User Guide
For Commercial Sector

Indonesia 2050 Pathway Calculator

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1. Overview of Energy Consumption in Commercial Sector

Commercial sector consists of trade, hotels, restaurants, financial institutions, government agencies, schools, hospitals, communication and others. Historical data from 2004 to 2011 show that this sector grows averagely 8% per year. However, the growth of this sector does not have the same pattern as the growth of energy consumption in commercial sector. The growth of energy consumption in commercial sector from 2004 to 2011 is 4% per year in average. In 2011, commercial sector accounts for 34.1 million boe or around 3% of total final energy consumption. 70.9 % of final energy consumption in this sector is consumed in the form of electricity followed by 16.0 % , 4.2 %, 3.9 %, 3.4 %,1.7%, and 0.01% for Automotive Diesel Oil (ADO), biomass, city gas, Liquid Petroleum Gas (LPG),kerosene, and Industrial Diesel Oil (IDO), respectively (Ministry of Energy and Mineral Resources, 2012). Figure 1 presents the final energy consumption in commercial sector by fuel types from 2000 to 2011.

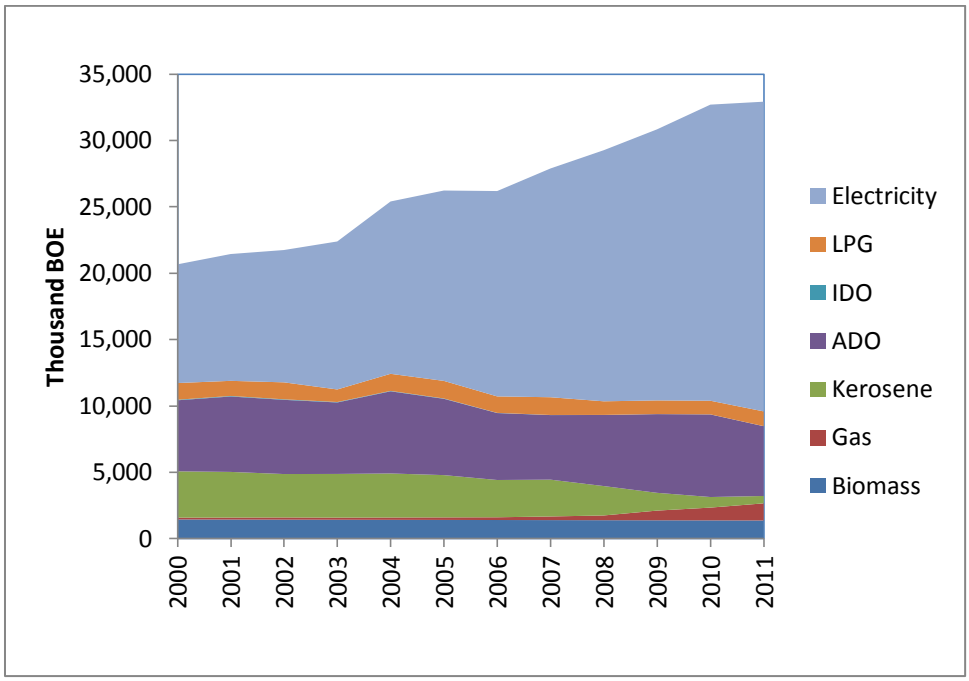

Figure 1. Final energy consumption by type of fuel 2000-2011 (Ministry of Energy and Mineral Resources, 2012)

Figure 1 shows that electricity is the form of final energy that is used the most with escalating trend each year. Economic growth is the main determining factor of final energy consumption in this sector. The higher the economic growth, the more economic activities occur in trading, hotel, restaurant, finance, government agency, school, hospital, communication and etc. which will ultimately increase the energy consumption in this sector.

Based on the data issued by the Green Building Council Indonesia (GBCI), the proportion of energy consumption in building sector from high to low is air conditioning, lighting and others (Figure 2).

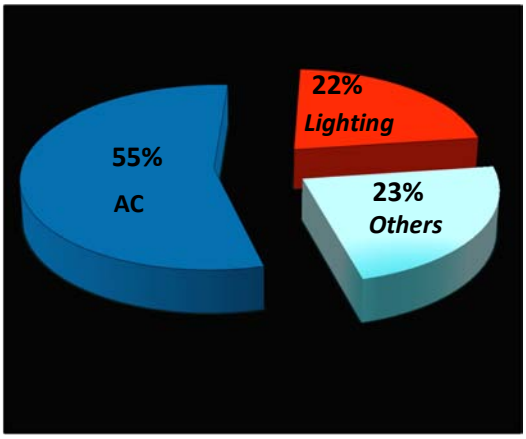

Figure 2. Energy consumption in building sector (Green Building Council Indonesia, 2014)

Commercial sector has energy saving potential. Based on the Draft of National Energy Saving Plan (RIKEN) 2011, the energy saving potential that this sector can achieve is between 10% t0 30% (Table 1).

Table 1. Energy Saving Potential

Sector	Energy Consumption by Sector in 2012 (Million BOE)	Energy Saving Potential	Energy Saving Target by Sector (2025)
Industry	305 (39,7%)	10 – 30%	17%
Transportation	311 (40,4%)	15 - 35%	20%
Household	92 (12%)	15-30%	15%
Building/Commercial	34 (4.4%)	10-30%	15%
Others (Agriculture, Construction and Mining)	26 (3.4%)	25%	-

Source: draft of National Energy Saving Plan (RIKEN) 2011 (Direktorat Konservasi Energi, Kementerian Energi dan Sumber Daya Mineral, 2014)

In order to achieve the energy conservation target, the government has issued the energy conservation policy. In general, the regulations related to energy conservation in commercial sector are:

- Standard and label of energy consuming appliances in commercial and household sectors
- Competence standard for manager and energy auditor in commercial building
- Government regulation/ governor regulation, Indonesia's National Standard (SNI) related to energy efficiency building (lighting, layout and building coat).

2. Methodology

Energy consumption in commercial sector is calculated by using the end-use model. This approach is adopted in order to accommodate the decreasing energy intensity in the future due to the penetration of high efficiency technology. By using this approach, energy consumption is the multiplication of activity level and energy intensity (see Eq.1)

$$Energy\ Consumption = Activity\ Level \times Intensity \quad (1)$$

In many literatures, the activities of commercial sector usually the floor area of commercial sector (Swisher, Jannuzi, & Redlinger, 1997). Since this kind of data is not available in Indonesia, GDP of this sector is chosen as activity level. Adopted the same structure of household sector, energy consumption is divided into four type of utilization in household, namely lighting, cooking, cooling, and others. Table 3 presents the GDP value used for I2050 PC model development.

Table 2. Model structure of household sector

Structure	Activity	Unit of intensity
Lighting	GDP of commercial sector	*boe/IDR*
Cooking		*boe/IDR*
Air conditioning		*boe/IDR*
Others		*boe/IDR*

Table 3. Gross domestic product in fixed price 2000 by sector (Billion Rupiah), 2004-2013

Sektor	2004	2005	2006	2007	2008	2009	2010	2011	2012*	2013**
1. Trade, Hotel & Restaurants	**271142.20**	**293654.00**	**312518.70**	**340437.10**	**363818.20**	**368463.00**	**400474.90**	**437472.90**	**473110.60**	**501158.40**
a. Wholesale & Retail Trade	222290.00	241887.10	257845.00	282115.80	301941.30	302028.40	331312.90	364472.10	396111.50	419458.00
b. Hotels	11590.70	12313.20	12950.50	13645.60	14261.50	15200.80	16230.90	17868.60	19540.00	21232.40
c. Restaurants	37261.50	39453.70	41723.20	44675.70	47615.40	51233.80	52931.10	55132.20	57459.10	60468.00
2. Communication	**34401.00**	**42856.80**	**54012.90**	**69535.60**	**91118.60**	**112627.30**	**132687.00**	**149456.20**	**167504.90**	**187633.80**
b. Communication	34401.00	42856.80	54012.90	69535.60	91118.60	112627.30	132687.00	149456.20	167504.90	187633.80
3. Finance, Real Estate and Business Services	**151123.30**	**161252.20**	**170074.30**	**183659.30**	**198799.60**	**209163.00**	**221024.20**	**236146.60**	**253022.70**	**272151.90**
a. Bank	68295.00	71366.90	72474.40	78241.00	84039.50	86057.50	90167.80	96393.10	104391.00	113983.60
b. Non-Bank Financial Institutions	12067.30	13074.90	14009.20	15149.80	16518.10	18147.60	19333.50	20745.10	22222.80	23780.50
c. Services Allied to Finance	1057.80	1128.30	1213.50	1331.00	1376.30	1424.60	1508.50	1627.20	1729.80	1817.30
d. Real Estate	44111.70	47714.60	51755.30	55819.10	60775.40	63957.60	67497.10	71760.20	76100.30	80684.70
e. Business Services	25591.50	27967.50	30621.90	33118.40	36090.30	39575.70	42517.30	45621.00	48578.80	51885.80
4. Services	**152906.10**	**160799.30**	**170705.40**	**181706.00**	**193049.00**	**205434.20**	**217842.20**	**232659.10**	**244869.90**	**258237.90**
a. General Government	72323.60	73700.10	76618.40	80778.20	84377.90	88683.20	92802.60	97806.00	99590.90	101031.80
1). Government Administration and Defence	46055.10	46889.60	48644.30	51148.90	53230.70	55845.80	58395.70	61510.90	62553.20	63407.20
2). Other Government Services	26268.50	26810.50	27974.10	29629.30	31147.20	32837.40	34406.90	36295.10	37037.70	37624.60
b. Private	80582.50	87099.20	94087.00	100927.80	108671.10	116751.00	125039.60	134853.10	145279.00	157206.10
1). Social and Community Services	21082.70	22604.50	24178.00	25777.40	27659.00	29688.70	31591.10	33800.10	36253.20	38898.20
2). Amusement and Recreational Services	6302.10	6713.10	7246.70	7751.80	8345.20	9000.10	9671.60	10461.70	11265.90	12237.50
3). Personal and Household Services	53197.70	57781.60	62662.30	67398.60	72666.90	78062.20	83776.90	90591.30	97759.90	106070.40

Note:

** Preliminary figures*

*** Very preliminary figures*

Source: Statistic Agency (BPS)

The base year data of energy intensity for each type of utilization (lighting, cooking, cooling, and others) is derived from the *Handbook of Energy & Economic Statistics of Indonesia*. 2012 and the judgement from the core team modeler.

3. Assumption

Growth assumption of commercial sector in this model is divided into three periods: 2011 – 2020 with 8% growth, 2025 – 2035 period (9%) and 2035 – 2050 period (12%). Such growth is obtained by considering the average historical GDP values and compare them with average growth of industry sector. Elasticity obtained by comparing the growths of industry and commercial sectors is 1.5, which means that the gowth of commercial sector will follow 1.5 growth of industry sector. Since the structure of energy consumption of commercial sector in *Handbook of Energy & Economic Statistics of Indonesia*. 2012 [1] is different from the structure in this model, the expert judgment is needed in order to find the energy intensity of each activity in base year. Table 4 presents the core team modeler's assumption in determining the energy consumption for each utilization by its type of fuel.

Table 4. The assumption of energy consumption for each activity by its type of fuel

	Biomass	Gas	Kerosene	ADO	IDO	LPG	Electricity
Lighting	-	-	-	-	-	-	22%
Cooking	100%	100%	100%	-	-	-	10%
Cooling	-	-	-	-	-	-	55%
Others	-	-	-	100%	100%	-	13%

Source: (Modeler, Core Team, 2014)

As mentioned before, due to the energy efficiency improvement and other factors, energy intensity for each type of activity is expected to decrease in 2050. Table 3 presents the result of stakeholder consultation on energy intensity reduction in 2050 in each level as compared to the base year (2011). In addition, in this model, the energy intensity between 2011 and 2050 are calculated by interpolation.

Table 5. The assumption of energy intensity reduction

Structure	Trajectory/Leveling	Energy Intensity Reduction by 2050
Lighting	Level 1	10%
	Level 2	25%
	Level 3	40%
	Level 4	80%
Cooking	Level 1	10%
	Level 2	30%
	Level 3	40%
	Level 4	50%
Cooling	Level 1	10%
	Level 2	20%
	Level 3	40%
	Level 4	60%
Other appliances	Level 1	5%
	Level 2	10%
	Level 3	20%
	Level 4	40%

Energy intensity reduction for each activity (lighting, cooking, cooling and other appliances) could be attributed to the penetration of high efficiency technology. For instance, energy saving in lighting activity, based on the stakeholder consultation, the technology that affects lighting intensity is lighting technology such as Compact Fluorescent Lamp (CFL), Light Emitting Diode (LED), and lighting sensor. In addition, the implementation of passive design in building such as the use of natural lighting also reduces the energy intensity. Based on BPPT study (2012), CFL and LEC could provide a significant energy saving feature up to 80% of electricity used for lighting. Meanwhile, halogen bulb could save 20% to 30%. Energy intensity is not merely related to appliances technology, but also other factors such as passive design of a building (insulation, natural lighting and etc.). BPPT study

also points out that the natural lighting could reduce the energy consumption for lighting by 17% - 40% *(Balai Besar Teknologi Energi Badan Pengkajian dan Penerapan Teknologi, 2012).*

Trajectories/One Pagers

Brief overview of each level used for level 1-4 scenarios is provided as follows:

I. Lighting in Commercial Sector

Commercial sector consists of trade, hotels, restaurants, financial institutions, government agencies, schools, hospitals, communication and others. The higher the floor area of this sector, the higher energy required for lighting. In general, the energy intensity for lighting is predicted to decrease due the penetration of high efficiency technology for example CFD, LED, lighting sensor and etc. Adoption of passive design in building through maximizing the use of natural lighting also contributes to reduce the energy intensity.

Level 1

Level 1 assumes that the energy intensity for lighting in commercial sector will decrease by 10% in 2050 compare to the base year. The use of CFL has been used widely in commercial sector. Bulb is not used any longer in commercial sector.

Level 2

Level 2 assumes that the energy intensity will decrease by 25% in 2050 compare to the base year. Commercial sector adopts the efficient technology such as CFL and LED. MEPS (Minimum Energy Performance Standards) Program enables the commercial sector to purchase the high efficiency products

Level 3

Level 3 assumes that the energy intensity will decrease by 40% in 2050 compare to the base year. Government policy on labeling and MEPS program for the building that consumes more than 6,000 TOE encourage the commercial sector to adopt the high efficiency technology for lighting.

Level 4

Level 4 assumes that there will be a reduction in energy intensity for lighting activity that 80% lower than the base year (2011). This situation is a result of the penetration of LED, natural lighting and lighting censor that have been widely used due to mandatory labeling and improved awareness on the importance of natural lighting in reducing energy consumption.

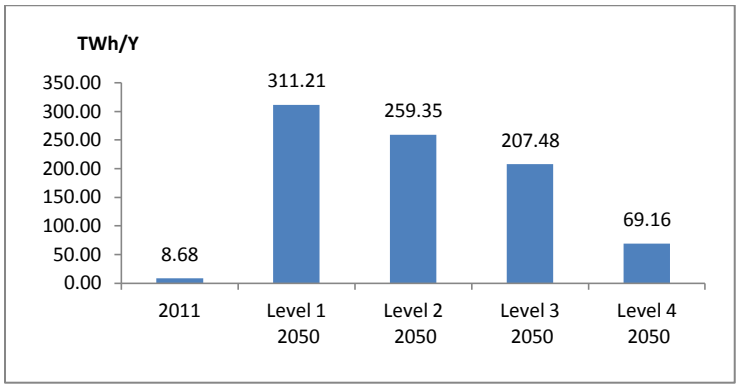

Figure 3. Energy consumption projection for lighting

II. Cooking in Commercial Sector

Types of energy used in commercial sector for cooking activity are (1) biomass (2) gas (3) kerosene (4) LPG, and (5) electricity. Cooking activity in commercial sector is expected to increase in the future because the consumers are predicted to order food from restaurant. Energy intensity for cooking activity is predicted to decrease following the penetration of high efficiency cooking appliances as well as government policy to reduce kerosene consumption.

Level 1

Level 1 assumes the energy intensity for cooking activity will be 10% lower than the base year in 2050. The high efficiency stove has been introduced, yet the adoption remains low. High efficiency stove is purchased mainly due to economic reason.

Level 2

Level 2 assumes the energy intensity for cooking activity will be 25% lower than the base year in 2050. Commercial sector starts using high efficiency stove and reduce kerosene consumption. The adoption of high efficiency stove is higher than level 1 due to active campaign by the government on the benefit of the stoves. In addition, the government also enforces the policy to reduce dependency on kerosene for cooking.

Level 3

Level 3 assumes that that the use of high efficiency stove has been widely used by the commercial sector. Standardization of efficient stove is imposed by government, thus the stove makers produce standard high efficiency stove. Commercial sector also shift from kerosene to natural gas. This

situation leads to a decrease in energy intensity for cooking which is 40% lower than the base year in 2050.

Level 4

Level 4 assumes that the energy intensity will be 50% lower than the base year in 2050. This situation is caused by the wide adoption of high efficiency stove and cooking appliances. Kerosene is not used any longer for cooking activity. Natural gas will be used widely and there will be a shift to electric stove.

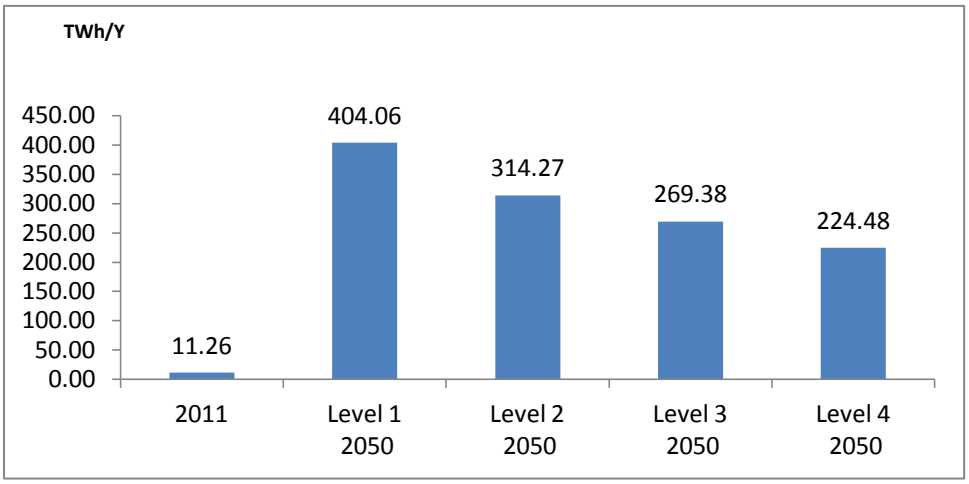

Figure 4. Energy consumption projection for cooking activity

III. Cooling in Commercial Sector

The current government policies related to air conditioning efficiency are labeling and the Minimum Energy Performance Standard (MEPS). Labeling is expected to provide information to community on the efficiency level of an appliance and encourage the producer to improve the efficiency of their products. MEPS is expected to limit the distribution of inefficient appliances in the market. In addition, it is mandatory for the commercial building with that uses more than 6,000 TOE of energy to conduct energy efficiency measures including the programs recommended from the energy audit such as bulb replacement to LED, efficient air conditioning and etc. Air conditioning with inverter technology currently develops significantly along with the production cost that continues to decrease. Ultimately, it will affect the use of air conditioning in the future and reduce the energy intensity. Passive design of a building such as the use of insulation will reduce the use of air conditioning.

Level 1

Level 1 assumes that the energy intensity of air conditioning for commercial sector will be 10% lower than the base line because the conventional air conditioning is replaced by the new air conditioning technology (change of technology occurs without any significant government intervention). Air conditioning with efficient technology feature starts to be adopted in commercial sector.

Level 2

Level 2 assumes that there is a decrease in energy intensity for cooling activity in commercial sector that is 20% lower than the base year. Labeling and MEPS are able to provide options, particularly efficient air conditioning products for commercial sector, to the buyers.

Level 3

Level 3 assumes that the energy intensity will be 40% lower than the base year in 2050. Air conditioning with energy saving technology is adopted in commercial sector. Labeling, MEPS and mandatory for building that consumes more than 6,000 TOE of energy to conduct energy efficiency measures have endorsed the commercial sector to use the efficient air conditioning.

Level 4

Level 4 assumes that the energy intensity of cooling activity in commercial sector will be 60% lower than the base year in 2050. Efficient air conditioning is massively adopted in commercial sector. Labeling, MEPS and mandatory for building that consumes more than 6,000 TOE of energy to conduct energy efficiency measures have endorsed the commercial sector to use the efficient air conditioning massively. The use of inverter, magnetic and AHU technologies as well as retrofitted chiller would lead to a significant decrease of energy intensity.

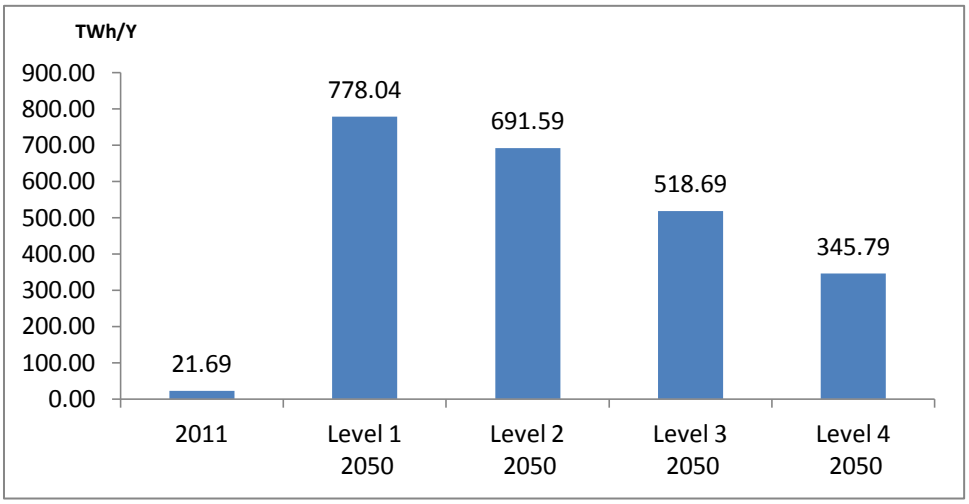

Figure 5. Energy consumption projection for cooling activity

IV. Other Appliances in Commercial Sector

Number of other electronic appliances in commercial sector is predicted to increase in the future. Electronic appliances found in commercial sector are electric motor, fan, oven, washing machine, and television. Currently, more people own electronic appliances and more electronic appliance producers in the market that compete to offer new technology and environmentally friendly products. Therefore, the energy intensity for other appliances is predicted to decrease because of the energy saving technology as well as energy efficiency awareness of appliances' users.

Level 1

Level 1 assumes that the energy intensity of other appliances in commercial sector will be 5% lower than the base year in 2050. Energy saving habit and energy saving technology have not been adopted widely.

Level 2

Level 2 assumes that the energy intensity of other appliances in commercial sector will be 10% lower than the baseline in 2050. Consumers start to develop the energy saving habit and the penetration of energy saving technology enables the consumers to replace their old appliances to the new efficient appliances.

Level 3

Level 3 assumes that the energy intensity of other appliances in commercial sector will be 20% lower than the baseline in 2050. The issuance of standardization policy and energy saving labeling causes the electronic producers to produce the energy saving products. Given the situations, the commercial sector customers have more product options and the labeling educates them to use the energy saving appliances.

Level 4

Level 4 assumes that the energy intensity of other appliances in commercial sector will be 40% lower than the baseline in 2050. The issuance of standardization policy and energy saving labeling causes the electronic producers to produce the energy saving products. Consumer chooses to utilize the energy saving products. The standardization policy is fully and strictly implemented, thus most of electronic appliances in the market are the energy saving ones. Thus, most appliances in commercial sector are the appliances with energy saving and environmentally friendly features.

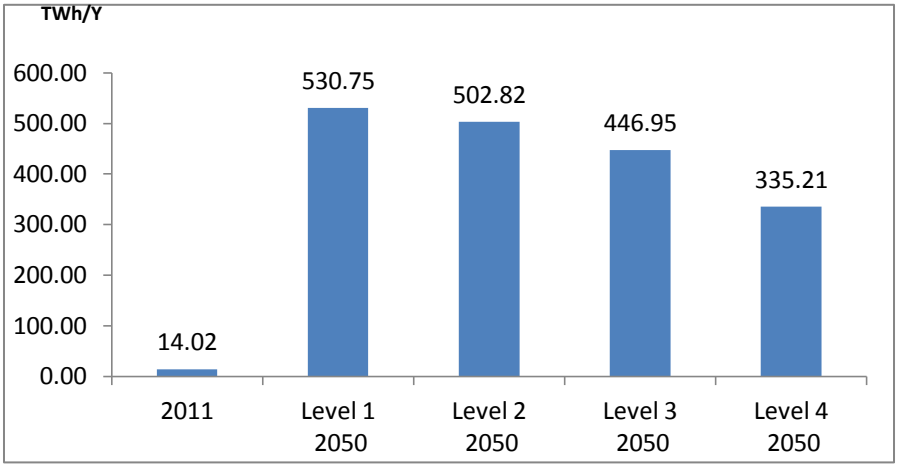

Figure 6. Energy consumption projection for other appliances

4. References

Balai Besar Teknologi Energi Badan Pengkajian dan Penerapan Teknologi. (2012). *Perencanaan Efisiensi dan Elastisitas Energi 2012.* Retrieved September 1, 2012, from http://www.bppt.go.id/unduhan/Buku%20PERENCANAAN%20EFISIENSI%20dan%20ELASTISITAS%20ENERGI%202012%20-%20B2TE%20-%20FINAL271112.pdf

Direktorat Konservasi Energi, Kementerian Energi dan Sumber Daya Mineral. (2014). Arah Kebijakan dan Pemanfaatan Energi di Sektor Komersial. *Focus Group Discussion Indonesia 2050 Pathway Calculator.* Jakarta: Kementerian Energi dan Sumber Daya Mineral.

Green Building Council Indonesia. (2014). Rating Tools and Energy Efficiency in Commercial Green Buildings Concepts. *Focus Group Discussion Indonesia 2050 Pathway Calculator 28 Agustus 2014.* Jakarta: Green Building Council Indonesia.

Ministry of Energy and Mineral Resources. (2012). *Handbook of Energy and Economic Statistics of Indonesia 2012.* Jakarta: Ministry of Energy and Mineral Resources.

Modeler, Core Team. (2014). Core Team Modeler Meeting. Bandung.

Swisher, J., Jannuzi, G., & Redlinger, R. (1997). *Tools and Methods for Integrated Resource Planning.* UNEP Collaboration Centre for Energy and Environment.