# 6. Thermal Independent – Science & Technology

The escalating geopolitical volatility in West Asia, particularly disruptions near the Strait of Hormuz, has highlighted a critical vulnerability in India's industrial architecture- its heavy reliance on imported fossil fuels for thermal energy. Achieving Thermal Independence is no longer just a climate goal; it is a strategic necessity for national security and industrial resilience.

## 1. Background and Core Definitions

To understand the transition toward thermal independence, it is essential to define the energy landscape of manufacturing-

**Industrial / Thermal Heat-** This refers to the thermal energy used in manufacturing processes such as drying, smelting, chemical reactions, and textile finishing. It accounts for approximately 25% of India's total energy consumption.

**Thermal Independence-** A nation's ability to generate the heat required for industrial processes using domestic, sustainable sources (like solar, biomass, or green hydrogen) instead of imported hydrocarbons (natural gas, LPG, or coal).

**Intermittency-** The non-continuous nature of renewable energy sources like solar and wind, which require storage solutions to provide steady 24/7 power for industrial kilns and furnaces.

## 2. The Current Crisis- Fossil Fuel Dependencies

For decades, India's industrial clusters—such as the textile hubs in Ludhiana or the ceramic units in Morbi—have functioned on a fossil-fuel-first model.

**Vulnerabilities Exposed-**

**Energy Security Risks-** India's heavy reliance on West Asian gas makes its industries sensitive to price volatility and supply chain disruptions during regional conflicts.

**Operational Inefficiency-** Traditional gas boilers are inherently wasteful, often losing 20–30% of their energy through exhaust heat.

**Environmental Impact-** Industrial heat is a primary driver of greenhouse gas emissions, complicating India's path toward Net Zero targets.

## 3. Comparing Emerging Thermal Technologies

As India moves away from combustion, two primary technological pathways have emerged-

| Feature | Concentrated Solar Thermal (CST) | Electrified Heating (Induction/Plasma) |
|---|---|---|
| Mechanism | Mirrors concentrate sunlight to heat a fluid/generate steam. | Uses electric current or ionized gas to generate heat. |
| Temperature Range | Up to ~400°C (suitable for food/textiles). | 1000°C+ (suitable for metals/ceramics). |
| Efficiency | High thermal efficiency; direct heat use. | Exceeds 90% (heat produced directly in material). |
| Storage | Uses thermal storage tanks (cheaper than batteries). | Depends on grid-scale Li-ion or pumped hydro storage. |
| Infrastructure | Requires space for mirror arrays. | Requires high-voltage grid upgrades. |

## 4. Structural Constraints in India

Transitioning to a thermal-independent model faces significant "on-the-ground" hurdles-

**Electricity Grid & Supply**

**Sharp Demand Spikes-** Rapid electrification of heat would overwhelm current grid capacities, as industrial processes require massive, continuous 24/7 power.

**Storage Limitations-** While solar and wind are growing, India's utility-scale storage capacity is not yet sufficient to bridge the gap during non-sunny or non-windy hours.

**Distribution Infrastructure**

**Ageing Local Grids-** Industrial clusters often suffer from overloaded transformers and a lack of high-voltage substations.
**Investment Gap-** Upgrading the "last mile" of industrial power delivery requires vast capital expenditure in transmission networks.

## 5. Global Best Practices

India can draw lessons from international projects that have successfully integrated sustainable heat-
**The Miraah Project (Oman)-** Uses solar thermal to generate steam for oil production, reducing gas consumption by 80%.
**Plug-and-Play Units (Spain)-** Modular solar thermal units installed on factory rooftops that connect directly to existing steam networks.
**Heat Purchase Agreements (Denmark)-** A "Heat-as-a-Service" model where energy companies own and operate the systems, and factories simply pay for the heat used, removing high upfront capital barriers.

## 6. Strategic Policy Measures Needed

To achieve a self-reliant thermal ecosystem, a multi-pronged policy framework is required-
**National Thermal Policy-** Establishing a dedicated roadmap for industrial heat decarbonization, separate from general electricity policies.
**Incentives for CST-** Launching Production-Linked Incentive (PLI) schemes and subsidies specifically for solar thermal, similar to those provided for Solar PV.
**Carbon Market Integration-** Utilizing the Carbon Credit Trading Scheme to allow factories to sell credits earned through heat decarbonization, helping offset the cost of new equipment.
**Hybrid Energy Frameworks-** Encouraging systems that use CST during the day, Induction heating for precision, and Gas/Biomass as a backup to ensure a gradual, non-disruptive transition.

## 7. Conclusion

Thermal independence is the next frontier for India's "Atmanirbhar" mission. By shifting from imported hydrocarbons to a mix of solar thermal and high-efficiency electrification, India can protect its manufacturing sector from geopolitical shocks. However, the success of this transition depends on urgent grid modernization and specific policy incentives that treat industrial heat as a unique and vital energy sector.

Source- https-//www.thehindu.com/sci-tech/science/electrifying-industrial-heat-as-a-path-to-indias-thermal-independence/article70736629.ece