INCREASING ENERGY EFFECTIVENESS BY MANAGEMENT METHODS IN TAIWAN REGIONAL HOSPITAL

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Abstract:
According to annual energy consumption report of non-manufacturers industries in Taiwan, hospital is the second ranking of total national energy consuming reports. The purpose of this study is to analysis Tawain region-teaching hospital in energy consuming amount, kinds, efficient, retrench, and density analysis through management methods and power efficiency in hospital. In addition, the study collected the hospital construction energy management experience, as well as the other hospitals, power, air conditions, lighting devices in saving power methods and dates for analysis to encourage hospital to escalate power usage efficient, minimizing man power expenditure, deduct hospital power expenditure. By the method of management accompany with the Taiwan Power Company discount program, the hospital can save a significant expenditure in power consumption. The way to save power expenditure include: (1) Select and sign a reasonable contract of power capacity can save fundamental power price. The power saving stands high as 2.7% to 2.85% for normal usage. Choice suitable power price period calculation plan and establish ice storage device not only can save monthly contract power fundamental fee but also can apply to Tai Power for 60% off peak power consuming measures. The off-peak power consuming measures have not only preferences benefit but also have 30-35% off discount. (2) Air condition power consuming occupies 50% of hospital total power usage. If apply an efficient management can save 8-15% power expenditure. (3) Lighting device can also modify by high efficient lamination device and management measures to save 50%-66% power expenditure. The above measures not only can save great power expenditure but also accomplish the Taiwan Power Company's policy to shift peak power consuming loading to balance the Taiwan area power supply. This policy also reduces power plants development to eliminate the impact of environment and power-restriction in convenience.

Keywords: contracted demand, power factor, time rate

1. INTRODUCTION

Due to the growth of economic development is increasing and the quality of the living environment is improving, the demands of medical environment quality from people are getting to increase more and more. Hospitals provide excellent healthcare environment, in addition, it is created the comfort health care settings and 24-hour convenience life by a super medical team with medical technology and advanced medical equipment. Those reasons show that hospitals are displayed as high energy-consuming industries.

This study used the quantitative research to analysis of hospital-related energy use, type, efficiency, conservation, and density statistics, those data provide basic information for the hospital building electricity. The amounts of energy used in hospital provide hospital which rising or decreasing through the planning and management of electricity, evaluate performance, and energy efficiency. For reducing hospital spending on overall energy costs, we must to consider the implementation of management methods, choice of reasonable contract capacity, selection of appropriate time price to use energy, and saving of electricity costs. While the power load is also reaching the peak, Taiwan power company would transfer and balance of power in Taiwan in order to reduce the impact on the establishment of new power plants and the natural environment.

2. PURPOSES OF THE RESEARCH

According to the information from Ministry of Health and Welfare, there are 530 hospitals in Taiwan in 2012. Those hospitals that passed the Taiwan hospital accreditation is about 89.1%, and those hospitals are including 23 medical centres, 20 regional hospitals, 306 district hospitals.

Table 1: The Users of Large Energy Consumption in 2012 Annual Report (depending on building using classification)

Classification	Case	Power (KWH)	Fuel Oil (KL)	L.P.G. (tonne)	Natural gas (TCM)	Gasoline (KL)	Diesel (KL)	Total (KLOEs)	Accounting rate (%)
School	247	2,314,889	1,514	190	7,463	1,037	4,751	591	15.7
Office building	209	1,299,015	261	9	1,176	4	45	324	8.6
Hospital	141	2,098,172	16,988	295	16,116	374	6,759	524	15.0
Discount stores	116	830,184	1	105	1,602	4	23	208	5.5
Department stores	88	1,384,998		372	9,492		32	355	9.4
Hotel	86	672,023	16,161	1,505	16,890	36	2,460	206	5.5
Government agencies	81	394,150	510	47	200	2,108	540	101	2.7
Railway station	70	1,943,772	156				43	483	12.9
Telecommunications network room	65	889,021			18		182	221	5.9
Defense agencies	35	257,798	70	68	1,778	515	771	67	1.8
Research institutions	29	485,271	41		969	198	222	122	3.2
Gallery	29	196,756		1	71	64	13	49	1.3
Composite mall	29	161,414			669		1	41	1.1
Sewage treatment plant	19	335,473		9		0	33	83	2.2
Warehouse	18	98,006				292	1,501	26	0.7
Air-port	6	181,806				30	25	45	1.2
others	156	1,023,431	3,101	335	3,975	94	8,506	271	7.2
Total	**1,424**	**14,566,181**	**38,803**	**2945**	**60,419**	**4,755**	**25,907**	**3,759**	**100**

Sources: from the investigation of Taiwan Green Productivity Foundation.

The Bureau of Energy, Ministry of Economic Affairs authorized the Taiwan Green Productivity Foundation to investigate in 2012 about the large energy users from 1,424 non-manufacturing industries which contract electrical capacity is above 800Kws. To understand the domestic industrial and commercial energy usages from various conditions, the users are according to the classifications of non-manufacturing major buildings about their energy usage consumption, as shown in Table 1, in which the large energy user from the 247 schools is about 15.7% (Taiwan Green Productivity

Foundation 2012 Annual Report) At this survey, the 141 of 530 hospitals from whole national hospitals in Taiwan is about 26.6%.

About the comparison of individual average energy usage between hospitals and schools, the average amount of each school energy usage from the whole national energy consumption is about 0.077 percent. However, the average amount of each hospital energy usage from the whole national energy consumption is about 0.112%. That means hospital is the largest energy usage category of non-manufacturing buildings.

3. THE RESEARCH METHODOLOGY

According to the investigation from Taiwan Green Productivity Foundation, Ministry of Economic Affairs, Bureau of Energy, the data of energy consumption from 141 medium and large hospitals in Taiwan is collected and analyzed from the energy usage and using situation in 2012: air conditioning, electrical, lighting, gas the statistical analysis of the load and energy consumption of fuel, etc., type, efficiency, savings, density, etc. (Taiwan Green Productivity Foundation 2012 annual report of the non-manufacturing energy audit), From the results of investigation, it showed that hospitals are the second-largest energy user in overall non-manufacturing industries. This information could provide as the design reference for the electricity planning of hospital

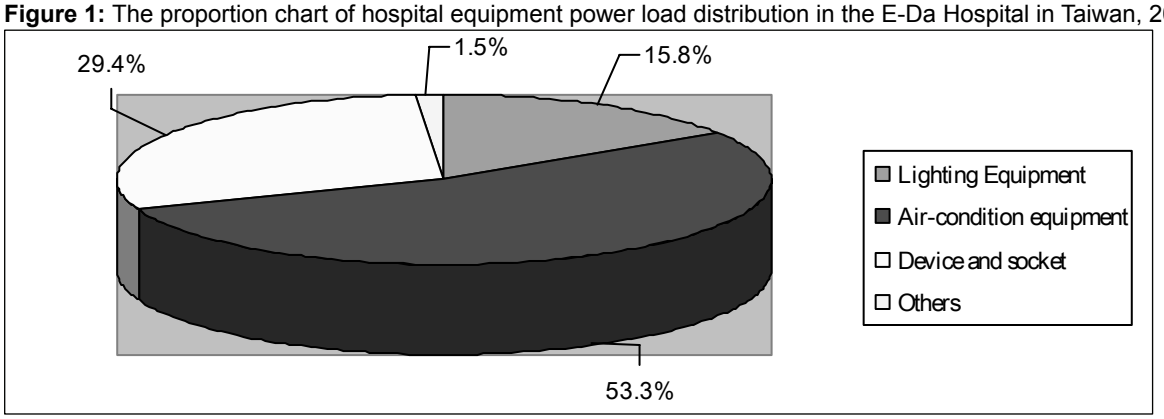
The energy use in hospital building is the most complex classifications, large amounts of energy use, and highest requirements of security. Because the growth of domestic economic development and the improvement of life quality are getting better and better, people will be concerning more and more about life environment quality of health care.

In order to provide a more secure, healthy, and comfortable environment, health caring institutes supply 24-hour-continuous use without any interruption, such as air conditioning, lighting, boilers, medical gas, and other energy-intensive medical equipment.

Under the framework of energy use, the hospital institutions should have appropriate energy conservation experience and technology for equipment electricity, air conditioning, lighting, boilers, etc. Generally, hospital institution would use the high-efficiency equipment and systems through regularize maintenance and appropriate equipment operation in order to enhance efficiency and management.

In this study, a regional teaching hospital, E-Da Hospital, in southern Taiwan, total number of beds to 930, for example, allocation of 2012 construction equipment power load scale. Electricity use by its distribution, the energy consumption from air-conditioning equipments of total power consumption is about 53.3%, the energy consumption from lighting equipment of the total electricity consumption is about 15.8%, the energy consumption from device and socket of total power consumption is about 29.4%, and Other devices is about 1.5%. In addition, it is really important issue for us that is how to consume a greater proportion of energy equipment and enhance the efficiency of power management, such as air conditioning, lighting, etc. This study compiled the domestic use for us that is how to consume a greater proportion of energy equipment and enhance the efficiency of power management, such as air conditioning, lighting, etc.

Figure 1: The proportion chart of hospital equipment power load distribution in the E-Da Hospital in Taiwan, 2012



This study compiled the domestic hospitals common energy conservation management practices and improve application methods in electricity, air conditioning, lighting, provide each hospital as energy saving improvement reference, in which the "Energy Load Management" to improve device applications in the most effective, followed by "choice high-efficiency equipment "," maintenance "and" replacement of old. ".

Hospital management major energy conservation projects as follows:
1) The power-saving energy management system
2) The air-conditioning system to save energy management
3) Energy saving lighting systems management

3.1. Power system saves energy management

According to the survey the main hospital expenditure items were fixed energy costs for electricity, fuel, water, gas, electricity expenses which the proportion of total energy expenditure costs up more than 70%, showing that electricity costs, the importance of the hospital's total energy expenditures accounted for, Gu Yu save energy expenses should be to effectively manage electrical equipment led to the project, its methods to strengthen the equipment load management, increase energy efficiency, improve power system.

The following is a common method of saving energy management of electric power:
1) Adjust Taiwan power electricity demand, contract capacity rationalization.
2) Choose a reasonable time price.
3) Improve power factor.
4) Set the ice-storage host.
5) Use of off-peak electricity
6) Dispenser installation of timers

3.2. Air-conditioning systems to save energy management

The main function of the air conditioning system is the indoor air temperature, humidity, pressure, flow, cleanliness controlled within a proper range, to provide a comfortable, healthy environment for space and domestic hospitals to a central system air-conditioning system is mainly based, and hospital improve the quality of medical services, to create a comfortable, healthy environment for treatment, but because of the comfort of air-conditioned environment and have to improve disease prevention and treatment, so any energy-saving measures are environment should not be at the expense of the quality of hospital care.

Hospital air conditioning and opening hours, depending on the different services have different regional operating time, but most of the service area is 365 days a year, 24 hours of continuous operation, it is necessary to provide a stable environment without affecting the quality of medical conditions, comfort healthy therapeutic environment, hospital cost control while also expect to maintain a high quality of medical standards, while reducing resource waste air conditioning, energy saving effect can be achieved.

In the whole area of space in hospitals, because the air conditioning system wide range of service areas, and for the continuity of the maximum load energy consumption, and because the district hospital staff work schedules are not the same, in fact, during the air-conditioning on energy management is not easy, air-conditioning system power consumption accounts for about 50% of the total electricity the whole hospital building energy consumption, the overall demand for electricity caused a great burden, how can maintain good comfortable air-conditioned environment, avoid unnecessary air conditioning waste of resources, you can maintain proper operating methods set by the air conditioning system and air-conditioning systems management methods to ensure that the device can operate at high efficiency conditions and effective air-conditioning energy management, to avoid errors due to the personnel to operate and manage the behaviour of negligence resulting in energy invisible The waste.

General air conditioning systems for the major energy-consuming equipment: ice compression hosts, ice water circulating pump, regional recycled water pumps, cooling water pumps, cooling tower fan pump, air-conditioning area boxes, blowers and other equipment.

The following is an energy-saving air-conditioning system common management methods:

1) A central monitoring adjustment cold room temperature.
2) Chiller reasonable load operation.
3) Downgraded chiller water temperature.
4) The establishment and maintenance benchmarks, implementation and maintenance operations.
5) Ice water pump, air-conditioning cooling tower fan boxes and inverter control.
6) Cooling tower cooling water control.
7) Air-conditioned open time control.
8) Exhaust fan opening reasonable period of time.
9) Additional electric air curtain.

3.3. Energy-saving lighting systems management

Complete with advances in technology, enhance national life, improve the people's quality of life requirements, creating a bright and comfortable medical environment is indispensable, and good lighting system design and planning, in addition to creating a comfortable and bright indoor lighting environment, the integration of space harmony of nature and characteristics, still need attention to the rational use of high-efficiency and energy-saving lighting equipment functional products.

React to the general hospital lighting electricity consumption accounts for the whole hospital building about 20% of the total energy consumption of electricity, while the lighting is the most used fluorescent light bulbs, energy saving bulbs; due to the use of a large quantity, so lighting equipment should be used and managed.

The main hospital lighting area can be divided into: the emergency area, outpatient areas, operating rooms, intensive care area, inspection area, ward areas, administrative offices, restaurants, shopping malls, warehouses, corridors, rooms and parking lot lighting and other areas, most of the region is 24 hours remain open.

When discussing the general energy-saving lighting systems, lighting system energy savings should be divided into "high efficiency lighting fixtures" in both directions and "lighting device management."

With the rapid development of technology, the rapid development of the current lighting, small size, high efficiency, high life expectancy of the green light, such as electronic ballast, power saving bulbs, T8 three-wavelength fluorescent lamps, T5 fluorescent lamps ultrafine diameter, LED lights, motion has been widely used in the market, less common for all aspects of energy saving lighting management methods:

1) Using high-efficiency lighting equipment
1.1) Electronic ballast fluorescent lamps.
1.2) Using energy saving light bulbs.
1.3) Using T5 high efficiency lamps.1.4 Mining LED high efficiency lighting.
2) The lighting device management
2.1) Points off the automatic installation of outdoor lighting control.
2.2) Public indoor walkway lighting the window retrofitting Auto Lighter.
2.3) With illumination adjus the number of lamps.
2.4) Interior architectural design pattern using daylight

4. THE RESULTS AND EFFECTS

From the cost control of hospital, the issue of power consumption is one of important indictors because it belongs to variable cost. We would say “To save more power expenditure, to reduce more cost of energy. ” Through the management methods, hospital can set power capacity, educate employees and people, increase energy effectiveness, and maintain the energy equipment and devices regularly. After those methods were used, the results of E-Da hospital show the energy usage intensity (EUI) and EUI rate are lower than the average Taiwan regional hospitals, as table 2 and table

3. In addition, we also can use the project of energy conservation to increase saving cost and reduce Qi CO2 (tonnes) suppression, as table 4 – results of energy conservation projec in the E-Da Hosptial.

Table 2: The Energy Usage Intensity (EUI) comparsion of a regional teaching hospital in southern Taiwan by annual report

	2008	2009	2010	2011	2012
Area	169,813.53	169,813.53	169,813.53	169,813.53	169,813.53
Power Consumption	26,953,200	27,461,000	28,082,916	29,050,200	28,545,600
EUI Unit	158.7	161.7	165.4	171.1	168.1

Sources: from the investigation of Taiwan Green Productivity Foundation.

Table 3: The EUI rate between Average Taiwan Regional Hosptial and E-Da Hospital

	2008	2009	2010	2011	2012
Average Taiwan Regional Hosptial	263.3	247.2	241.8	235	211.8
E-Da Hopsital (regional teaching hospital)	158.7	161.7	165.4	171.1	168.1

Sources from the investigation of Taiwan Green Productivity Foundation.

Table 4: The results of saving cost (NTD) and Qi CO2 (tonnes) suppression by energy conservation projects

	Saving cost (NTD)	Qi CO2
Hydraulic	1,442,000	24.43
Lighting	3,419,000	1,128.00
Gas	4,000,000	364.15
Diese	9,129,000	932.90
Air conditioning	11,443,000	3,903.87
Total	29,433,000	6,353.35

Sources from the investigation of Taiwan Green Productivity Foundation.

5. CONCLUSIONS

Taiwan is already one of the developed countries, so the main concerning of people is to improve the quality of the living environment. However, rapid deterioration of the urban landscape and seriously pollution of natural environment causes the inappropriate energy and resource consumption and territory lost. In recent years, Taiwan experienced 921 earthquakes, storms, and floods after several natural disasters, so many more people recognize that the Earth's resources due to excessive human consumption and environmental damage. Through the analysis of this study: the great energy conservation is not seen without the use of energy, but through effective management model with a specific behaviour or action in order to ensure that the limited energy utilization and cost control, such as lifting equipment work efficiency, the use of high-efficiency energy-saving products, and reasonable use of energy, energy-saving effectiveness.

This study analyzed the electricity planning for hospital equipment: If the contract capacity at the most appropriate time and price options, as well as energy saving methods in all aspects of electrical, lighting, air conditioning and other analysis and planning. Otherwise, the usual good equipment maintenance is to establish the correct and efficient operation and scientific management mode.

Can the energy conservation policy be implemented successfully? The main key is each colleague in the hospital because we should save energy well, be support by managers and colleagues, share the same goals and philosophy, and have the nice management of equipment use. Therefore, we will try to do the further research to focus on equipment work efficiency and employee education. Then, we could find out how other management method could do well or not. In fact, we should work together to implement energy conservation and do it right now. in order to provide future generations to have better global environment.

REFERENCE LIST

1. Arkar, C., Vidrih, B, and Medved S. (2007). Efficiency of free cooling using latent heat storage integrate into the ventilation system of a low energy building. Refrigeration 30:134-143.
2. Beedle L.S. (1988). Second Century of Skyscraper. Van Nostrand Reinhold Company.
3. Strakosch G.R.(1983). Vertical Transportation: Elevators and Escalators. John Wiley and Sons.
4. IESNA (2000) Lighting Control Strategies, The IESNA Lighring Handbook, Ninth Edition, The Illuminating Engineering Society of North America , New York.
5. Jakob M. (2006). Marginal costs, cost dynamics and co-benefits of energy efficiency investments in the residential buildings sector. *Energy Policy*, 34(2), 172-187.
6. Rongxin Yin., Peng Xu.,Mary Ann Piette., and Sila Kiliccote. (2010). Study on auto-DR and pre-cooling of commercial buildings with thermal mass in Cailfornia, *Energy and Buildings*, 42:967-975.
7. Zundel, S and Stieb, I.(2011). Beyond Profitability of Energy-Saving Measures-Attitudes towards Energy Saving, *Journal of Consumer Policy*, 34:91-105.
8. Chiu, Mei-Shiu. (2013). Tensions in Implementing the 'Energy-conservation/Carbon-reduction' Policy in Taiwanese Culture, *Energy Policy*, 55:415–425.
9. Ren, Jingbo, Du, Jun. (2012). 'Evolution of Energy Conservation Policies and Tools:The Case of Japan, *Energy Procedia,* 17:171 – 177.
10. Teng, Chih-Ching, Horng, Jeou-Shyan, Hu,Meng-Lei(Monica), Chien, Liang-Han, Shen, Ying-Chun, (2012). Developing energy conservation and carbon reduction indicators for the hotel industry in Taiwan, *International Journal of Hospitality Management*, 31:199–208.
11. Hsu, Chiung-Wen, Chang, Pao-Long, Hsiung, Chih-Min. (2012). Construction and Application of a Performance Assessment Model for Energy Conservation and Carbon .Reductionindustries, *International Journal of Hydrogen Energy*, 36:14093–14102.
12. Taiwan Green Productivity Foundation, (2012). Annual Report of Energy Consumption for Non-manufacturing Industries in 2012, Retrieved from http://www.ecct.org.tw/print/index.htm.