Energy saving on lighting circuit by cloud-based system

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Abstract

An energy saving plan for Hong Kong from Environment Bureau was launched for 2015 - 2025+ to save 40% energy. The plan not only analyzed energy use but also set out a strategy that could achieve this target. From the report, it is shown that air-conditioning consumes the highest energy in Hong Kong, followed by lighting. In our research project, we implemented cloud computing services to manage and control commercial lightings to achieve energy saving according to the target. It is known that the state-of-the-art computer technology is called cloud computing. As an energy efficient management system to control lighting of commercial buildings, cloud computing is particularly suitable due to the operational flexibility and scalability. We used cloud computing to control complex daylighting devices and wireless control system that can link up individual lighting by Internet of Things (IoT) devices. The installation and maintenance fee could greatly be reduced to benefit buildings in Hong Kong. The dimming control could intelligently be adjusted so that the ambient lighting condition is continuously balanced with the changing environment. This is critical for power saving and meeting the international green technology standards.

Introduction

Concerning international energy saving management, ISO 50001 is instrumental in improving business performance by managing energy more efficiently and so reducing our carbon impact. There were many concerns in implementing energy saving in practice, including measure and verification through calculating savings, baseline modelling, real-time savings tracking. On planning the energy management timeline, building owners are not that easy to monitor and control each part by low cost.

The implementation timescale is flexible, it will start by combining meters, gauges, sensors, daylight harvesting and wireless devices in the building. The channel number in the market is limited and far from enough for commercial and office space. Thus, the large scale of lighting control in a building by wireless technology is under our group to develop and integrate. We believe these cloud computing services are not only

suitable for energy saving in Hong Kong, but they facilitate energy saving of building into a new business model in Hong Kong, Energy Performance Contract (EPC). Regarding EPC, the client procures a guaranteed outcome through partnership but not asset purchasing. This new business model already is very common in Europe and Japan, and also being implemented in Hong Kong. In order to keep up with international standard, the measurement and verification of energy savings is crucial [1-7].

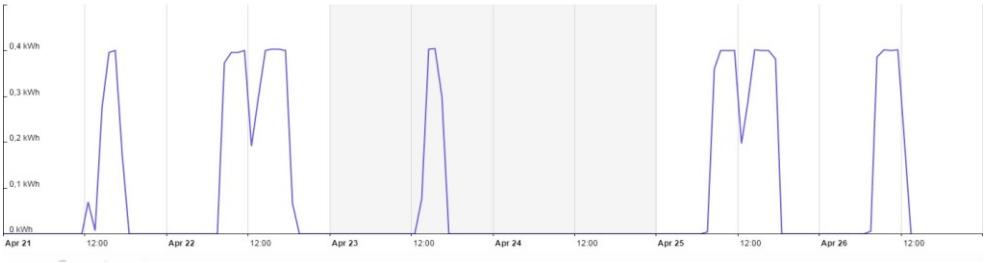

Figure 1 Shown electrical energy use in a selected lighting circuit at VTC

Cloud computing is an on demand network access to a shared pool of configurable computing resources. In this paper, we implemented lightings in energy savings of selected buildings in Vocational Training Council (VTC), Figure 1 shows the weekly usage of a selected lighting circuit in a lab of IVE. In a building management system for lighting, there are many opportunities to save energy. BACnet is commonly the backbone of the electrical system in a building, it send signals to control the lightings. The research plan is to implement energy saving strategy into the lighting network by introducing:

- Daylighting harvesting by using smart glass
- Implement wireless IoT module in lighting fixture to simplify the control
- Design energy saving to control lighting scenes

The demonstrative result shows that energy efficient lightings in Hong Kong follows International standards including ISO 50001, International Performance Measurement and Verification Protocol (IPMVP) from Energy Verification Organization (EVO) and other protocols in order to meet the energy saving objectives, which include:

- Validate obtained savings

- Real-time savings tracking
- Objective tool for partner-customer
- Guaranteed savings contracts

Cloud-LED EPC integrates lighting system service agreement. Lighting fixture and equipment are first installed at the customer site with no cost, and both parties may reap the benefit in the coming agreement years, usually 4 years. Cloud-LED works with customer to:

- Identify the scope of energy efficient lighting.
- Find the budget to integrate to an Energy Performance Contract (EPC).
- Measure & Verify the savings.

The way of business solve the problem of company have energy saving project but turn down because of lag budget. Company could take an action to replace the current lighting fixture with energy efficiency lightings without budget allocation. Cloud-LED EPC provides the integral services, it is an Energy Performance Contracting Scheme (EPC) with a customer time frame of usually four years period, the energy payback covers the cost of implementation of energy efficiency lighting fixtures and client company also enjoy the reduction of electrical tariff at soon as the project started. What client do is agree to enter into an EPC for commercial energy efficient lighting upgrades and retrofits.

Regarding a high standard international energy saving implementation, energy management are more concerned to fulfill the details in:

- ISO 50001 Energy Management Implementation.
- International Performance Measurement and Verification Protocol (IPMVP)
- Measurement and Verification (M&V) to calculating energy savings
- Baseline modelling to calculate energy saving
- Real-time savings tracking
- Corporate training

Result and Discussion

This project implemented the energy saving algorithm on commercial cloud (like vmware.com) with commercial public cloud (like DEXCell from DEXMA) to produce a hybrid cloud. The result of this project will benefit buildings in Hong Kong that concern high tech implementation of energy saving, as they could leverage an existing continual improvable process model developed from this project and start to realize the continuous cost reductions in energy consumption.

Finally, the benefits of Energy Performance Contracting Scheme results to buildings in Hong Kong could be summarized as:

- Saving energy means saving money.

- Increased asset value of buildings.

- Reduced operational costs.

Energy management system installed connected a gateway to internet, figure 2a shows the gateway and figure 2b shows a test temperature meter was connected to the gateway and temperature profile has been show for several days. and connect power meter to the gateway. The gateway is easy to setup by connect to 172.16.0.1 by either WiFi or Cat 5 connection.

The lighting load curves contain performance variables, it could be found that 1. What circuits are running at night, 2. What circuits generate starting peaks, 3. What circuit generate uncontrolled variability, the analysis of lighting load characteristics could improve checkpoints and improvements in ON/OFF control, lighting levels, and replacing lighting sources and voltage variation. In this regard, further reliability performance analysis leading to actionable recommendations to optimize energy use. Such study provides building owners, tenants, efficiency programs, and others with a model of an energy management initiative with proven results. Consultative and advisory services were essential to the success of this energy management initiative, it helps to keeping the building comfortable and productive for occupants, and responding to service requests.

Fig 2a

Figure 2b

From the setting page, the meters connected by Modbus are checked up running. The setting of configuration file added all meter setting according to resources provider by the meters vendors.

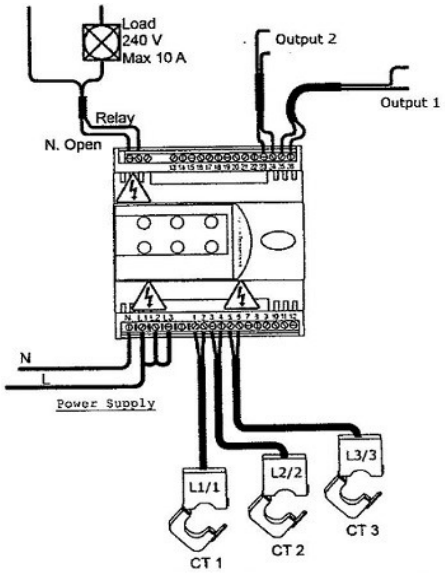

Figure 3a Connection diagram of three phase power meter

Figure 3b Picture of the 3 phase power meter

Figure 4 shows the cloud-based energy monitor system with different highlights could be chosen to shown according to the user.

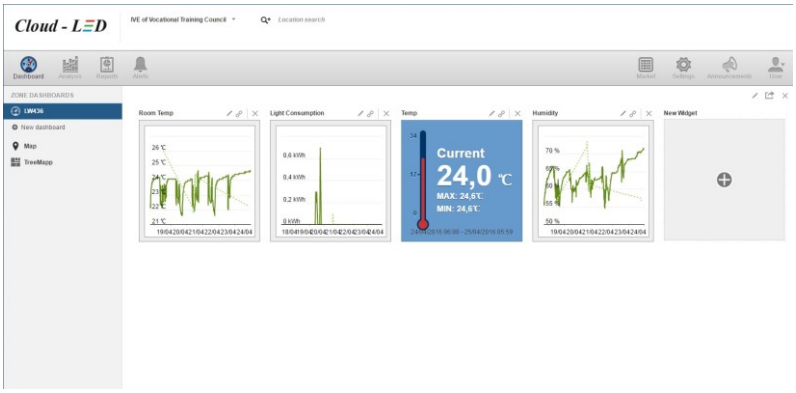

Figure 4 shows cloud-based energy monitoring

Cloud energy system provided charts, graphs, and metrics to reflect building performance, it also identify opportunities, including charts of electricity use for The building over a 24 hours day; metrics related to how a building start-up in the morning and shutdown in the evening; energy use intensity (energy use per square meter); and night variance, it shows the electricity use (in watts) during the building's unoccupied period. Reports were delivered to the building manager daily by e-mail, other materials were available through an online tool.

Figure 5 shows different reports and alert templates available

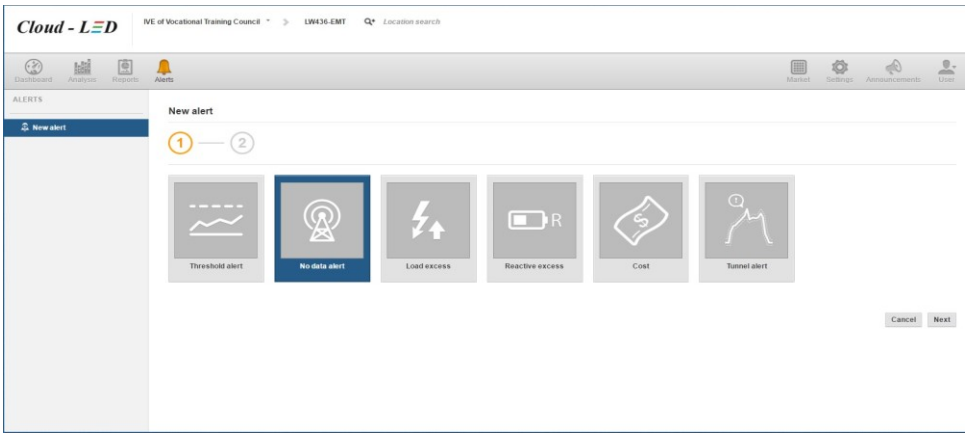

Figure 6 shows different alert could be generated

Cloud computing technology is an on demand network access to a shared pool of configurable computing resources. There are already commercial public cloud services provided on energy saving, however, the need of tailor made interface for each individual is needed, this develops the concept of a private cloud combined with public cloud to form a hybrid cloud which will solve the energy saving problems in Hong Kong. Private cloud services provide customization, efficiency, security and privacy. Building owners and management agent could use a cloud service means reduce their high investment to subscription of on demand network and access to a shared pool of configurable computing resources. In this project, we propose to study and implement a hybrid cloud to a newer delivery model with possible security concerns for energy savings.

Conclusion

The research objective is to construct a smart lighting connection on a commercial building scale, and implement it by computer cloud services. It implies social and economic aspects including commercialization potential. The energy saving could be one of the significant contribution to help in building energy saving as expected from Environment Bureau plan for 2015 - 2025+ in saving 40% energy.

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