AN EXPERT GUIDE TO

IMPROVING YOUR COMPANY'S SUSTAINABILITY WITH PREDICTIVE MAINTENANCE

ClimaCheck

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EXECUTIVE SUMMARY

According to the Glasgow Climate Pact, an environmental agreement reached at the COP26 United Nations Climate Change Conference in Scotland in November 2021, the transition to green energy is not enough on its own to mitigate the impact of global warming; it says the focus on energy efficiency also needs to be sharpened.

The COP26 agreement specifies that organisations must look into all areas to reduce their negative impact on our climate. Point 20 calls upon parties to:

> *Accelerate the development, deployment and dissemination of technologies, and the adoption of policies, to transition towards low-emission energy systems, including by rapidly scaling up the deployment of clean power generation and energy efficiency measures...*

In other words, the agreement calls for more sustainable development. Buildings offer huge potential to boost sustainability and one important aspect of this is improving the efficiency of refrigeration, air conditioning, and heat pump systems.

This guide explains how to implement predictive maintenance and energy optimisation to achieve energy savings and better reliability more sustainably.

It is possible to save 10 to 30% on energy usage with an effective maintenance and optimisation strategy based on real-time performance analysis of data. The challenges are to change how HVACR systems are commissioned, operated, and maintained.

Improving sustainability requires investment and a clear focus, but the return on investment (ROI) is short and the business benefits substantial.

THE POTENTIAL FOR ENERGY SAVINGS

Big changes are underway to reach a sustainable world with many organisations beginning to implement strategies aimed at achieving some, or all, of the United Nations' 17 sustainability goals as laid out in the 2030 Agenda.

There are many areas where organisations can start investing to contribute to these goals while, at the same time, decreasing their carbon dioxide (CO_2) emissions and saving money. The challenge is not so much the goals themselves; rather, it is identifying the solutions with the biggest impact and the shortest ROI.

You can steer your organisation towards becoming a net zero contributor as per the Green Building Council's 2030 objective while, at the same time, increasing its profits. This guide will show you how.

MOST SYSTEMS SAVE 10% TO 30% ON HVACR SYSTEM OPTIMISATION

Most organisations need cooling and heating, whether for air conditioning, warehouse refrigeration, food storage process cooling, or to keep employees warm, provide process heat, or deliver sanitary hot water.

Typically, between 40% and 60% of a building's total energy consumption is used by HVACR systems. In many cases, however, the efficiency of these systems is ignored so long as they deliver the intended temperature. This can lead to overconsumption with energy inefficiency translating into electricity bills that are 10% to 30% higher than they need to be.

But the costs don't stop there. High maintenance costs add even more to the bill.

Modern technology and methods make it possible to gain tighter control of your HVACR systems by, for example, implementing predictive maintenance and systematically working with energy optimisation.

Before you can act, however, you need to establish and understand your organisation's relationship with those systems. The crucial question is: Who owns the HVACR system your organisation depends upon? The answer will determine the approach you take.

If your organisation owns the HVACR systems, then you must begin the process of ensuring that your system's performance and maintenance are efficient (this guide will show you how).

If your organisation doesn't own the HVACR systems, then you need to demand that the owner start documenting performance. Without this documentation, you risk paying higher rent/energy bills caused by increased energy consumption.

This guide includes a checklist that will help you take your first steps in understanding where your organisation currently stands. Read on, and you'll also find more information about energy optimisation and predictive maintenance, along with the benefits of implementing both.

Predictive maintenance offers a host of business benefits, and this has resulted in it being implemented in many industries around the world. However, this has only been possible thanks to the vast amounts of data collected and then used in real-time analysis. This real-time information allows organisations not only to optimise systems, but also to curtail problems before they become unmanageable.

All these benefits translate naturally to HVACR systems, helping organisations to minimise their energy consumption, thus cutting energy bills, and lowering maintenance and repair costs.
But that's not all. Avoiding HVACR breakdowns also reduces the loss of time and valuable resources (such as perishable goods in a food and beverage supplier, for example).

The person responsible for the environmental performance of a business (typically the chief sustainability officer) is faced with the challenge of finding and implementing initiatives that combine two things – first, policies that positively impact on the environment and, secondly, finding significant savings without huge investments. If those policies can be implemented quickly and offer long-term benefits, so much the better.

Historically, maintenance of HVACR systems has been reactive, with a poor record of avoiding alarms and systems failures.

The transition to predictive maintenance for HVACR systems has been made possible by cost-effective sensors combined with modern data communication methods via the Internet of Things (IoT) – see the glossary at the end of this guide. This has allowed data to be collected from thousands of systems and analysed in the blink of an eye using the digital cloud.

This means that predictive maintenance no longer involves a huge investment; rather, all it takes is the smart implementation of advanced technologies and a judicious specification of responsibilities.

WHAT IS THE SAVINGS POTENTIAL FOR YOUR ORGANISATION?

The savings potential of predictive maintenance is huge. You need to consider several factors in order to get an idea of these savings.

Some are obvious, such as energy usage, production loss, maintenance costs, and lower margins which are directly connected to your HVACR system. Other costs are less obvious, such as those caused by shorter life expectancy and loss of customer confidence when HVACR systems cause problems. There are also intangible costs, such as the negative financial impact of a bad reputation and paying a higher interest on loans.

However, even if you only look at the potential in terms of energy savings, then optimising the HVACR system can yield savings of 10% to 30% with a typical ROI of around two years.

The more information you collect, the easier it will be to establish ROI accurately. And remember, when you include savings from all potential sources because of introducing predictive maintenance and energy optimisations, the ROI will be even shorter.

In our experience, adding all the additional benefits on top of increased efficiency, reduced breakdowns, and saved time can result in a ROI of less than a year based on the costs associated with an inefficient HVACR system, not forgetting the reduced stress for all involved.

In its guide, Operations & Maintenance Best Practices – A Guide to Achieving Operational Efficiency, the U.S. Department of Energy concludes that predictive maintenance will lead to the following:

> *Depending on a facility's reliance on reactive maintenance and material condition, it could easily recognise savings opportunities exceeding 30% to 40%. In fact, independent surveys indicate the following industrial average savings resultant from initiation of a functional predictive maintenance program:*
>
> - *Return on investment: 10 times*
> - *Reduction in maintenance costs: 25% to 30%*
> - *Elimination of breakdowns: 70% to 75%*
> - *Reduction in downtime: 35% to 45%*
> - *Increase in production: 20% to 25%.*

You can fill out our checklist here or in the end of this guide, to help you evaluate the status of your organisation and better understand from where potential savings may come. This checklist will also give you a good idea of where to start implementing your predictive maintenance strategy.

WHAT IS PREDICTIVE MAINTENANCE?

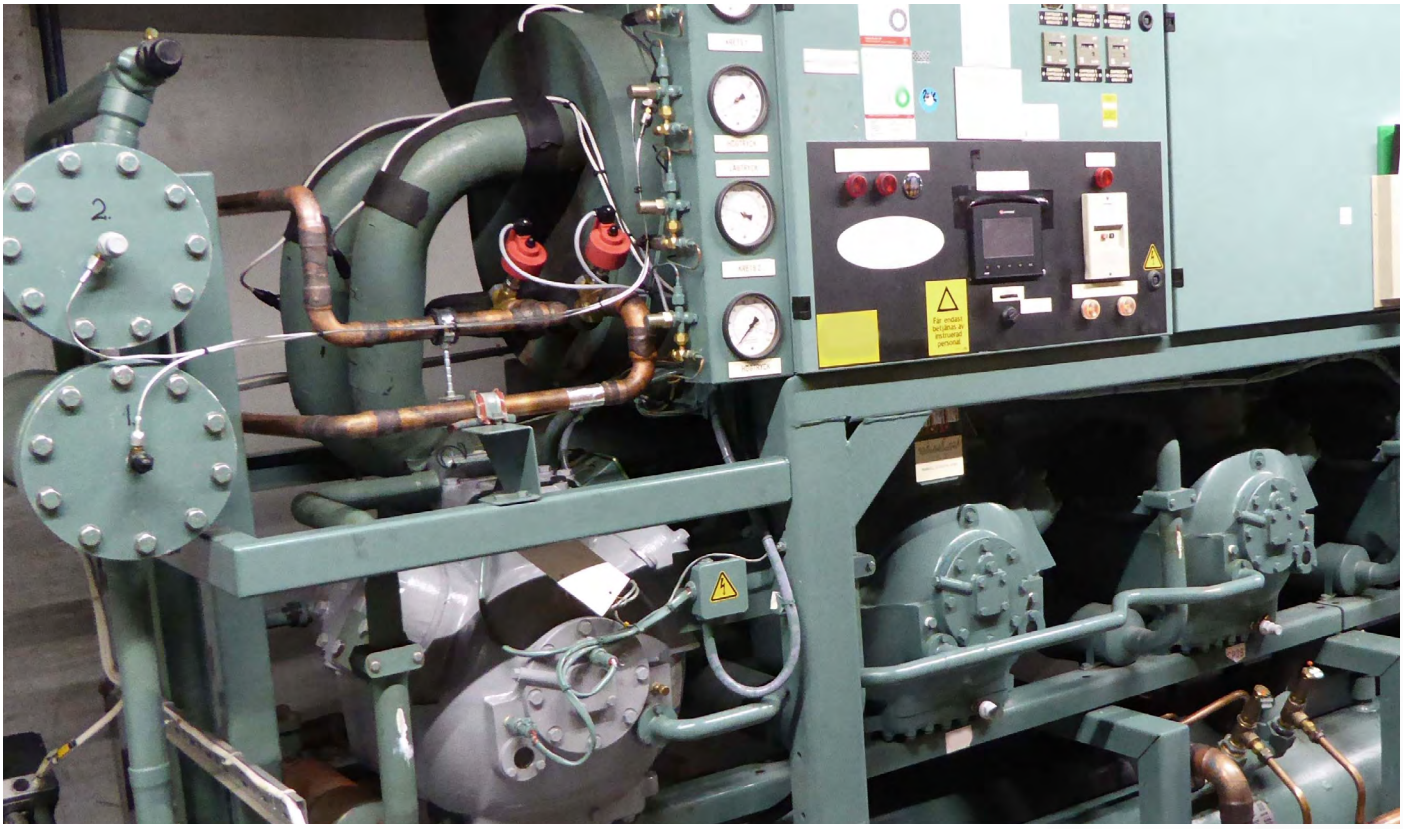
Predictive maintenance has gained a reputation as a global game-changer for sustainability, energy optimisation, and lower energy costs. Compared to scheduled (preventive) and reactive (post-failure/complaint) maintenance, predictive maintenance focuses on the wear and tear "condition" of equipment.

By using modern IoT platforms, performance analysis can be performed continuously. Indeed, IoT makes predictive maintenance cost-effective and allows continuous improvements as the platform learns from a huge number of sites.

Because you need more information to implement predictive maintenance on HVACR systems, a new way of working is required in most organisations. For example, data collection and documentation of maintenance must be revised to better monitor real-time performance over varying operating conditions.

With predictive maintenance, data is collected in real time in order to monitor increases or decreases in performance. This makes it easier to optimise energy usage continuously. HVACR systems are perfect for predictive maintenance since the conditions in which they operate vary despite the fact that their intended operation is known.

Once the systems are in place for predictive maintenance, a new world of improvement opportunities opens for organisations. Service visits are no longer based on the number of visits a year or runtime but instead on system performance as deviations and issues are detected in real time.



THE ROOT CAUSES OF AN INEFFICIENT HVACR SYSTEM

Implementing a predictive maintenance strategy for future operation requires an understanding of the current situation. One of the big questions is: why haven't businesses been able to do more to tap into potential savings?

The truth is that there are many reasons for inefficient HVACR systems. Here are some:

Design and installation

When specifiers initiate projects to install a new HVACR system, the client's focus is often on the design at maximum load. Rarely have they included the ability to monitor performance at normal operating conditions and loads. The measuring equipment installed to generate annual seasonal performance factor (SPF) are rarely detailed enough to benchmark, troubleshoot, or optimise, as there is no way to trace deviations at varying system loads and conditions. As a result, troubleshooting and optimisation become problematic.

There is also the question of perception. Clients often believe they have purchased a function with their HVACR system, yet the specification is not aligned with anything other than rating of the products that were delivered and installed. How the total system operates at different conditions after installation is rarely the contractor's responsibility.

As there may be five or more contractors involved in a typical project, it is common for operating staff to have problems with assigning accountability for low efficiency.

Furthermore, the complexity will inevitably increase because no building operates exactly as planned, and tenants and operating staff as well as a changeable climate have a significant influence on the efficiency and energy bill.

Commissioning and verification of performance

Commissioning a new HVACR system without the requirement to document performances may be common, but it is a huge risk in terms of future energy over-consumption.

A HVACR system without real-time performance analysis for current operating conditions and loads is hard to commission efficiently. With no relevant performance information, operators cannot optimise the system. This makes it impossible to determine the cost of consumption for chillers and heat pumps, or even to track hourly energy consumption.

Combined with data about outdoor temperatures and facility usage, this information is required to adjust usage based on usage patterns and outdoor conditions.

A high energy rating or approved factory tests of performance are not the same as efficient operation.

During operation and maintenance

Whatever the root causes of an inefficient HVACR installation, problems will inevitably arise during its operation and maintenance that will result in higher costs.

Often, clients fail to specify maintenance protocols; it therefore falls to the contractor to supply checklists with boxes to tick off or fill in. This is certainly a start, but checklists will rarely include details of performance or notes of acceptable limits for parameters.

This issue is exacerbated when an organisation deals with several contractors for maintenance. While none is responsible for the overall system, each affects the operating performance of its own sub-system, which in turn affects the whole.

Add to this the difficulty of tracking cost and responsibility for all this and the problem is multiplied. This is because there is no single entity responsible for the entire HVACR system – just a series of contractors focused on completing their own contract on time and at lowest cost to them. The long-term performance and reliability of your overall system is not their responsibility or focus.

This begs an important question: Who is responsible for operation and maintenance?

The person within the organisation responsible for environmental matters – typically the chief sustainability officer –may not be aware that the above are common issues. Besides, he or she cannot evaluate energy efficiency measures or upgrade

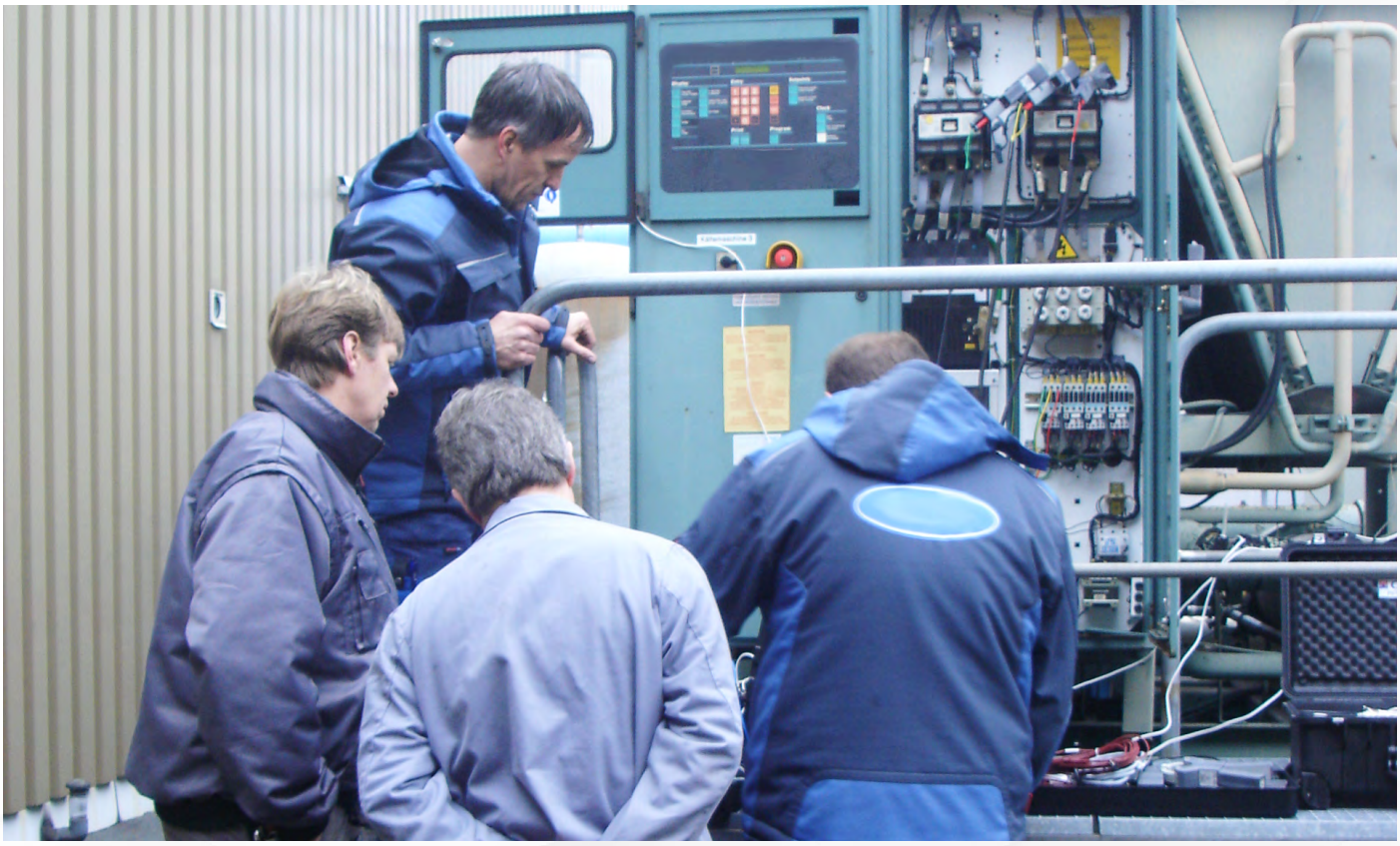
equipment if there is a lack of relevant baseline and post-measurement data.

If the HVACR systems are operating without alarms, then nobody within the organisation is likely to question them. They are, after all, doing their job, whether efficiently or not. From time to time, scheduled maintenance may pick up an issue, or a system may fail. Issues such as refrigerant leaks might be noticed at these times but often not until the system trips.

Existing in-house staff cannot be experts in all technologies; it is inevitable that they will depend on contractors' recommendations – even if they are not the best strategies.

The onus to establish responsibilities falls on the client who must build knowledge or use experts to specify installations with a mind on performance measurements and future maintenance. If all a contractor has to offer is lowest price, then it is unlikely to offer a high-quality service. By focusing on value for money rather than initial cost, the expenditure may increase marginally, but a world of headaches and expenses will be avoided.

With stipulations on documentation of performance in specifications as well as commissioning and maintenance in the contract, the responsibility can be assigned to the contractor, and it can focus on delivering operational efficiency. After all, HVACR systems are complex, and predictive maintenance for their optimisation requires knowledge of several different technologies.



HOW TO IMPLEMENT PREDICTIVE MAINTENANCE AND ENERGY OPTIMISATION

Implementing a predictive maintenance strategy for HVACR systems is a significant task and one that will involve the participation of many stakeholders from within the organisation. All need to see the value of the investment and understand how it will affect them.

While this strategy is focused on reducing the business's carbon footprint, saving energy, and minimising costs related to breakdowns and maintenance, there are many other benefits to consider too. These include:

- Increased time efficiency by focusing on long-term development, not short-term fixes.
- Improved maintenance based on performance-analysed conditions rather than a blind schedule.
- Fewer interruptions to operation from HVACR failure.
- No performance drift thanks to energy efficient operation.
- Lower reactive maintenance costs.
- Improved documentation for operational tracking and specification of new projects.
- Enhanced, easier reporting.
- Increased professionalism with maintenance contractors based on specific performance information together with recommendations for improvement.

However, none of these benefits will become apparent unless someone within the organisation has the mandate and the will to drive change.

Thus, it falls to top management to drive this change forward. The chief sustainability officer and technical director have key roles to play in ensuring that all who are responsible are informed, and it requires an 'all-hands-on-deck' approach when it comes to involvement.

In this section, we have put together a summary of the different stakeholders, their potential for involvement, and how predictive maintenance will impact on them.

Board of directors

Introducing predictive maintenance is an organisational effort that requires top to bottom involvement and a change in reporting. Without identifying costs and solutions, the incentives that organisations use will be wrong.

Maintenance might not normally be a subject for the board but upgrading reporting within an organisation is. Without upgraded reporting, it is simply not possible for organisations to make solid, strategic decisions based on hard facts. To this end, reports on energy consumption and the organisation's carbon footprint facilitate benchmarking.

Moreover, within an organisation, departments often work separately towards different goals and budgets rather than a common goal. Although predictive maintenance requires relatively small investments, the challenge for operational staff is to get funding approval because operational costs for energy use and reactive maintenance are often covered in budgets that are beyond their control.

As regulatory pressures increase and investor focus sharpens, sustainability risks are becoming financial risks. It falls to the board not only to update reporting requirements to better reflect energy efficiency, but also to identify how that data is used in order to remain competitive.

HVACR is the single biggest energy user in many operations and has high preventive and reactive maintenance costs; priority should fall on establishing benchmarking procedures that impact the total cost of operations.

By implementing predictive maintenance and documented energy optimisation, organisations can minimise the financial risks associated with sustainability and environmental issues.

Change is not always welcomed. Technical staff, and particularly operational managers, may see remote monitoring as a threat

to their positions – an insult, rather than a tool. Transparency and co-operation between departments can be seen as an opportunity or as interference in their role.

The board should give a clear direction for change to assuage such doubts, creating budgets and reporting that create the right incentives while also addressing potential resistance. After all, paradigm shifts are led from the top.

Chief executive officer (CEO)

While the HVACR system isn't likely to be a part of the CEO's daily business responsibilities, he or she does need to be aware of the potential cost savings that the organisation is missing out on by overlooking the optimisation of its HVACR systems.

This awareness is raised when it is identified how energy is used and how maintenance costs are distributed. The cost of introducing predictive maintenance and optimisation should be evaluated against all current costs and potential savings.

Once this is established, the CEO should ensure that management is interested and supportive of those responsible for the implementation of predictive maintenance. The scale of change involved necessarily crosses over several departments, making teamwork and inter-departmental communication essential.

In addition to this, the CEO needs to delegate responsibility for the upgrade of maintenance contracts of the organisation's HVACR systems. These include specification and establishment of the monitoring and documentation of performance as well as relevant benchmarking parameters.

Chief sustainability officer (CSO)

The CSO is often the organisational leader when it comes to starting the move towards predictive maintenance and energy optimisation. In this role, having actionable information about energy consumption is vital, as well as identifying resource allocation and areas of improvement.

This can be done by developing suitable benchmarking key performance indicators (KPIs) adapted to sustainability goals. This might include comparing different sites (in terms of climate and size differences, for example). Whatever the benchmarks, building structures internally and externally promotes a good example and shared experience that can benefit the entire organisation.

While the CSO might be the spearhead behind a more aggressive strategy to reduce the organisation's carbon footprint and to lower its operational costs, this strategy can be a positive driving force that opens new channels of inter-departmental communication and understanding.

Chief financial officer (CFO)

An inefficient HVACR system is costly, affecting all operations that depend on its operational status to be productive. With little or no documentation or analysis, it is impossible for a CFO to judge the cost-efficiency of the HVACR system.

Using submetering and separate costing for preventive, reactive, and predictive maintenance is the foundation for the competent, proactive, and cost-effective management of HVACR systems. With such documentation, organisations can track

energy consumption and cost, maintenance and repair costs, downtime costs, loss of production, and goodwill, as well as organisational stress.

The potential savings in fixing just one or two of these issues alone cover the cost to fix them all. Unfortunately, this information – and therefore, knowledge – is rarely known or visible to the organisation, let alone to the CFO.

Chief technical officer (CTO)

Predictive maintenance and energy optimisation will generate a lot of data, which will require a new system and routines for analysis. Ideally, the implementation of these should take place before the introduction of the predictive maintenance strategy, allowing the organisation to evaluate the performance of existing solutions and establish baseline performance.

This data can then be used to verify the efficiency of new solutions. It can also be used to begin a process of continuous improvement based on hard facts. This information will point the way to better technical solutions and more effective maintenance schedules.

Without this information, it is not possible to document operational performance over time or to validate that the design is in line with specifications. This means better control and less dependence on individual technicians – and a hope that services are high quality. As maintenance contracts rarely include quantifiable KPIs, this is a price-sensitive, highly competitive market.

To ensure that contractors don't focus solely on minimising cost of services and fast project completion, it's important to specify the need for quality of delivered systems. Predictive maintenance should also be specified; without this, contractors will view predictive maintenance as a cost and reactive maintenance as a bonus.

By installing systems and routines to analyse and monitor performance, the CTO will be able to verify the performance of any given system and its operation. Together with documentation of costs for both preventive and reactive maintenance, it will also be possible to incentivise contractors to focus on optimisation and maintenance based on a predictive, rather than a reactive, model.

Chief operating officer (COO)

Typically, organisations focused on sustainability have begun with choosing more eco-friendly materials and following green building rating requirements. Today, the focus is increasingly on boosting the efficiency of operation. This field can be more challenging to get acceptance for, coming as it does with the implication that systems were not purchased and maintained professionally.

There are also other challenges. Some may view an upgrade to predictive maintenance as an investment and find themselves locked down in time-consuming budgetary processes to release relatively small funds. Calculating ROI is tricky, too. Future failures cannot be specified, and future energy savings are always estimated. Moreover, it may be the case that reactive maintenance and energy consumption for HVACR systems are not reported separately.

Whatever the situation, the people who operate these systems have the most experience of them, making their insights invaluable. It is important to include them in any team tasked with introducing predictive maintenance and systems optimisation. At the same time, the COO should be aware of the secondary costs of avoidable reactive maintenance to the organisation – for example, when staff need to work around the issues caused by a breakdown.

Smoothing the course for implementing predictive maintenance requires effective monitoring and reporting systems, together with support to acquire funding for the migration. The U.S. Department of Energy's research (see earlier) shows that investments in predictive maintenance can pay back tenfold.

When creating routines for documentation and reporting, the focus should be on facilitating good decisions and efficient, reliable work rather than ticking boxes. Day-to-day business, agreements, systems, and reporting should all be updated for predictive maintenance.

Energy manager

The position of energy manager is an increasingly common one in organisations with high energy consumption. This person is dedicated to managing energy efficiency within a facility or organisation. Typically, this means harmonising reporting structures and data collection processes, as well as leading the way forward in finding methods of reducing energy consumption and assessing sustainability decisions.

Basic energy reporting on supply meters is not enough on its own to track and benchmark the consumption of a HVACR system. Loads and performances vary from day to day and depend on the weather conditions.

If an organisation fails to collect information about outdoor temperatures, it cannot benchmark or pick up the degradation of its systems. The solution to this is relatively simple: introduce structured submetering and data logging for outdoor temperature to establish energy signatures. When this information is combined with performance documentation, you have the information necessary for predictive maintenance together with data on climate-dependent performance.

Facility management, technicians, operational staff

These roles work daily with HVACR systems and experience all issues first-hand, whether in the form of an interrupted routine or the disruption to planned activities. It makes sense, then, that these stakeholders should have continuous access to the right information.

Achieving reliable, stable operations is an artform, but many current systems are set to run within fixed (not necessarily optimised) parameters for stability. Changing the operation of systems can be met with resistance, which makes the addition of performance analysis even more important. With real-time data showing improvements in efficiency without negatively impacting the equipment, there is little to resist, particularly since energy efficient operation is also generally more reliable.

Greater reliability, of course, removes most unplanned, unpredictable work.

"dDOP" THE NINE-STEP METHOD FOR SUCCESSFUL IMPLEMENTATION

A successful transition from preventive and reactive maintenance practice to predictive maintenance requires a structured approach. This should also give you the right tools for continuous monitoring and optimisation.

While purchased energy is a key starting point in tracking sustainability, predictive maintenance requires more data – but the key is not simply to collect data, it is to make actionable information from collected data.

Once the tools and routines for creating the information have been put in place, they can be adjusted for operational improvements and optimisation. Once optimised, the systems should be monitored 24/7. Not only does this give a continuous record of performance, but it will also detect deviations and send out alerts when they happen, long before they cause failures.

You can start to implement predictive maintenance and energy optimisation following nine steps, which use the dDOP method (data-driven energy optimisation and predictive maintenance) developed by ClimaCheck. These steps can also be used as a quick dDOP checklist to better understand the stops that your organisation needs to take.

1. Establish your energy baseline.
2. Start tracking maintenance costs.
3. Define data collection requirements from sites in the planning stage.
4. Define data collection requirements from existing sites.
5. Define how data points are transferred.
6. Assign responsibility for data collection and communication.
7. Assign responsibility for performance analysis.
8. Establish a commissioning procedure.
9. Establish a procedure for predictive maintenance and optimisation.

1. Establish your energy baseline

Your energy baseline is the foundation for all future benchmarking and evaluation of energy optimisation. If you already have this information, you have a historical baseline from which to start working. If not, then establishing a baseline should be a priority.

This starts with gathering hourly data in kWh for your different systems, as well as collecting outdoor temperatures. From this point, you can begin to identify information about the organisation's energy consumption and cost and set up appropriate targets for energy savings and cost reduction.

Many organisations have systems that monitor their total energy consumption. For those sub-systems with high energy use, systems that collect and store hourly data together with the outdoor temperature will yield essential information.

2. Start tracking maintenance costs

Can you track your HVACR system's maintenance cost? The truth is that, in many organisations, it has not been so easy to identify the cost of preventive and reactive maintenance.

This inevitably means that the true cost disappears, swallowed up and hidden by other costs. This makes it trickier to justify an investment in predictive maintenance strategies, as there are no obvious costs that can be reduced.

One example of this is when reactive maintenance occurs. The unexpected breakdown must be fixed and is not a part of any planned expenditure so recording the cost may not be a priority.

3. Define data collection requirements from sites in the planning stage

Data collection requirements introduced in the planning stage are a minimal cost, so it makes sense to ensure that a list of relevant data points is included in all specifications and contracts for upgrades and new installations.

Today's equipment, as installed, typically has all (or almost all) the sensors needed for predictive maintenance and optimisation. This includes sensors for pressures, temperatures, and power as standard. Specifying the addition of any missing sensors can be done at a low cost.

4. Define data collection requirements from existing sites

There are two ways that an organisation can introduce predictive maintenance in existing installations. First, it can simply follow procedures for new plants. This is a solution for organisations that have newer systems, with many sensors already installed.

However, for those with older systems, there is a second option. Upgrading old systems can be costly, so it may make more sense to implement a turnkey data acquisition system. Today, it is possible to get a pre-configured system with highly accurate sensors together with a gateway that transfers all collected data to the platform for performance analysis. This can be applied to any existing system without

needing to change existing controls or monitoring systems, thus providing an easy transition.

5. Define how data points are transferred

In this step, the task is to define how collected data points are transferred to the cloud to be analysed for predictive maintenance and optimisation. Most facilities have a BMS/BAS/SCADA system with standardised protocols for data management. These systems can also share data to gateways or through server-to-server. The data can be sent using existing LAN/WLAN connections or a built-in modem (creating a data collection system independent of the IT infrastructure on site).

If an organisation already has data collection, exchange, and storage strategies for the cloud, server-to-server can be a cost-effective solution.

6. Assign responsibility for data collection and communication

Data collection and communication requires clearly defined roles and responsibilities. Since there are several parties involved – for example, in-house staff, control contractors, and a cloud-based analyses/monitoring provider – a certain level of co-ordination and co-operation is required.

By establishing clear responsibilities, organisations can avoid delays and, by establishing who is responsible for what, all parties involved will clearly understand their role and responsibilities, enhancing co-ordination, co-operation, and communication.

7. Assign responsibility for performance analysis

The responsibility for performance analysis should not be neglected, either.

It should be specified that verification of performance is an integral part of all hand-over and warranty inspections as well as maintenance. This creates a performance analytics system with detailed performance protocols, allowing full evaluation of equipment to follow, and design and rating specifications to be developed so that no degradation occurs unnoticed over time.

Proper documentation of performance at hand-over and warranty inspections reduce the risk that equipment owners end up with high costs for problems in equipment that are missed due to the assumption that no alarms is the same as no issues. This documentation is an essential cornerstone for future maintenance as automatic detection of degradations is a primary feature of the analysing platform.

8. Establish a commissioning procedure

Commissioning is not something that can be completed with a snapshot inspection; it requires monitoring of performance over time. This should be a prerequisite not only to analyse, but also to confirm performance in different conditions. This also allows controls to be adjusted accordingly.

Again, assigning responsibility together with procedures for reports and performance follow-ups is important. It is a rare place in the world where winter is exactly like summer; in most places, it is not possible to

simulate summer/spring/autumn operations in winter or vice-versa.

It's important to avoid assumptions, too. It is a common assumption that a highly rated unit will perform just as rated when it is installed. This is usually wrong because operating conditions rarely match rating conditions and the optimisation of the equipment in its system is almost always neglected. True savings come when collected data is turned into information used to optimise the performance of the whole system.

9. Establish a procedure for predictive maintenance and optimisation

In this final step, organisations should introduce predictive maintenance contracts with performance monitoring in their facilities.

Typical things to include in a predictive maintenance contract involve setting up:

- Early warnings and alerts for performance deviations.
- Indirect leak detections and adapt on site leak detection intervals.
- An alert monitoring system.
- Scheduled online inspections to replace "ticking boxes".

Implementing these reduces time-consuming onsite inspections since a 24/7 performance monitoring system has been configured and installed. European Union regulations, for example, halve the number of on-site leak checks required for changes in refrigerant when they are monitored by indirect leak detection.

CAN YOUR ORGANISATION AFFORD NOT TO ACT?

ClimaCheck is a world leader in performance analysis of HVACR systems. The company's success comes from its in-house development of a unique, proprietary analysis that enables efficient energy optimisation and predictive maintenance.

Over the years, ClimaCheck has analysed thousands of HVACR systems, enabling some of the world's biggest businesses to reduce their CO_2 emissions while, at the same time, saving millions of Euros.

When ClimaCheck was awarded "WWF Climate Solver", it was calculated by WWF that the pioneering technology will reduce CO_2 emissions by 72 million tons per year if implemented in half of the air conditioning market. To set that number in perspective, Sweden's total CO_2 emission was 51.8 million tons (2018). If you want to be a part of this reduction, we can help your organisation to great savings!

To find out more about how ClimaCheck can help your organisation achieve its net zero contributor goals while at the same time increasing profits, why not schedule a meeting with one of our experts?

We can help with any situation, whether you are seeking a quick 'reality check' or a deep dive into the status of your equipment and agreements. We want to help you kickstart your predictive maintenance and energy optimisation programme.

Contact us here to get started now.

APPENDICES

A FOCUS ON SUSTAINABLE DEVELOPMENT

Currently, the building and construction industry emits around 39% of global greenhouse gases (GHG) annually while consuming around 30% of the world's energy. In other words, the industry currently has one of the highest carbon footprints of any in the world.

When it comes to sustainable development, some starting points include:

- Certifying buildings with 'green' certification systems.
- Selecting and reusing building materials with a low environmental impact where possible.
- Choosing eco-friendly energy supplies and HVACR systems with the highest possible efficiency to minimise energy consumption.
- Making installed building equipment operate as efficiently as possible.

The keys to success are using the right methods at the right time in the right place. Ways to implement sustainable development are increasing daily, in part due to new methods that combine performance analysis and the Internet of Things (IoT).

BENEFITS OF EFFECTIVE PREDICTIVE MAINTENANCE

There are multiple benefits to predictive maintenance. One of the biggest is that an optimised HVACR system is not only energy efficient, but also reliable. Here are just a couple of examples of how predictive maintenance can help your business.

First, the disruption to productivity caused by HVACR breakdowns is eliminated with reliable systems, preserving the efficiency of employee time and use of resources. The business world may not always be predictable, but a reliable HVACR system can help ensure your organisation is a 'steady ship'.

Second, an HVACR system with a modern platform and operating system makes benchmarking and optimising easy. Say you have a system that logs energy consumption in kWh together with outdoor temperatures as well as performance of all components, it is then easy to identify and fix deviations before they become problematic. In the end, your organisation reduces its CO_2 emissions, and saves time and money.
These are just two major benefits, but there are many more. Transitioning into predictive maintenance brings about change and new opportunities for your organisation. Your organisation not only becomes more sustainable, but also more competitive. In short, you can benefit from a wealth of economic and environmental advantages such as:

- Energy savings of, in most cases, 10% to 30%.
- Reduced CO_2 emissions.
- Lower maintenance costs.
- Happier, more satisfied customers.
- Less stress and frustration on staff with fewer problems and complaints.
- Fewer goods losses.
- More time and information for development.
- Improved planning for new projects.
- Increased efficiency in maintenance contracts with enhanced performance documentation and predictive maintenance.

CHECKLIST

Can be done online, here

Do you know how much electricity your HVACR systems use across your company property?
- □ Yes (0 – 20%)
- □ Yes (20 – 40%)
- □ Yes (40 – 60%)
- □ Yes (60 – 70%)
- □ Yes 71% or more)
- □ No

Do you know the COP, EER, or SPF that your systems are designed to work at?
- □ Yes
- □ No

Does your maintenance and/or monitoring deliver information on the operational COP, EER, and SPF of your systems?
- □ Yes
- □ No

Do you currently use performance analysis on your HVACR systems?
- □ Yes
- □ No

Does your organisation specify sensors, documentation, and services to enable predictive maintenance in new projects?
- □ Yes
- □ No

Do these performance analyses present different performances when set to different operational settings (COP, EER, and SPF depend on outdoor temperatures and the controlled settings)?
- □ Yes
- □ No

Do your monitoring systems document sub-efficiencies of compressor, condenser, and evaporator to give actionable information to avoid future failures?
- □ Yes
- □ No

Do you know the historical costs of maintenance and downtime of your chillers, heat pumps, and refrigeration equipment?
- □ Yes
- □ No

Have you made the transition from traditional maintenance contracts to predictive maintenance?
- □ Yes
- □ No

CHECKLIST CONCLUSIONS: YOUR ANSWERS AND WHAT THEY MEAN

If you answered "yes" to all the questions, congratulations! You already know the importance of keeping your HVACR systems optimised. You have improved the control over the costs and energy consumption of your systems and can avoid breakdowns and performance drift. You also have access to energy consumption reports, which help you to stay on top of your organisational sustainability reports.

If you answered "no" to one or more of the questions, you may have problems. However, don't despair. A more positive way to look at this is to see solving these problems as a golden opportunity for your organisation to make significant savings.

To get started, you can contact us here

GLOSSARY OF TERMS

BAS (also BMS)– Building automation system (also called a BMS or building management system): Provides automatic centralised control of a building's HVACR system, sometimes with other building systems such as lighting and security.

CO_2 – Carbon dioxide: One of the main greenhouse gases in the Earth's atmosphere.

COP – Coefficient of performance: The relationship between the power drawn out of a heat pump as cooling or heat, and the power that is supplied to the compressor.

dDOP – Data-driven energy optimisation and predictive maintenance: A predictive maintenance and energy optimisation method developed by ClimaCheck.

EER – Energy efficiency ratio: A measure of how well HVACR equipment uses energy; the ratio of heat output to power input while the system is in operation.

GHG – Greenhouse gas(es): Gases that cause the greenhouse effect, a process that leads to global warming when the Earth's atmosphere traps the Sun's heat.

HVACR – Heating, ventilating, air conditioning, and refrigeration.
IoT – Internet of Things: The interconnection via the internet of computing devices embedded in everyday objects, enabling them to send and receive data.

kWh – kilowatt hour: A measure of how much energy is being used in kilowatts each hour.

LAN – Local area network: A group of computers or other devices interconnected within a single, limited area.

ROI – Return on investment: A ratio between net income and investment used to measure performance of an investment.

SCADA – Supervisory control and data acquisition: A system comprising software and hardware parts that allows businesses to control industrial processes locally.

SPF – Seasonal performance factor: The net average seasonal efficiency of a heat pump or the average COP of a heat pump over the full heating season.

WLAN – Wireless local area network.

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