TOPTIER ENERGY SERVICES PVT LTD

The Hidden Energy Bill Behind India’s Decorative Laminates

How high-pressure laminate manufacturers can cut process heat costs, optimize renewable power and reduce Scope 1, 2 and 3 emissions



AI-generated illustration of a fictional laminate facility.

A decorative laminate arrives at a furniture factory as a finished sheet. Its energy bill began long before the sheet came out of the press. The paper had to be impregnated and dried, the layers heated and compressed, and the finished material cooled, trimmed and inspected. If the sheet fails inspection, the plant pays for much of that sequence twice.

That makes first-pass yield a useful starting point for a discussion about decarbonization. A rejected sheet absorbs paper, resin, heat and electricity before anyone decides what to do with it. A CFO can see the material loss. A plant head can trace the process deviation. An energy manager can show the extra fuel and power. Putting those three views together yields a more useful investment list than starting with the name of a technology.

Where the energy goes

High-pressure laminate, or HPL, typically uses kraft paper for the core and décor paper for the visible face. Thermosetting resin binds the layers. An optional overlay may be used, depending on the finish and grade. In a conventional line, treated papers pass through controlled drying and partial curing before cutting and layup. A hydraulic hot press then consolidates the layup under heat and pressure. The process finishes with cooling, trimming, sanding where required, inspection and packing. Compact grades share much of this sequence, with production conditions and material intensity varying by thickness and product design. Separate particleboard, MDF or plywood conversion lines need their own energy and product boundaries. ICDLI thin HPL EPD · US EPA laminating process reference

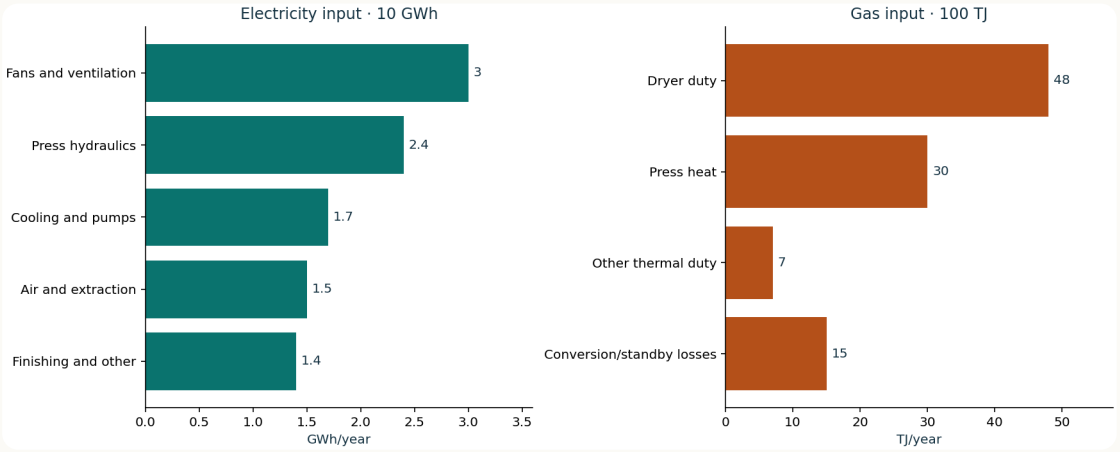
Three measurements make the production story clearer. First, record dryer fuel or steam by shift and link it to treated-paper throughput, moisture removal, resin pickup and rejects. Second, meter press heat and hydraulic electricity separately and record loaded cycles, idle time, heating, cooling and rejects. Third, measure electrical demand from fans, pumps, dust collection and air compressors while lines are running and while they are waiting. A utility that stays on between batches may offer savings without changing a product recipe.

Use kWh and delivered fuel MJ per square metre of saleable laminate, segmented by thickness and grade. Add kWh per press cycle and MJ per kilogram of treated paper for troubleshooting. A move toward thicker compact laminates can raise energy per square metre even as both process efficiency and yield improve. Normalize for product mix, output, startup and ambient conditions before drawing conclusions. Align scale tickets, meters and production logs to the same time period.

From paper rolls to finished laminate

Paper and resin	Kraft core paper, décor paper, overlay if needed and thermosetting resin
Impregnation and drying	Coat paper → remove carrier and partially cure → cut and prepare stacks Process heat and dryer fan power
Layup and hot pressing	Assemble layers → press with heat and hydraulic pressure Process heat and hydraulic power
Cooling and finishing	Cool → trim and sand where needed → inspect and pack Pumps, motors, extraction and handling
Dispatch	Saleable sheets to fabricators or distributors. Reconcile rejects and offcuts.

Industry process schematic. Actual line configuration varies. Sources: ICDLI thin HPL EPD (2022) and US EPA laminating process reference.



Hypothetical allocation. Both meters are shown at their respective input boundary. The fuel split traces fuel input to end-use duty or losses. It is not an industry benchmark.

Where the carbon footprint comes from

Scope 1 starts with on-site fuel. Gas, coal, oil or diesel can serve process heaters, boilers, standby power and company-controlled vehicles. Include refrigerant leakage where applicable and screen wastewater treatment and identified process GHG sources. Separately track formaldehyde, other volatile organic compounds, and dust under applicable air and workplace controls. For biomass, record non-CO_2 combustion GHGs and disclose biogenic CO_2 separately under the applicable inventory methodology. Include upstream fuel impacts in the appropriate Scope 3 category. The business case for biomass depends on delivered useful heat, fuel moisture and traceability, reliable supply, permits, combustion performance and ash handling.

Scope 2 covers purchased electricity, steam, heat and cooling. Location-based accounting uses average emissions for the grid supplying the plant. Market-based reporting reflects eligible contractual instruments where applicable. A power contract can save money and create a market-based claim if the attributes meet the quality criteria. Confirm ownership, exclusive claim, cancellation or retirement, geography, vintage and treatment of unclaimed supply. A generator, trader and buyer cannot each claim the same renewable attributes. Record both the electricity settlement and the instrument evidence. The route and ownership of an on-site installation also determine how its generation is accounted for. GHG Protocol Scope 2 Guidance

Scope 3 follows the material through purchasing, production and downstream use. Start with the bill of materials. Compare kraft paper, decorative paper and resin using supplier-specific cradle-to-gate factors for equivalent grades. If a site makes resin, account for purchased precursors and site energy. If it buys finished resin, use the resin supplier’s boundary and avoid counting the same inputs again. A conventional emissions inventory often starts with

expenditure estimates. A supplier or product decision needs physical quantities, defensible factors and enough detail to tell whether a change in grade, supplier or transport mode is responsible for the difference.

Carbon sources across the laminate value chain

Scope 1 · Direct	On-site dryers and heat systems, standby fuel, controlled vehicles, refrigerant leakage and relevant process or wastewater GHGs
Scope 2 · Purchased energy	Grid power and purchased steam, heat or cooling Keep location-based and eligible market-based claims distinct
Scope 3 · Value chain	Paper, resin, packaging, equipment, energy supply chains and freight Fabrication, waste and end-of-life treatment

Source: GHG Protocol scope definitions, applied to HPL.

Scope 3 category	HPL screening and next action
1. Purchased goods and services	Priority. Paper, resins or precursors, overlay, packaging and outsourced services. Procurement can set data requirements and qualify suppliers with technical teams.
2. Capital goods	Include relevant presses, lines and civil works. Finance and suppliers provide physical or spend data.
3. Fuel- and energy-related activities	Include upstream fuel and electricity activities and applicable electricity losses. Energy team reconciles against the Scope 1 and 2 ledgers.
4. Upstream transportation and distribution	Include inbound freight and purchased third-party freight, including outbound freight paid by the manufacturer. Logistics obtains lane, payload and fuel data.
5. Waste generated in operations	Track cured scrap, residues, dust, packaging, ash and wastewater by externally managed treatment route.

Scope 3 category	HPL screening and next action
6. Business travel	Screen by mode and distance. Finance owns travel data.
7. Employee commuting	Sample workforce trips, distance and mode. HR can support shared transport.
8. Upstream leased assets	Review leased warehouses, vehicles or equipment outside reported Scope 1 and 2.
9. Downstream transportation and distribution	Assess distribution of sold goods outside purchased freight in Category 4. Work with distributors.
10. Processing of sold products	Assess cutting, bonding or finishing by fabricators where HPL is sold as an intermediate product.
11. Use of sold products	A passive sheet generally has no direct use-phase energy. Evaluate relevant indirect use assumptions separately under the chosen reporting boundary.
12. End-of-life treatment	Model credible regional routes for installed products and offcuts. Adhesive bonds or mixed substrates can complicate separation.
13. Downstream leased assets	Assess only where the manufacturer leases assets to others outside its Scope 1 and 2 boundary.
14. Franchises	Check actual franchise arrangements and document exclusions if absent.
15. Investments	Screen applicable investments outside the organizational consolidation boundary.

GHG Protocol Scope 3 calculation guidance

How conventional operating practices become expensive

Three illustrative operating profiles show how the same equipment can produce different business outcomes. A **conventional plant** relies on fossil process heat and grid power, manages energy at the utility meter and has limited evidence for customer product declarations. Its first losses often show up in fuel per saleable sheet, standby power and scrap. A **transitioning plant** meters major loads, recovers selected heat, qualifies some renewable supply and asks key suppliers for footprint data. It can budget energy with more confidence, although savings depend on how consistently equipment and contracts perform. An **advanced plant** uses verified yield and heat data to guide targeted electrification, matches renewable power to demand, and routinely verifies supplier and product data. Its operating risk shifts toward maintaining controls, contractual performance, and dependable backup during equipment or grid constraints.

Each profile faces a different cost of delay. The first can miss efficiency projects with short paybacks. The second can sign a long-term PPA before confirming how much energy is usable across seasons. The third can overinvest in electrification if the planned sink turns out to be intermittent or the plant must pay for a larger connection. Customer tender requirements can turn reliable product data into a commercial advantage. Where data still come from averages, show the boundary and tell buyers which figures will be updated with verified supplier information.

Modernize the thermal system in stages

The first engineering step is a joint walk-through by process, utility, maintenance and quality teams. Measure dryer exhaust temperature and humidity, thermal supply and return, press cooling temperatures and loads by shift. Build a heat balance during stable production, grade changes and shutdown. Rank heat streams by actual usable

temperature and the hours they coincide with a receiving process. A warm exhaust stream has little financial value during a shift when its potential receiver is idle.

Recover clean heat where the pressure drop, cleaning schedule and corrosion risks allow it. Possible sinks include boiler makeup water, dryer inlet air and compatible wash water. Use suitable indirect exchangers where there is a contamination risk. Any change to dryer recirculation, airflow or exhaust should be validated against resin cure, emissions controls and fire safety. The same logic applies to dust extraction. Optimize fan control and isolate unused branches only where capture and safe operation stay within specification.

Industrial heat pumps are most useful where a steady, lower-temperature sink sits near a dependable source of recoverable heat. A hot-water preheat trial is easier to instrument and reverse than substituting a whole press heating system. Specify seasonal COP, temperature lift and guaranteed capacity at worst operating conditions. Check the electrical connection, refrigerant, source and sink profiles, bypass and backup. Where a press requires higher-temperature heat or a tightly controlled ramp, retain an independently validated heating route until qualification is complete. Electric boilers can provide controllable steam, though electricity tariffs, delivery capacity and supply emissions strongly influence results. IEA, Renewables for Industry

Equipment changes and the checks that go with them

Conventional setup	Alternative and operating check
Fixed-speed utilities	Efficient motors, VFDs and compressor controls Check duty, airflow and minimum safe extraction
Heat rejected to exhaust	Indirect heat recovery for inlet air or makeup water Check contamination, fouling and simultaneous demand
Fossil heat for warm water	Heat pump on eligible low-temperature duty Test seasonal COP, delivered temperature and backup
Fossil steam generation	Selective electric boiler, thermal storage or suitable renewable fuel Check tariff, grid capacity, permits and fuel quality
Limited freight data	Load consolidation and route optimization Compare tonne-km, carrier fuel and lifecycle emissions

Engineering screening examples. Select after heat mapping, quality review and vendor duty guarantees.

At the illustrative gas price used below, useful gas heat costs about ₹2.93/kWh thermal at 80% efficiency. At a COP of 2.5, an industrial heat pump breaks even on energy alone at about ₹7.31/kWh of electricity. An electric boiler at near-unity efficiency would need roughly ₹2.9/kWh before fixed charges to match the same useful heat cost. Test actual incremental energy and demand charges, capex, savings during shutdowns and the avoided cost of any existing equipment replacement. Hydrogen has a weaker case where heat recovery or proven electrification can meet the duty at a lower total cost. Thermal storage can be worth screening where a hot-water system can shift a flexible load without changing production.

Buy the renewable electricity the plant can use

Rooftop solar can offset a daytime base load after structural, shading, fire access and grid checks. Ground-mounted open-access solar may deliver more annual volume, but its generation can coincide with weekend shutdowns, holidays and rooftop output. Wind can add generation in evenings or other seasons depending on the project.

Ask bidders for metered or independently supported interval generation and test it against a full year of plant demand. Model loss-adjusted delivery, banking and net settlement in the applicable time blocks. A hybrid portfolio can reduce mismatch if the wind profile actually complements solar and the plant’s residual load.

Compare third-party open access, captive ownership and group captive on the landed cost after charges, losses, surplus settlement and residual grid bills. A captive ownership model can give the buyer more control and greater capital exposure. Group captive shares the investment and creates ongoing compliance and counterparty dependencies. Third-party open access can avoid equity participation but has a different surcharge and risk profile. India's March 2026 captive rules retain the central minimum thresholds of 26% qualifying ownership and 51% annual captive consumption. Test all eligibility and allocation conditions for the proposed SPV and users, and allocate the risk of captive-status failure in the agreements. Electricity (Amendment) Rules, 2026

Specify electricity around the residual load

Rooftop solar	Reduce daytime grid draw where generation coincides with plant demand
Open-access solar and wind	Match project-specific interval generation to demand after rooftop solar. Verify landed charges, banking and surplus settlement.
Residual grid supply	Cover unmatched load and reconcile ToD and billed demand.
Optional battery	Dispatch only against a measured deficit, billed peak or critical load.

Conceptual procurement and dispatch map. Use local settlement rules and interval data.

In Maharashtra, MSEDCL’s published Green Energy Open Access circular describes eligibility at 100 kW of sanctioned load or contract demand, with specific aggregation conditions. Check applicable

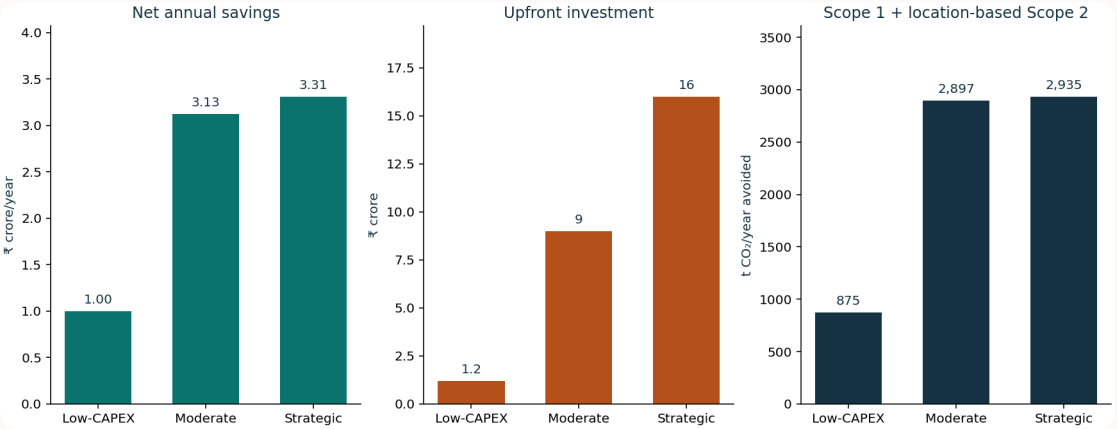
captive exceptions and the live state and licensee rules. For a site served by MSEDCL, build the grid baseline from the applicable tariff category, billing demand, time-of-day adjustments, fuel adjustments and relevant duties. Reconcile wheeling, transmission, loss factors, banking, standby, scheduling, deviations and applicable surcharges with current orders and offered terms. The March 2026 MYT order in Case 75 of 2025 is a source for the check. For another state, rebuild the comparison from its own regulator and distribution licensee documents. MSEDCL Green OA circular · MSEDCL tariff orders · MSEDCL distribution OA regulations

Screen battery storage against the mismatch left after load shifting, solar-wind optimization, and permitted banking. For example, a recurring evening shortfall of 0.5 MW for two hours calls for 1 MWh delivered before considering capacity fade or reserve. At 88% round-trip efficiency it needs about 1.14 MWh of charging energy. At an assumed ₹6/kWh charging cost and ₹10/kWh avoided rate, the energy-only spread is about ₹3,182 per cycle before battery ownership, losses outside the assumed efficiency, and demand charges. Add demand savings only if dispatch reliably clips the billed maximum. For resilience, verify critical loads, transfer controls and reserve. The example scenarios below assign zero battery investment or savings because no interval data are assumed.

What the numbers look like at a hypothetical factory

Consider an independent model for an Indian HPL plant consuming 10 GWh of electricity and 100 TJ of natural gas per year. Assume 2 MW peak demand and a 57% annual load factor, with production across multiple shifts and reduced weekend loading. Assume ₹8/kWh of avoidable grid energy, ₹650/GJ of gas on a net calorific basis, ₹5.50/kWh for consumed rooftop PPA energy and ₹6/kWh for

consumed open-access energy including assumed landed charges. These are commercial inputs for comparison and do not represent a quoted tariff. The model holds output, sales and billed demand unchanged. Add transformer or demand upgrades before approving a real electrification project.



Source: illustrative TOPTIER model. Carbon values use IPCC natural gas CO_2 and CEA FY2024–25 grid CO_2. Scope 3 is excluded.

The operating-efficiency package saves 0.6 GWh and 8 TJ. The moderate case saves 1 GWh and 20 TJ and supplies 5.5 GWh of already matched renewable electricity via rooftop and open-access purchases. The strategic case saves 1.3 GWh of base electricity use and 20 TJ of fuel through efficiency. It displaces a further 25 TJ of fuel with 20 TJ of useful heat from a heat pump at a COP of 2.5, adding 2.22 GWh of load. It assumes 7 GWh of matched renewable electricity and prices incremental grid purchases at the same avoidable rate. The modeled heat pump therefore adds around ₹1.78 crore of annual power cost before the rest of the portfolio is applied. Project bids must confirm renewable availability, time-block settlement, utilization, capital cost and downtime.

On these assumptions, the moderate package generates the highest NPV. Moving from moderate to strategic requires ₹7 crore more and lifts annual operating savings by only about ₹0.19 crore. The strategic

case cuts more direct fuel emissions, but electrification also increases grid draw relative to the moderate case. Lower-cost matched clean power, a higher measured COP, a higher delivered gas price or avoided boiler replacement could materially change that decision. The illustrative facility's Scope 3 reduction remains unquantified pending product and supplier data.

Metric	Baseline	Low-CAPEX	Moderate	Strategic
Gas remaining (TJ/yr)	100	92	80	55
Gross electricity (GWh/yr)	10	9.4	9	10.92
Residual grid purchases (GWh/yr)	10	9.40	3.50	3.92
Net operating savings (₹ crore/yr)	—	1.00	3.13	3.31
Capital investment (₹ crore)	—	1.20	9.00	16.00
Simple payback (years)	—	1.20	2.88	4.83
Scope 1 reduction (t CO_2/yr)	—	449	1,122	2,524
Scope 2 location-based reduction (t CO_2/yr)	—	426	1,775	410
Scope 2 illustrative market-based reduction (t CO_2/yr)	—	426	4,615	4,315
10-year NPV (₹ crore at 10%)	—	4.94	10.20	4.35
10-year project IRR	—	83.1%	32.7%	16.0%
Levelized abatement cost (₹/t CO_2, Scope 1 + location-based Scope 2)	—	-9,199	-5,731	-2,414

Metric	Baseline	Low-CAPEX	Moderate	Strategic
EBITDA margin uplift at ₹150 crore annual sales	—	0.67 pp	2.08 pp	2.21 pp

▼ **Model inputs and calculation**

Baseline variable energy cost = 10 GWh × ₹8/kWh + 100,000 GJ × ₹650/GJ = ₹14.50 crore/year. Scenario operating cost = 0.80 × residual grid GWh + 0.55 × rooftop GWh + 0.60 × open-access GWh + 0.065 × remaining gas TJ + incremental annual O&M, in ₹ crore. Incremental O&M is ₹0 / ₹0.15 / ₹0.35 crore per year. Assume rooftop PPA and OA contract prices, with assumed enabling works within capex. Project-life simplification: ten end-year flat cash flows, capex at year zero, no terminal value, tax, escalation, equity, replacement or additional working capital. Demand charges and fixed network charges are unchanged under the case assumptions. NPV = present value of net savings less capex. IRR sets that NPV to zero. EBITDA margin uplift assumes constant ₹150 crore sales. Levelized abatement cost = (annualized investment less net savings) divided by annual Scope 1 plus location-based Scope 2 reduction. Negative values represent modeled net savings.

Scope 1 baseline = 100 TJ × 56.1 t CO_2/TJ = 5,610 t CO_2. Scope 2 baseline = 10,000 MWh × 0.710 t CO_2/MWh = 7,100 t CO_2. Figures model CO_2 only; a verified t CO_2e inventory also accounts for relevant CH_4, N_2O and other gases. Location-based electricity uses grid-delivered load, including off-site OA volume, less on-site rooftop production. The market-based comparison assumes exclusive, retired and eligible renewable attributes and an illustrative 0.710 t CO_2/MWh proxy for unclaimed load where no

better residual or supplier factor is available. On-site supply is assumed to carry zero operational emissions with retained attributes. Confirm instrument quality and factor hierarchy for actual reporting. The two Scope 2 views are parallel estimates. Neither is a measured grid-wide displacement impact.

Key sensitivities: a ₹1/kWh increase in OA landed price cuts annual savings by ₹0.40 crore in the moderate case and ₹0.55 crore in the strategic case. Dropping seasonal COP from 2.5 to 2.0 adds about 0.56 GWh or ₹0.44 crore/yr at the assumed marginal grid rate. Recalculate upfront costs and margins with actual vendor quotes, discharge costs where relevant, contract structures and bills.

CEA grid factor, FY2024–25, version 21 · IPCC stationary combustion, 2006 Guidelines · GHG Protocol Scope 2 Guidance

A five-year sequence for plant and finance teams

Five-year investment sequence

0–6 months · Baseline	Plant and finance · High priority · Metering, grade-normalized kWh/MJ and yield Gate: reconcile meters with invoices and production.
6–18 months · Optimize	Procurement and utilities · High · Matched MWh, landed cost and verified savings Gate: complete interval model and verify contracts and approvals.
18–36 months · Pilot	Engineering and quality · Conditional · Recovered TJ, seasonal COP and pass rate Gate: confirm heat duty, quality and power connection.
36–60 months · Scale	Finance and sustainability · Conditional · Verified t CO_2 and supplier coverage Gate: approve scale-up after performance and margin review.

Proposed five-year rollout. Move to the next investment stage after verifying the preceding performance gate.

The first approval should fund meters, a baseline and measures that can be verified quickly. Plant operations and finance should agree on

the same production denominator and separate maintenance-driven improvement from capital savings. Then procurement can bring in rooftop and open-access offers with enough data for a bill simulation. Run downside cases for surplus, higher landed charges, an outage and lower production. Clear those cases before committing to equity or long-term offtake.

Make the investment gate for heat recovery and electrification a production trial. Measure energy per accepted sheet and confirm decorative finish, bond integrity and throughput against existing acceptance criteria. Put conditions for shutdown access, fallback heat, guaranteed duty and measured savings into the project scope. At the same time, start supplier engagement with the paper and resin inputs with the highest combination of purchased mass, footprint uncertainty and substitution potential. Build a product footprint from traceable inputs before seeking an external declaration.

What Indian manufacturers should watch

India's Carbon Credit Trading Scheme compliance mechanism applies to notified obligated entities and schedules. The 2025 rules and January 2026 expansion include certain pulp and paper and petrochemical entities. Check the latest notified schedule against each facility and its activities, especially integrated operations. A paper or resin supplier may face direct obligations while an HPL customer experiences an indirect commercial effect. The EU CBAM definitive phase began on 1 January 2026 for specified goods. Check actual customs codes against Annex I, especially for mixed export portfolios. A decorative laminate should not be assumed covered merely because it consumes energy or incorporates upstream materials. India GEI Target Rules 2025 · January 2026 expansion · European Commission CBAM

Check SEBI BRSR and BRSR Core applicability against listing and the relevant cohort, and distinguish voluntary value-chain ESG disclosures under the March 2025 circular from a customer's own supplier disclosure requirements. Check site-specific pollution control consents for inputs, fuel changes, air emissions, effluent and waste management. For customer claims, product EPDs can help when the units, grade, declared modules and time periods are comparable. A generic EPD is a benchmark for where to look and an inadequate substitute for a plant-specific footprint. SEBI circular, 28 March 2025 · PARIVESH

TOPTIER's perspective on improving business performance through decarbonization

Approve projects in the order that the plant can measure and use them. Reduce avoidable heat and electrical loads and stabilize quality. Model rooftop and open-access supply against the revised load, then choose a procurement structure that the finance and compliance teams can manage. Use the verified heat balance to select electrification duties and size backup. Retest the battery case after those changes and build supplier data collection into normal procurement. The result should be visible in three places the business already understands: energy cost per saleable sheet, plant reliability and verified emissions.

If a laminate plant can recover heat from one line, avoid an unnecessary night-time peak and buy renewable electricity it can use, those improvements can show up in the same operating review as yield and throughput. Start with twelve months of electricity bills, interval demand, site fuel records and production by grade. TOPTIER can help turn those records into a prioritized investment and procurement plan.

TOPTIER ENERGY SERVICES PVT LTD
Strategic Renewable Energy Procurement | Industrial Energy Optimization | Decarbonization Advisory
www.t-esco.in · +91 9156337278

“The most effective decarbonization strategy is not necessarily the one with the most advanced technology. It is the one that delivers the right combination of energy efficiency, commercial savings, operational reliability, and measurable carbon reduction.”

Research and regulatory sources checked 21 November 2026. The hypothetical case uses the FY2024–25 CEA factor for a fixed reference year.