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The industrial energy efficiency playbook

10 actions companies can take right now to reduce energy costs and carbon emissions

Acknowledgements

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ABOUT THE ENERGY EFFICIENCY MOVEMENT

The Energy Efficiency Movement is a forum that brings together like-minded stakeholders to innovate and act for a more energy-efficient world. Through innovation, the sharing of knowledge and insights, investments and the right regulations and incentives, we can optimise energy efficiency and accelerate progress toward a decarbonised future for all.

The Movement was launched by ABB in 2021 and it has received a positive reaction from throughout industry, with around 200 companies joining by November 2022. Among them are Microsoft, Alfa Laval and DHL Group, leaders in their industries and contributors to this report.

join.energyefficiencymovement.com

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Executive summary

The world's industries stand at an energy crossroads in 2022. The urgency of climate change demands action on all sides—from industry, governments and civil society. Energy shortages, brought on by the loss of Russian oil and gas supplies following the invasion of Ukraine in February 2022, have led to inflationary pressures and new energy security challenges that only add to this urgency.

Improving energy efficiency is an under-exploited opportunity to reduce both costs and emissions. While there has been a lot of discussion about how individuals can contribute to saving energy and how consumers can take steps to reduce their bills, the significant potential for energy efficiency and cost improvements in industry has received less attention.

Industry is the world's largest consumer of electricity, natural gas and coal, according to IEA figures.[i] The sector accounts for 42% of electricity demand, equal to more than 34 exajoules of energy. The iron, steel, chemical and petrochemical industries are the largest consumers of energy among the world's top-five energy-consuming countries—China, United States, India, Russia and Japan.[ii]

This energy consumption carries high costs in the current inflationary environment. It also created nine gigatonnes of CO_2, equal to 45% of total direct emissions from end-use sectors in 2021, according to the IEA.[iii]

The importance of energy efficiency in this context cannot be overstated. "We call it the 'first fuel,'" says the IEA's senior programme manager for energy efficiency, Kevin Lane. "It needs to be front-loaded across all the sectors."

This report, developed with ABB and other members of the Energy Efficiency Movement, provides a playbook for executives to address energy efficiency to help mitigate climate change and rising costs. It details 10 actions that industrial leaders should consider for their organisations (see Fig. 1) beyond basic energy efficiency "hygiene" measures like switching equipment off when not in use, converting fluorescent or halogen lighting to LED or insulating walls and piping.

The 10 actions have had to meet some essential criteria: 1) they rely on mature – secure, widely available – technologies; 2) they are material enough to have a meaningful impact on both energy costs and emissions; and 3) they can be deployed quickly without complex or expensive integrations. One of the most attractive aspects of energy efficiency for industry is that in many cases companies can enjoy significant improvements with little or no capital spending.

This list is by no means exhaustive and should be viewed as an inventory of short and medium-term opportunities for industry, as well as an invitation to discuss and document the solutions, use cases and best practices in energy efficiency. Readers are invited to engage with #energyefficiencymovement to share their energy challenges and discuss ideas and lessons learned.

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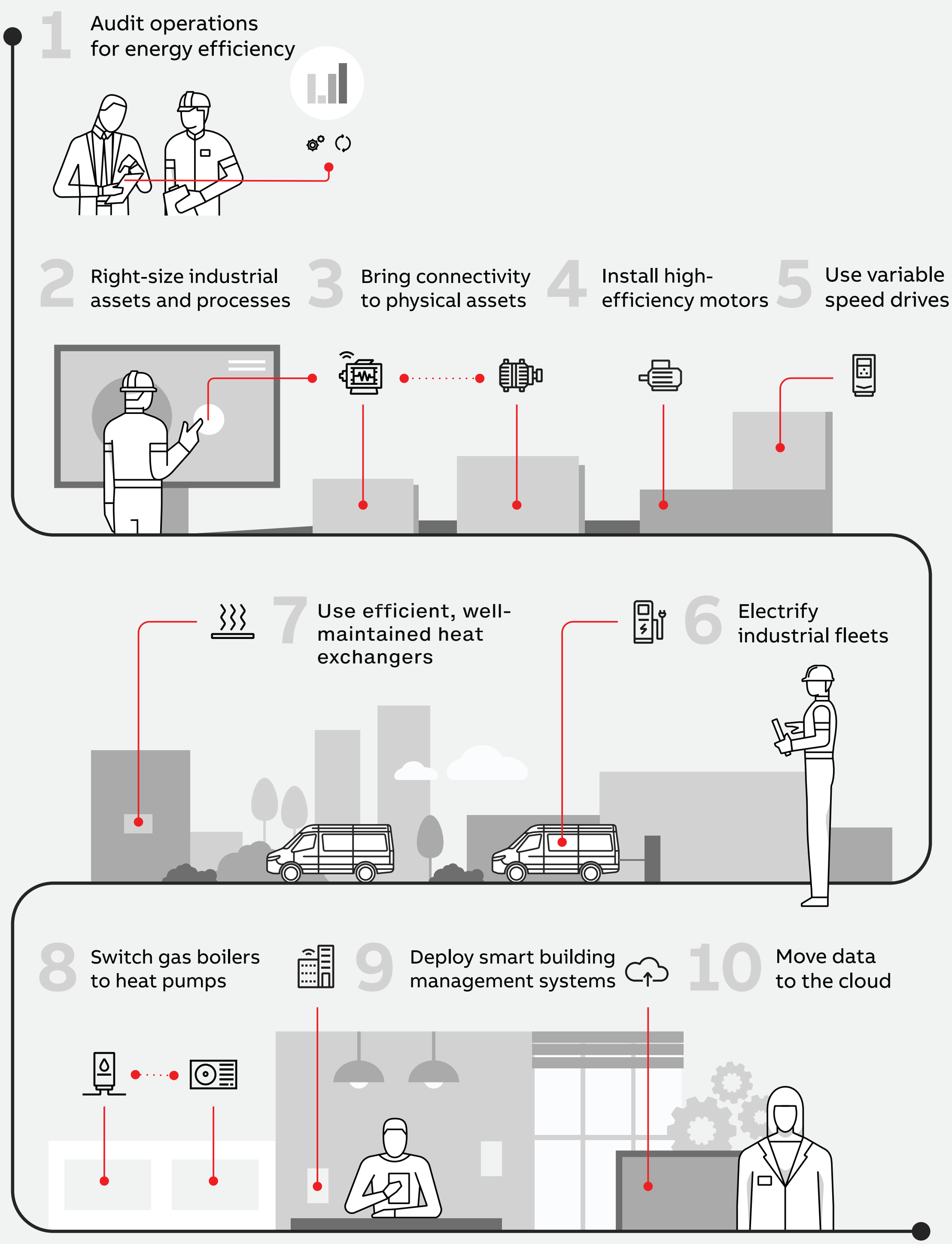
10 key energy efficiency actions for industrial leaders



Source: ABB, 2022

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Action #1: audit operations for energy efficiency

One of the quickest and easiest sources of energy efficiency gains in industry can come from optimising the way assets and processes function. An energy efficiency audit creates an important baseline for a business to make improvements and identify improvement opportunities. Audits can be carried out by established energy service companies (ESCos) and will provide a benchmark to identify potential areas for efficiencies, develop an action plan and measure progress.

What's involved?
An initial energy audit usually involves an analysis of historical energy consumption and the efficiency of equipment that is powered with electricity or fossil fuels, along with costs and operating characteristics. The ESCo will provide a catalogue of energy-using equipment, along with features such as load factors and demand profiles, to identify areas where savings could be realised. Once a baseline has been established, it may be possible—using sensor technologies and automation—to make auditing an ongoing process that yields continuous improvements. Audits may be part of a broader energy management certification process, such as ISO 50001.

What are the impacts?
While the audit itself does not directly create efficiencies, the measures that can be identified as contributing to efficiency could have a significant impact on costs and energy use.

How much does it cost?
Commercial and industrial energy audits can cost on the order of $0.25 per square foot ($2.70 per square meter).[iv]

How complex is it?
Audits are easy to carry out since the ESCo, which should be certified by a body such as the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), takes care of the process. The ASHRAE, as an example, provides standards for three types of audits:[v]

- Level 1: walk-through survey.
- Level 2: energy survey and analysis.
- Level 3: detailed analysis of capital-intensive modifications.

How quickly do you get results?
According to published sources,[v] even a level 1 commercial energy audit can help identify zero-cost efficiency measures that can immediately reduce energy use and costs by between 5% and 10%. More thorough audits can typically reveal up to 20% savings in buildings that have not been subjected to efficiency measures for a decade or more, with up to 40% reductions in cost and consumption being seen in some cases.

What are the critical success factors?
Getting an accurate audit result depends on having access to as much information as possible, which may involve deploying sensors and tracking energy consumption over a period of months.

What do the experts say?
"Before you can make any decisions, you need to get the facts straight," says Morten Wierod, president of the electrification business area at ABB. "Companies can do that with an energy audit, which in practice involves installing sensors to measure all the points of consumption. The first 50% reduction, with today's energy prices, will pay for itself within the first year—far faster than installing solar panels on the roof, for example."

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Action #2: right-size industrial assets and processes

Detailed analysis of industrial assets often reveals that equipment tends to be bigger than needed for the job it is doing, according to Adrian Guggisberg, president of the motion services division at ABB. This is because a margin of error is usually allowed for as part of plant designs or simply because the operating conditions have changed over time. Cumulatively, the oversizing of many components can result in excessive energy use and inefficient device loading. Matching equipment capacities to loads more accurately leads to more efficient energy and asset use.

What's involved?
Right-sizing industrial equipment for the task at hand requires detailed understanding of operational requirements, device efficiency and loading profiles. Depending on the equipment in question, it may be possible to improve loading by adjusting settings, upgrading or re-designing the asset, but if not then it may be necessary to swap out the machine for one more accurately sized for the process involved.

What are the impacts?
Swapping out motors so that they run with 95% loads will improve the efficiency of operations, ABB's Guggisberg notes.

Re-designing and upgrading plate heat exchangers to fit with the operating conditions also has a high impact on the overall efficiency of the industrial process. A heat exchanger is designed for a specific process at the time of purchase and design parameters are normally not the same as actual operating conditions.

A few years down the line, most plants have changed their operating conditions and they will not give the same outlet temperatures as before. An upgrade of the heat exchanger will be needed, which can easily be done in gasketed plate heat exchangers by adapting the number of plates.

How much does it cost?
Since the wholesale replacement of oversized assets is unlikely to be cost-effective, right-sizing can be carried out gradually as part of a plant's ongoing asset lifecycle management. When done in this way, it may be possible to realize immediate capital expenditure savings through the procurement of smaller, less expensive assets.

How complex is it?
Most of the complexity involved in right-sizing lies in the need to get accurate information on load profiles. This can be obtained from an analysis of operating modes and device specification, potentially facilitated through sensor data.

How quickly do you get results?
Reducing the power requirements of industrial assets yields immediate results in terms of energy and emissions reduction. If right-sizing is introduced as part of the standard replacement cycle, the speed and scale of results will depend on the lifecycle of assets.

What are the critical success factors?
Margins of error are built into industrial processes for good reason: to prevent failures that can compromise safety and production. In right-sizing, therefore, it will be key to address the following questions:

- How large is the oversizing of an asset?
- What are the chances of the asset being used to its full capacity?
- How meaningful will be the savings that can be achieved by right-sizing?

Another success factor is to ensure that process design and procurement teams are aligned on efficiency targets. Identifying an oversized asset is of little practical use if guidance to reduce the size is ignored when the asset is later replaced.

What do the experts say?
"As an example, most of the electrical motors in industry are oversized, because when the thing was designed it went through different hands—and everybody puts a margin on top," says ABB's Guggisberg. "Running an electric motor at 65% load is just not good efficiency."

Action #3: bring connectivity to physical assets

Many industrial leaders do not have a clear view of where energy is used in their operations. By connecting physical assets using the industrial Internet of Things (IoT), companies can better understand how assets are used, enabling smarter, leaner operations. Recent research from ABB, however, reveals that just 35% of industrial organisations globally have implemented IoT technologies at scale.[vii]

What's involved?
Industrial IoT technologies can track energy flows through a plant and show areas where energy is being needlessly used. This could be down to energy use in ancillary systems, oversized assets (see above), faulty equipment, heat losses or where no electricity should be needed, such as illuminating an unoccupied room.

What are the impacts?
There are losses in all industrial processes, with up to 95% of primary energy being lost on the way to carrying out the work for which it is needed.[viii] The point of connecting devices is to uncover previously unseen sources of waste. Although it is obviously impossible to know how significant these will be, a better understanding of how assets and workflows consume energy will almost certainly yield areas for improvement.

How much does it cost?
It is possible to connect physical assets even with limited sensor deployments. If the sensors are installed as part of wider moves to digitisation, then the efficiency gains and energy cost reductions they provide can contribute to the digital program's overall business case.

How complex is it?
IoT technologies are increasingly mature and simple to implement, although some integration work may be needed to obtain meaningful results from the data. Once the data is obtained, the complexity of what can be done with it is almost limitless. For example, companies are increasingly relying on detailed 'digital twins' of real-life operations to study the impact of process changes without affecting actual production. These digital twins can be used for a wide range of simulations, including efficiency studies. Using digital twins for modelling, testing and commissioning in a virtual environment instead of a physical setting —in effect, moving bits rather than atoms—also uses far less energy.

How quickly do you get results?
If sensor technologies reveal the presence of ghost assets—devices that are drawing power without doing any useful work—then these can be switched off or decommissioned straight away, delivering immediate cost and emissions benefits to the enterprise. Elsewhere, the exercise may reveal malfunctioning or incorrectly configured assets that require maintenance, adjusting or replacing. In these cases, the time taken to see results will depend on the remedial work needed.

What are the critical success factors?
Integrating data sources into visualisation and analysis software is key to ensuring efficiency gains can be identified with ease. And domain expertise is needed to tune the algorithms and analytics that go into making better decisions about electricity use. Without this, there is a risk that results could be disappointing.

What do the experts say?
"You can do a lot with sensor data that is already available," says Paul Röhrs, senior global digital advisor at Microsoft. "You just bring it all into the same place and let the data speak to other silos of data. The critical part is to get the data from the machine."

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Action #4: install high-efficiency motors

In industry, powertrains are used in countless applications to convert electrical energy into motion. The main elements of an industrial electric powertrain are the motor, variable speed drive and the application itself, such as a pump, fan or compressor.

The potential for powertrain efficiency is vast, says Professor Johann Kolar, head of the Power Electronic Systems Laboratory team at ETH Zürich, the Swiss federal institute of technology. It is estimated that an astonishing 46% of the world's electricity is used to produce mechanical energy through electric motor-driven systems. In industry, the consumption rises to two-thirds of total electricity.[ix]

The International Electrotechnical Commission establishes a range of international efficiency (IE) standards for motors, ranging from IE1 ('standard') to IE4 ('super-premium').[x] There are moves to introduce an even more advanced standard, IE5. More efficient motors tend to be more expensive but can yield important efficiency gains. Given the pervasiveness of motors in industry, a widespread transition to more efficient machines can yield major energy and emissions reductions.

What's involved?
Installing high-efficiency motors simply involves replacing older machines with ones that have a higher efficiency rating. Roughly 75% of the industrial motors in operation are used to run pumps, fans and compressors, a category of machinery that is highly susceptible to major efficiency improvements.[xi]

What are the impacts?
It has been estimated that if the more than 300 million industrial electric motor-driven systems currently in operation were replaced with optimised, high-efficiency equipment, global electricity consumption could be reduced by up to 10%.[xii]

How much does it cost?
Upgrading to more efficient models will require capital investment as there can be up to a 40% price differential.[xiii] However, expenditure on motors is often an attractive proposition because of their ease of installation. They can generally be installed without any modification of industrial systems.[xiv]

How complex is it?
Wholesale motor replacements might not be worthwhile in all cases but most of the electric power consumed by motors is used by mid-sized machines.[xv]

How quickly do you get results?
Energy-efficient motors deliver immediate results in terms of energy and emissions reduction—and can pay for themselves in less than a year.[xvi]

What are the critical success factors?
To maximise the efficiency gains from newer electric motors, it obviously helps to transition to the most efficient models available. That has cost implications which should be considered in the context of shorter payback times.

What do the experts say?
"Electric motors have been in use for 150 years and they are the steady workhorses behind our everyday lives," says ABB's Tarak Mehta, president of the motion business area at ABB. "Yet over the past decade, they have undergone a period of exceptionally rapid technological advancement. Some of the very latest motors specify energy losses about 15% lower than those delivered by earlier models."

Action #5: use variable speed drives

Today, most industrial electric motors operate at a steady speed and the motion they impart is regulated through valves (for fluids), dampers (for air) and brakes (for material). However, this way of controlling the motion, says ABB's Guggisberg, is akin to controlling the speed of your car with the brake while pushing the accelerator to the floor: energy is just wasted.

Variable speed drives are technologies used to control the speed of motors and the amount of torque produced—a crucial part of managing the energy consumed by motor-driven systems. Energy consumption is intelligently calibrated to match the amount of work that needs to be done. "Variable speed is like using the accelerator to control the speed of your car," says Guggisberg.

What's involved?
Introducing variable speed drives to electric motor-driven systems is easy and straight-forward. A technology provider or an ESCo can support in identifying which motors currently in use could and should be equipped with a drive to improve energy efficiency.

What are the impacts?
Installing variable speed drives can improve the energy efficiency of a motor-driven system by up to 30%, yielding immediate cost and emissions benefits.

How much does it cost?
The payback time of a variable speed drive in terms of energy savings is short (typically 1-2 years) in relation to its expected lifetime. High energy prices obviously shorten it further.

How complex is it?
As with the transition to more efficient motors, the introduction of variable speed drives does not require any changes to industrial processes.

How quickly do you get results?
The financial benefits accrue from the moment the variable speed drive enters operation and continue throughout its lifetime.

What are the critical success factors?
In common with many other efficiency improvements, leadership will need to decide whether the benefits of introducing variable speed drives warrant the immediate investment. This in turn will depend on the number, size and usage profile of installed motors – and the price of electricity.

It is worth noting that developments in motor and drive efficiency are increasingly being motivated by regulation, so investments in more efficient machines can help address compliance needs as well.

What do the experts say?
"Not every motor will benefit from a variable speed drive," says Mehta at ABB, but even assuming around 50% of today's motors would be upgraded, "we're talking about a major global improvement in energy efficiency."

FIND OUT MORE
See the ABB whitepaper "Achieving the Paris Agreement—The vital role of high-efficiency motors and drives in reducing energy consumption." Read now at:

www.energyefficiencymovement.com/wp-content/uploads/2021/03/ABB_MotionEnergyEfficiency_WhitePaper.pdf.

Action #6: electrify industrial fleets

Growing momentum behind vehicle electrification is bringing down the cost of batteries and electric drivetrains. This, coupled with sustained high oil prices, is making electric powertrains an increasingly attractive proposition for industrial vehicles such as forklifts, mining vehicles, trucks and delivery vans.

What's involved?

Transitioning to electric fleets will happen alongside development of charging infrastructure and low-cost, low-carbon electricity.

What are the impacts?

The efficiency gains apparent in industrial powertrains are also significant in mobility, where there is a shift from internal combustion engines (ICEs) to electric propulsion. Electric motors can achieve more than 95% efficiency, while diesel engines only reach 45% efficiency in the optimum load range.[xvii] Levels of electrification are negligible in air and maritime transport at this time, yet in road transport and in industrial mobility, fleet electrification is gaining rapid traction.

Replacing the diesel engine in a 24-tonne excavator with an electric powertrain, which combines battery power with a high-efficiency electric motor and drive, can eliminate 48 tonnes of CO_2 emissions per year, according to ABB.[xviii] In addition, regenerative braking for industrial vehicles can reduce fuel consumption by up to 30%.

How much does it cost?

Electric vehicles in the transportation of goods today are more expensive than traditional models, making the business case for switching on financial grounds alone more complex.[xix] Beyond capital expenditure considerations, however, on average electric vehicles have operating costs as much as 60% lower than equivalent vehicles powered by a diesel engine, mainly due to improved efficiency, reduced fuel consumption and reduced maintenance needs.[xx]

How quickly do you get results?

Vehicle electrification yields immediate efficiency gains although, as noted, the capital cost of moving to an electric fleet means financial benefits may be modest in the short term. Linked to vehicle electrification, industrial fleet owners can realise further efficiency gains through digital management of fleets, including optimising charge schedules.

What do the experts say?

"Fleet optimisation is the first thing to do to reduce emissions, especially as green technologies are not yet available in all regions and countries," says Florence Noblot, head of environmental, social and corporate governance at DHL Supply Chain, a division of Deutsche Post DHL, the global logistics company.

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Action #7: use efficient, well-maintained heat exchangers

Heat transfer is crucial when it comes to making an industrial process energy efficient and heat exchangers are used for heating and cooling in almost any industry worldwide. Heat exchangers, as static equipment, are often not subject to proactive maintenance and optimisation, instead experiencing run-to-failure operation without realising the environmental and cost impact of lost heat transfer.

Keeping a heat exchanger at its optimal performance level over time is crucial to ensure energy-efficient processes. Up to 2.5% of the world's CO_2 emissions come from unmaintained heat exchangers. This can be prevented simply by cleaning heat exchangers on a regular basis.

Selecting the right heat exchanger technology is another important step in optimising energy efficiency for a given application. An innovative and compact plate heat exchanger, for example, can be 25% more efficient than a shell-and-tube heat exchanger.

Furthermore, 20% to 50% of industrial energy input is lost as waste heat, for example in the form of hot exhaust gases or cooling waters. Recovering and reusing that heat in further processes is an important step in improving overall efficiency and decreasing carbon emissions. Solutions could be to reintegrate the heat in the process itself, or to provide the heat for use elsewhere, for example in district heating, electricity generation and so on.

What's involved?
A review of thermal losses in heat exchangers can be carried out by an ESCo or a specialist service provider. This can help form the basis of a thermal efficiency strategy with maintenance on site or costed technology upgrades.

What are the impacts?
"By first of all securing proper maintenance of heat exchangers, and then also make sure to select the right equipment for new installation, or by upgrading poorly performing heat exchangers, this has a large impact on the energy consumption," says Julien Gennetier, vice president of Alfa Laval's energy division.

How much does it cost?
Plate heat exchangers may have lower capital costs than shell-and-tube models because they are a sixteenth of the weight and use a tenth of the floor space, offering savings on shipping, handling and installation.[xxi] Plate heat exchangers also offer a reduced operational cost due to higher thermal efficiency.

How complex is it?
Cleaning or upgrading heat exchangers is an easy process that can be carried out as part of planned maintenance. Converting existing technology to a more efficient solution needs some re-piping but for many processes offers direct effects on operational cost.

How quickly do you get results?
Results start to accrue directly upon installation and with regular maintenance.

What are the critical success factors?
The significant efficiency gains available through heat exchanger equipment upgrades makes them highly desirable where possible, although expert advice is needed on the sizing and process integration.

What do the experts say?
"2.5% of the world's carbon dioxide emissions come from inefficient heat transfer in heat exchangers, due to them not being cleaned and maintained properly," says Kajsa Dahlberg, cleantech business developer at the heat exchanger manufacturer Alfa Laval. "By simple measures, the energy consumption can be immediately reduced."

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Action #8: switch gas boilers to heat pumps

Heat pumps are seen as key for global decarbonisation as a replacement for fuel-fired boilers. The IEA forecasts the technology will allow more than 50% of homes to use electricity for heating by 2050.[xxii] In industry, the technology can have similar benefits for space heating and can also be used for process heat of up to 356 F (180 C).[xxiii]

Industrial heat pumps make it possible to reuse excess heat from a process for other purposes, such as industrial process heating or space heating, avoiding the need for fuel-fired boilers.

What's involved?
Heat pumps take advantage of thermal gradients to improve the efficiency of electricity-to-heat generation processes, so should be considered wherever there is a need for low-to-moderate process heat or space heating.

What are the impacts?
Heat pumps are by far the most efficient way of obtaining low-to-moderate heat from electricity.

How much does it cost?
Industrial heat pumps can cost up to $90,000, according to published sources.[xxiv]

How complex is it?
Upgrading thermal equipment is not a trivial affair and in the case of heat pumps there may be constraints on the suitability of the environment for installation. However, the clear financial and ecological benefits of reducing energy demand for heating can provide a sound basis for upgrade programs.

How quickly do you get results?
The financial benefits start to accrue from installation. Heat pumps last up to 25 years, with a payback time of five years or less.[xxv]

What are the critical success factors?
As in other areas, it is important to choose the right heat pump technology for a given application and consider whether it would be advisable to add thermal heat storage to the setup.[xxvi]

What do the experts say?
With heat pumps, "You use one unit of electricity and you're getting three units of heat coming out the other end, which is an astonishing piece of magic," says Lane of the IEA.

FIND OUT MORE
Read the whitepaper "Using AI to Optimize the Flow of Energy Through the Built Environment," from BrainBox AI:

https://brainboxai.com/en/white-papers/using-artificial-intelligence-to-optimize-the-flow-of-energy-through-the-built-environment.

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Action #9: deploy smart building management systems

The built environment accounts for some 40% of total energy use and 30% of global greenhouse gas emissions, according to the United Nations Environment Programme.[xxvii] For industry, this is perhaps unsurprising in that buildings and associated infrastructure are seldom designed from the bottom up with energy efficiency in mind.

On the contrary, factories, warehouses and other industrial structures, along with auxiliary assets such as lighting and heating, ventilation, and air conditioning (HVAC) systems, are usually specified to minimise capital outlays, often at the expense of efficiency. This means there is plenty of scope for cost savings and efficiency gains with relatively simple, quick-payback interventions. Properly insulating buildings is perhaps one of the fastest and most cost-effective ways to save on energy.

Industrial facilities can save energy and costs by installing digital systems to control HVAC systems, lighting, blinds and so on. These systems typically sense when people are no longer present in the environment and respond accordingly, dimming or switching off lights and closing windows and blinds to minimise wasted energy.

HVAC systems are responsible for almost 50% of commercial building energy consumption, 35% of which is usually wasted, according to ABB partner BrainBox AI.[xxviii]

What's involved?
The purpose of a computer-based building management (or automation) system (BMS) is to monitor and regulate a building's electrical and mechanical assets, such as power systems, lighting and ventilation.[xxix]

Artificial intelligence (AI) can be used to analyse building use patterns and adjust temperatures, requiring almost nothing in the way of intervention. Similar impacts can be achieved using smart meters and intelligent thermostats to adjust building conditions to the real-time needs of workers, rather than relying on wasteful always-on heating, cooling and ventilation.

What are the impacts?
A BMS might typically control around 40% of a commercial building's energy loads, rising to 70% if the system covers lighting as well.[xxx] In an industrial setting, the impact of a BMS will depend on the extent to which building and industrial process loads are managed separately.

Combining artificial intelligence with industrial IoT can cut HVAC emissions by as much as 40% and reduce energy costs 25% while increasing occupancy comfort 60% and extending equipment life 50%.[xxxi]

How much does it cost?
Published costs for BMSs in the United States range from $2.50 to $7.50 per square foot ($26.91 to $80.73 per square meter), depending on factors such as the usage and age of the building and whether the installation is new or is an upgrade.[xxxii] Most industrial facilities built after 2000 will have included a BMS as standard, although in older buildings this may need updating.[xxxiii]

HVAC optimisation systems can effectively pay for themselves. In New York, for example, the application of these systems is expected to largely help avoid the need for retrofitting energy-inefficient buildings at a cost of upwards of $20 billion.[xxxiv] Some solution providers also offer flexible consumption models and "zero capex" arrangements, marketing smart building systems on a subscription-based "as-a-service" basis wherein end users pay only from a portion of the cost savings realised.

How complex is it?
The complexity of a BMS installation will depend on the number of building subsystems it covers, with advanced deployments potentially extending to applications such as fire safety and access control as well as HVAC and lighting. At the level of the user, the point of a BMS is to make life easier, for example by switching off lights and HVAC systems when nobody is around.

How quickly do you get results?
Although BMSs are not cheap, automation can deliver immediate results upon commissioning, with research showing the payback times for building energy management systems in commercial buildings dropped from 5.4 to 0.7 years between 1977 and 2017.[xxxv]

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AI takes a while to learn usage patterns in a building and then apply that knowledge to temperature optimisation, so efficiency gains may not fully kick in for a few months.

What are the critical success factors?
A common problem with BMSs is that the full functionality of the system is not utilised, leading to sub-optimal performance and a reduced return on investment. To overcome this problem, researchers say it is important to consider commissioning, user involvement in the BMS specification and perceptions of vendor performance.[xxxvi]

What do the experts say?
"Sizing an HVAC system in an industrial environment is not that simple because of the heat loads you have," says Guggisberg of ABB. "Often you see people have made mistakes and they have the cooling system running full blast and the doors are open because they can't get enough air into the room."

The level of impact that can be achieved with such technologies will vary in each building but could be significant. "No system is fully optimised at the moment," says Kolar of ETH Zürich.

FIND OUT MORE
Read the whitepaper "Using AI to Optimize the Flow of Energy Through the Built Environment," from BrainBox AI:
https://brainboxai.com/en/white-papers/using-artificial-intelligence-to-optimize-the-flow-of-energy-through-the-built-environment.

Action #10: move data to the cloud

Demand for digital services is growing rapidly. Many of the energy efficiency opportunities highlighted in this report rely on massive data storage and computing power to derive insights from operational information. But storing and using data takes energy. Global data centre electricity use in 2021 was 220-320 TWh, or around 0.9-1.3% of global final electricity demand. This excludes energy used for cryptocurrency mining, which was a further 100-140 TWh in 2021.[xxxvii]

The global demand for data processing has been growing fast, and it isn't likely to decrease any time soon—quite the contrary, in fact. For this reason, the technology industry has had a strong focus on energy efficiency. It has achieved impressive gains through concepts such as server virtualisation and cloud computing.

Further efficiencies have come through energy-efficient HVAC systems, motors, variable speed drives and the utilisation of waste heat from data centres—all opportunities highlighted in this report. Industrial organisations looking for greater energy efficiency can tap into many of these gains associated with more intelligent use of data and cloud-based management.

What's involved?
Moving data to the cloud is a key aspect of harnessing information about industrial assets and processes and applying analytics to optimise how systems are operated and how much electricity they consume. Research suggests, moreover, that cloud-based data centres are themselves upwards of 90% more energy efficient than on-premise computing approaches.[xxxviii]

The concept of "multitenancy" allows a single compute resource to serve multiple clients simultaneously, dramatically increasing utilisation rates. Local, privately-owned servers often lack the intelligence and hypervisors characteristic of advanced cloud systems and consequently are frequently kept in an "always-on" state that wastes electricity, even when an application is only occasionally used.

Virtualisation means producing (and buying) fewer servers to handle the same processing burden. Further, many data centre operators, especially hyperscale cloud players and colocation service providers, are among the most advanced users of renewable energy sources in their power mix.

What are the impacts?
Moving from on-premises, privately managed data processing to a cloud-based data centre presents a range of energy efficiency opportunities. The economies of scale associated with data centre consolidation can be significant in terms of cost. Cloud providers also recognise data centre cooling as one of—if not the single biggest—operating expense in their business and are aggressive about seeking energy efficiency improvements.

How much does it cost?
The ability to consume storage and compute functionality on an as-a-service basis means enterprises can shift capital spending to a variable operating expense and enjoy the flexibility and financial benefits that go along with that. While initial costs may increase (for example, when an organisation takes a "hybrid" approach, maintaining both a private data centre and working with a third-party provider), cloud-based arrangements are consistently shown to offer lower total cost of ownership over time.[xxxix]

How complex is it?
Transitioning compute workloads and data management to the cloud is a relatively straightforward proposition for most enterprises. Many compute workloads can be shifted with a simple transaction subscribing to a cloud service, while others require a more expensive and involved set-up, usually with a technology partner.

How quickly do you get results?
Most enterprises can expect to see immediate energy efficiency benefits. The extent of gains will depend on factors such as the number of servers used, the overall volume of data and the compute intensity of applications.

What are the critical success factors?
Power usage effectiveness (PUE)—the amount of energy that ends up being used for computation—is perhaps the most important metric in data centre design, highlighting the importance of efficiency for the industry. Ways PUE can be improved include switching off idle technology equipment, consolidating and virtualising servers and storage, running power distribution at higher voltages, using energy-efficient chipsets and management features and installing high-efficiency uninterruptible power supplies (UPS).[xl]

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Improvements in data centre design can drastically improve efficiency, with industry figures showing that computing power rose 550% between 2010 and 2018 with no more than a 6% energy gain.[xli] But even companies that have the resources to implement smart data centre design features such as intelligent cooling might struggle to match the efficiency of server and network virtualisation that comes with hyperscale cloud services.

What do the experts say?

"Our public cloud platform, Microsoft Azure, can help you save up to 93% of your energy consumption and is up to 98% more carbon efficient than on-premises solutions," says Christoph Pawlowski, industry advocate for sustainability at Microsoft, based on a study.[xlii]

FIND OUT MORE

See the IEA report "Data Centres and Data Transmission Networks." Read now at:
https://www.iea.org/reports/data-centres-and-data-transmission-networks

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Outlook and conclusions

While the overall impact of efficiency gains will vary greatly from one industrial sector to another, the opportunity for cost and emissions reduction is significant and remains largely overlooked. Many governments also offer incentive schemes for industrial energy efficiency that can help accelerate adoption of relevant innovations.

According to the IEA, the industrial world has work to do; energy efficiency is not on track to meet the goal of net-zero emissions by 2050[xliii] as defined in the 2015 Paris agreement. "Now is the time to invest in energy efficiency" says the IEA's Lane.

As industry considers how best to tackle the twin challenges of decarbonisation and energy affordability, it should be clear that efficiency deserves a much more prominent place on the industrial corporate agenda. An important element in realising gains from energy efficiency is empowering the industrial workforce to utilise relevant innovations.

Training and incentivising employees to make energy efficiency a priority and to use available technologies therefore must be part of any systematic approach to reducing energy consumption. More generally, as organisations consider their options to address climate change and rising energy costs, they are confronted with five possible paths:

- **Reduce energy consumption by producing less.** In most developed economies, however, this would likely lead to reduced economic activity and lower standards of living, an outcome that is likely to be socially and politically challenging.
- **Switch to renewable energy sources.** This is already happening, albeit at a rate that is unlikely to achieve global climate goals in time. Within hard-to-abate industries, the energy transition is likely to take decades.
- **Increase circular business models.** This could reduce the emissions from raw material acquisition and preserve the world's resources, but will not address those that come from energy use—and the timeframe for introducing circularity is also likely to be measured in decades.
- **Create carbon sinks to offset industrial emissions.** This can be achieved at low cost, for example by planting trees, but with uncertain results and longer time horizons. Quicker, more effective measures involve immature technologies and are costly.
- **Improve energy efficiency.** This allows industry to operate much like it has until now, maintaining productivity and profits but with lower costs and markedly reduced emissions. As this report has demonstrated, many efficiency measures can be implemented rapidly, with immediate results.

Mitigating climate change will undoubtedly require industry to pursue all these strategies to varying degrees, but energy efficiency stands out as the one that can produce the greatest results in the shortest time and with the fewest downsides. The technologies required for greater efficiency are available today and current high energy pricing conditions in some locations make the business case for their application more pressing than ever.

"We at times think we have done enough on efficiency," concludes ABB's Morten Wierod. "But technology has developed a lot over the last 10 years. It's opened a new door for energy efficiency. The technology we need is already available - and the time to implement it is now."

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