Automated Fault Detection and Diagnostics: Affordable Energy Efficiency for Buildings

Pacific Northwest
NATIONAL LABORATORY

New Technology Has Potential to Reduce Nationwide Energy Consumption in Buildings by 30 Percent

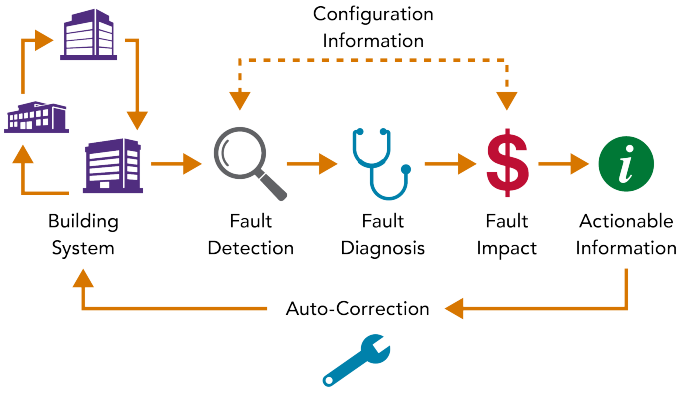
Buildings large and small are a part of everyday life. They routinely keep occupants warm or cool, and offer amenities such as adequate lighting and hot water, all of which would seem to be evidence that buildings must be operating properly.

But just because building systems seem to be working well does not mean they are. Buildings consume large amounts of energy to meet expectations for functionality, comfort and safety. In many cases, these structures use excess energy because they are not operating as well as they could be. And while some buildings possess a building automation system (BAS) that is supposed to efficiently manage operation of systems and devices, often the BAS has not been optimized. Further, a BAS typically offers a rich amount of operational data that is neither harvested nor analyzed.

That's where Automated Fault Detection and Diagnostics (AFDD) comes in. AFDD, developed at the U.S. Department of Energy's Pacific Northwest National Laboratory (PNNL), is a method to improve building operations, reduce energy consumption, and help ensure comfort and safety objectives. In U.S. buildings, it is believed that the use of AFDD, along with improved controls, can deliver a nearly 30 percent reduction in energy consumption. This significant opportunity translates to a potential nationwide savings of up to five quadrillion Btus—a massive amount of energy that could be used in more productive ways.

AFDD: IT'S ABOUT DATA, DETECTION AND DIAGNOSIS

AFDD involves the use of specially-designed algorithms that are deployed on another PNNL-developed technology, VOLTTRON™, a distributed sensing and control platform that can be integrated with a BAS. This may sound like a complicated and costly process, but it isn't. The algorithms and VOLTTRON™ can be hosted on small, inexpensive computing devices and readily deployed to generate actionable information using BAS data. But even in buildings that don't possess an automation system, there are ways to integrate AFDD technology to achieve operational benefits and energy efficiency.



Once deployed, the algorithms interrogate building operations, collect data, analyze the data, and then identify, diagnose and prioritize operational issues based on the cost impact. In some cases, the self-correcting AFDD technology can fix the problems, but at the very least reports them so that building managers and operators can address. There are three general types of algorithms that have been successfully tested in air-handling units and economizers in buildings on the PNNL campus in Richland, WA.

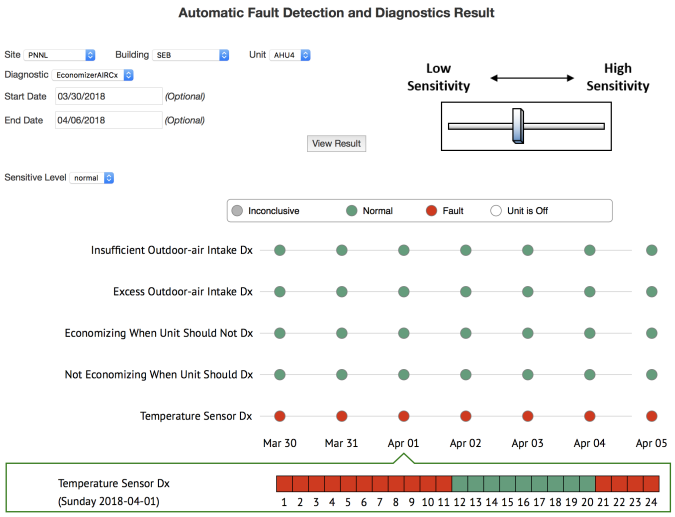
- Passive—"detection only"—algorithms that identify operational faults
- Active versions that seek out operational issues and implement control actions to correct problems
- Passive automated diagnostics that can be deployed in buildings that do not possess an automation system.

The following AFDD applications are available, with more in development.

- Temperature Sensor Fault
- Air-Handling Unit (AHU) Not Fully Economizing When It Should
- AHU Economizing When It Should Not
- Excess Outdoor-Air Intake
- Insufficient Outdoor-Air Intake.

WHY BUILDING OPERATORS/MANAGERS WILL BENEFIT FROM AFDD

Today, fault detection and diagnostic activities can be conducted in buildings, but must be done by analysts who visually observe equipment conditions or interpret data from routine operation and tests. This is labor intensive, costly and requires specific expertise. A handful of technologies also are available to detect and diagnose faults, but new, advanced products have been slow to emerge. PNNL's AFDD solution is designed to more conveniently and cost-effectively reduce energy consumption, operating costs and maintenance costs, while improving building conditions and extending the lifetime of equipment.



This result from a building on the PNNL campus identifies a temperature sensor fault that was occurring on a daily basis. The AFDD system enables building operators to drill down into hour-by-hour information.

ABOUT PNNL

Interdisciplinary teams at Pacific Northwest National Laboratory address many of America's most pressing issues in energy, the environment and national security through advances in basic and applied science. Founded in 1965, PNNL employs more than 4,000 staff and has an annual budget of approximately $1 billion. It is managed by Battelle for the U.S. Department of Energy's Office of Science.

Contact:
Dennis Stiles
Pacific Northwest National Laboratory
P.O. Box 999, K9-69 Richland, WA 99352
(509) 375-6374 | dennis.stiles@pnnl.gov

April 2018 | PNNL-SA-134215

U.S. DEPARTMENT OF ENERGY BATTELLE