Energy Saving Potential in a Fresh Market in Nakhon Sawan Province, Thailand

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Abstract

This research aims at studying the feasibility of starting an energy saving program at a fresh market in Nakorn Sawan province. The researcher investigated and collected data from fresh markets and identified the basic level of feasibility to make improvements at a targeted fresh market and then established a pilot program at the fresh market. From the research findings, six main energy saving measures, which can be divided into five electricity saving measures, and heat energy saving measures were found. All measures can result in saving up to 34.05%. As a result, it can be concluded that all proposed measures can be used as guidelines for saving energy in other fresh markets.

Keywords: energy saving, fresh market, energy consumption

Introduction

Nowadays, energy is essential for human beings as it is embedded in all sectors including housing, business, and manufacturing. As a result, energy is a really significant factor for the manufacturing industry. especially, due to rapidly growing industry and technology towards a global economy. This accelerates the demand for energy in order to uphold national development. Recent data indicates that Thailand has a steadily rising GDP which has risen annually at the average of 4% while the annual rate of electricity energy consumption has gradually increased at 4.2 %, which costs many billion baht[1].

Over the next 20 years, if either the energy saving measures or efficient energy increasing measures are not fully implemented, the demand for energy at BAU (Business-as usual) will actually increase from 71,000 ktoe/year (kilotonne of oil equivalent, as of 2010) to 151,000 ktoe (i.e. 2.1times or equivalent to 3.9% annual increasing rate), assuming that GDP increases at 4.2 % annually and the demand for energy in both industries and commercial buildings are higher than that in other sectors. Yunfeng[2] studied how to save energy in buildings in China by investigating the energy consumption condition and efficient consumption. The research findings indicated that the standard of living has been improved and building awareness towards the energy saving is the most successful factors for energy saving in China. Hyeonjeong[3] investigated the decision making and scheduling for electricity in the house model designed for energy saving purpose. The “data record for daily activities” were done for making decision in using energy. The data were collected and analyzed to the development indicators. The result showed that the volume of electricity consumption was significantly decreased by the setting switching on-and-off to home appliance. Ruzena[4] proposed the energy saving initiatives by setting new lighting system which focuses on the efficient lighting and expense. When the new energy saving strategies were used, it was seen that the full participation from employees in the sampled firms could help boost efficient energy savings. Rajesh[5] examined the assessment for feasibility for energy saving in hotels in Chaipura, India. According to research findings, applying the energy saving measures led to highly feasible energy saving. These measures can also be applied to analyze the energy saving feasibility in other sectors e.g. hospitals, office buildings, department

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stores, etc.

One of the important business sectors definitely relating to daily life in Thailand is the fresh market which uses many systems: lighting system, cooling system, electric motor system, and heating system from LPG and charcoal. Since this has resulted in the high energy consumption, the researcher co-ordinates with the Energy Office in Nakhon Sawan province for the efficient energy saving which includes energy consumption and energy cost reduction. In addition, the research can also be applied to other fresh markets in Thailand.

Materials and Methods

As illustrated in (Figure 1) this research was conducted by following six main steps for three sample groups – researcher group, vendors in fresh market, and governmental offices. Some steps were taken by more than one researcher. Furthermore, in step 4, preparing the pre-feasibility for improving the energy consumption in fresh market. was divided into 8 minor steps. All steps are as follows:

I. Identify research objectives – the researcher identified research objectives to prepare feasibility study for energy saving for both electricity and heat power in the pilot fresh markets

II. Review literature and previously related research – this is to understand the insight from the related studies

III. Collect data – the researcher collected data from fresh markets in Nakhon Sawan province to select the pilot fresh markets

IV. Prepare pre-feasibility study for improving the energy saving in fresh markets – this is to identify energy saving measures in order to apply to the others and can be divided into minor steps as follows (please see Research Findings for details):

a. Select fresh markets for preparing pre-feasibility study
b. Identify data which was focusing on the study
c. Design survey form
d. Contact fresh market managers/ owners
e. Collect data at fresh markets
f. Prepare pre-feasibility study for improving the energy saving
g. Select the “pilot fresh market”
h. Collect and analyze data and feasibility for improving the energy saving

V. Analyze the energy consumption of the pilot fresh markets – it is to calculate the saving rate from the energy saving measures by statistical techniques.

Summarize the feasibility of improving energy consumption in pilot fresh markets – this is to demonstrate the result of energy saving, reducing expenses, cost, and payback period of each energy saving measure.

Results

The research findings are as follows:

a. Select fresh markets for preparing pre-feasibility study

1) To identify the targeted four fresh markets for preparing pre-feasibility for improving energy saving, the researcher set up two main criteria as follows: The fresh market are owned by government offices

2) The fresh market is certified as a good and Thai healthy market at the excellent level (by Nakhon Sawan health station No. 8, Department of Health, Ministry of Public Health)

The fresh markets which meets requirements above are as follows (as expressed in Table 1):

b. Identify data which was focused to study as follows:

1) Primary data: location, name of fresh market, managers/ owners, map, layout (booth)

2) Energy consumption data: electricity usage rate, number and size of transformer, energy consumption data, number of electrical appliance, using method, and electrical power expense

c. Design survey form

The researcher team divided survey form into two types—Form 1 which focused on the co-operation and attitude of fresh market managers/owners and Form 2 which focused on other aspects to be used for pre-feasibility for improving energy saving in fresh markets.

d. Contact fresh market managers/ owners

The researcher contacted the four fresh market managers and owners – Nakhon Sawan Municipality, Banphotphisai Sub district Municipality, Thatako Sub district Municipality, and Phayuhakhiri Sub district Municipality.

e. Collect data at fresh markets

The researcher collected primary data, electricity and heat power usage data, and equipment using electricity and/ or heating power at all booths in four targeted fresh markets.

f. Prepare pre-feasibility study for improving the energy saving

Referring to two types of collected data (Table 2 and 3), the findings was shown as follows:

g. Select the "pilot fresh market"

The researcher verified the completeness of data for assessing the pre-feasibility of improving energy saving in fresh markets as expressed in (Table 4 and 5).

h. Collect and analyze data and feasibility for improving the energy saving

After selecting the fresh market at Nakhon Sawan Municipality as "pilot fresh markets", the researcher estimated and analyzed the initiatives to improve the energy saving, validated measures to adjust equipment (Table 6), and designed the set up the equipment to save energy.

Conclusions

1. Energy consumption analysis

With the total area of 1,970 m^2, the fresh market at Nakhon Sawan Municipality, ranked as good level, can be divided into two main areas – the front area which covers 1,250 m^2 and the back area which covers 720 m^2. There are 178 booth which operate approximately 18-20 hours/ day, at 11:00 PM – 7:00 PM.

As for the energy consumption, it was found that the highest energy consumption was in electricity power which totally requires 140,981.60 kWh/yearor, equivalent to 621,515.60THB/ year, and can be classified into two main purposes. The first one is the power used in the main area i.e. lighting systems within fresh market, side area, footpath and street, and toilets which operate at 5:00 PM – 8:00 AM. The usage in these areas is 61,947.97 kWh/year or equivalent to 272,582.12 THB/ year. The main purpose is lighting system (85 %). Another purpose is for booth in fresh market i.e. light bulb, cooler, grinder, coconut extracting machine, etc. which operates at 2:00 AM – 8:30 AM. The usage in these areas is totally 79,033.63kWh/year or equivalent to 348,933.48 THB/ year. The main purpose is lighting systems (51%) and electric motors used in grinder and coconut extracting machine (35%).

2. Result of energy consumption analysis

Measurement to energy consumption in fresh market :

As for the energy consumption at fresh market in Nakhon Sawan Municipality, it was found that the lighting system at the main area starts at 5:00 PM and fully operates at 6:00 PM until 8:00 AM of the following day. There is no energy consumption at the main area at 8:00 AM – 5:00 PM. For the electricity power used at booth (red line), it was operated at high level at 2:00 AM – 8:30 AM when the market vendors use chiefly for lighting in their booth (e.g. lighting, cooler, and grinder). From the summary of energy conservation measures, the total implemented measures saving for the market is around 140,981.60 Baht/year (48,010.92 kWh/year) in which all saving cost come from the electrical energy saving measures. All measures can result in saving energy up to 34.05%

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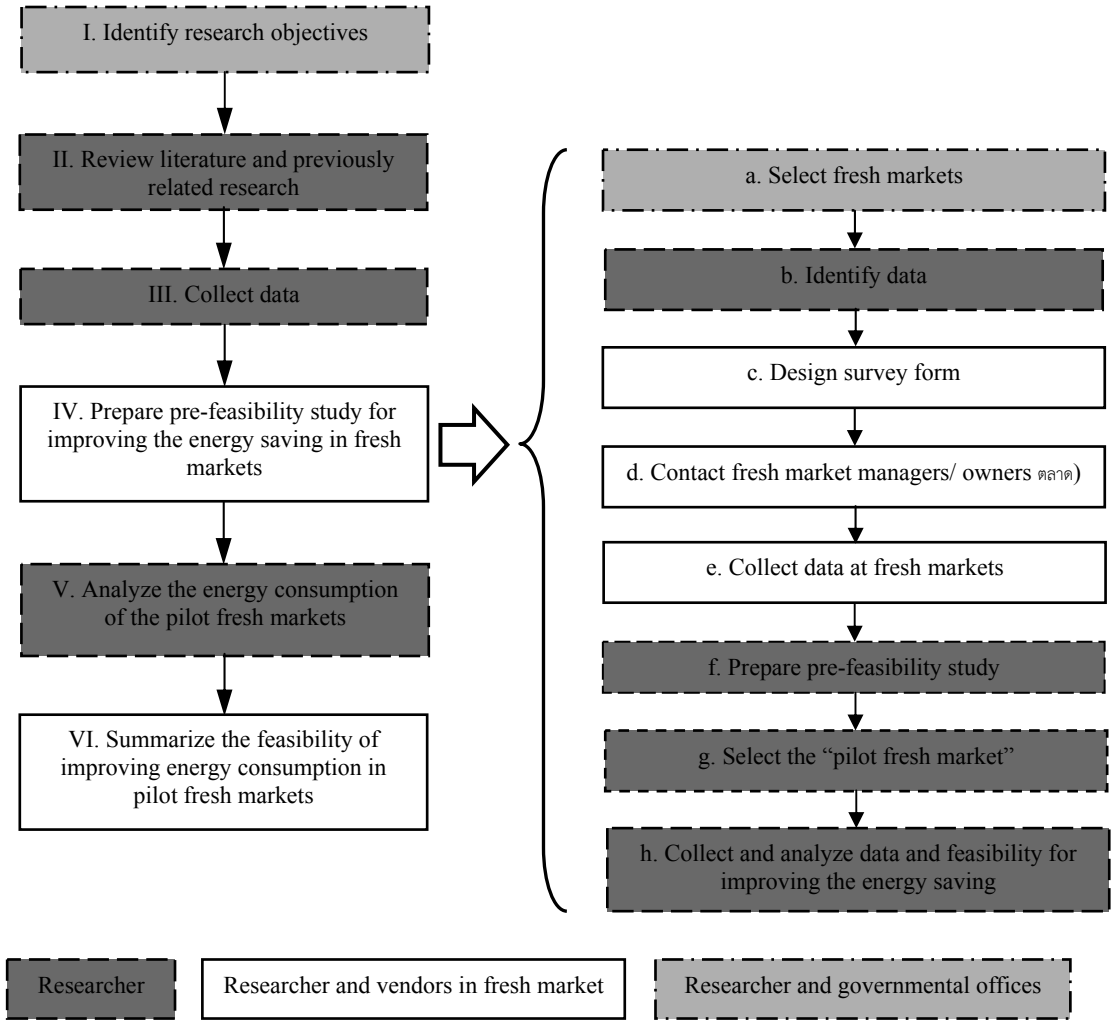

Figure 1 Research methodology

Table 1 The fresh markets that can be acceptable two main criteria

No.	Name of fresh market	Location				Fresh market managers/ owners	Remark
		House No.	Village No.	Sub-district	District		
1	Nakhon Sawan Municipality market	-	-	Paknampo	Meuang Nakhon Sawan	Nakhon Sawan Town Municipality	Thai healthy market good level
2	Thatako Subdistrict Municipality market	-	1	Thatako	Thatako	Thatako Subdistrict Municipality	Thai healthy market good level
3	Banphotphisai Subdistrict Municipality market	-	2	Thangio	Banphotphisai	Banphotphisai Subdistrict Municipality	Thai healthy market excellent level
4	Phayuhakhiri Subdistrict Municipality market	-	4	Phayuhakhiri	Phayuhakhiri	Phayuhakhiri Subdistrict Municipality	Thai healthy market good level

Table 2 Co-operation and attitude of fresh market managers/ owners

Detail	Municipality fresh market			
1. Municipality	**Nakhon Sawan**	**Thatako**	**Banphotphisai**	**Phayuhakhiri**
2. Co-operation and attitude of fresh market managers/ owners				
2.1 Activity for energy saving that Municipality has ever conducted	Yes	No	No	No
2.2 Activity for energy saving that the fresh market has ever conducted	Yes	No	Yes	No
2.3 Knowledge of energy saving	Yes (Medium)	Yes (Few)	Yes (Few)	Yes (High)
2.4 Interest in implementing energy saving activities	Yes	Yes	Yes	Yes
2.5 Attitude towards energy saving	Fully supporting	Not supporting	Supporting but in some extent	Supporting but in some extent
2.6 Energy management policy	Yes	Yes	Yes	Yes
2.7 Organization management	Yes	No	No	No
2.8 Motivation and reinforcement	Yes	No	No	No
2.9 Information system	No	No	No	No
2.10 Public relations	No	No	No	No
2.11 Investment	Yes	No	No	No
3. Assessing the readiness for participating the energy saving improvement				
3.1 Is your fresh market ready to join the energy saving campaign?	Yes	Yes	Yes	Yes
3.2 If your fresh market joins, you are willing to share cost of changing the equipment	Yes	Yes	Yes	Yes

Table 3 Other aspects to be used for pre-feasibility for improving energy saving in fresh markets.

Detail	**Municipality fresh market**			
Municipality	**Nakhon Sawan**	**Thatako**	**Banphotphisai**	**Phayuhakhiri**
1. Data Completeness	High	Medium	Few	Few
2. No. of trade panel	178	121	38	20
3. Energy consumption				
3.1 Electricity consumption (kWh/year)	140,981.60	78,342.26	20,890.15	20,406.42
3.2 Electricity cost (Baht/year)	588,716.64	313,369.04	83,560.60	81,625.68
3.3 Fuel consumption (LPG - kg/year)	5,832.70	1,825.00	5,333.06	-
3.4 Fuel cost (Baht/year)	163,315.61	51,100.00	149,325.68	-
3.5 Net consumption (MJ/year)	800,510.29	373,701.89	343,084.15	73,463.11
Total energy consumption (High-Low)	**1**	**2**	**3**	**4**
4. Energy consumption of market facility				
4.1 Electricity consumption (kWh/year)	61,947.97	21,435.71*	8,674.56*	20,307.87
4.2 Electricity cost (Baht/year)	272,582.12	85,742.84	34,698.24	81,231.4*8
5. Energy consumption of all trade panel				
5.1 Electricity consumption (kWh/year)	79,033.63	56,906.55	12,215.59	98.55
5.2 Electricity cost (Baht/year)	316,134.52*	227,626.20*	48,862.36*	394.20*
5.3 Fuel consumption (LPG - kg/year)	5,832.70	1,825.00	13,296.43	-
6. Maximum energy use by system sector (market facility)				
Lighting system (%)	94.31	58.38*	100.00*	100.00*
7. Maximum energy use by system sector (trade panel)				
Lighting system (%)	36.30	30.46	75.56	-**
8. Electricity saving potential (measure)	5	4	2	2
9. Thermal energy saving potential (measure)	1	1	1	Non
10. Percent of energy reduction of the total energy consumed				
10.1 Electricity saving potential (%)	30.34	13.57	20.05	71.76
10.2 Thermal energy saving potential (%)	23.29	50.00	25.00	0.00
11. Energy Saving				
11.1 Electricity saving potential (kWh/year)	42,772.56	10,629.96	4,189.04	14,644.10
11.2 Thermal energy saving potential (MJ/year)	68,248.00	45,834.88	166,970.05	0.00
Total energy saving potential (MJ/year)	**222,229.22**	**84,102.73**	**182,050.59**	**52,718.76**

Remark * The values are estimated or re-calculated by using energy data, -** very less usage

Table 4 The completeness of data for assessing the pre-feasibility of energy saving potential

Detail		Municipality fresh market			
Municipality		Nakhon Sawan	Thatako	Banphotphisai	Phayuhakhiri
1	Primary data	1	1	0.5	0.5
2	Market layout (position of energy equipment)	1	0.5	0.5	0
3	Energy consumption of market facility	1	0.5	0.5	0
4	Energy consumption of all trade panel	1	0.5	0.5	0
5	Fuel consumption (LPG – trade panel)	0.5	0.5	0.5	0.5
6	Percent of energy reduction of the total energy consumed (market facility)	1	0.5	0	0
7	Percent of energy reduction of the total energy consumed (trade panel)	1	0.5	0	0
8	Energy saving potential	1	0.5	0.5	0.5
Total (Ave.)		0.94	0.56	0.38	0.19
Data Completeness		High	Medium	Few	Few

Remark: 1 – Complete collected data, 0.5 – partially collected data and 0 – non data

Data completeness (Score) : High (0.8-1.0), Medium (0.5-0.8) and Few (less than 0.5)

Table 5 Energy usage data and energy saving potential

Detail		Municipality fresh market			
Municipality		Nakhon Sawan	Thatako	Banphotphisai	Phayuhakhiri
1. Data Completeness		High	Medium	Few	Few
2. No. of trade panel		178	121	38	20
3. Energy consumption					
	3.1 Electricity consumption (kWh/year)	140,981.60	78,342.26	20,890.15	20,406.42
	3.2 Electricity cost (Baht/year)	588,716.64	313,369.04	83,560.60	81,625.68
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	3.4 Fuel cost (Baht/year)	163,315.61	51,100.00	149,325.68	-
	3.5 Net consumption (MJ/year)	800,510.29	373,701.89	343,084.15	73,463.11
	Total energy consumption (High-Low)	**1**	**3**	**2**	**4**
8. Electricity saving potential (measure)		5	4	2	2
9. Thermal energy saving potential (measure)		1	1	1	ไม่มี
11. Energy Saving					
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	11.2 Thermal energy saving potential (MJ/year)	68,248.00	45,834.88	166,970.05	0.00
	Total energy saving potential (MJ/year)	**222,229.22**	**84,102.73**	**182,050.59**	**52,718.76**

Table 6 The energy conservation measure for improving the energy saving

No.	Title of Measure	Potential (per year)				Cost	Investment cost	Payback Period
		Energy source	Quantity	Unit	Energy (MJ)	(Baht)	(Baht)	(Year)
1	Replacing the existing gas stove (LPG) with high efficiency gas stove	LPG	1,358.71	kg	68,248.00	38,043.88	60,000.00	1.58
2	Replacing the existing incandescent light bulb with LED light bulb in trade panel area	Electrical	12,594.12	kWh	45,338.83	55,604.13	36,570.00	0.66
3	Replacing the existing fluorescent light tube (36 Watt) with LED light tube (18 Watt)	Electrical	6,268.06	kWh	22,565.02	27,674.03	49,500.00	1.79
4	Replacing the existing HID lamp (400 Watt) with LED light lamp (200 Watt)	Electrical	3,236.09	kWh	11,649.92	34,105.92	130,600.00	3.83
5	Replacing the existing spotlight (400 Watt) with LED light lamp (200 Watt)	Electrical	4,415.04	kWh	15,894.14	24,160.78	111,760.00	4.63
6	Replacing the existing fluorescent light tube (36 Watt) with LED light tube (18 Watt) in main market area	Electrical	2,842.92	kWh	10,234.51	12,565.71	27,000.00	2.15
7	Using solar power to produce electricity (20 kW)	Electrical	16,060.00	kWh	57,816.00	70,904.90	2,300,000.00	32.44
Total		-	-	-	231,746.43	263,059.35	2,715,430.00	10.32

Grand total electric saving = 140,981.60 kWh/year

Grand total cost saving = 48,010.92 Baht/year

Energy saving = 34.05 %