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From ineffective audits to energy excellence

Industrial companies are struggling to create major energy saving ideas, just as high prices are pressuring profitability. A deeper dive can find hidden drivers that could transform energy consumption.

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Energy makes up a significant part of the input costs in many manufacturing industries. The energy consumed in production accounts for up to 40 percent of the cost of cement,[1] for example, up to 30 percent of the cost of many common chemicals, and 10 to 20 percent of the cost of paper, steel, and food[2] production.

The relevance of energy in these cost structures has only grown. In Europe, natural gas prices may have fallen from their summer 2022 peak, but they have never returned to the levels seen in 2021—and as of early March 2026, they're rising quickly once again. Electricity prices in many markets have risen sharply thanks to fuel-price dynamics, higher demand, and the escalating cost of grid upgrades. In the European Union, for example, electricity prices for large industrial consumers rose 86 percent, on average, between 2020 and 2025.[3]

Against this backdrop, the imperative for companies to pursue meaningful improvements in energy efficiency has rarely been stronger. Leaders are working to protect profitability and maintain pledged decarbonization trajectories. Yet many organizations find themselves running out of ideas. Decades of traditional energy audits have delivered diminishing returns, leaving companies few actionable insights into energy losses across complex production systems.

That matters, because most industrial organizations do have significant unexploited opportunities to optimize their energy use. While conventional audits typically identify energy savings potential in the single-figure percentage range, companies that conduct deep, expertise-led energy transformations commonly find opportunities to improve energy productivity by 20 to 40 percent. For a business where energy accounts for 20 percent of operating costs, such a transformation can increase margins by four to eight percentage points (Exhibit 1).

Why energy audits are running out of steam

Regular efficiency audits have been standard practice for energy-intensive users for decades. Sometimes such audits are even mandated by governments and regulators. The Netherlands, for example, requires large enterprises to conduct energy audits every four years, and to implement all identified measures with a payback period of five years or less.

Most companies continue to rely on audit methodologies designed for an earlier era, however. And these approaches were optimized for speed, repeatability, and minimal skill requirements. Standard audits typically revolve around standardized lever lists and equipment walk-throughs. While efficient, they suffer from three structural limitations.

1. The lever lists are exhausted

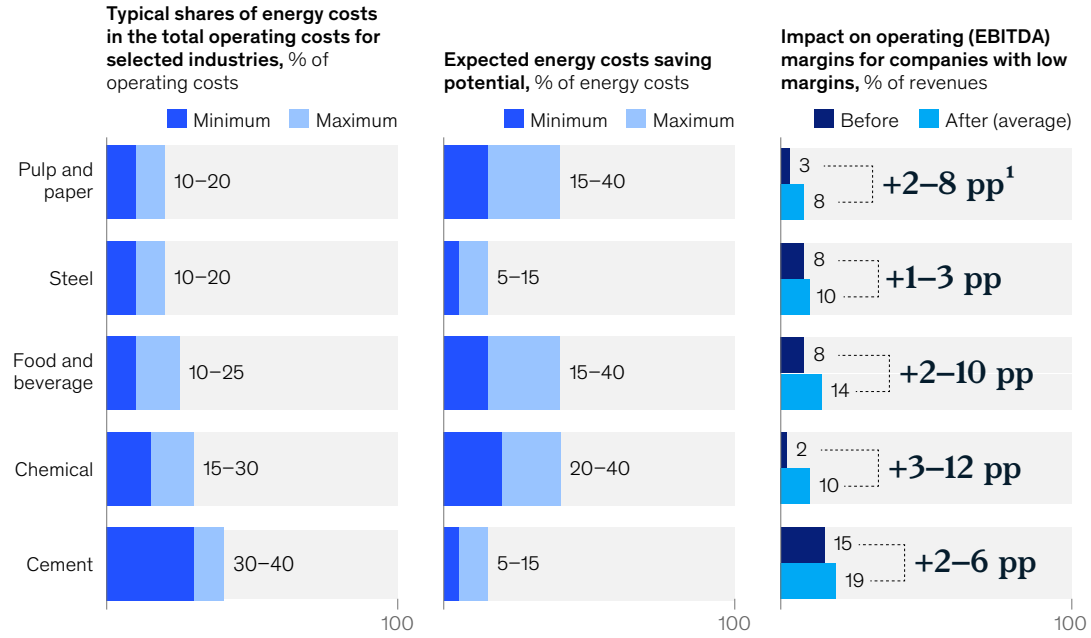
Large industrial players have already implemented most low-cost, short-payback measures. What remains are interventions that involve long payback periods and difficult business-case approvals. In practice, traditional audits keep surfacing the same proposals without delivering the next wave of impact.

[1] *Improving thermal and electric energy efficiency at cement plants: International best practice*, International Finance Corporation, June 2017.
[2] "Food and beverage manufacturing," Government of Australia, Department of Climate Change, Energy, the Environment and Water, 2025.
[3] Eurostat electricity prices for non-household consumers with consumption ≥150,000 megawatt-hours (MWh) (excluding VAT and other recoverable taxes and levies).

Exhibit 1

Selected examples of energy-intensive industries show that deep energy transformation can increase EBITDA margins by up to 12 percentage points.

Impact of deep energy transformations on companies' profits



[1]Percentage points.
Source: Industry associations statistics and annual reports of selected representative companies from each sector

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2. The focus is misplaced

Lever-based audits tend to assess equipment efficiency rather than the system-level drivers of energy demand. A boiler operating at 94 percent efficiency or a pump exceeding 90 percent may appear optimized, but the deeper question is why a system demands a particular pressure, flow, or temperature in the first place. Understanding the energy required by the product and mapping out the system losses identifies new opportunities with larger savings and better payback.

3. People and systems are neglected

Many organizations continue to invest in hardware while underinvesting in the management systems, capabilities, and cultural norms required to sustain performance. Evidence suggests that when teams are equipped with the right KPIs, develop digital literacy and loss-based thinking, and embed energy management into daily routines, they can deliver up to a 5 percent improvement in the first year and continue improving by 1 percent annually.

How to break the audit gridlock

To unlock meaningful and sustained improvements in energy productivity, companies need a different approach—one that fundamentally rethinks where they look for opportunities, how they diagnose performance, and how they engage their people in the process.

Organizations that succeed do three things well:

1. **Look in the right places** by assessing production networks, sites, and equipment portfolios with maturity surveys, external-factor benchmarking, best-practice comparisons, loss mapping, and expert-driven prioritization.

2. **Use the right tools and expertise** to reveal energy losses that traditional audits cannot see—through advanced heat-integration methods, advanced analytics, shutdown–start-up analysis, and full steam and power network simulations.

3. **Engage and enable their people** with strong ownership, normalized KPIs, systematic capability building, and sustained management attention.

Looking in the right places

A European pulp and paper company seeking to go beyond its mandatory audit requirements conducted deep, yearlong diagnostics at its ten largest mills. Despite extensive prior improvements, the company identified savings equivalent to nearly 40 percent of its external energy costs and implemented measures that reduced costs by 15 percent within a year.

Analysis of more than 1,200 ideas generated during that project demonstrated that while the potential was large, there were no silver bullets. Capturing 80 percent of the identified value required implementing roughly 120 initiatives across the ten mills. To help sites focus their engineering effort during the implementation phase of the project, the company used a variety of prioritization methods, including:

- best-practice benchmarks at equipment and system levels
- steam and power system modeling to identify inefficient operating practices
- loss mapping and expert-based hypotheses to concentrate on the highest-value problems

This approach revealed opportunities that were three to four times larger than those identified through lever-based audits.

For global manufacturers with ten or more sites, the challenge becomes even more complex. Energy prices vary, asset ages differ, and technical and cultural maturity can range widely. Another manufacturer with more than 40 sites used digital energy maturity surveys to create a fact-based, enterprise-wide prioritization. The surveys assessed three dimensions:

- technical systems (such as boilers, cooling towers, or drying machines)
- management systems (including KPIs, review cadence, and digital capabilities)
- cultural systems (behaviors, capabilities, and innovation orientation)

These surveys required only a few hours of input per site. When combined with baseline energy costs, they enabled the company to rank sites by potential impact and to identify process areas where performance lagged industry peers.

High-level survey scores correlated strongly with bottom-up diagnostic findings. Sites with robust management and cultural practices also outperformed technically—an insight that reaffirmed the role of well-trained engineers, clear targets, and disciplined performance management in sustaining technical excellence. That correlation helped the company focus subsequent bottom-up diagnostic efforts on the lowest-performing sites, where the potential for improvement was likely to be largest.

A diversified Asian industrial conglomerate applied a similar approach across manufacturing processes ranging from heavy industry to semiconductors. At this organization, survey-driven prioritization helped the company focus diagnostic resources on the most critical utilities and systems within each site, and set ambitious yet credible targets across the portfolio.

Applying the right expertise, tools, and methodology

Turning theoretical losses into real energy-efficiency improvements is a complex task. The pulp and paper company described above found that the identification of approximately 80 percent of the savings potential required advanced expertise or specialized tools. Twelve percent came from initiatives unique to individual sites, emphasizing the need for in-depth discussions with local engineers. Only 9 percent came from the simple, repeatable levers traditionally found in audit checklists. The lesson is clear: Complexity hides opportunity. Organizations need tools that reveal losses not easily seen through visual inspection or simple calculations. For example:

— **External factor analysis:** Advanced analytics modeling to isolate variability in energy consumption that remains after accounting for uncontrollable external factors such as ambient temperature. This powerful tool is also a key part in normalized KPI definition and forms the starting point to apply advanced analytics to further identify the root causes of the unexplained variability.

— **Shutdown and start-up analysis:** Quantification of energy consumed during production stops, distinguishing between short and long duration stops, and planned and unplanned events. Depending on the industry, assets might spend 10 to 30 percent of the time in nonproduction mode. Mapping historical performance and deep-diving to optimize start-up and shutdown procedures can lead to substantial impact in these industries.

— **Steam and power network optimization:** Modeling steam networks and electricity generation assets to identify periods of suboptimal operation can tap into large potential as electricity markets have become more volatile and complex. This volatility, combined with the flexible use of steam turbines and generation assets can provide substantial savings. The highly interlinked nature of these assets, combined with multiple constraints and different marginal production costs by asset and load, require dedicated simulation tools such as system digital twins (Exhibit 2) to uncover and capture the full potential. Deploying this approach at a large pulp and paper company resulted in annual energy cost savings of around €6 million. Energy system optimization is set to become even more complex, with the arrival of cheaper battery and thermal storage, along with new commercial models such as pay-as-produced power purchase agreements (PPAs) with generators.

Exhibit 2

Augmenting operators with a digital twin of the steam and power network can cut energy costs by 2 to 3 percent, with no capital expenditures.

Digital twin illustrative dashboard

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— **Advanced heat integration:** While the cost of industrial heat is rising, companies also have access to a range of advanced heat recovery technologies such as high temperature lift heat pumps, heat separation, or low-approach heat exchangers. Decades of heat generation optimization has often exhausted most of the improvement opportunities that can be identified using traditional pinch analysis. Instead, leading players are adopting more advanced techniques, such as source-sink-technology-location optimizers built on thermodynamic first principles. This approach starts by finding the most optimal combination of these new technologies across all the heat sources and sinks of an entire industrial complex. The potential of such optimization is large, often 20 to 40 percent of site steam production. At one liquid-based chemical plant, this approach identified net present value (NPV) positive integration options that would reduce steam generation and associated carbon emissions by 50 to 70 percent. To capture these opportunities, the optimizer solution is used as a starting point to reengineer the site's heat integration.

These tools don't just identify opportunities; they also provide a structured way to engage engineers and operators. By visualizing losses and framing the right technical problems, they stimulate solution design and accelerate implementation.

Engaging and enabling the workforce

Ensuring energy efficiency ultimately depends on people. Across industries, we see recurring challenges in four areas: ownership, communication, KPIs, and capabilities.

At one site with €150 million in annual energy spend, responsibility for energy management was assigned to a single employee, and it made up just one-third of their role. No audit—no matter how advanced—can compensate for insufficient ownership. External experts can catalyze improvement idea generation, but

they are no substitute for internal capabilities that monitor energy use, challenge day-to-day operations, and implement improvements.

Clear communication must be paired with KPIs that cut through external-factor noise. Normalized KPIs that use advanced analytics to correct for external factors, and leading shop-floor indicators such as furnace excess-oxygen levels, help teams see underlying trends, close performance gaps, and maintain a consistent review cadence.

Finally, in the longer term, the key difference is made by capabilities. Many engineering programs devote little attention to energy-system optimization, and common industrial-engineering tools often omit energy entirely. Systematic upskilling will become essential so that engineers can diagnose losses, redesign systems, and embed energy considerations into everyday decisions. That's vital, because more than 40 percent of a site's energy consumption often comes from hundreds or even thousands of small systems. Identifying and eliminating losses across those systems requires the combined effort of the entire organization.

A path toward sustained energy excellence

Companies that change where and how they look for energy improvements, and invest deeply in people, can unlock two to three times the savings typically identified through lever-based audits. Industrial companies can incorporate five management concepts into their energy-efficiency strategy:

1. **Use surveys to evaluate maturity**. Short, industry-specific assessments highlight gaps and prioritize sites quickly.

2. **Move beyond standard audits.** One-day workshops and checklist reviews miss most of the potential.

3. **Embrace complexity.** As energy systems evolve, digital tools are essential to navigate interdependencies and uncover hidden value.

4. **Dedicate time for collaborative problem solving.** Cross-functional discussions, site walks, and data deep dives are where insights emerge.

5. **Invest in capabilities, management, and culture.** The strongest performance comes from organizations where people, systems, and technology reinforce each other. Use systematic capability building to continuously improve and utilize the full power of the organization.

Energy excellence calls for more than a checklist. It requires a transformation. The companies that act now will not only reduce costs and emissions but also build lasting competitive advantage.

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