Demand Side Management Options in the Household Sector through Lighting Efficiency Improvement for Java-Madura-Bali Islands in Indonesia

Muhammad Ery Wijaya[1] and B. Limmeechokchai[2,*]

[1]The Joint Graduate School of Energy and Environment, King Mongkut's University of Technology Thonburi, Bangkok, Thailand
[2]Sirindhorn International Institute of Technology, Thammasat University, Patumthani, Thailand
*Corresponding Author: bundit@siit.tu.ac.th

Abstract: In 2006, the industrial sector became the biggest electricity consumer in Indonesia, followed by the household sector. The industrial sector consumed approximately 43% of total electricity followed by the household sector with 35%. By using the Long-range Energy Alternatives Planning system (LEAP) model for electricity projection from 2006 to 2025 for the Java-Madura-Bali (Jamali) islands, it was found that the household sector would become the biggest consumer by 2025, consuming about 42%. This study applied the demand side management (DSM) options to reduce electricity demand in the household sector by implementing lighting efficiency improvements namely: (1) replacing 40W incandescent lamps with 8W compact fluorescent lamps (CFL), (2) replacing 60W incandescent lamps with 12W CFL and (3) replacing 100W incandescent lamp with 20W CFL. With lighting efficiency improvements, the electricity demand would be reduced by 5.2% in 2025. For electricity generation capacity, it would reduce the electricity generation capacity by 3.2 GW or 5% of total generation capacity of the Business as Usual (BAU) scenario in 2025 and also reduce emissions by about 15.4 million tonnes of CO_2 equivalent, accounting for a reduction of 5.8% compared to the BAU scenario. The DSM costs are analyzed in order to achieve electricity demand reduction target. In addition, the externality costs avoided by DSM application are also calculated to find a reasonable incentive for it.

Keywords: The household sector, demand side management, electricity demand reduction, LEAP model, emission reduction.

1. Introduction

Economic and population growth increase the demand for electricity. During 1999 to 2006, Indonesia's Gross Domestic Product (GDP) average growth rate was 4.86% per year. The Indonesian population also increased from 205 million people in 2000 to 222 million people in 2006 [1]. Electricity consumption increased 45% from 2000 to 2006. In 2006, the industrial sector consumed 40% from total electricity produced in the country. The household sector was second electricity with 38% consumption. The smallest electricity consumer was the transport sector through electric railway transportation, which was only 67 GWh in 2006. Fig. 1 shows Indonesian electricity consumption by sector in 2006. The transport sector's electricity consumption is negligible.

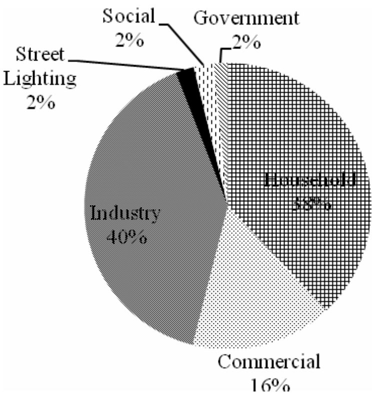

Figure 1. Indonesian electricity demand composition in 2006.

The increasing population would give increase the electricity consumption of the growing household sector. The electricity consumption of the household sector in 2005 was 41 TWh and in 2006 increased to 43 TWh, accounting for 6% of electricity consumption in 2005. The household sector in 2006 consisted of 33 million families and nearly 70% or approximately 24 million households are in the Java-Madura-Bali islands (Jamali). This paper analyzes the Indonesian electricity demand from 2006 to 2025 for the Jamali islands by using the Long–range Energy Alternatives Planning (LEAP) model. It also examines demand side management (DSM) options in the household sector by energy efficiency improvements in lighting to reduce electricity demand in the future.

2. Power Sector in Indonesia

Based on Electricity Law No. 15/1985, electricity supply activities in Indonesia include generation, transmission and distribution according to geographical location. The state takes responsibility and gives authority to the State Electricity Company (PLN). The electrification ratio which is supplied by PLN and non-PLN power plants in 2005 was 54% and increased 63% in 2006 [2]. The total installed capacity in Indonesia in 2006 was 30 GW [1] and almost 70% of total installed capacity in the country is located in the Java-Madura-Bali (Jamali) islands [3]. All the large generation units were installed on Java Island since past demand had been concentrated on this location, and it is the most developed island in the country [4]. The Jamali area consumed 79% of the country's total electricity consumption.

The electricity demand composition of the Jamali area is still dominated by the industrial sector followed by the household sector. Fig. 2 shows the electricity demand composition of Jamali area in 2006. The industrial sector consumed about 39 GWh or 43% of total electricity consumption, while the household sector consumed around 32 GWh.

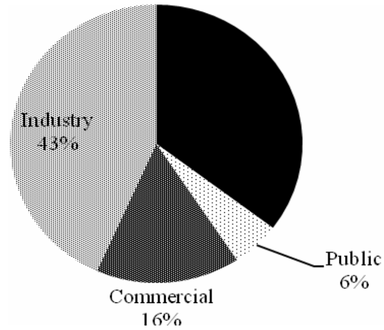

Figure 2. Jamali electricity demand composition in 2006.

3. DSM Options in the Household Sector

Demand side management (DSM) is the planning, implementation, and monitoring of utility activities designed to encourage customers to modify their electricity consumption patterns, both with respect to the timing and level of electricity demand [5].

In several years, the household sector was the most intensive sector for implementing DSM options. The reasons are that, the DSM implementation is low cost, easy to implement and has significant effects on the saving. When it is applied to the industrial sector, DSM options are expensive and difficult to implement. Several researchers have published a number of studies to investigate DSM opportunities and applications in the household sector. Ghisi et al. [6] assessed the residential electricity consumption and estimated the electricity end-use in the residential sector of Brazil. They found that the largest end-use devices are for refrigerators and freezers. Kadian et al. [7] investigated emissions related to energy applications of the household sector in Delhi, India and used energy conservation scenario focused on efficiency improvement technologies to mitigate the emissions from household sector such as in the lighting and cooling devices. Chaosuangaroen and Limmeechokchai [8] assessed energy savings planning in the household sector, small commercial buildings and small industries in Thailand by efficiency improvement mainly in the lighting, heating and cooling devices, electric motors, and other electric devices.

Similar to several studies that focus on lighting efficiency improvements by replacing incandescent lamps with compact fluorescent lamps (CFLs). Friedmann et al. [9] introduced CFLs to replace incandescent lamps in Mexico. They found that it could be significant to reduce electricity used for household lighting. However, 1/6 of the incandescent lamps can be replaced with CFLs only if they are used more than 4 hours per day, since they would be cost-effective to replace. Mahlia et al. [10] investigated the cost and benefits and emissions reduction of lighting in the residential sector by replacing incandescent lamps with CFLs in Malaysia. Kazakevicius et al. [11] found that in Lithuania replacing only the two most used 60W incandescent lamps per household with CFLs would save 190 GWh of electrical energy annually. Wall and Crosbie [12] assessed the potential of reducing lighting electricity consumption in the household sectors by replacing incandescent lamps with compact fluorescent lamps (CFLs) in the United Kingdom. Marpaung et al. [13] studied Indonesian DSM options in the household and industrial the sectors by replacing incandescent lamps with CFLs and replacing standard motors with efficient ones. The DSM effort investigated to mitigate the emission from the power sector.

4. The Long-Range Energy Alternatives Planning (LEAP)

The LEAP software system is a scenario-based energy-environment modeling tool developed by the Stockholm Environment Institute (SEI). It is suitable for various tasks including energy consumption forecasting, environmental emission analysis, integrated resource planning, and energy scenario-based analysis.

The LEAP serves several purposes: as a database, it provides a comprehensive system for maintaining energy information; as a forecasting tool, it enables the user to make projections of energy supply and demand over a long-term planning horizon; as a policy analysis tool, it simulates and assesses the physical, economic, and environmental effects of alternative energy programs, investments, and actions [14].

Unlike macroeconomic models, LEAP does not attempt to estimate the impact of energy policies on employment or GDP, although such models can be run in conjunction with LEAP. LEAP also does not automatically generate optimum or market-equilibrium scenarios, although it can be used to identify least-cost scenarios. The Important advantages of LEAP are its flexibility and ease-of-use, which allow decision-makers to move rapidly from policy ideas to policy analysis without having to resort to more complex models [15].

5. Scenario Analysis

5.1 Business as Usual (BAU) Scenario

The baseline scenario or business as usual (BAU) scenario is the scenario following the government's electricity plan. The data on existing, committed and candidate power plants and electricity demand profiles used in this study are based on Indonesia's energy economic statistics [1] and national electricity planning 2006-2026 [3]. In this study, the BAU scenario starts from 2006 as the base year. The population growth rate is assumed to be 1% per year and the electrification ratio is assumed to be 93% in 2026. The demand sector was divided into four categories; household, commercial, public and industry. The electricity demand in 2006 and the expected growth rate every 5 years are given in Table 1. The efficiency of transformation and distribution branches will calculated by using losses. In 2006, the losses were 15% and assumed to be reduced by 1% every five years.

In the Jamali system, the current total installed capacity is 19,615 MW. The Indonesian government in July 2006 by the Presidential regulation No. 71/2006 assigned PLN to accelerate coal power plant development. This effort is required to accelerate the energy diversification for electricity generation from oil to other resources using coal steam power plants with a total capacity of 10,000 MW, where in the Jamali system it would be installed by 6,650 MW.

The committed power plants in the Jamali system from 2006 to 2011 are gas turbine, geothermal, and coal steam with 790 MW, 470 MW, and 9,810MW respectively. The next committed power plant after 2010/2011 will be nuclear which is expected that nuclear power plant will feed into the Jamali system in 2016, 2017, 2023 and 2024 by an additional capacity of 1,000 MW each time. Since there is no more data for committed power plants, the other additional power plant would be calculated as inputs in endogenous capacity variables, and the power plant operation would follow the government's intention to promote using coal resources optimally. The supply planning was based on a required reserve margin. For Jamali, the projected reserve margin is 35% until 2019, and then from 2020 onwards the reserve margin is reduced to 30%.

Table 1. Electricity demand in 2006 and expected growth until 2025 in Jamali system.

Sector	Electricity demand 2006 (GWh)[a]	Growth rate/year (%)[b]			
		2006-2010	2011-2015	2016-2020	2021-2025
Household	32,334	8.9	8.2	7.1	6.2
Commercial	14,595	9.6	8.5	7.8	7.2
Public	4,932	10.7	11.1	10.7	10.7
Industry	39,661	4.0	3.5	3.6	3.8

Source:

a) CDI-EMR [1]

b) DEMR [3].

5.2 Lighting Efficiency Improvement (LEI) Scenario in the Household Sector

Lighting is the most widely used electrical device in the household sector. In Indonesia, approximately 59% of lamps were incandescent while the rest were fluorescent tubes [13]. In an incandescent lamp, electricity heats up a wire filament, causing it to glow and give off light. More than 90% of the energy produced by an incandescent lamp is heat, not light; therefore incandescent lamps are inefficient light sources [10], which is a good reason to replace incandescent lamps with CFLs. In LEI scenario penetration rate of the lighting replacement is assumed to be linear. Table 2 shows the lighting efficiency improvement scenarios.

The replacement of incandescent lamps with CFLs impacts the energy intensity (EI). The EI of the household sector in 2006 was 1,367 kWh/consumer. In the period of 2006-2010, replacing incandescent lamps by CFLs with penetration rates of 20% would be reduced EI by 93 kWh/consumer. In the period of 2011-2020 the EI would be reduced by 280 kWh/consumer, while in the last period (2021-2025) the EI would be reduced by 373 kWh/consumer.

Table 2. Lighting efficiency improvement scenarios.

Period	Measure	Penetration
2006-2010	Replace incandescent 40W to CFL 8W	20%
	Replace incandescent 60W to CFL 12W	
	Replace incandes(1995)cent 100W to CFL 20W	
2011-2020	Replace incandescent 40W to CFL 8W	60%
	Replace incandescent 60W to CFL 12W	
	Replace incandescent 100W to CFL 20W	
2021-2025	Replace incandescent 40W to CFL 8W	80%
	Replace incandescent 60W to CFL 12W	
	Replace incandescent 100W to CFL 20W	

6. RESULTS AND DISCUSSION

6.1 Electricity Demand Analysis

6.1.1 Business as Usual (BAU) Scenario

At the end of period, the demand will be increasing over three times than in the base year. It also shows that the industrial sector is not going be the largest electricity consumer in 2025. The household sector takes the largest share of electricity consumption by consuming 131.6 TWh or about 42% of total electricity consumption. The industrial sector takes the next place by consuming about 79.4 TWh. The high electricity consumption in the household sector is caused by the high growth rate in each period. The change of composition in the demand is an indication that there is a good opportunity to conduct energy efficiency efforts in the household sector to reduce the demand growth. Table 3 shows the electricity demand in the BAU scenario.

Table 3. Electricity demand projection by sector in the BAU scenario.

Sector	Electricity demand projection (TWh)			
	2010	2015	2020	2025
Household	45.5	67.9	96.6	131.6
Public	7.4	12.5	20.8	34.6
Commercial	21.1	32	46.9	66.7
Industry	46.4	55.4	66	79.4
Total	120.3	167.7	230.3	312.4

High growth rate of the public and commercial sectors increase the electricity consumption of both sectors over three times in the end of a period. In 2006, the public sector consumed 4.9 TWh, while in the 20 25, it is consuming 34.6 TWh. Electricity consumption of the commercial sector is also rapidly increasing from 14.5 TWh in 2006 to 66.7 TWh in 2025.

6.1.2 Lighting Efficiency Improvement (LEI) Scenario in the Household Sector

The lighting efficiency improvement in the household sector contributes to electricity demand reduction in 2025 by 15.5 TWh, accounting for a reduction of 13% as compared to demand in the household sector of the BAU scenario. Table 4 shows the electricity demand projection in the LEI scenario. Total electricity demand reduction in the LEI scenario is about 5.2% of total electricity demand in the BAU scenario in 2025.

Table 4. Electricity demand projection by sector in the LEI scenario.

	Electricity demand projection (TWh)				
	2006	2010	2015	2020	2025
Household	32.3	44.3	63.1	85.9	116.1
Public	4.9	7.4	12.5	20.8	34.6
Commercial	14.6	21.1	32	46.9	66.7
Industry	39.7	46.4	55.4	66	79.4
Total	91.5	119.2	162.9	219.6	296.8

6.2 Environmental Emission Analysis

6.2.1 Electricity Generation

Reduction of electricity demand in the LEI scenario impacts on the electricity generation capacity becasue the electricity generation is designed to fulfill the electricity demand. In the BAU scenario, to meet the demand in 2025, the electricity generation needs an installed capacity of 65.9 GW, while in the LEI scenario it needs only 62.7 GW or will save about 3.2 GW from the BAU scenario. The details of electricity generation capacity in each scenario are given in Table 5.

Table 5. Projection of power capacity for Jamali system.

Scenario	Total capacity (GW)				
	2006	2010	2015	2020	2025
BAU	19.5	28.6	37.7	49.2	65.9
LEI	19.5	28.4	36.5	46.9	62.7

6.2.2 Global Warming Potential (GWP)

The global warming potentials are always expressed relative to the level of CO_2. Table 6 shows the total emissions from each scenario. The BAU scenario emits about 288.5 millio n tonnes of CO_2 equivalent in 2025, while the LEI scenario would reduce emissions from electricity generation about 15.4 million tonnes of CO_2 equivalent, accounting for a reduction of 5.8% as compared to the BAU scenario.

Table 6. Total emissions in the BAU and LEI scenarios.

Scenario	Total emission (million tonnes of CO_2 equivalent)				
	2006	2010	2015	2020	2025
BAU	82.6	117.2	168.7	219.4	288.5
LEI	82.6	116.2	163.5	208.3	272.7

The success of the LEI scenario in reducing emissions comes from electricity demand reduction which reduces the electricity generation capacity. Moreover, it would reduce emissions from the power sector sector.

6.3 Demand Side Management (DSM) Costs

One of the key successes in DSM applications is supporting people taking part in the DSM program by giving incentives on free CFLs to replace incandescent lamps, thus financial limitations are one obstacle for the government to support it. In Indonesia, the CFL price varies depending on its quality and brand. The average prices of 8W, 12W, and 20W are 3.5 USD, 5.5 USD and 9 USD respectively.

In the base year, the household size in the Jamali area is 23.65 million households. The household growth rate is assumed to be 1% per year. The penetrations of lighting efficiency improvement are based on Table 2. In the period of 2006-2010, improvements need to be installed in 4.75 million households; in period of 2011-2020, 14.39 million households will install improvements while in the last period of 2021-2025, the improvements will be installed in 19.28 million households.

The costs of the LEI scenario are shown in Table 7. The highest cost is CFL 20W since the price of the lamp is slightly more expensive than others. The total cost in the period of 2006-2010 is 85.47 million USD; in period 2011-2020, 259 million USD will be spent on this program. Meanwhile, in the last period, it will consume 347 million USD.

Table 7. Lighting efficiency improvement budget.

Measure	Program cost of each period (million USD)		
	2006-2010	2011-2020	2021-2025
8W	16.62	50.36	67.48
12W	26.12	79.14	106.04
20W	42.74	129.49	173.52
Total cost	85.47	258.99	347.05

The high costs of the LEI scenario can be reduced by considering two benefits of the scenario, namely: (1) the external costs that can be avoided, and (2) the benefits from saving electricity, and avoiding the cost of the expanding electricity capacity due to reducing the electricity demand for lighting.

The unit damage cost of externalities will be adopted from the ExternE 2005 [16]. The value of unit damage is €19/tonnes of CO_2. The rate adopted for this purpose is €1=$1.4. In the period of 2006-2010, the external costs that can be avoided are 26.6 million USD, which will not be sufficient to cover the lighting replacement costs in that period. However, in the periods of 2011-2020 and 2021-2025, the external costs avoided will be able to cover the program costs. The details of external costs avoided are given in Table 8.

Table 8. The emissions and external costs avoided in the LEI scenario.

Period	Emissions avoided (million tonnes of CO_2)	Externalities cost avoided (million USD)
2006-2010	1	26.6
2011-2020	11.1	(1995)295.26
2021-2025	15.8	420.28

Moreover, the LEI scenario results in avoiding cost of electricity expansion planning. The component costs of electricity expansion are presented in Table 9. The avoided costs in the period of 2006-2010 are 17 million USD, increasing to 254 million USD in the period of 2011-2020. At the end of the period, the costs that can be avoided are about 355 million USD (see Table 10).

Total avoided costs of the LEI scenario can be calculated as the sum of the avoided externalities and expansion costs (see in Table 11). In the period of 2006-2010, the avoided costs are 43.6, which means that the total avoided costs can fulfill only half of the required costs to run the LEI scenario in that period. However, in the periods of 2011-2020 and 2021-2025, the total avoided costs would be able to cover all required costs of the LEI scenario.

Table 9. Components of costs of electricity expansion in all scenarios.

Type of power plant	Capital cost (10^3 US$/MW)	Fuel cost (US$/MWh)	O&M cost (US$/MWh)
Steam	1,226 a)	26.76 b)	2.15 b)
Gas turbine	550 b)	86.47 b)	11.69 b)
Combined cycle	600 c)	52.34 b)	5.37 b)
Geothermal	1,800 d)	48.19 b)	3 b)
Nuclear	1,728 e)	4.4 e)	8.3 e)

Source: a) BATAN, 2002 [17]
b) PLN, 2005 [18]
c) IEA, 2005 [19]
d) Sanyal, 2005 [20]
e) BATAN, 2006 [21]

Table 10. Avoided cost of electricity expansion planning.

Scenario	Total Cost (US$ million)		
	2006-2010	2011-2020	2021-2025
BAU	1,494	4,169	6,256
LEI	1,477	3,915	5,901
Total avoided costs	17	254	355

Table 11. Total avoided costs of the LEI scenario.

Avoided costs	Total Cost (US$ million)		
	2006-2010	2011-2020	2021-2025
Externalities cost	26.6	295.26	420.28
Expansion cost	17	254	355
Total	43.6	549.26	775.28

7. Conclusion

Indonesia, as a developing country, has rapid economic and population growth which consequently increases electricity demand. Our findings show that by 2025, the electricity demand will be three times that of 2006. The electricity demand composition also changes. In 2006, the industrial sector became the largest electricity consumer. Meanwhile, in 2025, the largest electricity consumer is turning to the household sector.

This study implemented one of the DSM options in the household sector by applying ther energy efficiency scenario through lighting efficiency improvement, namely: (1) replacing 40W incandescent lamps with 8W compact fluorescent lamps (CFL), (2) replacing 60W incandescent lamps with 12W CFLs, and (3) replacing 100W incandescent lamps with 20W CFL. The main aim of DSM is to reduce demand reduction in the future. The LEI scenario succeeds in reducing the electricity demand in 2025 by 5.2%. The LEI scenario also reduces electricity generation capacity by about 3.2 GW or 5% of total generation capacity of the BAU scenario in 2025. Furthermore, it reduces emissions by about 15.4 million tonnes of CO_2 equivalent, accounting for a reduction of 5.8% as compared to the BAU scenario.

The cost of the LEI scenario in the periods of 2006-2010, 2011-2020, and 2021-2025 are 85.47, 259, and 347 million USD, respectively. The high cost of the scenarios can be replaced by considering the benefits of the scenario, such as external costs that can be avoided by emission reduction and the avoided cost of the electricity expansion capacity due to reducing the electricity demand for lighting. The total costs avoided are 43.6, 549.26, and 775.28 million USD respectively. Another financial scheme that may available to support the lighting replacement program is through the Clean Development Mechanism (CDM) by selling carbon credit.

Finally, the DSM applications would be achieved if the Indonesian government and the Indonesian people support them. The government might support them by enclosing the energy policy and giving incentives to the people. Meanwhile, as the electricity consumer, Indonesian people might support it by being aware of and concerned with their daily electricity consumption.

Acknowledgments

The authors would like to acknowledge Sirindhorn International Institute of Technology of Thammasat University for providing all facilities during the study and the Joint Graduate School of Energy and Environment at King Mongkut's University of Technology Thonburi for providing scholarships.

References

[1] Center for Data and Information on Energy and Mineral Resources, Handbook of Indonesia's Energy Economic Statistics (2007) CDI-EMR, Jakarta, Indonesia.

[2] Center for Data and Information on Energy and Mineral Resources (2007) Key Indicator of Indonesia Energy and Mineral Resources,CDI-EMR, Jakarta, Indonesia.

[3] Department of Energy and Mineral Resources, National Electricity Masterplan 2006-2016 (2006) Jakarta, Indonesia.

[4] Rahmatullah C, Aye L, Fuller RJ, Scenario Planning for the Electricity Generation in Indonesia, *Energy Policy*, 35 (2007) 2352-2359.

[5] U.S. Agency for International Development, Indonesia Demand-Side Management, Volume I: Action Plan (1992) USAID, Washington DC., US.

[6] Ghisi E, Gosch S, Lamberts R, Electricity End-uses in the Residental Sector of Brasil, *Energy Policy* 35 (2007) 4107-4120.

[7] Kadian R, Dahiya RP, Garg HP, Energy-related Emission and Mitigation Opportunities from the Household Sector in Delhi, *Energy Policy* 35 (2007) 6195-6211.

[8] Chaosuangaroen P, Limmeechokchai B, Scenario-Based Assessment of Energy Savings in Thailand: A Long-range Energy Alternative Planning Approach, *Thammasat International Journal of Science and Technology* 13/2 (2008) 11-19.

[9] Friedmann R, De Buen O, Sathaye J, Gadgil A, Saucedo R, Rodriguez G, Assessing the Residental lighting Efficiency Opportunities in Guadalajara and Monterrey, Mexico, *Energy* 20 (1995) 151-159.

[10] Mahlia TMI, Said MF.M, Masjuki HH, Tamjis MR, Cost-benefit Analysis and Emission Reduction of Lighting Retrofits in Residential Sector, *Energy and Buildings* 37 (2006) 573-578.

[11] Kazakevicius E, Gadgil A, Vorsatz D, Residential lighting in Lithuania, *Energy Policy* 27 (1999) 603-611.

[12] Wall R, Crosbie T, Potential for Reducing Electricity Demand for Lighting in Households: an Exploratory Socio-technical Study, *Energy Policy* (2008) doi:10.1016/j.enpol.2008.10.045.

[13] Marpaung OP, Soebagio A, Shrestha RM, Factors affecting emission mitigation of T&D loss reduction for power sector planning with DSM options: a case of Indonesia**,** *Proceeding of Transmission and Distribution Conference and Exhibition 2002: Asia Pacific.* IEEE/PES 2 (2002) 1010-1014.

[14] Cai W, Wang C, Wang K, Zhang Y, Chen J, Scenario Analysis on CO_2 Emissions Reduction Potential in China's Electricity Sector, *Energy Policy* 35 (2007) 6445–6456.

[15] Stockholm Environment Institute, Long-range Energy Alternative Planning System, User Guide, Boston, USA, 2006.

[16] ExternE, ExternE: Externalities of Energy, Methodology 2005 (2005) Update, EUR21951, European Commission, Luxemburg, Germany.

[17] National Nuclear Energy Agency (BATAN), Comprehensive Assessment of Different Energy Sources for Electricity Generation in Indonesia (CADES) Phase I, Jakarta, Indonesia, 2002.

[18] State Electricity Company (PLN), Statistics 2005, Jakarta, Indonesia, 2005.

[19] International Energy Agency (IEA), Projected Costs of Generating Electricity 2005 Update, OECD Publication, Paris, 2005.

[20] Sanyal SK, Cost of geothermal Power and Factors that Affect It, *Proceedings of World Geothermal Congress 2005*, 24-29 April 2005, Turkey, 2005.

[21] National Nuclear Energy Agency (BATAN), Study on Economics, Funding and Ownership Structure in the Preparation of the First Nuclear Power Plant in Indonesia, Jakarta, Indonesia, 2006.