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The Future of HVAC is Predictive

How to Help Eliminate Downtime & Reduce Emergency Repairs

The Cost of Downtime: Why HVAC Resilience is Now Mission Critical

In today's interconnected world, the resilience of HVAC systems has become paramount, especially in critical environments such as healthcare facilities, data centres, educational institutions, manufacturing plants, and government buildings. Unplanned HVAC outages in these settings can lead to significant operational disruptions, financial losses, and, in some cases, jeopardise safety and compliance.

Beyond direct costs, the repercussions of HVAC failures extend to reputational damage and regulatory non-compliance. In sectors like healthcare and data centres, maintaining indoor environmental conditions is not just about comfort but also about meeting stringent regulatory standards.

Modern facilities also rely on precise environmental control.

Recent data highlights just how costly outages can become:

54% of organisations say their most recent outage exceeded **£75,000**

20% of organisations experienced disruptions **costing over £750,000**[1]

A failed HVAC system can:

- Compromise temperature-sensitive equipment
- Disrupt service delivery in hospitals and data centres
- Trigger tenant complaints and legal risks
- Damage high-value infrastructure or inventory

With the growing complexity and stakes, transitioning from reactive maintenance to predictive strategies isn't just an upgrade, it’s now a business imperative.

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From Reactive to Predictive: The New Era of Building Intelligence

For decades, HVAC maintenance strategies have followed two main models: reactive (fix it when it breaks) and preventive (fix it on a schedule). But in modern facilities, neither model offers the reliability or efficiency required today.

Research shows that HVAC systems frequently exhibit subtle performance degradations before a failure becomes apparent, which often go undetected by schedule-based approaches.[2] A foresight-driven approach solves this gap by continuously monitoring HVAC performance, detecting deviations from expected behavior, and alerting teams when early signs of failure arise.[3] Instead of relying on set service intervals, or worse, reacting to downtime, facility teams can stay ahead of issues.

Predictive Impact: KPIs That Matter

A recent study confirms the measurable benefits of predictive maintenance:

MEAN TIME BETWEEN FAILURES (MTBF) IMPROVED BY 80%
from 250 hours to 450 hours

MEAN TIME TO REPAIR (MTTR) IMPROVED BY 50%
from 6 hours to 3 hours

ENERGY EFFICIENCY INCREASED BY 4%
due to early detection of inefficiencies

SYSTEM DOWNTIME DECREASED BY 73%
from 15 hours to 4 hours monthly[2]

By leveraging real-time data, predictive maintenance represents a transformative approach with proven impact. This leap forward empowers building operators to evolve to dynamic, data-informed approaches that protect uptime, reduce waste, and extend asset life.

Key Benefits of Predictive Maintenance

Reduced Downtime: By forecasting potential failures, maintenance can be scheduled proactively, limiting unexpected disruptions

Cost Efficiency: Targeted maintenance reduces unnecessary servicing and extends equipment lifespan, leading to significant cost savings.

Enhanced Energy Efficiency: Continuous monitoring ensures systems operate at optimal performance, reducing energy consumption.

Improved Reliability: Early detection of issues enhances overall system reliability, ensuring consistent comfort and safety.

Implementing predictive maintenance strategies positions facilities at the forefront of building intelligence, ensuring operational excellence & resilience in an increasingly complex environment.

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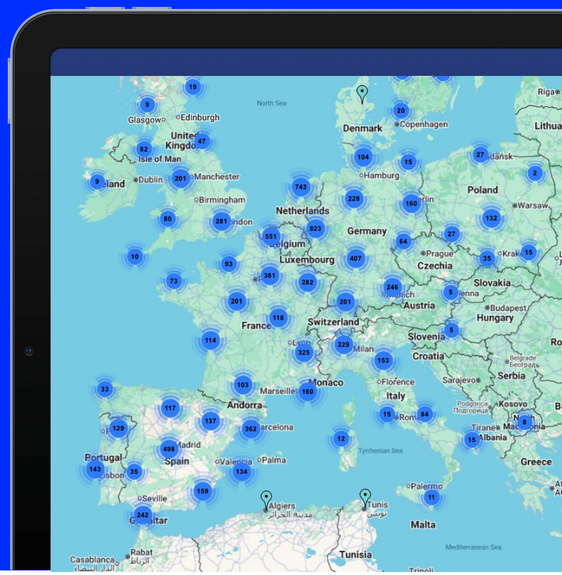
How Abound™ HVAC Performance Predicts Failures Months in Advance

Today's facilities demand more than routine check-ins—they need intelligent systems that anticipate risk and drive action.
Abound HVAC Performance, part of Carrier's Abound suite of innovative lifecycle solutions, is a cloud-based asset management and monitoring platform **built on AWS (Amazon Web Services)** that makes predictive maintenance a reality. By combining real-time analytics, machine learning, and expert system monitoring into one seamless digital solution, it empowers you to detect issues sooner, respond faster, and keep your HVAC systems performing at their best.

The Power of Real-Time Analytics

When your system is connected you're not just collecting data, you're gaining instant clarity on how your system is operating, what the key trends are, and when action is needed.



How Abound HVAC Performance turns live data into actionable intelligence:

Live System Health: See the current status of equipment performance in real-time.

Performance & Efficiency: Get insights into operational performance and inefficencies across your portfolio.

Dynamic Dashboards: Visualise critical KPIs for fast interpretation and facility-wide visibility.

Custom Reporting: Generate detailed insights based on what matters to your team.

Data That Drives Action: Insights are used to prioritise service, inform technicians before arrival, and reduce onsite guesswork.

Getting instant system insights help you act faster and smarter so you can prioritise service based on current equipment conditions, not outdated schedules. That means fewer unnecessary visits, better resource use, and consistently optimised performance. It's more than data. It's a strategic edge.

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The Predictive Edge Of Machine Learning

Live operational data tells you what's happening. Machine learning tells you what happens next. Abound HVAC Performance uses advanced machine learning algorithms trained on thousands of data points across HVAC systems worldwide as well as your equipment. These models identify early warning signs of equipment stress and performance degradation, often long before a traditional system would trigger an alert.

What Machine Learning Enables:

Anomaly Detection: Flags subtle deviations in system behavior that signal early signs of failure.

Smarter Prioritisation: Helps put the focus on issues based on severity and urgency.

Continuous Learning Improves over time based on new data and outcomes across Carrier's global network.

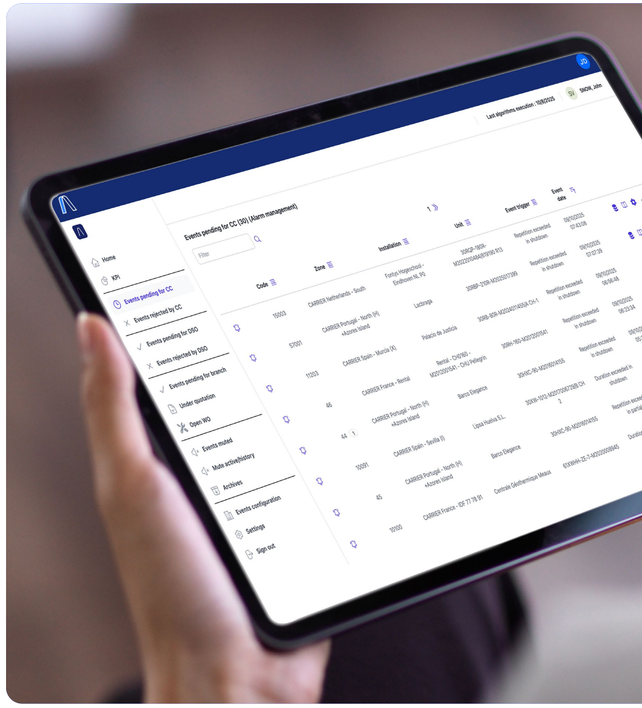
Turning Data Into Foresight

Machine learning gives your HVAC data a forward-looking purpose that guides smarter decisions. It enables earlier intervention, fewer emergencies, and more confident decision-making, empowering your team to operate with less risk and more control.

Take the Next Step

Together, these tools give teams advanced warning in advance for many performance issues allowing ample time to plan and react. If you're ready to replace reactive service calls with predictive foresight, explore how Abound HVAC Performance can fit into your building ecosystem.

For more information on Carrier's digital connectivity solution, visit carrier.com



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The Reliability Dividend

When maintenance becomes proactive, the impact goes far beyond just the equipment. Systems run more consistently. Repair teams are more efficient. Budgets become more predictable. And occupants notice the difference. The data shows:

Corrective maintenance can be up to 10 times more expensive than planned preventative maintenance.[4]

Occupant satisfaction improved when indoor environments were more stable and responsive to use patterns.[2]

Energy efficiency improvements of 11.9% and a marked decrease in emergency interventions were seen after the implementation of predictive HVAC controls.[5]

Preventative maintenance can yield a 545% return on investment by reducing downtime, extending equipment life, and improving energy efficiency.[4]

HVAC systems account for up to 40% of a building's total energy use, making them the single biggest driver of operating costs.[6]

But with predictive maintenance and smart controls, significant energy savings can be achieved and high ROI can be realised through not only reduction in energy use but energy demand can be reduced and reductions in emergency repairs and capital replacement costs.[4]

When building performance is guided by foresight, maintenance becomes a strategic function, not just a reactive one. Predictive HVAC practices don't just prevent problems; they unlock a higher standard of operational control and efficiency.

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Proactive Alerts in Action:
How Real-Time Insights Prevented Critical Failures

Example of three customer story:

Healthcare

The Carrier Customer Command Centre identified a **refrigerant leak** on a chiller unit at a hospital in Spain. By analysing historical trends and alarm patterns, the system detected persistent anomalies and alerted the customer immediately.

This early insight **prevented a loss of cooling performance** and **unnecessary energy consumption,** as well as **potential downtime,** ensuring comfort in this critical healthcare setting.

Data center

The Carrier Customer Command Centre issued an urgent alert for the **evaporator health** of an air-cooled chiller at a Spanish company to be inspected. Performance data revealed irregular behaviour that could have led to serious operational issues.

Taking immediate action helped the customer to **maintain system efficiency, avoid costly repairs** and **ensure uninterrupted operations.**

Industry

The Carrier Customer Command Centre detected an issue with the condenser health of a data centre in Spain.
The report showed an abnormal condenser pinch, which was possibly linked to fouling or a refrigerant imbalance.

Although the unit was still running, historical records indicated recurring pressure and temperature alarms. Acting on this alert enabled the customer **to prevent cooling inefficiency, rising energy costs** and **downtime** in a mission-critical IT environment.

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References

1 Uptime Institute, Annual Outage Analysis 2025

2 Kumar, S. (2024). “Smart Maintenance of HVAC Using IoT”. IJAST, Vol. 2, Issue 3

3 Choudhary, M. et al. (2022). “Review Paper on Machine Learning Algorithms for Predictive Maintenance in HVAC”. IRE Journals

4 Jones, Lange, LaSalle. “Determining the Economic Value of Preventive Maintenance”

5 Es-Sakali et al., (2022). "Review of Predictive Maintenance Strategies in HVAC Systems," Energy Reports, 2022

6 Wang H., et al (2024), “Energy optimization for HVAC systems in multi-VAV open offices: A deep reinforcement learning approach”, Applied Energy

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Explore how Carrier’s connected lifecycle solutions can drive greater value across your entire portfolio.

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