



Deliverable Report for MECON Project

Task 1.2

Baseline energy consumption of MECON household in Vietnam

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1. Overview of energy consumption for MECON target group in Vietnam

“New Modern Energy Consumer” target group is the person who earn between 2-5 dollars per day. They are the target group of project named “Effective energy efficiency policy implementation targeting “New Mordent Energy Consumer” in the Greater Mekong Sub-region” (MECON). This group is expected to play important role in energy consumption. So far there is no research had been done for this group in Vietnam. This report presents the projection of energy consumption of this group up to 2030. LEAP model was used to project energy consumption by types and appliances. The Figure 1 presents structure of energy consumption for MECON group, which is used in LEAP.

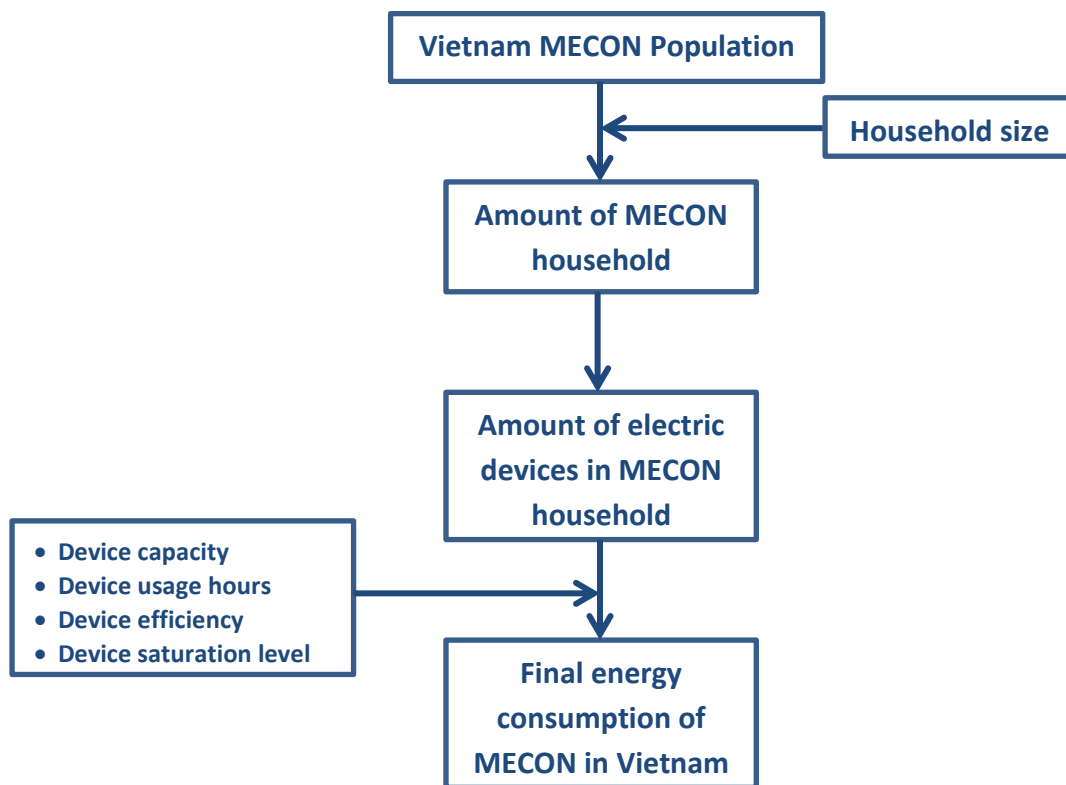


Figure 1: LEAP structure for MECON target group

2. MECON target group percent share

In order to compute the share of MECON group, econometric model was developed based on historical data of GDP, population and share of MECON (presented in equation 1). Table 1 presents these historical data and Table 2 shows the projected number of MECON households for period from 2013-2030.

$$MECON = a + b*GDPP + c*Year \text{ where } GDPP \text{ is } GDP \text{ per capita (in 2005) (Eq.1)}$$

Table 1: Historical data for GDP, population and those whose income between \$2-5 per day

Year	GDP (Current billion \$US)	Total Population (Million ppl)	Percent share of MECON population	Number of MECON Population	Number of MECON HH
1990	6.47	66.02			
1991	7.64	67.24			
1992	9.87	68.45	13.02	8.91	2.35
1993	13.18	69.65			
1994	16.31	70.83			
1995	20.80	72.00			
1996	24.69	73.16			
1997	26.89	74.31			
1998	27.23	75.46	19.61	14.80	3.90
1999	28.70	76.60			
2000	31.18	77.64			
2001	32.52	78.69			
2002	35.10	79.73	27.03	21.55	5.69
2003	39.56	80.90			
2004	49.52	82.03	36.68	30.09	7.94
2005	57.65	82.39			
2006	66.39	83.31	43.67	36.38	9.60
2007	77.52	84.22			
2008	98.27	85.12	44.36	37.76	9.96

2009	101.63	86.03			
2010	112.77	86.93			
2011	134.60	87.84	48.11	42.26	11.15
2012	155.57	88.76	48.32	42.89	11.32
2013	170.57	89.69	48.44	43.45	11.46

Source: <http://data.worldbank.org>

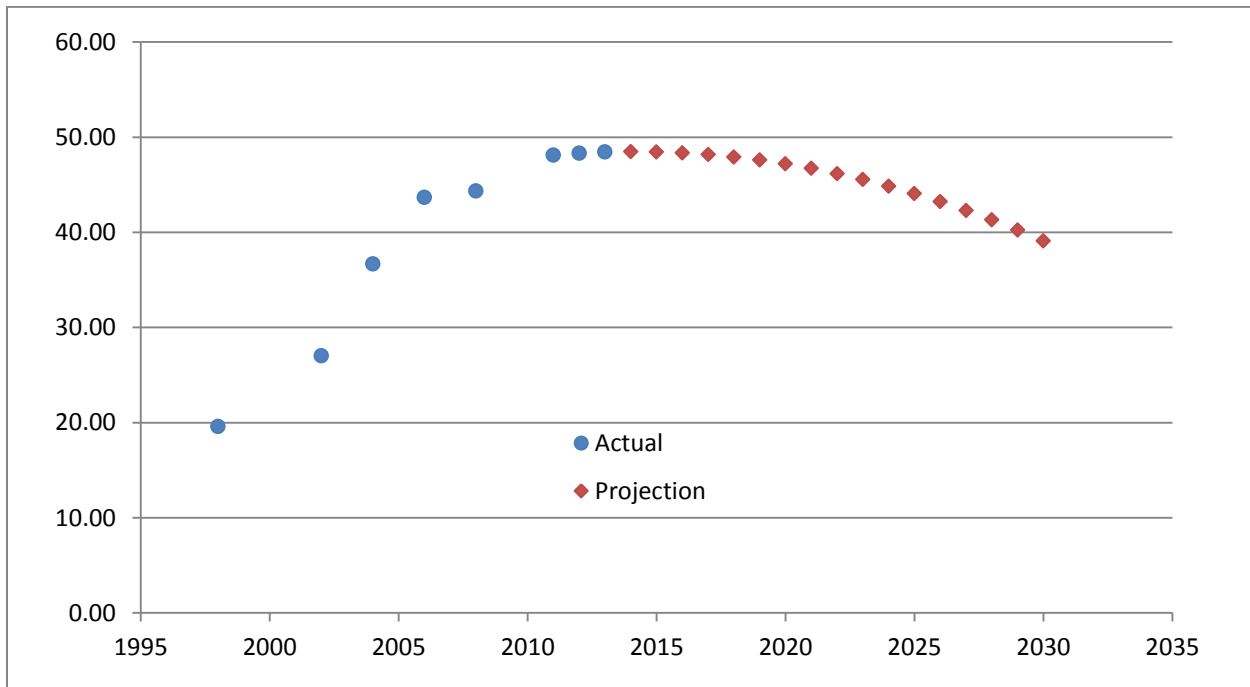


Figure 2: Share of MECON group

The total number of MECON household is presented in Table 2 below.

Table 2: Number of MECON household period 2013-2030

Year	Number of MECON HH (Million HH)
2013	11.46
2014	11.59
2015	11.71
2016	11.81
2017	11.89
2018	11.95

2019	11.99
2020	12.01
2021	12.02
2022	12.00
2023	11.96
2024	11.90
2025	11.82
2026	11.72
2027	11.59
2028	11.43
2029	11.25
2030	11.05

3. Structure of demand use for MECON target group

To create structure of energy consumption in household in LEAP, it is important to have the basic structure of electric appliances that are used in the MECON target group. To do this, household survey is needed in order to have the right information to this specific group. In LEAP structure, they are divided into 7 categories which are lighting, cooking, cleaning, entertainment, cooling, heating and others as shown in Figure 3.

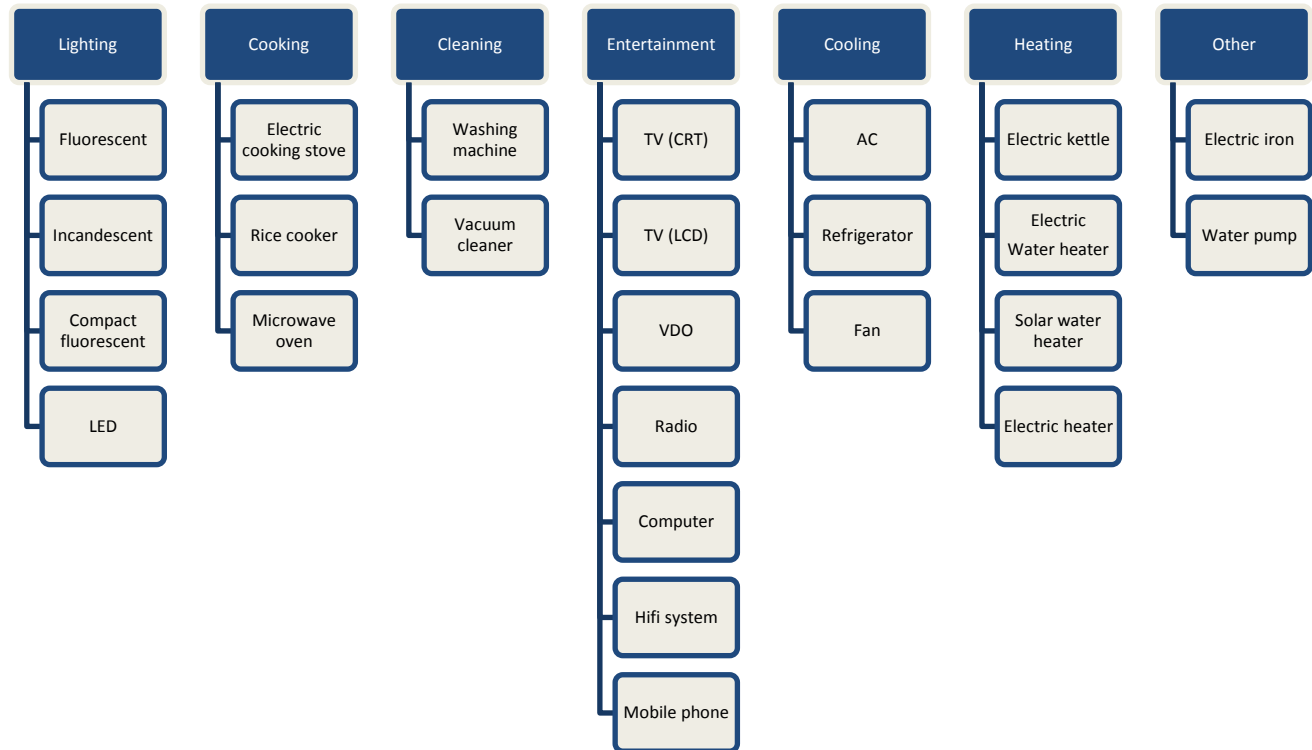


Figure 3: Electric appliance categories in MECON household in Vietnam

The structure above is classified based on the purpose of use electric appliance. For lighting, there are four main types of lamps which are fluorescent, incandescent, compact fluorescent and LED. Equipment used for cooking includes rice cooker, microwave and electric cooking stove. For cleaning purpose, there are only two devices which are washing machine and vacuum cleaner. It was found that common entertainment devices are TV, computer, radio and Mobil phone. There are two type of TV which been found from the household survey which are CRT and LCD. The proportion of LCD is still pretty low compared to the CRT. For cooling purpose, Vietnamese use AC; refrigerators and electric fans. Equipment used for heating purpose includes electric kettle, electric water heater, solar water heater and electric heater. Other appliances are electric iron and water pumps.

4. Key assumptions

Key assumptions for LEAP software to project energy baseline for MECON target group are shown in Table 3

Table 3: Fundamental key assumptions

Parameter	Detail
Base year	2013
End year	2030
Population (2013)	89.69 million people
Population growth rate	1.50%
Household size	3.79 peoples
Amount of total Vietnam household	23.67 million households
Thai MECON population share (2013)	48.44
Number of Vietnam MECON population (2013)	43.4 million people
Number of Vietnam MECON household (2013)	11.5 million households

From household survey in Task 3, we conducted 302 samples of MECON target group in Vietnam. The data is used to calculate energy consumption in the household as shown in below

$$\text{Electricity consumption (kWh/year)} = \text{Power of appliance (Watt)} \times \text{Hour use per year (Hr)} \times \text{amount of appliances} \times \text{coefficient} \quad \text{Eq.(3)}$$

However, each device does not use the rated power all the time such as refrigerator. This is because the on/off function in order to save electricity consumption for those devices. Therefore, a coefficient is used in Eq. (3) which is applied from the study of China’s urban households. For this study, the coefficient for refrigerator is 0.36. The Table 4 presents energy consumption of each device for MECON group of Vietnam in 2013.

Table 4: Energy consumption of each device for MECON target group in Vietnam in 2013

Appliance	All surveyed households					
	Wattage (Average)	Amount of appliances per household	Hours used (hours/day)	% of households owning the appliance	Energy consumption (kWh/HH/year)	% of household owning the EE appliances
Lighting technologies						
Incandescent light bulb	50.00	2.26	3.45	26.44	142.30	
Fluorescent light bulb	35.84	4.44	5.78	37.97	335.72	
Compact fluorescent light bulb	18.66	3.74	3.06	26.78	77.93	
LED	36.00	2.75	5.91	2.71	213.56	

Kerosene light bulb	60.00	1.00	5.45	0.68	-	
Cooking appliances						
Electric cooking stove	1300.00	0.05	0.29	11.19	6.94	
Rice cooker	583.73	0.85	1.64	41.36	296.73	
Microwave oven	850.00	1.00	0.28	6.78	86.87	
Biomass Stove	-	-	-	17.97	-	
Improve biomass stove	-	-	-	5.42	-	
Charcoal Stove	-	-	-	4.41	-	
LPG Stove	-	-	-	42.03	-	
Kerosene Stove	-	-	-	0.00	-	
Cleaning						
Washing machine	572.02	1.00	0.20	20.68	41.76	5.56
Vacuum cleaner	1000.00	0.50	0.15	0.68	27.38	
Cooling appliances						
AC	1533.33	0.22	3.00	7.46	369.38	11.11
Refrigerator	83.76	1.00	14.00	34.92	214.01	1.07
Electric fan	57.81	1.82	6.12	95.25	235.03	23.49
Heating						
Electric kettle	679.69	0.39	2.00	27.80	193.51	6.09
Electric water heater	945.45	0.04	1.37	18.64	18.91	
Electric Heater	500	0	2	2	18	
Solar water	500	0	2	3	18	
Entertainment						
TV CRT (box TV)	91.92	1.07	7.15	25.42	256.69	
TV LCD (flat screen TV)	147.00	1.12	5.97	19.32	358.76	19.32
Video/DVD player	50.25	0.16	1.57	22.71	4.61	
Radio	31.15	0.18	4.59	8.47	9.39	
Computer	130.36	0.17	4.16	27.80	33.65	
Hi-fi system	50.00	0.03	0.61	5.08	0.33	
Mobile phone	4.81	1.85	2.00	40.68	6.50	
Other appliances						
Water pump	145.83	0.04	1.03	27.12	2.19	
Electric iron	1000.00	0.47	0.27	22.71	46.99	

The data from Table 3 will be used in LEAP software as Business As Usual (BAU) scenario in Vietnam. The result of energy consumption baseline for MECON household in Vietnam is described in the next sections. For efficient technology, the energy consumption is assumed 20% lower than the conventional technology for every appliance. As seen the Table 4, there are only six appliances that MECON households own the EE technology; washing machine 5.56%, AC 11.11%, refrigerator, 1.07%, electric fan 23.49%, electric kettle 6.09%, and TV 19.32%.

5. Results

From key assumptions and energy consumption of MECON household in section 4, they are inputted into LEAP software. The final energy consumption for MECON target group in Vietnam is shown in Figure 4

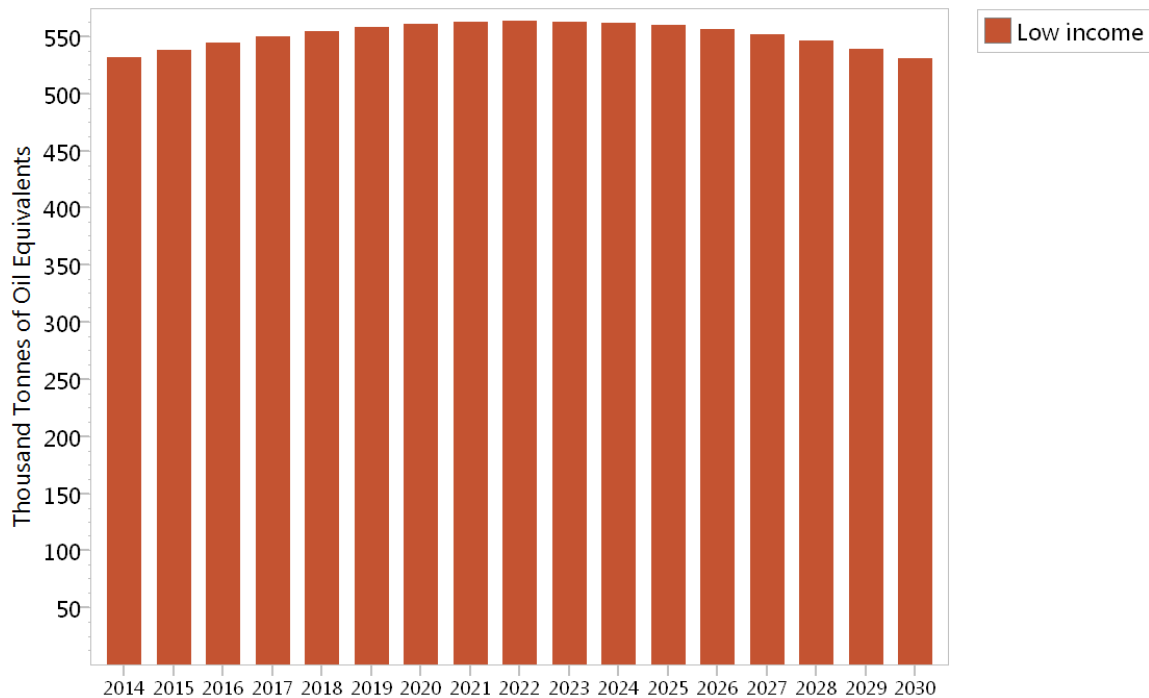


Figure 4: Energy consumption of MECON in Vietnam in BAU scenario during 2014-2030

The final energy consumption of MECON group will be varied accordingly to the number of MECON households. It will increase slightly until 2020 and then start decreasing until 2030. Total energy consumption in 2014 is 529 ktoe and it will reach 548.9 ktoe in 2020 (growth rate of 0.0059%) then decrease to 504.9 ktoe in 2030 (growth rate of -0.008%). In general total energy consumption MECON will decrease from 529 ktoe in 2014 to 504.9 ktoe in 2030 (annual growth rate of - 0,0029% per year) as shown in Figure 4.

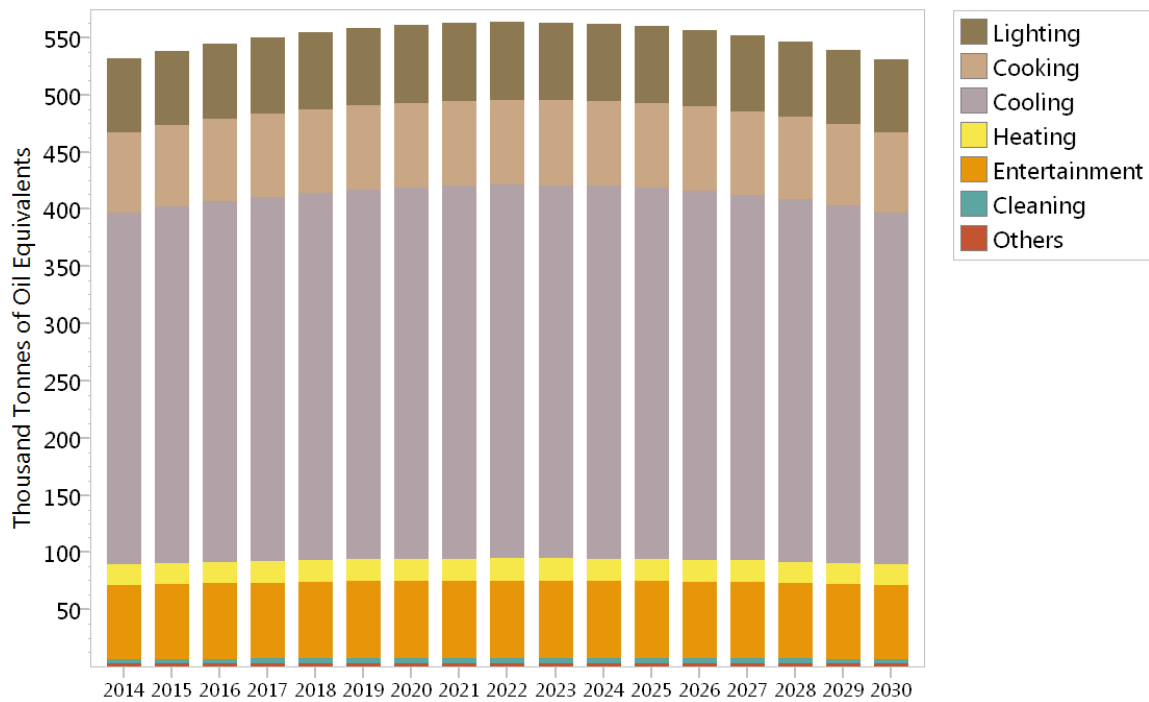


Figure 5: Energy consumption by category for MECON group in Vietnam in BAU scenario during 2014-2030

There are several electric appliances categories for MECON households. It was found that cooling devices take the highest energy consumption at 292.6 ktoe (58%) in 2030 followed by cooking, entertainment, lighting, heating, cleaning, and others at 66.6 ktoe (13.2%), 61 ktoe (12.08%), 60.9 ktoe (12.06%), and 17.3 ktoe (3.4%), 3.8 ktoe (0.7%), and 2.4 ktoe (0.4%) respectively as shown in Figure 5. Energy consumption of all type equipment decreases at annual growth rate of -0.003% per year as the number of MECON households decrease.

5.1 Lighting

Five technologies are in this category. Fluorescent lamps dominates as the highest usage for MECON household followed by compact fluorescent (CFL), incandescent (ICD) and LED and kerosene. However kerosene used for lighting is very little (<0.001% of total energy consumed for lighting in the whole period 2014-2030). LED is relatively expensive and not popular, that is why electricity consumed by this technology is still very small portion (less than 0.25% in total energy consumed for lighting).

As a result, final energy consumption in lighting was 63.9 ktoe (FLS 48.2 ktoe (75.5%), ICD 9.9 ktoe (15.5%), CFLS 5.5 ktoe (8.7%)) in 2014 and these number will slightly reduce according to the decrease of MECON percent share in Vietnam which will take account in 2030 at 60.9 toe (FLS 46 ktoe, ICD 9.4 ktoe, CFLS 5.3 ktoe) as shown in Figure 6.

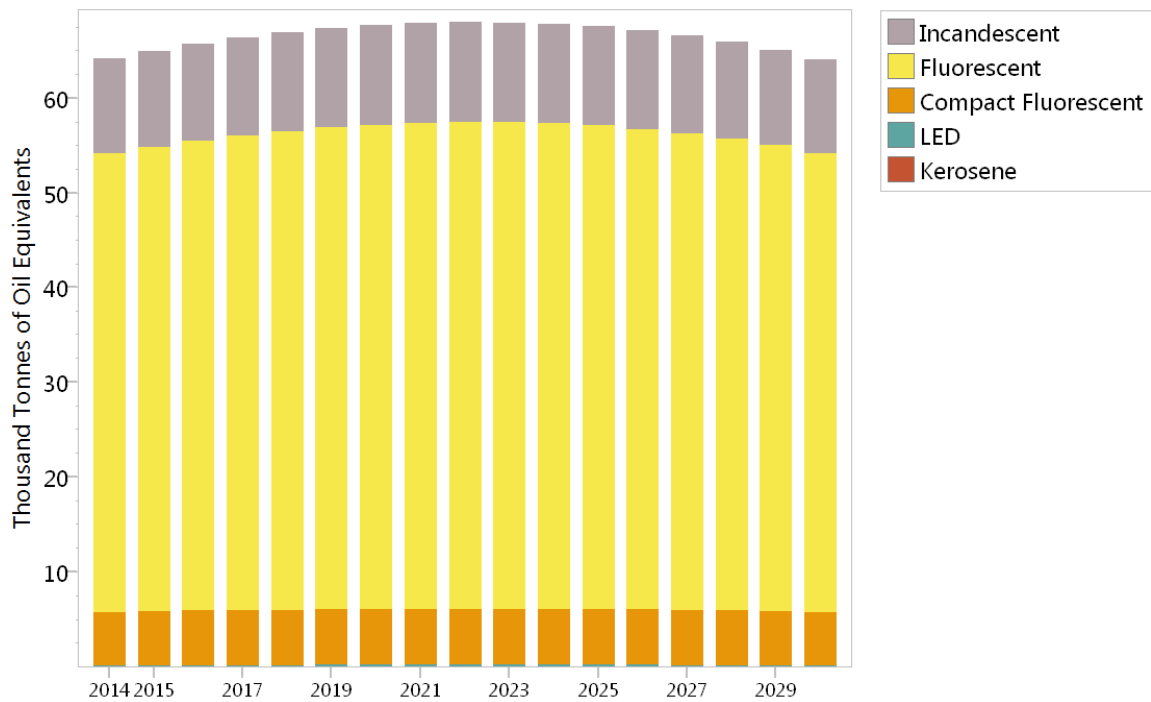


Figure 6: Energy consumption for lighting of MECON group in Vietnam in BAU scenario during 2014-2030

5.2 Cooking

As mentioned earlier, cooking appliances is the second highest energy consumed in household. In 2014, it consumed approximately 69.9 ktoe and it is expected to decrease in next 16 years. The energy consumption in cooking will be 66.6 ktoe (13% in the total energy consumption) in 2030 as shown in Figure 7. There are six cooking technologies in MECON household. It is found that rice cooker is the highest energy consumption in this category (78% of total energy consumed for cooking) because it is common used in every household.

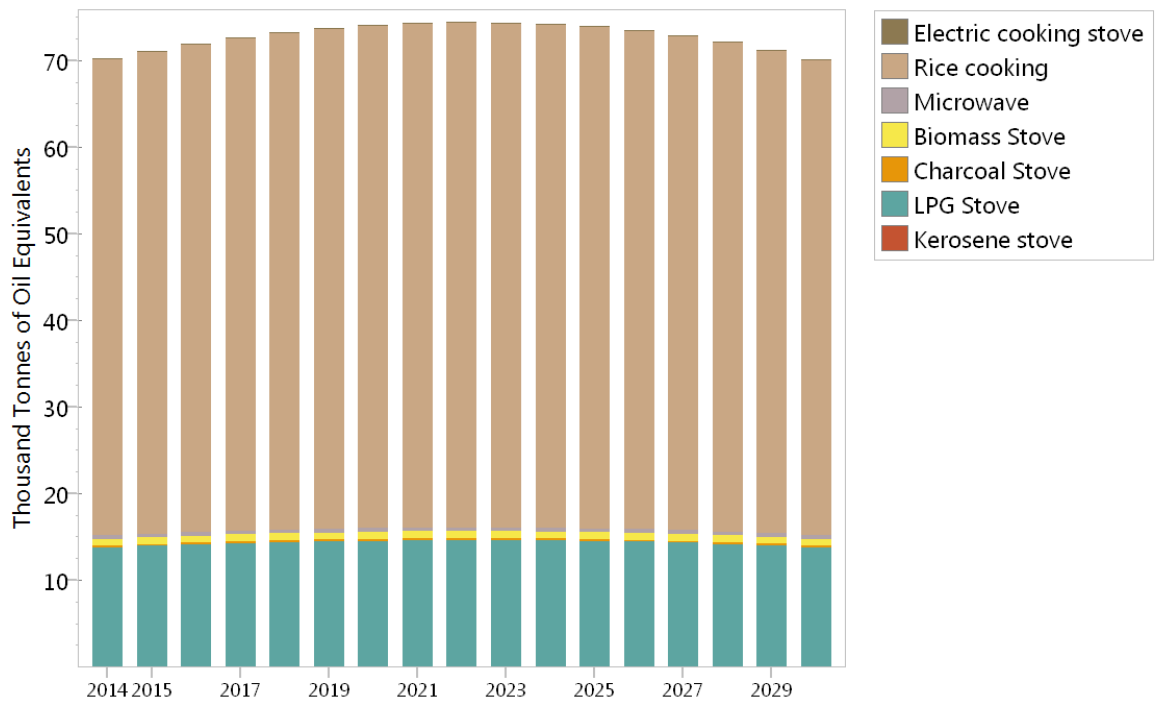


Figure 7: Energy consumption for cooking appliances of MECON group in Vietnam in BAU scenario during 2014-2030

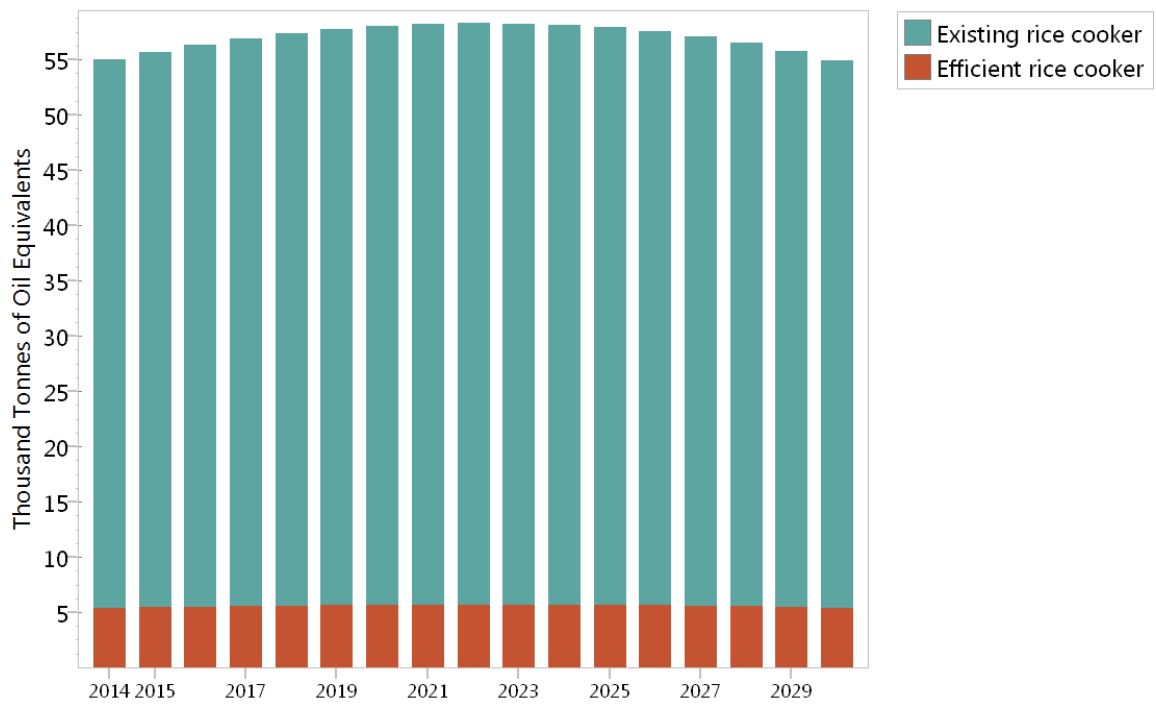


Figure 8: Electricity consumption for rice cooker of MECON group in Vietnam in BAU scenario during 2014-2030

According to BAU scenario, LPG cooking stoves, electric cooking stove and microwave will not consume energy that much as compare to rice cooker, but it is expected to be high energy consumption devices once this target group is shifted to have more income in the future. There are two types of technologies for rice cooker called existing and efficient (the one with efficient stamp, normally with temperature sensors), however the households owned efficient technology is still small share. This leads to the electricity consumption of efficient rice cookers only 10% of total electricity rice cooker consumed for period of 2014 – 2030.

5.3 Cooling

For cooling category, there are only three appliances which are AC, fan and refrigerator. It was found that MECON households in Vietnam do not have AC that much when compared to fan and refrigerator. As a result, fan is the highest energy consumption device in this category at approximately 233.1 ktOE (79.6%) in 2030, followed by refrigerator and AC at about 56.3 (19.2%) ktOE and 3.13 ktOE (1%).

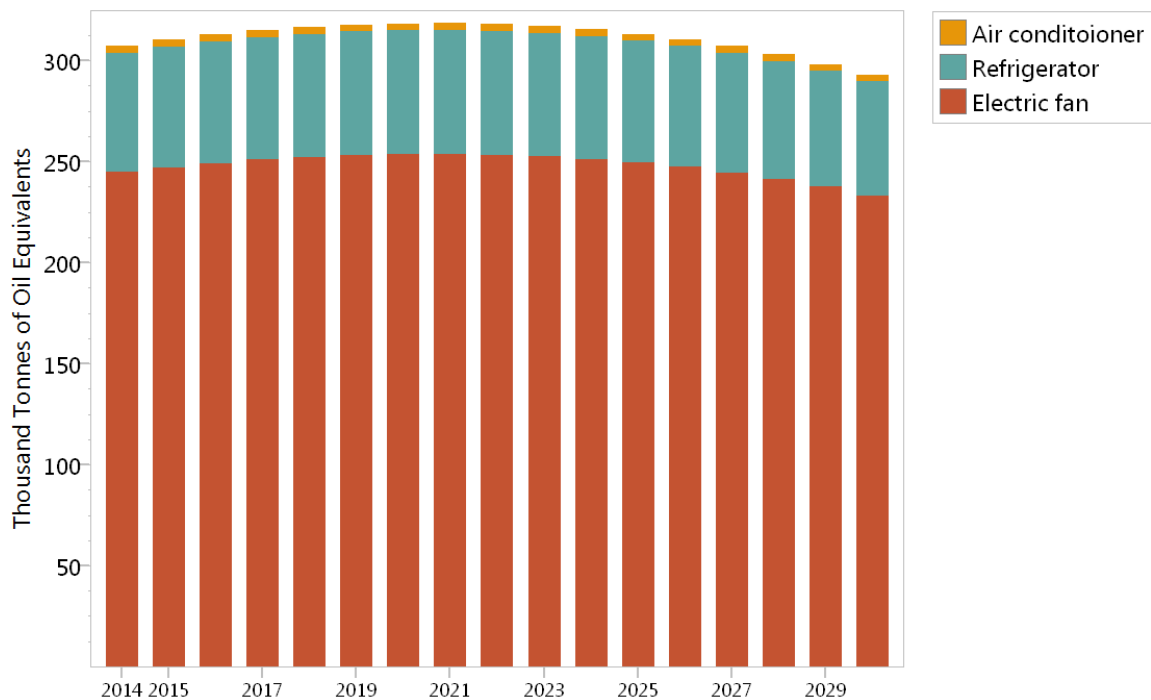


Figure 9: Energy consumption for cooling of MECON group in Vietnam in BAU scenario during 2014-2030

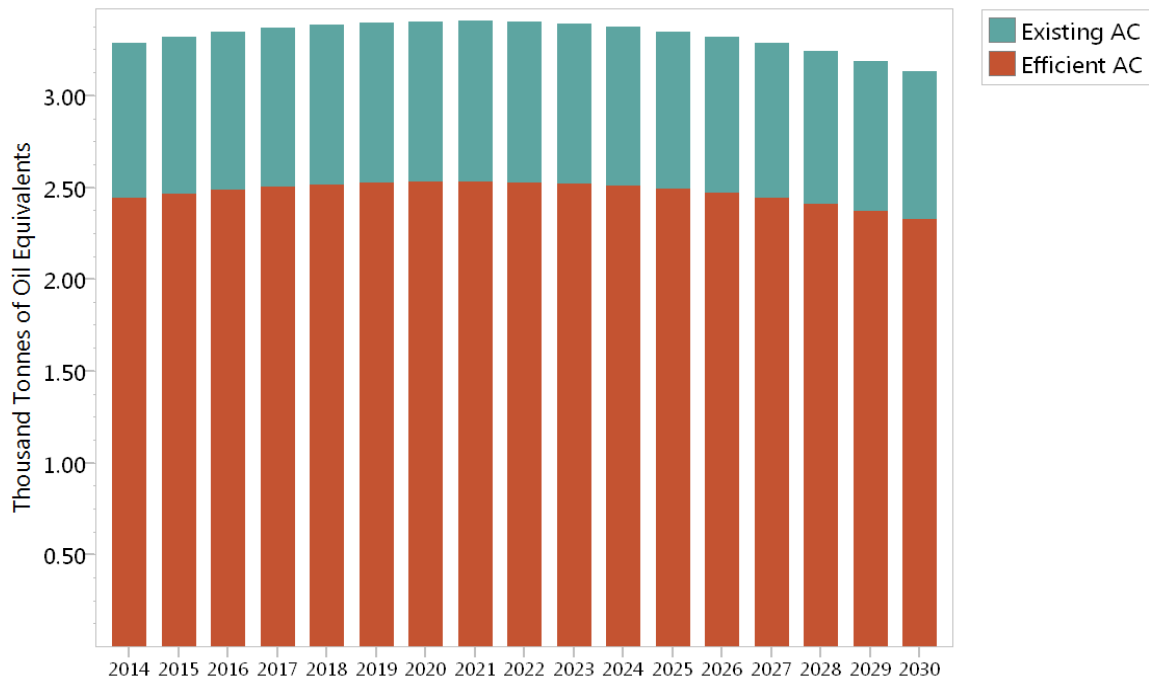


Figure 10: Electricity consumption for air conditioner of MECON group in Vietnam in BAU scenario during 2014-2030

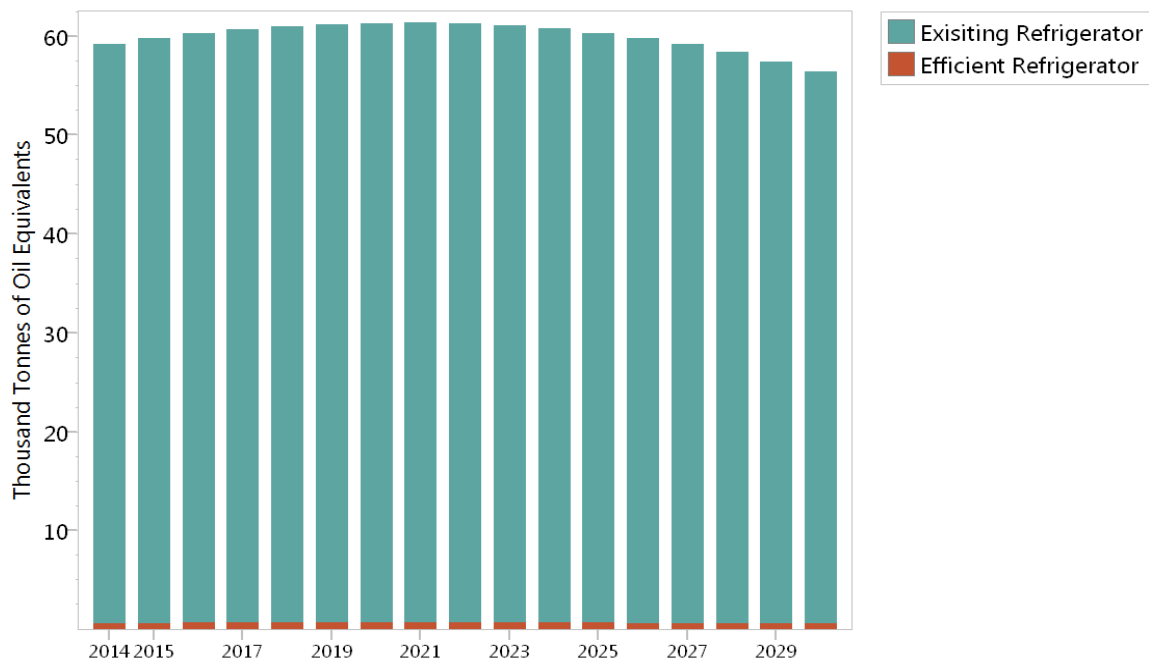


Figure 11: Electricity consumption for refrigerator of MECON group in Vietnam in BAU scenario during 2014-2030

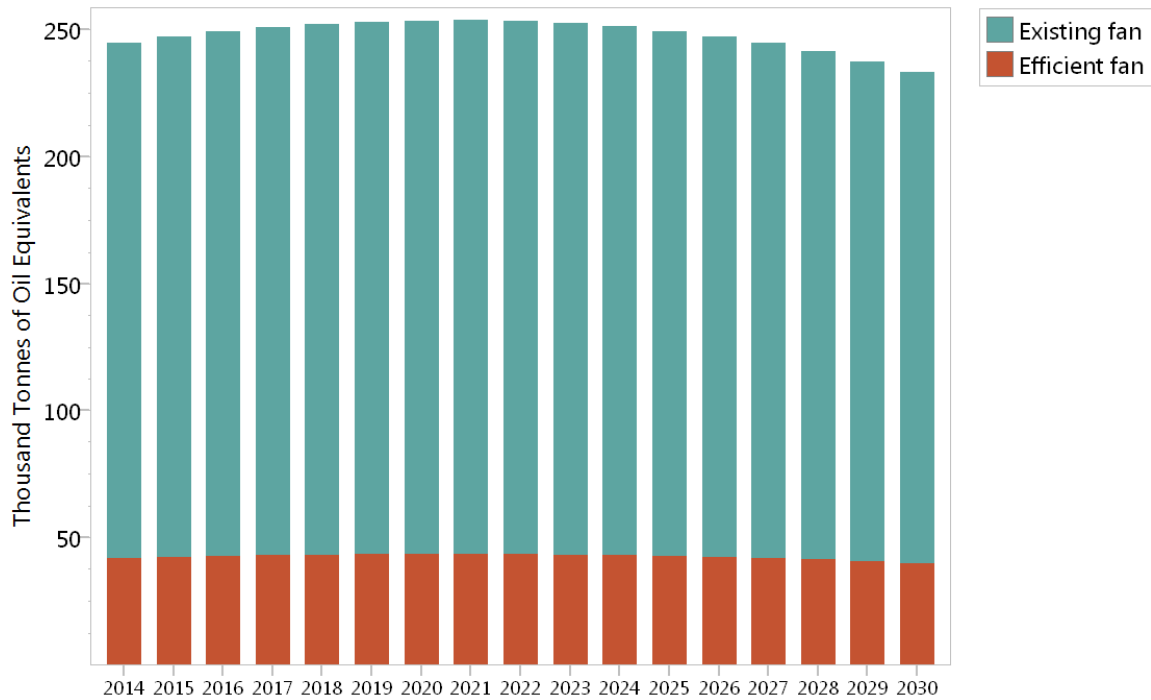


Figure 12: Electricity consumption for fans of MECON group in Vietnam in BAU scenario during 2014-2030

It is clear that electric fan consumes higher energy than AC and refrigerator even its power is much less those devices. This is because hour used in electric fan is more often than washing machine in household as well as those devices are high wattage which consumers most likely to purchase the efficient products instead.

Efficient technology equipment are with stamp issued by ministry of industry and trade (MOIT) normally with inverter for air conditioners and refrigerators. However the household owning these efficient equipment are still limited due to the availability, high cost and limited knowledge of MECON consumers. That is why electricity consumption for efficient refrigerator and fans accounted for only 17% and 1% respectively. Surprisingly the number of MECON households using efficient air conditioners are three times more comparing to the ones owing existing technology. This could be explained that the MECON household having air conditioners are relatively rich and they have better access and understanding on heavy electricity consuming like air conditioners.

5.4 Heating

There are four appliances in this category which are electric kettle, electric water heater, solar water heater and electric heater. It was found that electric kettle dominates energy consumption in this category and reaches 96% (16.7 ktoe) of total energy consumed for heating purpose. Electricity consumed for hot water is the second consumer while solar water heater is still small share. Total energy consumed in in 2030 is expected at 17.3 ktoe and shown in Figure 13.

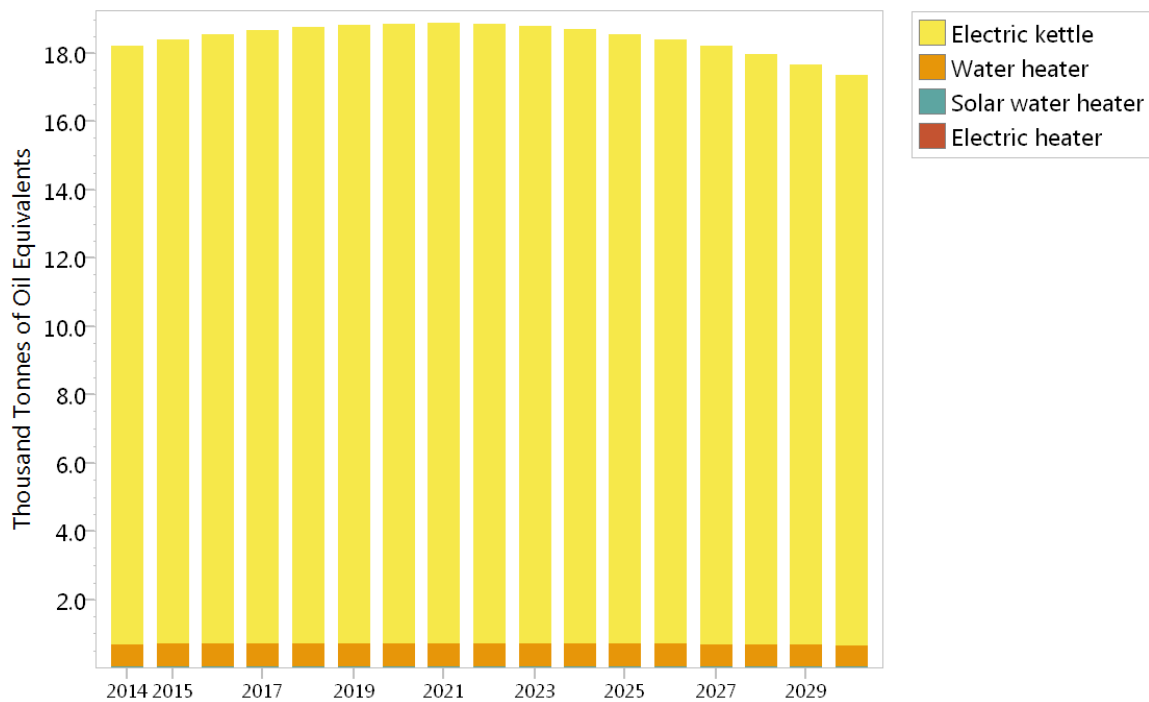


Figure 13: Energy consumption for heating for MECON group in Vietnam in BAU scenario during 2014-2030

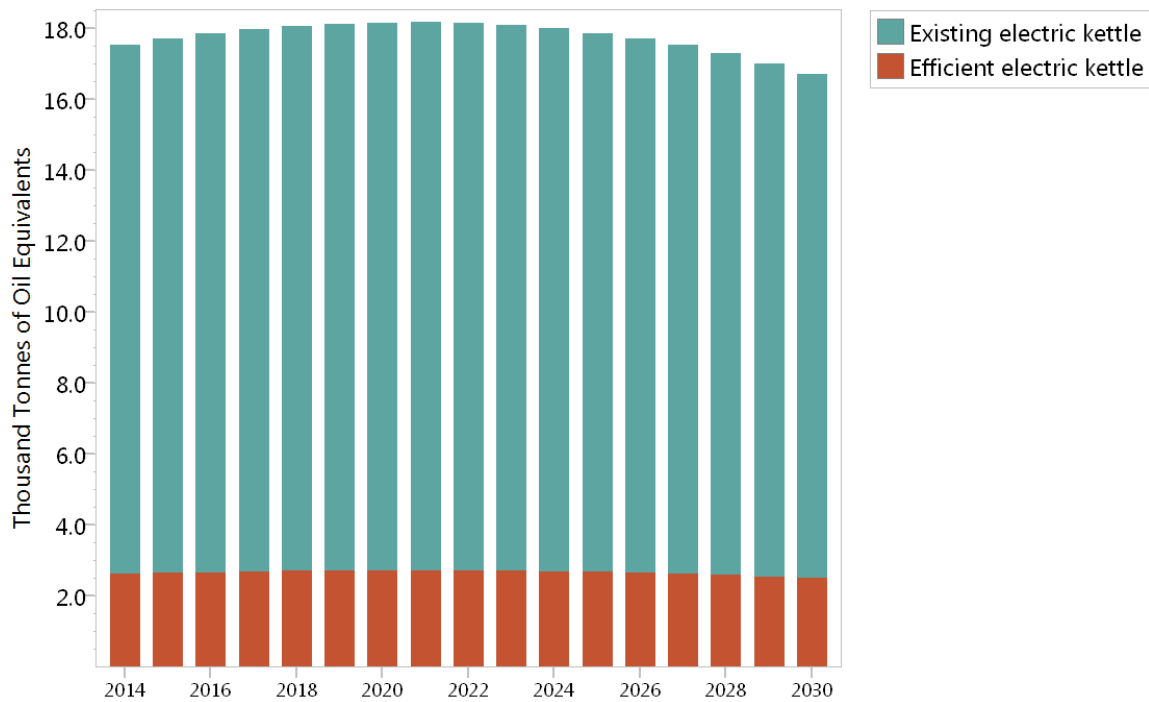


Figure 14: Energy consumption for kettle of MECON group in Vietnam in BAU scenario during 2014-2030

Efficient kettles are kettle with efficient stamps. Only 15% of electricity consumed for efficient kettles. This illustrates that number of MECON households using efficient technology are few. This could be explained that majority of MECON had owned kettle relatively long time before that the introduction of efficient stamp program in Vietnam.

5.5 Entertainment

In this category, TV is the highest energy consumer at approximately 57.2 ktoe (12%) in 2030. Computer is the second equipment consumed electricity (2.4 ktoe in 2030). It was found that even though there are LED technology in the market in the present, but it is still expensive for low income household. It was found that there are only two technologies that are used in low income household which are CRT and LCD technologies.

CRT still takes market share greater than LCD technology under BAU scenario. However, this trend is likely to change according to new technology in the market. There will be higher share in the future for new policy scenario for this target group.

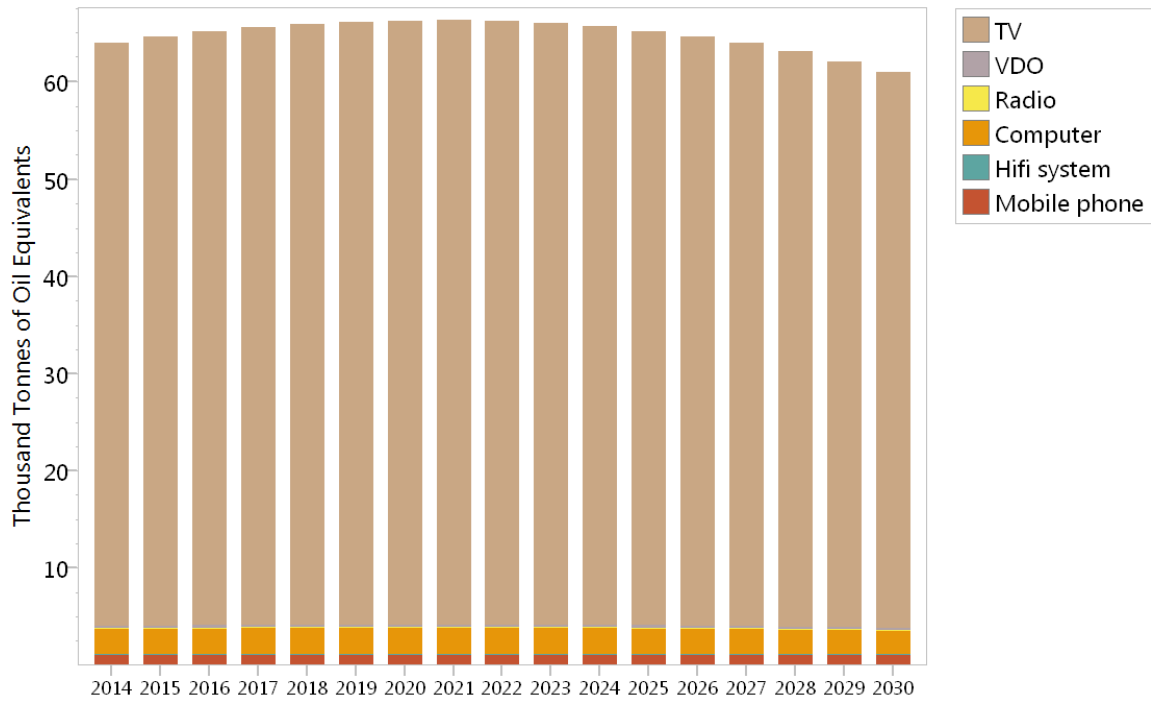


Figure 15: Energy consumption for entertainment of MECON group in Vietnam in BAU scenario during 2014-2030

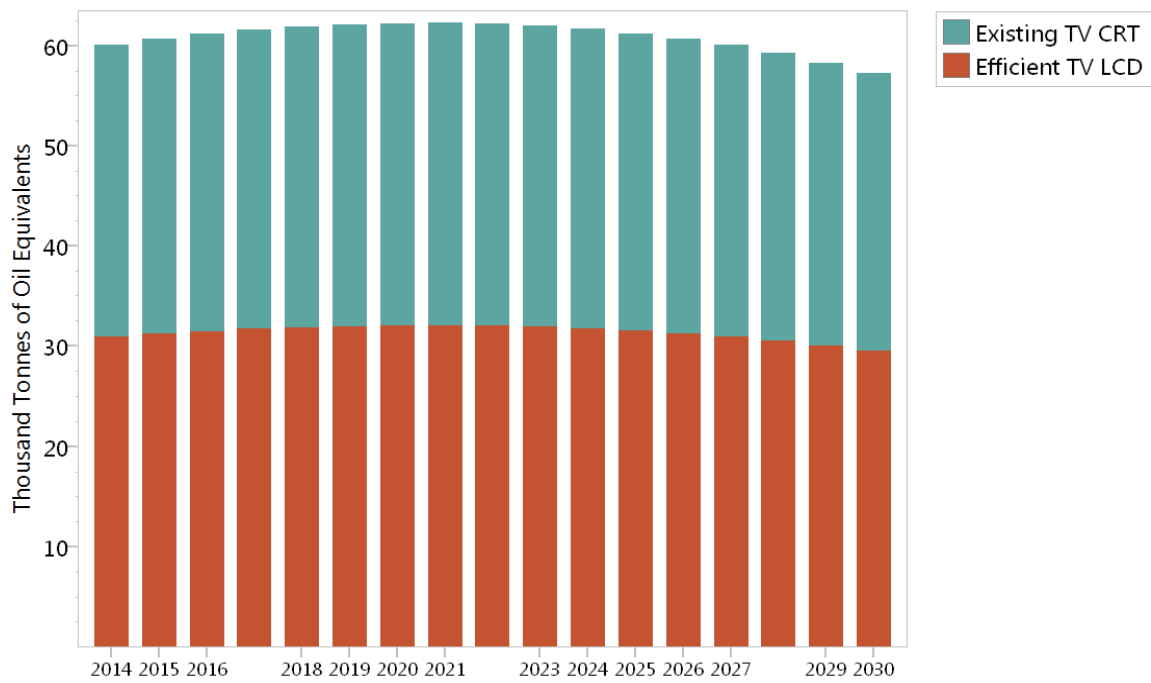


Figure 16: Energy consumption for TV of MECON group in Vietnam in BAU scenario during 2014-2030

5.6 Cleaning

There are two majority devices for this group which are washing machine and vacuum cleaner. However, the percent share of washing machine and vacuum cleaner in low income household are still low because of its price compared to other devices. According to BAU scenario, the energy consumed for vacuum cleaner in low income household in Vietnam is very small share (0.03%). It was found that washing machine consumed energy at approximately 3.866.6 ktoe in 2030.

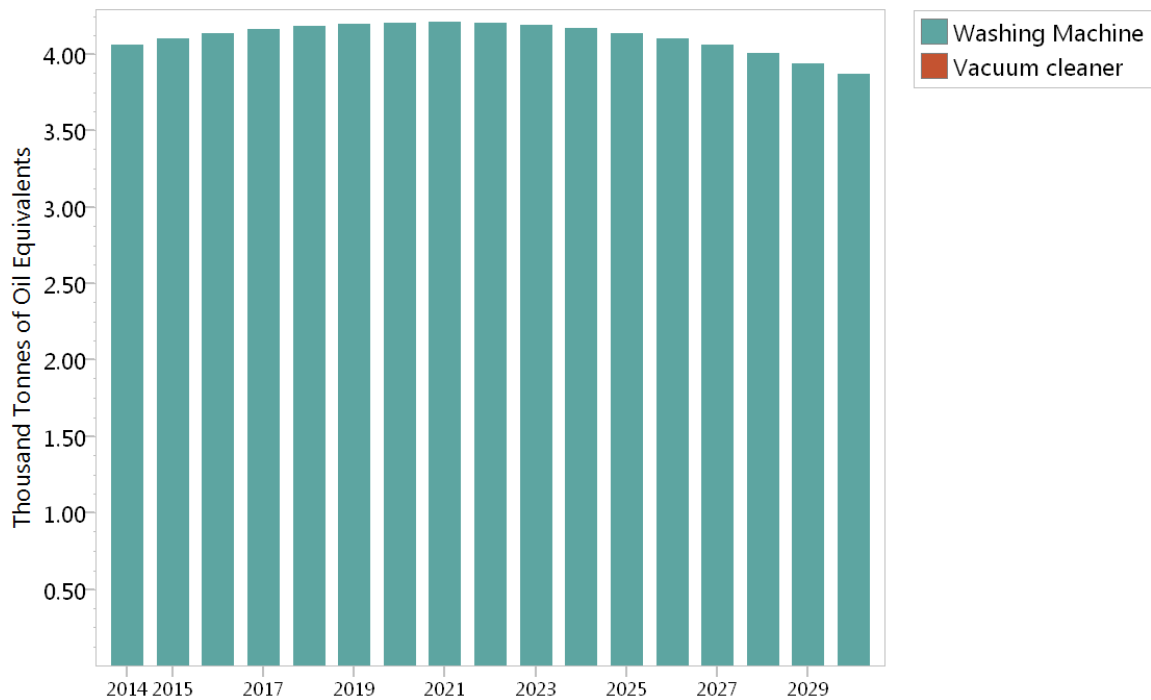


Figure 17: Energy consumption for cleaning of MECON group in Vietnam in BAU scenario during 2014-2030

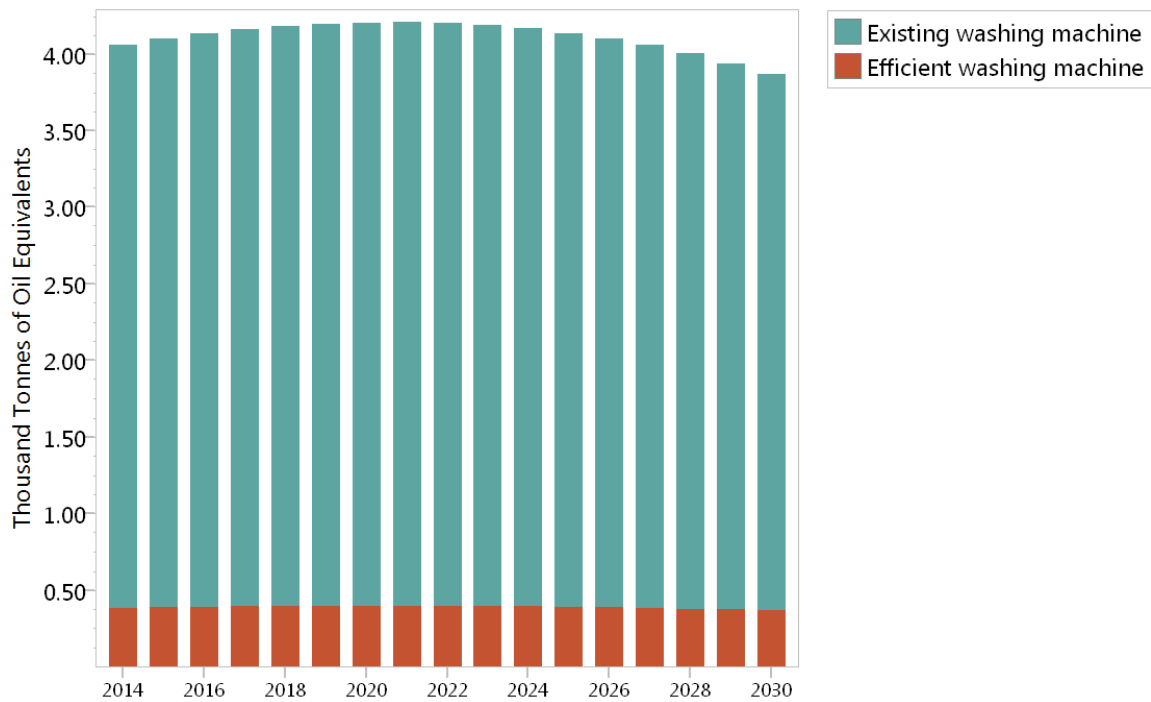


Figure 18: Energy consumption for washing machine of MECON group in Vietnam in BAU scenario during 2014-2030

Washing machines with efficient stamp are efficient technology equipment. Electricity consumed for efficient washing machine occupies for only 9.5% of total electricity consumed for washing machine in MECON households. This shows that the number of MECON using efficient washing machine is limited. This is because of high cost and limited understanding of MECON consumers about efficient washing machine.

5.7 Others

There are two equipment under this category are water pump and electric iron. In 2014, it was found that these electric iron dominate energy consumption in this category and will reach 2.303 ktoe (93.9%) in 2030. Total energy consumed in this group will be 2.456 ktoe in 2030. Compare to other categories as mentioned earlier, this group consume the least energy.

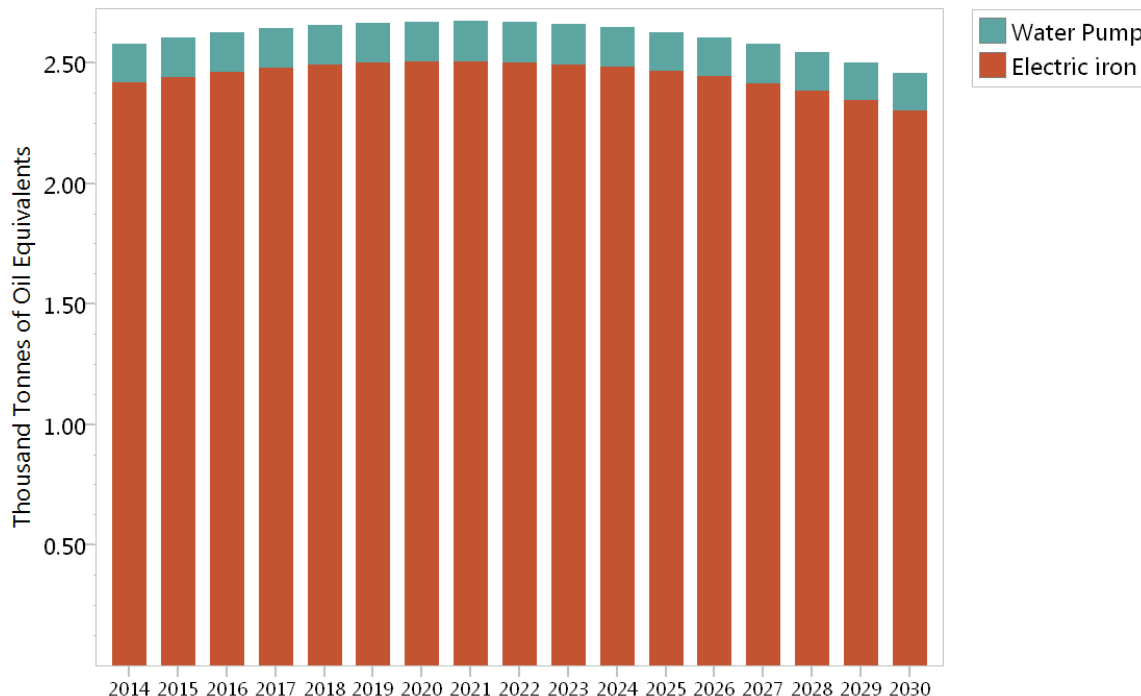


Figure 19: Energy consumption for other category of MECON group in Vietnam in BAU scenario during 2014-2030

6. Conclusions

MECON households in Vietnam have fundamental electric appliance such as fan, rice cooker, TV, lighting and refrigerator. This is because most of Vietnamese citizen can access to electricity more than 95%. As a result, the accessibility to electricity is not a problem for Vietnamese household when compared to other countries in Southeast Asia such as Myanmar, Cambodia and Laos. However, this benefit also results to the energy consumption in the country as well. It is found that daily electric devices dominate energy consumption in household such as fan, rice cooker, TV and lighting. Although, their power are not high comparing to large electric device e.g. AC, refrigerator, washing machine but the frequency of use is more often.

According to the projection of MECON population percent share in Vietnam in the future, it is expected to decrease from 48.44% in 2013 to 39.11% in 2030 and total MECON households will also decrease from 11.46 million to 11.05 million. As a result, the total final energy consumption for MECON household will be slightly decrease at approximately 0.003% per annum under BAU scenario. This is because the change of the MECON household only but their energy consumption trend in the future for each device still remain the same as of the year 2030. However, this target group is expected to have more income in the future, and they will purchase more modern appliances in order to provide more comfortable and reduce electricity bill such as AC, vacuum cleaner, lighting, TV, washing machine. This expectation would affect

to energy consumption in the future because MECON household will transfer as medium income group and they will consume more energy.

Key finding for this target group is common devices that usually use in daily such as rice cooker and fan and lighting. It was found that these devices consume higher energy than those large appliances such as AC, refrigerator, washing machine. This is because the more often use, the more energy consume. However, rice cooker, fan and lighting are fundamental appliances in household but modern entertainment devices that are expected to play important role in future household such as LCD and LCD television. Moreover, cooking device such as LPG cooking stove and rice cooking are more likely to use in rural area than urban area in Vietnam. This is because urbanization lifestyle prefers buying food rather than cooking regarding the free time and convenience. It should be noted than although stoves might not be considered as majority appliances in the future in the city but microwave oven for warming foods will take this important role for modern energy consumer household in Vietnam.

Alternative scenarios for energy consumption in MECON household will be addressed in order to analyze how low income household can shift from non-efficient products to efficient product in the future and what appliances should be taken in to consideration. This will result in energy consumption in the household as a whole picture when compared to BAU scenario.