Energy-Saving Actions in a NMB-Minebea Thai Factory

Mr. Manoch Wongthanakunchorn
Taikisha (Thailand) Co., Ltd.

Abstract

A new plant in Bang Pa-in has been recently built with the prospect of decreasing energy use and carbon dioxide emissions. This would also achieve cost savings and contribute to an increased understanding of the energy consumption for the different types of utility equipment and machine. The report represents only energy-saving actions in the new factory, but does not reveal the details of engineering design, the investment that went into the new factory and cost-benefit analysis.

1. Introduction

As energy costs have soared in the past few years, there has been increasing and will be continuing a great amount of attention and concern focused on energy-savings. Up to date, companies have taken comprehensive approach to environmental protection since the Kyoto Protocol was adopted in 1997. In general, the purpose of a corporate policy is to share responsibility for preserving the environment and to be in compliance with environmental regulations. Today, a sense of environmental protection becomes committed to a corporate culture.

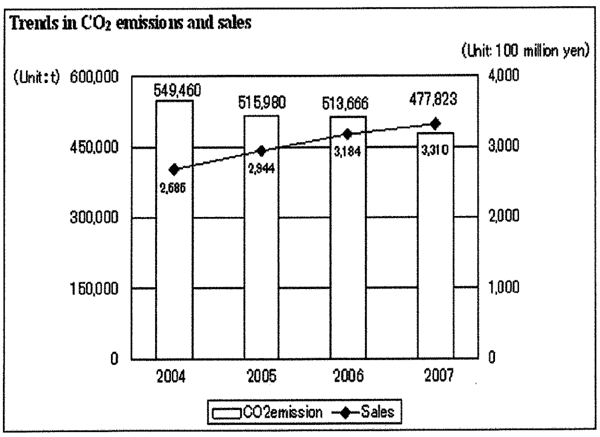

Figure 1: *In Japan, Minebea could reduce carbon dioxide emissions by 15% from 2004 to 2007*

Environmental philosophy plays a vital role in raising energy awareness and in bringing down energy consumption. For example, in Japan, a company has achieved solid increase in sales since 2004. At the same time, they made a lot of progress towards minimizing and mitigating carbon dioxide emissions through saving energy by adopting energy-efficient air conditioning system and manufacturing equipment (See figure 1).

In Thailand, we should promote the environmental philosophy that encourages companies to be more active and be aware of environmental concern in their activities.

In Ayuttaya, a new factory was recently built by examination from the stage of design to construct from the viewpoint of energy savings.

The following is an outline of energy-savings in the selection of utility machine and equipment to be used at the new factory. This report describes the difference between the conventional and the new specification. It also summarizes the energy-saving actions achieved and the opportunities that exist for selection of machine and equipment towards energy-savings.

2. Energy-saving actions approach

2.1 Overview of energy-saving actions

The starting point of the approach was to design to examine the opportunity for energy saving in factory and its facility systems. With extensive design, the potential energy savings can be implemented by the selection and installation of very efficient equipment, machine and modern building materials. In addition, the potential design would be achieved according to the requirements and in accordance with the investment plan.

2.2 Selection of energy-efficient equipment, machine and materials

In order to take account of energy conservation and carbon dioxide reduction, the possible efficient equipment and materials to be used in the new factory are presented in Table-1.

(1) Roofing & ceiling and external wall

Conventional roofing uses only metal sheet insulated by a thermal reflective component, such as glass wool. More heat and thermal reflective materials applied to a roof, ceiling, and external wall have energy-saving benefits, thus lowering inside temperature. Example of the heat and thermal reflective materials includes ceramic coatings

(2) Fluorescent lamp ballast

Unlike magnetic ballasts using coiled wire and creating magnetic fields, electronic ballasts use solid state components to transform voltage; as a result, the electronic can function more efficiently and cooler than magnetic.

(3) Outdoor lighting

LEDs use less energy, last longer and emit less CO_2 than HIDs. In addition, unlike HIDs, LEDs contain more environmentally friendly substances. However, LEDs are more expensive than HIDs.

(4) Downlight

Unlike incandescent bulbs, LEDs are focused lights. Compared to 20 w/h for incandescent bulbs, LEDs produce 7 w/h. This results in low heat build-up. Nowadays, although the cost keeps reducing, LEDs are still expensive.

(5) Transformer

In general, compared to 83.8 kW for conventional (or standard) transformer, low-loss distribution transformer uses 67.3 kW. Although investing in transformers with low losses is more expensive, payback for the utility during

Equipment	No.	Economical equipment/ machine/ materials	Comparison in specifications used by NMB – Minebea Thai	
			Conventional specification	**New specification**
Building work	1	Roofing & Ceiling	Heat transmission coefficient, k = 0.608	Heat transmission coefficient, k = 0.560
			Heat transmission load = 26.16 W / h	Heat transmission load = 8.49 W / h
			Material: Metal sheet with glass wool (d = 24 kg / m^3, t = 50 mm)	Material: Metal sheet with glass wool (d = 24 kg / m^3, t = 50 mm) and gypsum board and thermal reflective coated ceramic
		External wall	Heat transmission coefficient, k = 2.491	Heat transmission coefficient, k = 2.491
			Heat transmission load = 43.49 W / h	Heat transmission load = 26.05 W / h
			Material: Concrete block walls (t = 90 mm) with plaster mortar	Material: Concrete block walls (t = 90 mm) with plaster mortar and thermal reflective coated ceramic
Electrical works	2	Fluorescent lamp ballast	Magnetic (or coil) ballast Watts = 46	Electronic ballast Watts = 36
	3	Outdoor lighting	HID light bulb Watts = 400	LED light bulb Watts = 90
	4	Downlight	Incandescent bulb Watts = 20	LED light bulb Watts = 7
	5	Transformer	Conventional (or standard) Watts = 83.8 k	Low-loss distribution Watts = 67.3 k
Mechanical Works	6	Chiller	Air-cooled screw COP = 2.8 Refrigerant: R-407C	Water-cooled centrifugal COP = 6.0 Refrigerant: HCFC 123
	7	Temperature difference in chilled water	Supply temperature = 7.0 °C	Supply temperature = 7.0 °C
			Return temperature = 12.0 °C	Return temperature = 15.0 °C
			Annual power consumption for pumps = 1,254 MW	Annual power consumption for pumps = 946 MW
	8	Fan	Type: Sirocco fan Fan efficiency: 0.5 – 0.6 Motor efficiency: 0.8	Type: Plug fan Fan efficiency: 0.7 Motor efficiency: 0.9
	9	OAHU	Only AHU No OAHU	AHU and OAHU
	10	Exhausted air recycling system & CO_2 sensor	Non-recycling	Recycling by 73.3% (Using oil mist collectors or carbon filters)

Table 1: Comparison in specifications of equipment, machine and materials used by NMB – Minebea Thai

the lifetime of the energy-efficient transformer would be more saver than conventional.

(6) Chiller

Centrifugal chillers have a high quality and reliability. Referring to the threshold value for heating - COP, water-cooled centrifugal chiller can offer better performance when compared to air-cooled screw chiller. Compared to R-407C, HCFC-123 refrigerant is more environmentally safe and offers the lowest global warming potential[1].

(7) Temp difference in chilled water

We designed a new chilled water system that allows use of the chilled water supply at 7°C and the chilled water return at 15°C. Operating with this temperature range usually results in a greater △T but the system could require less water flow rate of cooling, resulting in potential savings in power required for pumping.

(8) Fan

Typically, plug fans with the use of direct driven system are designed to provide more efficient and reliable than sirocco fans with belt driven system. The plug fans reduce the energy demand to a large extent to which sirocco fans require.

(9) OAHU

The new design has beneficially integrated OAHU into HVAC system. The OAHU potentially minimizes heat of the outside air intake, resulting in reducing energy consumption and improving performance of HVAC system.

(10) Exhausted air recycling system

The exhausted air recycling system improves energy efficiency by re-circulating exhausted air back into energy and a cooling system. To improve air quality, oil mist collector and CO_2 sensor used for the filtration of air contaminants and oil mist and smoke are also added to HVAC system.

3. Evaluation of energy-saving actions

In order to estimate electricity savings and carbon emissions reduction, we find the difference between electricity inputs and carbon emitted as compared between the conventional and the new specification in terms of design and actual result.

Table 2 shows summary of estimated performance data for the equipment, the machine, and the materials. The savings potential per design is 40.4%, and the actual result is 44.8%*. This means that the more energy saves, the lower operating cost is.

In the table-3, we compare energy consumptions among the equipment, the machines, and the materials obtained from conventional and the new specification per design. We also compare them with the actual results calculated are the hourly values for the 12 months of the normal operations. Our study shows that in general, energy consumptions derived from the new specification (both per design and per actual) are less than those from the conventional. This implies that the new specification is more efficient than the conventional. It has the potential to achieve energy savings.

Indicators	Estimated performance figures as compared to the conventional specification	
	New specification (per design)	Actual result*
Electricity savings potential (kWh)	567.2	629.8
CO_2 emissions reduction potential ($kg\text{-}CO_2$) (@ 0.386 $kg\text{-}CO_2$ / kWh)	218.9	243.1

Table 2: Results of electricity savings and CO_2 emission reduction potential

* The figures are estimated on the basis of the performance of equipment, machine and materials as compared to the conventional specification. These estimators are subject to change as annual performance figures are received.

Equipment	No.	Economical equipment/ machine/ materials	Parameter(s)	Comparison of energy consumptions				Remark(s)
				Thailand's Standard	Conventional Specification	New Specification (Per design)	New Specification (Per Actual)*	
Building work	1	Roofing	Transmission of heat from roof (W / m^2)	15.0 W / m^2 (RTTV)	26.16 W / m^2	8.49 W / m^2	12.14 W / m^2	(1) Outdoor temp (per design) = 35 °C (2) Outdoor temp (per actual) = 35 °C
		External wall	Transmission of heat from external wall (W / m^2)	50.0 W / m^2 (OTTV)	43.49 W / m^2	26.05 W / m^2	29.63 W / m^2	
Electrical works	2	Fluorescent lamp ballast	Input power per unit (Wh / unit)	18.0 W / m^2 (OTTV)	46.0 Wh	36.0 Wh	33.3 Wh	(1) OTTV (per conventional) = 17.58 W / m^2 (2) OTTV (per design) = 12.79 W/m^2 (3) OTTV (per actual) = 13.98 W/m^2
	3	Outdoor lighting	Input power per unit (Wh / unit)	18.0 W / m^2 (OTTV)	400.0 Wh	90.0 Wh	110.9 Wh	
	4	Downlight	Input power per unit (Wh / unit)	18.0 W / m^2 (OTTV)	20.0 Wh	7.0 Wh	7.9 Wh	
	5	Transformer	Loss of transformer (kWh)	n/a	83.82 kWh	67.28 kWh	8.06 kWh	(1) Design load: 100% (2) Actual load: 12% of the capacity of transformer
Mechanical Works	6	Chiller	COP (kW / kWh)	n/a	2.80	6.06	5.58	(1) Design capacity: 530.0 USRT (2) Actual capacity: 242.5 USRT
	7	Temperature difference in chilled water	Total input power of chilled water pump (kWh)	n/a	112.0 kWh	74.0 kWh	74.0 kWh	*Efficiency of pump* (1) Per conventional: 59.5% (2) Per new design: 63.0% (3) Per actual: 64.0%
	8	Fan	Total input power of fan (kWh)	n/a	271.8 kWh	220.1 kWh	217.0 kWh	*Efficiency of fan* (1) Per conventional: 51.0% (2) Per new design: 63.0% (3) Per actual: 66.0%
	9	OAHU	Total cooling load (kW)	n/a	1,992.0 kW	1,863.0 kW	870.0 kW	Actual operating production machine: 70% (another 30% is to be operated in future)
	10	Exhausted air recycling system & CO_2 sensor	Outdoor air volume (m^3/h)	n/a	30,000.0 m^3/h	8,000.0 m^3/h	8,000.0 m^3/h	

* These estimators are subject to change as annual performance figures are received.

Table 3: Comparison of energy consumptions among conventional, new (per design), and new (per actual) specifications

4. Summary

This report presents an opportunity for improving energy efficiency and reducing carbon dioxide emissions in NMB-Minebea Thai. One of the most interesting actions is the selection of high-efficient equipment and machine and use of modern materials in the design process to end up with better results over the life-time of a factory. In theory, overall, the electricity savings potential is 4,968,672 kWh/year, and the carbon dioxide reduction is 1,757,130 kg-CO_2/year. In practice, depending on the operation, this savings potential can be achieved more than expected. Energy savings actions must be further achieved and could be implemented by studying actual performance of the system and analyzing records.

REFERENCES

1. Bivens, D. B, 1996. "Alternative Refrigerants for Building Air Conditioning". Energy Systems Laboratory, p 289.

Acronyms

d	Density	**°C**	Degrees Celsius
t	Thickness	**mm**	Millimeters
COP	Coefficient of performance	**m^2**	Square meters
$\triangle$T	Delta-T	**m^3**	Cubic meters
CO_2	Carbon dioxide	**h**	Hour
HCFC	Hydro-chlorofluorocarbon	**W**	Watts
HID	High intensity discharge	**kW**	Kilowatts
LED	Light-emitting diode	**MW**	Megawatt
HVAC	Heating, ventilation, and air conditioning	**n/a**	Not available
AHU	Air handling unit		
OAHU	Outdoor air handling unit		
OTTV	Overall thermal transfer value		
RTTV	Roof thermal transfer value		