PEEDA
People, Energy & Environment Development Association

MECS
Modern Energy Cooking Services

Primary Use Electric Cooking Technology Available in the Nepalese Market

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1. INTRODUCTION

As electric cooking is an emerging technology in Nepal this report seeks to establish the most suitable electric cooking appliances for widespread use in the country. Electric cooking offers multiple social, environmental, economic, and health benefits; the Government of Nepal aims to ensure 25% of households use electric stoves as their primary mode of cooking by 2030.

Responding to this policy environment, this report provides a summary of the potential electrical cooking technologies that could serve as the primary cooking appliance for households within Nepal. Working mechanisms, key components, evaluations, and comparisons between the devices are presented in this document. Primary data collected by PEEDA, and its team forms the basis of this report alongside information sourced from secondary means.

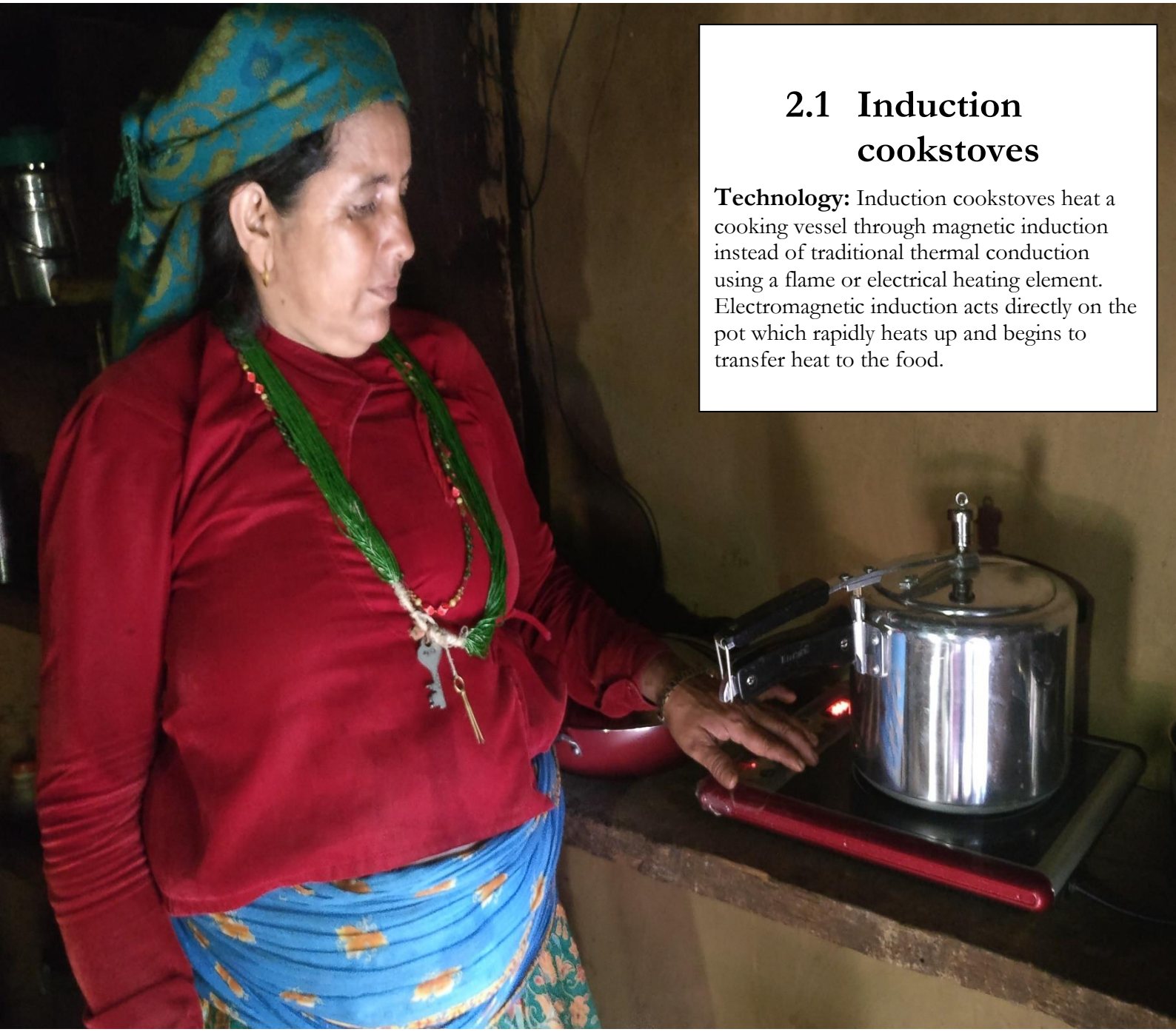
2. ELECTRIC COOKER APPLIANCES

The following examples give an idea of the different types of electric kitchen appliances found in the Nepalese market.

- **Induction cookstoves**
- **Infrared stoves**
- **Electric pressure cookers**
- Hot plates
- Microwave ovens
- Electric and gas cookstoves
- Roti makers
- Electric ovens
- Rice cookers
- Slow cookers
- Electric frying pans
- Air fryers
- Electric kettles and other water heaters

The **induction**, **infrared**, and **electric pressure cooker** will be described in detail in this document. These have been selected as these devices can be used as primary cooking appliances to cook most Nepalese dishes and can be employed for a variety of cooking practices. Although in the case of infrared cookers, appropriate safety measures need to be installed by the utility beforehand.

Disclaimer: Electric cooking is a rapidly evolving sector. The content discussed in this report represents the technology available in the Nepali market during the time of report preparation or to maximum information available to authors.



2.1 Induction cookstoves

Technology: Induction cookstoves heat a cooking vessel through magnetic induction instead of traditional thermal conduction using a flame or electrical heating element. Electromagnetic induction acts directly on the pot which rapidly heats up and begins to transfer heat to the food.

2.1.1 Working mechanism

Lying below the bottom of the cooking pot is an electromagnet that creates a strong magnetic field that surrounds the cooking pot. Using alternating current (AC), the direction of this magnetic field is rapidly changed back and forth. According to Faraday's law of electromagnetic induction, the changing magnetic field within the cooking pot creates a corresponding electric current within the pot. Through energy losses (eddy current losses resulting in resistive heating) in the pot, the electric current is immediately converted into heat energy, thus the pot and then the food is heated. This is an extremely efficient process. The electrical current induced in the cooking pot is of no danger and does not prevent handing of the pot during cooking.

Power levels between zero and the maximum rated power for a given cookstove are achieved through pulsing the maximum power level. For example, a 1 kW rated cookstove would achieve a 500 W power output by pulsing 1 kW for 50% of the time.

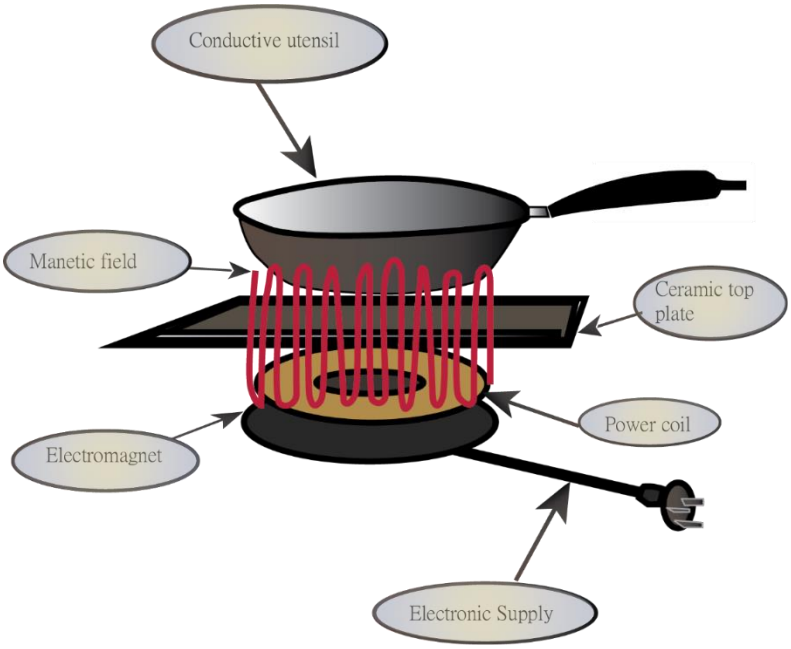


Figure 1 - Diagrammatic representation of Induction cookstove

2.1.2 Benefits

The key benefit of induction cooking is that it is inherent efficient. When transferring energy from the cookstove to pot an efficiency of 98.8% is possible, representing a 70% reduction in energy consumption compared to biomass stoves. For applications where low power consumption is especially important - e.g., villages with an off-grid power supply - this is an extremely attractive quality. Other benefits include the ability to control the heat level with high precision along with the high speed of cooking versus traditional methods, as the pan reaches temperature in seconds rather than minutes. Another important benefit of this method is its greater safety as the device does not get very hot and switches off when not in contact with a cooking vessel. Unlike cooking with LPG or biomass, safety is improved by the lack of an open flame (a quality shared by all-electric cooking methods).

2.1.3 Drawbacks

For nearly all models of induction cooktops, the cooking vessel being used must be made of, or contain, a ferromagnetic metal such as cast iron or magnetic stainless steel. This drawback may severely limit the usefulness of this method if appropriate cooking vessels are not provided or are damaged/lost. In this case, it may be difficult for users to obtain suitable new cooking vessels due to the limited market penetration of induction cooking in Nepal at the time of writing.

It is worth noting that copper, glass, non-magnetic stainless steel, and aluminium vessels can potentially be used if placed on a ferromagnetic disk. However, this would effectively convert the induction cooker into a conventional hotplate and would result in far less efficient electric cooking.

2.1.4 Nepalese market for induction cookstoves

There is a large variation in the types of induction cookers available on the market at the time of writing, with differing features, power consumption, starting power, surface material, and internal circuitry; there is a similar variation in the qualities of these cookers. Costs start from NPR 2,000 and increase up to NPR 11,000 for a single-pot induction cookstove. The basic operating mechanism for all brands of induction cookers is fundamentally the same, the cost differences mainly relate to production quality and power output. The actual power created by the cookstove generally does not match up to the labelled power, e.g., a Media induction cooker is advertised at 2000 W power mode consumes power close to 1700 W. The advertised rating and actual consumption can be different when tested in a lab. So, careful research into brand quality should be carried out before any induction cookstoves are purchased. There has been a proliferation of cheap induction cookers into the Nepalese market, many of which are faulty or of extremely poor construction. Again, caution should be used before making any purchases, and ensuring that the product has at least a one-year guarantee is an important safeguard.

2.1.5 Summary

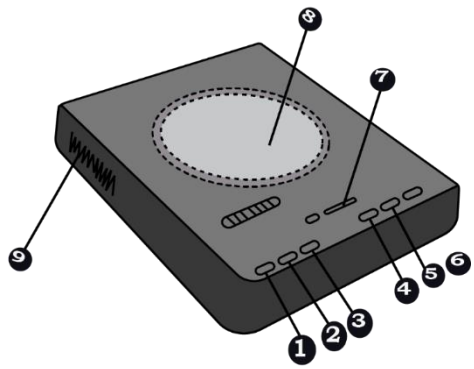
Induction cookstoves offer many advantages as an electric cooking technology that could serve as a primary cooking appliance: primarily efficiency and safety. In areas with a low power supply such as off-grid locations or to those whose electricity costs are significant, this increased efficiency is extremely valuable. The induction cookstove must be used with a suitable cooking vessel otherwise the working mechanism will fail to operate. This may potentially limit flexibility and usefulness in areas with limited access to new cooking vessels. This can be mitigated with the use of a ferromagnetic disk with the loss of some efficiency. This technology has many attractive qualities for widespread use across the whole of Nepal.

2.2 Infrared (IR) Cookstove

Technology: Infrared cookstoves use heated coils to emit radiant heat, which is the same heat created by traditional cooking methods. This radiant heat is transferred as heat waves to the pot.

2.2.1 Working Mechanism:

At their core, infrared cookstoves rely on quartz infrared heating lamps which are encased in a corrosion-protected metal enclosure. These lamps are then surrounded by radiant coils to transmit the required radiant heat. This heat is emitted by the coil under a ceramic/glass surface and is directly passed to the cooking pot to minimize the air being heated; this serves to increase the cookstove's efficiency, The ceramic/glass upper surface has a low ability to conduct heat to maximise the heat that reaches the pot; again, this increases efficiency.



1. Timer
2. Lock
3. Decrease Temp
4. Increase Temp
5. Function
6. On/Off
7. High Temp indicator
8. Cooking Area
9. Air Vent

Figure 2 - Infrared cookstove with key components labelled.

2.2.2 Benefits

A key advantage over induction cooking is the ability to cook food in any standard flat base pot. For use as a primary cooking appliance, this is an important consideration. It can also reach much higher temperatures than the induction cooker and EPC - up to 600°C - although this high temperature is rarely needed for the main Nepalese staple foods. It can be found in the Nepalese market at rates of NPR 3,800 and above. It also includes additional accessories like barbeque stand for barbequing which is not possible with the induction cookstove.

2.2.3 Drawbacks

The coil is heated rather than the cooking vessel directly, as such the efficiency of this method is necessarily lower than induction cooking. Some heat is also lost to the surroundings unlike in induction cooking, lowering efficiency further. The cooking efficiencies for IR cookstoves are around 65%. IR cookstoves are also less safe than induction cookstoves, which do not get very hot and switch off when not in contact with a cooking vessel. While the hot cooking surfaces of IR cookstoves are a potential hazard, especially to younger children unaware of the risk, it is worth noting that this is a similar but far less severe version of the safety issue caused by traditional cooking methods which use an open flame. Generally, the power can be varied within a 200 W to 2 kW range. However, unlike the induction cookstove which varies this power output with on /off cycles, infrared cookers vary power output at the expense of power factor. Critically, tuning the infrared stove to 200 W mode decreases the power factor to 0.33 which causes a surge in reactive power that can damage the local distribution line infrastructures. Therefore, widespread adoption of infrared cookers can even cause damage to the grid and it is **strongly recommended that households do not adopt IR cookstoves unless the utility company has installed appropriate safety measures** (e.g. appropriate sizing of capacitors) to address this issue.

2.2.4 Nepalese Market for IR cookstoves

Currently, there are a limited number of brands of IR cookstoves available in the Nepalese market. Those that do exist tend to be of a higher specification and as such are more expensive, starting at around NPR 4,000 and ranging up to NPR 10,000. Generally, the power can be varied within a 200 W to 2 kW range. As is also the case with ICs and EPCs, this is still an emerging technology in Nepal these cookstoves are not widely available, therefore the skills needed to repair the cookstove should it break down are also not widely available. This should be factored into any purchasing decision.

2.2.5 Summary

Infrared cookstoves offer high versatility and ease of use which make them appealing for use as primary cooking appliances. This comes at the cost of some efficiency, however, so in situations where energy consumption is at a premium these factors must be weighed against each other. It is also critical that the local grid has appropriate safety measures in place to handle the load caused by IR stoves.

2.3 Electric Pressure Cooker

Technology: An electric pressure cooker (EPC) is often called a multicooker because it can perform multiple cooking operations: frying, boiling, steaming, pressure cooking, and baking. Electric pressure cookers are comprised of three main components: the inner pot, the cooker base, and the lid. They can be viewed as a combination of a pressure cooker, hot case, and rice cooker

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2.3.1 Working mechanism

The inner pot is a removable vessel. When heated, the liquid inside the inner pot boils and turns into steam which creates pressure. A floating valve present in the lid of EPC moves up and so the user can find out that pressure has built up and the lid cannot be opened after this – a key safety mechanism. Sensors are used to monitor and then automatically regulate the cooker's pressure & temperature based on the cooking program selected. Periodically engaging the heating element to maintain a stable temperature and level of pressure creates a 'positive feedback loop', and results in precise cooking conditions. If any unsafe conditions are detected the cooker will signal an 'error' with a beep and cut off power to the heating element.

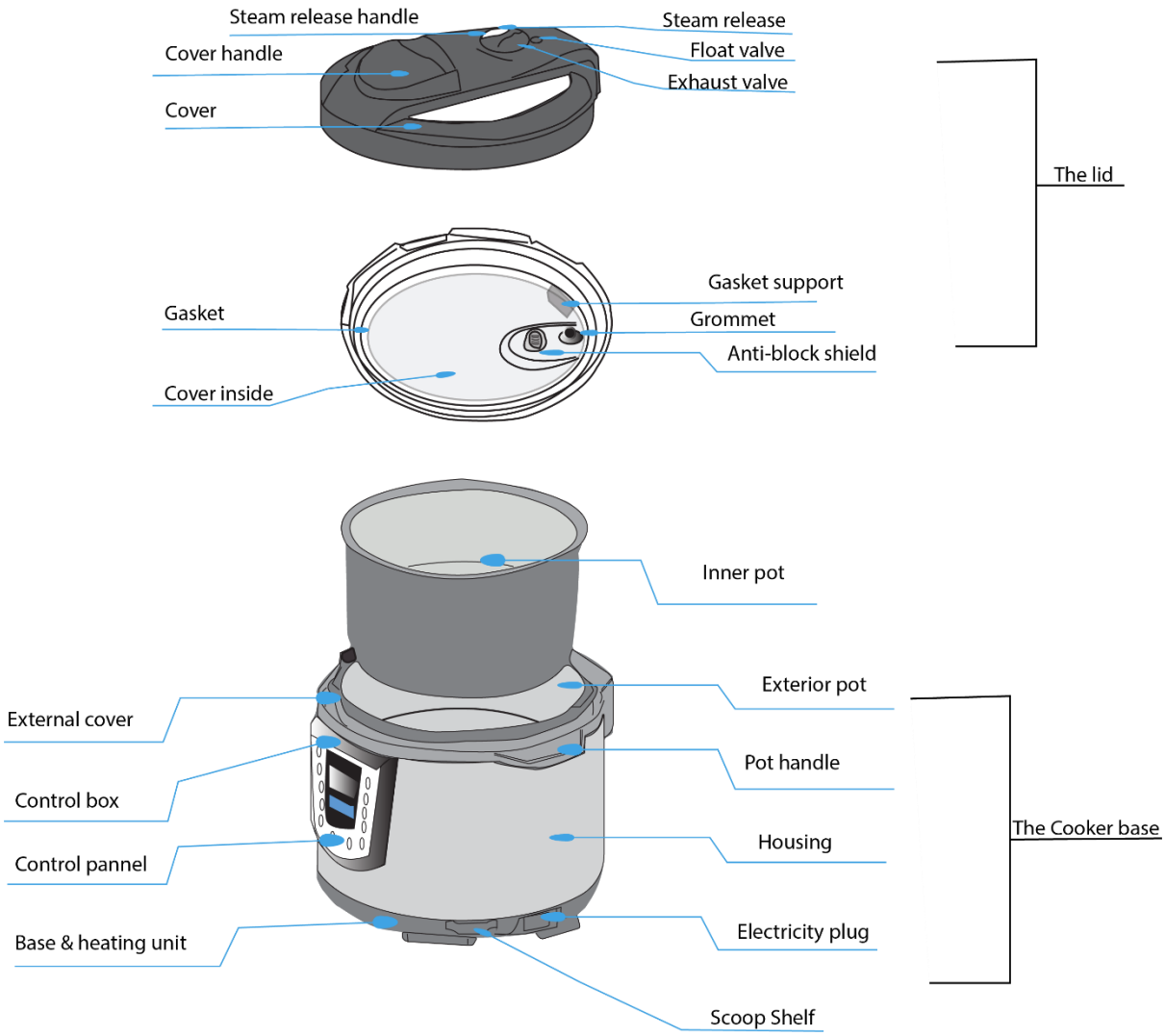

Figure 3 – A technical diagram of an electric pressure cooker

2.3.2 Benefits

EPCs can work in both pressurized and non-pressurized states; during pressurized cooking food can absorb more heat from the water. Consequently, pressurized cooking is optimum for cooking "heavy foods" (foods that require boiling for more than an hour). EPCs are also highly efficient devices as the heat is transferred directly into the pan from the heating element. There is considerably lower heat lost to the surroundings than other cooking methods due to the closed nature of the design. Compared with IR cookstoves, EPCs can reduce energy demand by 80 percent for "heavy foods" and by 50 percent across the entire range of foods that they can cook. Built-in safety features in EPCs make it a safe and durable technology.
There is also a considerable time-saving feature of EPCs; food cooks faster at higher pressures meaning total cook time can be reduced – this is a significant advantage if cooking for large groups. EPCs, therefore, cook food far faster than when using open pots although they are slightly slower compared to using traditional pressure cookers on IR and IC stoves. Another advantage of EPCs is the simplicity of the cooking process. Once the cooking pot has been filled and the device switched on, minimal human input is required.

2.3.3 Drawbacks

EPCs cannot be used to cook every type of dish. Deep frying is not possible in EPCs while shallow frying takes a longer time compared to IR and IC stoves. Dishes like chapatis or pancakes are a challenge to make using an EPC because of the high sides of the cooking pot which hinder access to the bottom. EPCs perform best when cooking near their maximum capacity. To illustrate this: EPCs contain pre-set time settings that are independent of the volume of the dish cooked. Because of this, once the EPC has reached pressure, it takes the same pre-set amount of time to cook large volumes of food as small volumes, making it advantageous to batch cook.

There are more potential points of failure on an EPC than the other technologies due to the increased part count and use of electronic control systems. Should maintenance be required this would introduce complexity. Another key drawback is the cost – an EPC costs on average two times more than an IR cookstove.

2.3.4 Nepalese market for EPCs

The capacities of the EPC models found within Nepal usually range from 2.5 to 6 litres, although it is possible to find larger models targeted at institutional users or restaurants. A capacity of 2.5 litres is large enough for a small household of two to four people; 6-8 litre cookers are better for larger households of six people or more, or those that regularly cook batches of 'heavy foods' like beans. In the Nepalese market, the majority EPCs are found of capacity 5 litres and 6 litres.

In terms of power rating, AC electric pressure cookers tend to range from 700W to 1.2 kW, with the capacity of the pot usually the key determinant in the power rating. Lower power models may be more desirable for mini-grids, where peak loading may be an issue, but higher power models are likely to be slightly more energy-efficient, as they will cook faster, so local conditions must be assessed before the capacity of the required pot is decided upon.

2.3.5 Summary

EPCs offer a safe, fast cooking method suitable for cooking for large groups. Low energy demands mean that they are suitable for micro-grids and also that the cost of cooking on an EPC is approximately 50% cheaper than on an IR or IC stove. However, they work best when cooking at full capacity and have a higher number of potential failure points than the other technologies discussed in this report. Until the maintenance infrastructure in Nepal improves, this will continue to be an issue. Whilst certain cooking methods are not possible with EPCs, most of staple Nepalese cuisine is compatible with the technology – judged to be an acceptable amount to allow for widespread adoption.

3. COOKER USAGE GUIDELINES

Induction cookstoves – Things to remember

- Automatic power turn off is achieved when cookware is removed
- Power should be continuously supplied for at least 2 more minutes after turning off the stove to release the residual heat out from the fan.
- Induction cookstoves will display an error if the cookware is not ferromagnetic or if the size of the pot is smaller than the size required for the product
- A child lock feature is also available in some models

IR cookstoves- Things to remember

- Double touch the blinking signal to turn the cooker power on.
- It is recommended to keep the device linked to power for 15 minutes to enable heat to dissipate off. This process does not draw much current as a 10-15 W fan is installed in it.
- Lower the power immediately from 2000 to 1000 as soon as the cooker is turned on as it draws heavy current in 2000 mode (>8 amps)
- While boiling milk or tea, it is recommended to cook with low heat to prevent spillage in the glass top that can result in damage.
- While cooking chapati, it is recommended to cook on low heat
- Do not spill water or any other liquids over the stove as it can result in damage to the top plate
- Clean the cooking surface at the end of use
- Do not clean the utensils with wire. Use a soft sponge for cleaning the utensils if non-stick.
- Do not keep the cooker ON if there is no need to cook

EPC- Things to remember

- Clean the inner lid after use
- Make sure that you never fill more than half of the pot with liquid.
- When using the quick release, push the valve upwards until the pressure goes out. Remember to push the valve to a closed position for next use.
- Make sure the lid is properly closed and listen for steam escaping
- Use the right amount of water as EPC requires less water than cooking in other stoves
- Frying takes a longer time and requires constant power. The food tastes good without the requirement of heavy pre–frying before pressurizing.
- Stirring is not possible during cooking time.
- Pressing the float valve to quickly release pressure to open the EPC can be dangerous.
- Each time you depressurise, you add at least 5 mins to the cooking time and increase the cost by up to 50%. You also loose around 100ml of water, so if you open up, remember to top up!

4. COOKER USAGE GUIDELINES

	Green shaded cells indicate notable advantages when compared with the other devices
	Orange shaded cells indicate drawbacks when compared with the other devices

Parameter	Induction cookstove	Infrared cookstove	EPC
Can be the primary cooking stove?	Yes	Yes - **but only if appropriate safety measures have been installed by the utility.**	Yes
Multiple cooking techniques	Steaming, stewing, stir-frying, sautéing, baking and other cooking practices can be performed while grilling and roasting are not practical.	Steaming, stewing, stir-frying, sautéing, baking and other cooking practices can be performed. Grilling stands are sometimes available while purchasing this stove. So, grilling is also possible in Infrared making it advantageous over Induction.	Baking, shallow fry, boiling, stewing, and steaming can be performed. Roasting, grilling & deep frying are not practical.
Cost of technology in Nepal	NPR 3,000 – 11,000	NPR 3,800 – 9,000	NPR 6,000 – 20,000
Requirement of special cookware	Only ferromagnetic cook pots can be used with a flat base	Cooking pots of any material can be used. A flat base is essential but not compulsory. The use of a curved base pot will result in the localization of heat in certain areas leading to the burning of food.	Only pots that have been provided by the manufacturer can be used. Normal household pots cannot be used. Multi pot can be handy if multiple dishes are to be prepared. Accessories like a steamer, baking tray are provided along with the packaging in some EPCs.
Additional cookware cost	Additional cookpots like a magnetic pressure cooker, kettle, frying pan & Tawa set must be purchased, costing around NPR 7000 in total	None	None

Minimum Total start-up investment	Min. NPR 6,700 (Induction hub NPR 3,000 plus Hawkins 3l induction base Pressure cooker set NPR 3700)	Min. 3500 NPR (if cooking pots are already present at home otherwise Hawkins 3 litre aluminum cooker costs NPR 2400, rendering total start-up cost to NPR 5900)	Min. 6000 NPR
Thermal Efficiency	Hot start efficiency of 75- 80%	Hot start efficiency of 70%.	Hot start efficiency of 82% to 90% is seen in the EPCs available in the Nepalese market. 90% efficiency is seen for Urban EPC. Maximum energy savings for heavy food due to pressurized cooking and good insulation.
User Modes	Modes of 100W, 400W, 700W, 1000W, 1200W are present to manually change the heat output during cooking. Cooking options similar to EPC: keep warm, milk, stir fry, vegetables, and Daal are present.	Modes of 200, 400, 800, 1000, 1300, 1600, 1800, and 2000 are present to manually change the heat output during cooking. Cooking modes of Fried, BBQ and Soup are present.	No option to manually change the heat output during cooking. Cooking modes of Rice, Daal/Soup, Meat, Beans, Steam, Fry, keep warm and DIY modes are present.
Supply Curve	Induction maintains temperature for a particular mode by a cut-off of demand. For cooking in lower modes, oscillating demand, usually within several seconds can be seen. Pressing 100 W mode in induction does not mean 100 W peak demand but rather 700 W peak demand oscillating for few seconds.	A precise temperature control function is available. Power cut-off to maintain a particular temperature is not seen and it continuously supplies power as the set mode.	Until pressurization is reached maximum power is required and then cycling on & off power takes place till the food is cooked.
Power requirement	700 W - 1200 W power and 3.5 A - 5.4A current is drawn at different modes. Power factor of almost 1 for all the different modes of the stoves.	240 W – 2 kW power is drawn at different modes of the stove. 2.7 A to 8.9A current is required in different power modes. The starting mode of 2000W requires almost 8.9A current. The power factor ranges from 0.3 at 200 modes to 1 at 2000 mode	For preheating of EPC more power is required and after pressurization lower power is required For Urban EPC 960W & 4.5Amps current at preheating mode is required. A high-power factor of almost 1 is present for different modes of the stoves

Max. Frying Temperature	A maximum frying temperature of 270 degrees Celsius can be reached for the Bajaj Induction stove after which oscillation in the demand keeps the temperature constant. E3 error is displayed in some models to prevent overheating.	Frying temperatures can reach higher than 600 degrees Celsius.	In most Nepalese models the maximum frying temperature that an EPC can reach is about 160-200 degrees. At this temperature, it takes a longer time to shallow fry, and it is difficult to burn spices like Fenugreek seeds. Pre-programmed settings in EPCs do not allow the user to control the heat output of EPC.
Response Time of the stoves	Quickest to respond to because no heating element is present.	The heating element first needs to cool down to decrease temperature. So, the response is slower than Induction.	Users cannot turn the temperature up/down for EPCs as such quick response features are absent in EPC. But the thin and well-insulated body of EPC makes it more responsive to user commands.
Residual Heat (Loss)	Residual heat generated is least	Residual heat generated is maximum. So, after the device turn off, extra cooking can be performed to utilize waste heat	Automatic Keep Warm features are present in EPC that uses the residual heat generated for keeping the food warm till it is served.
Effect of radiations in food	Inductions work below the electromagnetic spectrum of UV. Visible light, laser, infrared, microwaves, and radio waves are non-ionizing. So, there is no damage to food	Infrared rays are non-ionizing and so food is not radioactive to be harmful.	Heatwaves are non-ionizing and heat transfer is through conduction from the hotplate.
Heat Loss in the cooking pot	Cooking pots are sources of heat loss as household pressure cookers and pans are not insulated	Cooking pots are sources of heat loss as they are not insulated	The cooking pot is kept inside an insulated chamber so there is negligible heat loss while cooking
Design	Compact, but requires additional magnetic pots. Glass surface on top means it requires handling with care	Compact, portable but requires additional pots to cook. Glass ceramic and heating elements means it must be handled properly	Compact, portable, and robust design. It is possible to pack and carry during travel and does not need extra pots.
Safety features	Automatic shutdown when no cooking pot is placed. No scalding (heat burns) from touching the cooktop. In most brands, error codes from E0 – E8 can be found to detect different safety issues making it the safest cooktop.	It does not detect missing cookpot Heavy heat burns or scalding can result from touching the heated stovetop.	It does not detect missing cookpot. Four levels of safety features are present in 3rd generation EPCs such as float valve pin, silicone rings, thermal fuses & insulated lids with anti-food block shields. The added benefit of safety is seen as cooktop and cookpot are a single unit. Float valve pin locks the EPC lid. Antiblock shield prevents food from clogging in the weighted valve.

			Silicone ring helps release pressure if the weighted valve gets blocked The insulated case prevents scalding heat injuring when touched Thermal fuse, a one-time cut-off device to interrupt electric current when heated to a specific temperature is present.
Ease of use	Easy with different power modes to reduce/increase heat output	Easy with knob/button to reduce/increase heat output.	Requires more practice than other stoves. No buttons to increase/decrease heat output by the user is present. Users struggle with opening/closing the lid, choosing the right button to cook food, forgetting to close the steam vent, etc.
Requirement of supervision during cooking time	No auto-off feature when food is cooked so supervision is required	No auto-off feature when food is cooked so supervision is required	Requires no supervision. Device turns Automatic off when food is cooked. Also, the timer delay function makes delayed cooking start possible.
Health impact	People wearing cardiac pacemakers should not go near induction	None	None
Ease of cleaning	Easy	Easy	Easy
Cooking time (Processing time not considered)	total cooking time for a meal of rice, daal, and chicken gravy for 5 people – 73 minutes	total cooking time for a meal of rice, daal, and chicken gravy for 5 people- 74 minutes	Cooking time is longer in EPCs than when using a traditional pressure cooker on an Induction or Infrared although this gap becomes shorter when larger quantities of food are cooked. However, it is much faster than open vessel cooking. total cooking time for a meal of rice, daal, and chicken gravy for 5 people – 90 minutes
Typical energy use to cook dal, rice, and gravy meat for 5 people	1.18 unit	1.26 unit	Very important criteria and the main advantage of EPC 0.63 unit
Typical energy cost in Kathmandu assuming 10NRPS per unit.			Very important criteria and the main advantage of EPC

However, Tariffs vary per usage.			

* This information is based on a Bajaj Induction Stove (SPLENDID 740075), an Electron e-Touch Infrared Stove (Serial no: BET2020050604) and Urban EPC (Model No: HD60 – 100N).

** Time and Energy consumption figures on IC and IR figures were calculated using a traditional stovetop pressure cooker

PEEDA along with their partners KAPEG, University of Bristol and MECS are currently working on the research of electric cooking in Nepal.
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