

Executive Summary

Evaluation and Monitoring of the Project Promotion of Participatory Energy Conservation (SMEs)

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ABSTRACT

The Department of Alternative Energy Development and Efficiency (DEDE) has been assigned the King Mongkut's University of Technology Thonburi (KMUTT) to monitor and evaluate the Promoting Energy Conservation in Small and Medium-Sized Industry and Commercial Building Project. This project has been completed in fiscal year 2007 and 2008. There were a total of 569 factories and buildings participated the project according to the contract number 220/52, September 18, 2009. The aims of this report are to evaluate the satisfaction of project participants, operational results, supportive programmes, and comments in order to develop and improve the energy conservation programmes in more efficient way.

KMUTT was monitoring the project through direct contact to the 569 participants. It has been found that there were 3,363 recommended energy conservation measures by the expert team, of which 2,921 measures have been implemented, which is equivalent to the energy-savings of 5,108.65 toe/year or 159,144,566.50 Baht/year. The total investment cost is 40,406,687.36 Baht with the average payback period of 0.25 year.

Regarding the continuing implementation of energy conservation measures after the end of the project, there are 164 additional measures of which 136 measures have been completed. These measures result in energy-savings of 1,185.72 toe/year or 23,228,020.28 Baht/year. The total investment cost is about 16,450,590.00 Baht with the average payback period of 0.71 year. In addition, there are 9 on-going measures and 19 planning measures, which not been evaluated yet.

The achievement of the project can be summarized as follows: the small and medium-sized factories and buildings in fiscal year 2007 and 2008 can reduce the energy consumption of 6,294.37 toe/year, which is equivalent to 4.34% of the total energy consumption; the monetary-savings of 182,372,586.78 Baht/year; the total investment cost of 56,857,277.36 Baht; and the average payback period of 0.31 year.

For project's problems and barriers, it was found that 442 recommended energy conservation measures have not been implemented yet. This accounts for 13.14% of the total recommended measures. Among the unimplemented measures, problems and barriers are included technical aspect, human capacity, financial, and closed down enterprise.

With respect to the evaluation of participants' attitude and satisfaction, the survey was conducted on 3 target groups, including management level, energy conservation working team, and representative of worker. The evaluation is shown that 95.60% of project participation has moderate to highest level in terms of increasing knowledge and skill on energy conservation. The employees have moderate to highest level with regard to energy conservation participation and energy awareness. For the successfulness after joint the project, in overall 90.11% of project participation has moderate to highest level. With regard to the participants' satisfaction, 94.36% of the participation has moderate to highest level as well.

In addition, the project monitoring and evaluation has received valuable comments and suggestions from the participants. This reflects to the overall attitude and expectation to the project. These comments and suggestions can be used to improve and develop for the next projects.

Executive Summary

The Department of Alternative Energy Development and Efficiency (DEDE) has been assigned King Mongkut's University of Technology Thonburi (KMUTT) to monitor and evaluate the Project Promoting Energy Conservation in Small and Medium-Sized Industry and Commercial Building. This project has been completed in 2007 and 2008. There were 569 factories and buildings participated in the project. The evaluation process is included results of the implemented energy conservation measures, satisfaction of the project activities, problems and barriers, supportive programmes from the government, and comments. These evaluated issues can be used in developing the project in an efficient and sustainable manner. The followings are summary of the results obtained by the evaluation.

1. Data collection

KMUTT was used the direct data collection to 569 project participants. For each participant, the visiting included site survey, follow-up energy conservation measures as well as interviewing the representative of the factories/buildings who involved in the project. The interviews are classified into 3 groups, including management level, energy conservation working team, and representative of the workers. The consulting team used the questionnaire for conducting data collection. In the total of 569 participants, the data collection can be distinguished into 5 regions, as followings.

1) Central	252
2) North-eastern	96
3) Northern	92
4) Southern	48
5) Eastern	81

2. Targeted group

The total number of 569 small and medium-sized enterprises from 5 regions was participated in fiscal year 2007 and 2008. These can be further classified into 479 factories and 90 commercial buildings, as shown below.

1) Industry group of 479 factories

1. Pulp and paper	15
2. Chemical	87
3. Wood and furniture	39
4. Metallic	63
5. Textile	43
6. Food	191
7. Non-metallic	34
8. Other	7

2) Commercial building group of 90 buildings

1. Hotel	57
2. Hospital	17
3. Office	9
4. Department store	4
5. Educational institution	3

3. Energy consumption situation

The total energy consumption of the involved factories and buildings were 145,170.52 toe/yr in the fiscal year 2007 and 2008. This can be classified by industry and building and energy consumption characteristics, as shown followings.

1) Industry

There are 8 industry groups of 479 factories

The total energy consumption	136,454.63	toe/year
- Electricity	495,703,739.72	kWh/year
- Thermal energy	3,981,451,415.02	MJ/year

2) Building

There are 5 building groups of 90 buildings

The total energy consumption	8,715.89	toe/year
- Electricity	89,915,655.00	kWh/year
- Thermal energy	46,215,299.29	MJ/year

Details of the data are as shown in table 1.

4. Recommended energy conservation measures by the expert team

In 569 factories and buildings participated the project in the fiscal year 2007 and 2008. It was found that there were 3,363 energy conservation measures recommended by a team of experts. It can be summarised as following.

1) Recommended energy conservation measures

Types	Amount of Recommended energy conservation measures		
	Electricity	Thermal	Total
Factories	2,548	292	2,840
Commercial Buildings	511	12	523
Total	3,059	304	3,363

2) Energy-saving potential

Types	Electricity-saving (kWh/year)	Thermal energy-saving (MJ/year)	Total energy-saving (toe/year)	Monetary saving (Baht/year)	Investment cost (Baht)	Payback period (Year)
Factories	36,618,346.77	129,730,272.03	5,390.24	164,397,328.68	48,964,967.63	0.30
Commercial Buildings	7,614,935.69	1,208,906.26	669.72	24,396,304.02	6,119,941.00	0.25
Total	4,233,281.46	130,939,178.30	6,059.95	188,793,632.70	55,084,908.63	0.29

Details of the data are as shown in table 2.

5. Implemented energy conservation measures

KMUTT has been conducted the survey through 569 factories and buildings involved the project. It was found that 2,921 recommended energy conservation measures have been implemented, which is accounted for 86.86% of the total recommended measures (2,921 in 3,363 measures). It can be summarised as following.

1) Implemented energy conservation measures

There are 2,921 implemented measures and can be classified as following.

Types	Electricity measure	Thermal energy measure	Total
Factories	2,198	249	2,447
Commercial Buildings	464	10	474
Total	2,662	259	2,921

2) Total energy-saving

Types	Electricity-saving (kWh/year)	Thermal energy-saving (MJ/year)	Total energy-saving (toe/year)	Monetary saving (Baht/year)	Investment cost (Baht)	Payback period (Year)
Factories	31,005,001.07	107,368,042.82	4,490.96	136,850,679.62	35,350,676.36	0.26
Commercial Buildings	6,983,227.36	1,192,969.65	617.69	22,293,886.88	5,056,011.00	0.23
Total	37,988,228.43	108,561,012.47	5,108.65	159,144,566.50	40,406,687.36	0.25

Details of the data are as shown in table 3.

6. Unimplemented energy conservation measures

The survey and data collection in the 569 factories and buildings involved the project revealed that there are 442 recommended measures not been implemented yet. It accounts for 13.14% of the total recommended measures (442 in 3,363 measures). This is due to some problems and barriers, including technical aspect, human capacity, financial aspect, and closed down enterprise. It can be summarised as following.

1) Unimplemented energy conservation measures

Types	Electricity measure	Thermal energy measure	Total
Factories	350	43	393
Commercial Buildings	47	2	49
Total	397	45	442

2) Problems and barriers for unimplemented measure

Percentage share of problems and barriers are distinguished below.

No	Type of problems and barriers	Amount of unimplemented measures			Percent of total unimplemented measures		
		Factories	Commercial buildings	Total	Factories	Commercial buildings	Total
1	Technical aspect	175	19	194	39.39	4.3	43.89
2	Human capacity	50	10	60	11.31	2.26	13.57
3	Financial aspect	82	10	92	18.55	2.26	20.81
4	Technical aspect and human capacity	7	0	7	1.58	0	1.58
5	Technical aspect and financial aspect	7	1	8	1.58	0.23	1.81
6	Human capacity and financial aspect	1	0	1	0.23	0	0.23
7	Technical aspect, human capacity and financial aspect	15	0	15	3.39	0	3.39
8	Closed down enterprise(๘ enterprises) ***	49	5	54	11.09	1.13	12.22
9	Un specify	8	3	11	1.81	0.68	2.49
	Total	394	48	442	89.14	10.86	100

7. Additional implemented energy conservation measures

The survey has been conducted after the end of project in year 2007 and 2008. It was found that 112 factories/buildings in the 5 regions have been implementing additional energy conservation measures. There are a total of 164 measures, of which 136 measures have been completed while 9 measures are on-going and 19 measures are planning implementation. The additional implemented energy conservation measures are summarised below.

1) Additional implemented energy conservation measures

There are 136 measures and can be classified as following:

Types	Electricity measure	Thermal energy measure	Total
Factories	105	12	117
Commercial Buildings	14	5	19
Total	119	17	136

2) Total energy-saving

Types	Electricity-saving (kWh/year)	Thermal energy-saving (MJ/year)	Total energy-saving (toe/year)	Monetary saving (Baht/year)	Investment cost (Baht)	Payback period (Year)
Factories	3,073,490.79	30,799,651.42	991.01	17,243,288.72	9,644,090.00	0.56
Commercial Buildings	1,168,650.29	4,018,113.00	194.71	5,984,731.56	6,806,500.00	1.14
Total	4,242,141.08	34,817,764.42	1,185.72	23,228,020.28	16,450,590.00	0.71

Details of the data are as shown in table 4.

8. Summary of total energy-saving

The summary of total energy-saving achieved in the project fiscal year 2007 and 2008 is identified into 2 characteristics: 2,564 electricity measures; and 493 thermal energy measures. It can be summarised below.

1) Implementing energy conservation measures

There are a total of 3,057 implemented measures and can be classified below.

Types	Electricity measure	Thermal energy measure	Total
Factories	2,303	261	2,564
Commercial Buildings	478	15	493
Total	2,781	276	3,057

2) Total energy-saving

Types	Electricity-saving (kWh/year)	Thermal energy-saving (MJ/year)	Total energy-saving (toe/year)	Monetary saving (Baht/year)	Investment cost (Baht)	Payback period (Year)
Factories	34,078,491.85	138,167,694.24	5,481.97	154,093,968.34	44,994,766.36	0.29
Commercial Buildings	8,151,877.65	5,211,082.65	812.40	28,278,618.44	11,862,511.00	0.42
Total	42,230,369.50	143,378,776.89	6,294.37	182,372,586.78	56,857,277.36	0.31

Details of the data are as shown in table 5.

9. Evaluation of organisation energy management

From the survey and monitoring the project participation in fiscal year 2007 and 2008. The consulting team has been monitoring the organisation energy management in each factory/building in order to analyse the improvement and follow-up the organisation energy management. This can be summarised as followings.

- Energy management policy – there are energy management policy which is supported by the management level in most participants. But it is lack of the follow-up determined policy.

- Organisation arrangement – mostly participants are having person responsibility for energy and energy committee, which is selected from different departments. However, the committee has no real power. Once the end of project, they are not playing an importance role in energy conservation.

- Motivation and convincing in energy conservation – in most participants use the established energy committees for pursuing energy conservation activities. But the management level should put more afford to support the energy conservation programmes.

- Information system – it is found that in most participants' do not having a good energy information system. Generally, they have internal summary report, which is

distributed to management level. This information does not disseminate widely to the employees.

- Public relation – in most participants, they do advertise regarding energy conservation programme to the employees. In addition, they arrange some training but it is during the project period. It should be encouraged more campaign and advertising even after the end of the project.

- Investment – participants are concern with the payback period as an indicator for investment in energy conservation measures. Some participants are having budgets for the investment in the important of energy conservation project; however the rest of them is considered the measures that are having short payback period or lower investment.

10. Evaluation of attitude and satisfaction

Data analysis for evaluation of the significant successful project is included the evaluation of participants' comments, level of participants satisfaction, and requirement for the supportive programmes from the government. The survey and evaluation processes are targeted into 3 groups, including management level, energy conservation working team, and representative of employee. This can reflect to the attitude about energy conservation from different levels. The evaluation is summarised as followings.

10.1 Attitude and comment on the project

Data analysis for evaluation of attitude and comment on the project states the results of 90.58% of energy conservation awareness and project participation of employee, 90.11% of successfulness of energy-saving after joining the project, and 94.36% of satisfaction of the project's participation.

10.2 Benefit from project's participation

Data analysis for evaluation of benefit from project's participation states the results of 95.60% of achieving knowledge and skill for energy conservation, 92.70% of ability to follow activities and the measures that have been proposed by consulting team, and 96.79% of useful for organisation on this project.

10.3 Opinion of the overall energy conservation programme

Data analysis for evaluation of opinion of the overall energy conservation programme states the results of 88.02% of energy conservation working team maintained the energy conservation activities.

10.4 The need for supportive programmes from the government and comments

Data analysis for evaluation of the need for supportive programmes from the government and comments states the results of 80.13% of supporting a low interest for investment on energy conservation measures, 86.01% of supporting a low tax for energy efficiency equipments, 92.87% of training and workshop on energy audit, energy conservation analysis, 87.87% of study visit to successful energy conservation factory/building, and 93.22% of dissemination and suggestion the measures that can be self-implemented.

11. Useful comments and suggestions to the project

From the survey and evaluation process, the project has received valuable comments and suggestions that can be used to improve and develop for next year project. These also reflect to the overall attitude and expectation from the participants. The useful comments and suggestions are summarised below.

- Consulting team/expert – they should have more time for consultation in each visit and follow-up the measures. In addition, the experts should have more experiences and sound understanding of the manufacturing process and able to provide precisely information according to the needs. They should provide consultation even the end of the project.

- Energy conservation campaign and advertising – most participants require the information regarding energy conservation programmes. Government unit should provide information sources that can be used for factories/buildings. It should have workshops for employees both in technical aspect and energy awareness. Also, it should have a study visit to successful factory/building so that they could apply for their own energy conservation programmes.

- Project operation – mostly, participants agree that it is a good project and has benefits to both organisation and employee. They also want to implement a similar project to achieve energy-savings. The project should follow-up and stimulates employees to participate simultaneously. In addition, participants want to have more supportive in new energy technologies and some budgets for implementing energy conservation programmes.

12. Data base information system

Data collection and monitoring of the project promotion of participatory energy conservation from year 2003 to year 2009 are conducted. The total of 1,872 enterprises data collection are summarized as followings:

12.1 Amount of enterprises participated the project

The total of 1,872 enterprises participated the project during year 2003 to 2009 are classified by types of the supporting funds as followings:

No.	Year	Supporting funds	Amount of enterprises
1	2546	Energy Conservation Fund	38
2	2547	Energy Conservation Fund	32
3	2548	Energy Conservation Fund	202
4	2549	Energy Conservation Fund	420
5	2549	Government Budget	101
6	2550	Energy Conservation Fund	102
7	2550	Government Budget	163
8	2551	Energy Conservation Fund	467
9	2551	Government Budget	211
10	2552	Government Budget	136
Total			1,872

12.2 Data base information classified by yearly

1) Total energy consumption during year 2003 to year 2009 are 397,458.10 toe (excluding energy consumption of 32 enterprises in year 2004 and 420 enterprises in year 2006 due to lack of data reporting).

2) Total energy saving achieved from the project during year 2003 to year 2009 are 26,909.26 toe or 6.77 % of the total energy consumption (excluding energy consumption of 32 enterprises in year 2004 and 420 enterprises in year 2006 due to lack of data reporting).

3) Total energy conservation measures during year 2003 to year 2009 are 10,495 measures classified into electrical measures of 9,152 and thermal energy measures of 1,343.

Details of the data are as shown in table 6.

12.3 Data base information classified by types of enterprises

1) Total energy consumption classified by types of enterprises during year 2003 to year 2009 can be summarized as followings:

Types	Amount of enterprises	Electricity (kWh/year)	Thermal energy (MJ/year)	Total energy consumption (toe/year)
Factories	1,628	1,883,659,379.75	9,253,729,220.78	379,535.83
Commercial Buildings	244	193,880,671.03	59,220,077.03	17,922.29
Total	1,872.00	2,077,540,050.78	9,312,949,297.81	397,458.12

Details of the data are as shown in table 7.

2) Total energy saving classified by types of factories and commercial buildings during year 2003 to year 2009 can be summarized as followings:

Types	Electricity-saving (kWh/year)	Thermal energy-saving (MJ/year)	Total energy-saving (toe/year)	Monetary saving (Baht/year)	Investment cost (Baht)	Payback period (Year)
Factories	126,723,095.34	577,060,921.92	24,459.43	570,097,989.21	150,665,883.00	0.26
Commercial building	27,274,280.81	5,303,960.30	2,449.85	66,596,402.82	22,461,441.55	0.34
Grand total	153,997,376.15	582,364,882.22	26,909.28	636,694,392.03	173,127,324.55	0.27

Details of the data are as shown in table 8.

3) Total energy conservation measures classified by types of factories and commercial buildings during year 2003 to year 2009 can be summarized as followings:

Types of enterprises	Amount of enterprises	Amount of measures		
		Electricity	Thermal energy	Total
Factories	1,628	7,909	1,289	9,198
Commercial buildings	244	1,243	54	1,297
Grand total	1,872	9,152	1,343	10,495

Details of the data are as shown in table 9.

Table of data collection and survey data evaluation

Table 1: Current energy consumption classified by type of enterprises

No.	Type of factories/ buildings	Amount of enterprises	Energy consumption per year		Ton of oil equivalent per year	
			Electricity (kWh/year)	Thermal energy (MJ/year)	Total	Average/ enterprise
1	Pulp and paper	15	10,302,502.00	99,280,680.00	3,228.14	215.21
2	Chemical	87	98,497,514.00	161,740,259.26	12,184.83	140.06
3	Wood and furniture	39	40,721,013.00	1,487,887,882.05	38,691.50	992.09
4	Metallic	63	53,315,504.00	78,835,479.16	6,409.70	101.74
5	Textile	43	37,689,606.00	151,823,684.45	6,805.85	158.28
6	Food	191	215,984,850.72	1,875,587,144.06	62,804.96	328.82
7	Non-metallic	34	33,468,698.00	126,296,286.05	5,841.86	171.82
8	Other	7	5,724,052.00	-	487.8	69.69
Sub total of factories		479	495,703,739.72	3,981,451,415.02	136,454.63	284.87
9	Hotel	57	49,971,589.00	45,961,783.82	5,305.20	93.07
10	Hospital	17	20,628,965.00	279,891.51	1,764.61	103.80
11	Office	9	9,911,996.00	2,759.96	844.76	93.86
12	Department store	4	7,372,914.00	-	628.31	157.08
13	Educational institution	3	2,030,191.00	-	173.01	57.67
Sub total of commercial buildings		90	89,915,655.00	46,244,435.29	8,715.89	96.84
Grand total		569	585,619,394.72	4,027,695,850.31	145,170.52	255.13

Note: Data collecting from evaluation and monitoring of the project promotion of participatory energy conservation, Department of Alternative Energy Development and Efficiency, year 2007 and year 2008.

Table 2: Summary of energy conservation potentials by consulting team classified by type of enterprises

No.	Type of factories/ buildings	Amount of enterprises	Amount of Recommended measures	Electricity saving (kWh/year)	Thermal energy saving (MJ/year)	Total energy saving (toe/year)	Monetary saving (Baht/year)	Investment cost (Baht)	Payback period (Year)
1	Pulp and paper	15	85	998,080.77	1,199,873.30	113.49	3,779,309.16	709,623.20	0.188
2	Chemical	87	560	8,402,824.51	13,419,728.42	1,028.04	34,570,212.48	6,085,453.84	0.176
3	Wood and furniture	39	209	2,934,782.66	35,254,753.51	564.97	14,020,980.10	2,316,329.71	0.165
4	Metallic	63	391	4,891,702.37	2,941,521.30	490.50	16,743,655.94	2,073,794.39	0.124
5	Textile	43	262	3,341,462.96	10,201,063.07	525.63	15,135,053.04	5,325,322.40	0.352
6	Food	191	1,096	13,355,149.07	54,955,902.54	2,109.44	66,030,306.04	29,183,081.88	0.442
7	Non-metallic	34	193	2,053,866.50	11,757,429.90	503.61	11,392,970.61	2,718,312.22	0.239
8	Other	7	44	640,477.93	-	54.57	2,724,841.33	553,050.00	0.203
Sub total of factories		479	2,840	36,618,346.77	129,730,272.04	5,390.24	164,397,328.69	48,964,967.63	0.298
9	Hotel	57	336	4,935,009.99	1,208,906.26	445.36	15,429,232.26	4,255,513.00	0.276
10	Hospital	17	97	1,439,072.29	-	118.27	4,493,781.61	1,004,128.00	0.223
11	Office	9	52	818,441.15	-	70.09	2,820,937.93	674,200.00	0.239
12	Department store	4	21	263,752.81	-	22.47	936,690.64	124,760.00	0.133
13	Educational institution	3	17	158,658.45	-	13.52	715,661.57	61,340.00	0.086
Sub total of commercial buildings		90	523	7,614,934.69	1,208,906.26	669.70	24,396,304.02	6,119,941.00	0.251
Grand total		569	3,363	44,233,281.46	130,939,178.30	6,059.95	188,793,632.70	55,084,908.63	0.292

Table 3: Summary of energy conservation measures monitoring classified by type of enterprises

No.	Type of factories/ buildings	Amount of enterprises	Recommended measures	Implemented measures	Under implementing measures	Electricity saving (kWh/year)	Thermal energy saving (MJ/year)	Total energy saving (toe/year)	Monetary saving (Baht/year)	Investment cost (Baht)	Payback period (Year)
1	Pulp and paper	15	85	77	8	864,527.17	1,009,685.80	82.48	3,328,781.19	544,766.00	0.164
2	Chemical	87	560	477	83	6,908,876.36	13,338,239.68	887.68	29,343,599.27	4,848,549.35	0.165
3	Wood and furniture	39	209	177	32	2,668,012.55	25,067,450.02	405.65	12,385,626.92	1,628,349.71	0.131
4	Metallic	63	391	356	35	4,416,978.53	1,992,441.06	412.45	14,968,319.32	1,695,701.19	0.113
5	Textile	43	262	220	42	2,821,770.79	6,266,826.56	373.69	10,862,480.38	1,519,831.40	0.140
6	Food	191	1,096	938	158	11,243,676.45	49,437,385.63	1,913.51	54,496,883.26	22,927,586.49	0.421
7	Non-metallic	34	193	161	32	1,569,660.69	10,256,014.07	386.42	9,240,436.87	1,680,442.22	0.182
8	Other	7	44	41	3	511,498.53	-	28.46	2,224,552.40	505,450.00	0.227
Sub total of Factories		479	2,840	2,447	393	31,005,001.07	107,368,042.82	4,490.34	136,850,679.62	35,350,676.36	0.258
9	Hotel	57	336	301	35	4,409,180.79	1,192,969.65	402.97	13,666,481.50	3,466,613.00	0.254
10	Hospital	17	97	88	9	1,348,529.25	-	110.55	4,207,328.09	749,098.00	0.178
11	Office	9	52	51	1	814,301.15	-	69.73	2,809,345.95	674,200.00	0.240
12	Department store	4	21	18	3	254,807.71	-	21.71	905,554.78	124,760.00	0.138
13	Educational institution	3	17	16	1	156,408.45	-	13.33	705,176.57	41,340.00	0.059
Sub total of Commercial buildings		90	523	474	49	6,983,227.36	1,192,969.65	618.29	22,293,886.88	5,056,011.00	0.227
Grand total		569	3,363	2,921	442	37,988,228.43	108,561,012.47	5,108.63	159,144,566.50	40,406,687.36	0.254

Table 4: Additional implemented energy conservation measures

No	Types of factories/buildings	Implemented measures	Under implementing measures	Planning process measures	Total measures	Electricity-saving (kWh/year)	Thermal energy-saving (MJ/year)	Total energy-saving (toe/year)	Monetary saving (Baht/year)	Investment cost (Baht)	Payback period (Year)
1	Pulp and paper	4	-	1	5	745,137.00	-	63.50	2,462,106.40	5,000,300.00	2.03
2	Chemical	30	3	2	35	963,311.60	246,574.00	87.93	3,016,195.84	402,380.00	0.13
3	Wood and furniture	8	-	-	8	45,701.00	26,412,953.68	629.14	2,796,473.26	711,200.00	0.25
4	Metallic	16	1	1	18	266,099.00	39,817.20	23.62	1,001,981.50	187,000.00	0.19
5	Textile	7	-	-	7	70,346.60	248,385.20	11.87	1,328,422.92	815,500.00	0.61
6	Food	40	1	5	46	890,309.35	3,518,861.34	159.17	4,356,975.33	2,460,510.00	0.56
7	Non-metallic	11	1	-	12	77,186.24	333,060.00	14.46	2,228,773.47	67,200.00	0.03
8	Other	1	-	-	1	15,400.00	-	1.31	52,360.00	-	-
Sub total of Factories		117	6	9	132	3,073,490.79	30,799,651.42	991.01	17,243,288.72	9,644,090.00	0.56
9	Hotel	16	-	6	22	1,095,891.29	4,018,113.00	188.51	5,732,066.00	6,402,500.00	1.12
10	Hospital	2	3	3	8	42,099.00	-	3.59	97,075.56	4,000.00	0.04
11	Office	1	-	1	2	30,660.00	-	2.61	155,590.00	400,000.00	2.57
12	Department store	-	-	-	-	-	-	-	-	-	-
13	Educational institution	-	-	-	-	-	-	-	-	-	-
Sub total of Commercial buildings		19	3	10	32	1,168,650.29	4,018,113.00	194.71	5,984,731.56	6,806,500.00	1.14
Grand total		136	9	19	164	4,242,141.08	34,817,764.42	1,185.72	23,228,020.28	16,450,590.00	0.71

Table 5: Summary of energy-saving of implemented measures including additional measures

No	Types of factories/buildings	Electricity-saving (kWh/year)	Thermal energy-saving (MJ/year)	Total energy-saving (toe/year)	Monetary saving (Baht/year)	Investment cost (Baht)	Payback period (Year)
1	Pulp and paper	1,609,664.17	1,009,685.80	161.08	5,790,887.59	5,545,066.00	0.96
2	Chemical	7,802,920.96	13,584,813.68	986.65	32,211,688.87	5,240,979.35	0.16
3	Wood and furniture	2,701,605.07	51,480,403.70	949.87	15,034,739.89	2,339,549.71	0.16
4	Metallic	4,763,216.13	2,032,258.26	454.03	16,441,172.83	1,993,481.19	0.12
5	Textile	2,459,338.53	6,464,344.39	389.61	10,744,018.66	2,235,796.40	0.21
6	Food	12,133,985.80	52,956,246.97	2,057.63	58,853,858.59	25,388,096.49	0.43
7	Non-metallic	2,080,862.67	10,639,941.44	438.20	12,740,689.51	1,746,347.22	0.14
8	Other	526,898.53	-	44.90	2,276,912.40	505,450.00	0.22
Sub total of factories		34,078,491.86	138,167,694.24	5,481.97	154,093,968.34	44,994,766.36	0.29
9	Hotel	5,505,072.08	5,211,082.65	590.49	19,398,547.50	9,869,113.00	0.51
10	Hospital	1,390,628.25	-	114.51	4,304,403.65	753,098.00	0.17
11	Office	844,961.15	-	72.35	2,964,935.95	1,074,200.00	0.36
12	Department store	254,807.71	-	21.71	905,554.78	124,760.00	0.14
13	Educational institution	156,408.45	-	13.33	705,176.57	41,340.00	0.06
Sub total of Commercial buildings		8,151,877.65	5,211,082.65	812.40	28,278,618.44	11,862,511.00	0.42
Grand total		42,230,369.50	143,378,776.89	6,294.37	182,372,586.78	56,857,277.36	0.31

Table 6: Energy consumption, energy saving, and amount of measures classified into yearly

Year	Amount of enterprises	Amount of Measure		Energy Consumption			Energy-Saving					
		Electricity	Thermal Energy	Electricity (kWh/ปี)	Thermal Energy (MJ/ปี)	Total energy-saving (toe/ปี)	Electricity (kWh/ปี)	Thermal Energy (MJ/ปี)	Total energy-saving (toe/ปี)	Monetary saving (Baht/year)	Investment cost (Baht)	Payback period (Year)
2546	38	172	29	519,978,338.23	1,490,098,447.31	79,575.70	10,725,950.34	27,124,568.76	1,556.15	39,533,995.55	10,277,576.67	0.24
2547	32	125	34	-	-	-	1,612,239.77	4,986,106.36	255.44	8,686,816.06	1,085,846.37	0.14
2548	202	808	160	311,293,998.45	1,710,316,219.54	67,005.72	12,945,711.53	73,651,156.00	2,846.69	58,168,650.91	11,244,809.72	0.21
2549	521	2,515	433	101,044,897.99	238,820,051.49	14,262.99	49,393,053.33	243,883,875.05	9,982.46	185,815,759.78	48,664,496.61	0.25
2550	265	1,265	175	284,037,454.87	1,543,128,823.32	60,728.77	19,258,000.46	64,242,338.55	3,161.90	92,301,930.26	36,440,634.97	0.24
2551	678	3,542	402	705,443,119.65	3,749,320,821.14	148,855.83	49,850,755.30	141,717,308.66	7,602.95	211,719,968.44	51,839,174.03	0.26
2552	136	723	109	155,742,241.59	581,264,935.03	27,029.09	10,211,665.41	26,759,528.85	1,503.67	40,467,270.97	13,574,785.55	0.33
Grand total	1872	9,150	1,342	2,077,540,050.78	9,312,949,297.83	397,458.10	153,997,376.14	582,364,882.23	26,909.26	636,694,391.97	173,127,323.92	0.27

Table 7: Energy consumption classified by types of enterprises

No.	Types of factories/buildings	Amount of enterprises	Energy consumption		
			Electricity (kWh/year)	Thermal energy (MJ/year)	Total (toe/year)
1	Pulp and paper	51	49,228,159.37	173,807,468.39	8,308.29
2	Chemical		453,321,820.23	871,629,956.44	59,258.03
3	Wood and furniture	109	126,593,359.61	2,514,794,498.53	70,310.85
4	Metallic	268	414,767,492.42	691,786,268.94	53,675.38
5	Textile	162	188,075,623.51	902,587,135.70	37,388.98
6	Food	569	517,017,155.08	3,716,279,428.40	132,016.65
7	Non-metallic	103	114,830,705.29	350,666,720.46	16,126.73
8	Other	38	19,825,064.24	32,177,743.92	2,450.92
Sub total of factories		1,628	1,883,659,379.75	9,253,729,220.78	379,535.83
9	Hotel	32	91,865,425.06	37,873,979.02	8,724.34
10	Hospital	10	54,712,274.80	4,914,030.32	4,778.35
11	Office	30	22,485,174.74	13,273,898.11	2,230.12
12	Department store	125	21,683,698.70	703,752.94	1,864.33
13	Educational institution	47	3,134,097.73	2,454,416.64	325.15
Sub total of commercial buildings		244	193,880,671.03	59,220,077.03	17,922.29
Grand total		1,872	2,077,540,050.78	9,312,949,297.81	397,458.12

Table 8: Energy saving classified by types of factories and commercial buildings

No	Types of factories/buildings	Electricity-saving (kWh/year)	Thermal energy-saving (MJ/year)	Total energy-saving (toe/year)	Monetary saving (Baht/year)	Investment cost (Baht)	Payback period (Year)
1	Pulp and paper	3,265,051.90	28,382,188.65	950.10	20,878,109.06	2,260,635.57	0.11
2	Chemical	28,039,879.31	108,678,736.33	4,962.18	118,969,331.48	25,718,628.36	0.22
3	Wood and furniture	7,862,488.84	55,368,008.95	1,980.71	35,305,206.22	5,598,458.13	0.16
4	Metallic	25,116,340.29	33,391,942.00	2,930.85	92,731,126.56	14,843,217.43	0.16
5	Textile	12,231,669.71	49,666,363.91	2,218.07	61,594,222.56	23,868,450.18	0.39
6	Food	38,511,765.73	276,781,827.34	9,833.93	192,648,598.25	67,707,446.77	0.35
7	Non-metallic	8,196,623.54	22,941,076.68	1,241.57	37,163,608.67	8,611,130.12	0.23
8	Other	3,499,276.02	1,850,778.06	342.02	10,807,786.41	2,057,916.44	0.19
Sub total of factories		126,723,095.34	577,060,921.92	24,459.43	570,097,989.21	150,665,883.00	0.26
9	Hotel	9,922,015.82	3,909,759.51	938.09	31,052,460.36	12,385,023.55	0.40
10	Hospital	3,850,116.47	378,015.51	337.06	15,566,967.51	2,706,274.00	0.17
11	Office	3,118,155.65	695,655.00	282.20	8,535,009.83	2,687,793.00	0.31
12	Department store	9,549,215.26	74,755.28	815.55	8,046,037.36	4,152,211.00	0.52
13	Educational institution	834,777.61	245,775.00	76.95	3,395,927.76	530,140.00	0.16
Sub total of commercial building		27,274,280.81	5,303,960.30	2,449.85	66,596,402.82	22,461,441.55	0.34
Grand total		153,997,376.15	582,364,882.22	26,909.28	636,694,392.03	173,127,324.55	0.27

Table 9: Energy conservation measures classified by types of factories and commercial buildings

No.	Types of factories/buildings	Amount of enterprises	Amount of Measures		
			Electricity	Thermal	Total
1	Pulp and paper	51	228	51	279
2	Chemical	328	1,761	185	1,946
3	Wood and furniture	109	483	94	577
4	Metallic	268	1,442	108	1,550
5	Textile	162	714	114	828
6	Food	569	2,519	653	3,172
7	Non-metallic	103	553	68	621
8	Other	38	209	16	225
Sub total of factories		1,628	7,909	1,289	9,198
9	Hotel	32	159	5	164
10	Hospital	10	59	1	60
11	Office	30	146	1	147
12	Department store	125	629	41	670
13	Educational institution	47	250	6	256
Sub total of commercial buildings		244	1,243	54	1,297
Grand total		1,872	9,152	1,343	10,495

TABLE OF CONTENTS

	Page
Abstract	
1. Data collection	1
2. Targeted group	1
3. Energy consumption situation	2
4. Recommended energy conservation measures by expert team	2
5. Implemented energy conservation measures	3
6. Unimplemented energy conservation measures	3
7. Additional implemented energy conservation measures	4
8. Summary of total energy-saving	5
9. Evaluation of organisation energy management	5
10. Evaluation of attitude and satisfaction	6
11. Useful comments and suggestions to the project	7
12. Data base information system	7

TABLE OF CONTENTS

		Page
Table 1	Current energy consumption classified by type of enterprises	10
Table 2	Summary of energy conservation potentials by consulting team classified by type of enterprises	11
Table 3	Summary of energy conservation measures monitoring classified by type of enterprises	12
Table 4	Additional implemented energy conservation measures	13
Table 5	Summary of energy-saving of implemented measures including additional measures	14
Table 6	Energy consumption, energy saving, and amount of measures classified into yearly	15
Table 7	Energy consumption classified by types of enterprises	16
Table 8	Energy saving classified by types of factories and commercial buildings	17
Table 9	Energy conservation measures classified by types of factories and commercial buildings	18



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