



CATALYST

Efficiency Enhancing Controller
Patent Pending

Technology Overview



A subsidiary of the Performance Mechanical Group
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Introduction

We want to thank you for the opportunity to introduce the CATALYST: Efficiency Enhancing Controller. This patent-pending retrofit technology adds dynamic control to constant volume HVAC systems and produces dramatically more efficient operation. It represents a new, unprecedented frontier of energy savings opportunities. It is the result of classic ingenuity combined with the capabilities of some of the world's leading manufacturing firms.

Exclusive distribution rights for the CATALYST are held by Transformative Wave Technologies (TWT), a wholly owned subsidiary of the Performance Mechanical Group. TWT developed the technology in-house, has proven the savings potential in the field, and brought the technology to the marketplace. In 2009, Yaskawa America was selected as the manufacturer for the CATALYST controller.

The CATALYST technology is built on proven hardware that has been utilized in the industrial and commercial sectors for decades. At the same time it makes use of the latest

technological advances in HVAC system control. The CATALYST controller has a small footprint which enables it to be easily installed inside the HVAC equipment cabinet. It integrates readily with existing thermostats or building management systems. The technology combines several well-practiced efficiency measures with our proprietary **Opti-Run** fan control logic to create a highly intelligent system. This custom microprocessor-embedded program effectively manages the system's operation without compromising comfort or indoor air quality.

The CATALYST has an extraordinary return on investment (ROI), especially when combined with utility funding. Virtually any existing HVAC unit can be retrofitted with the CATALYST to achieve dramatic energy savings. Options for improving the efficiency of older existing HVAC equipment have historically been limited or economically unfeasible. The CATALYST will make a major contribution toward the energy conservation goals of utilities, business operators, and public entities.



Current Landscape

There is currently a very visible focus on the need to reduce energy consumption. The federal government is devoting billions of dollars toward energy efficiency upgrades to public buildings. The private sector is also recognizing the financial benefits of projects that reduce energy costs and improve the financial bottom line. Furthermore, utilities are subsidizing sensible efficiency projects all across the country.

Heating, Ventilation, and Air Conditioning (HVAC) typically accounts for about 30% - 50% of the energy consumed in a commercial building. A small decrease in energy use by HVAC systems can have a large impact on the overall energy and greenhouse gas profile of a building. Increasing a building's energy efficiency is one of the most effective ways for organizations to simultaneously meet their carbon reduction goals and reduce operating costs.

“Small packaged heating, ventilation, and air-conditioning (HVAC) systems are among the most common HVAC systems for small commercial buildings. These systems, however, are notorious for a host of problems requiring 25 to 35 percent more energy than is necessary to heat, cool, and ventilate ... buildings.”

Source: California Energy Commission's Public Energy Research Program

Over 50% of the commercial floor space in the United States is reportedly served by rooftop-packaged HVAC units. These simple, constant volume systems are often equipped with airside economizers. An economizer allows the HVAC equipment to use outside air to satisfy cooling needs when conditions permit. This free cooling cycle meets the comfort needs of the space without using electrically powered compressors. A

properly functioning economizer is indispensable to an efficiently operated HVAC system in most climate zones.

Unfortunately, the vast majority of economizers are not operating correctly. Most facility operators are not receiving the full benefit of these energy-saving devices due to common failures. With recent changes in the energy codes across the country, we are now starting to see split system HVAC units equipped with economizers. This increases the total number of economizers nation-wide and creates an additional opportunity to capture savings in split systems, provided that they are functional and operated properly.

The HVAC equipment's role is not just to provide comfort. It is also responsible for ensuring proper fresh air ventilation rates. Current practice is to set ventilation levels based upon the maximum occupancy of the space served. Since a typical space is rarely at full occupancy, this means that most spaces are over-ventilated the majority of the time. An energy penalty occurs when the HVAC equipment unnecessarily conditions large amounts of fresh air. Current standards allow for the amount of fresh air to vary based upon actual occupancy levels rather than the maximum anticipated occupancy rating of the space. However, this practice is rarely applied to existing equipment as a retrofit strategy due to cost barriers, especially on constant volume equipment.

In any economy, efficiency makes financial sense. Investing in energy efficiency reduces operating expenses and can lead to increased profitability. It is the rare capital improvement to a facility that will produce a return on investment. In the current economic climate, it is even more important to focus on strategies that reduce operating costs, save energy, and lower maintenance costs. A reduction in energy expenses can help absorb some of the economic burden of a slow economy and support the profitability of the overall enterprise.

Catalyst Overview

The CATALYST is a retrofit technology for constant volume rooftop HVAC systems. This patent-pending retrofit process and technology is a multi-faceted improvement that will typically reduce energy consumption in these systems by 30-40%.

The core of the CATALYST is a controller with our proprietary **Opti-Run** fan control logic. We are able to embed this custom logic, along with several additional energy saving functions, into the controller. This reduces the number of components and installation time, which allows us to provide a more attractive financial payback for clients. Once installed, the CATALYST device optimizes the heating, cooling, economizer, and ventilation functions of the HVAC equipment in response to input from the existing thermostat or building management system.

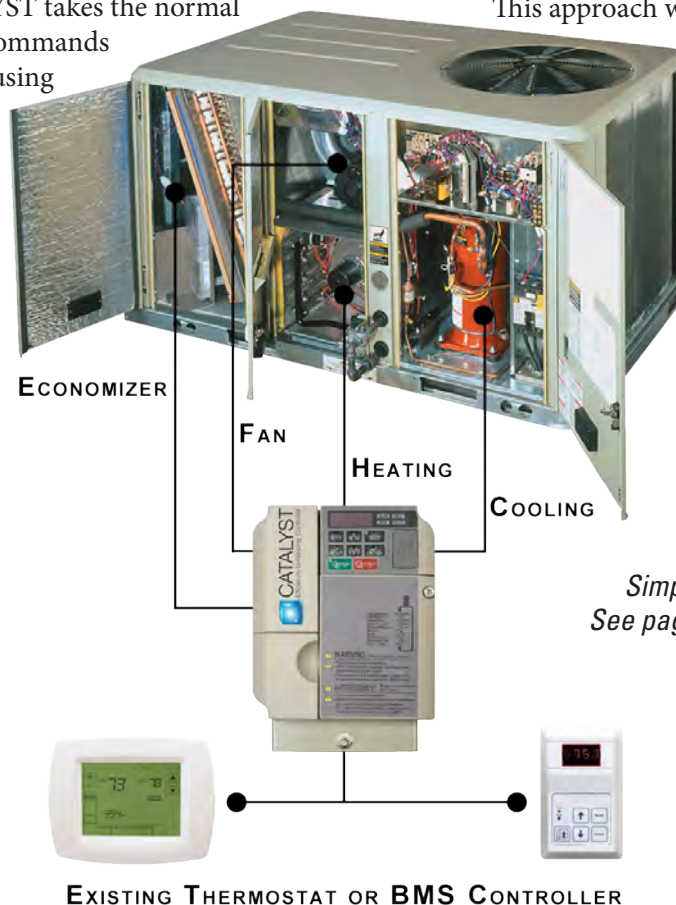
The installation of this technology does not undermine the integrity or performance of the unit. The device is installed between the thermostat (or BMS controller) and the control terminals on the HVAC unit. The CATALYST takes the normal thermostatic controller commands and adds intelligence by using proprietary logic, which enables the HVAC unit to make better decisions regarding its operation. This approach to system integration allows us to interface

with a variety of systems in the same consistent manner. The CATALYST technology also includes the installation of additional sensors designed to provide critical information to the controller. This allows the technology to optimize the performance of the unit and provide feedback on the system's operation and energy performance.

The CATALYST also reduces maintenance and service costs associated with each piece of equipment. The fan speed control feature reduces wear and tear on the fan motors by providing soft-start capability. By improving the control strategies, compressor runtimes are reduced and life spans are increased.

The logic for all of these strategies is embedded in the onboard programmable logic controller by CATALYST manufacturer Yaskawa and cannot be changed in the field except by authorized personnel with specific programming tools. Yaskawa also factory-installs the external wiring harnesses to minimize installation error and access to the internal controller terminals.

This approach will reduce the potential for unauthorized field changes that may undermine the anticipated energy savings and creates a process that will produce reliable and repeatable energy savings.



*Simple Catalyst EEC schematic.
See page 11 for a detailed schematic.*

Energy Saving Strategies

The CATALYST technology equips the HVAC system with a number of advanced energy saving strategies not commonly applied to constant volume rooftop packaged equipment. These include:

Opti-Run Fan Control – The CATALYST will modulate the speed of the system fan according to a unique logic sequence based on space needs and input from the new sensors. This allows us to achieve significant fan energy savings while operating the unit within the manufacturer’s rated design parameters. The CATALYST monitors key system variables and adjusts as needed to ensure proper equipment operation. These combined capabilities go beyond the abilities of a typical variable frequency drive (VFD) installation.

Integrated Economizer – The CATALYST will control the economizer to allow for the simultaneous use of mechanical cooling and “free” outside air to satisfy a space. Most economizers on rooftop packaged units operate on an “either/or” basis, leaving considerable energy savings unrealized.

Advanced Economizer Changeover – The CATALYST introduces the ability to sense and compare outside air and return air based on dry bulb temperature, enthalpy, or dew point depending upon the specific climate involved. Differential changeover will select the preferred source of air for mechanical cooling operation.

Unoccupied Damper Control – During calls for heating or cooling when the space is unoccupied the outside air damper will remain closed. This will lower heating and cooling costs because the system will not treat outside air during periods when ventilation air is not required.

Demand Control Ventilation – Demand Control Ventilation (DCV) uses a CO² sensor to establish occupancy levels and match the amount of ventilation air delivered to the space to the occupancy level. By only bringing in the amount of ventilation air that is actually needed, we reduce the amount of heating and cooling required for treating this air. DCV is a well-established energy efficiency strategy that assures indoor air quality while reducing energy use.

This strategy is documented in ANSI/ASHRAE Standard 62, *Ventilation for Acceptable Indoor Air Quality*.

Demand Charge Reduction - To provide an additional energy savings benefit, the CATALYST also contains features to reduce the facility’s energy “demand”, which is the rate of energy use. In a commercial building, demand charges can account for 10-20% of the total energy bill. Reducing demand saves money and reduces overall energy costs. The CATALYST reduces demand charges by decreasing the maximum consumption of each HVAC unit. It can also be set to limit demand based on overall building consumption, or it is capable of receiving a “load-shed” signal from the local utility.

eIQ Energy Intelligence Platform

CATALYST controllers can operate as stand-alone units or wirelessly networked together using the eIQ: Energy Intelligence Platform. The eIQ Platform can then be integrated with an existing Building Management System for a total facility solution.

The eIQ Platform adds remote access, fault detection, diagnostic capability, and a host of other features to the CATALYST installation. This communicating version will automatically notify operators of any equipment performance issues or compromised efficiency, allowing for the quick remedy of problems before occupant comfort suffers, and energy costs skyrocket. It also provides assurance that the anticipated savings are being achieved and sustained.

The features of the eIQ Platform include:

Web-Based Access – The system can be accessed anytime, anywhere by an authorized user on any computer with an Internet connection.

Real-time Energy Consumption Monitoring – This provides clients with the capability to capture and document the actual energy savings of the CATALYST-equipped systems, or the entire building.

Demand Limiting – The system can either use preset demand parameters or monitor an automated signal from the local utility (where available) to limit the consumption of the unit and demand levels.

Fault Detection and Diagnostics – We have developed several proprietary diagnostic functions to actively monitor the energy consumption and performance of the equipment. This includes the addition of several sensors to verify the status of key conditions including airflow, discharge air temperature, and compressor status. These additional points of information are recorded and then normalized based on outside air conditions and time of day. The system is then monitored for any performance abnormalities, which will trigger an alert.

Remote Notification – Through remote access the system can send e-mail notifications to any contact of choice based on system performance, component integrity, or comfort related issues. Often times the system will trigger a warning before occupant comfort starts to suffer. Each site is monitored to verify that the system is operational.

Building Management Controls – The system can be integrated with most Building Management Systems. The CATALYST with the eIQ Platform can also serve as an open-protocol Building Management System for very little additional cost. It is capable of controlling lighting, HVAC, schedules, space temperatures, keycard access, total building energy usage, and more.



energy intelligence platform

Monitor your HVAC systems from anywhere through the eIQ Energy Intelligence Platform

Preventative Maintenance Cost Avoidance – The CATALYST is able to monitor filter performance and operating conditions of the equipment. Preventative maintenance programs are often based on the assumption that air filters need to be replaced quarterly. By actual monitoring of the filter performance it may be possible to schedule filter changes and PM visits on an “as-needed” basis, resulting in reduced overall maintenance costs.

Warranty – The CATALYST hardware is warranted for 5 years to provide confidence that the technology will provide long-lasting savings and performance.

The eIQ Platform is a subscription-based service. The cost of the subscription is easily offset by the avoided energy costs, which result from the advanced diagnostics and fault detection.

See page 10 for an eIQ Network diagram

Cost Effectiveness & Implementation

As capital budgets continue to shrink and operating costs continue to rise, it is important that the economics of the CATALYST opportunity make sense and are attractive to all involved. In a typical application, the CATALYST will reduce HVAC energy consumption by 25-40%. When the CATALYST includes the eIQ Platform, the operational savings achieved during the initial installation can be maintained for the life of the equipment. This avoided electrical expense is sometimes as much as 10% of the annual utility cost. The CATALYST will also reduce the demand at each site, which can lower the overall utility expense by another 2-3%.

A system equipped with the CATALYST technology can demonstrate its proper operation in a manner of minutes. This makes verification of the measure simple. As long as the technology remains in place, and in working order, the energy savings will be reliable and consistent. When coupled with the eIQ Platform, we are able to guarantee the savings for the life of the product.

The installation of the CATALYST technology provides an opportunity to identify and address operational and service related deficiencies. Under no circumstances will the technology be applied in systems that are not properly repaired or controlled.

COST DISCUSSION

We have several strategies for the implementation and funding of a CATALYST upgrade. On a capital purchase program our target is to meet a total installed cost to the client that produces a 2-3 year payback, after utility rebates. This is considered to be very attractive by most clients. Utility funding will vary from market to market. We are working with a number of utilities to obtain a general funding commitment that we can count on. A specific equipment list for a proposed site allows us to develop a preliminary installation cost and savings estimate for presentation to the local utility. This will allow them to respond with a firm funding commitment and allow us to produce a final Payback/ROI Analysis for the client.

Total lifetime energy cost reductions per RTU for Fault Detection & Diagnosis (FDD)

These estimates show total lifetime net savings for an individual rooftop unit operating in different types of buildings in various California regions. The greater the cooling loads, the greater the possible savings with an FDD system.

Location	Building Type	Lifetime Net Savings
Northern California	Modular school	4,328
	Restaurant	4,800
	Retail store	5,840
Southern California	Modular school	5,496
	Restaurant	6,772
	Retail store	9,756

Source: California Energy Commission's Public Energy Research Program

Conclusion

The CATALYST: Efficiency Enhancing Controller can provide a significant reduction in energy expenses and a positive impact on the bottom line. Facilities equipped with the CATALYST technology will appreciate an unprecedented reduction in the energy costs associated with the operation of constant volume HVAC equipment. Additional documentation can be made available that will further elaborate on our technology and the benefits it represents.

We look forward to taking the appropriate next steps to further assist you in the evaluation of this technology and the opportunity it represents. We welcome the opportunity to work with you or your staff in the coming days and weeks.

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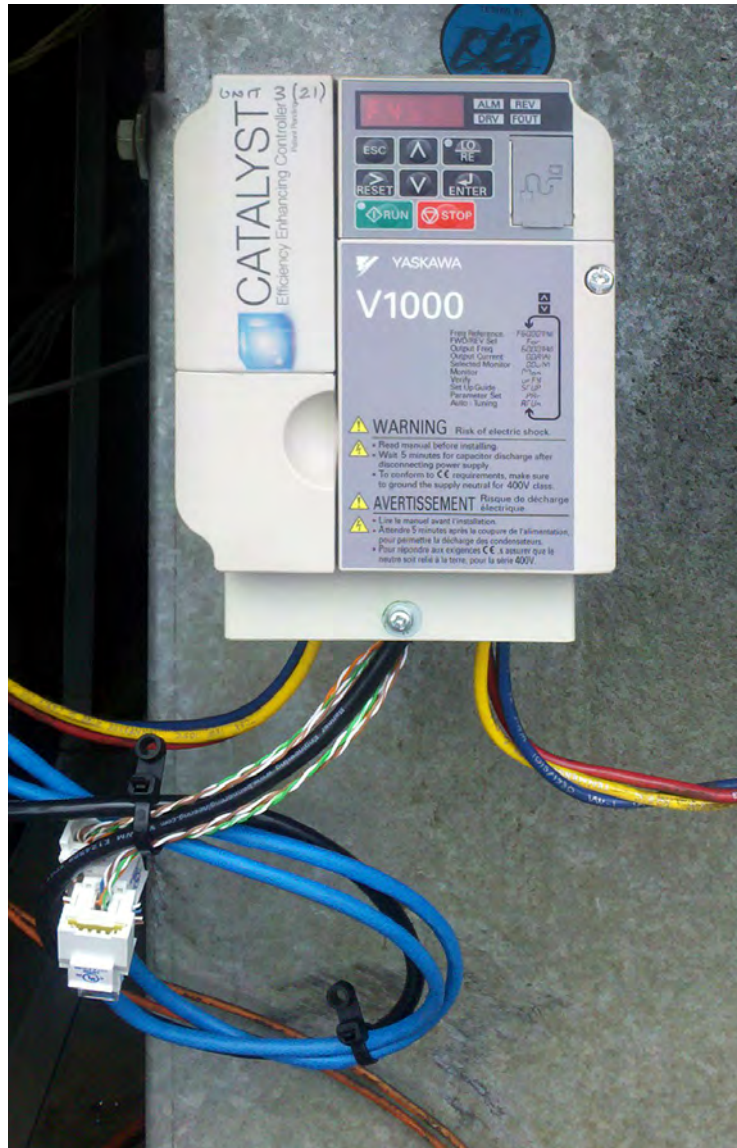
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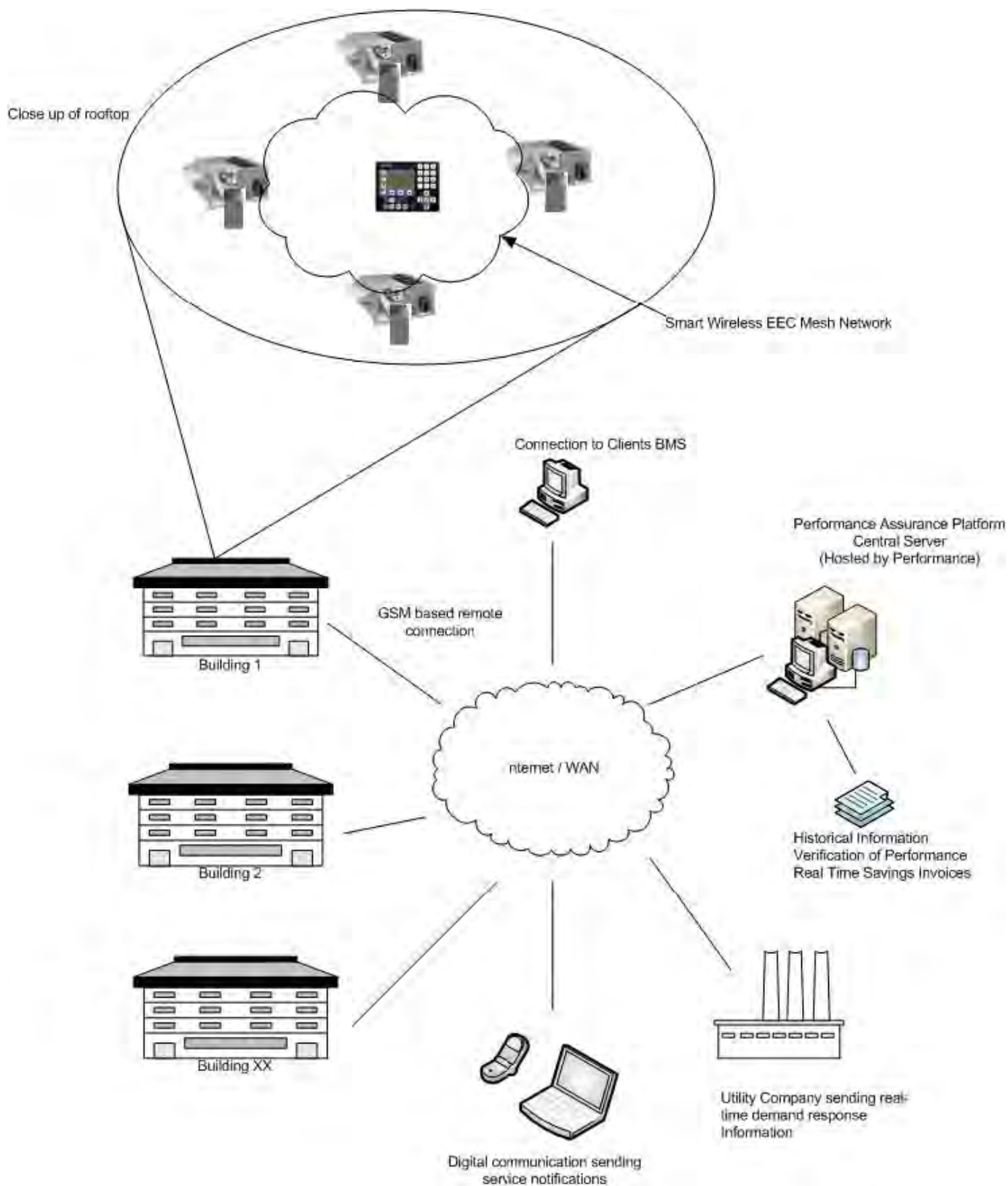


Catalyst Efficiency Enhancing Controller - Technology Overview

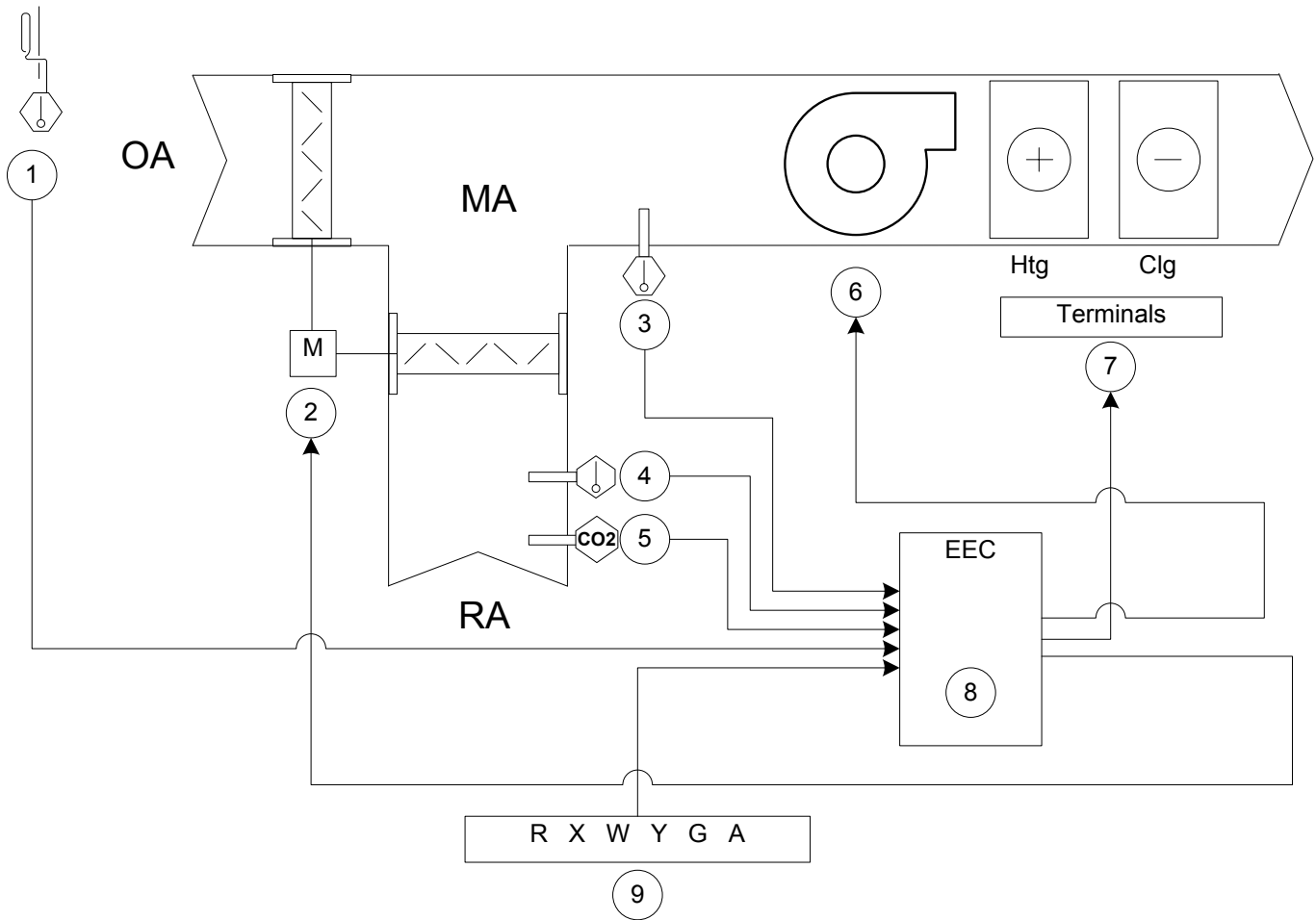


The Catalyst EEC in the field

e-IQ Network Diagram



Catalyst EEC Field Installation Schematic



Legend	
Number	Description
1	Outside Air Sensor
2	Economizer Actuator
3	Mixed Air Low Limit
4	Return Air Sensor
5	CO ² Sensor
6	Fan Motor
7	HVAC Equipment Terminals
8	Catalyst EEC Controller
9	Existing Thermostat



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