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Alternative Heating Technologies Amid Global Gas Supply Risks

14 March 2026

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14 March 2026 · 9 min read

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WHY IN NEWS

By 14 March 2026, escalating tensions around Iran — driven by the US-Israel conflict — have renewed fears of disruption to gas flows through the **Strait of Hormuz**, prompting Indian policymakers and industry bodies to revisit the strategic case for alternative industrial heating technologies, given that India imports nearly half of its natural gas through Gulf sea lanes.

THE ENERGY DEBATE INDIA IS NOT HAVING

India's energy conversations centre on electricity, solar power, and petroleum imports. What is systematically overlooked is the third pillar of industrial energy: **heat**. Boilers, furnaces, kilns, steam systems, and process-heating equipment are the backbone of sectors such as textiles, chemicals, ceramics, food processing,

pharmaceuticals, glass, and metals. In 2022-23, industry accounted for roughly **37% of India's total final energy consumption**, and a significant share of that was thermal energy — not electricity.

When natural gas supply becomes uncertain, industrial heat security becomes an economic issue with immediate production consequences. India imported approximately **26.6 billion cubic metres (BCM) of LNG** in FY 2024-25, most of it transiting through the Gulf. Any sustained disruption at the Strait of Hormuz would hit Indian industry — especially fertiliser plants, petrochemical units, and glass and ceramic factories — before consumers feel the effect.

This is the strategic context in which the case for **alternative heating technologies** has moved from niche discussion to policy urgency.

WHY INDUSTRIAL HEAT IS NOT THE SAME AS ELECTRICITY

A common misunderstanding is that electrifying industry solves all energy problems. For heating, this is only partially true because industrial heat demands span a wide temperature ladder. Low-temperature applications in food processing and dairy require heat below 100°C. Textile scouring and bleaching, pharmaceutical sterilisation, and brewery operations need 100–180°C. Chemical reactors, paper mills, and rubber processing operate in the 200–400°C range. Cement kilns, steel furnaces, and glass melting demand temperatures well above 1,000°C, with some processes exceeding 1,600°C.

No single technology covers this entire range. The transition away from gas-fired heat must be sector-specific and phased. This is precisely why the conversation about alternative heating technologies requires technical granularity rather than broad declarations about renewable energy.

THREE TECHNOLOGIES THAT CAN REPLACE GAS HEAT

Concentrated Solar Thermal (CST)

Among the most promising low- and medium-temperature options is **Concentrated Solar Thermal (CST)**. Unlike solar photovoltaic (PV) panels, which generate electricity, CST captures sunlight directly as usable heat. Mirrors or reflective surfaces — called heliostats or parabolic troughs — concentrate solar radiation onto a receiver, which transfers the energy to a working fluid such as thermal oil or water.

The critical feature that makes CST viable for industry is **Thermal Energy Storage (TES)**. Heat is stored in media such as molten salt, thermal oil, or phase-change materials, allowing the system to deliver process heat even after sunset or during cloud cover. This makes CST dispatchable — a property that solar PV alone cannot offer for heat applications.

CST can currently deliver temperatures up to approximately **400°C**, making it suited for textile processing, dairy, food and beverage manufacturing, and industrial laundries. According to the **Ministry of New and Renewable Energy (MNRE)**, India has an estimated **CST potential of 6.45 GWth** (thermal) — a figure

that reflects the country's high solar irradiance, particularly in Rajasthan, Gujarat, and parts of Maharashtra and Telangana. This potential remains almost entirely untapped.

The most internationally cited proof of concept is Oman's **Miraah Solar Thermal Project** at the **Amal oilfield**, originally developed by GlassPoint Solar (now operated by **Petroleum Development Oman (PDO)** following GlassPoint's liquidation). The first **330 MWth** phase is operational, generating approximately **2,000 tonnes of solar steam daily** for thermal enhanced oil recovery — one of the largest industrial solar-heat deployments in the world. When fully completed to **1,021 MWth**, it will produce 6,000 tonnes of steam per day.

Electromagnetic Induction Heating

Induction heating is particularly relevant for industries that work with conductive metals. An alternating current passes through a copper coil, generating a rapidly changing magnetic field. When a conductive material — steel, aluminium, copper — is placed within this field, **eddy currents** are induced inside the material itself. These currents encounter the material's electrical resistance, generating heat through **Joule heating** (named after physicist James Prescott Joule, 1841).

The critical distinction from conventional flame heating is that the heat is generated *inside the material*, not applied to its surface from outside. This has major practical consequences: thermal efficiency can exceed **90%**, compared to 40–60% for gas-fired furnaces. Heating is also rapid and highly controllable, reducing cycle times and improving product consistency.

Industries with the strongest case for induction adoption include automotive component manufacturing, metal forging, precision machining, and heat treatment. Since induction heating requires only electricity — not gas — its emissions profile depends entirely on the power source. If powered by renewables, it produces **zero direct on-site emissions**, making it a powerful decarbonisation tool alongside a gas-independence strategy.

Plasma Torches for Ultra-High Temperatures

Some industrial processes — particularly smelting, high-grade ceramics, advanced materials synthesis, and parts of cement and steelmaking — require temperatures that no conventional electric heater can deliver efficiently. This is the domain of **plasma torches**.

A high-voltage electric arc is struck between electrodes inside a chamber. A working gas — typically argon, nitrogen, or air — is forced through this arc, ionising it into a **plasma**, often described as the fourth state of matter. Plasma jets from industrial torches can deliver temperatures between **5,000°C and over 10,000°C**, far exceeding the limits of gas combustion.

Plasma torches allow much tighter control over the chemical atmosphere in the heating zone — a feature critical for advanced ceramics and specialty alloys where oxidation or contamination must be prevented. Countries including Japan, South Korea, and Germany have been advancing plasma-based furnaces for specialised metallurgy.

For India, plasma technology is particularly relevant to the steel sector — which is both a major emitter and a large gas consumer — and to the growing advanced materials and defence manufacturing ecosystem.

WHAT INDIA NEEDS TO DO: POLICY AND GAPS

The Missing Policy Category

Despite its scale, **industrial heat decarbonisation has no dedicated policy framework in India**. The country has a National Solar Mission, a National Hydrogen Mission, and a Green Hydrogen Policy, but no equivalent strategy for the roughly **37%** of industrial energy consumed as heat. This is a gap that has persisted through multiple national energy plans.

The **National Mission for Enhanced Energy Efficiency (NMEEE)**, launched in 2008 under the National Action Plan on Climate Change (NAPCC), covers energy efficiency in industry but does not specifically target heat-source transition. Similarly, the **Bureau of Energy Efficiency (BEE)** has conducted energy audits of industrial units but without a programmatic push toward heat-technology alternatives.

Structural Barriers to Adoption

The transition is not blocked by science alone. High upfront capital costs deter industries — particularly MSMEs — from switching even when the long-term economics favour it. The vendor ecosystem for CST components, induction systems, and thermal storage is extremely thin in India, meaning most equipment must be imported at significant cost. Awareness in traditional industry segments — ceramics, textiles, glass — remains low, and financing instruments specifically designed for industrial heat retrofits do not yet exist at scale.

A structural problem also lies in how energy is planned: electricity and heat are treated as separate categories by different ministries and regulators. Industrial heat decarbonisation requires integrated planning that currently does not happen.

The Strategic Opportunity

India's context differs from Europe's in one important respect: India does not use natural gas for residential space heating at the same scale as northern European countries. Its gas demand is concentrated in fertilisers, petrochemicals, and industrial processing. This concentration is precisely what makes targeted alternatives viable — the demand is industrial, clustered in specific sectors, and addressable through sector-specific technology deployment.

The strategic opportunity is to build domestic manufacturing capacity in CST components, induction power electronics, thermal storage equipment, and plasma systems — turning the heat transition into an industrial-development story, not merely an energy-security story.

WHY THIS MATTERS FOR UPSC

This topic connects to **energy security** under GS-3, industrial decarbonisation policy, the role of MNRE, India's renewable energy targets, and the geopolitical vulnerability of import-dependent energy supply chains. For Mains, it also connects to questions about why India's industrial sector is the most difficult to decarbonise, and what policy instruments are needed beyond solar power and EVs.

UPSC RELEVANCE

CST, induction heating, plasma torch, Thermal Energy Storage (TES), Joule heating, Strait of Hormuz, LNG, MNRE, NMEEE, BEE, Miraah Project.

MAINS GS-3:

Energy security, industrial decarbonisation, technology transition, import dependence, climate policy for industry.

★ FACTS CORNER — KNOWLEDGEPEDIA

GEOPOLITICAL TRIGGER:

Key chokepoint: Strait of Hormuz — handles approximately 20% of globally traded oil and significant LNG volumes

India's LNG imports: Approximately **26.6 BCM in FY 2024-25**, largely routed through Gulf sea lanes

India's industry energy share: Industry accounts for approximately **37% of India's total final energy consumption**

CONCENTRATED SOLAR THERMAL (CST):

Mechanism: Mirrors/reflectors concentrate sunlight onto a receiver; heat stored in Thermal Energy Storage (TES) media

TES media: Molten salt, thermal oil, phase-change materials

Temperature range: Up to approximately **400°C**

Best fit sectors: Textiles, food & beverage, dairy, pharmaceuticals, industrial laundry

India's CST potential: **6.45 GWth** (thermal) — MNRE-GEF-UNIDO CST Roadmap

Key global project: **Miraah Solar Thermal Project, Amal oilfield, Oman** — 330 MWth operational (of planned 1,021 MWth); generates ~2,000 tonnes solar steam/day; operated by PDO (Petroleum Development Oman)

ELECTROMAGNETIC INDUCTION HEATING:

Mechanism: Alternating current → changing magnetic field → eddy currents → Joule heating inside metal

Named after: James Prescott Joule (1841)

Thermal efficiency: Can exceed **90%** (vs 40–60% for gas furnaces)

Best fit: Automotive components, metal forging, heat treatment, precision manufacturing

Emission profile: Zero direct on-site emissions if electricity source is renewable

PLASMA TORCHES:

Mechanism: High-voltage arc ionises a working gas (argon/nitrogen/air) into plasma — the fourth state of matter

Temperature range: **5,000°C to over 10,000°C**

Best fit: Smelting, advanced ceramics, specialty alloys, steel, defence materials

INDIAN POLICY ARCHITECTURE:

MNRE: Ministry of New and Renewable Energy — nodal body for CST potential assessments

BEE: Bureau of Energy Efficiency — conducts industrial energy audits

NMEEE: National Mission for Enhanced Energy Efficiency — launched 2008 under NAPCC

Gap: No dedicated national industrial heat decarbonisation policy exists

OTHER RELEVANT FACTS:

Solar PV generates **electricity**; CST generates **heat directly** — functionally different applications

Industrial heat decarbonisation is widely called the “hardest sector to decarbonise” globally

High-temperature processes (>400°C) cannot yet be served by CST; require induction, plasma, or green hydrogen

India's gas demand is concentrated in fertilisers, petrochemicals, and industrial processing — unlike Europe's residential use pattern

Denmark's district heat models demonstrate the importance of **heat purchase agreements** and storage integration

Sources: [MNRE](#), [Bureau of Energy Efficiency](#), [International Energy Agency](#), [The Hindu](#)

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