IBM puts Smarter Buildings research into practice

"Living Lab" provides an ideal workplace for researchers at the least environmental cost

Smart is...

Optimising energy and water usage and enhancing the working environment for IBM researchers by analysing data from thousands of sensors throughout the building.

IBM saw an opportunity to put its latest Smarter Buildings research into practice by turning its Smarter Cities Technology Centre in Ireland into a "Living Lab". 2,500 sensors provide real-time data on heating and cooling systems, lighting, water and electricity meters, footfall and motion within the 35,500 sq ft building, enabling the creation of comprehensive energy usage models. Real-time reports provide deeper insight into how the space is being used, how the infrastructure is performing, and where resource usage can be optimised.

IBM Research – Ireland has been a leading player in IBM's Smarter Buildings initiative for more than five years, and has developed a methodology known as Green Sigma™, which marries Six Sigma engineering principles to statistical analytics techniques to identify energy wastage in buildings.

When the Analytics and Optimisation Group moved into IBM's Smarter Cities Technology Centre in Dublin, they saw an opportunity to put their theories into practice by turning the 35,500 sq ft building into a real-world embodiment of Smarter Buildings principles. Creating a "Living Lab" would provide an ideal working environment for IBM researchers, while minimising energy costs and environmental impact.

Niall Brady, the Lead Research Engineer for Smarter Buildings and Energy Analytics, explains: "We had built our Green Sigma models around the data from a traditional building management system, but this could only take us so far. To create a genuinely smart building, we needed more data at a finer level of detail. We decided to invest in converting an old IBM server manufacturing facility into a fully instrumented laboratory that would give us the insight we needed to improve energy efficiency and enhance the working environment for our colleagues."

Sensor-driven analytics

The team installed more than 2,500 sensors that provide a full picture of almost every aspect of the building's status. For example, an intelligent lighting system uses infrared sensors to determine whether a space is occupied or not, how much daylight there is, whether the lights are on and what level of lighting they provide. Sub-meters on individual electrical circuits and water pipes provide statistics on usage, updated every 15 minutes. Sensors on infrastructure such as boilers, chillers and pumps monitor performance and report any component failures immediately.

Data from the systems that manage these sensors is collected by IBM® Tivoli® Monitoring for Energy Management and stored in a central data warehouse based on IBM DB2®. IBM TRIRIGA® Energy Optimization and IBM Cognos® Business Intelligence analyse this data and provide reports and dashboards that display current and historical status.

Business benefits

- Provides detailed analysis of energy and water usage, helping to identify and resolve problems quickly and measure improvements accurately against the baseline.
- Reduces electricity usage by 180,000 KWh, an annual saving of 20 percent, by introducing intelligent lighting, improving pump monitoring and eliminating unnecessary air-conditioning and water heating.
- Cuts treated water requirements by 60 percent by introducing submetering and harvesting rainwater from the building's roof.
- Saves €5,000 by replacing paper towels with electric hand-dryers, at a cost of just 2,000 KWh in electricity.
- Reduces office paper requirements by nearly 50 percent by reconfiguring printers.

Sophisticated energy modelling

Brady's team also began working on loading the data into IBM SPSS Modeler to create statistical models of energy usage, based on historical data acquired over the previous 12 months of operation. These models are now being used to create detailed energy forecasts that predict the building's behaviour and energy usage in different weather conditions and at different times of the year. This will enable the building management team to create policies for heating, lighting and air conditioning that minimise waste while maintaining a comfortable working environment.

"Most of the energy performance prediction models that are currently available on how buildings behave are based on industry-standard building modelling software applications, and offer only theoretical predictions about how equipment uses energy in lab conditions," comments Brady. "By contrast, our approach gives us a new ability to see how, for example, an air conditioning unit is actually performing in a specific location under specific operating conditions, based on the real-time detailed sensor data that is now available to us. From this, we're building up comprehensive statistical models of how our building actually operates, and why. And critically, we've established a baseline for performance that will allow us to measure the success of our energy-saving initiatives going forward."

Dramatic year-one savings

In year one, the team has already achieved some impressive results. The intelligent lighting system uses 45 percent less electricity than the previous infrastructure; the installation of point-of-use water heaters has saved 65 percent on water heating costs; improved monitoring of water pumps has reduced their energy usage by 30 percent; and a change in policy has reduced out-of-hours air-conditioning (outside of specific designated areas) by 98 percent. In total, this adds up to an annual saving of 180,000 KWh, which is the equivalent of 100 tonnes of CO2, and reduces the building's electricity bill by nearly 20 percent.

Smarter Buildings

Instrumented

Data from sensors in electricity and water meters, lighting, heating and air conditioning systems, pumps and other infrastructure is collected into a central database for analysis.

Interconnected

Real-time reports and dashboards provide immediate insight into the status of the building's working areas and infrastructure, as well as measuring energy efficiency against baseline levels.

Intelligent

Rule-based analytics enables identification of systemic problems in heating and cooling supply systems, pinpointing equipment failures and problem areas. This results in fewer help-desk calls and less maintenance work, as well as achieving significant savings.

Solution components

Software
- IBM® Tivoli® Monitoring for Energy Management
- IBM TRIRIGA® Energy Optimization
- IBM Cognos® Business Intelligence
- IBM SPSS® Modeler

Services
- IBM Research

"Now that we've established a proper baseline, we will be able to start a continuous improvement effort using energy analytics embedded in the IBM TRIRIGA Energy Optimization software. Over the longer term, our efforts will serve as a blueprint for other organisations to adopt a Smarter Buildings strategy and make a substantial contribution to energy efficiency in the world's Smarter Cities."

— Niall Brady, Lead Research Engineer for Smarter Buildings and Energy Analytics, IBM

Water usage has also been greatly improved. Almost 150,000 litres of rainwater have been harvested from the building's roof, and provide nearly 60 percent of the grey water requirements of the building's toilets. Overall, the building has reduced its treated water requirements by 250,000 litres, a saving of more than 60 percent.

Proving the case for energy-efficient technologies

By replacing paper towels in the restrooms with high-speed hand-dryers, the building saves €5,000 per year and eliminates the environmental impact of processing approximately 400,000 pieces of waste paper. Sensors on the new hand-dryers show that they only require 2,000 KWh of electricity per year.

"Many building management companies probably have a gut feeling that electric hand-dryers save energy, but they don't have a way to find out for sure," says Brady. "By installing circuit level sub-meters, we can actually prove that the cost of the electricity is about one percent of the cost of the paper towels. That's what Smarter Buildings are all about: they give you the data to measure your performance, and once you can measure it, you can start to improve."

Identifying problems proactively

The analytics software also helps the team identify anomalies and address issues much more quickly. As a former manufacturing plant that was not originally designed for energy efficiency, the IBM Research – Ireland lab had some systemic problems in its heating and cooling systems, which the new solution was able to pinpoint. As a result, the team has been able to address faults and reduce maintenance effort.

As another example, analysis revealed a significant discrepancy between the readings from the main water meter and the sub-meters in the building's kitchens and restrooms: a large quantity of water seemed to be going missing. When the team investigated, they found that some unstoppered pipes were constantly discharging water into the ground. Detecting and fixing this problem will save millions of litres of water over the coming years.

Ongoing improvements

"We've already demonstrated the enormous environmental and financial benefits that a fully instrumented building can deliver, and this is only the first year," says Brady. "Now that we've established a proper baseline, we will be able to start a continuous improvement effort using energy analytics embedded in the IBM TRIRIGA Energy Optimization software. Over the longer term, our efforts will serve as a blueprint for other organisations to adopt a Smarter Buildings strategy and make a substantial contribution to energy efficiency in the world's Smarter Cities."

For more information

To learn more about how IBM and its customers are building a Smarter Planet, contact your IBM sales representative or IBM Business Partner, or visit us at **ibm.com**/smarterplanet

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