

HOUSEHOLD ELECTRICITY DEMAND FORECAST AND ENERGY SAVINGS POTENTIAL FOR SELECTED COUNTRIES IN SOUTHEAST ASIA

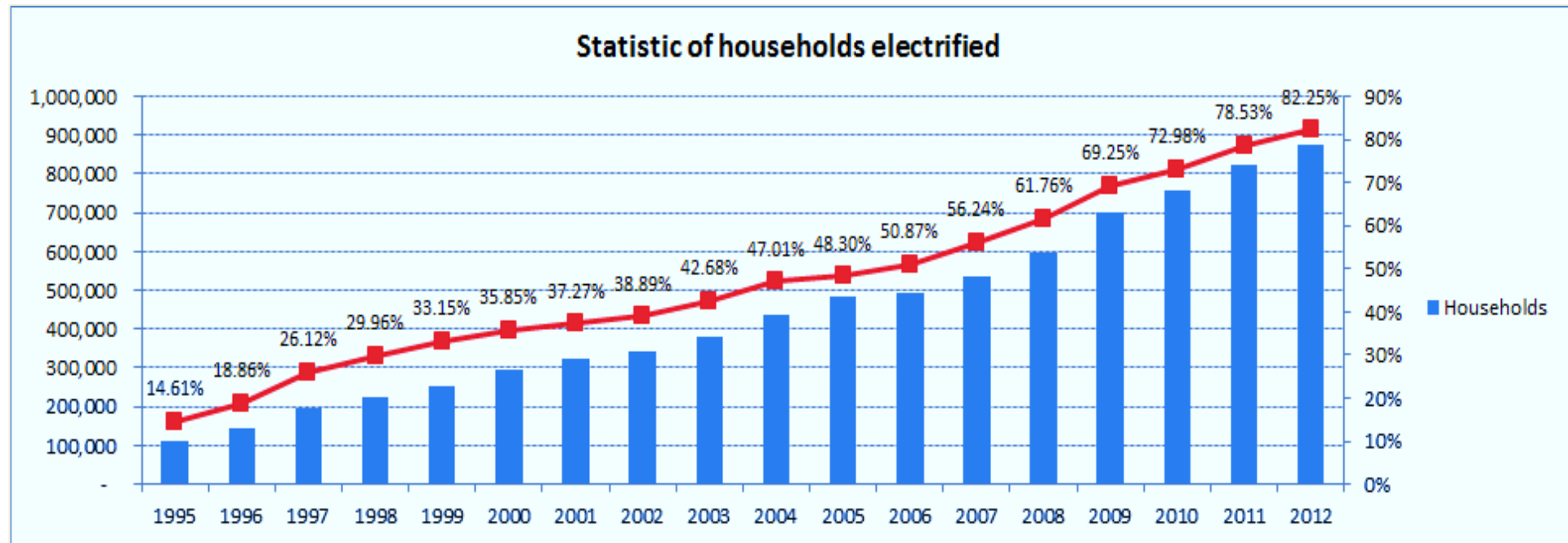
– The Case Study of Vientiane, Lao PDR

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Research Background

- High potential of economic growth in emerging economy
 - Increase in the income per capita, the purchasing power and affordability of local people to buy more convenient and more expensive products
 - Increment of number of users and the corresponding market size leading to the necessity for increasing energy security
 - Electrification and more accessibility and openness to the new market of electric appliances in the future

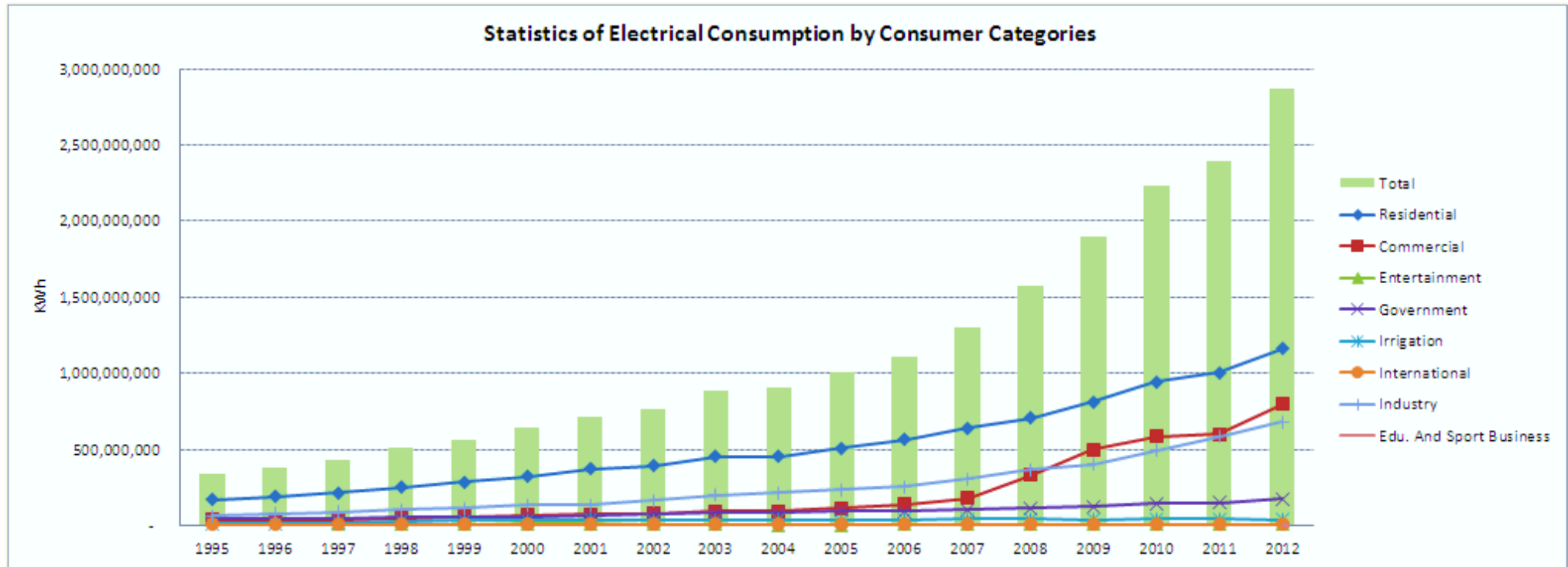
Significance of the Problems (1)



Source: Electricite Du Laos (EDL), Statistic Year Book 2012

- From Power Development Plan of Laos (PDP 2010-2020), the government plans to increase the Electrification to **90%** within **2020**, as the target to lead the country to achieve the economic growth and enhance the quality of live of its people.

Significance of the Problems (2)



Source: Electricite Du Laos (EDL), Statistic Year Book 2012

- Residential sector is the most electricity-consuming sector in Lao PDR during the period 1995-2012
- In 2012, the share of electricity consumption of residential sector is accounted for 40% of total demand.

Factors Influencing Electricity Demand

- Household characteristics
 - Household size and housing unit size
 - Hong Kong: the elasticity coefficient of household size to electricity consumption = 0.9 (Lam, 1998)
- Socio-economic structure
 - Urbanization implies greater access to electricity because of easier accessibility to the grid
 - Tend to increase their consumption after moving to an urban setting
- Income level of a household
 - Behavioral effects related to the variation in income
 - The number and size of appliances that a household processes
 - Hong Kong: the elasticity coefficient of annual income to electricity consumption is 0.533 (Lam, 1998)

Factors Influencing Electricity Demand

- Characteristic of electric appliances
 - Normally, the electricity consumption rises with the stock of electric appliances
 - Efficiency of electric appliance
- Electricity price
 - Demand for electricity during both peak and off-peak periods is responsive to changes in price
 - Filippini (1995) says that partial own-price elasticity varies from -1.29 to -2.42

Standard and labeling program

- Energy efficiency labels are informative labels affixed to manufactured products to describe their energy performance, usually in the form of energy use, efficiency or energy cost.
- Potential policy for promoting the energy-saving program, increasing the energy efficiency and enhancing consumer welfare (Wiel and McMahon, 2003)
 - The number of refrigerator models and features available to consumers were significantly increased since efficiency standards had been put into practice
 - The purchase prices were even lower than those expected by the regulators
 - The average amount of electricity needed to operate new refrigerators in the USA dropped by 75% during 30 years

EGAT's Thailand Energy Efficiency Label



Survey Program on Household Electricity Demand (1)

- 600 Households living in Vientiane
- Collected from 31 Villages in 5 districts
- Provided data
 - Demographic data (type of housing, income, family member)
 - Usage hour
 - The number and capacity of each appliance
 - Monthly energy consumption (kWh)
 - Monthly energy cost shown in electricity bill



Survey Program on Household Electricity Demand (2)

Table 1. Criteria for dividing households by income class.

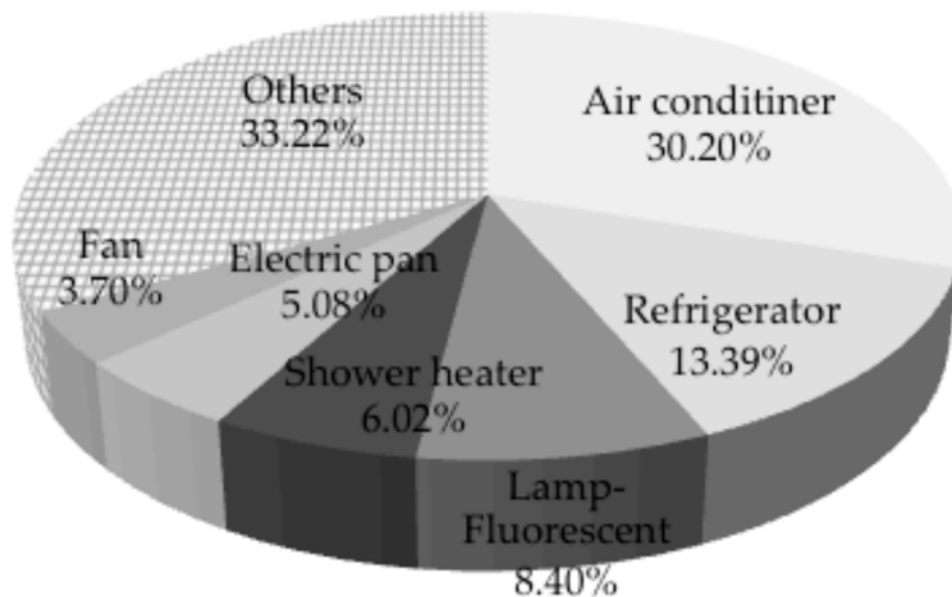
	Monthly income in USD	Exchange rate at 1 November 2013
Low-income group	Lower than 200	7905 LAK/USD
Middle-income group	Between 200 and 500	
High-income group	More than 500	

Source: Author's own elaboration based on the Planning Department of Phnom Penh Municipality (2002).

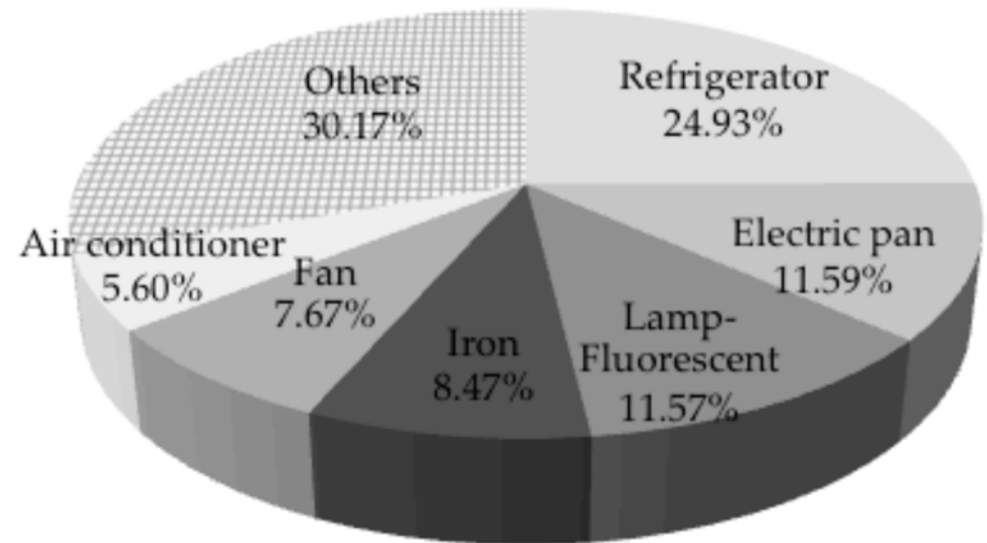
- Characteristics of energy consumption behavior of each income group
 - Average number of electric appliances per household
 - Average capacity of each electric appliance
 - Average usage hours of each electric appliance
 - Average energy consumption of each electric appliance

Structure of Energy Consumption by Income Group

High Income

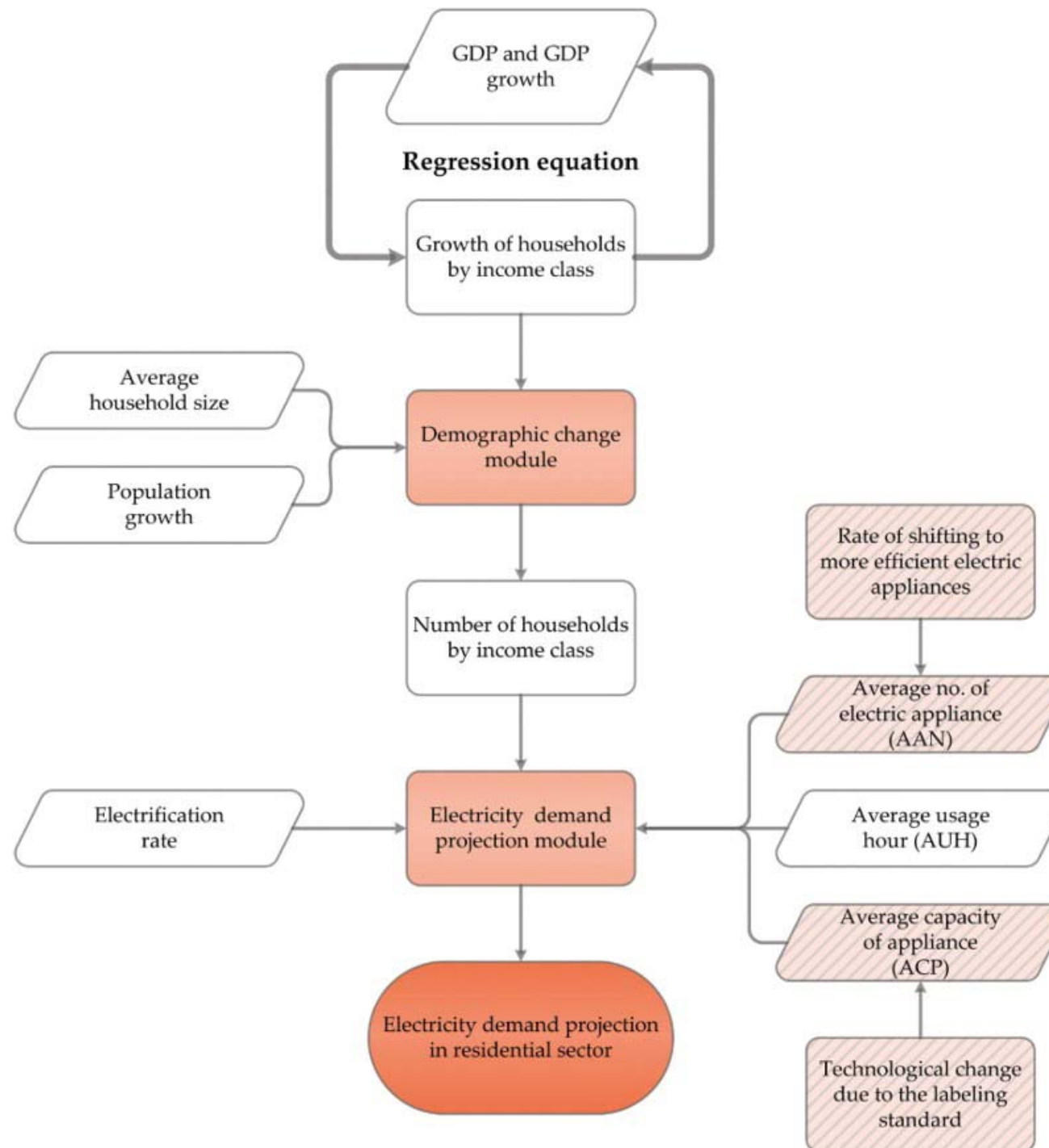


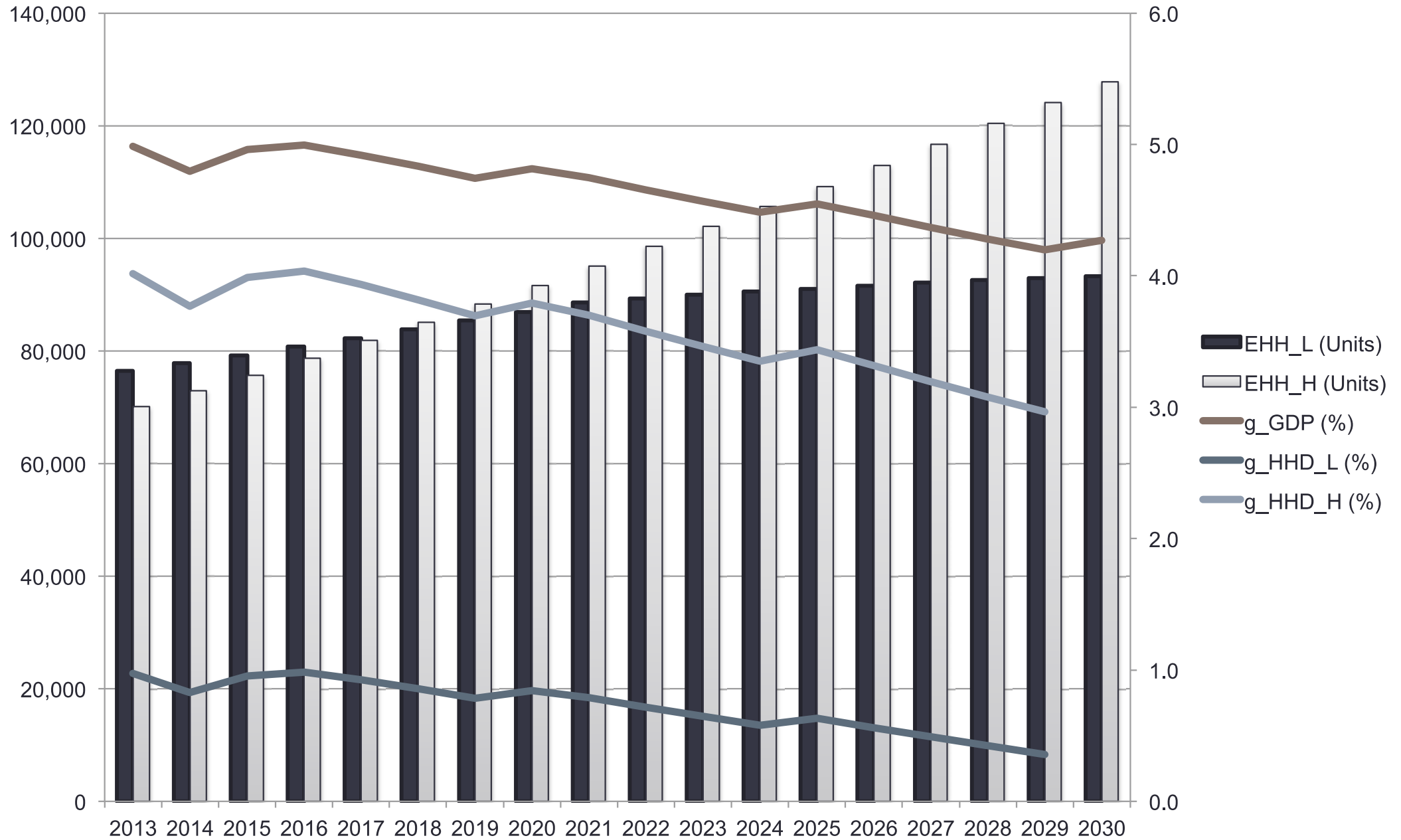
Low-and-middle Income



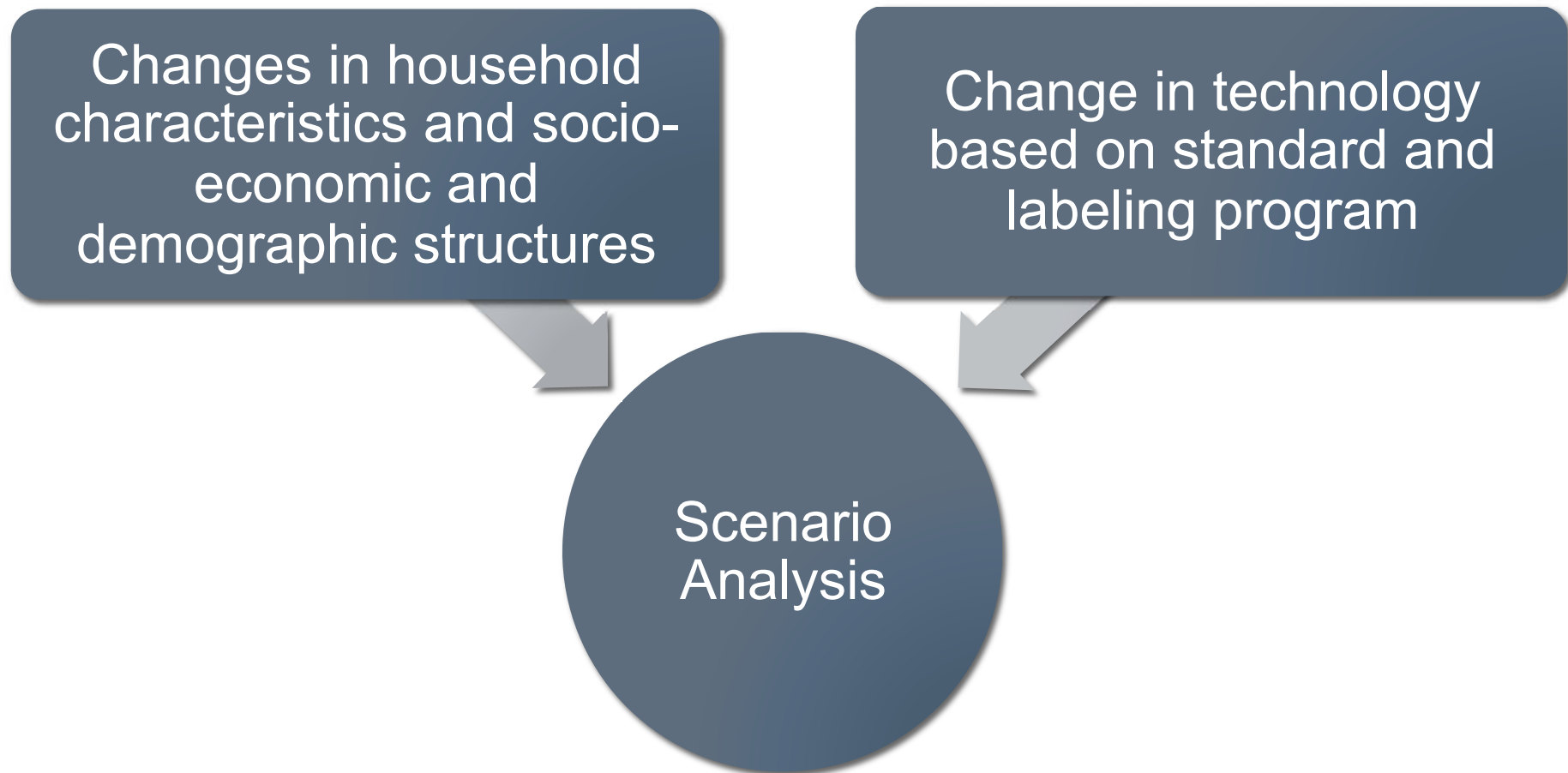
Electricity Demand Forecasting

- The **end-use model** makes the projection of relevant information on the level of energy required and the technical efficiency
- Model can be separated into two modules
 - Demographic change module
 - Electricity demand projection module
- The relevant variables is projected over the time span 2013–2030





Electricity demand forecasting



Change in Technology Based on Standard and Labeling of Thailand (1)

- Air conditioner is the most electricity-consuming appliance
- Energy consumption criteria of air conditioner according to the energy efficiency standard of EGAT is called Energy Efficiency Ratio (EER)

$$\text{EER(BTU/hr/W)} = \text{Power of air conditioner[BTU/hr]}/\text{Capacity[Watt]}$$

Table 6. EGAT energy efficiency labelling standard of air conditioners: Y2011.

Capacity	Energy efficiency ratio (EER: BTU/h/W)		
	No.3	No.4	No.5
Not over 8000 W	10.60–10.99	11.00–11.59	More than 11.60
8000–12000 W	9.60–10.59	10.60–10.99	More than 11.00

Source: Author's own elaboration based on the Electricity Generating Authority of Thailand (2010).

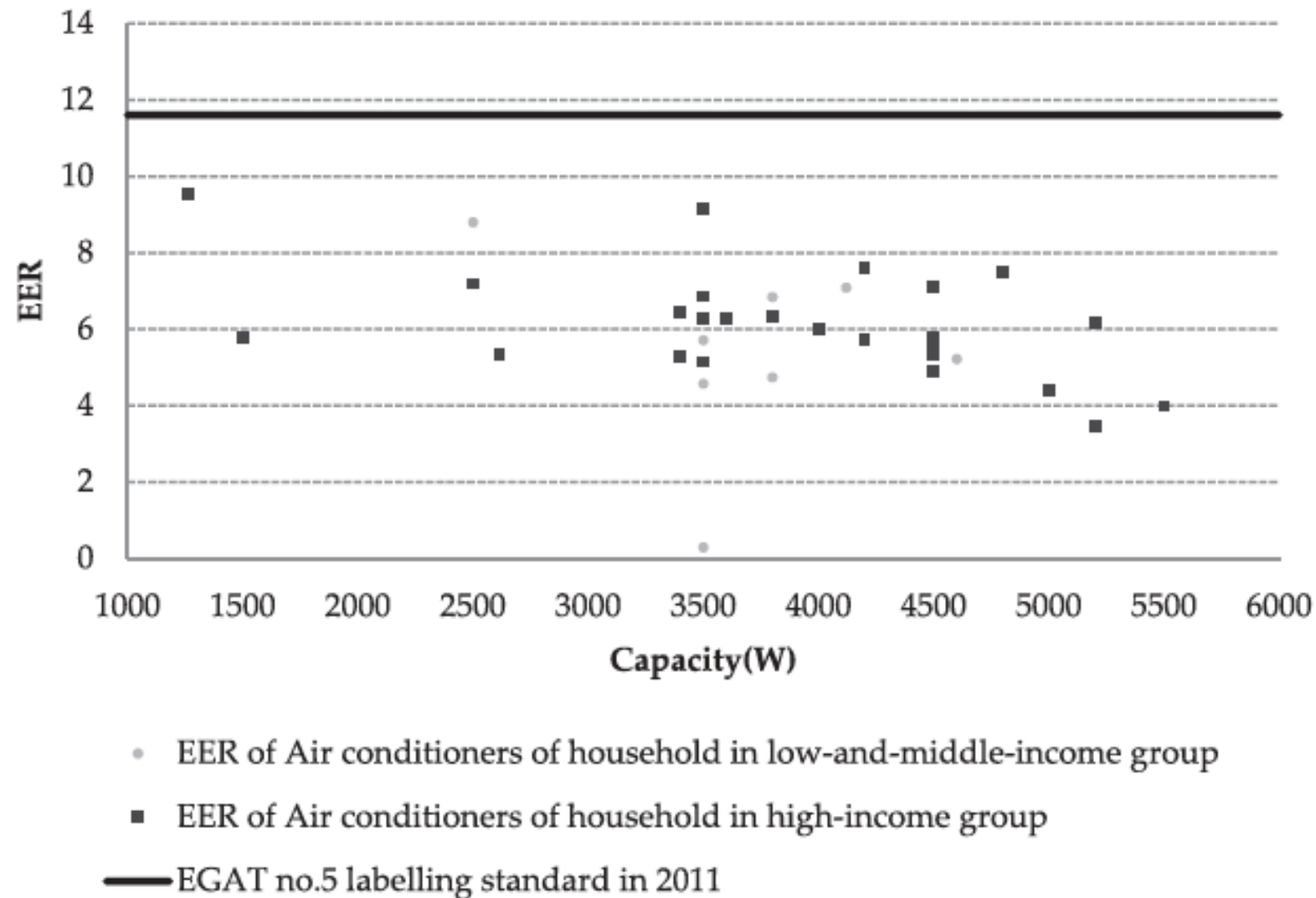


Figure 3. Comparison of EER of air conditioners with EGAT energy efficiency labelling standard (Criteria: No.5, Y2011). Source: Author's own elaboration based on questionnaire.

S-Shaped Curve Penetration Rate

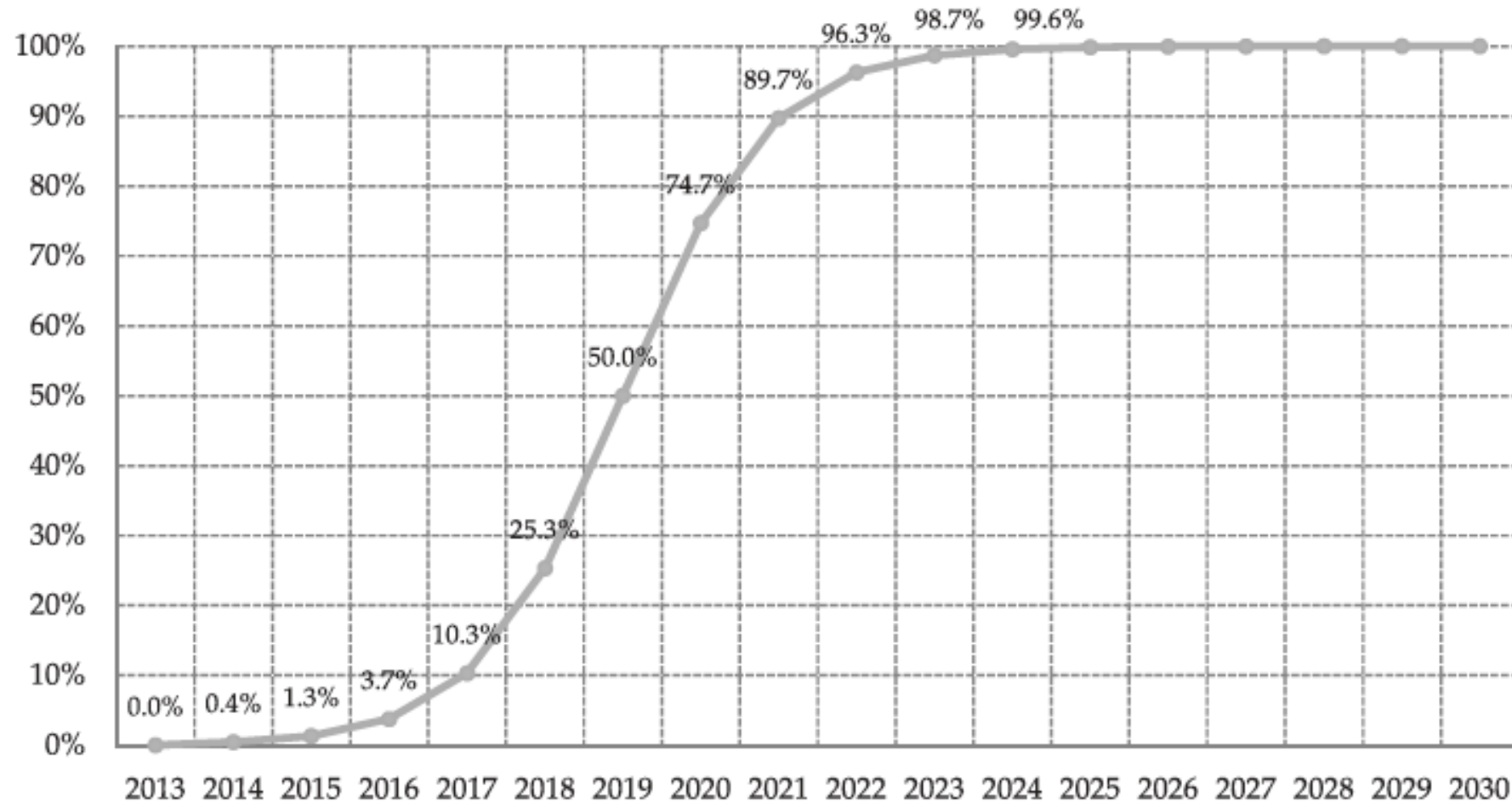


Figure 5. S-shaped curve penetration rates of air conditioners with 10-year life span. Source: Author's own elaboration.

Change in Technology Based on Standard and Labeling of Thailand (2)

- **Lighting equipment** is the easiest to be replaced with more advanced technological ones under the most economical budget
- Switching from fluorescent to T5-28W lamp
- Switching from incandescent lamp to compact fluorescent lamp

Table 7. Relationship between the capacities of incandescent lamps and CFLs that keep the same level of brightness.

Brightness (Lumen)	Capacity (Watts)	CFL Capacity (Watts)
400–500	40	7.94
650–900	60	12.57
1100–1750	100	20.31

Source: Author's own elaboration based on the Electricity Generating Authority of Thailand (2010).

Switching to Electric Appliances with Thai Standard: Results

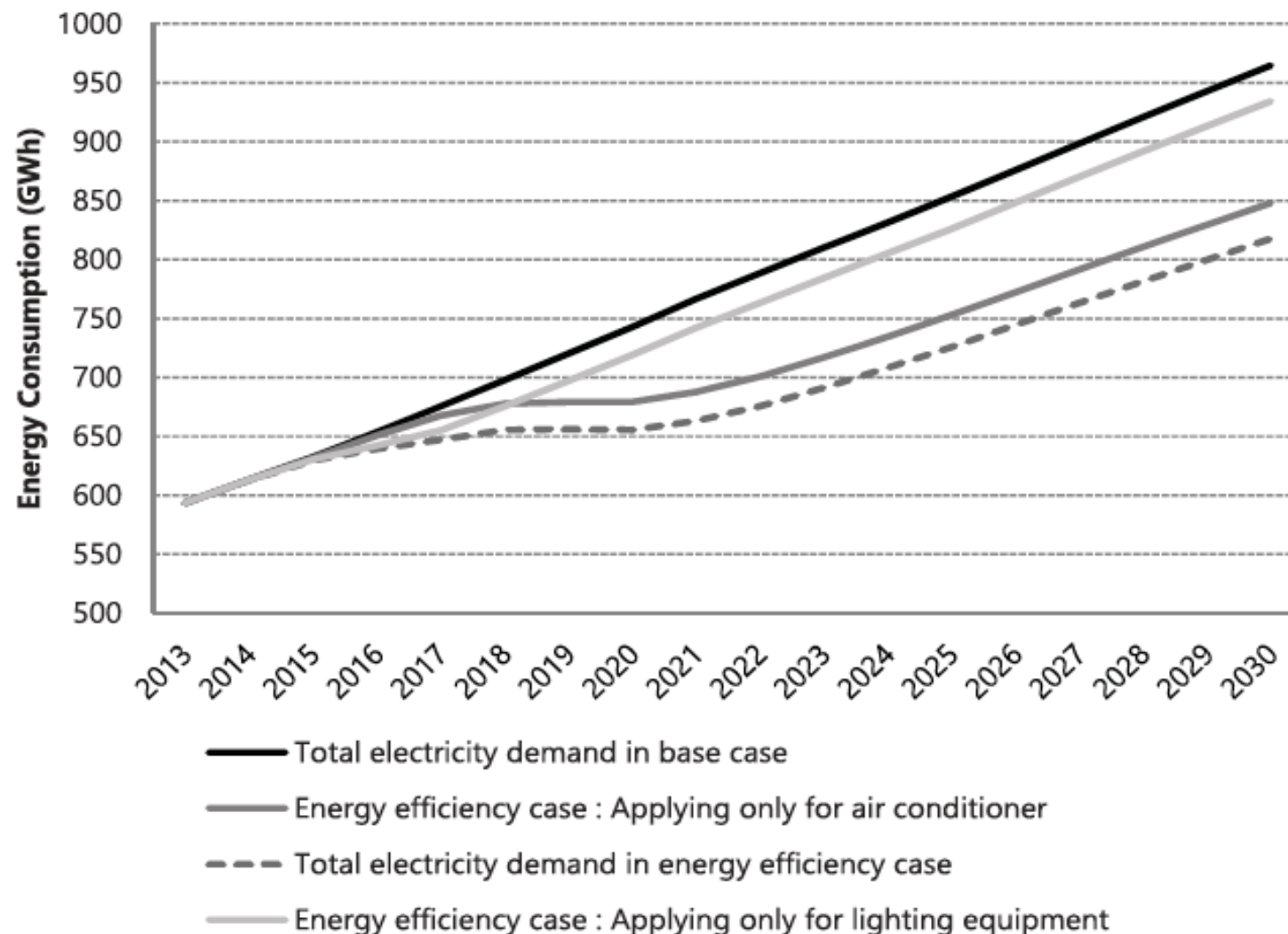


Figure 7. Scenarios of household electricity demand of Vientiane during the period 2013–2030. Source: Author's own elaboration based on simulation results.

Switching to Electric Appliances with Thai Standard: Results

- The overall electricity consumption of residential sector in 2030 can be reduced by 15.2% (6.5% reduction from low-and-middle-income group and 18.1% reduction from high-income group)
- For high-income group, electricity consumption from air conditioners can greatly reduced by 48.7% compared to the baseline scenario, by switching to the ones with EER=11.6 according to Thai standard
- For from low-and-middle-income group, changing lighting equipment shows a distinct reduction by 33.5% from the base case

Conclusions

- There still is plentiful room for improvement in energy efficiency, esp. of air conditioning technology used in residential sector.
- These results may imply a reduction in negative environmental impacts as well.
- Therefore, the government of emerging economies should support the **EES&L program** to improve the efficiency of electricity consumption as the other countries around the world taking actions and clearly seeing the achievement.
- **Promoting** to the public and **stimulating** the energy efficiency attitude and the action of household toward sustainability are key factors.

Thank You for Your Attention
