-affairs-security-and-defence-indias-strategic-balancing-in-2025/

[2] A Case Study of Russian Cyber-Attacks on the Ukrainian Power Grid, accessed on February 24, 2026, https://digitalcommons.pepperdine.edu/cgi/viewcontent.cgi?article=1216&context=ppr

[3] Oil Energy, India-U.S. Relations, and the Russia Conundrum | Council on Foreign Relations, accessed on February 24, 2026, https://www.cfr.org/articles/oil-energy-india-u-s-relations-and-the-russia-conundrum

[4] Security Implications of China's Military Presence in the Indian Ocean - CSIS, accessed on February 24, 2026, https://www.csis.org/analysis/security-implications-chinas-military-presence-indian-ocean

[5] Logistic battle of Ladakh - Indian Defence Industries, accessed on February 24, 2026, https://indiandefenceindustries.in/notes/logistic-battle-ladakh

[6] Operational Energy - OUSD A&S - acq.osd.mil, accessed on February 24, 2026, https://www.acq.osd.mil/eie/ero/oe/index.html

[7] Department of Defense Operational Energy Strategy - The Center for Climate & Security, accessed on February 24, 2026, https://climateandsecurity.org/wp-content/uploads/2024/11/2023-Operational-Energy-Strategy.pdf

[8] US Army launches advanced reactor programme - World Nuclear News, accessed on February 24, 2026, https://www.world-nuclear-news.org/articles/us-army-launches-advanced-reactor-programme

[9] Army announces next steps on Janus Program for next-generation nuclear energy, accessed on February 24, 2026, https://www.army.mil/article/289074/army_announces_next_steps_on_janus_program_for_next_generation_nuclear_energy

[10] Department of Defense Breaks Ground on Project Pele Microreactor, accessed on February 24, 2026, https://www.energy.gov/ne/articles/department-defense-breaks-ground-project-pele-microreactor

[11] Chapter 12, accessed on February 24, 2026, https://indsr.org.tw/uploads/enindsr/files/202206/06a75ced-ba76-43fc-9dee-b02cebe9932c.pdf

[12] Chapter 12, accessed on February 24, 2026, https://indsr.org.tw/uploads/enindsr/files/202206/06a75ced-ba76-43fc-9dee-b02cebe9932c.pdf

[13] Chinese soldiers gear up for winter warfare | The Strategist, accessed on February 24, 2026, https://www.aspistrategist.org.au/chinese-soldiers-gear-up-for-winter-warfare/

[14] Powering the PLA Abroad: How the Chinese Military Might Fuel Its Overseas Presence, accessed on February 24, 2026, https://www.rand.org/pubs/external_publications/EP70351.html

[15] Security Implications of China's Military Presence in the Indian Ocean - CSIS, accessed on February 24, 2026, https://www.csis.org/analysis/security-implications-chinas-military-presence-indian-ocean

[16] Energy security | NATO Topic, accessed on February 24, 2026, https://www.nato.int/en/what-we-do/wider-activities/energy-security

[17] NATO PA weighs Ukraine war's impact on energy and trade, says rebuilding must start now, accessed on February 24, 2026, https://www.nato-pa.int/news/nato-pa-weighs-ukraine-wars-impact-energy-and-trade-says-rebuilding-must-start-now

[18] Oil Energy, India-U.S. Relations, and the Russia Conundrum | Council on Foreign Relations, accessed on February 24, 2026, https://www.cfr.org/articles/oil-energy-india-u-s-relations-and-the-russia-conundrum

[19] Siachen glacier is turning into a high-altitude dumping site | Dialogue Earth, accessed on February 24, 2026, https://dialogue.earth/en/nature/siachen-glacier/

[20] Siachen Glacier: Battling on the roof of the... - Indian Strategic Studies, accessed on February 24, 2026, https://www.strategicstudyindia.com/2015/06/siachen-glacier-battling-on-roof-of.html

[21] Indian Oil completes highest-ever winter stocking in Ladakh - Energy News, accessed on February 24, 2026, https://energy.economictimes.indiatimes.com/news/oil-and-gas/indian-oil-sets-record-with-winter-fuel-stocking-in-ladakh/126253478

[22] Arjun (tank) - Wikipedia, accessed on February 24, 2026, https://en.wikipedia.org/wiki/Arjun_(tank)

[23] Why is that ARJUN tank is mocked all over the world? : r/IndianDefense - Reddit, accessed on February 24, 2026, https://www.reddit.com/r/IndianDefense/comments/1hx5jle/why_is_that_arjun_tank_is_mocked_all_over_the/

[24] T90 Bhishma, Armoured Vehicles Nigam Limited, India, accessed on February 24, 2026, https://avnl.co.in/products/t90-bhishma
[25] Oil Energy, India-U.S. Relations, and the Russia Conundrum | Council on Foreign Relations, accessed on February 24, 2026, https://www.cfr.org/articles/oil-energy-india-u-s-relations-and-the-russia-conundrum
[26] Sukhoi Aircraft Fuel Consumption Calculator, accessed on February 24, 2026, https://www.consumptioncalculator.io/fuel/Sukhoi_Aircraft_fuel_consumption_calculator.php
[27] Vikramaditya Class Indian Aircraft Carrier - ODIN, accessed on February 24, 2026, https://odin.tradoc.army.mil/WEG/Asset/5ade60d5b386f3639549d0f8fa1be24b
[28] INS Vikramaditya - Wikipedia, accessed on February 24, 2026, https://en.wikipedia.org/wiki/INS_Vikramaditya
[29] Indian Navy SAILS towards pursuance of the energy and... - PIB, accessed on February 24, 2026, https://www.pib.gov.in/PressReleasePage.aspx?PRID=1573389
[30] Indian Navy's Green Initiatives: Sustainable Defence at Sea, accessed on February 24, 2026, https://clearcutmedia.co.in/indian-navy-green-initiatives-sustainability/
[31] Southern Command Pune declares 2047 as 'Net Zero Carbon Year' - PIB, accessed on February 24, 2026, https://www.pib.gov.in/PressReleasePage.aspx?PRID=2022733
[32] Oil Energy, India-U.S. Relations, and the Russia Conundrum | Council on Foreign Relations, accessed on February 24, 2026, https://www.cfr.org/articles/oil-energy-india-u-s-relations-and-the-russia-conundrum
[33] Ukraine's energy system under attack - IEA, accessed on February 24, 2026, https://www.iea.org/reports/ukraines-energy-security-and-the-coming-winter/ukraines-energy-system-under-attack
[34] Sept. 2024 – Attacks On Ukraine's Electricity Infrastructure Threaten Key Aspects of Life As Winter Approaches, accessed on February 24, 2026, https://ukraine.ohchr.org/en/Attacks-On-Ukraines-Electricity-Infrastructure
[35] A Case Study of Russian Cyber-Attacks on the Ukrainian Power Grid, accessed on February 24, 2026, https://digitalcommons.pepperdine.edu/cgi/viewcontent.cgi?article=1216&context=ppr
[36] ENERGY HIGHLIGHTS - nato ensec coe, accessed on February 24, 2026, https://www.enseccoe.org/wp-content/uploads/2024/10/Energy-Highlights-No.19.pdf
[37] Who would live and who would die: The inside story of the Iranian attack on Al Asad Airbase, accessed on February 24, 2026, https://www.cbsnews.com/news/iranian-attack-al-asad-air-base-60-minutes-2021-08-08/
[38] Enhancing Operational Readiness: The Tactical Microgrid Standard - PowerSecure, accessed on February 24, 2026, https://powersecure.com/blog/enhancing-operational-readiness-the-tactical-microgrid-standard-and-the-impact-of-microgrids-on-modern-military-bases
[39] Chinese soldiers gear up for winter warfare | The Strategist, accessed on February 24, 2026, https://www.aspistrategist.org.au/chinese-soldiers-gear-up-for-winter-warfare/
[40] Siachen Glacier: Battling on the roof of the... - Indian Strategic Studies, accessed on February 24, 2026, https://www.strategicstudyindia.com/2015/06/siachen-glacier-battling-on-roof-of.html
[41] Security Implications of China's Military Presence in the Indian Ocean - CSIS, accessed on February 24, 2026, https://www.csis.org/analysis/security-implications-chinas-military-presence-indian-ocean
[42] Oil Energy, India-U.S. Relations, and the Russia Conundrum | Council on Foreign Relations, accessed on February 24, 2026, https://www.cfr.org/articles/oil-energy-india-u-s-relations-and-the-russia-conundrum
[43] Power Grids and Points of Vulnerability - Internet & Social Media Law Blog, accessed on February 24, 2026, https://www.internetandtechnologylaw.com/cybersecurity-power-grid-concerns/
[44] Destabilizing Power Grid and Energy Market by Cyberattacks on Smart Inverters - arXiv, accessed on February 24, 2026, https://arxiv.org/html/2505.14175v1
[45] Chinese hackers targeted India's power grid system through malware: Report, accessed on February 24, 2026, https://www.deccanchronicle.com/nation/current-affairs/010321/chinese-hackers-targeted-indias-power-grid-system-through-malware-re.html
[46] China-Linked Cyber Operations Targeting US Critical Infrastructure - NJCCIC, accessed on February 24, 2026, https://www.cyber.nj.gov/threat-landscape/nation-state-threat-analysis-reports/china-linked-cyber-operations-targeting-us-critical-infrastructure
[47] Energy Affairs, Security and Defence: India's Strategic Balancing in 2025, accessed on February 24, 2026, https://moderndiplomacy.eu/2025/09/30/energy-affairs-security-and-defence-indias-strategic-balancing-in-2025/

[48] Energy Affairs, Security and Defence: India's Strategic Balancing in 2025, accessed on February 24, 2026, https://moderndiplomacy.eu/2025/09/30/energy-affairs-security-and-defence-indias-strategic-balancing-in-2025/
[49] Indian Oil completes highest-ever winter stocking in Ladakh - Energy News, accessed on February 24, 2026, https://energy.economictimes.indiatimes.com/news/oil-and-gas/indian-oil-sets-record-with-winter-fuel-stocking-in-ladakh/126253478
[50] Energy Affairs, Security and Defence: India's Strategic Balancing in 2025, accessed on February 24, 2026, https://moderndiplomacy.eu/2025/09/30/energy-affairs-security-and-defence-indias-strategic-balancing-in-2025/
[51] Small Modular Reactors and India: Institutional Drivers and Challenges - MP-IDSA, accessed on February 24, 2026, https://idsa.in/publisher/issuebrief/small-modular-reactors-and-india-institutional-drivers-and-challenges
[52] Parliament question: financial and operational structures for SMR deployment - PIB, accessed on February 24, 2026, https://www.pib.gov.in/PressReleasePage.aspx?PRID=2201523
[53] Maharashtra and Andhra Pradesh proposed for first Indian SMRs - World Nuclear News, accessed on February 24, 2026, https://www.world-nuclear-news.org/articles/maharashtra-and-andhra-pradesh-proposed-for-first-indian-smrs
[54] Researchers' Discovery Could Boost Solid-State Battery Performance - News Center, accessed on February 24, 2026, https://news.utdallas.edu/science-technology/su-solid-state-battery-performance-2025/
[55] Why We Must Prioritize Solid-State Batteries For Drone Technology - Forbes, accessed on February 24, 2026, https://www.forbes.com/councils/forbestechcouncil/2025/07/01/why-we-must-prioritize-solid-state-batteries-for-drone-technology/
[56] World's first solid-state battery to be integrated into defence drone - Aerospace Global News, accessed on February 24, 2026, https://aerospaceglobalnews.com/news/world-first-solid-state-battery-defence-drone/
[57] ESOX solid-state batteries for defence - E-Mobility Engineering, accessed on February 24, 2026, https://www.emobility-engineering.com/esox-solid-state-batteries-defence-x1-drone-x2-ugv/
[58] Optimizing Electric Vehicle Batteries for the Defense Industry - Hypercraft, accessed on February 24, 2026, https://hypercraftusa.com/optimizing-electric-vehicle-batteries-for-the-defense-industry-the-future-of-military-mobility/
[59] Larsen & Toubro and DRDO to develop air independent propulsion system to generate H2, accessed on February 24, 2026, https://h2-tech.com/news/2023/06-2023/larsen-toubro-and-drdo-to-develop-air-independent-propulsion-system-to-generate-h-sub-2-sub/
[60] Breathing Underwater: How AIP Systems Revolutionise Submarine Warfare - The Geostrata, accessed on February 24, 2026, https://www.thegeostrata.com/post/breathing-underwater-how-aip-systems-revolutionize-submarine-warfare
[61] Aatmanirbhar Bharat: DRDO's Fuel Cell-based Air Independent Propulsion system to soon be fitted onboard INS Kalvari - PIB, accessed on February 24, 2026, https://www.pib.gov.in/PressReleasePage.aspx?PRID=1893096
[62] Indian MoD signs two contracts worth $335 million to upgrade Kalvari-class submarines with AIP and electronic HWT capabilities - Naval News, accessed on February 24, 2026, https://www.navalnews.com/naval-news/2024/12/indian-mod-signs-two-contracts-worth-335-million-to-upgrade-kalvari-class-submarines-with-aip-and-electronic-ewt-capabilities/
[63] India to launch national SAF roadmap: ISMA | Latest Market News - Argus Media, accessed on February 24, 2026, https://www.argusmedia.com/en/news-and-insights/latest-market-news/2781853-india-to-launch-national-saf-roadmap-isma
[64] Developing a Sustainable Aviation Transition Strategy in India | Air and Space Power Centre, accessed on February 24, 2026, https://airpower.airforce.gov.au/blog/developing-sustainable-aviation-transition-strategy-india
[65] Green wings: India's SAF revolution in the making - Deloitte, accessed on February 24, 2026, https://www.deloitte.com/in/en/issues/climate/sustainability-and-climate/sustainable-aviation-fuel-report.html
[66] Fuelling a cleaner sky: India's opportunity in sustainable aviation fuel - KPMG, accessed on February 24, 2026, https://assets.kpmg.com/content/dam/kpmgsites/in/pdf/2025/11/fuelling-a-cleaner-sky-indias-opportunity-in-sustainable-aviation-fuel.pdf

[67] India's next big power move is set to unfold in the Bay of Bengal - The Economic Times, accessed on February 24, 2026, https://m.economictimes.com/news/economy/infrastructure/great-nicobar-mega-infrastructure-project-indias-next-big-power-move-is-set-to-unfold-in-the-bay-of-bengal/articleshow/128458307.cms
[68] The Great Nicobar Project aims to create India's Hong Kong. So, why the row? - India Today, accessed on February 24, 2026, https://www.indiatoday.in/india/story/great-nicobar-port-project-controversy-sonia-gandhi-bjp-attack-row-ecology-legal-human-rights-concern-explained-2784301-2025-09-10
[69] Great Nicobar Island Development Project - Wikipedia, accessed on February 24, 2026, https://en.wikipedia.org/wiki/Great_Nicobar_Island_Development_Project
[70] Great Nicobar Mega Project Cleared by NGT: Strategic Imperatives Amid Ecological Concerns - Sanskriti IAS, accessed on February 24, 2026, https://www.sanskritiias.com/current-affairs/great-nicobar-mega-project-cleared-by-ngt-strategic-imperatives-amid-ecological-concerns
[71] Andaman & Nicobar Island Tenders 20 MWh BESS Project - Mercom India, accessed on February 24, 2026, https://www.mercomindia.com/andaman-nicobar-island-tenders-20-mwh-bess-project
[72] Island Grid Modernisation Gains Momentum as Andaman & Nicobar Floats Tender for Battery Storage Project - EQ Magazine, accessed on February 24, 2026, https://www.eqmagpro.com/island-grid-modernisation-gains-momentum-as-andaman-nicobar-floats-tender-for-battery-storage-project-eq/
[73] Government steps to Strengthen Strategic Petroleum Reserves - PIB, accessed on February 24, 2026, https://www.pib.gov.in/PressReleasePage.aspx?PRID=2113233
[74] Ukraine's energy system under attack - IEA, accessed on February 24, 2026, https://www.iea.org/reports/ukraines-energy-security-and-the-coming-winter/ukraines-energy-system-under-attack
[75] Oil Stocks of IEA Countries - Data Tools, accessed on February 24, 2026, https://www.iea.org/data-and-statistics/data-tools/oil-stocks-of-iea-countries
[76] China's Oil Demand, Imports and Supply Security - Center on Global Energy Policy at Columbia University SIPA | CGEP, accessed on February 24, 2026, https://www.energypolicy.columbia.edu/publications/chinas-oil-demand-imports-and-supply-security/
[77] Schemes - ISPRL: Indian Strategic Petroleum Reserves Limited, accessed on February 24, 2026, https://www.isprlindia.com/schemes.asp
[78] Strategic Petroleum Reserve Programme - PIB, accessed on February 24, 2026, https://www.pib.gov.in/PressReleasePage.aspx?PRID=1945418
[79] India's Strategic Petroleum Reserves: Safeguarding Energy, accessed on February 24, 2026, https://ifluids.com/blog/indias-strategic-petroleum-reserves/
[80] Government steps to Strengthen Strategic Petroleum Reserves - PIB, accessed on February 24, 2026, https://www.pib.gov.in/PressReleasePage.aspx?PRID=2113233
[81] Oil Energy, India-U.S. Relations, and the Russia Conundrum | Council on Foreign Relations, accessed on February 24, 2026, https://www.cfr.org/articles/oil-energy-india-u-s-relations-and-the-russia-conundrum
[82] iDEX Details | DDPMoD - Department of Defence Production, accessed on February 24, 2026, https://www.ddpmod.gov.in/offerings/schemes-and-services/idex
[83] India's Path to Defence Self-Reliance: Challenges and Progress in the iDEX Initiative - IDSA, accessed on February 24, 2026, https://idsa.in/publisher/issuebrief/indias-path-to-defence-self-reliance-challenges-and-progress-in-the-idex-initiative
[84] Defence India Startup Challenge - iDEX, accessed on February 24, 2026, https://idex.gov.in/challenges
[85] July-September 2021, Army Sustainment Professional Bulletin, accessed on February 24, 2026, https://asu.army.mil/alog/ARCHIVE/PB7002103FULL.pdf
[86] Operational Energy — Essential Knowledge for Military Officers - Naval Postgraduate School, accessed on February 24, 2026, https://nps.edu/web/eag/operational-energy-essential-knowledge-for-military-officers
[87] Energy Affairs, Security and Defence: India's Strategic Balancing in 2025, accessed on February 24, 2026, https://moderndiplomacy.eu/2025/09/30/energy-affairs-security-and-defence-indias-strategic-balancing-in-2025/
[88] Parliament question: financial and operational structures for SMR deployment - PIB, accessed on February 24, 2026, https://www.pib.gov.in/PressReleasePage.aspx?PRID=2201523
[89] India's Joint Doctrine for Multi-Domain Operations: A Whole-of-Nation Framework, accessed on February 24, 2026, https://usiofindia.org/pdf/file_68c3c9dd2b33e.pdf