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DEVELOPMENT OF ENERGY CONSERVATION PROGRAMS FOR RESIDENTIAL AND SMALL COMMERCIAL BUILDINGS IN THAILAND

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ABSTRACT
This paper projects five scenarios of the energy consumption of residential houses and small commercial buildings in Thailand in the next 20 years from 2010 to 2030. The first scenario presents the consumption trend at which the energy performance of the household appliances and equipments and the behaviors of the energy end-use have no change during the period. This scenario represents a "Business as Usual" case and is called BAU I. The second scenario presents as well a BAU case but derived from different data sources, designated as BAU II. Even developed from different methods, both BAU I and BAU II show similarly that the energy consumption of the sector in 2030 will increase two folds from the present 2010. Scenarios III and IV examine two specific cases of fuel switching for cooking. First, liquid petroleum gas (LPG) is substituted totally by electricity. This situation will lead to a crisis of the affordability of electricity of the whole country. Second, fuel wood and charcoal are substituted by LPG. This will again lead to a serious scarcity of LPG. The results of this study also demonstrate that a desirable scenario of intensively implementing various energy conservation campaigns can reduce the consumption of the sector upto 23% of that under BAU II.

Keywords: Household appliances, Energy perfor-mance, Energy end-use, Residential houses, Small commercial buildings

1. INTRODUCTION

Energy is an important factor for existence, quality of life adaptation, and economic development of the country. Thailand is a developing country where the energy demand is increasing continuously. However, Thailand has limited energy resources and half of the energy used is imported. In 2010, total electricity generation was 165,457 GWh, increasing 11.5% from 2009 (APERC, 2010). The fuel used for power generation, more than 70% were from natural gas and the remaining were from fuel oil, coal, diesel, hydro, and other renewable energy sources. The generating capacity comprises domestic electricity production and power buy from Lao PDR and Malaysia. In Thailand, residential and small commercial sectors contribute almost 30% of total electrical energy consumption of the whole country. In tropical regions such as Thailand, comfort air conditioning has been increasingly used corresponding to the increase in disposable income. Air conditioning has penetrated significantly over 50% of municipal households. Air conditioning load accounts for over 70% of total electric load in a small household. This is addressed specifically in the Demand Side Management Plan of the electric utilities (Chirarattananon and Limmechokchai, 1996). Energy efficiency improvement and conservation has been a main focus in Thailand's energy policy. Since 1992, under the Energy Conservation Promotion Act, B.E. 2535 (1992), the Energy Conservation Promotion Fund (ENCON Fund) has been established to provide financial support to government agencies, state enterprises, non-government organization, individual, and businesses that wish to implement measures to increase efficiency in energy utilization. The fund also allocates in each year a budget to monitor and evaluate the implemented energy efficiency programs which would provide the valuable information on real progress for better program design in the future.

This study was a part of a large research project on the development of a 20-year strategic plan for energy conservation in Thailand. The project obtained a financial support from the ENCON fund. This paper aims to present, through different energy consumption scenarios, the quantitative information of the energy use in residential houses and small commercial buildings including illustrating the different characteristics of the energy use in buildings in municipality area and those located outside. The study finally introduces a scenario of the energy efficient program that would lead to a reduction of the energy consumption of the sector. The study of the energy consumptions in residential and small commercial buildings in this paper is found in line with researches conducted in various locations especially in developing countries where the pace of urbanization is accelerating and consequently rising up substantially the energy consumption of the countries. A study in Manila metropolis, Philippines focused on the electricity usage in homes (Sahakian, 2011). It explored the social and cultural drivers behind the household electricity consumption. Policy recommendations were also provided based on the research results. A research conducted by Ruijven et al. (2011) developed a model to project the household energy use in India. A result from the study reported that the total Indian residential energy use will increase by around 65–75% in 2050 compared to 2005. Cai and Jiang (2008) studied the household energy use for five cities covering rural village to central city in China. It was found that the patterns of energy consumption vary substantially. As people lifestyles become more urbanized, the proportion of energy used for cooking decreases. Likewise, the proportion of energy used for recreation and electricity end uses also increases. For homes in villages, it was necessary to decrease the total energy consumption to improve end-use energy efficiency. Households in county towns should use natural gas and other cleaner energy resources to replace coal step-by-step. For household in the city, saving energy becomes important due to its dense population.

2. ENERGY USE IN RESIDENTIAL AND SMALL COMMERCIAL BUILDINGS

This study adopted two reports for projection of the energy consumption in residential and small commercial buildings in the next 20 years (2010-2030). The first is a report of a research project on the energy consumption in residential sector published by the Department of Alternative Energy Development and Energy Efficiency (DEDE), Ministry of Energy, Thailand (DEDE, 2003). This project carried out a large survey to compile the energy consumption data from houses throughout Thailand. This project report was adopted in this study for developing an energy end-use model for residential houses (RES) and small commercial buildings (SMC). Due to different energy end-use patterns, the model differentiated each building type to those situated in municipality (In M) and outside the municipality (Out M). The model defined appliances and equipments into four groups as follows:

Lighting: fluorescent and incandescent lamps.

Cooking: electric rice cooker, electric stove, LPG stove, electric frying pan, oven, microwave, blender juice, toaster and electric kettle.

Entertainment: television, stereo, VCD/DVD player, radio and computer.

Table 1 The energy consumption share of activities (%) in residential and small commercial buildings

Activity		RES		SMC	
		In M	Out M	In M	Out M
Lighting		12.5	16.5	11.7	9.0
Cooking		11.1	14.3	7.2	7.1
Entertainment		16.6	17.8	19.3	9.9
Amenity	Other	25.9	35.5	36.7	52.9
	A/C	23.2	8.9	16.5	5.1
	Hot water	7.1	2.4	-	-
Other		3.6	4.7	8.6	16.0
Total		100	100	100	100

Amenity: fan, air-conditioning, vacuum cleaner, washing machine, water heater, electric water pump, iron, refrigerator and freezer. Provided in appendix, Table A.1 presents the energy consumption share of a number of household appliance and equipments. Table 1 presents the aggregated data of the consumption share by activities. It is observed that the equipments in amenity activity contribute the most significant share of electricity consumption for all building categories.

It should be reminded that the table presents only the electricity consumption. The uses of other fuel types were needed to be gathered from different responsible government agencies and institutes such as Petroleum Authority of Thailand (PTT), Department of Alternative Energy Development and Energy Efficiency (DEDE), Energy Policy and Planning Office (EPPO). As the number of members in a family or family size has changed when the time passed by, a report established by the Department of Provincial Administration, Population Statistics (DOPA, 2008) was used to reflect a change in nature of population settlement. Although the Thai population would not much increase, a general trend shows that the family size becomes smaller. An assumption set in the study was that the average members in a household was 4 people in 2010 and linear decreased to 3.5 people in 2030. The assumption made the number household increase nearly 25% in the year 2030. The unit number of residential and small commercial buildings within and outside the municipality is shown in Fig. 1. The numeric figures are provided in Table A.2 in the appendix.

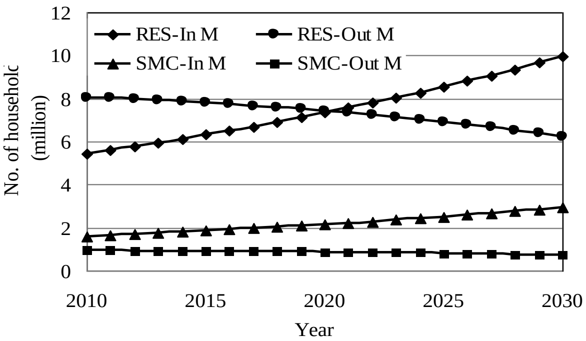

Figure 1 Number of residential and small commercial buildings within and outside the municipality

3. ENERGY CONSUMPTION SCENARIOS

This section describes one-by-one five scenarios of the energy consumption in residential houses and small commercial buildings in the next 20 years.

3.1 Scenario I: Business as Usual I (BAU I)

This scenario (BAU I) was established to portray the energy consumption trend of the residential and small commercial buildings at which the energy performance of the appliances and equipments and the behaviors of the energy end-use have no change during 2010-2030. The BAU I actually adopted directly the electricity demand forecasting of business as usual by the electric load forecast sub-committee under the committee for administration of energy policy (AEP, 2010). The numeric figures of the demand forecast for the residential and small commercial buildings are presented already in Table A.3 in the appendix. Figure 2 exhibits a plot of the total sum of the electricity consumption from both building categories.

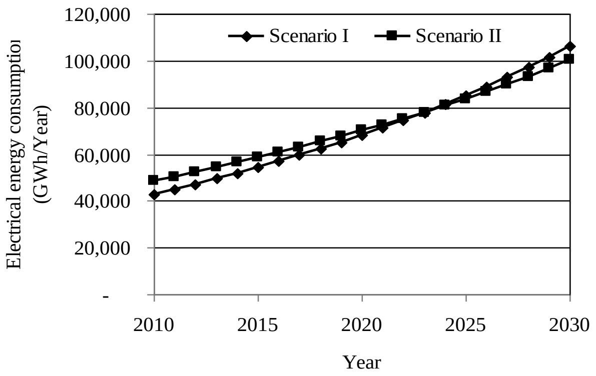

Figure 2 Total electricity consumption of residential and small commercial buildings in Scenario I and II

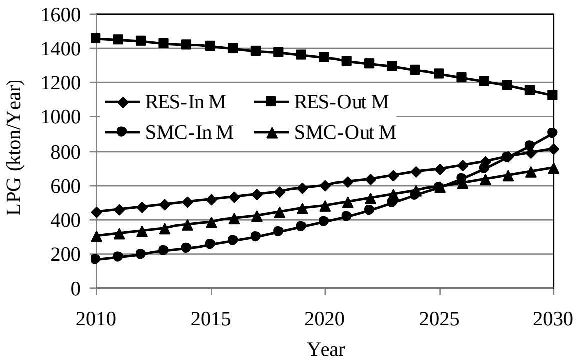

Figure 3 LPG consumption for cooking (BAU I)

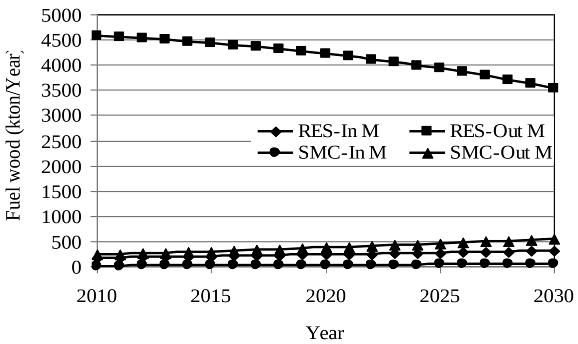

Figure 4 Fuel wood consumption for cooking (BAU I)

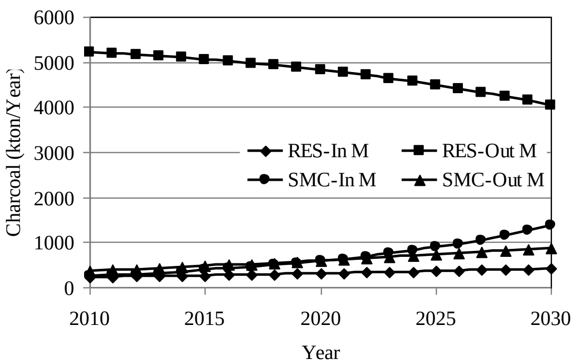

Figure 5 Charcoal consumption for cooking (BAU I)

It is found that under the BAU situation, the consumption in year 2030 will become two folds of that in the present year 2010. It should be noted that the forecast was made on the assumptions of the country economic growth that could not provide the details of the energy consumptions to the equipment level. For the LPG consumption, the data was obtained from a reference report published by the Energy Policy and Planning Office (EPPO), Ministry of Energy, Thailand (EPPO, 2010). The data was manipulated and segregated into each sub sector by the proportion use in 2001. The BAU I assumed that fuel wood and charcoal consumption were same amount from 2001 (DEDE, 2003). Figures 3-5 illustrate respectively the consumptions of LPG, fuel wood and charcoal for cooking in the buildings. From Figs 3-5, only the consumptions from the residential houses outside the municipality decreases; this results from the urbanization of the country.

3.2 Scenario II: Business as Usual II (BAU II)

Similar to Scenario I (BAU I), Scenario II (BAU II) portrays the BAU lines that were developed under different data and assumptions. The electrical energy consumption trend of the BAU II was established by adopting the energy end-use models described in Section 2 instead of the load forecast by the sub-committee of the energy policy development of Thailand. However, the LPG, fuel wood and charcoal consumptions of the BAU II are all identical to that of BAU I.

The BAU II assumed that intensities of most end-use activities in the households reach saturation and hence the corresponding energy demands also reach saturation since 2010. Followings describe the assumptions set for Scenario II:

- For residential houses, the energy consumption for lighting, cooking, entertainment and amenity, except air conditioning and hot water generation, reach their saturation. In each year, the units of electric water heater will increase 200,000 units (EGAT, 2006). In average, an electric water heater consumes electricity 1,084 kWh per year.
- Demand for air conditioning of both residential and small commercial buildings combination will increase 718,980 units of air conditioner each year (EGAT, 2006). An air conditioner (EER=10) consumed 1,854 kWh per year.
- For small commercial buildings, the rate of electricity consumption increases inline with the growth of all activities similar to the BAU I.
- Implementation of energy labeling, minimum energy performance standard (MEPS), and high energy performance standard (HEPS) conducted by EGAT and DEDE for household appliances are assumed to be continued.

In addition to the above assumptions, the BAU II also accounts for the two issues influencing the energy consumption of the buildings:

- *Number of households in municipality area*
  Although the energy consumption per unit of household is assumed to be non-change, the overall consumption of energy of the whole country will be varied with the change of number of household units within and outside municipal areas.

  Urbanization due to the immigration of people and the growth of the cities themselves increase the energy demand and consumption of a country. Complexity also increases due to behavioral changes of use of household appliances both within and outside municipality.

- *Saturation of energy used*
  Projects of Minimum Energy Performance Standard (MEPS) of certain appliances, Energy Labeling and High Energy Performance Standard (HEPS) which include fluorescent lamp, incandescent lamp, electric stove, oven, microwave, electric kettle, TV, computer, water cool air-conditioning, vacuum cleaner, washing machine, electric water heater, refrigerator and freezer have been implemented and monitored continuously by DEDE (MU, 2010). Among various appliances, those that could be found in mostly all households mean that the number of equipments per household reaches saturation. For whole energy consumption, although the number of household is increasing, the potential of saving from the projects and the saturation of equipments per household can be assumed that the energy consumption of activities reach saturation except air-conditioner and electric water heater which has increased each year about 718,980 and 200,000 units, respectively. It is interesting to note that the increasing of air conditioner in Kasikorn Bank research report (KRC, 2010) was 1,090,000 to 1,150,000 units.

The consumption of the base year 2010 of this scenario is identical to that of scenario I. However, the energy growth is dependent on the two factors and the assumptions mentioned above. Figure 2 shows electricity consumption of scenario II together with that of scenario I. Examining BAU II and BAU I, the whole energy consumption in 2030 are 100,475 GWh and 106,223 GWh, respectively, or about 5% difference. In BAU II, the total electricity demand is estimated about 48,611 GWh in 2010 and 100,475 GWh in 2030. The electrical energy demands in 2030 for residential buildings within and outside municipal areas are more than 2.2 times and 1.1 times to that in 2010. For small commercial buildings, the 2030 electrical energy demands for those within and outside municipality are more than 4.9 times and 2.3 times to that in 2010, respectively. Figure 6 shows electricity consumption of Scenario II in various activities. When electricity for growing use of air-conditioning and hot water heating is accounted, total energy demand in the BAU II scenario matches with that of the BAU I in 2030. The authors believe that the energy consumption projection of Scenario II is a reasonable one. Figures 7 and 8 show the energy consumptions of the residential and small commercial buildings within and outside the municipality of BAU II.

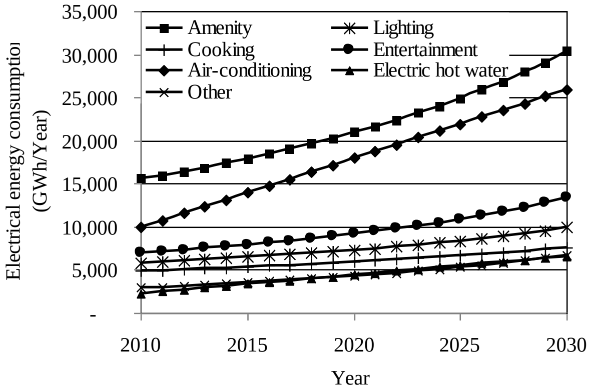

Figure 6 Electrical energy consumption by activities (BAU II)

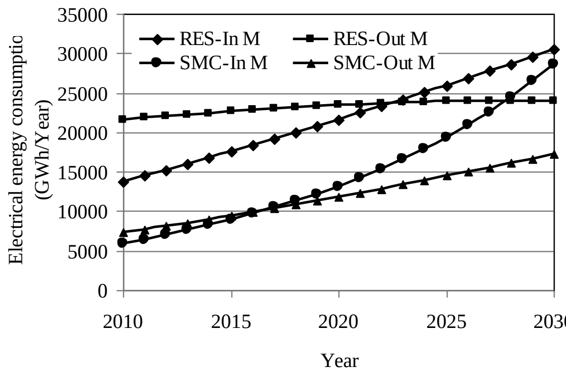

Figure 7 Electricity consumption of residential and small commercial buildings within and outside the municipality (BAU II)

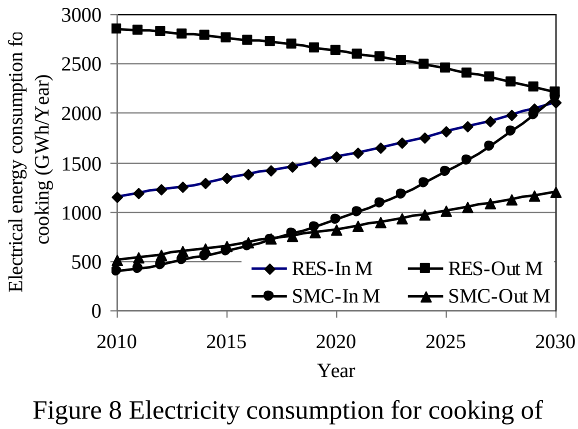

Figure 8 Electricity consumption for cooking of residential and small commercial buildings within and outside the municipality (BAU II)

3.3 Scenario III: Electricity to Replace LPG

In this scenario, there was again no plan to improve the energy efficiency of the appliances in the residential and small commercial buildings. However, this scenario assumed that all of the useful heat consumption from LPG and fuel wood and charcoal for cooking were substitution by electricity. The result is that the whole electricity consumption was 141,237 GWh in 2030 or higher than the BAU II about 41%. Due to the nature of electricity as an energy form that cannot be stored, Scenario III is warning the future expansion plan of electric generation.

3.4 Scenario IV: LPG to Replace Biomass

Identical to scenario II, this scenario has no energy plan to improve energy efficiency in residential and small commercial buildings. However, all of the useful heat consumption of fuel wood and charcoal for cooking are substituted by LPG. The result is that the LPG consumption is equal 6,075 thousand tons in 2030 or higher than that of BAU II about 72%.

3.5 Scenario V: Energy Efficiency Programs (EEP)

Scenario V is the desirable scenario of energy efficiency programs (EEP). Even agreeing that air-conditioning and hot water demands increase steadily up to 2030, the EEP features a reduction of energy demand from that presented in the BAU scenario by up to 23% for both electricity and LPG. The study examines an energy conservation plan that could be implemented to realize the EEP. The plan includes rigorous electric lighting program to eliminate incandescent lamps and to steadily increase electric lighting efficiency to its technical potential. The plan also includes application of mandatory minimum efficiency requirements on air-conditioning, hot water generation, and other energy intensive end-uses. It also calls for simultaneous application of energy labeling and higher energy performance standards with implantation of mandatory measures. Innovative programs include development and promotion of solar cooling and heating for air-conditioning and hot water generation. The plan includes program of replacement of every low energy efficient appliance with high energy efficient one when its life expires.

Minimum energy performance standards (MEPS) is a measure to enforce devices and appliances produced in the country and imported for sales needed to improve their efficiency to comply with the minimum requirements. This measure eliminates the low performance equipments from the market. Implemented simultaneously, higher energy performance standard (HEPS) encourages expansion of equipments with high energy efficient in market. Both MEPS and HEPS would benefit to energy savings for the country as a whole.

To minimize the constraints to the producers, procedure to stringent the requirements of MEPS and HEPS would be carried out for every five year that would allow the producers and the responsible authorities a period of time to plan before the enforcement. Already conducted in Thailand, MEPS and HEPS should be continued and expanded to cover more number of household equipments. Government should also provide additional support to enhance the ability of various testing centers to testing and certification performance standards. Including public relations people to see the benefits to be gained from use of effective equipment, encourage consumers to use efficient equipment more by reducing tax for the ones who use those equipments. This would drive manufacturers turned to producing and selling equipments with high energy performance.

a) Energy performance improvement of appliances

Opportunities to improve energy efficiency in residential and small commercial buildings, details and assumptions to consider the improvement by end-use device to meet savings potential of each activity are as follows.

- *Lighting*
  In residential and small commercial buildings, fluorescent lamp and incandescent lamp are the two most common electric lamps used that should be taken into consideration for the electricity demand. For fluorescence lamp and ballast, the “Energy labeling of high efficient fluorescence lamp and electronic ballast campaign” should be implemented in a way that buyers can bring labels for reduction of electricity costs. For CFL, the “Exchange incandescence lamp for CFL campaign” should be implemented. It is suggested that the programs should be supported by Sub District Administrative. Energy saving potential of lighting resulting from high energy efficient fluorescent lamp penetrates 10% (new acquisition and replacement), electronic ballast penetrates 5% and incandescence lamp is replaced by CFL with the replacement rate of 20% each year.

- *Cooking*
  For this activity, the use of electricity and LPG needs to be careful so it would not increase from the BAU scenario. It is also expected to switch the use of energy from fuel wood to charcoal in the future increase of 10% per year from 2011 while total useful heat demand for cooking unchanged from the BAU. Improvement of the energy performance of LPG and charcoal stoves offers a great opportunity to help reduce the waste of energy. Promotion of LPG and charcoal stove by the “Energy labeling of high efficient stove campaign” should be implemented to gradually increase the concentration of the standard every five years period which focus on saving fuel costs especially for restaurants target. Energy saving potential of cooking (both LPG and charcoal) resulting from all new stoves are high energy efficient and the existing conventional LPG stoves are replaced by the high energy efficient one at a rate of 10% each year which the energy consumption from stove calculated by the average efficiency of MEPS and HEPS. And assume that average lifetimes of LPG stove for residential building and small commercial building are 10 years and 5 years, respectively.

- *Entertainment*
  Appliances used in this activity such as computer, DVD/VCD player and so on have less potential to

save electricity when compared to those in other activity categories. Although the number of some appliances is growing, the development of MEPS and HEPS can help maintain the electricity demand in this activity not to change too much. This study did not focus particularly on the saving potential from equipments in this category. Additional obstacle is the lack of reliable data to anticipate the electricity demand from the increasing unit of the devices.

- *Amenity*
  Except air conditioner and electric water heater, most of the equipments in this category i.e. fan, washing machine, pump, iron, refrigerator etc. already reach saturation. The increasing electricity demand is due to the increase in the number of households.

Table 2 Programs for high efficiency technology appliances for every five year period

Appliances	2010	High Efficiency Technology 2011-15	2016-20	2021-25	2026-30
Fluorescence lamp	36W	30 W	28 W	25 W	
Ballast	Magnetic ballast	Electronic ballast			
Incandescence lamp	Incandescence lamp	Compact fluorescence lamp			
Air Conditioner	EER 11	MEPS= EER 11 HEPS= EER 12.5	MEPS= EER 12.5 HEPS= EER 14	MEPS= EER 14 HEPS= EER 17 Hybrid system Solar cooling system	MEPS= EER 17 HEPS= EER 18
Hot water heater	Electric water heater	Air-conditioner which can produce hot water (MEPS)			
LPG stove	49%	MEPS= 53% HEPS= 58%	MEPS= 58% HEPS= 60%	MEPS= 60% HEPS= 63%	MEPS= 63% HEPS= 65%
Charcoal stove	25%	MEPS= 30%	MEPS= 30%	MEPS= 30%	MEPS= 30%

In 2030, the electricity demand of this activity will increase up to 51,864 GWh or 1.25 times from the year 2010. In Thailand where the summer is long, hot and humid, both air-conditioner and hot water heater have, in recent, become large electricity-consuming appliances. A measure arising in the conservation plan is the use of high efficiency air conditioner and hot water heater. The use of energy efficient air conditioner that can produce simultaneously hot water is also a quite interesting measure. For far future, the use of solar energy for cooling and heating in residential and small commercial buildings offers a substantial electrical energy saving for electricity demand for air conditioning and hot water generation. "MEPS & HEPS Campaign" that has already been implemented should be continued. The energy performance standards of the equipment should be gradually stringent by the standard revision every five years.

Large energy saving potential from Amenity activity results from the energy performance improvement of air conditioning and hot water generation. The existing air conditioner (in base year 2010) will be replaced at a rate of 10% each year with the new high energy efficient one. From 2021, 10% of new air conditioner will be replaced by the hybrid system and then after 2025, 20% of new air conditioning will be replaced by solar system (5% hybrid and 15% solar system). For hot water generation, a promotion of air conditioner that can produce hot water can penetrate into the market at the rates of 10%, 45% and 100% of new demand for hot water generation for first, second and third period, respectively. Table 2 shows the energy efficiency campaigns for appliances for every five years period.

b) Energy saving potentials

The campaigns of high efficient equipments and the potentials of the energy savings are broken down by category. Figure 9 illustrates the saving potential according to the plan.

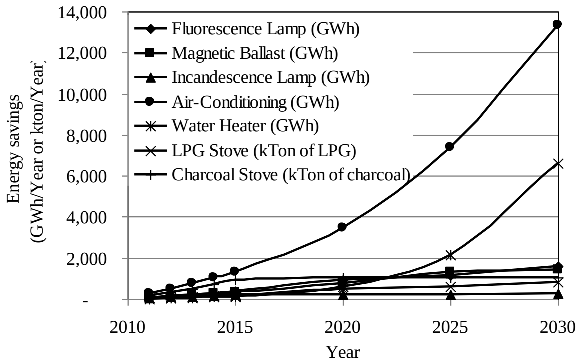

Figure 9 Energy saving potentials according to the energy conservation plan in Table 1

Figures 10-12 show the comparison of the energy consumptions of residential and small commercial buildings between Scenario II (BAU II) and Scenario V (EEP). Overall, the consumptions of both electrical energy and LPG will be decreased about 23%.

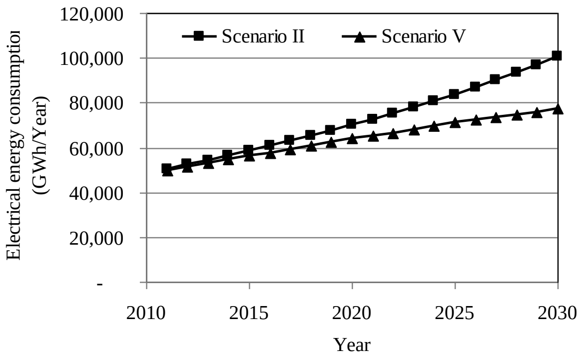

Figure 10 Comparison of the electrical energy consumption between Scenario II and Scenario V

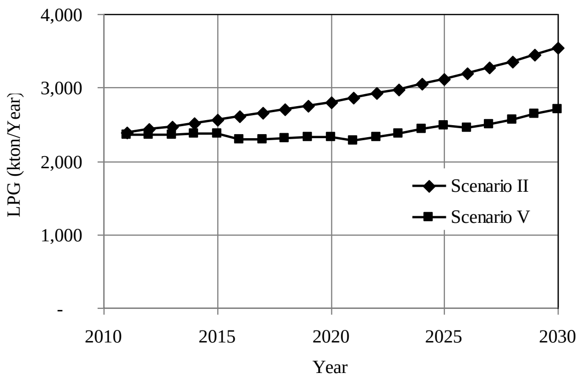

Figure 11 Comparison of the LPG consumption between Scenario II and Scenario V

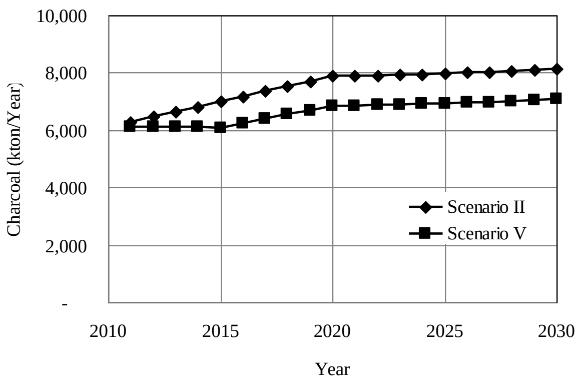

Figure 12 Comparison of the charcoal consumption between Scenario II and Scenario V

4. CONCLUSIONS

This paper examines five scenarios of energy consumptions of residential and small commercial sectors in Thailand. Without implementing any energy conservation measures, the consumption of these sectors is expected to increase from the current (2010) of electricity 48,611 GWh and LPG 2,360 kton to electricity 100,475 GWh and LPG 3,538 kton in the next twenty years (2030). Although the consumptions by the main activities i.e. lighting, cooking, entertainment reach saturation, the increase of units of air-conditioners and electric water heaters in the sectors results in dramatic increasing electricity consumption. This study also examines particular situations of the fuel switching for cooking by the sector. For one case, it was assumed that electricity was totally used for cooking. The situation would lead to a crisis of the affordability of electricity of the country. Another case assumed fuel wood and charcoal for cooking were substituted by LPG. This would again leads to the scarcity of LPG. However, the shift of fuel wood to charcoal offers an opportunity of energy efficiency improvement. The scenarios mentioned above warrant an importance of energy efficiency in residential and small commercial buildings in Thailand. This study demonstrates that implementing various energy conservation programs can saved the energy consumption of these sectors by 23,219 GWh and 829 kton or equivalent to 23% from its BAU scenario.

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APPENDIX

Table A1 The shares of electrical energy uses of the four building categories

Activity	Appliance and equipment	Share of energy used in residential house (%)		Share of energy used in small commercial building (%)	
		Within Municipality	Outside Municipality	Within Municipality	Outside Municipality
Lighting	fluorescent lamp	11.93	15.64	11.46	8.73
	incandescent lamp	0.52	0.86	0.26	0.29
Cooking	electric rice cooker	4.25	7.31	2.93	3.47
	electric stove	0.29	0.21	0.33	0.02
	electric frying pan	1.24	0.99	0.54	0.66
	Microwave	0.97	0.34	0.49	0.1
	Oven	0.28	0.31	0.17	0.03
	electric kettle	3.69	4.62	2.54	2.55
	blender juice	0.12	0.19	0.19	0.25
	Toaster	0.26	0.32	0.1	0
Entertainment	TV	8.26	10.67	5.22	5.06
	VDO/VCD player	0.26	0.31	0.19	0.15
	Stereo	5.39	5.27	3.22	3.39
	Radio	0.38	0.58	0.25	0.2
	Computer	2.34	0.94	10.35	1.09
Amenity	Fan	6.09	7.13	3.97	3.66
	wall fan	1.06	0.97	1.45	1.16
	floor air-conditioning	12.83	2.9	7.7	2.66
	wall air-conditioning	10.38	2.88	5.8	0.97
	vacuum cleaner	0.52	0.2	0.33	0.1
	washing machine	1.4	1.17	0.91	0.79
	water heater	7.12	2.42	1.81	1.25
	Iron	5.23	7.16	3.27	3.56
	electric water pump	1.81	6.06	1.12	2.71
	Refrigerator	9.17	14.9	5.49	6.8
	Freezer	0.61	1.03	21.3	34.33
Other		3.59	4.65	8.62	16.03
Total		100	100	100	100

Table A2 Number of household within and outside municipal areas (Million)

Year		2010	2011	2012	2013	2014	2015	2020	2025	2030
Residential houses	In M	5.44	5.60	5.77	5.95	6.13	6.31	7.34	8.55	9.96
	Out M	8.05	8.01	7.96	7.91	7.86	7.80	7.43	6.91	6.23
	Total	13.49	13.61	13.73	13.86	13.98	14.11	14.77	15.46	16.19
Small commercial buildings	In M	1.59	1.64	1.69	1.74	1.80	1.85	2.15	2.51	2.92
	Out M	0.94	0.94	0.93	0.93	0.92	0.91	0.87	0.81	0.73
	Total	2.54	2.58	2.62	2.67	2.72	2.76	3.02	3.32	3.65

Table A3 The electricity consumption (GWh) forecasted by the electric load forecast sub-committee under the committee for administration of energy policy

Building	2010	2011	2012	2013	2014	2015	2020	2025	2030
Residential houses	30,311	31,605	33,020	34,545	36,123	37,682	46,113	56,036	68,020
Small commercial buildings	12,645	13,313	14,061	14,892	15,766	16,704	21,949	28,754	38,053