Do households in developing country choose energy efficient air conditioner?: Evidence from the Philippines

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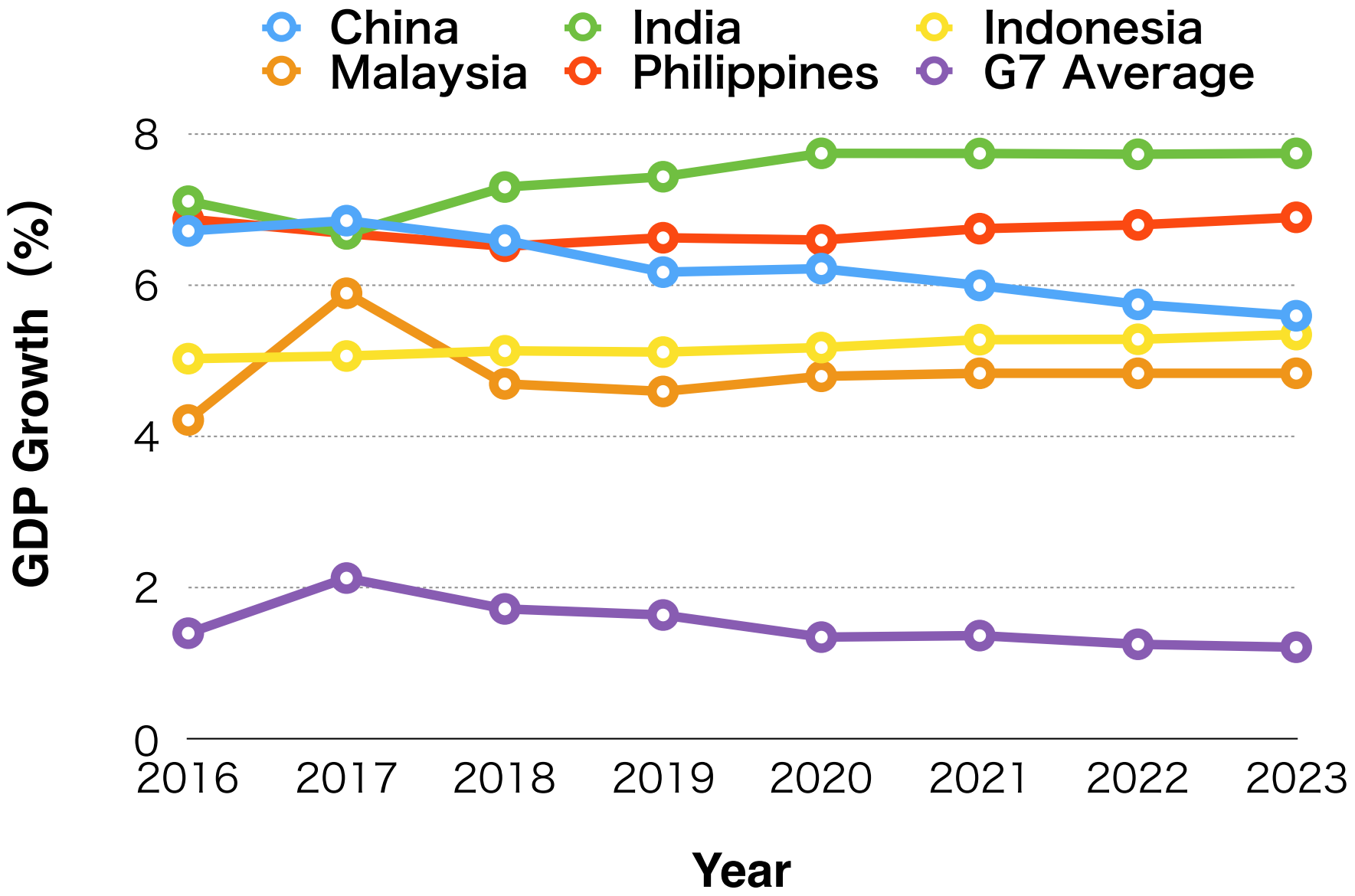
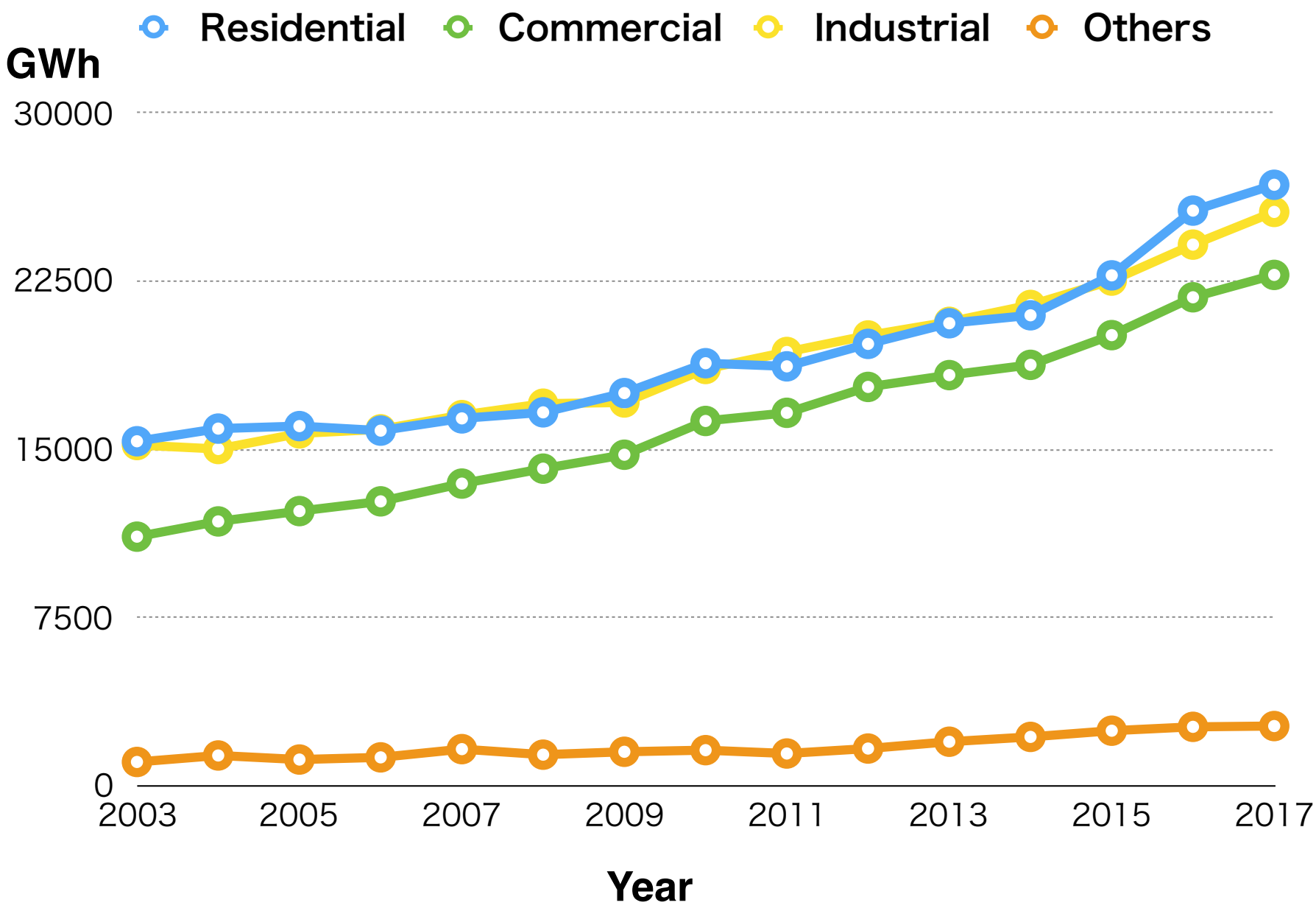
1. Motivation & Research Objective

Changes in GDP Growth



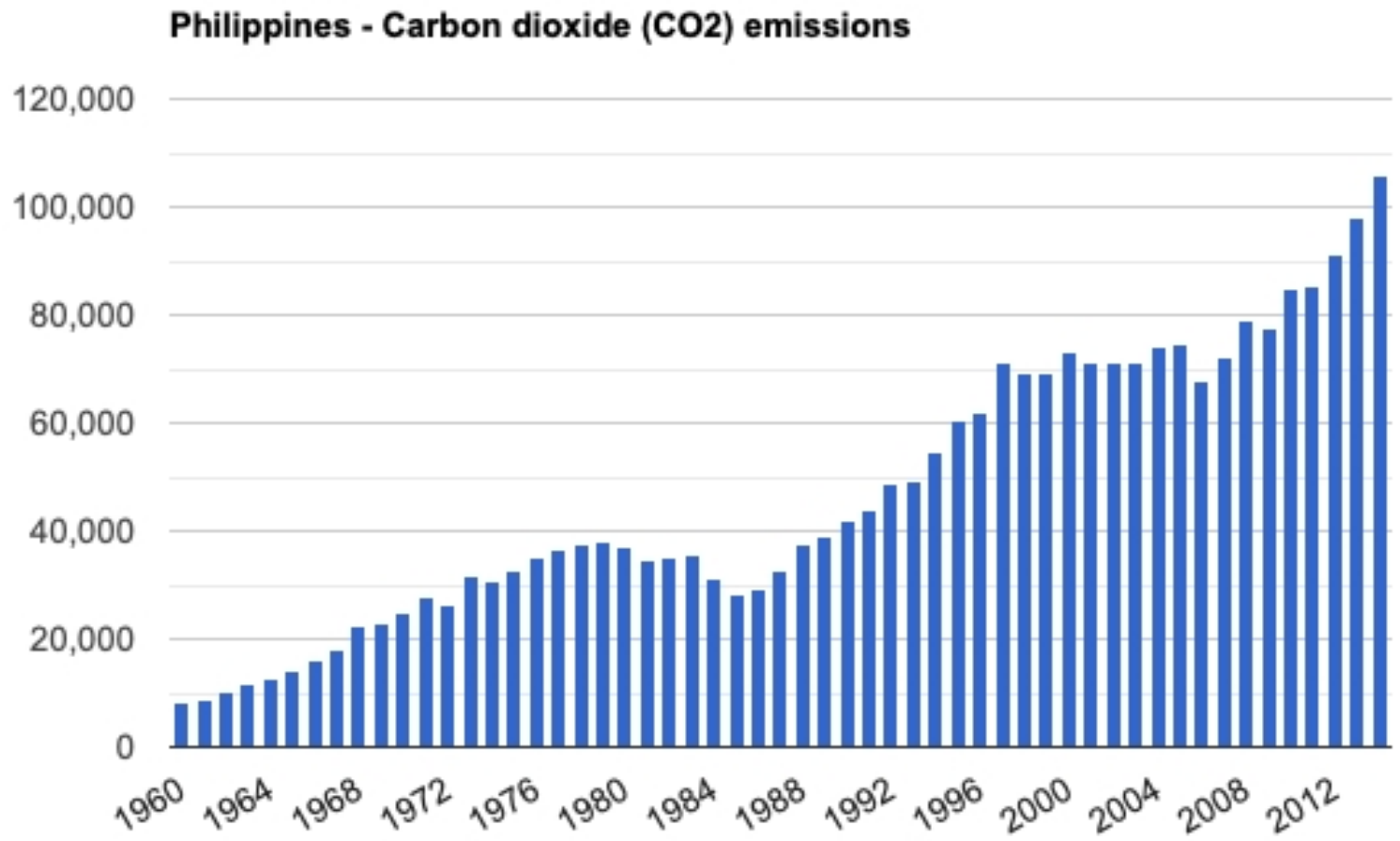
Source: Graph was created by the author with data available from IMF World Economic Outlook Database
https://www.imf.org/external/pubs/ft/weo/2018/02/weodata/index.aspx

Changes in Electricity Consumption in Philippines



Source: Graph was created by the author with data available from Public of Philippines, Department of Energy
https://www.doe.gov.ph/sites/default/files/pdf/energy_statistics/05_2017_power_statistics_as_of_30_april_2018_electricity_consumption_05042018.pdf

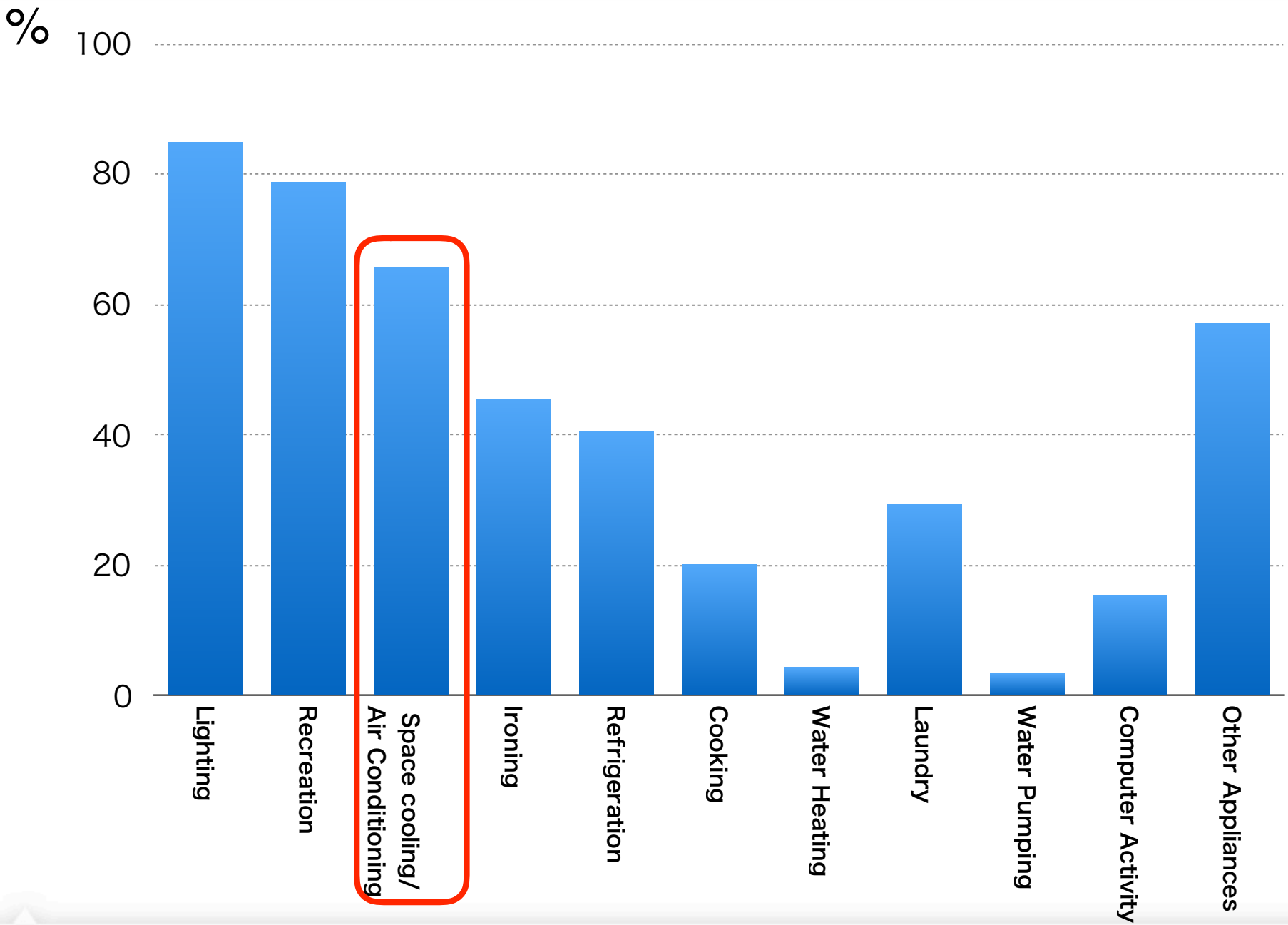
Changes in CO_2 emissions in Philippines



Source: TheGlobalEconomy.com, The World Bank

Source: downloaded from https://www.theglobaleconomy.com/Philippines/Carbon_dioxide_emissions/

End-use of household electricity in Philippines(2011)



Source: Graph was created by the author with data available from National Statistics Office and Department of Energy
2011 Household Energy Consumption Survey (HECS)

AC Ownership in Philippine

- Currently, air conditioners (hereafter AC) are used by around **16% of Metro Manila**'s population of 13 million and **7% of the Philippines**' population of 107 million [a]
- The percentages of AC owners are expected to increase in the future due to its economic growth

☞ **One of the effective energy-saving behaviors that households can take is choosing energy efficient AC**

[a] PSRC (Philippine Survey and Research Center), 2019. Internal data listed in full report on our focus group discussion.

Research Objective

1. Understanding the energy consumption pattern, energy-saving behavior, and consciousness towards energy and environment

2. Understanding awareness and degree of trust towards energy labels

3. Estimating preferences for each attributes of AC

4. Examining what **information in energy label** encourages consumers to choose energy efficient AC

Where is Philippines & Manila?

2. Literature Review

Literature Review

Relationship between energy label and purchase decisions of appliances

[Question A] T test: Are home appliance with eco label more popular than those without eco label?

– Waechter et al. (2015) , Gasper & Antunes (2011) , Deutsch (2010)

[Question B] Regression analysis: What type of people tend to buy energy efficient appliances?

– Murray & Mills (2011)

[Question C] Choice Experiment study: What factors & whether or not energy label affect purchasing decisions of home appliances?

– Jain et al. (2018), Davis & Metcalf (2016), Newell & Siikamaki (2014), Heinzel (2012), Ward et al. (2011), Shen & Saijo (2009),

Summary of Choice Experiment

Author	Country	Survey Time	Appliance	Survey	Method	Eco or Efficient label/info	No. of Sample
Jain et al. (2018)	India	2015	AC	Face-to-face Survey	CE	+ve	148
Davis & Metcalf (2016) JAERE	US		AC	Internet Survey	CE, Regression analysis	+ve	2,440
Newell & Siikamaki (2014) JAERE	US	2011	Water heater	Internet Survey	CE	+ve	1,214
Heinzle (2012) J Conump Policy	Germany	-	TV	Internet Survey	CE	+ve	252
Ward et al. (2011) Energy Policy	US	2009	Fridge	Internet Survey	CE	+ve	355
Shen & Saijo (2009)	China	2006	AC Fridge	Face-to-face Survey, Internet Survey	CE	+ve	600 each, 1200 in total

Literature Review: Interesting Findings

- **Waechter et al. (2015)**
  - Consumers mainly **focus on energy efficiency class** (e.g., A) and largely ignore information about annual electricity consumption (e.g., 129kWh/year)
  - As people use mental shortcuts to reach decisions (Kahneman, 2011), people tend to focus mainly on **highly accessible attributes**
- **Newell & Siikamaki (2014)**
  - Insufficient information can lead to considerable undervaluation of energy efficiency.
  - It is also found that **simple information on the monetary value of energy savings was the most important** element guiding energy efficiency investments

3. Methodology

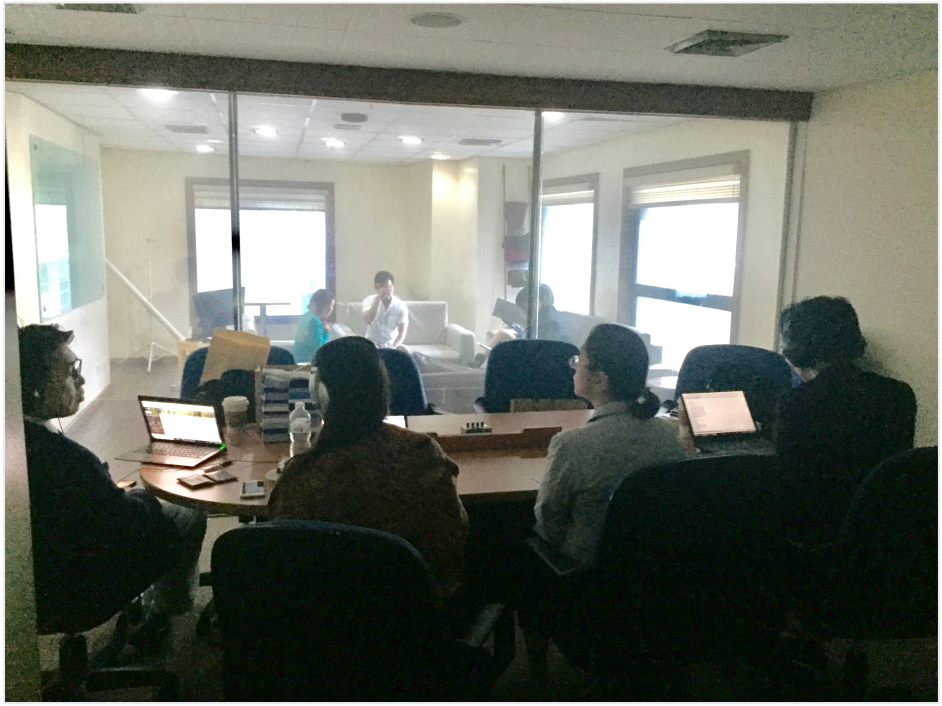
Survey Schedule

Date	Tasks
25 February	Market research at Manila
26 February	Focus group discussion
1 March	Pre-Test
23 May	Hearing investigation at Department of Energy, Philippines
24 May	Hearing investigation at Meralco (Manila Electric Company), Philippines
13 July - 16 August	Conducting the face-to-face survey

Window Type AC at appliance shop

Focus Group Discussion

Pre Test



Hearing at Meralco Power Lab

Summary of Survey

- **Period**: 13 July - 16 August, 2019
- **Method**: Face-to-Face Survey conducted by PSRC
- **Area**: Metro Manila
- **Respondent (600 respondents)** :
  - 25-65 years old
  - Decision-maker for home appliances
  - Interested in purchasing AC in next 2 years
  - Random sampling according to socio-economic class (SEC), gender, age range and household size range
- **Questionnaire**
  - Choice Experiment for Window type and Split type
  - Electricity consumption, Interest on energy issues, awareness and trust on energy labels, AC usage
  - Time Preference
  - Socio-demographic Information

Face-to-Face Survey

An Example of Choice Set

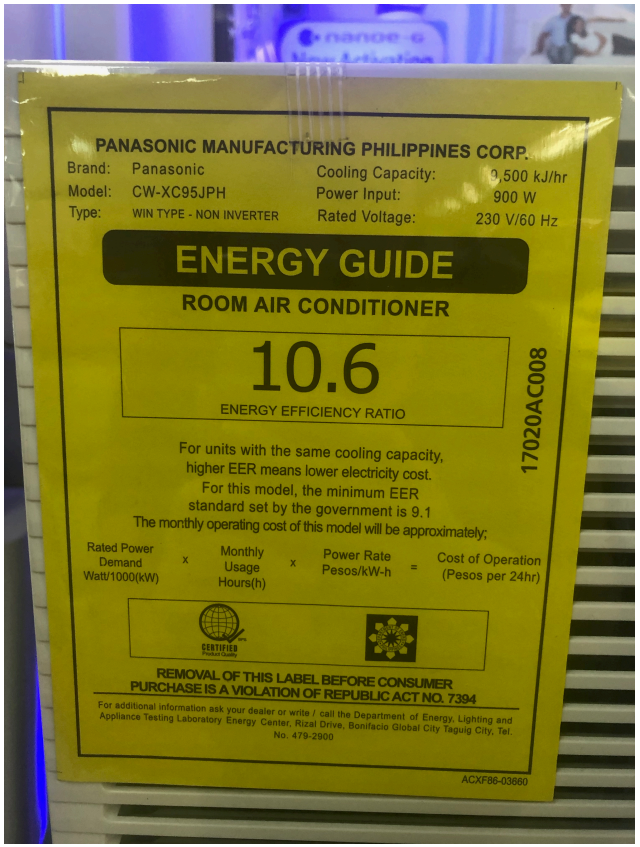
Assumption:

1. Purchase a new air conditioning unit of window (split) type for the bedroom that has1 horse power covering 14-17m^2.
2. No installation cost

	AC 1	AC 2	
Purchase Price	30,000 PhP	15,000 PhP	**I purchase neither AC 1 or AC 2**
Additional Function	Without any function	With air purification function	
Country of Manufacturer	US	Philippines	
EER	13	9	
Choose one			

Energy Efficiency Information

ENERGY GUIDE
Energy Efficiency Ratio



Orange Tag
Estimated Cost/ hour

New ENERGY GUIDE
Energy Rating

Attributes and Levels: Window Type

Energy Efficiency Info

Purchase Price (PhP)	Additional Function	Country of Manufacturer	EER	PhP/h	Energy Rating
15,000	Without any function	Philippines	9	6.04	★ (EER 9)
20,000	With noise reduction function	Japan	11	4.89	★★ (EER 11)
25,000	With air purification Function	Korea	13	2.70	★★★ (EER 13)
30,000	With smart function	US	15	2.32	★★★★ (EER 15)

Attributes and Levels: Split Type

Energy Efficiency Info

Purchase Price (PhP)	Additional Function	Country of Manufacturer	EER	PhP/h	Energy Rating
25,000	Without any function	Philippines	9	5.01	★ (EER 9)
30,000	With auto-cleaning function	Japan	11	4.06	★★ (EER 11)
35,000	With air purification Function	Korea	13	1.97	★★★ (EER 13)
45,000	With smart function	US	15	1.71	★★★★ (EER 15)

Estimation Model

- **Mixed logit model**
  - suggested by Revelt and Train (1998) relaxed restrictions of homogeneity of preferences and independence of irrelevant alternatives (IIA) that are assumed by the conditional logit model

- **Explanatory Variables**
  - AC Price (non random variable)
  - Random variables: levels of other attributes
  - ASC (I don't purchase neither AC 1 or AC 2)
  - Interaction Terms
    - Estimated Cost per hour * Level 2 (Energy Efficient Information)
    - Estimated Cost per hour * Level 3 (Energy Efficient Information)
    - Estimated Cost per hour * Level 4 (Energy Efficient Information)
    - Energy Rating * Level 2 (Energy Efficient Information)
    - Energy Rating * Level 3 (Energy Efficient Information)
    - Energy Rating * Level 4 (Energy Efficient Information)

Reference:
Revelt, D., Train, K., 1998. Mixed logit with repeated choices: households' choices of appliance efficiency level. *The Review of Economics and Statistics* 80(4), 647-657.

4. Preliminary Results

Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Gender (1=female)	600	0.5	0.50	0	1
Age	600	43.98	10.38	25	65
Household Size	600	5.24	1.98	1	13
d_HighIncome (1=Monthly household income is PhP 100,000 and over)	600	0.268	0.44	0	1
Status of AC holding (1= AC owner)	600	0.67	0.47	0	1
Monthly Electricity Bill (PhP)	600	3738.92	2260.50	1000	19000
AC Daily Usage (hours)	600	5.73	5.12	0	22
Willing to purchase used AC (1=unwilling to purchase used AC)	600	0.8967	0.30	0	1

Estimation Result: Window Type

	Model 1	Model 2
Fee（Non-random parameter）	0.000	0.000
Additional Function (base variable: d_No Additional Function)		
d_Noise Reduction	0.117	0.084
d_Air Purification	0.038	0.026
d_Smart Function	0.334*	0.302
Country of Manufacturer (base variable: d_Philippines)		
d_Japan	0.276	0.248
d_Korea	-0.583***	-0.613***
d_US	-0.401**	-0.417**
Energy Efficiency (base variable: Level1)		
d_Level 2	0.665***	0.347
d_Level 3	0.711***	0.172
d_Level 4	1.064***	0.355
d_Treatment PhP*d_Level 2		0.220
d_Treatment PhP*d_Level 3		0.626***
d_Treatment PhP*d_Level 4		0.544***
d_Treatment EnergyRating*d_Level 2		0.687***
d_Treatment EnergyRating*d_Level 3		1.005***
d_Treatment EnergyRating*d_Level 4		1.615***
ASC	-5.493***	-5.043***

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ASC	-5.493***	-5.043***

Estimation Result: Split Type

	Model 1	Model 2
Fee（Non-random parameter）	-0.000	-0.000
Additional Function (base variable: d_No Additional Function)		
d_Auto Cleaning	0.367**	0.384*
d_Air Purification	0.235	0.274
d_Smart Function	0.403**	0.425**
Country of Manufacturer (base variable: d_Philippines)		
d_Japan	0.328*	0.356**
d_Korea	-0.404**	-0.368**
d_US	-1.481	-0.105
Energy Efficiency (base variable: Level1)		
d_Level 2	0.568***	0.420*
d_Level 3	0.777***	0.372*
d_Level 4	1.176***	0.543**
d_Treatment PhP*d_Level 2		0.191
d_Treatment PhP*d_Level 3		0.499**
d_Treatment PhP*d_Level 4		0.684***
d_Treatment EnergyRating*d_Level 2		0.334*
d_Treatment EnergyRating*d_Level 3		0.910***
d_Treatment EnergyRating*d_Level 4		1.460***
ASC	-9.033***	-10.072***

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d_EnergyRating*d_Level 4		1.460***
ASC	-9.033***	-10.072***

Summary

- Respondents have positive preference towards
  - Smart function compared to no additional function
  - Positive preference towards Japanese AC
  - AC with higher energy efficiency
- On the other hand, they have negative preference towards
  - AC produced by Korean and US manufacturer
  - Option of "I do not purchase AC"
- We found similar preferences among window type and split type
- Regarding the type of information regarding energy efficiency,
  - **Higher energy efficiency** in **energy rating** is preferred to lower energy efficiency in EER

Discussion

- **Contribution**
  - **Energy Policy (Energy label design)**:
    - Energy Rating > PhP/hour > EER
  - **Supplier**:
    - Incentives to make energy efficient AC
    - Smart function can be a new important function of AC
- **Further Tasks**
  - Data-screening!
  - Including interaction terms
    - Some socio-demographic information * AC Price
    - Time preference*AC Price
    - Energy interests * Energy Efficiency
    - Trust on label * Energy Efficiency …