

Household Survey on Air Conditioner Use and Energy Consumption in Vietnam

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Abstract

Demand for electricity is rapidly increasing in Vietnam due to increased use of air conditioners (ACs) and other electrical appliances. Therefore, effective measures are needed for reducing Vietnamese electricity consumption to reduce potential future demand. In 2016, we conducted a survey of 30 households in urban and rural areas of Hanoi and Long An in northern and southern Vietnam, respectively, to examine differences in electricity consumption and the use of ACs and other electrical appliances between different locations and socioeconomic classes. We found that ACs were mainly used in the summer (May–October in Hanoi; March–August in Long An). Households with higher incomes tended to use ACs for most or all of the year. Many households tended to use ACs while sleeping. Younger respondents tended to use ACs for a longer period of time compared with their parents. Respondents in Long An seemed less dependent on ACs compared with those in Hanoi because of regional characteristics and their custom of cold-water bathing. Although increased income is a major factor underlying the use of ACs, other factors such as the structure of modern housing, health awareness, the inability to open windows and local customs were also found. Together, the present results suggest that both hard-type (e.g., improving the thermal performance of residential buildings) and soft-type (e.g., publication of basic tips for energy-saving AC use) policy approaches will be important for reducing future energy consumption in Vietnam.

Key words: air conditioning, consumer behavior, lifestyle, sustainable consumption

1. Introduction

In 1986, the government of Vietnam initiated a set of economic reforms (collectively referred to as the *Đổi Mới* Policy) with the aim of transitioning the Vietnamese economy to a socialist-oriented market economy. The success of these reforms meant that in only 20 years Vietnam went from being one of the poorest countries in the world with a per capita GDP of about 200 USD in 1990 to being a middle-income country with a per capita GDP that exceeded 1000 USD in 2008. During this period, the Vietnamese economy grew at an average annual economic growth rate of 7%, second only to that of China. While this rapid economic growth has brought about material affluence, various social problems have also emerged. For example, social inequality has increased, with the gaps between the rich and poor, and urban and rural areas becoming increasingly apparent (Taylor, 2004). Along with this economic growth, a new urban, educated

middle class has formed (Nguyen-Marshall et al., 2012). This new middle class, made up of people generally in their 30s with a college degree work at companies with foreign affiliations, are relatively free from old perspectives, have rational values and drive mass-consumption trends in the country (King et al., 2008). The parents of this new middle class, the so-called *Bao Cấp* generation, had a tough time during their adolescence in the “subsidy period” before the *Đổi Mới* (1975–1986) (Teekantikun, 2014) and some were educated in the former Soviet Union or in Eastern European countries. The grandparents of this new middle class were born before the country achieved independence, experienced extreme poverty under a protracted period of war (First Indochina War, 1946–1954; and Second Indochina War, 1965–1975); and were middle-aged as the country transitioned to a socialist state. This intergenerational gap, together with the current socioeconomic disparities, greatly divided society because,

in a sense, the social wisdom of the ancestors hardly worked.

Due to its high economic growth, Vietnam's final energy demand increased by an average of 4.1% annually between 2006 and 2015, and if this trend continues, Vietnam's final energy demand is projected to grow by 2.5 times between 2015 and 2035 (Danish Energy Agency, 2017). According to a 2016 Vietnamese household living standard survey, ownership rates of major household appliances were 92% for a color television, 69% for a refrigerator, 35% for a washing machine, 27% for a water heater and 19% for an air conditioner (AC) (GSO of Vietnam, 2018). Compared to the ownership level of 2006, AC ownership increased by a factor of six, whereas those of other electric appliances increased by factors ranging from one to four. If this proliferation continues, energy demand in the country will further increase, leading to greater impacts on the global environment (Sahakian, 2014). Therefore, it is important to find a way to reduce the energy used for ACs and other household electric appliances.

Many studies have been conducted on the indoor thermal environment of houses in Southeast Asia, mainly in the field of building environmental engineering (Kubota et al., 2011; Uno et al., 2003). Kubota and Ahmad (2006) and Kubota (2007) examined how residents used ACs or opened windows to cool their living space. Several studies on household energy use have also been conducted in Vietnam (Kim et al., 2000; Le et al., 2009; Le & Yoshino, 2010; Nagasaki et al., 2011; Sawashima & Matsubara, 2017; Le & Pitts, 2019). Kim et al. (2000) measured the indoor thermal environment (temperature and humidity) of traditional housing in Hanoi, but because this study was conducted in the 2000s, a time when ACs were not in widespread use, the impact of AC use was not examined. Le et al. (2009), Le & Yoshino (2010) analyzed questionnaire survey data to investigate the relationship between electronic appliance ownership and energy consumption. Nagasaki et al. (2011) surveyed energy consumption in six houses in Ho Chi Minh City, the largest city in Vietnam, investigating the hours and temperature setting of AC use. Sawashima & Matsubara (2017) surveyed four houses in Haiphong, northern Vietnam, and investigated the hours and temperature setting of AC use. Le & Pitts (2019) studied the energy usage patterns of 60 households in Tuy Hoa City on the south-central coast of Vietnam. Despite these many studies, there are no studies that have focused on AC use by different income groups in Vietnam.

Here, we collected basic data on AC use and household energy consumption from households in different socioeconomic classes in urban and rural areas of Vietnam. Using this data, we then considered the following research questions: 1) When and how are electric appliances used in urban and rural areas of Vietnam? 2) How has the spread of electric appliances

differed from that in other Asian countries, such as Japan? 3) What are the drivers and barriers to owning new electric appliances, especially cooling appliances such as ACs? 4) To what extent are people aware of energy saving?

2. Methods

2.1 Survey Area

Vietnam is a large country with a north–south orientation. Vietnam's climate can be divided into two zones: a tropical monsoon zone and a warm–dry winter zone. The southern part of Vietnam, especially Ho Chi Minh City and the surrounding Mekong Delta, has a tropical savanna climate, with annual average temperature ranging from 22°C to 27°C all year round. The northern part, including Hanoi, has four seasons, and the temperature typically varies from 14°C to 33°C. We accounted for the two different climates by conducting our interview survey once in northern Vietnam (Hanoi in March) and once in southern Vietnam (Long An Province in August). Both surveys were conducted in 2016.

Hanoi is the capital of Vietnam and the second most populated municipality. Its population exceeds seven million and the main industry there is the service industry (GSO, 2020). Long An (population 2 million) is a mid-sized province that adjoins Ho Chi Minh City and is located at the entrance to the Mekong Delta. Since 2002 improvements in transportation access have resulted in many factories relocating from Ho Chi Minh City to industrial zones in Long An, which together comprise 28 industrial parks (Runckel, 2006; VOV World, 2016). The major industry in Long An is manufacturing, which accounts for half of the gross regional product, although the production of raw materials in rural areas accounts for approximately 20% of the gross regional product (GSO, 2020).

Fifteen households were selected in each region with consideration given to ensuring a selection of households that would represent the diversity in Vietnam with respect to household size, monthly income and occupations of family members. Local officials helped us select households from each income class. Monthly incomes in urban areas of Hanoi and Long An were classified as low, <10 million VND (457 USD; 1 USD = 21,887 VND); middle, 10–30 million VND (457–1,371 USD); and high, >31 million VND (1,416 USD); in rural areas of Hanoi as low, <5 million VND (226 USD); middle 5–10 million VND (226–457 USD); and high, >10 million VND (457 USD); and in rural areas of Long An as low, <5 million VND (226 USD); middle, 10–25 million VND (457–1,142 USD); and high, >25 million VND (1,142 USD). In Hanoi, nine households were selected from the central districts of Hanoi City (i.e., Ba Dinh District, Dong Da District and Hai Ba Trung District) and the fast-developing new urban district Thanh Xuan; and six

households were selected from a rural area (Dong Anh District) (Fig. 1). In Long An, three households were selected from Tan An City, the provincial capital, and the remaining 12 households were selected from Thanh Hoa District, which has a town area (six households) as well as rural areas that are characterized by a mix of Melaleuca tree plantations and other agricultural activities (six households).

2.2 Household Interviews

We conducted face-to-face interviews based on a questionnaire that comprised items similar to those used in our previous work in Chiang Rai, Thailand (Yoshida et al., 2020). The questions were asked and then answered in Vietnamese by the head of each household or their family members. These responses were translated immediately into English by an attending interpreter. The survey consisted of six parts: household attributes, ownership of electric appliances, use of ACs, knowledge and intention to save electricity, information related to the purchase of electric appliances, and future purchasing and lifestyle prospects. The basic specifications of the household electrical appliances, including the manufacturer's name, model, year of manufacture and power consumption, were identified by inspection of the product labels or by observation of the product's appearance. The layout of each residence was recorded through photographs and hand drawings. The residential floor space was measured in all households in Long An, but only three households in Hanoi due to time constraints or the respondents' refusing permission. From 10 households in Hanoi and 11

households in Long An, monthly electricity bills (from one to six months) were also obtained. Each household visit took 1–1.5 hours.

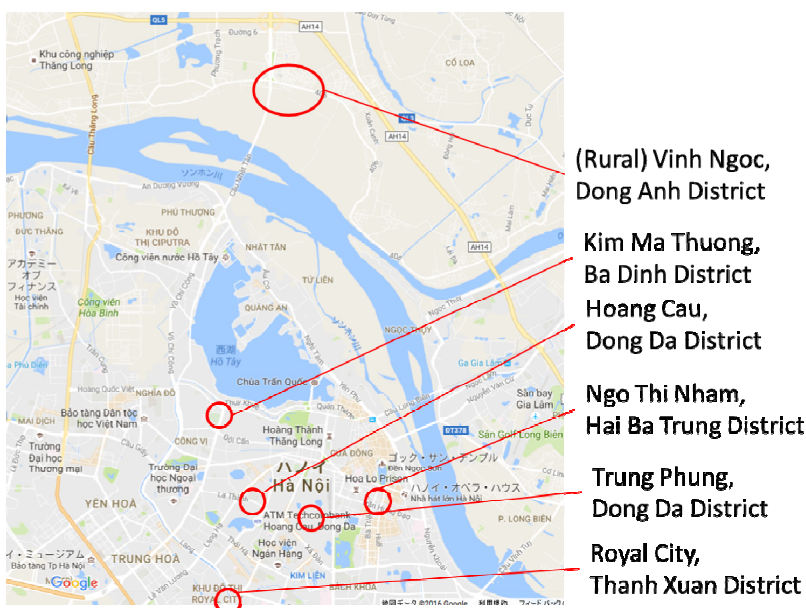
3. Results

3.1 Respondent Characteristics

Tables 1 and 2 present summaries of the households that were visited. In Hanoi, there were six three-generation households (40.0%), four couples or single parents with child(ren) (26.7%), three elderly couples (20.0%), one single-person household (6.7%), and one other (6.7%). In Long An, there were six couples or single parents with child(ren) (40.0%), two three-generation households (13.3%), two elderly couples (13.3%), one single-person household (6.7%), and four others (26.7%). The “other” category was large in Long An because there many more households in which the respondents were living with a brother/sister or other relatives. The average number of household members was 4.4 in Hanoi and 5.1 in Long An.

In Hanoi, there were three high-income households, four middle-income households and two low-income households in the urban area and two high-income households, three middle-income households and one low-income household in the rural areas. In Long An, there were two high-income households, four middle-income households and three low-income households in the urban areas and two high-income households, two middle-income households and two low-income households in the rural areas.

Survey area in Hanoi



Survey area in Long An



Fig. 1 Study areas in Hanoi (left) and Long An (right).

Table 1 Summary of the study households in Hanoi.

ID	House		Respondent		Household		Main income earner in household			Electrical appliances in household			
	Location	Type	Gender	Age	Monthly income (1000 VND)	Other members (age)	Academic level	Occupation	TV	AC	Electric fan	Fridge	Rice cooker
1	Urban	Three-story town house	F	68	26,000	Husband (77), son (44), daughter-in-law (41), grandchild (12)	College/university	Engineer, businessperson	3	3	5	1	2
2	Urban	Three-story town house	F	45	17,000	Husband (47), daughter (21), daughter (6), father-in-law (77), mother-in-law (71)	Upper secondary	State enterprise employee	3	2	4	1	1
3	Urban	Three-story town house	M	68	7,500	Wife (67)	Vocational school	Retired, dancing teacher	3	2	5	2	2
4	Urban	Flat, apartment	F	29	8,500	Husband (33), son (4), son (<1)	College/university	Electrical technician	1	0	2	1	1
5	Urban	Four-story town house	F	78	15,000	Son (46), daughter-in-law (41), grandchildren (14, 8)	Vocational school	Train conductor/supervisor	2	2	3	1	1
6	Urban	Five-story town house	F	41	100,000	Husband (41), son (16), son (9), mother (67), sister (34)	Graduate school	Director, businessperson	3	8	13	1	1
7	Urban	Condominium	M	41	50,000	Wife (40), son (13), daughter (<1)	College/university	Manager, businessperson	1	2	1	1	1
8	Urban	Two-story town house	F	51	10,000	Daughter (24), daughter (19)	Lower secondary	Street food vendor	1	1	2	2	1
9	Urban	Four-story town house	M	62	30,000	Wife (62)	Graduate school	Engineer	3	4	13	2	2
10	Rural	Two-story detached house	F	59	15,000	Husband (60), son (34), daughter-in-law (24), grandchildren (9, <1)	Lower secondary	Farmer, mechanic	3	1	8	1	2
11	Rural	Two-story detached house	F	61	6,500	Husband (66), son (33), daughter-in-law (32), grandchildren (12, 9)	Lower secondary	Farmer, taxi driver	1	1	3	1	3
12	Rural	Three-story detached house + coop	M	38	9,500	Wife (38), son (18), son (13)	Lower secondary	Farmer, speaker rental service	2	0	4	2	1
13	Rural	Single-story detached house + coop	M	61	600	None	No formal education	Farmer, scrap buyer	1	0	2	0	0
14	Rural	Three-story detached house + coop	M	47	12,000	Wife (44), son (23), son (20)	Lower secondary	Farmer, construction worker	2	0	5	1	1
15	Rural	Single-story detached house + two coop	M	54	10,000	Wife (48), daughter (26), daughter (20)	College/university	Accountant	1	0	2	1	1

Note: 1 USD = 21,887 VND (average exchange rate during March – August 2016; Resona Bank).

Table 2 Summary of the study households in Long An.

ID	House		Respondent		Monthly income (1000 VND)	Household		Main income earner in household			Electrical appliances in household				
	Location	Type	Gender	Age		Other members (age)	Academic level	Occupation	TV	AC	Electric fan	Fridge	Rice cooker		
1	Rural	Single-story detached house	M	43	25,000	Wife (41), children (17, 11, 7)	Lower secondary	Farmer	1	0	7	1	1		
2	Rural	Single-story detached house	M	39	11,000	Wife (38), children (20, 16, 11)	Lower secondary	Farmer, embankment construction business	1	0	3	1	1		
3	Rural	Single-story detached house	M	41	16,000	Wife (33), children (15, 13, 5)	Elementary	Commune committee member, farmer	1	0	5	1	1		
4	Rural	Single-story detached house	M	31	27,000	Wife (30), children (5, <1), brother (24), sister-in-law (24)	Lower secondary	Truck driver	2	1	4	1	1		
5	Urban	Single-story detached house	M	81	1,000	Wife (65)	Upper secondary	Lottery ticket seller	1	0	4	1	2		
6	Urban	Three-story detached house	M	67	60,000	Wife (64), son (41), daughter-in-law (41), daughter (38), son-in-law (42), grandchildren (18, 16, 13, 9, 11, 8)	Upper secondary	Home appliances shop owner, forest owner	6	5	20	1	1		
7	Urban	Single-story detached house	F	39	2,000	Son (14), daughter (6)	Elementary	Freelance worker	1	0	3	0	1		
8	Rural	Single-story detached house	F	70	600,000	None	Lower secondary	Farmer, cashew shell peeler	1	0	1	0	1		
9	Rural	Single-story detached house	M	48	3,500	Wife (48), daughter (24)	Lower secondary	Farmer, cashew shell peeler	1	0	2	1	1		
10	Urban	Single-story detached house	F	41	15,000	Husband (44), son (16), son (11)	Lower secondary	Nail and hair salon owner	1	2	5	1	1		
11	Urban	Single-story detached house	M	31	10,000	Wife (37)	College/university	School teacher	1	1	3	1	1		
12	Urban	Single-story detached house	M	66	20,000	Wife (64), son (40), daughter-in-law (37), grandchildren (16, 13, 7)	Lower secondary	Food store and restaurant owner, forest owner	2	0	10	1	3		
13	Urban	Single-story detached house	F	25	20,000	Husband (28), uncle (41), aunt (41), uncle's children (13, 11, 9)	College/university	Accountant company employee	1	3	8	1	1		
14	Urban	Single-story detached house	F	54	213,000	Husband (60), brother (55), son (29), daughter-in-law (25), son (22) grandchildren (8, 3)	College/university	Trade and investment company owner	3	5	10	1	1		
15	Urban	One-story detached house	M	40	7,000	Wife (40), son (11), mother (81)	Lower secondary	Street food seller	1	0	4	0	1		

Note: 1 USD = 21,887 VND (average exchange rate during March – August 2016; Resona Bank).

3.2 Housing Characteristics

In the urban areas of Hanoi, the traditional residences are row houses (aka shop houses or pencil houses) (Shinozaki et al., 2005), which have a narrow facade, long depth, and multiple stories (Fig. 2). The walls are made of brick, and the floor is either tiled or made of concrete without any insulation. Except for at the ends of the row house complex, sunlight cannot penetrate deep inside the houses, which means the room temperature rarely goes above 30°C (Thao & Nam, 2018). In the urban areas of Hanoi, the total floor area of a three-story house was 81.74 m² (Household 3) and that of a four-story house was 191.18 m² (Household 9). In contrast, a typical household in a rural area (Household 15) was situated on a large plot of land (150 m²) and the total floor area of the main building and annex was 48.46 m². The rural houses also usually had ponds/wells, gardens and livestock huts.

In Long An, most of the residences were single-story buildings, and the houses were relatively new compared with the houses in Hanoi. Several households were rebuilding their house with brick and concrete instead of the traditional palm-leaf thatching. On average, the houses were 14–17 years old in Hanoi and 8–9 years old in Long An. All the residential buildings that we visited, except for one apartment in Hanoi, were detached houses or row houses. The average housing unit had a floor area of about 60–80 m² and 2–3 bedrooms.

3.3 Ownership of Electronic Appliances

Televisions (TVs), rice cookers and electric fans were items owned by most households regardless of whether they were located in an urban or rural area. In urban areas of Hanoi, ACs were very popular and many households owned two or more units; even some low-income households owned an AC unit. Refrigerators, washing machines and electric water heaters were also owned by low-income households. Many households in urban areas used gas for cooking, but several had switched from gas to electricity for safety concerns. In

Hanoi, due to the cold weather in winter, some ACs had both a cooling and heating function, and electric water heaters were used to heat water for bathing. Several high-income households also had a halogen heater in their bathrooms and a stand-up, hanging-type electric clothes dryer.

In rural areas of Hanoi, ACs were not widely used and only high-income households owned one, but most rural households said they would like to have one in the future. We also found that refrigerators, washing machines and water heaters were owned mainly by middle- and high-income households. Several households used both wood and gas for cooking.

In Long An, high-income and several middle-income households in the urban areas owned ACs. One high-income household in a rural area had a plan to install an AC, but most households said that they preferred fans and the natural breeze over ACs, which is in contrast to the rural households in Hanoi. Several households in urban areas of Long An were planning to install ACs in their bedrooms. The main reason for purchasing an AC was to provide greater comfort and a healthy environment for their children while they are studying or sleeping. Most people, excluding old people and infants, used cold water to shower throughout the year. In general, the older generations are comfortable with bathing with cold water from a nearby river, as they have done from an early age. However, wealthy, white-collar workers who are accustomed to spending their whole day in an air-conditioned office said that they preferred taking a warm shower and that this had become a habit for most of them.

3.4 AC Usage

In Hanoi, the main period in which ACs are used for cooling lasts three months (June–August) in light-use households and seven months (April–October) in heavy-use households. Heating was mainly used by high-income households from December to February.



Fig. 2 Front view of representative housing units in urban (left) and rural (right) areas of Hanoi (a) (b) and Long An (c) (d).

Members of households lacking ACs with a heating function warmed themselves using electric blankets and/or oil heaters. In Long An, the corresponding period of AC use in light-use households was two to six months (March–August), but heavy-use households used their AC all year round. Also, the period of use tended to be longer in households with higher incomes.

To understand more about the daily use of ACs, we asked each household to tell us who switched the AC on or off and how many hours they used the AC in each room. In Hanoi, eight households said that they used the AC while they slept (10 pm to 6 am). In Hanoi, children/grandchildren tended to use ACs for longer hours than did their parents (Fig. 3); the average daily usage time for children/grandchildren was 8.1 h, whereas that for their parents it was 5.3 h. In Long An, four out of six households also said that they used the AC while they slept and the period of usage was one to two hours earlier than that in Hanoi (i.e., 8 pm to 5 am).

Regarding the temperature setting, 12 households said that they used a setting of 25°C–26°C, but some households used a setting 2°C–3°C higher or lower. It should be noted that older family members (grandparents) reported simply turning off the AC rather than adjusting the temperature because they could not read the English on the remote control for the AC unit, whereas the younger family members (parents in their 30s and 40s and their children) reported being able to read the English and understand how to control the AC.

In response to the multiple-choice question, “What do you usually do to reduce electricity consumption when using the AC unit to cool a room?” most people in Hanoi chose “close windows/doors” followed by “limit the time/hours of use,” “clean the filter” and “do not turn on/off frequently” (Fig. 4). In Long An, most people chose “clean the filter” and “close windows/doors.” No one in either location chose “set air flow direction to horizontal.” Only one respondent in Long An chose “do other things,” which was to use an energy-saving mode.

Regarding simultaneous use of a fan and AC, more households in Hanoi than in Long An said that they used both at the same time.

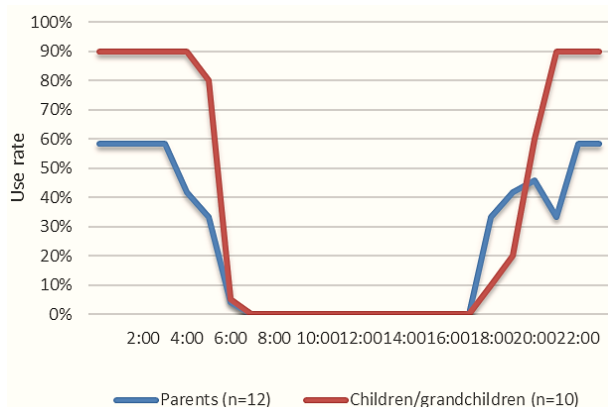


Fig. 3 Daily usage patterns of air conditioning for cooling by households in Hanoi.

3.5 Alternative Methods of Cooling

Regarding alternative methods of cooling, in Hanoi most people chose “open a window and let the wind in” and “do other things” (e.g., use a hand fan), followed by “have a cold drink,” “take a shower” and “go to a public space, shopping mall, cafe, etc.” (Fig. 5). In Long An, most people chose “have a cold drink,” “take a shower,” “open a window and let the wind in” and “sprinkle water,” meaning sprinkling water over the roads and pavement to lower the temperature via evaporation. No one chose “go to a public space, shopping mall, cafe, etc.”

3.6 Energy Saving

Due to the increased ownership of electric home appliances, electricity consumption by low-income households in urban areas and high- and middle-income households in rural areas of Hanoi had reached about 160–280 kWh per month (300–500 thousand VND; 14–23 USD). Electricity consumption of high- and middle-income households in urban areas and high-income households in rural areas in Hanoi had reached 330–670 kWh per month (600–1200 thousand VND; 27–55 USD), approximately twice that of the other groups.

In Hanoi, monthly electricity consumption data were obtained from monthly electricity bills provided by several respondents. The electricity consumption of the households with ACs was highest in summer (May–October) followed by spring (March–April) and winter (January–February); autumn (November–December) was the lowest season. In contrast, the electricity consumption of the households without ACs remained almost the same throughout the year. In rural areas of Hanoi, electricity consumption was highest in summer followed by winter and spring. Electricity consumption in rural areas of Hanoi was highest in winter when they turned heaters on for their livestock.

In Long An, the electricity consumption of the low- and middle-income households without ACs in urban areas and low- and middle-income households in rural areas without ACs was a maximum of 140 kWh per month (250,000 VND; 11 USD). In contrast, the electricity consumption of middle-income households with ACs in urban areas and high-income households with ACs in rural areas was about 200 kWh per month (400,000 VND; 18 USD). The electricity consumption of high-income households with ACs in urban areas reached 1,000 kWh per month (2 million VND; 91 USD).

In response to a question about the household’s intention to save energy, 80% of the respondents in Hanoi and 100% of the respondents in Long An said that they tried to save energy, and almost all of these respondents chose “economic reasons” as the trigger for wanting to save energy. With regard to energy-saving labels on electric appliances, the majority of respondents said that they did not remember seeing the labels, which suggests

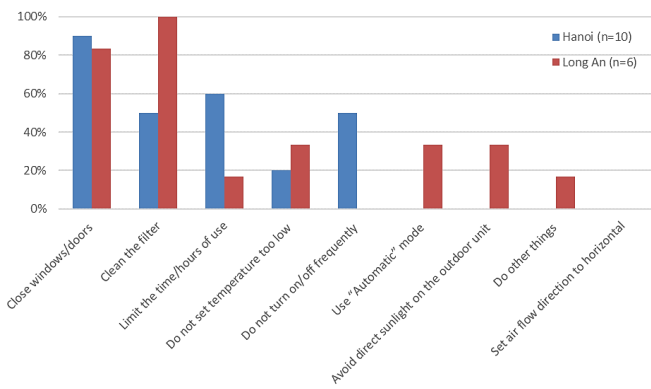


Fig. 4 Responses to the question “What do you usually do to reduce electricity consumption when using the air conditioning unit to cool a room?”

that the government’s publicity and advertising of the meaning of energy labels may not have been successful at leading consumers to purchase products with high energy efficiency.

3.7 Future Prospects

Regarding electric appliances that the respondents planned to buy in the future, the demand for ACs was highest in Hanoi. In Long An, the demand for LEDs (light-emitting diodes) or smart TVs was largest, with ACs third after electric fans. Most households responded that “money” was the main barrier to buying new products; very few households selected “space” or “electric capacity.”

Although most of the respondents in Hanoi were unsure about what their ideal lifestyle would be, they tended to choose “healthy” or “convenient & comfortable” instead of “environmentally friendly” as their ideal lifestyle. In Long An, because it had been difficult to obtain clear responses to the question about ideal lifestyles in Hanoi, we changed the question to ask about the changes in their living environment in the past 10 years, as well as future changes that they expected to see in the local area over the next 10/20/30 years. Many people said that they had seen an improvement in infrastructure, manifested in the construction of roads, and that they had been able to purchase household appliances and motorbikes in the past 10 years. They said that they hoped for more improvements in the future.

Thus, from these responses, we can infer that Vietnamese households will likely be demanding more convenient and comfortable lifestyles in the future.

4. Discussion and Conclusion

How does the spread of electric appliances in Vietnam differ from that in Japan in the past? In Japan in the late 1950s, with the rapid growth of the Japanese economy, refrigerators, washing machines and black-and-white TVs were informally referred to as the

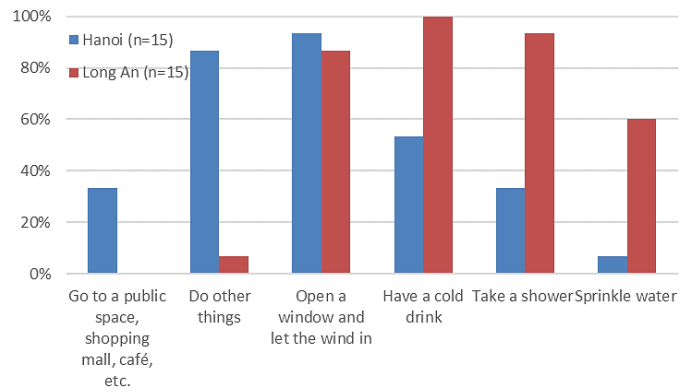


Fig. 5 Methods of cooling besides using air conditioning units or fans (multiple responses were possible).

“three sacred treasures.” Like the Imperial Regalia, which represent the three virtues of valor, wisdom and benevolence, these electrical goods were said to be symbols of affluence, longing and convenience. In the mid-1960s, the “sacred treasures” changed to cars, ACs, and color TVs; and in the 1990s to digital cameras, DVD players, and flat-screen TVs. Thus, the items most coveted by people have shifted from home appliances related to daily life to digital home appliances related to entertainment and hobbies.

In contrast, in Vietnam in the 1990s, TVs, video players and motorcycles were the “sacred treasures” for the Vietnamese people (Minagawa, 1997). In fact, data from the Vietnam Household Living Standards Survey (GSO, 2006, 2018) have indicated that the penetration rate of these three items was higher than that of all other items until the first half of the 2000s. It is interesting to note that the penetration rate of video players was higher than that of appliances useful in daily life such as refrigerators and washing machines (Trinh, 2014). Since 2006, the penetration of telephones (including mobile phones) has increased rapidly, whereas that of video/DVD players has decreased, such that mobile phones are now considered to have replaced video players as one of the “sacred treasures” (GSO, 2006, 2018; Trinh, 2014).

In our survey, the penetration rate of ACs was clearly higher among the higher income groups and many households said they would possess more ACs if they had enough money. One obvious factor in owning and using an AC was “increased income.” As incomes rose, more people came to live in modern houses and use more electric appliances including ACs. Although the airtightness of houses in Vietnam had somewhat improved (Kim et al., 2000), most respondents reported being dissatisfied with the indoor thermal environment because it was not suitable for Vietnam’s hot, humid climate. The thermal environment can be improved by using electric fans and opening windows to increase air flow; however, several respondents pointed out that in reality the windows cannot be opened due to noise or heat caused by

urbanization or because they felt it was unsafe to have a window open at night. Global warming appears to be an additional reason windows cannot be opened. Together, we conclude that these are the major factors leading Vietnamese people to purchase and use ACs (Fig. 6).

Although the Vietnamese government has promoted the use of products with high energy efficiency since 2003 (Nong et al., 2020), few households recognize the energy labels on electric appliances. Koning et al. (2015) found that although awareness and knowledge of sustainable consumption is generally low among the urban middle-class in Vietnam, motivation to live healthy lifestyles and protect the planet for future generations is high. Our study shows that the habit of showering with cold water has been changed by the introduction and use of ACs. As the number of people who spend more hours in air-conditioned rooms increases, it is likely that more people will opt to use ACs for longer hours and to take hot showers. This represents a major shift in the daily behavior of Vietnamese people. However, this also suggests that promoting energy-saving lifestyles among young people (e.g., TV commercials encouraging people to dress in lighter clothes in the office or adopt traditional habits such as bathing with cold water) may help to avoid the overuse of ACs in the future.

Previous studies have suggested improving the indoor thermal environment by improving the thermal performance of residential buildings and promoting the use of high-efficiency ACs (Sawashima & Matsubara, 2017; Le & Pitts, 2019). We found that people's awareness of energy saving is still low, so these hard-type measures are still needed. As the number of households installing ACs increases in both urban and rural areas, however, new measures drawing on a broader perspective are also needed. We need to place equal importance on soft-type policy approaches, such as publication of basic

energy-saving tips for AC use and promotion of environmentally friendly lifestyles.

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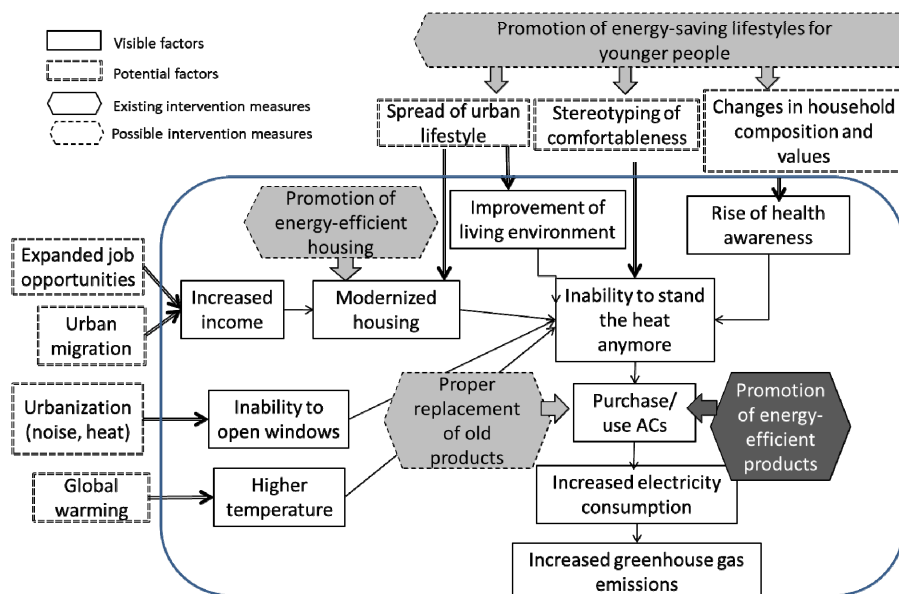


Fig. 6 Motivation for owning and using air condition units, and expected measures to mitigate environmental impacts.

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