Sustainability Strategies on Deep Energy Saving and Energy Management of Property Developer

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ABSTRACT

This paper presents the sustainability strategies on energy management implemented by a property developer, which achieved deep and continuous improvement in the period from 2001 to 2015. It aimed for reducing electricity consumption across their portfolios in Hong Kong over the years, and strategically established a comprehensive energy database for monitoring and analysing the energy data. This "Knowledge-based energy management" involved the collecting, analysis of operating data and turning them into information for determining strategies to enhance the operation efficiencies of their plant and equipment. It also involved the carrying out of practical researches through both in-house efforts and collaboration with universities and equipment manufacturers.

With a sufficient understanding of energy use and building performance, ambitious energy targets were set. Energy management opportunities (EMOs) were then identified and implemented systematically. This amounted to a 16% reduction in electricity energy consumption despite a 16% increase in gross floor area from 2001 to 2015. Three key issues will be discussed in this paper including database establishment, energy improvement practices and energy efficiency research. It is concluded that the "Knowledge-based energy management" strategy has potential to be success industry-wide.

Keywords: *sustainability strategies, knowledge-based energy management, energy saving*

1. INTRODUCTION

Hong Kong is one of the high density financial and commercial cities in the world. As much of our activities take place indoors, buildings consume substantial amount of energy. In 2013, over 92% of electricity generation was consumed by these buildings and around 66% of it was contributed by commercial sector (Hong Kong Energy End-use Data 2015). To cope with the energy saving plan of HKSAR (i.e. reduce energy intensity by 40% by 2025 using 2005 as the base) (Energy Saving Plan, 2015) and implement low-carbon living and working style, contribution from the commercial sector is important.

Nowadays, commercial buildings are always better managed. The control of major building services installations like, heating and ventilation air-conditioning (HVAC) system, electrical distribution system, lighting system, lift and escalator system are normally integrated into the building management system (BMS) to facilitate daily operation. Developers are more willing to invest as it can increase their rental income and reputation. Nevertheless, operators of the building tend to focus in routine operation and prevention of equipment breakdown instead of operation efficiencies. They are conservative and prefer replacing inefficient building services installation until the end of their equipment life. This case study investigated a developer in Hong Kong, who works in another way and their energy saving journey showcased the success of transforming routine operation into a Knowledge-based management and strategy.

2. CASE STUDY

2.1 Background of the case

This case study is a developer established in 1970s in Hong Kong. It owns and manages office, retail, hotel and residential properties, with a focus on mixed use developments in prime, accessible locations across Hong Kong, Mainland China and the United States. Up to 2015, they have investment properties (office, retail and hotel) of over 2.72 million square meters (Annual Report, 2015).

Since 2001, this developer have worked to reduce electricity use, by monitoring and analysing data collected and stored in a comprehensive energy database, setting energy efficiency targets and developing strategies and actions to meet these targets. Up to 2015, over 37 million kWh energy consumption was reduced despite there was increase in portfolios size. In percentage, this amounted to a 16% reduction in electricity energy consumption despite a 16% increase in gross floor area from 2001 to 2015. By implementing knowledge-based energy management and continuously evaluating their operation, they set an ambitious target for 2020 of reducing annual energy consumption by 64 million kWh electricity (26%) compared with 2008 baseline (Annual Report, 2015).

What makes their operation efficiencies and energy management different is that they act on information and researches; collaborate with academia to sustain their initiatives; actively influence their stakeholders and make their energy performance transparent through the yearly sustainable development (SD) reporting and carbon disclosure project.

Their energy improvement journey can be described in 3 stages:

- Establishment of database and using extensive operating data to monitor building performance from early 2000's
- Develop Knowledge-based energy management system, reduction plan and influencing others from 2006
- Carry out practical researches, collaborate with universities and put newly discovered measures into practice from 2010

2.2 Methodologies

2.2.1 From dataset to knowledge-based

It has been long in the building industry that building operation data collected with the BMS are not fully utilized. Indeed, these data are extremely useful in analysing the building performance, especially in energy management and evaluate system efficiencies.

The reasons they are not used are that most of them are raw data, lack of housekeeping or even not properly logged. And it is extremely difficult to analyse such "big data" without technical expertise and systematic management. To begin with, this developer started to build up a high level energy database from 2001. By means of simple utility bills and analysis tools, the energy data, in correlation with other parameters such as occupancy level and outdoor temperature, are transformed into valuable information. It is extremely useful as it can give the management a full picture of how the energy is utilized throughout the years (Figure 1).

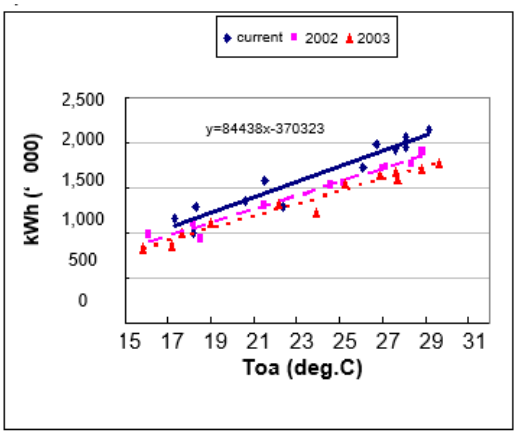

Figure 1: Energy database with correlation with outdoor air temperatures (TOA)

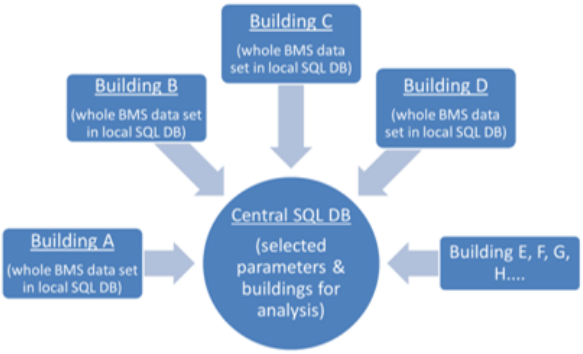

Figure 2: Strategy in logging BMS data in SQL DB

Besides energy data, BMS hourly operating data like, supply and return temperatures, flow rates, damper and valve positions can also provide a lot of information in the characteristics, performances and efficiencies of different building services installation. However, the data amount and network requirement can be enormous that BMS network may not able to cater. In 2005, the developer started to collaborate with BMS vendors in establishing hardware and software strategies and investigating the technology breakthrough in building individual BMS logging database. Instead of tradition csv, text or excel files, they explored a way to use Structured Query Language (SQL) database (DB) that is optimized for large data storage and prompt data retrieval. Individual and central databases

were built to mitigate the network loading and prioritize frequent analysing data. Figure 2 is a diagram showing the strategy on how to manage the large amount of monitoring data from individual buildings.

With the aid of energy and BMS databases above, energy consumption and system performance are easily keep tracked and analysed. Management would be easy to establish energy baseline and improvement plan for upcoming years. Measurement and verification methods can also be developed for verifying the success of initiatives by means of the data.

2.2.2 From knowledge to internal and external energy strategy

Establish targets and strategies internally

By reviewing the extensive operating data in a systematic way, raw data are transformed into information and knowledge. Improvement opportunities could be identified through the regular equipment performance monitoring. For instance, the chiller control optimization was identified based on the analyses of chilled water / condenser side water supply and return temperatures and electricity power consumption; VAV system static pressure reset was reviewed based on the statistic of VAV boxes damper position. A series of methodology for practical use of operating data was thus developed such as, energy performance analysis in chiller performance and chilled water system (Yu and Chan, 2012), feasibility study in conversion of cooling tower, VSD chillers, duct static pressure reset (Zhang et al., 2015), automatic tube cleaning system and chilled water differential pressure reset (Xuefeng et al., 2015). Those operating information not only give simple performance evaluation, but also facilitate management decision on operation optimization as well as replacement investment. Figure 3 showed a chiller performance analysis using year round operating data and design figures from the manufacturer, to justify whether the chiller should be replaced.

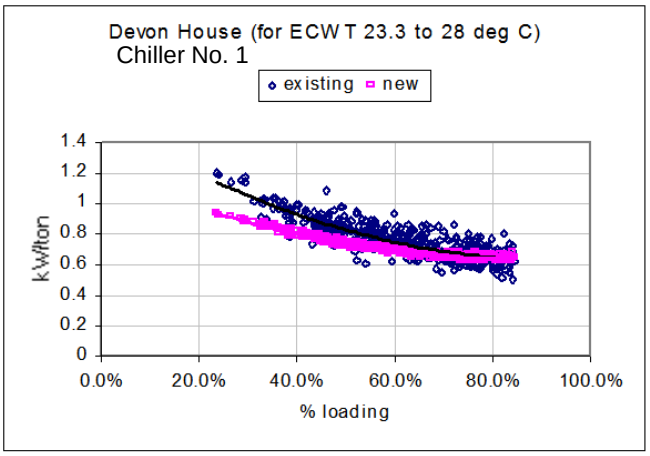

Figure 3: Strategy in logging BMS data in SQL DB

Instead of relying advices from energy consultant or equipment manufacturer, self-studies with actual site operating data provide more objective findings. Figure 4 is a road map showing the energy analysis they have been carried out in past years. Sometimes, it can speed up energy saving opportunities and bring out new initiatives as data are readily on hand for in-depth analysis. More importantly, the effectiveness of energy saving opportunities and new initiatives can be closely monitored. Detailed measurement and verification (M&V) can be done to verify the saving and summarize the pros and cons of different measures for future implementation.

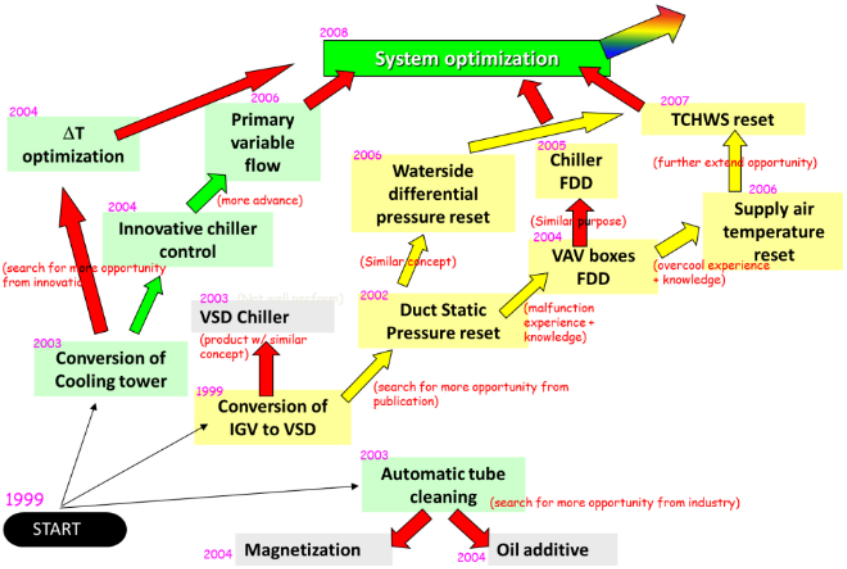

Figure 4: Road map of energy analysis in past years

Readiness of data also helps in other ways, e.g. meeting local energy codes, acquiring international recognition (e.g. BEC2012, ISO 50001), professional awards and developing reduction plan. Long before the implementation of mandatory energy audit initiated by Hong Kong government in 2012, the developer was able to carry out similar audits from 2010 and establish an ambitious energy plan, i.e. target for 64 million kWh electricity saving a year (26%) by 2020 for Hong Kong portfolio with 2008 as the baseline.

Benchmarking with others globally

In addition to internal target, it is also good to a company to step up to the industry globally. In 2006, the developer spearheaded a 'Best-in-class' exercise to benchmark and share best practices with peer companies in the USA, Australia, the UK, Singapore and Hong Kong. The objectives were to understand the practices adopted by industry leaders and ways to enhance each participant's performance through sharing of knowledge. The developer did not only manage their own consumptions but more importantly influenced others and facilitated other owners to reduce carbon emission.

Influencing stakeholder and the society

Success of sustainability is building on the cooperation with all stakeholders. Instead of own long-term energy reduction target, initiatives should also extend to stakeholders by various programs like tenant engagement.

Electricity consumption of tenants accounts for over 40% of the total consumption of a typical office building in Hong Kong (Annual Report, 2015). Management companies, indeed, can play an active role to encourage energy saving in the tenant side.

In this case, free energy audit was provided to the tenant. They started to carry out free energy audits for its office tenants and explore improvement opportunities in their premises. According to the information collected, about 44% of their office areas had been audited and the tenants' power intensity has been reduced by 35% from 2009 to 2015 (Figure 5).

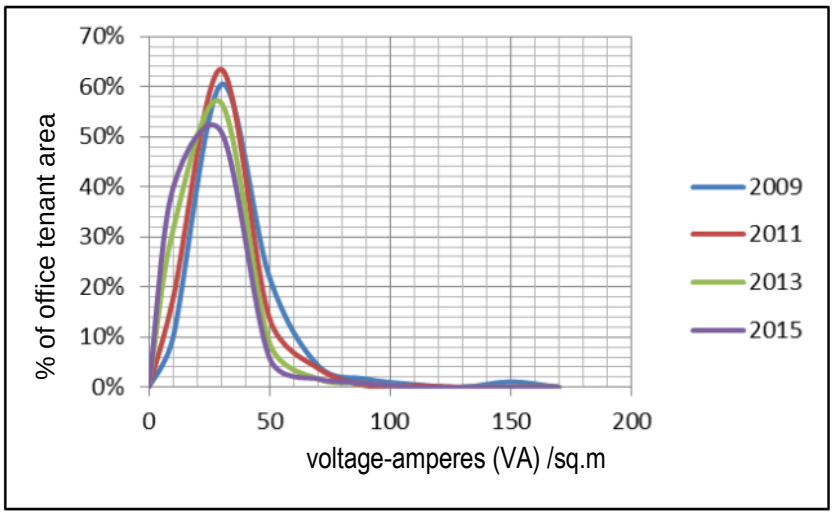

Figure 5: Reduction on tenant's power intensity from 2009 to 2015

Furthermore, increasing energy conservation awareness among own staff and tenants through targeted campaign can help decrease the cooling demand in office and retail portfolios, and thus further reducing the total building energy consumption. For example, the developer implements "Green Pledge" with tenants to apply a series of green initiatives that help improve the environmental performance of their office premises, encourages the tenants in shopping malls to join the Green Shop Alliance that join forces to promote green shopping practices by putting forward the green initiatives.

2.2.3 From experience to action research and new initiatives

Technology comes in steps. In the past, energy reduction can be easily achieved by chiller and LED replacement. However, it is making difficult in further saving if there is no major breakthrough in technology advancement. Though developers can make a different step, they can partner with universities as they have valuable experience and operating data to share. In this case, the developer demonstrated a good movement as they have established a joint research centre with an international grade national university, Tsinghua University, to carry out researches on optimization of plant efficiencies of existing buildings. Operating buildings can be used as living laboratories for testing pilot initiatives in energy efficiency improvement and to put newly discovered measures into practice.

Academia can involve at various phases of development to help optimize energy efficiency through the life cycle of buildings also, e.g. integrated design at planning and testing and commissioning stages and monitoring based commissioning in operating stages. This kind of collaboration can result in substantial energy savings, and also help influence and share new knowledge with colleagues, partners, industry peers and researchers about new building technologies and management processes.

Moreover, we can partner with equipment vendor. Synergy can be found when building owner, suppliers and academia are pull together. With the technical support from equipment manufacturer, operating experience from building owner and in-depth analysis from universities, new energy initiative and control algorithm can be discovered and refined. For instance, the developer developed a fault detection and diagnosis (FDD) program of VAV terminals with Hunan University and Honeywell Limited and won the ASHRAE Technology Award in 2013.

3. DISCUSSION

In previous sections, we have identified different aspects in forming a sustainable energy strategy. That included the development of database and knowledge, establishment of internal and external strategies and partnering with equipment vendors and academia.

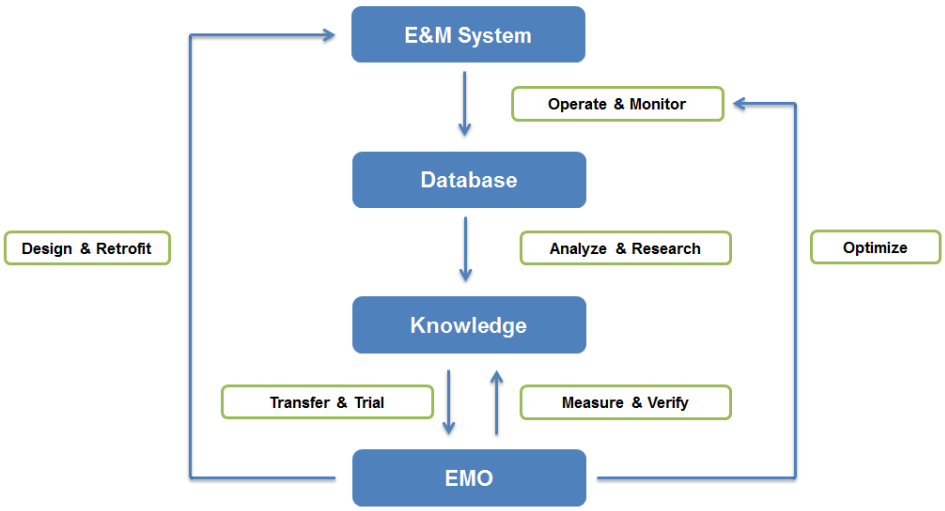

Figure 6: Process of knowledge-based management

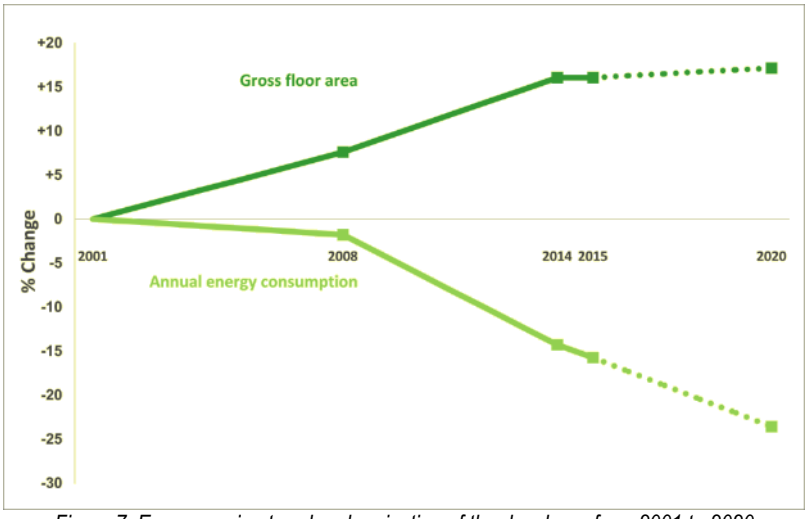

Figure 7: Energy saving trend and projection of the developer from 2001 to 2020

The main concept of this idea is Knowledge-based management (Figure 6). First of all, build a database integrating the data collected from different electrical and mechanical (E&M) system. With simple data mining tools, data can be clustered into information and knowledge with a series of analysis and researches by professionals, engineers and operators. Individual initiative and strategy can then be set, including short term EMOs and long term reduction strategies. The implementation can be supported by manufacturer and academia as they have expertise in product design and installation. Performance is closely monitored by means of sensors afterwards and allowed benchmarking with others. Experiences and knowledge are accumulated throughout the processes. Figure 7 summarized the developer's energy reduction trend despite the increase of gross floor area from 2001 to 2015.

Difficulties in setting up the database and energy management system

Data from BMS and energy meters can be enormous. For instance, a 70-storey high grade A office buildings with VAV system and having area around 2,000 sq.m per floor, can have more than 40,000 BMS points and more than 100 energy meters installed in total. If data are logged in every 5-minute, there will be over 11 million data set per day. Data mining process can be exhaustive if they are not properly managed and analysed. At the same time, buildings that were built over 15 years ago may not have the capability to log such a large amount of data in terms of hardware and software provision. Moreover, owners may not invest in such infrastructure as there is no direct payback from them.

Nevertheless, prioritizing the BMS points to be logged and selecting the right logging interval may solve the problems. For instance, less frequent energy data is more critical than routine hourly operation data as energy data can provide clues in major energy use installation. Instead, operating data can be logged at designated interval and specific periods (e.g. a few weeks in summer and winter times) to mitigate the loading on the hardware and software infrastructure.

4. CONCLUSION

Apart from traditional operation and maintenance practices and preventative maintenance, Knowledge-based management could be another way in enhancing energy efficiency and forming energy management strategy. With the establishment of energy and operating databases, analysis could be carried out effectively. The operation data would be turned into valuable knowledge, and strategies and initiatives are then established which eventually enhance the building performance. Moreover, synergy and innovation could also be stimulated.

In conclusion, Knowledge-based management in sustainability strategies is viable and would be a new way out in energy management.

ACKNOWLEDGEMENTS

The case study presented in this paper was supported by Swire Properties Limited.

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