Large electric pressure cookers in schools: Evidence from Lesotho

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In partnership with;

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Abbreviations

AC	Alternative Current
ECCD	Early Childhood Care and Development
EPC	Electric pressure cooker
EPC4S	Electric Pressure Cookers for Schools
ESMAP	Energy Sector Management Assistance Program
Hz	Hertz
IMF	International Monetary Fund
kg	Kilogramme
kW	Kilowatt
kWh	Kilowatt hour
LEC	Lesotho Electricity Company (Pty) Ltd
LEWA	Lesotho Electricity and Water Authority
LPG	Liquefied Petroleum Gas
LSL	Lesotho Maloti
MECS	Modern Energy Cooking Services
MJ	Mega Joule
STEER	Centre for Sustainable Transitions: Energy, Environment and Resilience
$	United States Dollar
V	Volt
WFP	World Food Programme

Acknowledgements
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Data presented in this report was collected by WFP over a period of 6 months with funding from WFP Innovation Accelerator. The findings of this report would not be possible without the efforts of the Lesotho Government, and the management of the five schools in which the pilot project was conducted, but particularly the dedication of the cooks and teachers that recorded the data on each dish cooked every day.

About WFP
The World Food Programme (WFP) is the world's largest humanitarian organization saving lives in emergencies and using food assistance to build a pathway to peace, stability and prosperity, for people recovering from conflict, disasters and the impact of climate change. A member of the UN family, WFP is governed by an Executive Board consisting of 36 Member States, which provides intergovernmental support, direction and supervision of WFP's activities.

About MECS
Modern Energy Cooking Services (MECS) is an eight-year research programme funded by UK Aid (FCDO). We are a geographically diverse, multicultural and transdisciplinary team working in close partnership with NGOs, governments, private sector, academia and research institutes, policy representatives and communities in 16 countries of interest to accelerate a transition from biomass to genuinely 'clean' cooking.

Executive Summary

This report provides results of a pilot project introducing energy-efficient Electric Pressure Cookers in peri-urban schools of Lesotho as part of the school feeding programme. This project was led by WFP's Country Office in Lesotho with funding from WFP's Innovation Accelerator (INKA).

This report explores the potential of modern energy cooking systems using large EPCs to cook and prepare school meals in Lesotho instead of relying on traditional biomass or fossil fuel-based cooking solutions. It assesses the hypothesis that *cooking with EPCs in schools brings good value for money in addition to health, environment, and gender co-benefits.*

Quantitative and qualitative methods were used to better understand the cooking practices, challenges of cooking large portions of food for schools, energy consumption, time spent on cooking and the social impacts of introducing EPCs in five schools in peri-urban areas of Maseru, Lesotho. The data was collected over six months, from January to July 2022, first conducting a baseline before the introduction of EPCs and a follow-up study thereafter.

Across selected schools, data analysis shows that schools were able to serve the same types of food such as porridge (porridge's main ingredient across the schools was either super cereal or maize or sorghum), papa (it is a stiff porridge made from maize or corn), samp (it is a dish made from dried corn kernels that have been pounded and chopped until broken), rice, vegetables, beans, fish, eggs, etc. before and after the introduction of EPCs. The cost of cooking fuel per student using an EPC is approximately one third the cost of using LPG, and one sixth the cost of using firewood. Results from the schools using LPG show a cost reduction of up to 69% by adopting EPCs. The cost savings reached 95% switching from firewood to EPCs at Leqele school. The cost savings of cooking with an EPC is due to its higher energy efficiency compared to firewood and LPG.

The report also analysed time spent on cooking. Results suggest that the use of EPC saves cooks time compared to other fuels. On daily basis, transitioning to EPC saved approximately 35% of the cooking time. This is equivalent to more than one hour. Furthermore, using an EPC allowed teachers at Star Classic to focus on teaching as they could safely leave it while cooking using the automatic timer.

Besides cost and time savings, there were other co-benefits of using EPC highlighted by users in the evaluation survey. They reported that cooking with EPCs is safer, healthier, and provides a better physical working environment.

1. Project context

According to Our World in Data, access to electricity in schools globally has significantly increased in recent years. It increased from 68 per cent, and 89 per cent in 2017 to 76 per cent, and 90 per cent in 2020 in primary, and secondary schools respectively (OWID, 2020). In Lesotho, around 54 per cent of 1,452 schools had access to electricity in 2019 with 204 additional schools planned to be electrified under the "*Lesotho Renewable Energy and Energy Access Project 2020-2027*" through minigrids (World Bank, 2020).

1.1 Country context

Lesotho is a small, mountainous, landlocked country with a population of 2.2 million (see Figure 1). It is a lower middle-income country, ranked 168 of 191 on the Human Development Index (UNDP, 2023). The economic effects of COVID-19 and long-term issues, such as climate change, land degradation, HIV prevalence, unemployment, and slowing economic growth, pose significant barriers to development.

WFP has been in Lesotho since 1962. One of the priority areas of WFP's Country Strategic Plan (2019–2024) is support school feeding, with a strong focus on capacity strengthening. The school feeding programme remains an essential source of nutritious meals for children. It ensures that 390,000 pre-school and primary school students get at least one meal daily. In 2020, WFP handed over school feeding in primary schools to the Government. WFP continues serving meals to over 60,000 pre-school children and deploys innovative solutions to help schools transition to cleaner energy sources.

Most school kitchens use wood and shrubs which produce harmful emissions and cause respiratory diseases. The continuous use of wood worsens deforestation, adversely affecting land earmarked for crop and livestock production. It also incurs high costs for schools that could otherwise be reinvested in other school activities. Clean energy sources for cooking can reduce environmental degradation and boost food security and sustainable development in Lesotho.

Figure 1 – Map of the Kingdom of Lesotho

1.2 Project description

In 2022, WFP's Country Office in Lesotho with the support of WFP's Innovation Accelerator, introduced **Electric Pressure Cookers (EPCs)** in peri-urban schools as part of the school feeding programme. The purpose of the project was to assess whether institutional EPCs could be a viable alternative to cooking with firewood, charcoal, kerosene, or gas in schools to improve health and reduce deforestation and cooking costs.

The schools were selected by the Ministry of Education and Training based on the following criteria: being a WFP assisted school, connected to electricity (a qualified electrician assessed and prepared the schools' electrical systems to ensure they were fit for electric cooking), willing to take part in the project, and located in Maseru. Five pre-primary/primary schools were identified for the pilot project: Victor Nthethe ECCD, St. Bernadette Nursery, Leqele Combined School, Star-Classic Pre-Primary school, and Rainbow Pre-Primary.

Based on the number of enrolled students (see **Table 1**), Leqele Primary School had the highest number of students and Star-Classic had the lowest. This gives an opportunity to understand the opportunities and challenges of using EPCs in schools of varied sizes.

Table 1 - Total number of students, cooks, stoves and EPCs in selected schools

School	Number of students	Number of appliances		Number of cooks	Cooking fuel
		Stoves	EPCs		
Rainbow Pre-primary School	201	3	2	1	LPG
St. Bernadette Nursery	190	6	2	4	LPG
Leqele Combined School*	1,279	4	4	6	Firewood
Victor Nthethe ECCD	180	3	2	2	LPG
Star-Classic Pre-primary School	27	3	2	1	LPG

* About 50 of the students enrolled at Leqele Combined School are Early Childhood Care and Development (ECCD) students. The rest are primary students.

All schools employed cooks, and at Star Classic teachers were also involved in the cooking. This school had a small number of enrolled students, but teachers were still needed to help prepare and cook school meals, distracting them from their teaching responsibilities. Cook to student ratios varied significantly from school to school, for example, it is 1:215 at Leqele Combined school while it is 1:41 in St. Bernadette Nursery. The higher the number of students, the bigger the burden on cooks.

All schools had access to electricity and clean water for drinking and cooking. Leqele provided just lunch to the primary students, Victor Nthethe provided breakfast, lunch, and dinner, with the other three schools providing breakfast and lunch. All meals were free. As shown in **Table 1**, fuel use before the study was either LPG (gas cylinder) or firewood.

The gas stoves used in the schools are locally fabricated (see

Figure 2). There was no fuel stacking (the parallel use of multiple stoves and fuels (Perros et al., 2022)).

Figure 2 - LPG (gas cylinder) used as a cooking fuel before the introduction of EPCs at Star-Classic

Victor Nthethe, St Bernadette, and Star-Classic schools prepared meals in an indoor school kitchen with ventilation while Rainbow prepared meals in an indoor school kitchen without ventilation. Leqele prepared meals in the open-air with firewood using tripod stoves (see **Figure 3**).

Training. Eight government representatives (all female) and WFP staff learned to use EPCs through the EPC4S project via cooking demonstrations (a training of trainers approach). WFP worked with the Ministry of Agriculture, Department of Nutrition and Home Economics, Ministry of Education, Early Childhood Care and Development, and School Feeding Programme sections to try different dishes prepared in EPCs and developed a cookbook for pre-school cooks. A three-day cooking training session was then organised with school cooks where the government officials were facilitators or trainers.

Choice of cooking solutions. EPCs significantly reduce energy demand, better than any other electric cooking solution due to insulation, pressurisation, and automatic control (ESMAP, 2020). Heat is generated within the pot, avoiding losses in transfer, and insulation prevents it from escaping. Pressurisation raises the boiling point of water molecules in the food, accelerating its cooking time. The combination of these features makes EPCs the most efficient eCooking appliance for many food types.

A study by MECS shows that when compared with resistive element hotplates, modern hobs (induction and infrared) can save approximatively 10 per cent of the energy consumption, automated devices such as rice cookers can save approximately 25 per cent, and EPCs can save approximately 50 per cent (Scott and Leach, 2023). Tests performed on larger EPCs of various capacities (33, 40, and 65 litres) (Batchelor, 2021) show efficiency and costs per capita meal of the same order as domestic EPCs. These considerations informed the choice of a 40 L EPC used in this project. EPCs were air delivered from China.

2. Methodology

Before the study, the five schools were cooking with LPG and firewood using locally manufactured gas cookstoves and three-stone fires respectively. The hypothesis of this study is that *"cooking with EPCs in schools brings good value for money in addition to health, environment, and gender co-benefits."*

2.1 Research questions and approach

Quantitative and qualitative methods were used to assess the technical and economic feasibility, and willingness to adopt EPCs in schools.

Technical feasibility. The study intended to understand whether large EPCs are suited to the schools' electricity connection and under real world school kitchen conditions. Consistent functionality of the EPCs was important, so the study wanted to understand any technical limitations or issues.

Economic feasibility. A crucial aspect to evaluate was whether EPCs are economically viable compared to other cooking solutions. This required establishing the cost of cooking with biomass and gas before the introduction of EPCs and afterwards with electricity.

Willingness to adopt. The school cooks need to be willing and able to cook with EPCs, and they need to be able to cook all types of food for the school meals (such as starch, beans, and sauce). The study aimed to establish whether cooks, after the training, were comfortable and confident using EPCs, and if they thought it was easier, faster, and more convenient than other cooking solutions.

2.2 Data collected

Quantitative and qualitative methods were used to better understand; cooking practices, the challenges of cooking substantial proportions of food for school meals, energy consumption, time spent on cooking, and the impacts of introducing EPCs. The data used in this study were collected in five schools over six months from January 2022 to July 2022 (before and after the introduction of EPCs) using:

- Cooking diaries – data on food cooked, appliances used, cooking processes and time spent on cooking,
- Smart metres – manual measurements of fuel use and/or electricity data from smart meters,
- Baseline and evaluation surveys – demographic data and qualitative feedback from school management and cooking staff,
- Face to face interviews and focus groups - with school staff members (cooks, teachers, and headteachers).

Cooking Diaries

Over the last five years, MECS has been using and refining the cooking diary method (Leary, Batchelor, and Scott, 2019) to collect data from households on how people from different countries, cultures, and cuisines cook, and how compatible these practices are with modern energy cooking products and services, such as electric cooking devices. This form of data collection, processing, and analysis enables the researchers to understand how people cook and how their practices change when they transition to a different fuel or appliance. It is a more in depth and person-centric method that other efficiency tests such as the Water Boiling Test (WBT), Controlled Cooking Test (CCT), and the Kitchen Performance Test (KPT) (Leary, Batchelor, and Scott, 2019). Cooking diary protocols match recordings of what and how people cook with quantitative measurements of energy consumption. The data are collected for at least two weeks to capture any variations in daily cooking routines. It includes information about the different dishes cooked, cooking time, and energy consumption, allowing an analysis of energy used and costs to the dish level.

In this study, the cooking diary method has been adapted to collect and analyse the data from school settings. Before and after cooking each dish, school cooks recorded the cooking time and fuel consumption (by volume for LPG, or weight for firewood). Gas meters and weighing scales were used to establish how much LPG and firewood was used for each dish respectively. Once the EPCs were installed, electricity use was recorded directly using a smart meter per appliance. One electric smart meter was installed in each of the four pre-schools and four meters were installed in Leqele combined school.

Data were collected before (baseline) and after (transition) the introduction of the EPCs. During baseline data collection, the schools continued to cook as normal, simply recording the data in a cooking diary. Cooks were requested to keep track of their cooking. With support from the WFP team who visited regularly, the cooks wrote down the details of each cooking session such as cooking time, fuel consumption for each dish, and the ingredients used for each meal.

Smart metres

Significant amounts of data were collected over six months (February – July 2022). The use of smart meters simplifies the process of data collection for the EPCS as they track functioning time (equivalent to time spent cooking a dish) and the associated electricity consumed (equivalent to electricity used to cook the dish).

Cooking diaries were used to capture the start and end cooking time for each dish. There was quite a bit of variability in the number of days each school recorded data, ranging from 7 to 106 days (see Table 2). This data was then merged with the data from smart meters to analyse the amount of electricity and time used to cook each dish/meal.

Table 2 – Number of days data were recorded in different schools

School	Baseline (days)	Transition (days)
St Bernadette Nursery School	15	61
Victor Nthethe ECCD	17	106
Rainbow Pre-primary School	11	48
Star Classic Pre-primary School	6	76
Leqele Combined School	7	7

Baseline and evaluation surveys

A baseline study was conducted by the WFP Research Assessment and Monitoring (RAM) team in December 2021 to understand the current cooking practices, status of the kitchens and stoves, types of foods cooked, sources and cost of fuel, and challenges faced by the schools. A structured questionnaire was used for data collection and the data was used to compile a baseline report.

A follow-up study was done in February 2022 after distributing the EPCs to assess the user experiences among the cooks and school management, and the impact of the shift to electric pressure cookers. The follow-up study was done using a structured questionnaire, focus group discussions with cooks and pupils, and observations. A final follow-up study was done in August 2022 to ascertain if the cooks were still using the EPCs, the EPCS were still functioning well, and to identify if there were any new challenges to using the EPCs. A structured questionnaire was administered to the school management and cooks to collect this data.

Interviews and focus groups

Interviews and focus groups were used to understand cooking practices in schools, how these affect the choice of cooking energy solutions, to understand cooks' perspectives on what value EPCs bring to their kitchen, and how they feel about using them. This qualitative data was used for behaviour change analysis.

Face-to-face interviews were conducted with key informants; school principals, teachers, cooks, and through transect walks around the schools. WFP and the Ministry of Education and Training of Lesotho facilitated additional focus group discussions with the cooks (11 females) and Leqele primary learners (8 females and 2 males). This approach was used to capture unexpected outcomes and most significant changes resulting from the intervention.

Assessment of electrical systems and retrofitting of the kitchens

After the baseline phase, the school electrical systems were assessed to ascertain their capacity to handle cooking with the large EPCs. Among the parameters checked were the size and quality of electrical cables, capacity to add new connections on the distribution boards, and availability of space in the kitchen to install new sockets for cooking with the EPCs. All the kitchens were retrofitted by adding new circuit breakers on the distribution boards for the EPCs, changing the electrical cables to recommended sizes where necessary, and adding new electric sockets.

Quantitative Data Analysis

2.3 Data consistency

The data collected was checked in preparation for analysis. The number of days for which good data was collected in each school is provided in **Table 3**. Comparing **Table 2** to **Table 3****Error! Reference source not found.**, shows that some raw data were not used in the analysis. This is mainly due to inconsistencies in the data, missing data from the cooking diaries or incorrect smart meters recordings. If the smart meters' record is flawed or erroneous, the time and amount of electricity used to cook the related dish cannot be obtained. This happened in some cases where the same record of electricity consumption was repeatedly generated for consecutive but different cooking events.

Table 3 - Number of days good data collected in different schools

School	Baseline (days)	Transition (days)
St Bernadette Nursery	15	59
Victor Nthethe ECCD	11	80
Rainbow Pre-primary School	11	25
Star Classic Pre-primary School	5	63
Leqele Combined School	7	7

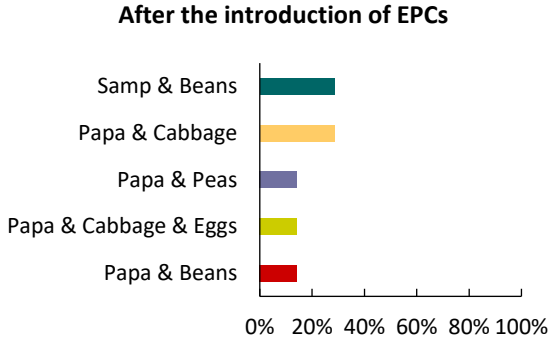
Despite the errors and missing data, the remaining data were good enough to assess differences between cooking practices before and after the introduction of EPCs. However, the comparison of time spent on cooking different dishes was not analysed due to missing baseline records for the start and end cooking times. Data from interviews and focus groups were used to fill the gap to a certain extent.

2.4 Cooking practices in schools

During the baseline survey, school cooks reported that they usually arrive early in the morning, around 6 am. The average time spent on cooking was 2 to 5 hours daily. To reduce the cooking time, St Bernadette, Victor Nthethe, and Star Classic soaked beans with hot water for 20 minutes, 1 hour and 12 hours respectively, before cooking.

All schools covered pots with a lid to increase the efficiency of cooking and reduce the cooking time. **Table 1** shows the number of pots/stoves that schools were using before the introduction of EPCs and the number of EPCs provided to each school.

Data entries in the cooking diaries for the types of food that were served or cooked before the introduction of EPCs are limited compared to the data entries after the introduction of EPCs. This may not give the most accurate comparison of cooking routines (the variety of food served and the frequency of serving or cooking specific types of food) before and after the introduction of EPCs, but a realistic comparison can still be drawn from the available data. **Figure 4 -**



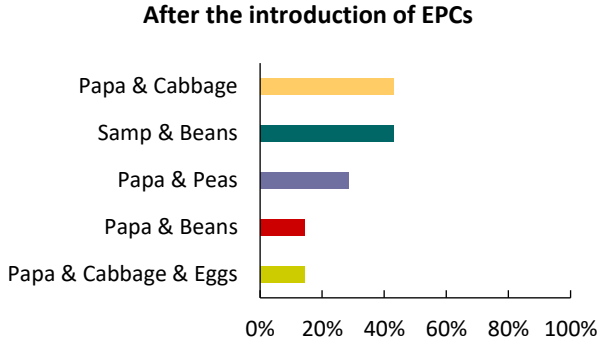
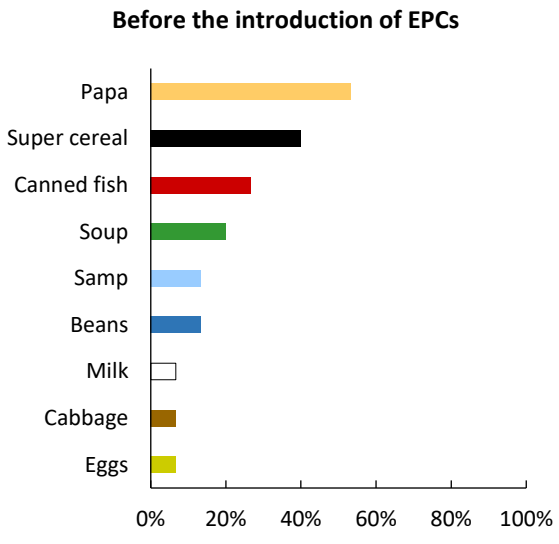
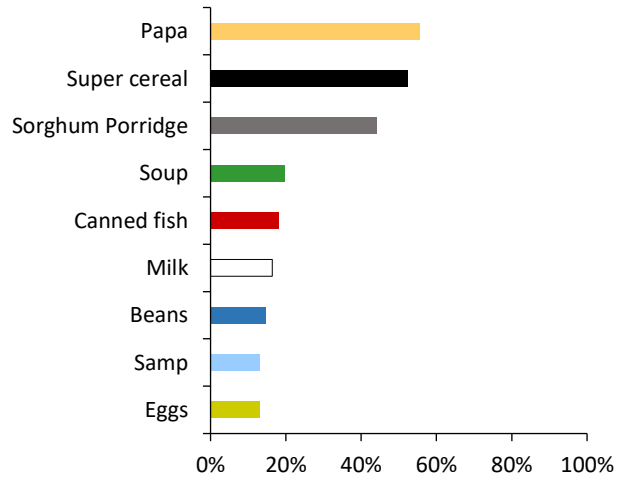


Figure *8* show that popular dishes remained the same after the introduction of EPCs and all schools were able to provide a variety of foods.

Among the popular dishes, papa was at the top. Papa is usually served with Chakalaka or vegetable soup, or simply soup made with tomatoes, peppers, carrots, and onions. Papa is a local dish enjoyed not only at schools but also in almost every household in Lesotho. The figures show that across the five schools, papa was served at least one in every two days after the introduction of EPCs and a little bit less, around one in three days before the introduction of EPCs.

Porridge is also popular in schools providing breakfast since it is served daily. Another typical Basotho dish is Samp. It can be cooked together with beans in a single pot. Eggs are another popular dish across the five schools as source of protein. They were served either boiled or fried.





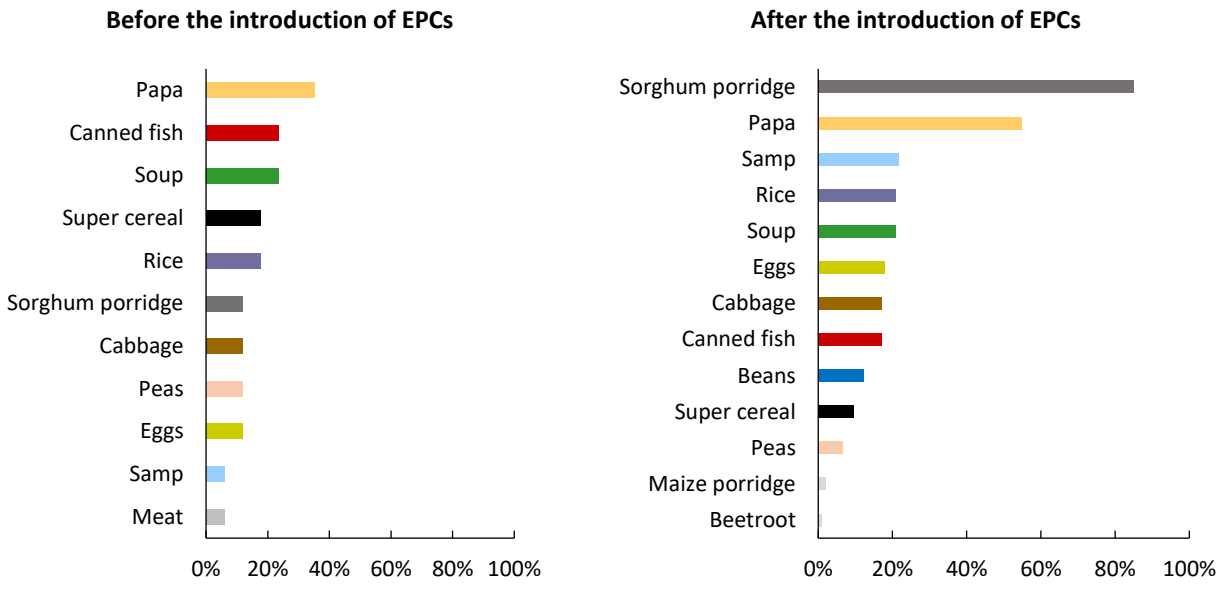


Figure 5 - Types of food served/cooked at Victor Nthethe Pre-school before and after EPC introduction

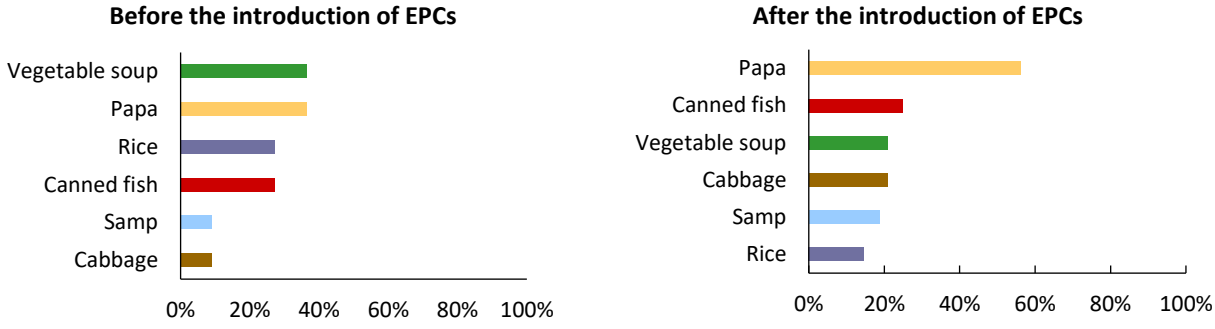


Figure 6 - Types of food served/cooked at Rainbow Nursery School before and after EPC introduction

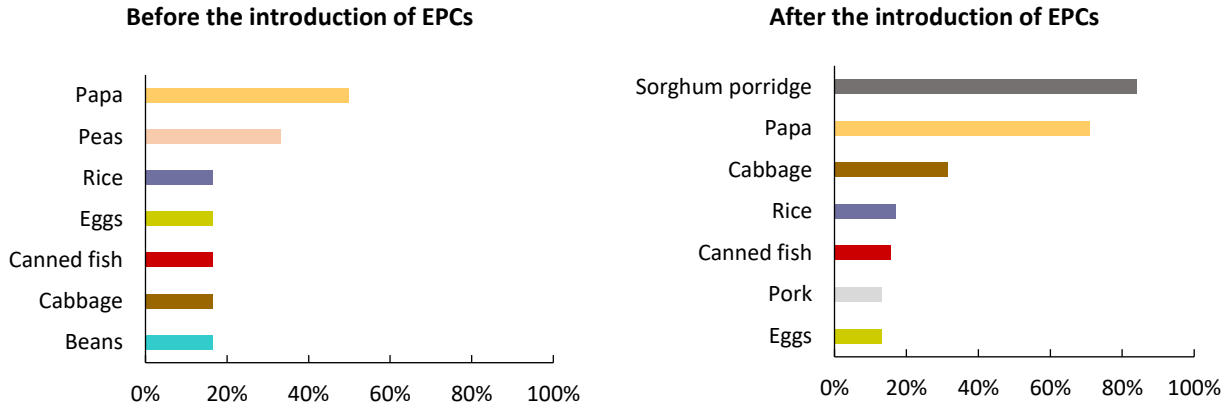


Figure 7 - Types of food served/cooked at Star Classic Pre-Primary School before and after EPC introduction

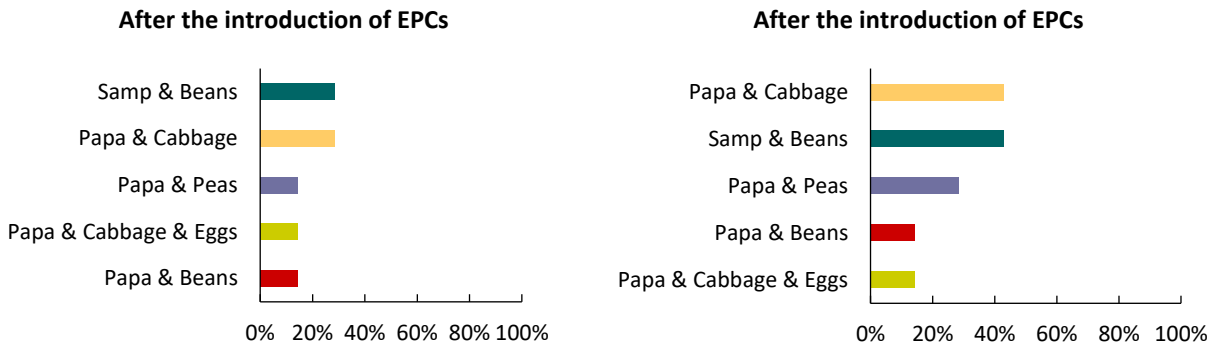


Figure 8 - Types of food served/cooked at Leqele Combined School before and after EPC introduction

As shown in **Table 4**, schools did not change their food menus and were also able to provide balanced meals (vegetables and fruits, bread, cereals and potatoes, milk and dairy products, and protein) using EPCs as the primary cooking appliance.

Table 4 - Types of food served/cooked at schools before and after the introduction of EPCs

		Fruits and vegetables								Bread, other cereals and potatoes						Milk and dairy products		Meat, fish, chicken and alternatives					
		Cabbage	Vegetable	Peas	Carrots	Beetroot	Chakalala	Morogo	Vegetables	Rice	Samp	Papa	Rice	porridge	Super cereal	Milk	Eggs	Canned fish	Beans	Pork	Wors	Meat	Chicken
Rainbow	Before EPCs	✓	✓							✓	✓	✓						✓					
	After EPCs	✓	✓							✓	✓	✓						✓	✓				
Victor Nthethe	Before EPCs	✓		✓		✓	✓				✓	✓	✓	✓	✓		✓	✓				✓	✓
	After EPCs	✓	✓	✓		✓				✓	✓	✓		✓	✓		✓	✓	✓				
St. Bernadette	Before EPCs	✓									✓	✓		✓	✓	✓	✓	✓	✓				
	After EPCs	✓						✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓			✓	
Leqele	Before EPCs	✓		✓							✓	✓					✓		✓				
	After EPCs	✓		✓							✓	✓					✓		✓				
Star- Classic	Before EPCs	✓		✓						✓		✓					✓	✓	✓				
	After EPCs	✓	✓	✓	✓				✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		

2.5 Quality and reliability of power supply

One of the pre-requisites for a school to participate in this pilot project study was having access to reliable and stable power supply. Data collected across all the selected schools shows acceptable levels of power reliability and quality. **Figure 9** shows voltage magnitude and frequency measured at different schools for over a week from 25th April to 1st May 2022.

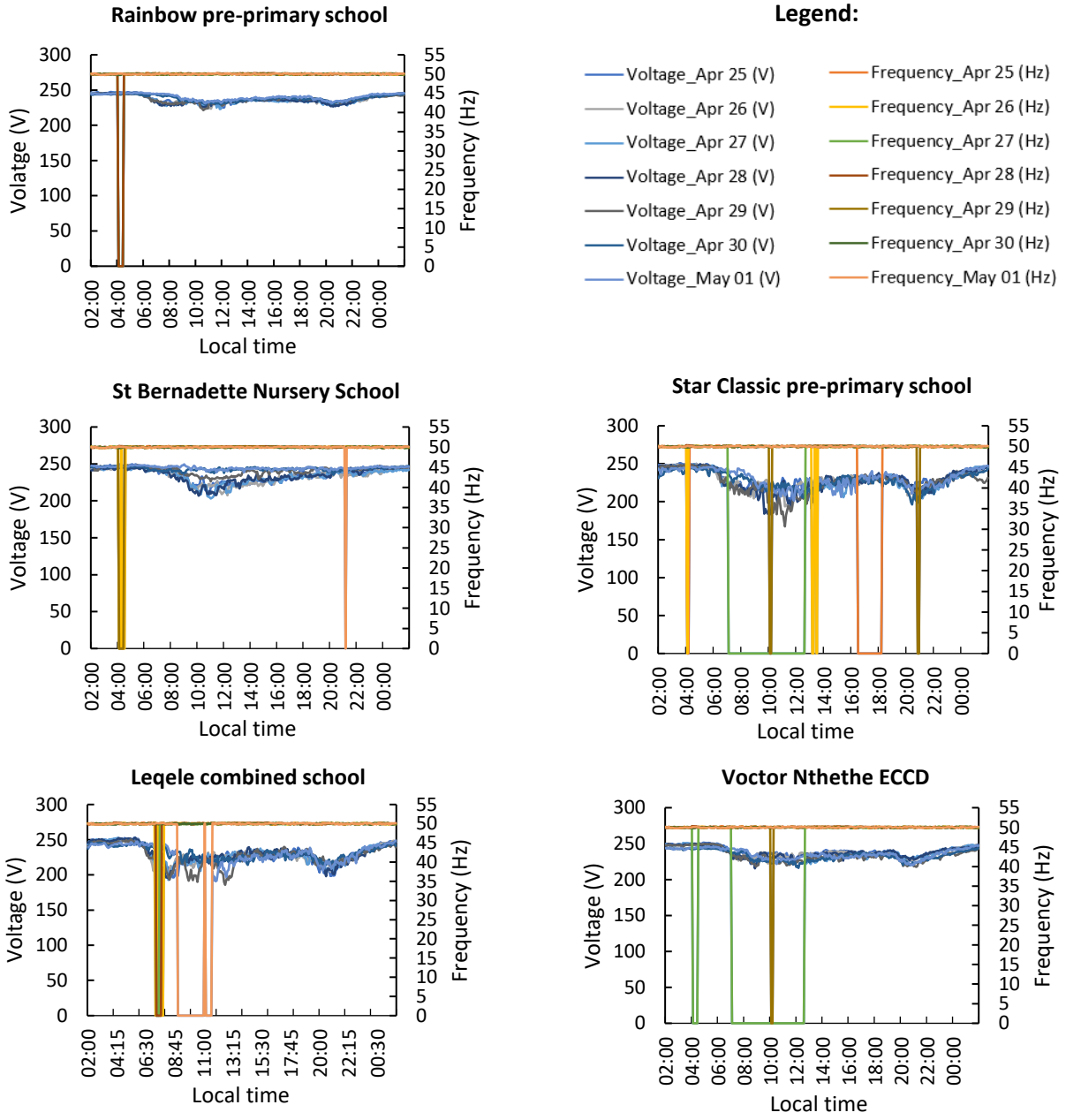


Figure 9 – Voltage magnitude and frequency measured at EPCs' inputs over a week from 25th April to 1st May 2022 for every 15 minutes over 24 hours

The average voltage was around 220 V. The maximum voltage can get to 250 V while the minimum voltage reaches 167.5 V. These voltage ranges did not affect the performance of the EPCs. This is also in line with the findings of MECS' study (Batchelor, 2021) that explored the performance of an EPC at lower voltages than the rated voltage (240V). It shows that a 1 kW EPC can still operate satisfactorily at half the rated power by increasing the cooking time by 20 per cent of the cooking time at rated power.

In terms of power cuts, during the cooking time (06:00 – 13:00), Rainbow and St Bernadette had a reliable power supply, while Leqele, Star Classic, and Victor Nthethe experienced one major power cut (two to five

hours) each in the week when the voltage data was collected. During the power cut, Leqele reverted to using firewood while Victor Nthethe went back to LPG, fuels each school were using before the study. Considering fuel (e.g. a back-up diesel powered generator) and/or appliance stacking during a transition phase (e.g. whilst the power system infrastructure is being strengthened) is important whilst schools do not have access to consistent power supplies. The two schools without power cuts were able to cook exclusively with the EPCs.

2.6 Energy consumption and cost of cooking fuel

2.6.1 Cooking fuel prices

The cost of fuels considered in the study were derived from surveys. LPG and electricity prices were verified using users' payment receipts to ensure accuracy and the electricity tariff is officially published by LEWA. The cost of firewood was solely derived from responses given by Leqele combined school's cooks in the baseline survey.

LPG - The price of LPG used in this report is $2.16/kg. This price was obtained by calculating the average costs of LPG from different schools and includes the cost of transport. The cost of 19 kg and 48 kg LPG cylinder is LSL 560 and LSL 1,448, respectively. Adding the transport cost, estimated at LSL 100 and LSL 200 respectively, the average cost is around LSL 34.56 per kg. Using the 2022 exchange rate ($1 = LSL 16), the final estimated price is $2.16/kg.

Firewood - The only school that used firewood is Leqele combined school. From the baseline survey data collected from this school, cooks reported that they spent LSL 2,240 on a pickup truck load of firewood and used it for 5 to 7 days. The total weight of firewood used for cooking meals for 7 days from 25th January to 2nd February 2022, as recorded in cooking diaries, is around 300 kg. So, the average price of firewood was taken as $0.46/kg.

Electricity – The approved electricity price in Lesotho is LSL 1.9624/kWh for general purpose customer category such as schools (LEWA, 2022). Adding 9% VAT, the overall end-user electricity price is around $0.13/kWh.

2.6.2 Monthly energy consumption and costs

The data analysed in this report was collected daily. The energy used for cooking in a day would depend on the number of meals cooked in the day, the number of dishes within the meal, the cooking process of each dish, and the amount of food cooked.

The average cost of gas used per day at Rainbow ($0.76) and Star Classic ($0.69) schools seems to be lower than those at other schools (more than $2), however, this was explained because breakfast (usually porridge) was not served at Rainbow and Star Classic during the baseline period when data was recorded. After the EPCs were introduced, breakfast was served at Star Classic, but not at Rainbow. In all cases, cooking fuel expenditures before the introduction of EPCs were higher than electricity expenditure after the EPCs were introduced, as shown in **Table 5**.

Table 5 - The comparison of energy cost at different schools per day and per student

School	Fuel	Units*/day	Cost/day ($)	Cost/day/student ($)
St Bernadette	Gas	1.09	2.35	0.012
	Electricity	5.58	0.74	0.004
Victor Nthethe	Gas	0.95	2.05	0.014
	Electricity	5.45	0.73	0.005
Rainbow	Gas	0.35	0.76	0.004
	Electricity	4.17	0.56	0.003
Star Classic	Gas	0.32	0.69	0.025
	Electricity	3.63	0.48	0.017
Leqele	Wood	43.05	20.00	0.018
	Electricity	22.65	3.02	0.003
Units*: kg for LPG and kWh for electricity				

Monthly costs have been estimated (based on the shorter period of recorded data available) and are shown in **Figure 10**. The estimates are extrapolated from daily average cooking fuel expenditures in **Table 5**, calculated based on 22 school days per month.

From the average monthly costs, calculated ratios of cost of electricity consumed by EPCs to the cost of LPG/firewood in different schools show that cost savings range between 27 per cent and 69 per cent for schools that transitioned from LPG, and up to 85 per cent for Leqele combined school that switched from firewood. Cooking on an open-air fire using tripod pots required large amounts of firewood daily, whereas the same volumes of food can be cooked more efficiently with an EPC. The savings made at Rainbow nursery and Star Classic pre-primary schools could even be higher if the data on the amount of LPG used to cook breakfast before the introduction of EPCs was available and included in the cost saving calculation.

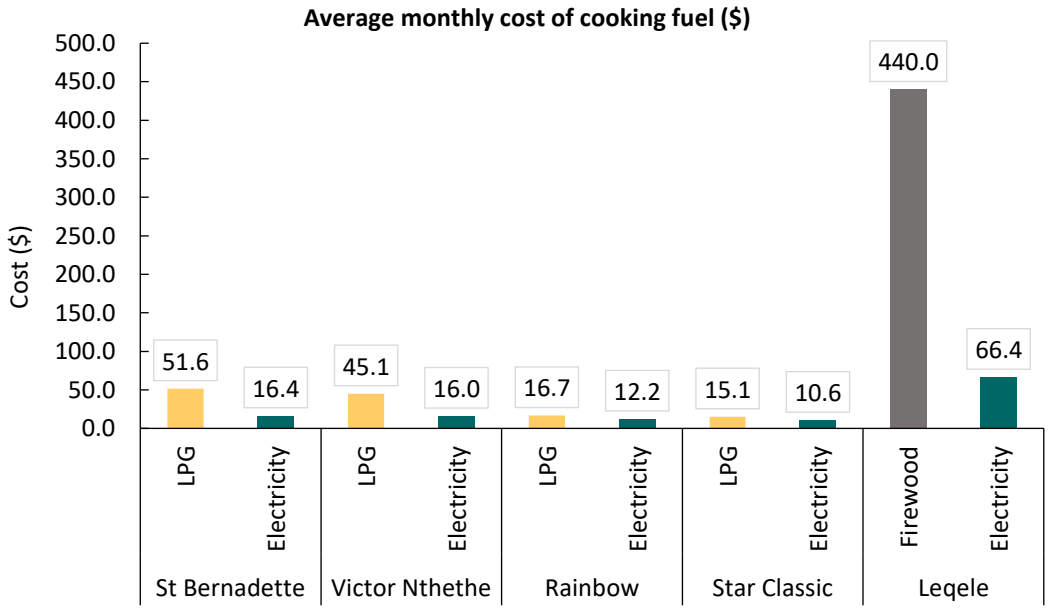


Figure 10 – Average monthly cost of cooking fuel at selected schools before and after the introduction of EPCs

To understand how much each of the selected schools spent on cooking fuel compared to each other, the average monthly cost per student was calculated (see **Figure 11**). From the figure, **the average cost of cooking fuel per student using an EPC is about one third the cost of using LPG, and one sixth the cost of using firewood**. This is in line with other findings from MECS research, which finds that, across multiple countries, the cost of cooking with an EPC at the household level is approximately one third the cost of using LPG (Scott and Leach, 2023). Star Classic seems to be an exception as the cost of cooking fuel using an EPC was around two-thirds the cost of LPG. At Star Classic, teachers are also responsible for cooking, so it is plausible that they were less able to accurately record data all the time, leading to an overall appearance of difference in performance.

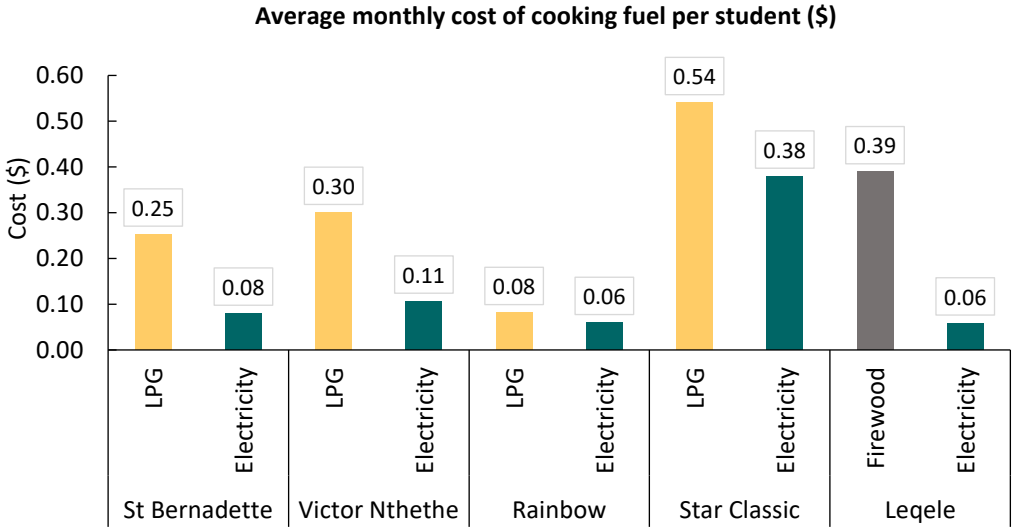
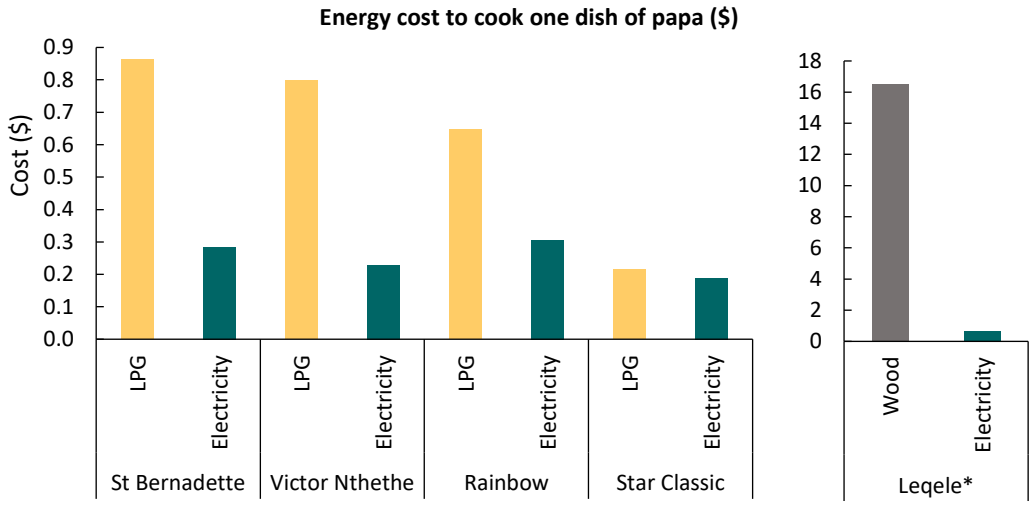


Figure 11 – Average monthly cost of cooking fuel per student at selected schools before and after EPC introduction

2.6.3 Energy cost for cooking common dishes

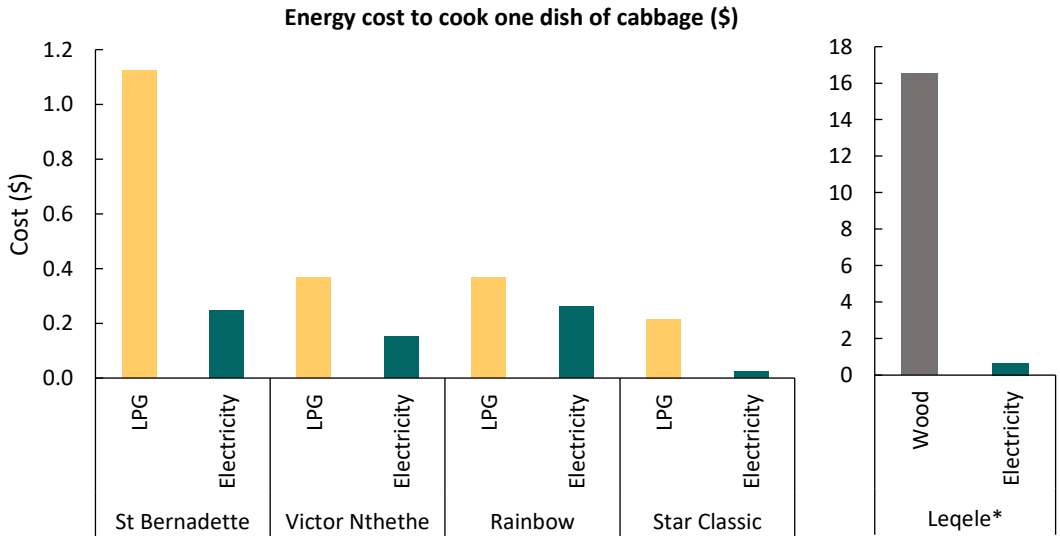
In the previous section it has been shown that the introduction of EPCs in schools did not affect the kind of dishes included in school menus. Papa and cabbage are two popular dishes served at all schools during both the baseline and transition phases. An analysis of the cost of energy to cook these two specific dishes shows significant cost saving at all schools (see **Figure 12** and **Figure 13**), particularly Leqele primary school which switched from firewood. The cost of firewood required to cook one meal of papa and cabbage for 1,279 students is 17 times as expensive as cooking with EPC from $17 to 1$. The cost of cooking papa and cabbage with an EPC was around 45 per cent and 35 per cent, respectively, the cost of using LPG.

Beans are another popular dish in Lesotho schools. During the data collection period, some schools did not serve them during both the baseline and transition so comparative data is unavailable. However, recognising their popularity and the fact that beans require a significant amount of energy compared to most dishes (see **Figure 12Figure 14**), the cost of energy for their cooking was analysed in the remaining schools. Some schools used to soak beans before cooking to save cooking time and energy. This practice changed with the introduction of EPCs as they quickened the cooking time, making soaking less important for schools. It took between 23 per cent and 30 per cent of the cost of LPG to cook one dish of beans for St. Bernadette and Star Classic. It was about 2 per cent of the cost of firewood for Leqele combined school to prepare a dish of samp and beans using an EPC. Samp and beans is a one dish meal so both are cooked at the same time.



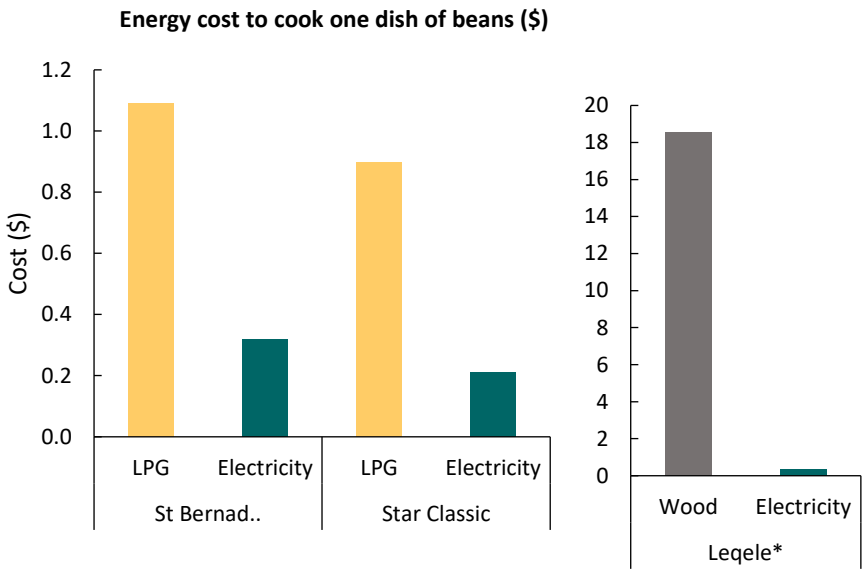
Leqele* - there was no data specific for papa (dish level) so the meal level data (papa + cabbage) was used.

Figure 12 – Energy costs ($) for cooking papa before and after the introduction of EPCs at different schools



Leqele* - there was no data specific for cabbage (dish level) so the meal level data (papa + cabbage) was used.

Figure 13 – Average costs of cooking fuel for one dish of cabbage before and after the introduction of EPCs at different schools



Leqele* - there was no data specific for beans (dish level) so the meal level data (samp + beans) was used.

Figure 14 – Average costs of cooking fuel for one dish of beans before and after the introduction of EPCs at different schools

2.7 Energy consumption and cost by school

In the previous two sections, a general analysis was provided to have a comparison of amount and cost of cooking fuels across the selected schools. As the number of schools is this study is small, individual school analysis of the amount and cost of cooking fuel used before and after the introduction of EPCs is done separately. This analysis focusses on the amount of energy and cost per dish and per meal to establish which dishes/meals are more energy intensive.

In **Figure 15**-**Figure 19** dishes with more than one data-point are represented by three points (average – column height, minimum and maximum – bar length). Those with only one data-point are just represented by that single value and are included for illustrative purposes only as their accuracy is not reliable enough to draw conclusions from.

2.7.1 St Bernadette nursery school

Saint Bernadette nursery school served two meals, breakfast and lunch, to 190 students over the study period. Samp and beans was the most energy intensive dish cooked before the introduction of EPCs. After EPC introduction this changed to sorghum porridge and samp being the top-two energy intensive dishes. While it is known that samp and beans are long-cook foods, sorghum porridge's high energy consumption comes from the fact that it is cooked without the lid on and therefore takes longer to cook. Surprisingly, sorghum porridge required almost double the amount of energy as super cereal porridge. Whilst we cannot tell for certain why, the reason for the difference may be the way super cereal is processed prior to purchase, whereas sorghum is just milled.

The list of all dishes and the amount of energy required for their cooking at St Bernadette are given in **Figure 15**. The figure also provides the comparison of the cost of cooking fuels for common dishes and meals before and after the introduction of EPCs. The cost of electricity used for cooking is significantly lower than the previously used LPG. It is on average a third of the cost of LPG used to cook the same dish.

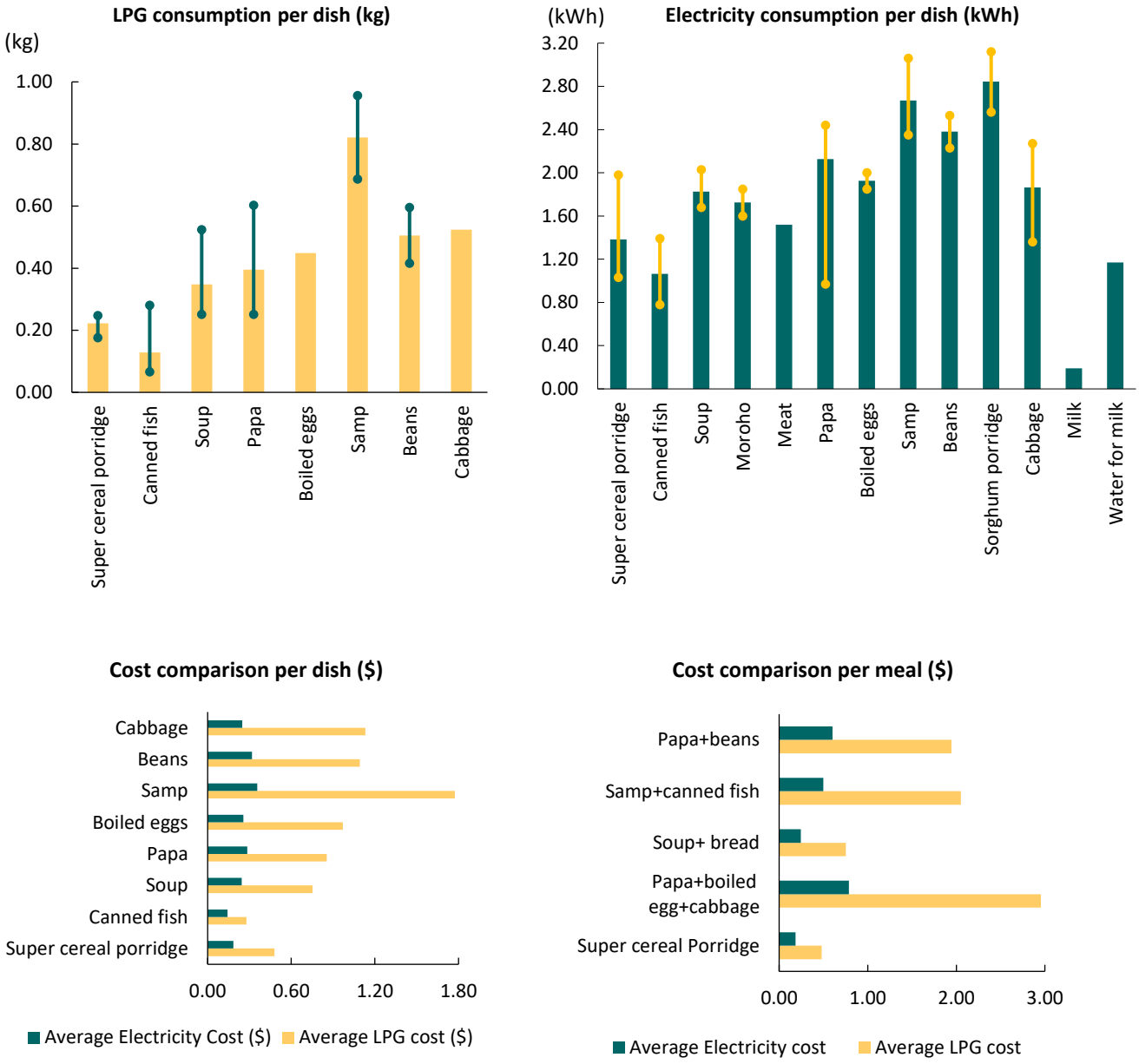


Figure 15 - Energy consumption and cost of cooking fuel per dish/meal at St Bernadette Nursery School

2.7.2 Victor Nthethe ECCD

Victor Nthethe ECCD served two meals, breakfast and lunch, to 180 students over the study period. Samp and maize porridge are among the most energy intensive dishes cooked during the study period; both before and after the introduction of EPCs. The list of all dishes and the amount of energy required for their cooking are given in **Figure 16**. The figure also provides the comparison of the cost of cooking fuels for common dishes and meals before and after the introduction of EPCs. The cost of electricity used for cooking is significantly lower. It is on average slightly over a third of the cost of LPG used to cook the same dish.

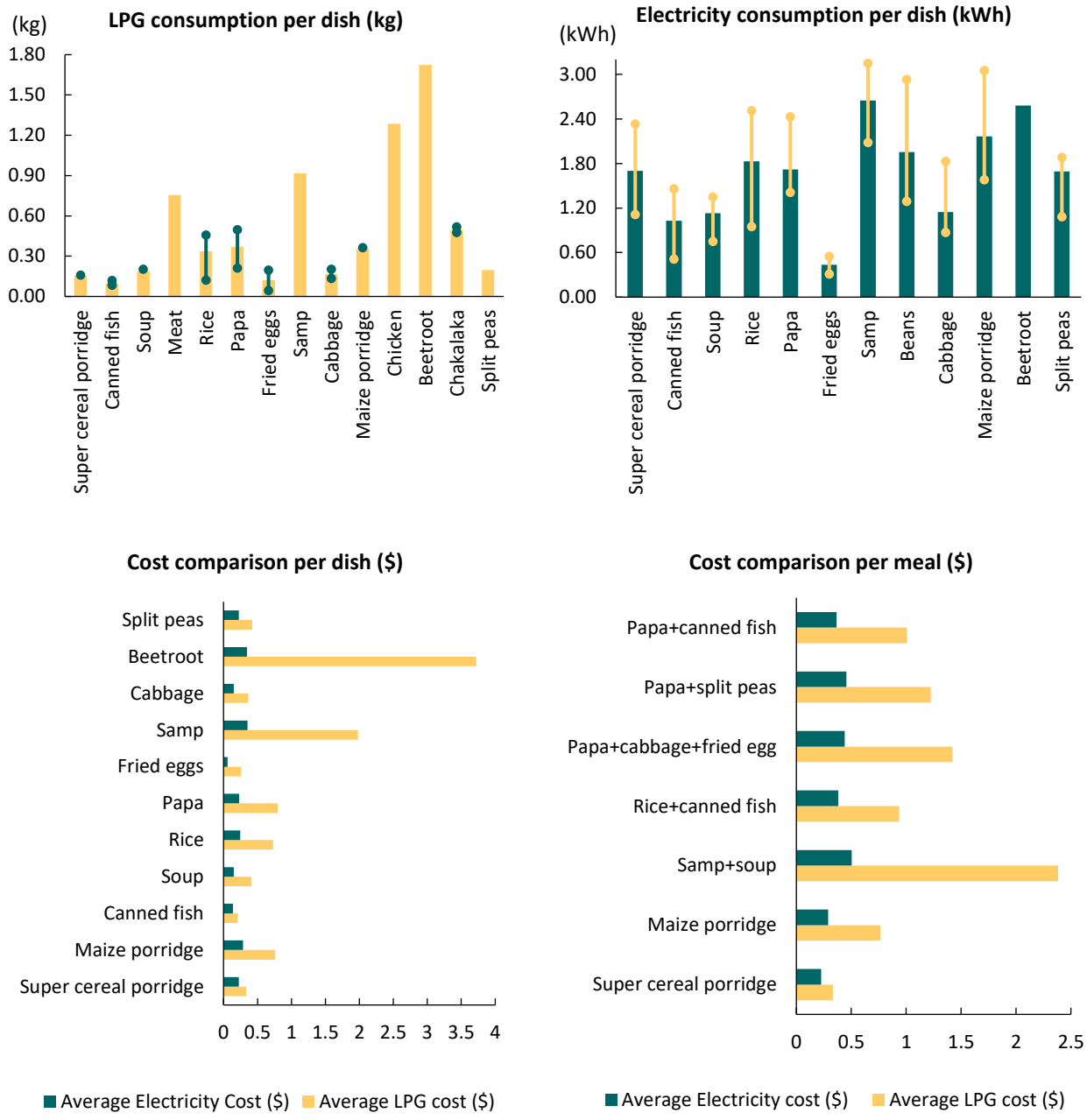


Figure 16 - Energy consumption and cost of cooking fuel per dish/meal at Victor Nthethe ECCD

2.7.3 Rainbow pre-primary school

Rainbow pre-primary school served lunch during the study period to over 201 students. Samp and papa are among the most energy intensive dishes cooked during the study period; both before and after the introduction of EPCs. The list of all dishes and the amount of energy required for their cooking are given in **Figure 17**. The figure also provides the comparison of the cost of cooking fuels for common dishes and meals before and after the introduction of EPCs. The cost of electricity used for cooking is significantly lower. It is on average slightly over a half of the cost of LPG used to cook the same dish.

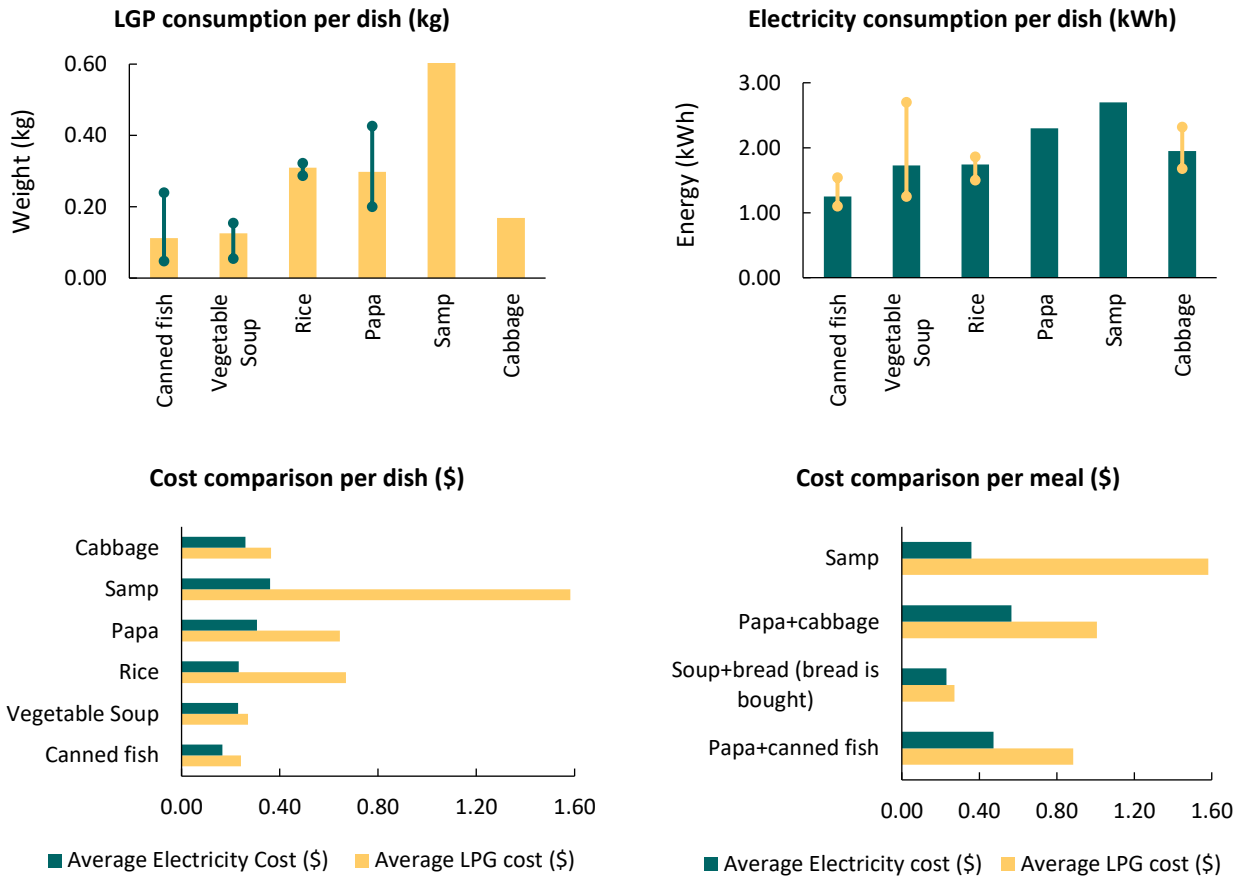


Figure 17 - Energy consumption and cost of cooking fuel per dish/meal at Rainbow pre-primary school

2.7.4 Star-Classic pre-primary

Star Classic pre-primary school served breakfast and lunch during the study period to over 27 students. Beans and sorghum porridge are among the most energy intensive dishes cooked before and after the introduction of EPCs. The list of all dishes and the amount of energy required for their cooking are given in **Figure 18**. The figure also provides the comparison of the cost of cooking fuels for common dishes and meals before and after the introduction of EPCs at Star Classic. The cost of electricity used for cooking is significantly lower. It is on average slightly over a third of the cost of LPG used to cook the same dish.

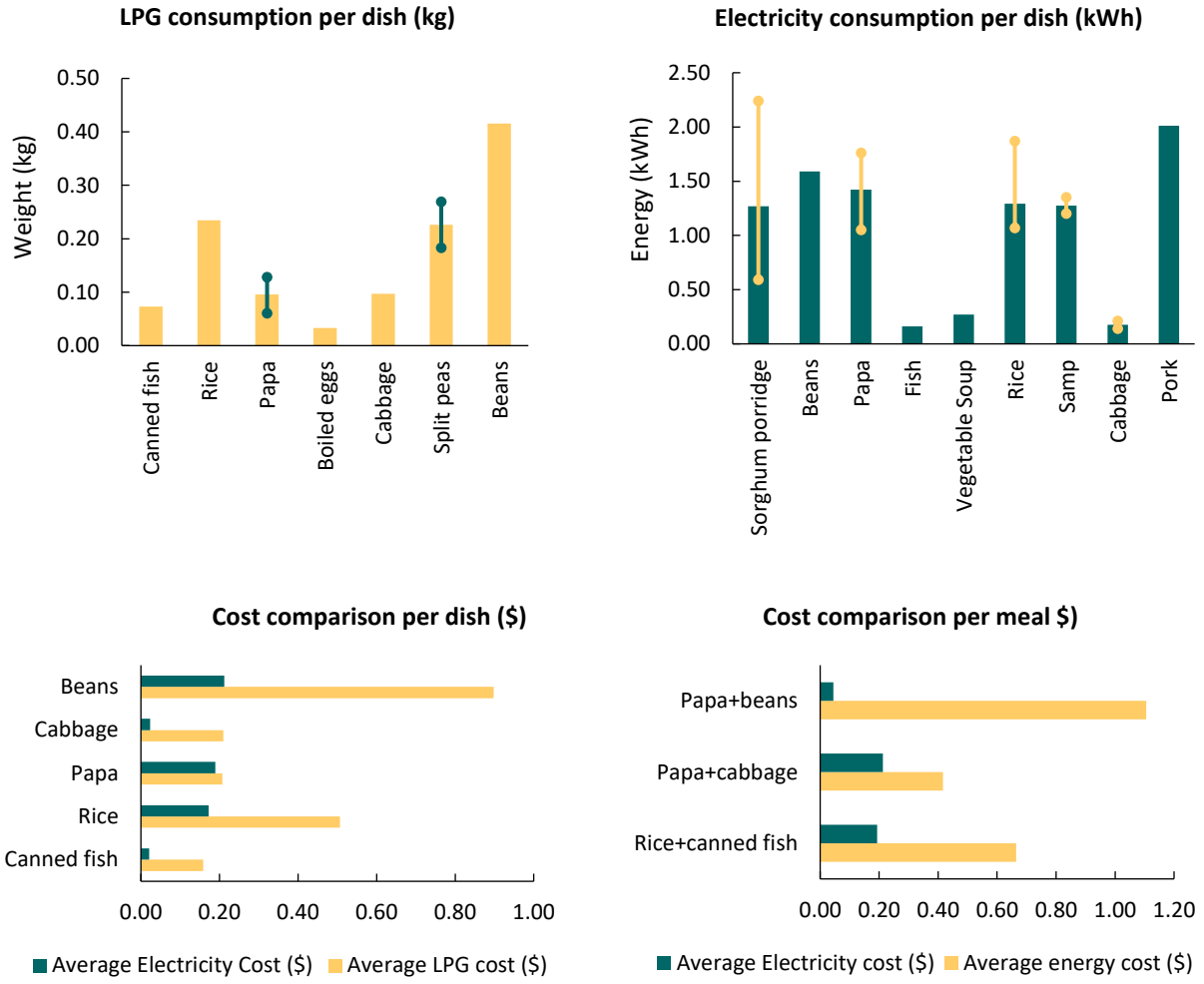


Figure 18 - Energy consumption and cost of cooking fuel per dish/meal at Star Classic pre-primary school

2.7.5 Leqele combined school

Leqele combined school served lunch during the study period to over 1,279 students. Data was collected at meal rather than individual dish level. The meals served during the week of data collection and their associated energy consumption are provided **Figure 19**. The figure also provides the comparison of the cost of cooking fuels for meals. The cost of electricity used for cooking is significantly lower. The cost savings are more than 95 per cent of the cost spent on wood to cook the same meal.

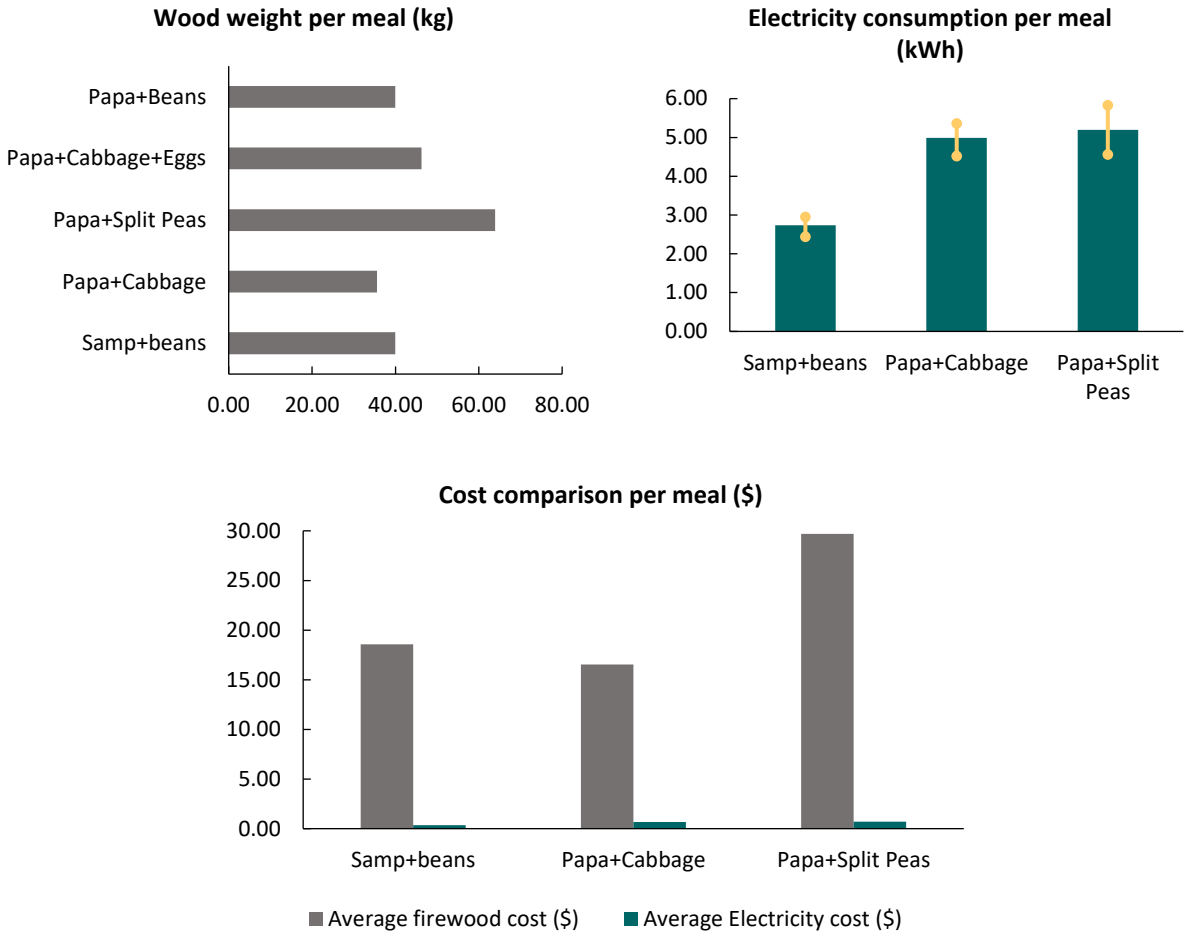


Figure 19 - Energy consumption and cost of cooking fuel per dish/meal at Leqele combined school

These results provide evidence that cooking with EPCs is cheaper than LPG and firewood in schools. Converting the prices to the common unit for comparison, the prices of electricity, LPG, and firewood are $0.133/kWh, $0.158/kWh, and $0.104/kWh respectively. This makes LPG the most expensive fuel per kWh (fuel prices are also discussed in section 2.6.1). Of the five schools in the study, four were previously cooking with LPG and the switch to electricity has resulted in significant savings in all cases.

Whilst fuel cost is one comparator, fuel use and therefore efficiency is also important for schools which are catering, in many cases, for large numbers of students. Energy efficiency can be assessed using the average ratios of energy required to cook a dish on LPG or wood to the energy required to cook the same dish using an EPC.

Using calorific values of firewood, electricity, and LPG given in **Error! Reference source not found.** the e nergy ratios were calculated (see **Error! Reference source not found.**). Results in Table 7 show that cooking with LPG and wood required up to 4 times and around 50 times as much energy as using an EPC, respectively. The control cooking test results from the Nepal eCookBook gave similar energy ratios for LPG to electricity at the household level.

From this analysis, it is clear that the cost savings from cooking with an EPC come primarily from the efficiency of the EPC (i.e., energy saving) since the fuels' unit prices in Lesotho are not very different from each other. As larger EPCs become more common in the marketplace, efficiencies could improve further, both through technological improvements and as users become more familiar with their operation (for example soaking beans before putting them in an EPC shortens the cooking time even further).

Table 6 - Calorific values of firewood, LPG, and electricity

Fuel	Calorific value
Wood	15.9 MJ/kg
LPG	49 MJ/kg
Electricity	3.6 MJ/kWh

Table 7 – Average ratios of energy used to cook different dishes before the introduction of EPCs to the energy used after the introduction of EPCs

School	Average ratio
St Benedict	2.88
Victor Nthethe	2.54
Rainbow	1.88
Star Classic	4.15
Leqele	50.15

2.8 Cooking time

As previously mentioned, there was no cooking time data collected in the cooking diaries during the baseline phase. Estimated cooking times provided by cooks during the baseline survey were used for the comparison between the average time spent cooking per day before the introduction of EPCs and after. Results are given in **Table 8**.

Similar to energy consumption, cooking time depends on the number of meals per day, the number of dishes in the meal, the process of cooking the dishes, the amount of food cooked, as well as the cooking

they did not serve breakfast during the data collection period. It would be expected that Star Classic would have the shortest cooking time due to a significantly lower number of students than the other schools in the study.

Table 8 - Average time spent on cooking at different schools before and after the introduction of EPCs

School	Cooking Fuel	Average cooking time/day (hours)
St Bernadette	Gas	2 - 4
	Electricity	2.18
Victor Nthethe	Gas	2 - 4
	Electricity	1.76
Rainbow	Gas	2 - 4
	Electricity	1.55
Star Classic	Gas	2 - 4
	Electricity	1.93
Leqele	Wood	~ 5
	Electricity	3.17*

* Cooking time at Leqele is evaluated by calculating the average time as the cooking is staggered (one EPC was used at least twice per meal) due to high number of students.

Qualitative analysis

2.9 User experience

The results of the study revealed that the overall user experience and perspective of using EPCs for cooking school meals instead of LPG and firewood was positive. Respondents reported some issues related to cooking school meals with LPG. For example, running out of gas while cooking and spending time on refilling the gas cylinder could lead to delays in preparing food for children or even cancelling the main meal for the day. An interviewee highlighted that using LPG for cooking is expensive as they spend around LSL 1,650 for 48 kg of gas including transportation, ***"gas is expensive, we spend LSL 1,400 to buy 48kg of gas and pay LSL 250 for transportation".***

Figure 20 – Locally made LPG stove and cooking pots used for cooking school meals before EPCs introduction

The cooks at Leqele primary school, where meals are cooked outside regardless of hot or rainy weather conditions, reported challenges ***"the weather was the main problem, it would be raining, and we would still have to cook no matter what, it was really challenging for us,"*** and may delay or cancel the meal preparation ***"sometimes the kids would eat late because of the weather conditions or environmental issues beyond our control"***. The cooks mentioned that cooking with firewood was stressful because they were always under pressure to cook and prepare school meals on time, ***"we were always in a rush to ensure that the kids had their meals on time."***

Figure 21 – Wood smoke negatively affects cooks' health and environment (photo taken at Leqele Combined School)

After the introduction of EPCs, Victor Nthethe school cooks reported time savings of about 1 hour on average compared to gas, ***"compared to cooking with gas, pressure cookers save time".*** They found EPCs were easy to clean compared to stainless steel pots, ***"what I like about the pressure cookers is that they are easy to clean, unlike the steel pots that require a lot of efforts to scrub with steel wool both inside and outside."*** Children noticed that the food used to be contaminated with sand in windy days which ceased to be the case once the EPCs were introduced.

The school cooks from Rainbow noticed reduction of food waste as they started to measure the food ingredients accurately after the introduction of EPCs,

- ***"Cooking with pressure cookers taught us to measure food before cooking,"*** reported by a school cook.
- ***"Now, we use measuring spoons and other utensils when preparing meals,"*** reported by a school cook.
- ***"Since the use of pressure cookers, we have realised some food savings,"*** reported by a school cook.

Furthermore, teaching staff members from Rainbow who participate in cooking and preparing school meals reported that they were able to focus on teaching or conducting other activities because cooking with EPCs requires less supervision compared to cooking with LPG.

Figure 22 – Cooking and preparing school meals using large EPCs

With EPCs the school cooks at Leqele primary school mentioned that they were able to overcome the weather and environmental conditions and have better control over cooking and serving school meals on time and they spent less time on cooking, ***"now it takes us 30 minutes to cook dishes that used to take us 2 hours,"*** the school cook. Additionally, the use of EPCs, eliminating smoke emissions, enabled cooks and staff members involved in cooking to wear finer clothes that would have otherwise been dirtied with soot. Not many people will appreciate these impacts without having previous experience of cooking with firewood. ***"We are now able to wear our best and expensive clothes to work but when cooking with firewood we could not do that,"*** the school cook.

3. Key findings, challenges, and recommendations

From the analysis of data collected across the five schools the following key findings have been identified:

- **The cost of cooking fuel per student using an EPC is approximately one third the cost of using LPG, and one sixth the cost of using firewood.** Results from the schools using LPG show a cost reduction of up to 69 per cent by adopting EPCs. The cost saving reached 95 per cent switching from firewood to EPCs at Leqele school. These savings could repay the investment cost of 6 EPCs in less than a year. It would require more time for LPG users, but given that an electric pressure cooker has a minimum five-year lifespan it is an attractive investment.

- **The energy ratios show that cooking with LPG and firewood requires up to 4 times and around 50 times as much energy as an EPC, respectively**. With the cost of energy per kWh not being significantly different across fuels, the energy cost savings of cooking with an EPC come from its cooking efficiency (i.e., energy saving). Cost savings of transitioning to EPCs are already clear and could become even better in the future, with new generations of large EPCs, increase in LPG and firewood prices, and optimised cooking practices.

- **The use of EPCs in schools in Lesotho saves environmental cost (i.e., avoided: deforestation - land degradation, biodiversity loss, water table detriment, raising of local temperature etc; health care costs; carbon emissions).** On average, a school transitioning to using EPCs from LPG saves around $0.0037 per day per student of environmental cost based on IMF's methodology. This is higher for wood fuel.

- **EPCs are safer than other cooking solutions**. EPCs are well insulated, eliminating the possibility of burns. Using electricity, EPCs avoid the risks associated with LPG cylinders. Being used indoor, EPCs do not require cooks to work outside regardless of the weather. EPCs have no emissions, protecting cooks and children from air pollution and respiratory diseases. EPCs also decrease CO2 emissions, lowering contributions to climate change.

- **The use of EPCs saves time compared to other fuels.** This can be factored in two ways: (i) it is safe to multitask when cooking with an EPC as you can safely leave it and attend to other tasks; (ii) transitioning to EPCs saved cooks on average 28 per cent to 48 per cent of the previous cooking time, equivalent to more than one hour per day.

- **Introduction of EPCs in schools is compatible with existing power generation infrastructure**. As cooking in schools happens between 6:00 to 14:00 local time, an off-peak period of power demand, Utilities or minigrids would be able to serve increased demand with existing infrastructure.

- **The introduction of EPCs does not affect diets.** Schools were able to serve the same types of food (such as porridge, papa, samp, rice, vegetables, beans, fish, eggs, etc.) before and after the introduction of EPCs.

- **EPCs are more reliable**. While LPG forces schools to skip the meal when the cylinder finishes and extreme weather events prevent the possibility to cook outside, EPCs use electricity which is constantly available, except in the occurrence of blackouts. During the study there were some power cuts, so access is not yet constant, however, blackout frequency is expected to decrease as energy provision improves in Lesotho. Fuel stacking is an option in the short term whilst upgrades take place. A secondary fuel, such as LPG, can be used as an alternative fuel in those circumstances.

- **Washing EPCs after cooking requires less time and water.** Washing EPCs after cooking was reported to be less time consuming and requires less water compared to other cooking appliances. This is due to both the cooking process in the pot as well as the absence of smoke on the outside. While water was not highlighted as an issue in the selected schools, water may be a challenge in rural schools.

- **EPCs reduce food consumption and food waste**. With the measuring of ingredients before cooking, cooks have reported reductions in the amount of food used. Portions and nutritional value can also be calibrated more accurately.

- **EPCs can provide a better work environment.** Cooking with EPCs is less stressful compared to other fuels as it requires less intensive work, less supervision, no smoke and increased cleanliness.

These key findings support this study's hypothesis that cooking with EPCs in schools brings good value for money in addition to health, environment, and gender co-benefits. Despite the potential, transitioning from traditional biomass and fossil fuels to cooking with EPCs in schools presents various challenges ranging from the up-front cost of the appliance, lack of awareness, lack of retailers, limited electricity access in remote

regions, and a weak enabling environment (e.g. policies and regulations to support the transition). These challenges can be overcome by implementing the MECS transition theory of change which consists of three interrelated dimensions: the enabling environment, consumer demand, and the supply chain.

Enabling environment – National governments need to lead this transition by creating an enabling policy and regulatory environment to support the transition to electric cooking. MECS has already established evidence that integrating eCooking into electrification plans under a single investment can be a cost-effective approach, the same approach can be adopted in schools by integrating clean cooking into school feeding programme plans. Tackling both issues together is more cost effective than planning and funding them separately. Other ways to support the transition include encouraging supply chain development (e.g. through incentives for private sector involvement throughout the supply chain), an ecooking tariff for schools (considering that most use in schools occurs off-peak), financial support to reduce the upfront cost of appliances, mobilising investment to expand or upgrade existing electricity infrastructure both in schools and nationally. In some countries a specific eCooking strategy helps to provide focus to the issue, but it's not a pre-requisite to action. Many countries already have sector specific, but often siloed, taskforces and working groups. Bringing together a cross-sector group including representatives from clean cooking, electrification, school feeding, school infrastructure, education, finance, energy provision and regulation could increase awareness of the potential for ecooking in schools and drive national action.

Consumer demand – Many schools in Lesotho and in Sub-Saharan Africa use firewood for cooking. There is a need for awareness creation among schools and national governments that there is a cost-effective alternative available and that the transition can happen in stages if needed (e.g. if the electricity infrastructure is less secure). More evidence like the findings in this report are one way of creating awareness among stakeholders and more pilot projects in different countries should be supported.

The supply chain – EPCs, especially the large volume ones used in this study are still a relatively new technology in the eCooking appliance space and in almost all cases they need to be imported. This incurs additional costs through international shipping, VAT, import taxes, and customs clearing charges, before local sales taxes and supplier profit margins are added. If demand becomes high enough then economies of scale come into play, however, until that happens the costs for early adopters will be higher. There are several ways to support a fledgling market, both the suppliers and consumers, which loops back to national governments, regulators, and utilities supporting a positive enabling environment. One of the very positive takeaways from this study is that the schools started to save money on fuel costs from day one of using the EPCs. It's not a deferred benefit. There's an investment to be made in moving away from an existing set up, but even with the current higher cost of the EPCs, the costs were recovered in less than 1 year (compared to continued firewood use), as adoption increases and the appliance costs come down, that period will reduce further.

4. Conclusions

This study report has provided evidence on the cost-effectiveness of cooking with large electric pressure cookers, its compatibility with diets, and cooking practices in five schools in Lesotho.

This study has successfully demonstrated the feasibility, desirability, and viability of transitioning from cooking with traditional biomass and fossil fuels to using electric pressure cookers in schools. With the electrification rate due to increase substantially by 2030, large EPCs could become the cooking appliance of choice in schools globally, including in low-income countries. As a pilot study, this can be used by other countries to introduce the use of EPCs in schools.

Recognised as the most efficient cooking appliance on the market, interest in large EPCs is growing. Its integration in school feeding programmes globally could also play a key role in accelerating progress towards SDG7 (targets 7.1 and 7.3) in both energy efficiency and access to clean cooking. In addition, the use of electric cooking in remote areas can strengthen electricity demand and contribute to the expansion of mini-grid electrification through renewables (SDG 7.2). To enable a full transition to electric cooking, further work to strengthen and stabilize power grid networks, both national and minigrid is needed. MECS is supporting minigrid developers to integrate eCooking in their designs, whereby schools are a natural anchor load, enhancing stability and affordability for all users, not just the schools.

An integrated approach that encompasses clean cooking, electrification, and school feeding programmes could allow a faster transition towards modern cooking, using schools as innovation hubs for knowledge transfer and the penetration of modern cooking solution in communities.

This report calls for a global effort to unlock several development benefits achieved by promoting modern cooking in schools. The collaboration between WFP and MECS continues to support strategic interventions in pilot projects for large EPCs in schools. Lesotho was the first, but pilots are now underway in more countries, with more in the pipeline. The partners will continue this work, establishing evidence and learning to support investment and decision making by Governments and other actors.

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WFP World Food Programme

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