The Indonesia Cooking Diaries Study

IISD REPORT

IISD International Institute for Sustainable Development
UK aid from the British people
MECS Modern Energy Cooking Services
ESMAP Energy Sector Management Assistance Program
Loughborough University

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International Institute for Sustainable Development

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Modern Energy Cooking Services

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1.0 Project Overview

1.1 Project Background

The Indonesian government has promoted liquefied petroleum gas (LPG) as a primary cooking fuel since 2008. Owing to a successful conversion program from kerosene to LPG, more than 80% of Indonesian households are currently using LPG for cooking; in urban areas, this number is estimated to be close to 89% (Dihni, 2021). Yet, this high prevalence of LPG comes at a cost to the government. In Indonesia, LPG is sold either in non-subsidized 12-kg LPG tubes or highly subsidized 3-kg LPG cylinders. Even though the subsidy is intended for poor and vulnerable groups, there is no restriction on buying subsidized 3-kg LPG cylinders. Consequently, the vast majority of LPG consumed among Indonesian households—94% in 2022—was subsidized LPG, a large fiscal strain on the government's budget since the costs for these subsidies climbed to more than IDR 100 trillion in that year (Audit Board, 2023; Wisnubroto, 2023). Moreover, domestic LPG production is limited, so close to 79% of LPG consumed in Indonesia had to be imported in 2022, which is massively impacting Indonesia's trade balance (Ministry of Energy and Mineral Resources, 2023).

As a result, the Government of Indonesia has set out a strategy to reduce LPG usage. First and foremost, this transition aims to alleviate the significant financial burden on the government caused by LPG subsidies, which, as noted above, account for significant spending from the national budget. By reducing reliance on subsidized LPG, the government can reallocate these funds to other critical areas, such as health care, education, or infrastructure development. Reducing LPG consumption will also help balance Indonesia's trade deficit, as a significant proportion of LPG is imported, and a reduction would decrease the outflow of national currency to foreign markets, hence preserving foreign exchange reserves. Additionally, less reliance on imported LPG can reduce the impact of global price fluctuations and supply chain disruptions on Indonesia's economy and thus increase the country's energy security.

A prominent tool in this strategy is induction stoves: the government—through the National Energy Council—aims to meet 22% of the total cooking energy demand in Indonesia with induction stoves by 2030 (Christian, 2022). This transition would be a new development in Indonesia; aside from rice cookers, which have become the norm for cooking rice in many Indonesian households, particularly in urban areas, using electrical cooking devices to cook side dishes (those served alongside rice) is not widespread. In fact, in 2021, only 0.76% of all households used electric stoves for cooking, which is even lower than in 2011 (Widi, 2022). However, this transition is not without its challenges. As Indonesia currently relies to a large extent on carbon dioxide-emitting coal for electricity generation, the environmental benefits of induction stoves, which are said to be more energy efficient than cooking with LPG, could be offset by the emissions from coal-fired electricity. This paradox highlights the need for Indonesia to focus on developing renewables alongside the promotion of induction stoves.[1]

Nevertheless, certain developments relevant to the further uptake of induction stoves in Indonesia have happened over the past few years. By mid-2022, PT Perusahaan Listrik Negara (PLN), Indonesia's state-owned electricity company, had carried out two pilot trials in Bali and Solo, where about 1,000 induction stoves and cookware were distributed to households and micro businesses (Coordinating Ministry for Economic Affairs, 2022; Setiawan, 2022a). Praised as a success, it is not clear to what extent those pilot projects effectively made the participants in these trials change their cooking practices to essentially move away from cooking with LPG. For 2022, PLN targeted 300,000 current LPG users to switch to induction stoves. Although no information has been provided on whether this was achieved, the government announced in September 2022 that it would support a much larger conversion program to distribute 15 million additional induction stoves by 2025, with a budget of IDR 5 trillion (CNN Indonesia, 2022). However, the measure was suspended shortly after being announced when the Indonesian parliament failed to approve it (Setiawan, 2022b). Instead, a similar—but much smaller—program focusing on distributing 500,000 rice cookers to households meeting specific conditions began in October 2023 and distributed about 50,000 rice cookers until December 2023; because the program was limited to rice cookers, it does not support an increase in the uptake of induction cookers (Utama, 2023). Finally, beginning in January 2024, the Indonesian government began enforcing a more targeted policy for accessing subsidized 3-kg LPG cylinders. This new policy requires individuals to pre-register to be eligible for the subsidy and could be a meaningful step in helping to promote induction stoves, as it improves price competitiveness compared to LPG (Damayanti, 2024). However, it is not yet clear how strictly the plan is being implemented and how many households that currently have access to subsidized LPG will no longer be able to have this in the future. In fact, the government expects that the consumption of subsidized LPG will be 8.03 million tonnes in 2024, only slightly lower than the 8.07 million tonnes consumed in 2023 (Muliawati, 2024).

[1] By mid-2023, the installed capacity for new and renewable energy reached only 12.5% of total electricity generation capacity, and Indonesia is on track to miss its 23% target for 2025 (Karyza, 2023). Nevertheless, Indonesia has revised its on-grid renewable energy target for 2030 under the Just Energy Transition Partnership and the Comprehensive Investment and Policy Plan upward from 34% to 44% (Karyza, 2023). Because the country's renewable energy deployment efforts have lagged behind the original targets, so far there has been a gap between policy aspirations and implementation on the ground.

1.2 Project Goals and Objectives

Following the Cooking Diaries approach developed by the Modern Energy Cooking Services program (Leary et al., 2019), this study analyzes the feasibility of switching from cooking with LPG stoves to induction stoves for side dishes by looking at users' general cooking experiences and thus the compatibility with common practices and other factors, such as cooking durations, energy demand, or cooking costs. Given Indonesia's specific context of promoting induction stoves as a primary strategy for transitioning away from LPG, this study will solely focus on switching from LPG stoves to this particular electric cooking appliance. The study aims to achieve these project goals by collecting primary quantitative and qualitative data about cooking behaviours, preferences, and sentiments among urban Indonesian households. In particular, the data collected includes information about the following aspects:

- understanding typical cooking behaviours in urban Indonesian households;
- understanding the ease of replicating typical cooking behaviours in urban Indonesian households with induction stoves;
- understanding the implications of replacing existing LPG stoves with induction stoves in urban Indonesian households and in Indonesia more generally; and
- understanding the need for further political support to accelerate this transition to induction stoves, as desired by the government.

This research fills a gap in understanding the cultural and real-world implications of cooking with induction stoves in Indonesia, adding to existing research that assesses potential implications in more context-free experiments.[2] As such, the study aims to make recommendations for policy-makers on more realistic expectations about such a transition and possible ways to ease the transition from LPG to induction stoves and overcome potential limitations.

[2] Various studies have looked at the theoretical efficiency and duration of induction stoves primarily by heating one litre of water to its boiling point (e.g., Hakam et al., 2022). While these studies carried out in controlled environments provide objective data, their validity is limited for cooking in real-world settings.

2.0 Research Methodology

The study was structured into two phases and covered participants from 10 households in South Jakarta. It was carried out between March and June 2023. Prior to the first phase, the participants took a registration survey to provide information about socio-economic characteristics and the local setups.

In the first phase, the participants cooked with their existing appliances and used a standard diary form to note detailed information about dishes cooked, including time spent cooking and the amount of fuel used.[3] This data was then collected by several enumerators, who were also available throughout the study to support the participants if needed.

In the second phase, following a training workshop and a week to test out induction stoves, the same households were provided suitable cookware by the International Institute for Sustainable Development (IISD) and requested to cook with the induction stoves as much as possible.[4] In addition to the support of the enumerators, all participants also had the chance to get in touch with and learn from each other by sharing experiences through a group chat. Measurements were again taken, and data was collected by enumerators to understand energy consumption and time spent cooking with induction stoves. The participants were also asked to measure the electricity consumption of the rice cookers they already owned and used in this phase to provide a more complete picture of the total electricity consumption and cooking practices of combining both induction stoves and rice cookers.

Participants took part in an initial interview before the induction stove phase and an exit interview to record their attitudes toward induction stoves after the study ended. The full cycle of the research is summarized in Table 1.

[3] For LPG, the scales—despite specific arrangements made—were not sensitive enough to record small variations that occur when cooking only one dish—that is why the fuel measurements were made for entire meals (e.g., breakfast, lunch, dinner, snack).

[4] The original plan included only 1 day of training for the participants. However, the participants were hesitant to use the induction stoves and required more time to familiarize themselves with the appliances. It was therefore decided to extend the Learning Phase to 1 week, which effectively reduced the time for Phase 2 to 2 weeks.

Table 1. Research cycle of the Indonesia cooking diaries study

Level	Intensive Cooking Diaries: Phase 1 (Benchmark phase)
Duration	2 weeks
Description	Baseline measurement is done using normal cooking practices using existing LPG stoves.
Role of participants	The participants cook using their regular LPG stoves and cookware. The participants record their cooking activities and the details of the dishes they cook. The participants measure the weight of their LPG tanks using calibrated scales provided by IISD before and after they cook. The participants submit information about their cooking activities, LPG measurements, and pictures of dishes and cooking processes to their assigned enumerators through their smartphones.
Role of enumerator	The enumerators receive information about cooking activities and pictures from the participants through smartphone messages and record them in the cooking diaries. The enumerators schedule daily visits to the participants' houses for monitoring purposes. They also provide consultations via their phones if urgent matters arise.

Level	Learning Phase
Duration	1 week
Description	Induction stove setup and training for learning to cook with induction stoves.
Role of participants	The participants join a cooking training session for induction stoves and start trying out the functions in their homes with the induction stoves provided.
Role of enumerator	The enumerators set up the induction stoves and energy meters to track consumption at the participants' homes. The enumerators remain available to support the participants in the process of learning to cook with induction stoves.

Level	**Intensive Cooking Diaries: Phase 2 (Transition phase)**
Duration	2 weeks
Description	Transitional measurements by cooking with induction stoves.
Role of participants	The participants transition to cooking only with induction stoves and the new cookware. The participants record their cooking activities and the details of the dishes they cook. The participants measure the electricity consumption of their induction stoves and rice cookers using energy meters provided by IISD. The participants submit information about their cooking activities, electricity measurements, and pictures of dishes and cooking processes to their assigned enumerators through their smartphones.
Role of enumerator	The enumerators receive information about cooking activities and pictures from the participants through smartphone messages and record it in the cooking diaries. The enumerators schedule daily visits to the participants' houses for monitoring purposes. They also provide consultations via their phones if urgent matters arise.

2.1 Participant Recruitment

A number of criteria and steps were taken to determine the area and participants for the cooking diary study.

The research project had to be conducted in an urban area to ensure a stable electricity supply to operate the induction stoves at all times. Prior to the project's start, IISD approached the community leaders in Pasar Minggu, a district in South Jakarta, to obtain their consent for the study to be conducted in their communities. Moreover, local community leaders informed the local security services about the upcoming project and pointed out the number of crowd gatherings that would take place during the three weeks of this study. After gathering initial information about availability, electricity connections, and the economic status of households in that community, IISD and the local community leaders assembled a small team of enumerators and jointly selected the candidates for the study. Candidates were selected according to various criteria, including ensuring that participants represented different socio-economic backgrounds, with at least five participants representing low-income households.

At the beginning, 20 pre-selected candidates proposed by the community leaders were invited to an introductory meeting to learn about the project. Finally, 15 out of these 20 pre-selected candidates eventually became participants in the study, as IISD aimed to enrol a slightly smaller number of participants. However, despite full or partial participation throughout the study, several of these participants did not qualify for inclusion in the final sample size for a variety of reasons, including misreporting of cooking practices, continued excessive cooking with LPG during Phase 2, and unanticipated personal life changes. This reduced the final number of participants who provided valid information and data to 10.

2.2 Devices Used in the Study

2.2.1 Devices Used for Cooking

In Phase 2 of the study, the participants were asked to replace their cooking appliances that used LPG with one of two types of single-burner induction stoves, each of which had different maximum power outputs.[5] Each household's power supply determined which induction stove could be used.

The 1,000 W induction stoves could only be used at full capacity by participants whose households had a power connection of 1,300 VA or higher. Households with a 900 VA power connection—one level below the 1,300 VA connection—were unable to cook with an induction stove if the maximum wattage of 1,000 W was used. Their circuit breakers would automatically cut off the power if a power load of more than 900 W was applied simultaneously.

On the other hand, the 2,000 W induction stoves only function at full capacity in households with a power connection of 2,200 VA or higher—one level above 1,300 VA connections. To put these figures in context, in 2021 only about 24% of households in Indonesia had an electricity connection of 1,300 VA or more, and only about 7% of households in Indonesia had an electricity connection of 2,200 VA or more (Safitri & Pratama, 2022).

1,000 W induction stove

Technical specification

Power level	200–1,000 W
Temperature level	60–240°C
Voltage	220–240 V
Dimension	28 × 35 × 6.8 cm
Weight	2.8 kg

2,000 W induction stove

Technical specification

Power level	200–2,000 W
Temperature level	60–240°C
Voltage	220–240 V
Dimension	29 × 37 × 3.8 cm
Weight	2.8 kg

[5] The standard LPG stoves are dual-burner stoves that allow for simultaneous cooking. The single-burner induction stoves were selected because only a few dual-burner induction stove types exist on the Indonesian market. These can be further considered as luxury products, which are significantly more costly due to the relevant price premium, and therefore likely not affordable for many Indonesian households.

IISD distributed the induction stoves depending on the power capacity of each participant's household. As conventional cookware for LPG stoves does not work on induction stoves, the participants were also given induction stove-compatible cookware. This included a regular and non-stick frying pan, a normal pot, and a steamer pot. Due to the study's focus on analyzing the switch from LPG stoves to induction stoves, no other additional electrical cooking utilities (e.g., pressure cookers, electric frying pans or even microwaves) were distributed to the participants. Where certain products, such as electric rice cookers, were already common in Indonesian households, information was additionally collected for these existing items.[6]

Regular frying pan

Non-stick frying pan

Normal pot

Steamer pot

2.2.2 Measurement Devices Used

In Phase 1, participants used digital scales to weigh the cylinders to determine LPG consumption when cooking with LPG stoves. The digital scales chosen measured weight to a 1/100 decimal factor, which was considered important to measure LPG consumption even for very short periods of cooking. For the study, two types of scales were used to accommodate the different sizes of the two LPG cylinder types sold in Indonesia[7]:

Platform/floor scales were used by households with the 12-kg LPG tanks

Technical specification

Technique	Measure weight in kg
Procedure	Place items on the top and record the weight represented by the digits on the display Used for LPG
Load capacity	3–100 kg
Precision	Class III, 1/3000 F.S*
Power source	AC/DC
Display windows	5 digits (999.99)

[6] This was the case for nine of the 10 participants, and the final participant did not use a rice cooker by choice (due to medical reasons).

[7] To ensure accurate weight measurements, the LPG cylinder needed to be placed in the centre of the scale's plate. The dimension of the scale's plate was therefore the main consideration for selecting the two different types of scales.

Platform/floor scales were used by households with the 12-kg LPG tanks

Technical specification

Technique	Measure weight in kg
Procedure	Place items on the top and record the weight represented by the digits on the display
Load capacity	3–30 kg
Precision	Class III, 1/3000 F.S*
Power source	AC/DC
Display windows	5 digits (999.99)

*Accurate to 1/3,000 fraction of the full scale.

These digital scales were modified by the vendors to allow LPG cylinders to remain on the scales for continuous weight measurement throughout the study. The modification was made by removing the battery and connecting the power source of the scale directly to the power plug, with the aim of reducing the interruption in the weighing of the cylinders and ensuring accurate measurement. In addition, this modification also reduced the need to lift and move the LPG cylinders regularly during the study. This was done to avoid unplugging the LPG cylinders' valves as much as possible for safety reasons and to eliminate the need for the study's elderly participants to lift the LPG cylinders regularly. Right before these scales were distributed to and used by the participants, they were calibrated to ensure that accurate data was being collected.

In Phase 2, power meter devices were installed to measure the electricity consumption of the induction stoves and, when used, of the rice cookers. These power meters were constantly attached to the power plug the participants used to draw power for their induction stoves. They were able to measure both the power consumption of the electrical cooking appliances and the duration of power usage.

Power meter

Technical specification

Technique	Metering amount of power in kilowatt-hours (kWh)
Procedure	Connected to the socket and used with provided appliances
Used for	Electricity
Overload threshold	3,680 W
Display type	LCD
Measurement base/ increment	1/10 kWh (000.1 kWh) for power consumption

2.2.3 Typical Indonesian Food

Indonesian cuisine is a mix of traditional cooking methods and diverse ingredients, ranging from rice dishes to the widespread use of coconut milk and the growing popularity of frozen food.

Rice

Rice is the staple food item in Indonesia and is widely eaten as the main dish in combination with several side dishes. The most common cooking method in urban areas is using electric rice cookers; very few people use LPG stoves to cook rice in urban areas.

Rice dishes

Some Indonesian dishes have rice as their main ingredient, for example, fried rice, rice with coconut milk *(nasi liwet)*, or rice with turmeric and coconut milk *(nasi kuning)*. One of the most popular rice variations is Jakarta's popular *nasi uduk*, in which screwpine leaves are added during the steaming process.

Vegetables

Indonesian cuisine consists of a wide array of vegetable-based dishes. Popular vegetable choices include water spinach/morning glory, spinach, melinjo, papaya, and cassava leaves. Vegetables like winged beans, tomatoes, cucumber, and a variety of bitter melons are commonly eaten raw, with sauce or chili paste.

Dishes with coconut milk

Coconut milk is a very popular food ingredient used in Indonesia. Dishes named *opor* and *soto*, which involve boiling other ingredients in coconut milk, are two of the most popular food styles across the country. *Rendang* is another popular Indonesian dish, where beef is slow-cooked with coconut milk and spices for hours.

Fried dishes

Frying is a very popular cooking method in Indonesia. From bananas to chicken, Indonesians are familiar with fried dishes and usually consume them while they are hot.

Instant noodles

Instant noodles are a popular choice of food in Indonesia and have become the favourite of many Indonesians because of their simplicity. They are mostly consumed as a side meal but can also be served as a main dish as an alternative to rice.

Frozen food

Rapid urbanization in Indonesia, followed by the expansion of retail outlets and supermarkets, has resulted in easy access to frozen food products. More and more Indonesians regularly consume frozen foods, such as potatoes (French fries), cassava, chicken nuggets, dumplings, *hakau* (Chinese buns), kebab, mini burgers, or even fried rice.

Chili paste

Chili paste (sambal) is another very common food used in Indonesia. It gives many Indonesian dishes their typical reddish colour, such as in *balado*-type dishes, curries, or the famous *rendang* beef. On other occasions, it is just served on the side for dipping or garnishing. Indonesians have numerous ways to prepare chili paste, including mixing ground chilis with other ingredients, such as shallots and tomatoes.

Water heating/boiling

Heating water serves multiple purposes for cooking-related activities, including preparing main courses and drinks like tea or coffee.

3.0 Research Findings and Analysis

3.1 General Characteristics of Participants

The study participants were between 34 and 68 years old, and all but one were women. On average, these people lived in four-person households with a minimum of three and a maximum of six household members. All but one of the participants were homemakers, and they had diverse educational backgrounds. Six of the participants' households had a low socio-economic status; three were from a lower-middle class; and one was from the upper-middle class.[8]

Nine participants were using the highly subsidized 3-kg LPG cylinders—which can be accessed by anyone on the market—and only one consumed the non-subsidized 12-kg cylinders. Moreover, eight participants lived in households with a 1,300 VA electricity connection installed, and the remaining two participants lived in households with a 2,200 VA electricity connection. Besides the difference in the size of the connection, there was no difference in the price of these non-subsidized tariffs.[9] Of the 10 participants, nine used electric rice cookers instead of LPG stoves for their rice cooking.

[8] Kuppuswamy's socio-economic scale was used to determine the participants' socio-economic status. This scale ranges from 3 to 29 and is based on family income, education, and occupation of the head of the family. A score below 11 determines low socio-economic status, between 11 and 15 indicates lower-middle socio-economic status, and between 16 and 25 indicates upper-middle socio-economic status. The scores of the households of the participants ranged between 4 and 20.

[9] In Indonesia, electricity connections at 1,300 VA and 2,200 VA are considered unsubsidized, as they cost the same to use, though the latter has higher connection fees. IISD offered funding upgrades for participating households to make better use of induction stoves, but none of the participants was interested in this offer, mostly due to the fear that this could change their social status and put them at risk of losing access to potential social benefits in the future.

Table 2. Characteristics of study participants

No	Age	Education	Occupation	Number of people living in the house	Capacity of electric power	Main source of energy for cooking	Estimated monthly LPG spending	Use of rice cookers	Socio-economic status
1	76	Primary school	Homemaker	5	1,300 VA	LPG (3 kg)	80.000	Yes	Low income
2	41	Bachelor's degree	Homemaker	5	1,300 VA	LPG (3 kg)	40.000	No	Upper-middle income
3	34	High school	Homemaker	5	1,300 VA	LPG (3 kg)	40.000	Yes	Low income
4	68	Middle school	Homemaker	5	2,200 VA	LPG (3 kg)	60.000	Yes	Lower-middle income
5	44	High school	Homemaker	5	1,300 VA	LPG (3 kg)	40.000	Yes	Low income
6	46	Bachelor's degree	Kindergarten teacher	5	1,300 VA	LPG (3 kg)	80.000	Yes	Lower-middle income
7	49	High school	Homemaker	3	1,300 VA	LPG (3 kg)	60.000	Yes	Low income
8	60	Primary school	Homemaker	4	1,300 VA	LPG (3 kg)	80.000	Yes	Low income
9	59	Middle school	Homemaker	6	1,300 VA	LPG (3 kg)	60.000	Yes	Low income
10	40	High school	Homemaker	4	2,200 VA	LPG (12 kg)	220.000	Yes	Lower-middle income

Source: Authors.

3.2 Cooking Diary Study Results

The Indonesia Cooking Diary study collected data on various aspects of participants' cooking practices. The following section presents this data and outlines the findings in terms of cooking instances, cooking times, energy consumption and general cooking practices while comparing the LPG and the induction cooking phases.

3.2.1 Number of Cooking Instances

In the entire study duration, which consisted of cooking with LPG in Phase 1 and cooking with induction stoves in Phase 2, there were 1,102 cooking instances.[10] While the participants recorded 703 cooking instances with the LPG stoves within the 14 days of Phase 1, 399 cooking instances were recorded for the same duration during the induction stove phase (Phase 2).[11] This translates to 63.79% of cooking instances happening in Phase 1 and only 36.21% happening in Phase 2.[12]

Furthermore, the number of cooking instances recorded in a day per participant can vary according to cooking practices. Larger weekend meals, for example, can take longer to prepare than regular meals. These daily cooking instances are presented in Table 3.

Table 3. Number of cooking instances per day during the study period

	Phase 1: November 30, 2022–December 7, 2022													
ID	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	6	2	2	5	3	1	5	5	2	2	4	2	2	0
2	7	7	10	1	6	7	7	5	6	2	2	3	3	2
3	9	6	6	5	2	11	5	7	11	7	3	4	5	6
4	8	2	2	1	5	3	4	2	2	2		2	2	
5	8	3	4	6	6	4	8	3	6	5	6	0	6	4
6	6	5	7	3	5	6	4	7	6	4	3	3	7	7
7	2	6	5	4	6	8	6	4	5	5	2	6	6	7

[10] For this study, cooking instances include all the instances when the LPG and induction stoves were used. This mainly includes cooking food but can also include boiling water for other household purposes, such as bathing.

[11] The data for Phase 2 in this section and all following ones covers cooking with induction stoves but not rice cookers; the only exception is data regarding the load profiles of electricity consumption in Section 3.2.4, which includes data from both cooking with both induction stoves and rice cookers.

[12] This low rate of cooking in Phase 2 may have been due to a bit of a reluctance to use the new induction stove, which is natural when people are being confronted with a new technology. Some participants continued to use their LPG cookers to some extent for specific reasons—for example, particular meat dishes were considered to work better with LPG and some household members were not trained to use induction stoves; the study aimed to keep the use of LPG for any cooking to a minimum. On average, participants cooked 41% less in Phase 2 than in Phase 1; however, this differed considerably between households. While one participant cooked only 1% less in Phase 2, others cooked up to 74% less. This latter participant reported an inability to cook with induction stoves in the evening because their household's water jet-pump to fill their water storage for bathing was running at this time and electricity capacity was considered insufficient to allow for cooking with an induction stove simultaneously.

	Phase 1: November 30, 2022–December 7, 2022													
ID	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
8	7	4	5	1	10	3	5	3	5	4	5	3	4	4
9	2	4	1	4	6	5	6	8	5	5	6	9	6	4
10	11	11	11	9	13	11	8	12	13	3	7	8	7	

	Phase 2: December 22, 2022–January 3, 2023													
ID	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	4	1	1	2	1	1	1	1	1	2	2	1	3	3
2	2	6	4	4	2	4	2	2	5	7	1	2	4	3
3	6	6	4	6	4	4	8	6	6	6	10	11	3	6
4	3	1	2	1	2	1	2	3	2	2	2	3	2	2
5	3	4	2	2	3	1	2	3	2	2	1	2	2	2
6	5	5	1	3	1	3	5	6	4	5	3	4	1	2
7	4	3	3	2	1	2	3	2	4	4	2	2	2	3
8	3	2	3	1	2	1	2	2	2	3	2	2	1	2
9	4	2	3	2	3	3	3	3	3	3	2	1	2	3
10	1	3	3	4	2	1	2	3	2	2	3	3	1	2

Source: Authors.

3.2.2 Duration of Cooking Time

The participants in the study spent 17,610 minutes (close to 294 hours) cooking during the entire study duration. The cooking duration in Phase 1 was 10,053 minutes, around one third more than the 7,557 minutes in Phase 2. The total duration translates to an average daily cooking duration across all 10 participants of about 718 minutes in Phase 1 and about 540 minutes in Phase 2. This difference in the average daily cooking time across all participants can be partly explained by the fact that there were fewer cooking sessions in Phase 2. Yet, the average cooking duration per cooking instance was 14.32 minutes for Phase 1 and 18.94 minutes for Phase 2, which explains why the percentage of the total duration of cooking (57.09%) in Phase 1 is lower than the percentage of the total cooking instances (63.79%) in Phase 1, and respectively higher for cooking in Phase 2. Table 4 summarizes these findings.

Table 4. Total cooking duration and average duration per cooking instance in Phase 1 and Phase 2

	Phase 1	Phase 2
Total duration (minutes)	10,053	7,557
Duration per cooking instance	14.3	18.94

Source: Authors.

The cooking durations can also vary significantly per day, depending on the cooking practices of the participants. Table 5 presents all of these daily cooking durations.

Table 5. Duration of cooking instances (in minutes) per day during the study period

	Phase 1: November 30, 2022–December 7, 2022													
ID	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	59	9	41	48	46	121	133	40	34	18	46	114	24	
2	135	131	132	23	134	156	81	100	86	67	49	43	33	32
3	86	80	77	34	10	211	68	85	200	138	8	13	22	83
4	82	1	23	5	46	32	40	33	30	28		28	63	
5	73	74	38	85	96	66	109	62	88	75	52	0	75	60
6	65	47	75	28	41	55	43	105	50	28	28	44	55	102
7	42	49	79	29	85	134	43	102	128	93	38	79	81	84
8	96	72	165	9	100	43	65	65	90	65	65	48	77	79
9	24	38	31	52	76	52	165	213	60	71	67	135	72	40
10	162	127	149	139	183	125	86	146	174	30	123	157	71	

	Phase 2: December 22, 2022–January 3, 2023													
ID	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	62	38	9	31	4	15	10	12	7	51	19	15	36	50
2	29	103	108	128	65	121	29	62	133	142	13	37	112	98
3	119	95	42	152	146	30	110	175	100	67	95	120	19	186
4	45	13	37	25	51	11	22	46	25	44	45	49	26	22
5	51	65	57	47	55	35	43	74	37	45	25	40	28	34
6	58	60	15	30	72	35	38	103	37	65	52	74	16	11
7	150	70	115	50	65	74	58	56	69	135	35	45	35	25
8	43	23	35	17	21	13	18	34	24	39	30	24	27	31
9	59	55	38	27	32	59	28	59	42	46	36	18	37	43
10	40	81	63	80	54	30	70	72	30	70	91	60	35	83

Source: Authors.

3.2.3 Energy Consumption of Cooking Instances

The study measured the amount of energy consumed for cooking. For this purpose, the LPG used in Phase 1 was measured in kg, and the electricity in Phase 2 was measured in kWh. To compare the energy consumption of Phases 1 and 2, these two measurement units were converted into kilocalories (kcal).[13]

Throughout the entire study period, participants consumed a total of 227,928.5 kcal of energy for the recorded cooking instances. Broken down into the two phases, they consumed 169,200 kcal in Phase 1 but only 58,728.5 kcal in Phase 2. This higher energy consumption in Phase 1 compared to Phase 2 is not surprising as there were almost twice as many cooking instances in Phase 1 (703 vs. 399). However, the data shows that the average energy consumption per cooking instance was also generally higher in Phase 1 (240.6 kcal) than in Phase 2 (147.2 kcal) (Table 6).

Table 6. Total energy consumption and average energy consumption per cooking instance in Phase 1 and Phase 2

	Phase 1	Phase 2
Total LPG consumption, kg	14.1	68.289
Total LPG consumption, kcal	169,200	58,728.54
kcal per cooking instance	240.68	147.19

Source: Authors.

Furthermore, comparing the energy consumption and the cooking duration, the energy consumption is approximately 16.82 kcal per minute in Phase 1 and 7.77 kcal per minute in Phase 2. This comparison shows that cooking with an induction stove in Phase 2 was more energy efficient than cooking with LPG stoves in Phase 1, as less kcal per minute of cooking time was consumed in Phase 2.

In line with cooking instances and duration, the energy consumption also varies significantly per day and participant. Table 7 presents the daily energy consumption per participant throughout the study period.

[13] Conversion in kcal is a common practice in the Indonesian context. It stands for the amount of heat (energy) needed to raise the temperature of 1 kg of water by 1°C. Research from Agency for the Assessment and Application of Technology and the National Research and Innovation Agency use a conversion rate of 1 kg of LPG = 12,000 kcal, and 1 kwh of electricity = 860 kcal. These conversion rates are used in this study (Fitriana & Sugiyono, 2020).

Table 7. Energy consumption of cooking instances (in kcal) per day during the study period

	Phase 1: November 30, 2022–December 7, 2022													
ID	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	540	120	840	600	420	1,620	24,00	540	1,560	360	1,740	6,660	180	0
2	720	960	1,200	180	660	1260	540	960	1,740	240	600	300	480	600
3	600	1,320	780	180	240	10,740	540	600	720	780	120	300	180	540
4	2,820	3,600	360	60	1080	300	480	720	240	1,020	0	240	480	0
5	1,560	1,080	840	1,440	720	840	1,140	1,020	1,440	1,200	420	0	1,140	660
6	600	480	900	240	120	720	360	1,020	960	660	1,020	480	1,260	1,500
7	240	480	540	180	660	2,820	660	660	720	1,020	600	840	1,080	1,500
8	3,360	1,740	3,900	300	4,260	1,800	2,520	2,100	2,400	1,980	1,980	1,020	3,360	3,480
9	120	240	0	360	60	180	300	1,140	540	660	1,680	1,260	1,140	420
10	2,040	2,280	3,600	3,240	3,720	3,240	1,800	3,120	2160	1,560	2,760	3,120	1,320	0

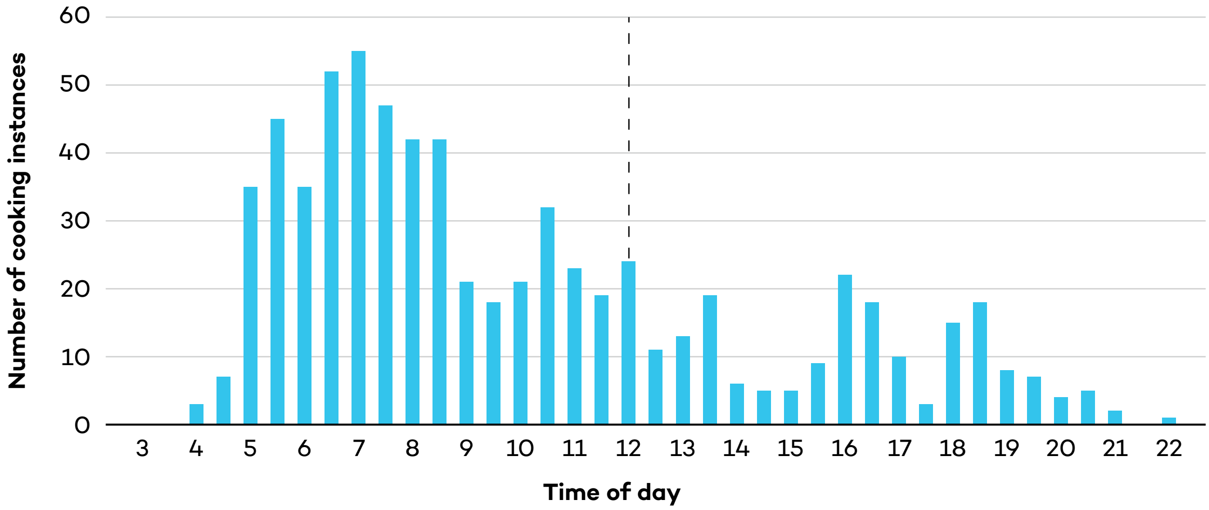
	Phase 2: December 22, 2022–January 3, 2023													
ID	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1	587.38	331.1	35.26	366.36	55.04	128.14	129	140.18	57.62	595.98	135.02	109.22	357.76	643.28
2	287.24	1,157.56	1,115.42	1,251.3	680.26	1,191.1	179.74	614.9	1,321.82	1294.3	77.4	335.4	1,049.2	739.6
3	1,079.3	995.02	503.1	1,541.12	1,335.58	380.12	1,315.8	1,695.06	911.6	774	980.4	1,255.6	189.2	1,986.6
4	153.08	74.82	110.94	74.82	153.94	145.34	208.12	189.2	145.34	239.08	226.18	326.8	154.8	92.02
5	496.22	370.66	197.8	382.7	385.28	155.66	298.42	417.1	263.16	261.44	116.1	459.24	223.6	390.44
6	747.34	656.18	71.38	260.58	205.54	313.9	592.54	1,130.04	421.4	794.64	540.08	407.64	143.62	147.92
7	402.48	479.02	530.62	87.72	40.42	699.18	40.42	199.52	120.4	1161	221.02	77.4	211.56	242.52
8	456.66	284.66	399.04	173.72	290.68	171.14	215.86	296.7	256.28	288.1	323.36	296.7	244.24	380.98
9	344	289.82	326.8	223.6	180.6	354.32	154.8	321.64	234.78	250.26	301	104.06	215.86	238.22
10	141.04	249.4	165.12	301.86	168.56	157.38	253.7	215.86	153.94	378.4	525.46	210.7	178.88	442.9

Source: Authors.

3.2.4 Load Profiles

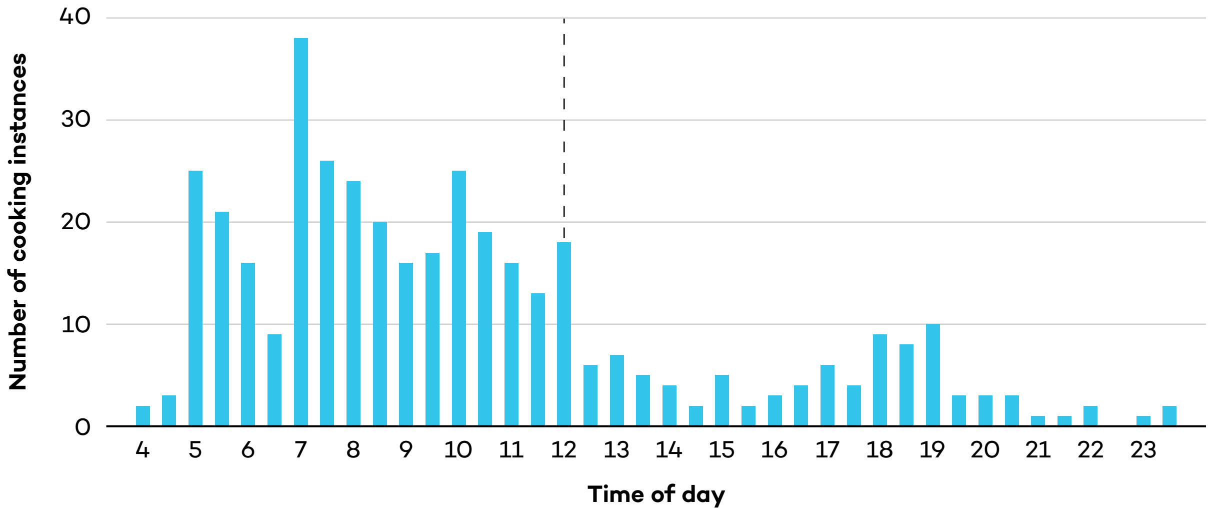
Load profiles—graphic representations of all cooking activities according to their start times within a day—visualize the distribution of cooking activities throughout the day.[14] Except for minor differences, the distribution of cooking instances in Phase 1 and Phase 2 followed similar patterns (Figure 1 and Figure 2). For both phases, there were primarily three peak periods in a day—early morning, around noon, and early evening—and most of the cooking instances were recorded in the mornings, indicating that the participants were cooking less during these latter two times of the day.

Figure 1. Load profile of cooking instances according to start time in Phase 1



Source: Authors' calculations.

Figure 2. Load profile of cooking instances according to start time in Phase 2



Source: Authors' calculations.

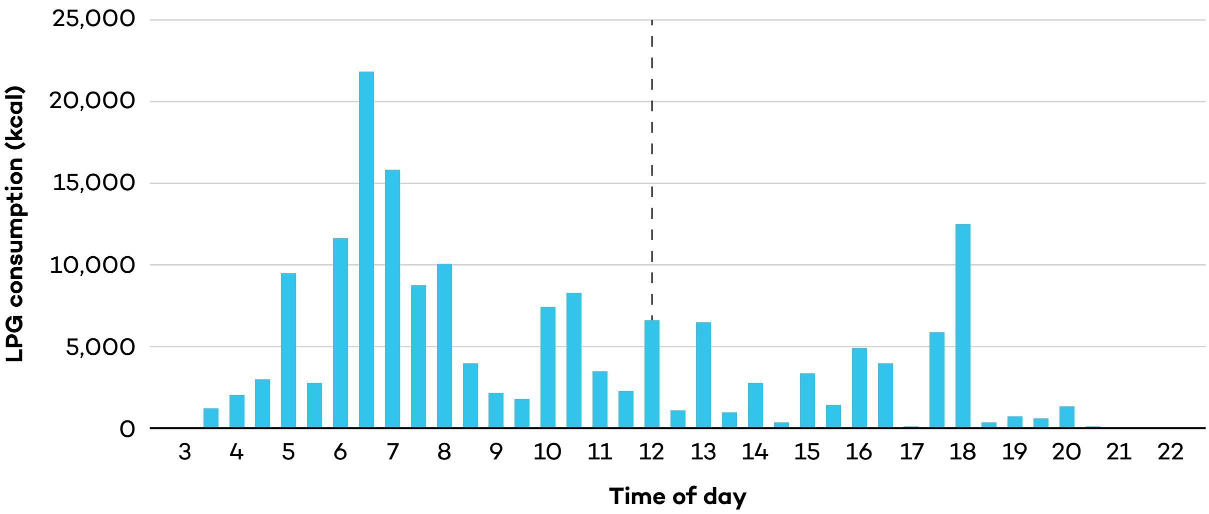
[14] For all of the following load profiles, all the cooking instances that start within a 30-minute interval (e.g. between 3:00am and 3:29am) are added to this interval even though one runs longer than the 30 minutes and some part of the cooking duration falls in (an)other interval(s).

In Phase 1, the load profile of LPG energy consumption (Figure 3) is almost identical to the daily distribution of LPG cooking instances (Figure 1). However, when LPG consumption is compared with the electricity consumption of induction stoves and rice cookers (Figures 3 and 4), there are points of divergence.

The LPG graph shows a significant peak in energy consumption in the early morning. In contrast, during the induction stove phase, electricity consumption is high in the morning as well but does not peak as sharply. In the evening, LPG use shows a noticeable but smaller peak compared to the morning, while evening electricity consumption during the induction stove phase remains relatively high, comparable to morning use.

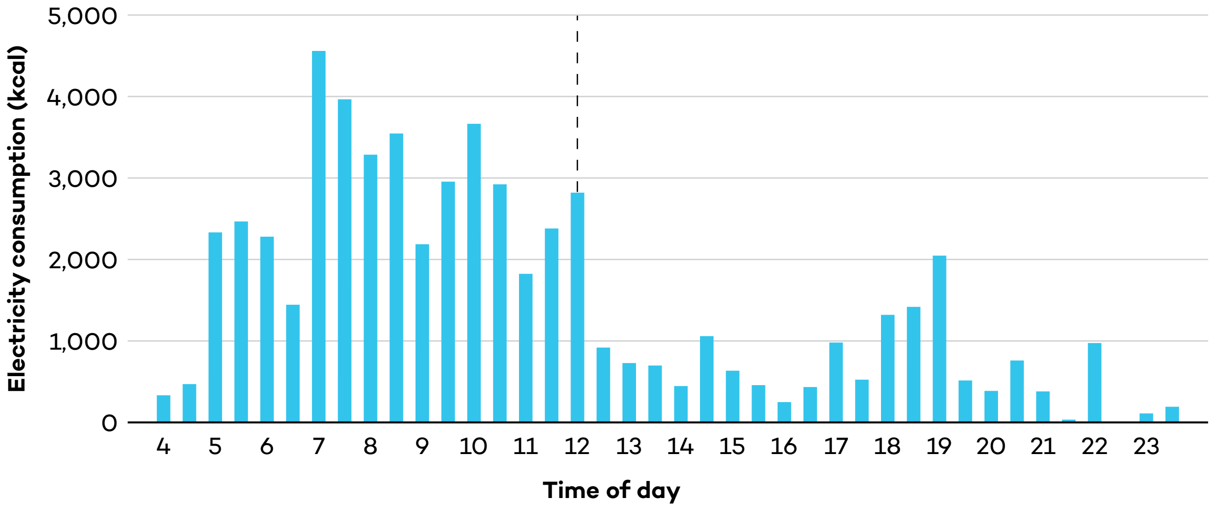
The LPG consumption pattern is characterized by high variability, with sharp increases during meal preparation times and lower use at other times. In contrast, the electricity consumption for induction stoves suggests more even energy demand throughout the day, indicating a more constant level of cooking activity.

Figure 3. Load profile of LPG consumption in kcal according to start time in Phase 1



Source: Authors' calculations.

Figure 4. Load profile of electricity consumption from induction stoves in kcal according to start time in Phase 2



Source: Authors' calculations.

In Phase 2, 58,728.5 kcal (68.289 kWh) of electricity was consumed by the induction stoves and 27,269.74 kcal (31.709 kWh) by rice cookers. Considering that participants would have used the electricity output for rice cookers regardless of the study, and at worst, only shifted the use to a different time, cooking with induction stoves therefore increased the total electricity use for cooking almost threefold. The timing of both these modes of electricity consumption follows a similar pattern, particularly showing peak cooking times.

Looking closer at the five 2-hour intervals (5 a.m.–7 a.m., 7 a.m.–9 a.m., 9 a.m.–11 a.m., 11 a.m.–1 p.m., and 6 p.m.–8 p.m.) in which about 83% of all the energy consumption from induction stoves and 87% of all the energy consumption from rice cookers fall shows only small variations (Table 8). From 5 a.m. to 7 a.m., induction cookers are used slightly more (14.51%) than rice cookers (12.57%), and the same is the case for the period between 7 a.m. and 9 a.m. (26.15% vs. 24.30%). Between 9 a.m. and 11 a.m., the use of rice cookers accounts for 29.78%, while the percentage of induction cookers is a bit lower (19.97%). Between 11 a.m. and 1 p.m., the use of induction stoves (13.53%) is again a bit higher than rice cookers (8.20%) whereas, between 6 p.m. and 8 p.m., rice cookers (11.84%) are used slightly more than induction stoves (9.03%). Overall, those figures show that the participants predominantly used the induction stoves and the rice cooker at overlapping times, meaning a household's wattage limit allowed the simultaneous use of both electrical cooking appliances.

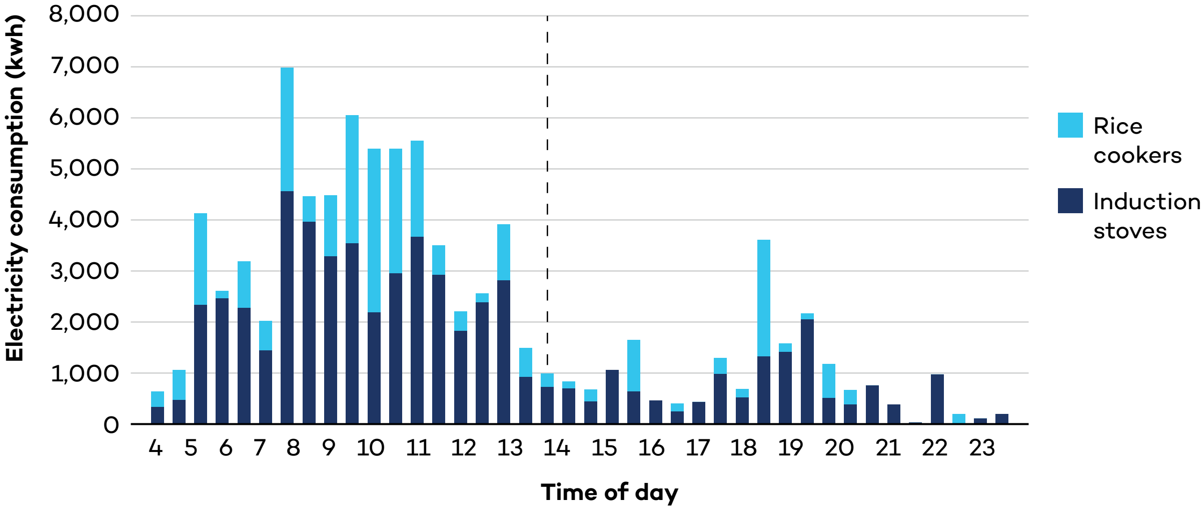
Table 8. Energy consumption according to start time for induction stoves and rice cookers during selected 2-hour intervals

	Induction stove (% of 58,728.5 kcal)	**Rice cooker** (% of 27,269.74 kcal)
5 a.m.–7 a.m.	14.51	12.57
7 a.m.– 9 a.m.	26.15	24.30
9 a.m.–11 a.m.	19.97	29.78
11 a.m.–1 p.m.	13.53	8.20
6 p.m.–8 p.m.	9.03	11.84

Source: Authors.

Comparing Figures 2 and 4, it can also be noted that the load profile of electricity consumption follows a similar structure to the distribution of induction cooking (Figure 2). Again, there are three peaks at similar times of the day. The one difference, however, is that the early morning peak of energy consumption is significantly lower than the midday peak. The early morning cooking represents quicker and less energy-intensive cooking instances, such as preparing breakfast and coffee, whereas the midday peak represents cooking instances for lunch preparation and seems, therefore, more energy intensive.

Figure 5. Load profile of electricity consumption according to the start times of cooking instances[15] in Phase 2



Source: Authors' calculations.

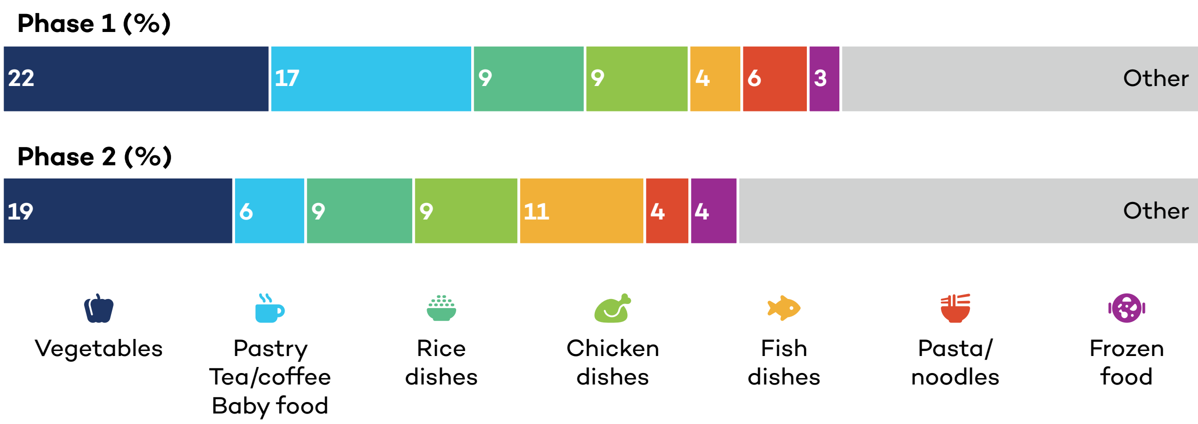
[15] The rice cookers generally had two functions: (1) cooking the rice and (2) continuing to heat the rice after it is cooked. The collected data is inconsistent in that there were cases where both the cooking and continuously heating the rice were recorded as only one cooking instance and not two separate cooking instances (one for the cooking and one for continuing to heat it). Where this was the case, the total electricity consumption was allocated to the time when the cooking of the rice had started.

3.2.5 Cooked Dishes

The two phases of the study revealed a consistent pattern of food preferences, with eggs, chicken, fried foods, tempeh, tofu, vegetables, noodles, and boiling water being the most commonly prepared foods. Vegetables (as side dishes) were the most frequently cooked category in both phases and also accounted for the longest cooking time. They account for over 22% and 19% of the total cooking instances in Phase 1 and Phase 2, respectively, and over 26% and 20% of the total cooking duration. Similarly, chicken and rice dishes, with their significant number of cooking instances and durations, made up a stable percentage of total cooking time across both phases. Fish dishes, however, increased significantly in Phase 2 compared to Phase 1, both in the number of times cooked and the duration cooked. Meanwhile, other dishes and cooking categories, such as tea, coffee, and noodles, experienced more modest changes in cooking instances and duration between Phase 1 and Phase 2, suggesting a relatively stable preference for these foods.

A summary regarding the number of instances and duration of the most common foods—including fried dishes, boiling water, vegetables, rice dishes, and chicken—is presented in Figures 6 and 7.[16]

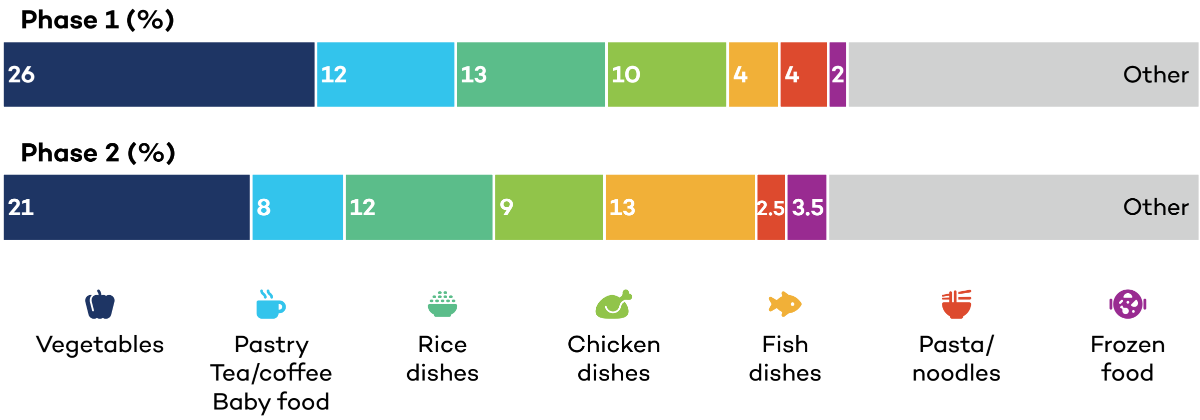
Figure 6. Share of all cooking instances in Phase 1 and Phase 2 for selected foods



Source: Authors' calculations.

[16] "Chicken dishes" includes various types of dishes with chicken as their main ingredient, such as fried chicken, chicken curry, slow-cooked chicken with spices, or fried chicken with spicy sauce. "Rice dishes" include various rice preparations, such as fried rice, steamed rice, butter fried rice, and aron rice. "Frozen food" refers to the cooking instances involving the preparation of frozen food, such as chicken nuggets. "Vegetables" covers different types of vegetables, such as pumpkin, spinach, and cucumber, cooked in various ways, such as fried (e.g., *bakwan*) or steamed. "Fish dishes" include dishes with fish as the main ingredient, including fried fish, nila fish, fish rolls, and tuna fish.

Figure 7. Share of total cooking duration in Phase 1 and Phase 2 for selected foods



Source: Authors' calculations.

3.2.6 Comparison of Specific Dishes

Looking at dishes that were cooked in both phases of the study period regularly offers a better assessment of the differences in energy consumption and time spent than looking at the entire dataset (Table 9).

Fried eggs and fried chicken, boiling water, and noodles were all common dishes prepared in both Phase 1 and Phase 2. As shown by the lower energy consumption per cooking instance for each of the four foods, the data suggests that the participants, on average, saved energy throughout when they were cooking with induction stoves compared to cooking with LPG. The following energy savings can be noted when cooking with an induction stove instead of LPG: 19 kcal for preparing noodles, 125 kcal for frying chicken, 177 kcal for frying eggs, and 290 kcal for boiling water.

In terms of time per cooking instance, the results were more mixed. Cooking with induction stoves took less time for boiling water and frying chicken, with differences of 2.03 and 0.52 minutes, respectively. In contrast, frying eggs took 3.29 minutes longer, and preparing noodles took 3.25 minutes longer with induction stoves.

Nevertheless, the cost comparison shows that induction cooking is always cheaper in scenarios where no subsidies for purchasing LPG are provided. This is particularly the case for frying eggs and boiling water, where cost differences are about 70%. This picture changes when subsidies for purchasing LPG are provided, as this would make frying chicken and preparing noodles more expensive when using induction stoves. Thus, the data suggest that for certain dishes—but not for all—a cost savings from using induction stoves depends on whether participants purchase subsidized or unsubsidized LPG.

Table 9. Energy consumption and time characteristics of selected dishes

	Dish	Cooking instances	Total energy consumption (in kcal)	Energy consumption per instance (in kcal)	Duration per instance (minutes)	Cost per instance (IDR)[17]
Phase 1	Fried egg	35	8,562	244.62	6.06	135.89 (subsidized) 373.3 (non-subsidized)
Phase 2		20	1,347.62	67.381	9.35	113.19
Phase 1	Boiled water	68	27,097.32	398.49	17.21	221.36 (subsidized) 608.79 (non-subsidized)
Phase 2		38	4,118.54	108.38	15.181	182.07
Phase 1	Fried chicken	43	11,440.00	256.74	14.02	142.62 (subsidized) 392.24 (non-subsidized)
Phase 2		16	2114.74	132.17	13.5	222
Phase 1	Noodles	31	4,556.40	151.6.	9.41	81.64 (subsidized) 224.54 (non-subsidized)
Phase 2		15	1,980.58	132.03	12.66	221.7

Source: Authors' calculations.

[17] Assuming the price of non-subsidized LPG is IDR 6,666 per kg, the price of non-subsidized LPG is IDR 18,333 per kg (Muliawati, 2024), and the price of electricity (for households with 1,300 VA and 2,200 VA connections) is IDR 1,444.7 per kwh.

3.2.7 Fresh Cooking and Cooking Processes

In both Phase 1 and Phase 2, participants cooked mostly fresh food. In Phase 1, at least 83.07%[18] of cooking activities were intended for fresh food, while in Phase 2, fresh food represented 90.73% of cooking activities. Table 10 shows similar values for the other indicators, "reheating" and "half or slightly cooked," indicating that cooking practices did not change much from Phase 1 to Phase 2 and suggesting that the types of cooking instances on induction cookers were largely the same as on LPG.

Table 10. Distribution of fresh cooking (by percentage and instance)

Cooking method	Phase 1	Phase 2
Freshly cooked	83.07% 584	90.73% 362
Reheating	4.55% 32	4.76% 19
Slightly cooked or half-cooked	6.40% 45	4.51% 18
N/A	6.26% 42	0.00% 0
Total instances	**703**	**399**

Source: Authors' calculations.

A similar picture emerges for cooking methods, which did not fundamentally change when switching from LPG to induction stoves. The order of the most common cooking methods remained the same in both phases. However, comparably, more boiling and frying appeared when cooking with LPG than with induction stoves, and more stir-frying and steaming appeared when using induction stoves than when cooking with LPG in Phase 1.

The cooking methods comparing Phase 1 and Phase 2 are represented in Table 11.

[18] About 6% of the values are classified as n/a. Given the high share of freshly cooked food, it is likely that a large percentage of these missing values would fall under the category "freshly cooked." If added, the percentage of freshly cooked in Phase 1 would be at a similar level to that in Phase 2.

Table 11. Popular cooking methods (by percentage and instance)

Cooking method	Phase 1	Phase 2[19]
Boiling	47.37% 333	38.72% 145
Frying	35.70% 251	33.33% 133
Stir-frying	11.52% 81	18.54% 66
Steaming	5.26% 37	8.90% 34
N/A	0.14% 1	0.25% 1
Total instances	**703**	**399**

Source: Authors' calculations.

3.2.8 Leftovers

During both Phase 1 and Phase 2 of the study, the majority of the prepared food was consumed right away. Specifically, leftovers accounted only for 4.16% of the meals cooked in Phase 1 and 2.51% in Phase 2.[20] This indicates that the use of induction stoves did not negatively impact cooking efficiency or make it more difficult to accurately plan meal sizes and portions.

Table 12. Distribution of finished foods

Use of food	Phase 1	Phase 2
Finished food	75.25%	96.74%
Leftover	4.16%	2.51%
N/A	20.63%	0.75%

Source: Authors' calculations.

[19] In Phase 2, some cooking instances referred to mixed cooking methods, such as boiling and stir-frying. In such cases, both categories were counted proportionately.

[20] However, there have been missing values for about a fifth of the cooking instances in Phase 1, which could reduce the validity of the data for this category. If the missing data were proportionately distributed to "finished food" and "leftovers" following the pattern for the data that exist, then the share of leftovers would only increase slightly to 5.15%.

3.2.8 Use of Cookware and Lids

The usage of cookware was relatively similar in both phases, with most cooking activities using a frying pan in both phases. However, moving from Phase 1 to Phase 2, the use of frying pans increased slightly, the use of steamers increased significantly, and the preference for pots decreased slightly from Phase 1 to Phase 2.

Table 13. Distribution of cookware used (by percentage and instance)

Tools used	Phase 1	Phase 2
Frying pan	50.64% 356	56.89% 227
Pot	42.96% 302	32.8.% 131
Steamer	1.14% 8	10.28% 41
n/a	5.26% 37	0.00% 0

Source: Authors' calculations.

Overall, the participants used lids in roughly one third of all their cooking instances in both phases, suggesting using lids is not a very widespread practice among the participants of the study. Otherwise, the use of lids has been similarly low in both phases, with a slight increase in lid use in Phase 2.

Table 14. Distribution of the use of lids (by percentage and instance)

Lid use	Phase 1	Phase 2
Yes	27.31% 192	34.59% 138
No	67.99% 478	65.41% 261
N/A	4.69% 33	0.00% 0

Source: Authors' calculations.

3.3 Survey Results

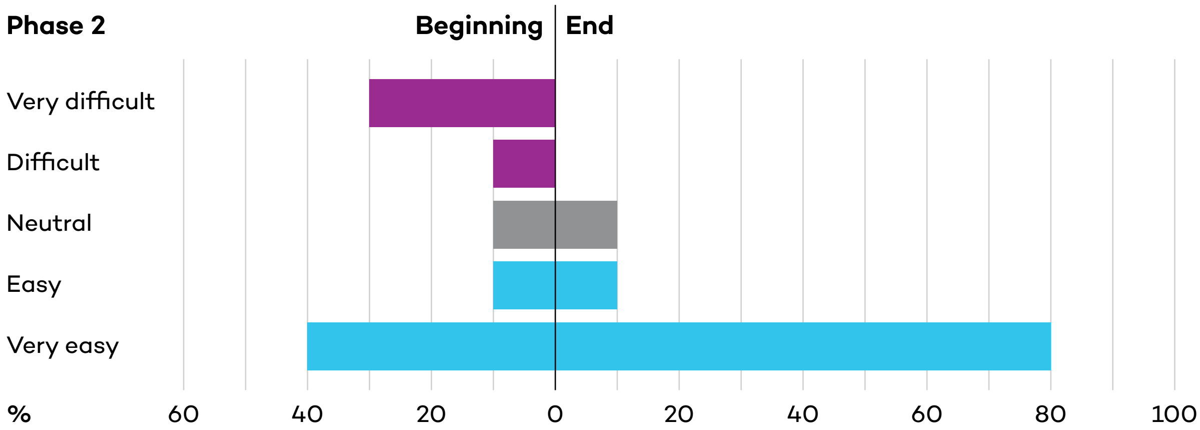
An initial survey and an exit survey were carried out at the beginning and end of Phase 2, respectively. The responses provided insights into participants' perceptions of cooking with the induction stove, the extent to which the experience during Phase 2 met their expectations, and the implications of the induction stove trial for a possible permanent switch from LPG to induction stoves.

3.3.1 Attitudes About Induction Stoves and Learning to Use Them

For all the participants, this study was the first time they had ever used an induction stove; however, 60% had heard of the stoves as an alternative to cooking with LPG before they were contacted by IISD. Participants primarily saw them at the homes of family and friends, in hotels, in shopping complexes, or on TV. Their first impression when receiving the induction stoves and related cookware at the beginning of the transition phase was mostly positive, with the stoves being described as modern, clean, and pretty; however, some were concerned about being electrocuted.

At that time, 40% of the participants anticipated that cooking with induction stoves would be "very easy," 30% of the participants thought it would be "very difficult," and 10% each thought it would be "easy," "neutral" or "difficult." After the end of Phase 2, the number of participants who thought cooking with induction stoves was "very easy" increased to 80%, and there was no participant who believed it was "very difficult" or "difficult." Moreover, no participant considered cooking with induction stoves more difficult compared to what they had expected: the perception indeed remained stable for all who had previously believed that it was "very easy" and improved for all the others. When asked how long it took to get used to cooking with induction stoves, participants stated that it took from a few days up to a week to get used to it.

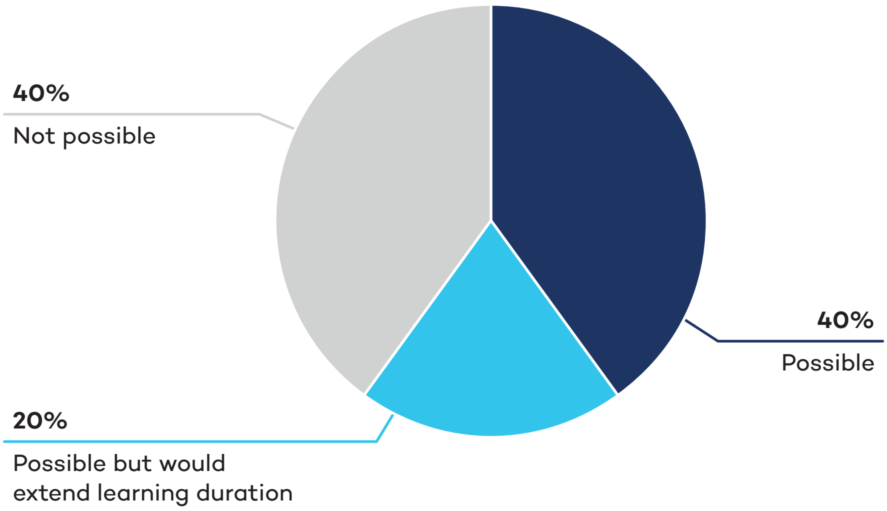
Figure 8. Perception about the difficulty of cooking with induction stoves



Source: Authors' calculations.

In addition, in this particular study, the participants received training for cooking with induction stoves, were offered ongoing support from the enumerators and the project team in case they faced any obstacles, and were connected with other participants to facilitate peer learning among the group about suitable foods and cooking techniques. Forty percent of participants think they would have managed to learn how to cook with the stoves just as well on their own compared to with the support provided, and 20% thought it would have been possible to learn but would have taken them longer without the support. Even though a majority of the participants would have been able to learn how to use an induction stove, 40% of the participants stated that they would not have been able to learn to cook with induction stoves by themselves and relied on the support provided.

Figure 9. The feasibility of learning to cook with induction stoves without additional support



Source: Authors' calculations.

Moreover, all participants indicated a need for a change in their cooking strategy when cooking with induction stoves. When asked for details, most referred to a faster cooking time, which required preparing the food in advance, indicating a rather small change in cooking habits. In relation to this, others also noted the need to constantly watch the food, which prevented them from multitasking while cooking, doing other household chores, or taking care of their children. As a result, other household activities had to be carried out sequentially rather than simultaneously, which could extend the total time the participants required to complete all their household duties.

Finally, limitations on available power capacity was another issue the participants had to deal with, even though only one participant experienced a power outage during the study as a result of the induction stove.[21] The strategies commonly used to manage limited energy access included

- reducing the heat: the maximum heat used was 800 kW/h, and, depending on the type of cooking, many participants mostly used even below (around 200 kW/h only);[22]
- turning off other household appliances while using the induction stoves: two participants said they turned off their rice cookers, and another 40% turned off even more household appliances (e.g., irons or water pumps); and
- scheduling the cooking time to accommodate the maximum power capacity.

Nevertheless, there are some practical limitations to these strategies—for example, family considerations do not allow switching off some household appliances at all times, such as an air conditioner in the morning when the rest of the family is still sleeping or a water pump in the evening to fill up the water storage for bathing. The latter, for example, prevented one participant from cooking at all after 5 p.m. with their induction stove. It was also difficult to always control the electricity consumption of other household members, particularly children.

3.3.2 Attitudes About How Induction Stoves Function

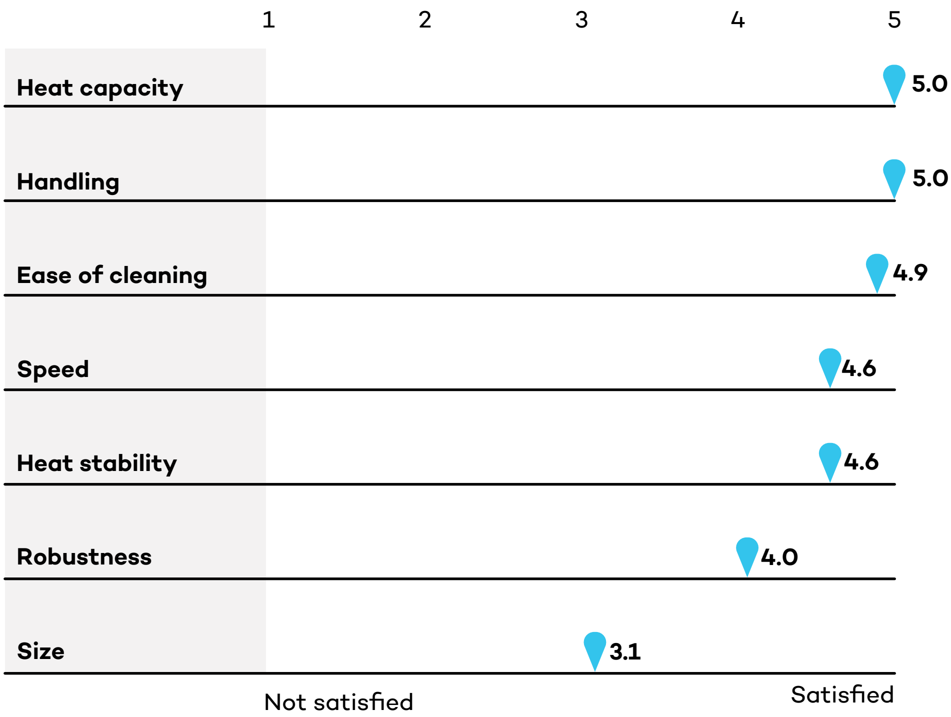
The participants were asked to rate their experience regarding specific features of the induction stoves on a scale of 1 (not satisfied) to 5 (satisfied).

Overall, the participants seemed generally quite happy with the features of the induction stoves, as all features were given an average rating of at least 3 or above. In particular, the most positive attitude was regarding the heat capacity, ease of handling, and cleaning, which all got average scores of or close to 5, followed by speed and heat stability, with an average rating of 4.6. The participants were least satisfied with the size of the induction stoves and the cookware provided, giving an average score of 3.1. Despite selecting the standard size for appliances in the market for this study, the size of induction stoves and the pots that could be used with them were significantly smaller than the standard cookware used on LPG stoves. In addition, standard LPG stoves are usually dual-cooker stoves, which allow for cooking several dishes simultaneously. Several participants reported that their induction stoves easily slid away on slippery surfaces but nevertheless gave an average score of 4 for the robustness of the devices.

[21] Several other participants experienced power cut-offs during the "Learning" phase but none of them more than two times.

[22] In addition to avoiding power outages, this was also a cautious strategy to avoid food from being burned, which happened various times during the transition phase. With more time and practice cooking with induction stoves, the participants might have become able to increase the power and still avoid burning the food.

Figure 10. Attitudes toward specific aspects of induction stoves



Source: Authors' calculations.

These findings were also largely in line with the participants' responses to questions about the advantages and challenges of cooking with induction stoves. As advantages, most participants said induction stoves are faster, safer, easier, and cleaner. As such, several participants noted that no risk of gas leaks and an automatic turn-down mode gave them more peace of mind, while cooler kitchen air and cookware, as well as no dust or soot, made cooking with an induction stove more pleasant. Some participants also noted that there was no need to get refills, which is the case for LPG, and thus less work and uninterrupted cooking. They appreciated that induction stoves are portable, which increases their flexibility in terms of where they can be used.

The most common challenges were related to the size of the stoves and cookware. Participants stated that these features did not all meet their expectations and limited both the amount of food they could cook and their confidence in certain cooking styles, such as "frying." Some also raised the issue of the stoves' higher complexity, with more buttons for the different programs written in English only. Another challenge for using induction stoves was the setup of the kitchens. Various participants noted that there is no space to use and store induction stoves in their often small kitchens, so they had to be creative about finding safe and practical solutions for using them. Furthermore, kitchens in many households tended to be quite wet, causing safety concerns around electricity use, vibrations, or even slightly moving induction stoves. In addition, the lack of plugs available in some participants' kitchens and the subsequent need for extension cords was another safety issue.[23]

[23] In two instances, the extension cords used to power the induction stoves melted. In one case, it was the result of poor quality and in the other case an over-use of a multi-plug extension cord. After all low quality and multi-plug extension cords were replaced, no further similar issues appeared.

3.3.3 Attitudes Toward the Taste of the Dishes Cooked With Induction Stoves

When asked about the taste of the food they cooked with induction stoves, most participants seemed quite happy. In total, 90% of the participants were either very satisfied or satisfied with the taste of the food that they cooked with the induction stove. The remaining participant ranked it as a 3 on a scale of 1 to 5 and therefore was not particularly unsatisfied either.

When asked about which dishes, in particular, tasted better, which tasted worse, and which they were unable to cook with the induction stoves, a clear pattern was apparent. Dishes that were boiled, sautéed, or stir-fried were generally considered better tasting. In contrast, dishes that required frying or cooking meat and fish for a longer duration, such as a stew, were generally more likely to be considered worse tasting or even too difficult to prepare with induction stoves.

Figure 11. Taste satisfaction of dishes cooked with induction stoves

Not very satisfied	**0%**
Not satisfied	**0%**
Neutral	**10%**
Satisfied	**30%**
Very satisfied	**60%**

Source: Authors' calculations.

3.3.4 Attitudes About the Transition to Induction Stoves

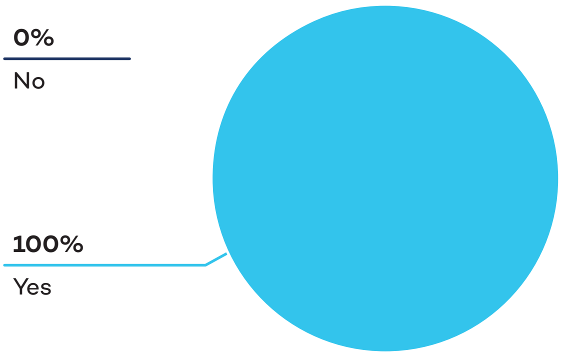
Several questions on the exit survey were intended to explore how open the participants were to transitioning to induction stoves going forward.

According to the survey, all participants were interested in continuing to use the induction stoves, provided they were able to keep them after the study. Moreover, more than two thirds (70%) expressed a general interest in buying the induction stove that was provided to them by the project team under the assumption that the price would not be a determining factor (Figure 13).

However, when asked how much they would be willing to spend on an induction stove, only three participants indicated an amount higher than IDR 700,000—the price of standard induction stoves on the market. Importantly, five participants would only be willing to spend over about 30% less than the actual price.[24]

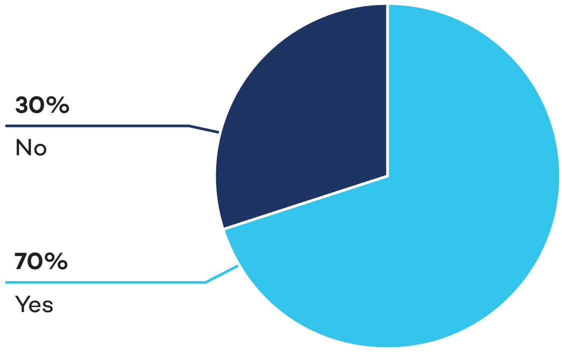
[24] This is roughly what a standard LPG stove in Indonesia costs.

Figure 12. Interest in continuing to use induction stoves after the study



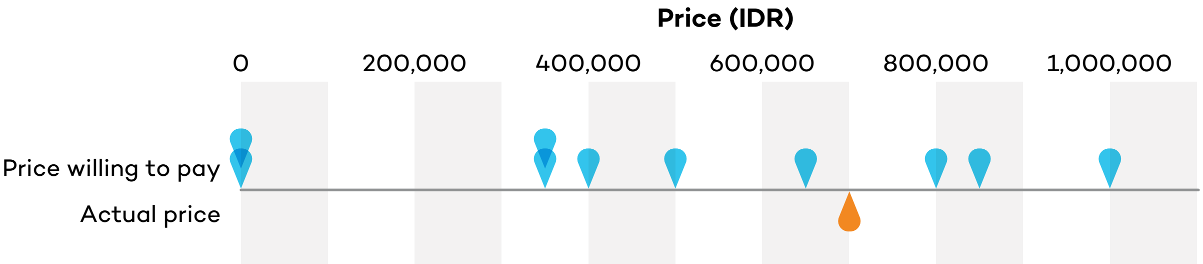
Source: Authors' calculations.

Figure 13. General interest in buying an induction stove



Source: Authors' calculations.

Figure 14. Price willing to pay for an induction stove



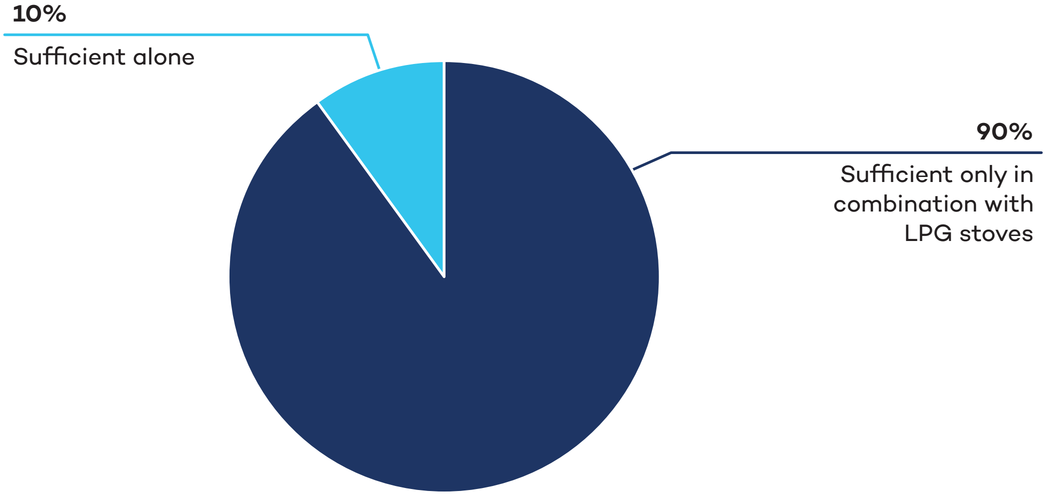
Source: Authors' calculations.

In addition to the costs of purchasing a stove and new cookware, the running costs for the fuel—in the case of induction stoves, electricity—are another determining factor for the affordability of induction stoves. Generally, there was a significant level of concern among the participants about rising fuel costs when cooking with induction stoves. Initially, 80% of the participants were "very afraid" or "afraid" that cooking with an induction stove would increase the costs of cooking significantly. However, at least half of them noted that this worry disappeared throughout the study when they saw no significant impact on their electricity bills or, with the help of the project team, calculated the costs depending on their usage.[25]

Finally, almost all participants (90%) believed that induction stoves could not be used for all the daily cooking purposes for which they are currently using LPG stoves. Thus, they were not seen as an option to fully replace the LPG stoves. While several participants noted different purposes for which the induction or LPG stove would be their preferred option, others linked the limitation of using only induction stoves to the small size and limited variety of cookware that they possess. Different design/size options and the availability of more cookware could therefore potentially increase the perception that induction stoves would be sufficient for all daily cooking purposes.

[25] The information about whether this was the case for the other half as well is not available.

Figure 15. Sufficiency in meeting all daily cooking purposes



Source: Authors' calculations.

4.0 Discussion

The introduction of induction stoves appeared to be generally welcomed among the participants. A majority of the participants had heard of them and also had a positive image of them even before being approached for this study. After the induction stoves were used for roughly 2 weeks, they received generally good ratings in terms of a wide range of characteristics, such as heat capacity, speed, and cleanliness, whereas the size—the standard one on the market—was the lowest-ranked characteristic.

During the entire study period, LPG in Phase 1 was used almost twice as often for cooking than induction stoves in Phase 2, with 703 instances of LPG use compared to only 399 instances for induction. The reduced cooking activity observed in Phase 2 may be partly due to low familiarity with the new induction technology, leading to more hesitation for its use. Consequently, this correlates with a longer total cooking duration in Phase 1 with LPG (10,053 minutes) than in Phase 2 with induction stoves (7,557 minutes) but a shorter cooking time in relation to what the share of cooking instances could have suggested. The difference in total cooking duration is due to the shorter average duration of each cooking instance in Phase 1 (14.32 minutes) compared to Phase 2 (18.94 minutes). Looking at specific dishes (see Table 9), the average time taken to prepare similar meals was comparable. However, certain dishes, like boiling water or making noodles, were faster, on average, with induction stoves, while others, such as frying chicken and frying eggs, were slightly faster with LPG. Therefore, it can be concluded that cooking with induction stoves did not seem to offer a time-saving advantage over LPG cooking for the participants of our study. One reason for this longer duration—which is at odds with the widespread assumption that cooking with induction stoves is generally faster, validated by various studies—was that many participants used induction stoves very conservatively due to the fear of power outages and to avoid food being burned, and therefore did not maximize the full capacity of the induction stoves.

Participants were also able to successfully replicate the common dishes and cooking practices used to cook with LPG when cooking with induction stoves, with some minor variations, such as a slight increase in the proportion of fish dishes and a small decrease in the proportion of vegetables, rice, and chicken dishes. The data collected also indicates that switching to cooking with induction stoves does not require significant changes in cooking habits. For instance, the majority of food was freshly cooked in both phases. Boiling and frying remained the two dominant cooking methods in both phases, and most of the prepared food was consumed immediately after preparation in both phases. Further, the cookware used remained largely the same, as did the use of lids. Finally, the daily distribution of cooking instances and energy consumption indicates that despite reduced frequency, cooking routines were comparable among Phase 1 and 2, as the load profiles of the cooking instances peak in the early morning, early afternoon, and early evening, and this pattern is similar in both phases of the study. Against this backdrop, it can be noted that there was no significant change in cooking habits with the transition to induction stoves.

However, the consistent cooking habits can also be attributed to the efforts undertaken by the research team to sensitize the participants to the use of induction stoves. Among others, those efforts included allowing more time to try out the new stoves than originally planned, at the request of participants. Looking back, a significant number of participants, yet not a majority, reported that they would not have been able to use the induction stoves without the versatile support provided by the project team, and others confirmed that it would have taken them longer. Whereas at the start of the study there was a fairly even distribution of participants' perceptions of the difficulty of cooking with induction stoves, by the end of the study, this perspective shifted drastically toward perceiving it as easy. The rapid familiarization with induction stoves shows that even a very short testing period for the technology can reduce mental hesitation to using induction stoves.

Despite similar cooking habits in Phases 1 and 2, induction stove cooking seems to require extra routines to guarantee satisfying results, including adopting simpler new routines, such as preparing food in advance or monitoring it closely during cooking. Other routines were more difficult to implement due to power connections, such as shifting cooking to different times of the day or unplugging other electrical appliances while cooking. However, the quantitative data on rice cooker use suggests that it was predominantly used simultaneously with induction stoves without an issue. In fact, the induction stoves increased electricity consumption for cooking—almost tripling it over the study period compared to the electricity consumption of the rice cookers already in regular use by the participants. This shows that the wattage limit of a household, at least when cooking with the conservative style most participants of this study used, seemed sufficient to allow the simultaneous use of both the induction stove and the rice cooker. Yet, some restraining factors cannot be completely mitigated, such as high consumption rates of electricity for other uses (e.g., air conditioners), which at times prevented some participants from using the induction stoves with their current electricity connections.

In addition, there are more systematic barriers to longer-term induction stove use that are likely widely overlooked. For example, the setup of kitchens and limited space and plugs for an induction stove caused many participants to have to improvise to use induction stoves (e.g., by temporarily removing other household appliances that are needed or cooking on the floor) for the period of the study. While this seemed acceptable for the study period, the use of induction stoves over a longer period would likely require more structural adjustments of the kitchen designs, which could limit their adoption.

Overall, participants were generally satisfied with the food they cooked on their induction stoves; however, they were considered inferior to current LPG stoves for the preparation of certain dishes. As noted above, no changes in cooking habits, such as a drastic reduction in fried foods, were observed during the limited duration of Phase 2. The proportions of certain foods cooked (particularly fried foods) remained broadly constant over the two phases, but it can be expected that the increased difficulty and complexity of induction cooking may have affected cooking habits if the study had been continued over a longer period. All participants expressed an interest in continuing to use the induction stoves, but most of them viewed the induction cooker as a supplementary appliance in Indonesian kitchens. They saw it as a tool that could be used alongside LPG stoves, depending on cooking needs, rather than as a replacement for them. The perception that induction stoves will play a secondary role in Indonesian kitchens further highlights the need for a more appropriate kitchen setup, as induction stoves would need to be added to a limited kitchen space that includes LPG stoves.

A better stove design may improve the perception of induction stoves, especially since the small size of induction stoves was a disadvantaging factor, both in terms of the stove and associated cookware size and in terms of both models' single stove cookers as opposed to the typical dual-stove cookers for LPG. However, induction stoves can still be considered competitive with LPG. Irrespective of participants primarily cooking on very low heat, the cooking duration was only slightly slower, and installing induction cookers with two burners seems feasible for households with 1,300 VA power connections.

Converting electricity consumption into kilocalories (kcal) shows that both the total energy consumption of all participants together and the energy consumption per cooking instance are higher for the LPG phase than for induction cooking in Phase 2. This resulted in a higher kcal consumption per minute for the LPG phase, at 16.82 kcal/min, compared to 7.77 kcal/min for the induction phase. Based on this observation, it can be highlighted that cooking with induction stoves was more energy efficient than cooking with LPG, and a shift could therefore have positive societal implications due to the rationalized energy demand.

Finally, there was initial widespread concern about the higher fuel costs associated with electricity compared to LPG. However, as the study progressed, many participants found that these concerns were unsubstantiated. This experience illustrates how practical testing of a new technology (in this case, the induction stove) can help to dispel pre-existing prejudices. The participants' assessment is underpinned by the finding from four commonly cooked dishes across Phase 1 and Phase 2 that the induction cooker is always more cost-effective than unsubsidized LPG. For certain specific tasks, such as boiling water, using an induction cooker was even cheaper than using subsidized LPG. Noting the advantages of induction stoves over LPG, such as cost, that were highlighted by this study, a majority of the participants indicated an interest in purchasing an induction stove, but the willingness to spend the market price to buy an induction stove was limited. However, over time, the cumulative cost savings from lower electricity prices compared to LPG (especially unsubsidized LPG) would offset the cost of the induction stove, which may increase the willingness to spend on such induction stoves. For instance, every time water is boiled using an induction cooker instead of LPG, a saving of IDR 426.72 was achieved compared to boiling water with non-subsidized LPG. Additionally, using an induction stove saved IDR 39.29 per boiling instance when compared to the subsidized LPG cost. This implies that to offset the cost of the induction stove, 1,640.42 cooking instances are required when compared to non-subsidized LPG prices and 17,816.2 cooking instances when compared to subsidized LPG prices. For the other three dishes assessed more in detail in this study—frying eggs, frying chicken, and making noodles—cost offsetting would take longer due to a smaller difference between the costs or, in certain cases, cannot be offset against subsidized LPG as the running costs for using induction stoves have been shown to be higher.

5.0 Conclusion

Over a period of 4 weeks, this study collected quantitative and qualitative data from 10 participants from a South Jakarta district in Indonesia about their cooking practices using LPG stoves in Phase 1 and induction stoves in Phase 2 of the study and their perception about the latter. The main aim of the study was to assess how compatible induction stoves are with Indonesian cooking styles and to what extent induction stoves meet the needs of local communities, particularly as the Indonesian government wants induction stoves to significantly replace cooking with (largely imported) LPG. Therefore, the objective was to analyze how smoothly one could introduce induction stoves in Indonesia using a sample of 10 households as an example, with a particular focus on its energy implications at the household level. Alongside other cooking diary studies, this research contributes to a better understanding of the potential and challenges associated with a large-scale shift to electric cooking with induction stoves and provides insights into the implications of such a transition.

This study concludes that switching to induction stoves seems to be generally feasible in the urban context of Indonesia. It recognizes cost and energy effectiveness and generally positive sentiments and openness shown by the participants toward induction stoves. These results describe a strong foundation for the Indonesian government to build on. However, in order to facilitate wider adoption of this technology, especially in different contexts across Indonesia, several policy strategies are recommended.

In order for induction stoves to be widely used in urban areas, it is necessary to address infrastructure constraints, such as electricity bandwidth, to enable the use of induction stoves. In addition, the technology must be made accessible and affordable for all socio-economic groups. This includes widespread upgrading of electricity connections and ensuring stable access to electricity. Furthermore, the government should consider reforming subsidies for LPG to create better market incentives for the uptake of induction stoves. The ongoing effort to better target access to such subsidies can be an important step in the uptake of induction stoves if it is carried out thoroughly. Even with a more level playing field between electricity and LPG costs, the time for offsetting the costs of purchasing an induction stove can nevertheless remain long, possibly discouraging many people from making the switch to induction stoves. The introduction of support for the adoption of induction stoves in the form of grants or loans, particularly for underprivileged groups, could be beneficial. Such a scheme was envisaged in the announced—but later abandoned—LPG-to-induction-stove conversion scheme but could be revived as an effective tool to achieve the government's induction up-scaling target. This would make the use of induction stoves more financially viable and might encourage more households to switch. To address the reluctance and concerns around induction stoves, organized training and trial sessions seem to be another effective approach for the larger adoption of induction stoves, as the study shows that even short-term interventions can help to reduce this reluctance, ensure long-term satisfaction with cooking on induction stoves, and tackle unfounded prejudices.

Given the differences in culture and cooking practices across Indonesia, a combination of cooking with LPG and induction stoves appears to be the most practical approach in the short to medium term. This approach would enable users to slowly adjust to using induction

stoves while still having the option of using LPG stoves for certain dishes and needs. Another barrier to rapid induction up-scaling is the physical layout of many Indonesian households' kitchens, which limits the use of induction stoves. As a result of these challenges to the promotion of induction cookers, the government needs to define realistic expectations about the extent of induction stove uptake without overlooking its considerable potential. For instance, this study showed that participants increasingly used induction stoves on low-power mode but still managed to perform their usual cooking activities in only slightly longer times than cooking with LPG. Therefore, more households than originally expected, including even those with similar or weaker electricity connections than the participants of this study, could likely use induction stoves, demonstrating the feasibility of the government's target and the potential for widespread use of induction stoves in Indonesia. Finally, the shift to induction cooking should be accompanied by an increase in low-carbon electricity generation. Otherwise, the promotion of induction stoves may be a successful policy to address issues such as trade and budgetary concerns but may not maximize the potential for progress on climate change mitigation, which is becoming increasingly important for Indonesia.

This study was a first attempt to analyze the introduction of induction stoves in real-world cooking experiences. Nevertheless, there are important limitations due to the study design and implementation, and further analysis is required on this topic.

First, the sample size was small, and the duration of this study was short. Replicating the exercise with a larger sample size and over a longer period would provide more robust data. Certain changes in cooking habits, such as a greater use of different cooking methods, may take a longer time to fully develop, and this study may not have been able to detect this. For example, while frying was mentioned as a disadvantage of induction stoves in the qualitative analysis, the quantitative data did not support the expectation that the participants used this cooking method significantly less often. This could be explained by the fact that they may have been in the trial phase before concluding that other cooking methods might be more suitable for cooking on induction stoves.

Second, the study also shows that cooking on a very low induction mode gave acceptable results. Therefore, it would be interesting to assess whether this would allow for using dual-cooker induction stoves and how much that would increase the perception that induction stoves would be sufficient to meet all cooking purposes, particularly as the size of induction stoves was one of the main limitations reported for cooking with them. In addition, the effective yet low-power cooking mode of induction stoves might enable their use in households with lower electricity connections. Previously, these homes were thought to have insufficient electricity capacity for operating induction stoves. Further research could aim to assess this additional potential for the large-scale introduction of induction stoves in Indonesia.

Third, in the study, the use of induction stoves came with trade-offs, meaning that participants had to carefully plan their cooking times, avoid using other household appliances, or coordinate electricity use with other household members while using the induction stove. This situation prevented the participants from fully experiencing all the benefits of induction stoves, such as faster cooking at full power, which may have influenced their opinion on cooking with induction stoves. Nevertheless, all participants chose not to upgrade their electrical connections, even when the staff team offered to enable them to do so without additional costs. Future research should explore whether a positive perception about induction stoves increases if such limiting factors do not exist. While this would not show a representative picture of the current feasibility, it could provide a good picture of the true potential of induction stoves once more Indonesian households have increased their power connections—a likely step in line with the ongoing development of the country—in the future.

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