Predictive Maintenance Solutions
White Paper

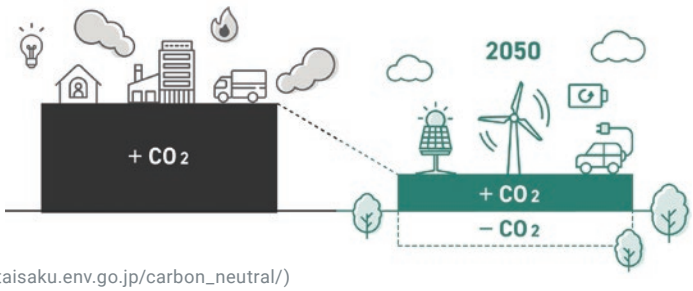
OMRON

Achieving Carbon Neutrality with Facility Maintenance

〈Vol.5〉 Achieving Both Environmental and Business Goals

Achieving Carbon Neutrality Through Efficient Facility Maintenance

Carbon neutrality is the balancing of carbon dioxide and other greenhouse gas emissions with the removal of these gases (e.g. through forest management) to achieve a net zero carbon footprint. In this document, volume 5 of our Predictive Maintenance Solutions series, we discuss how you can achieve both your environmental and business goals by streamlining facility maintenance.



Source: Ministry of the Environment website(https://ondankataisaku.env.go.jp/carbon_neutral/)

The Global Pursuit of Carbon Neutrality

With the vast range of weather disasters occurring across the world in recent years, reducing the greenhouse gases causing them has become a topic of global concern. To address this issue, the Paris Climate Agreement stipulates that participating countries work to reduce emissions to achieve carbon neutrality by the latter half of this century. Signatory countries have each set ambitious goals for 2050 in what has become a global race toward carbon neutrality.

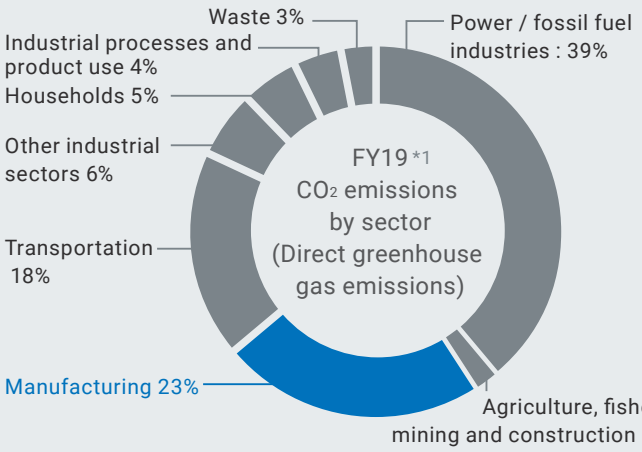
Why the Manufacturing Sector Should Work Toward Carbon Neutrality

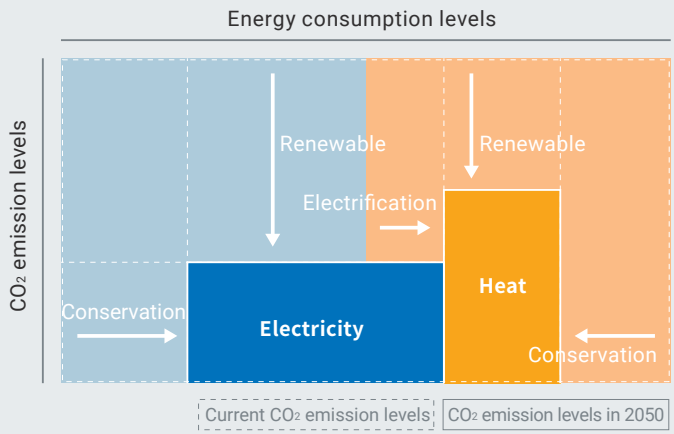
According to investigation by Japan's National Institute for Environmental Studies, manufacturing accounts for 23 % of the world's energy-related CO2 emissions.*1 This is a sizable share, indicating carbon neutrality efforts in the manufacturing sector can greatly impact total CO2 emission levels. Factories in particular, with their massive power consumption and industrial waste, are a major source of CO2 emissions, and in urgent need of improvement.

To hit the very ambitious target of achieving carbon neutrality by 2050 requires action across all industries and departments. In doing so, it is crucial that each company balance the three main aspects of emission reduction—energy conservation, renewable energy, and electrification—to implement the right measures for its business. This document describes some of the steps you can take in facility management with regard to the "energy conservation" aspect.

- Power / fossil fuel sector: Expand use of renewable energy
- Transportation sector: Use renewable energy, e.g. by using electric vehicles
- Manufacturing and building sectors: Implement rigorous energy conservation measures, use renewable energy

*1. Created based on the data from the Greenhouse Gas Inventory Office of Japan, National Institute for Environmental Studies





Efforts Toward Carbon Neutrality

Conserving Energy Using Localized Clean Room Environments

A clean room, by nature of its structure, consumes large amounts of energy. Many of our manufacturing customers have successfully reduced energy consumption by adopting localized clean room environments each scaled to its particular process, whether it be assembly, inspections, or otherwise.

Conserving Energy Using Inverters

In some factories, entire production floors may be air conditioned, leading to significant energy consumption. Some customers, including manufacturing companies, have successfully reduced this consumption by adopting inverter fan motors and by visualizing power consumption using demand monitoring equipment to optimize production equipment operation schedules (e.g. by optimizing break time distribution).

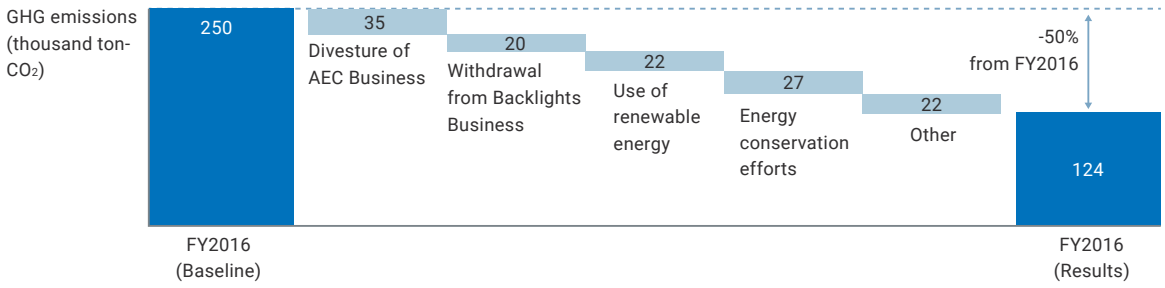
Our Commitment to the Environment

Indicators and Targets.

Omron's "Carbon Zero" initiative sets the goal of reducing greenhouse gas emissions to zero by 2050. Using the Scope 1 and 2 *1 greenhouse gas emission quantities of fiscal 2016 as a baseline, we backcast from fiscal 2050 to set reduction targets for fiscal 2030 and fiscal 2020.*2 We are currently taking several measures to meet these goals. For example, in fiscal 2018, we began using electricity sourced from renewable energy for our Japanese locations. In fiscal 2019, we analyzed the energy conservation potential*3 of our locations in the Asia Pacific region, where we consume the third largest amount of energy, after Japan and China. In our Indonesian plants, we identified areas where annual energy consumptions could be cut by 23%, and are taking action based on a medium-term plan aimed to address these issues. In fiscal 2020 we implemented energy conservation measures in several of our locations and built new solar power generation systems. We also analyzed the energy conservation potential of our plants in Malaysia, which consume large amounts of energy. As a result of these efforts, in fiscal 2020, we were able to reduce greenhouse gas emissions by 124kt-CO2, or by 50% compared to fiscal 2016. Omron will continue to work to reduce greenhouse gas emissions toward our goal of net zero by 2050. We are currently developing our next long-term vision, which will include targets for Scope 3*1 emissions as well.

*1. Scope 1: Direct greenhouse gas (GHG) emissions. Direct GHG emissions occur from sources that are owned or controlled by the company, for example, emissions from combustion in owned or controlled boilers, furnaces, vehicles, etc.
Scope 2: Electricity indirect GHG emissions. Scope 2 accounts for GHG emissions from the generation of purchased electricity consumed by the company. Purchased electricity is defined as electricity that is purchased or otherwise brought into the organizational boundary of the company.
Scope 3: Other indirect GHG emissions. Scope 3 is an optional reporting category that allows for the treatment of all other indirect emissions. Scope 3 emissions are a consequence of the activities of the company, but occur from sources not owned or controlled by the company.
(The Greenhouse Gas Protocol (https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf))
*2. Greenhouse gas emissions calculated from sales forecasts, including the Automotive Electronic Components Business (AEC) that was sold off in October 2019. In considering targets to align with the SBT criteria in fiscal 2017, we set 2016, the year of the latest values, as the reference year. (SBT: Science Based Targets. Science-based, medium- to long-term targets for reducing greenhouse gases.)
*3. OMRON's unique approach to identifying energy loss risks and opportunities for improving energy efficiency at production locations, formulating specific measures with estimates of impacts and costs.

GHG Emissions in Fiscal 2020



Achieving Both Environmental and Business Goals

In the past, businesses often sacrificed the environment for the sake of their business goals. Today, however, they are faced with the daunting task of achieving both their business goals and their environmental goals. This was thought to be particularly difficult in facility maintenance, which impacts both business and the environment. Fortunately, technological advances have given rise to solutions that can simultaneously resolve environmental and business issues.

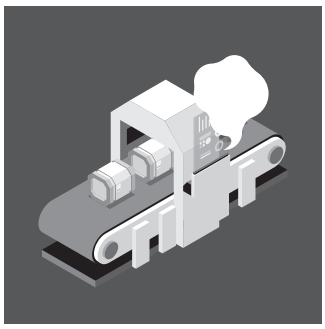
Issues in Facility Maintenance

Environmental burden		Business burden
	Major/minor downtime, which leads to prolonged production time	
More power usage	Longer idle time	Availability loss
	Premature replacement of production facility parts	Performance loss
More waste	Massive number of defective products	Quality loss

Two Types of Failures That Cause These Issues

The above issues are mainly caused by two types of facility failures: no-function failures and less-function failures. The key to simultaneously achieving your environmental and business goals is to efficiently prevent these failures.

No-function failure



Failure that causes the production facility to stop operation. Such failures compromise the energy efficiency of production as a whole.

Less-function failure

Failure that compromises the performance of the production facility. Such failures slow down production, compromise efficiency, and lead to more disposal (defective products), all of which waste energy.

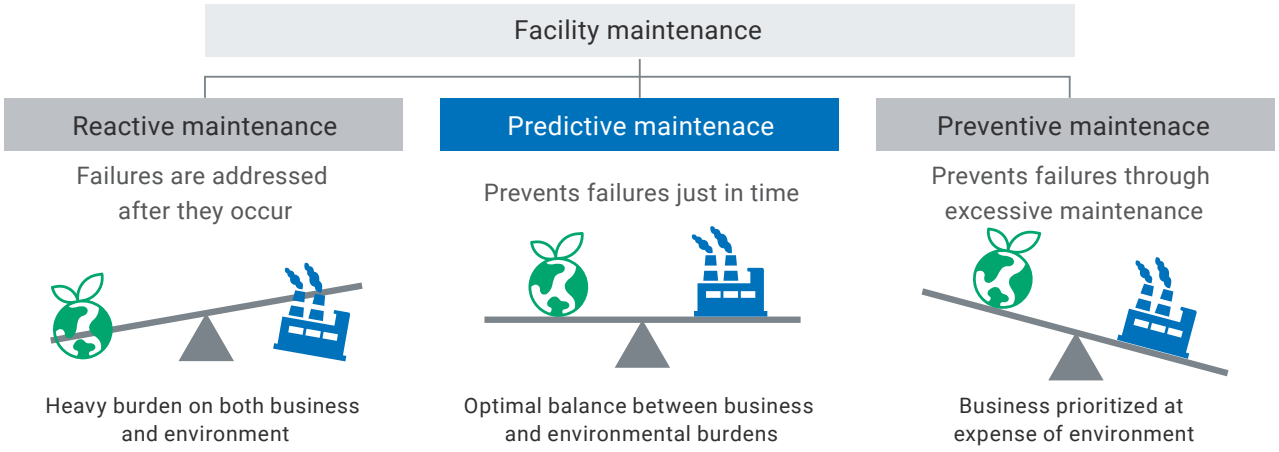
The thinking behind ISO14001

Waste treatment and excessive energy conservation measures can have adverse effects on a company's business, making such efforts unsustainable. It is therefore critical to tie your business goals to your environmental goals so that both can be pursued simultaneously. ISO14001, an international standard for environmental management systems, recommends organizations to balance environmental protection with social needs and flexibly adapt to changes in the environmental situation.

ISO14001

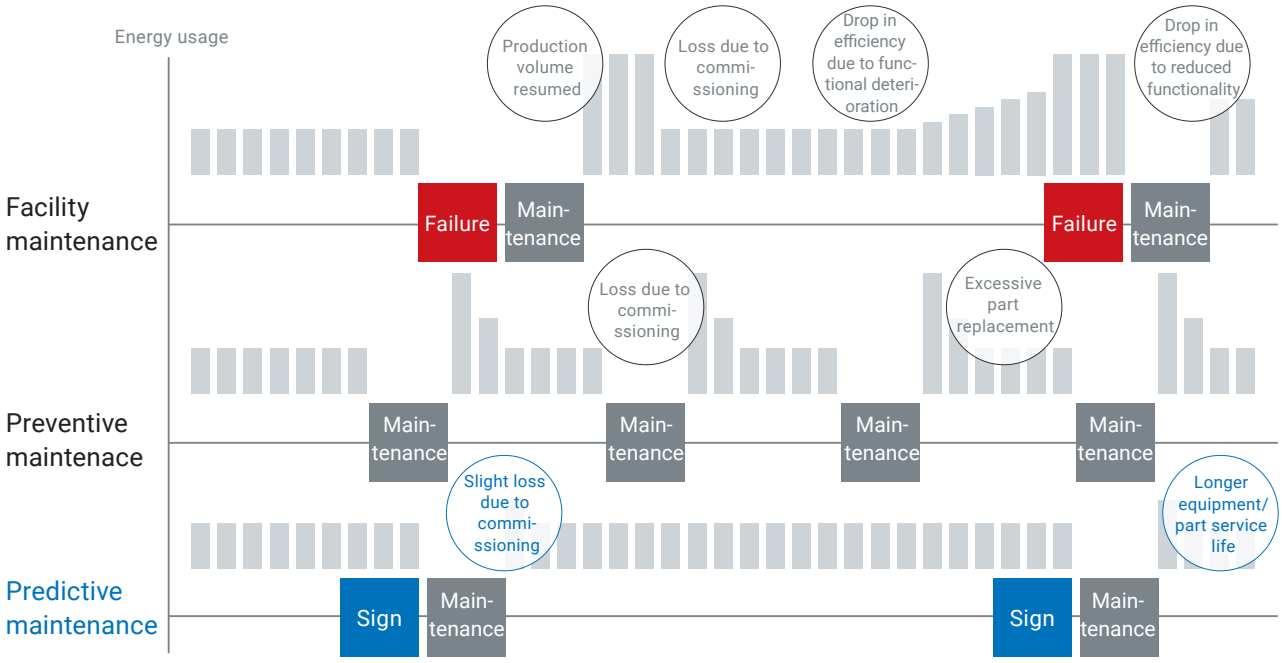
Preventing Failure by Switching to Predictive Maintenance

There are three main styles of maintenance: reactive maintenance, preventive maintenance, and predictive maintenance. In reactive maintenance, failures are addressed after they occur, which is environmentally costly. In preventive maintenance, failures can be prevented through regular manual inspections; however, this method requires outage of facilities during inspection and can lead to premature part replacement, both of which can be taxing on the environment. This has led many organizations to look to a third option: technology-driven predictive maintenance.



Conserving Energy Through Predictive Maintenance

Predictive maintenance allows you to effectively cut energy use by reducing the frequency of failures and inspections. According to “Economics of Manufacturing Machinery Maintenance” (June 2020) by Douglas S. Thomas and Brian A. Weiss, adopting predicitive maintenance would be effective in reducing 0.8 billion USD of defects and 18.1 billion USD of downtime.*1 This is friendly to the environment and the losses should be eliminated.

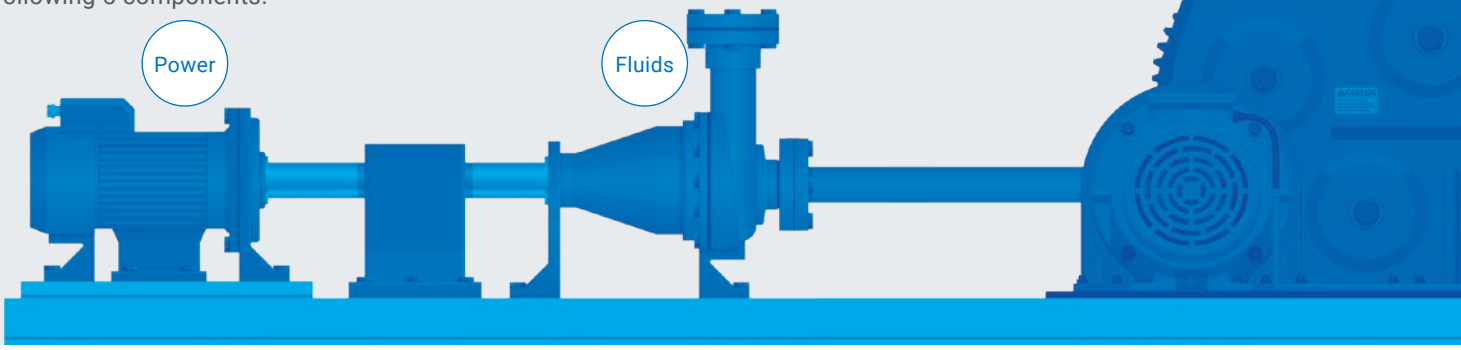


References:
NIST Advanced Manufacturing Series 100-34, Economics of Manufacturing Machinery Maintenance , Douglas S. Thomas, Brian A. Weiss, June 2020
https://www.nist.gov/el/applied-economics-office/manufacturing/topics-manufacturing/manufacturing-machinery-maintenance
https://nvlpubs.nist.gov/nistpubs/ams/NIST.AMS.100-34.pdf

Site-Contained Solutions

Omron's Predictive Maintenance

Omron's site-contained predictive maintenance solutions enable a wide range of processes—from collecting data from relevant devices, visualizing and analyzing this data, all the way to making assessments and judgments based on this analysis—to be conducted using on-site condition monitoring devices, letting you start small as at the department level. The solutions monitor the conditions of the following 5 components.



Power must never be stopped; critical facilities need advanced anomaly detection

Here, power is defined as something that converts energy (e.g. Electrical energy) into heat or force for moving machinery. Some examples include motors and heaters, and also the control panels that control them. When power fails, the entire facility stops functioning, which greatly impacts production. Power is, therefore, as important as the heart is to the human body, and should never be allowed to stop, making understanding the mechanism of its failure and constant monitoring of its deterioration status extremely critical.

Solutions for preventing no-function power failures

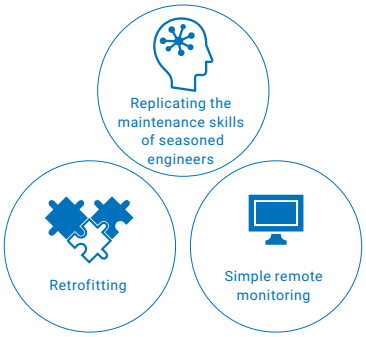
Our solutions prevent no-function facility failures by digitizing information on the deterioration status of power components. This allows for the detection of signs of motor bearing and insulation failures, both of which consume high levels of energy, and of abnormal facility temperatures that are a direct cause of wasted energy.

Products for monitoring the conditions of 3-phase induction motors and their peripherals

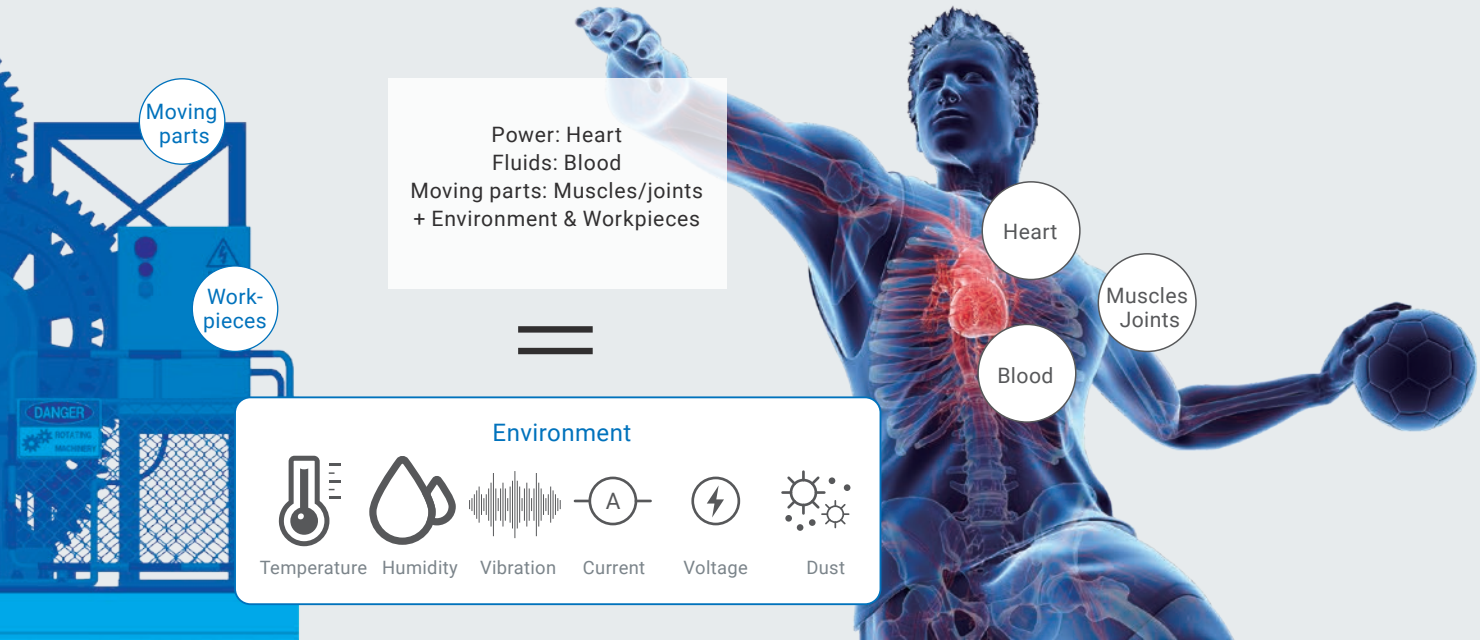
Products for monitoring the temperature conditions of devices and equipment

Products for monitoring the trend of insulation degradation in motors

Products for monitoring the voltage, current, and remaining life of switched-mode power supplies



Three Values of Condition Monitoring



Monitoring all fluid components, moving parts, environmental components, and workpieces to maintain excellent health

Electric currents, liquids, gases, and other fluids flow through wiring and piping. Moving parts use energy fed to them to move and process objects. By monitoring these components along with workpieces and environmental components, you can detect changes in facility conditions and deduce their causal relationships. In the human body analogy, these components would each correspond to the blood, muscles (joints), and living environment; checking on them is therefore akin to a physical, through which the state of a person's body and their lifestyle are examined to determine the causes of problems and even find solutions for them.

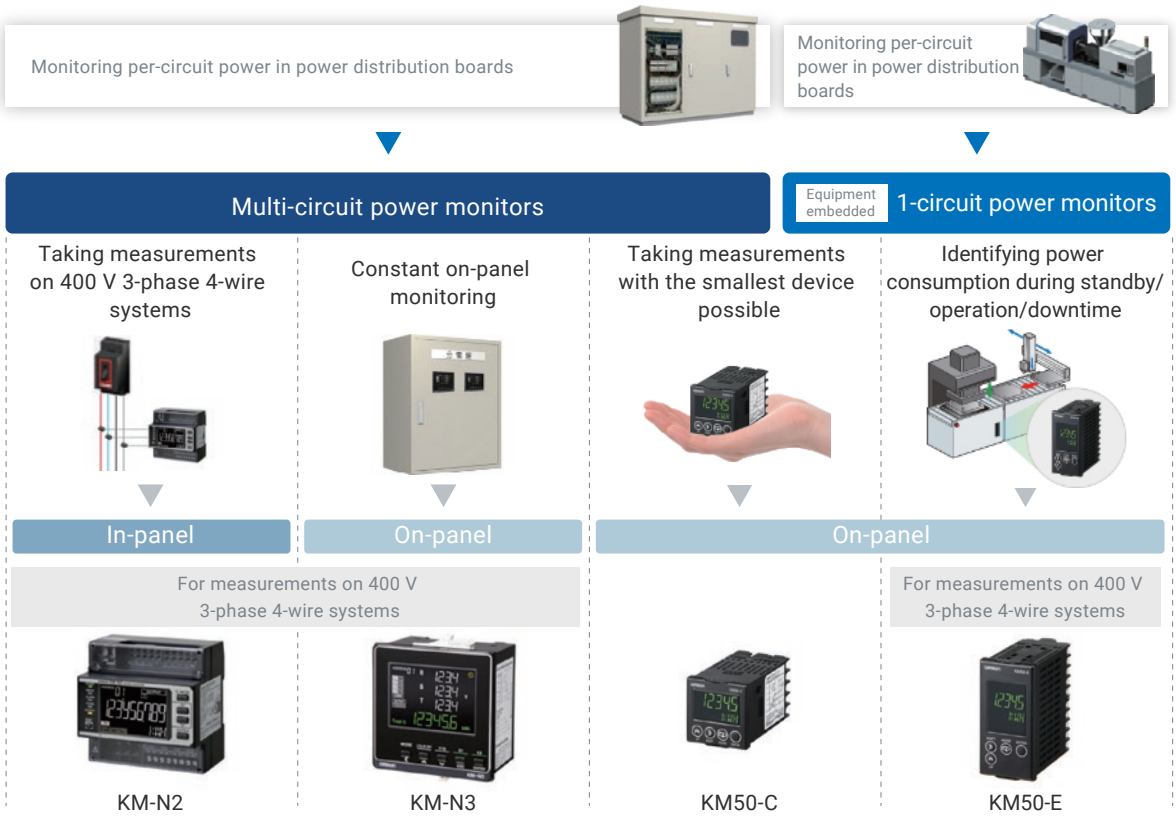
Condition sensing for preventing less-function failures

Information on all changes in the conditions of facility components—including fluids, moving parts, environmental components, and workpieces—is digitized to keep the facility in excellent health at all times and thus prevent less-function failures. This not only stabilizes quality but optimizes energy use as well.

Monitoring transmission, moving parts, and environments

Electric Power Monitoring Solutions

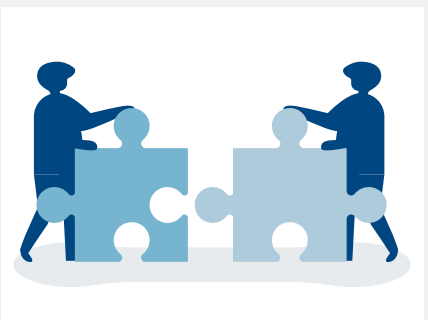
To achieve carbon neutrality, power usage needs to be visualized per production line and per equipment, as well as for the plant at large, so that lines and equipment that consume large amounts of electricity can be identified and improvements can be made accordingly. Our KM Series products, with their ability to monitor electric power usage of a wide range of equipment and lines, make this visualization possible.



The Continuing Evolution of Maintenance Innovation Solutions

Business planning with an eye toward energy management

We are now creating new maintenance innovation solutions that empower our customers to proactively manage energy in their own plants and supply chains. To this end, we are collaborating with a wide range of companies through open innovation.



Use Cases: Reducing Loss Through Maintenance Innovation

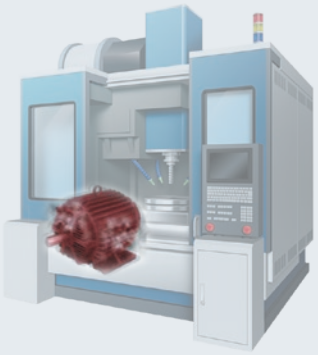
Omron released its first condition monitoring device in 2017, and has continued to expand its product lineup ever since. So far our solutions have been chosen by our customers as a means to achieve their business goals. Going forward, we expect them to be increasingly implemented to meet environmental goals as well. Here are some customer use cases that were able to deliver positive environmental effects.

Reducing Disposal Loss by Preventing Power Failures

Power servo motors | Prevents major downtime | Reduced disposal losses

Background

In processing machines, which process metals, for example, cutting oil mist can seep into the equipment, causing insulation to deteriorate faster. Insulation defects can stop production, which can lead to energy loss due to disposal or even bigger problems, such as smoke or ignition accidents.



Implementation

With past inspection methods using insulation resistance meters, measurements often varied depending on when they were taken. Installation of an insulation resistance monitoring device (K7GE) allowed for data to be immediately and automatically accumulated. This data made clear the effects temperature, humidity, and manual measurement had on data accuracy, and also demonstrated that the device could improve maintenance operation.

Impact

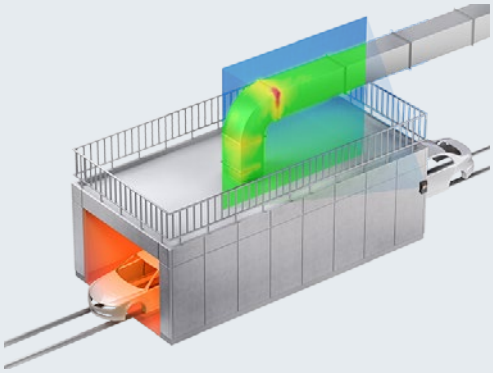
Reduces effort required for inspections using insulation resistance meters and enables systematic maintenance by identifying trends in insulation deterioration. Customer can now take action before insulation defects can occur, conserving the energy needed to respond to unexpected failure.

Reducing Energy Loss in Drying Oven by Monitoring Duct Conditions

Hot air duct (“fluid” component) | Performance degradation | Reduced energy loss

Background

Thermal degradation was causing hot air to leak from the ducts of a car paint-drying oven. Such leaks not only impact drying quality but also lead to wasted energy. To detect or prevent hot air leaks, maintenance workers had to risk their own safety to approach the ducts to regularly monitor them using thermoviewers.



Implementation

A thermal condition monitoring device (K6PM-TH) was installed on equipment in operation to examine how temperature distributions changed during hot air leaks, and the results were shared with multiple other plants. While each of these plants was considering adopting the device, a decision was made to implement it as part of a remote monitoring system for a new plant then under construction. This predictive maintenance system was deployed as part of the company’s initiative to apply IoT in its plants, and combines Omron’s condition monitoring devices with power monitoring devices and environment sensors.

Impact

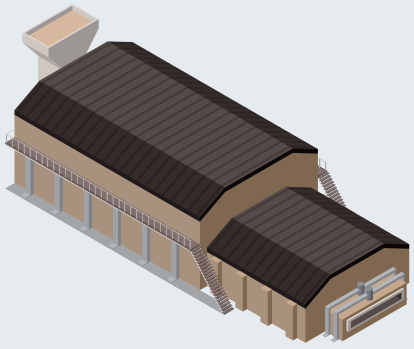
Reduces manual operation, streamlining maintenance. Monitoring devices deliver around-the-clock visualization of energy conditions so that any losses caused by hot air leaks can be swiftly detected, allowing for a more advanced system where maintenance is performed if and when a drop in energy conditions is observed. The customer is planning to further observe and study the efficacy of the solution before deploying it to other plants.

Optimizing Water Use in Fusion Furnace by Simultaneously Monitoring Flow Rate and Temperature

Cooling water ("fluid" component) | Performance degradation | Reduced disposal losses

Background

The growing focus on SDGs and ESG management has given rise to stricter factory wastewater regulations, forcing manufacturers to work to restrict their resource use. Reducing wasted water is especially a pressing issue in facilities with equipment that uses large quantities of water, such as glass fusion furnaces. In the case of this customer, operators worked in shifts to monitor the quantity and temperature of cooling water around the clock, and would drain the water whenever it exceeded the specified amount. The optimal flow rate was therefore unknown, leading to large amounts of water going to waste.

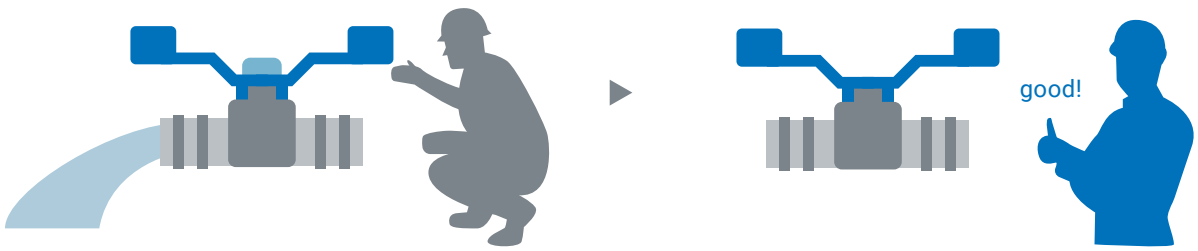


Implementation

An IoT flow sensor (E8FC) simultaneously detects flow rate and temperature, allowing operators to make sure that water of the optimal temperature is flowing at the optimal rate, and adjust (open/close) the valves as needed. A similar solution can be provided through valve automation using mass flow meters but is expensive to implement. The customer therefore decided to adopt our system, which was likely to provide much better return on investment.

Impact

Provides insight into the health of fluid components, allowing for the consistent supply of cooling water which is optimal in terms of temperature and flow rate. This not only saves water but prevents quality defects as well, a perfect example of how environmental and business goals can be simultaneously achieved.



Large amounts of waste water

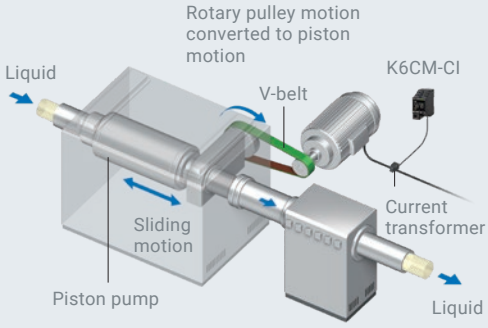
Temperature and flow rate maintained at optimal levels

Reducing Disposals Due to Contamination in Beverage Manufacturing Process

Power induction motor | Prevents major downtime | Reduced disposal losses caused by defective products

Background

Deteriorated/worn piston seals were allowing foreign matter to make its way into the product, leading to disposal by the lot, which was a huge waste of energy. To prioritize business goals, the customer had taken the preventive maintenance approach: parts were replaced frequently and long before deterioration could progress. These replacements needed to be conducted on holidays or late at night when production was stopped, leading to otherwise unnecessary power consumption.



Implementation

A single unit of Omron's condition monitoring device was installed on existing equipment in operation to verify its effectiveness, and the results were shared with multiple other factories. While each factory was pursuing its own study, a decision was made to use this or a similar device in a remote monitoring system for a new factory being set up. A predictive maintenance system using Omron's condition monitoring device was deployed as part of an effort to enable IoT in the factory. Going forward, the customer plans to deploy this system to existing equipment in other factories while continuing to assess its effectiveness.

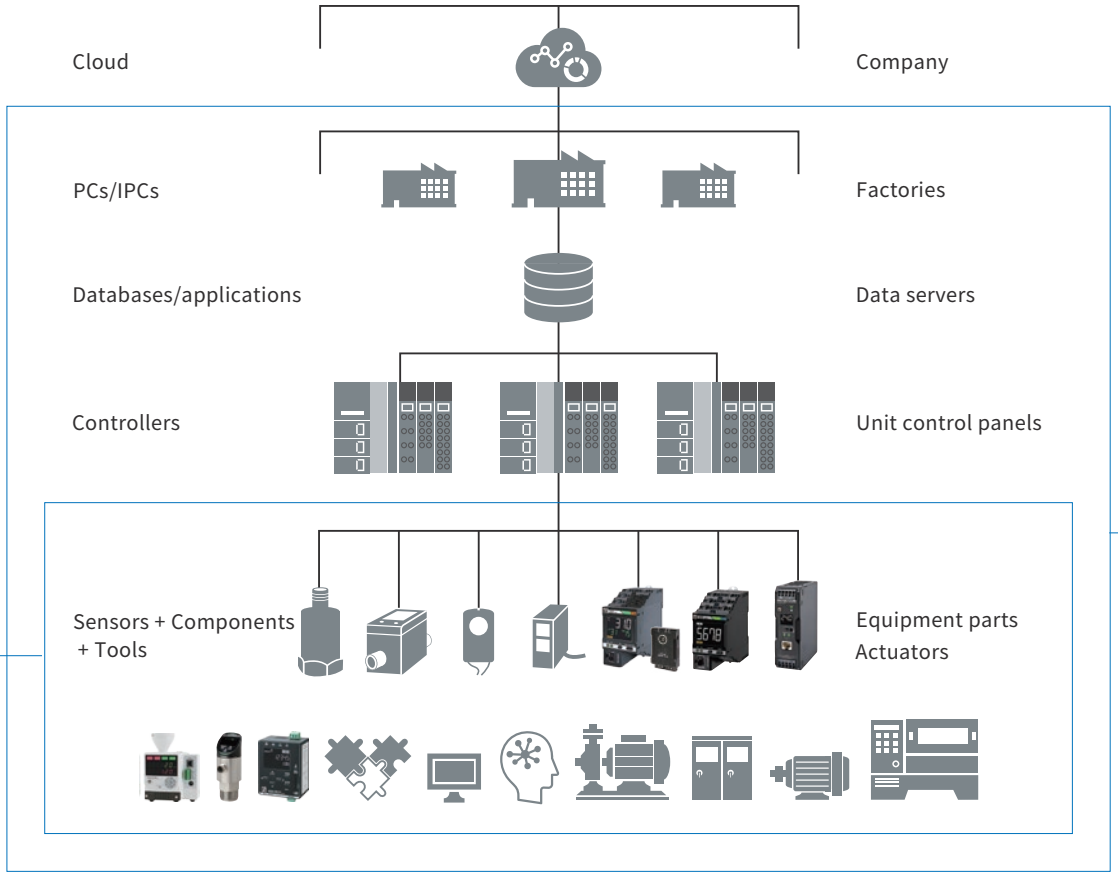
Impact

Detects seal deterioration to prevent beverage contamination that can lead to mass disposal, thereby conserving energy that would be needed for additional production to make up for the disposal. Conserves energy also by enabling parts to be replaced based not on schedule but on their actual conditions, reducing part disposals and the frequency of scheduled repairs.

The Continuing Evolution of Predictive Maintenance

Omron's Co-Creation Services

The solutions discussed so far are "site-contained;" in other words, they allow issues to be addressed within the manufacturing site, enabling customers to easily start small. The next important step after this phase of on-site equipment condition monitoring is to optimize the factory as a whole by connecting different equipment for more expansive predictive maintenance. Our co-creative services can provide you with solutions that meet your specific needs.

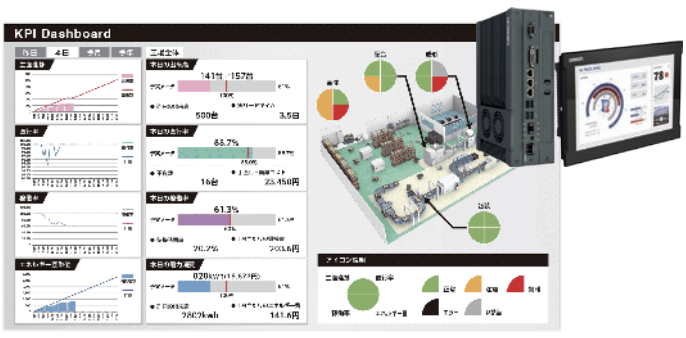


Site-Contained Solutions

On-Site Data Utilization Service

i-BELT

Omron's on-site data utilization service Our i-BELT services are co-creation services that provide close support to help you identify and resolve issues in visualization, analysis, and control using data collected from the production site.



On-Site Data Utilization Service i-BELT

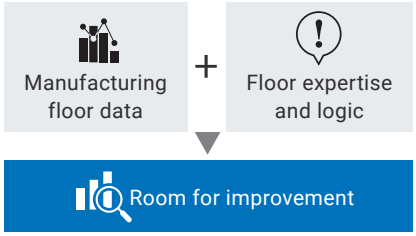
Utilizing on-site data is essential to streamlining energy use and fundamentally reducing energy consumption. i-BELT allows you to do just that, by leveraging information digitized by sensors and components, marshaling our years of experience and expertise in control on FA sites, and applying cutting-edge technologies. The service adopts logical and scientific methods to guide you in your journey to resolve your management issues, and allows us to help our customers digitally transform their production sites into those where data is readily available and usable for anyone who needs it.

Co-creation working closely with you

Setting the project goal through discussions, we collaboratively work with you for a resolution of the challenges based on manufacturing floor data.

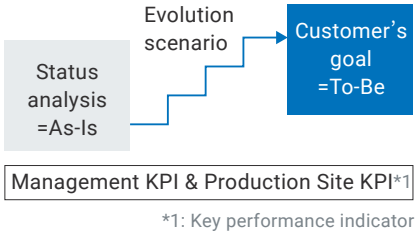
Formulation of challenges based on data

From a bird's-eye view of production facility and elementsbased on an actual object/ place/situation, we quantify the room for improvements through a logical & scientific approach.



Firm advancement of innovations in phases

After recognition of a scenario for attaining the goal with you,we provide assistance through a multi-stage approach for floor innovation that ensures results.



*1: Key performance indicator

Energy management service

Focusing on power usage, we offer support in striving for zero waste energy management throughout the manufacturing process from equipment to the entire factory.

	Visualization - Energy	Analysis - Energy	Control - Energy
1. Examination service	• Analysis of energy consumption • Sensing	• Analysis of energy demands	• Study of energy control algorithm
2. Installation service	• Determination of key variables • Implementation of visualization system	• Monitoring/flash report for abnormal situation	• Implementation of control
3. Continuous evolution service	• Version update	• Regular reporting • Energy diagnosis	• Continuous monitoring

i-BELT Use Cases

Optimization of air compressor setting pressure

Background

Identifying power consumption during standby/operation/downtime

Implementation

Visualization > Analysis > Control

Collection of data on e/production/ quality/facility operation

Comparison analysis with the target value and reference value

Detected pressure loss occurring in compressed air piping in multiple locations of production facility.

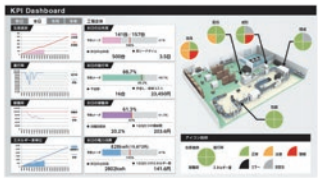
Energy control linking production floor with facility

Real-time predictive control of compressor based on the amount of usage on manufacturing floor to realize optimized control without waste.* 1

Impact

Reduction of compressor power consumption by 18%

In addition to conserving energy, the solution had the effect of mitigating pressure drops in devices that were causing energy loss, thereby reducing minor equipment downtime due to energy fluctuation.



Reducing Energy Loss by Optimizing Equipment Operation Time

Background

Customer wanted to reduce factory power consumption by optimizing power usage.

Implementation

Visualization > Analysis > Control

Visualizing equipment energy conditions

Sensors were attached to several different devices to identify which elements could be effectively improved.

Batch analysis of electric power and equipment behavior

Found that equipment in operation 24/7 could actually be stopped during certain periods.

Automatic energy conservation

Identified when equipment could be stopped without impacting production. Automated energy conservation by adding eco-mode control features to equipment.

Impact

Cut energy use by 23 % across all factory equipment

Achieved automatic power saving by identifying when equipment could be stopped without impacting production and adding eco-mode features to equipment.

To monitor the condition of 3-phase induction motors and peripheral equipment

For load abnormality

K6CM-CI

For insulation degradation

K6CM-IS

For bearing wear

K6CM-VB

Motor Condition Monitoring tool

To monitor the trend of insulation degradation in motors

K7GE

K7GE-MG Logging Tool

To monitor the temperature status of devices and equipment

K6PM-TH

Thermal Condition Monitoring tool

Products for monitoring fluid components, moving parts, and environments

E8FC/E8PC ZN-PD-S STC-R E9NC-T

Products for monitoring power usage and identifying problems

KM50-E

KM50-C

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