Towards Clean and Sustainable Cooking:

The Outlook for Electric Cooking in Morocco

Workshop summary report
Revision 1 – March 2020

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Executive summary

The workshop “Towards Clean and Sustainable Cooking: The Outlook for Electric Cooking in Morocco”, organised by the International Energy Agency, in conjunction with the Moroccan Ministry of Energy, Mines and the Environment (MEME) and the Moroccan Agency for Energy Efficiency, set out to investigate the feasibility of electric cooking in a country where there is a need for a reduction in dependence on both biomass fuels and on imported and subsidised butane for domestic cooking. The Moroccan government recognises the importance of a transition to cleaner and more sustainable cooking methods due to the environmental and health costs associated with biomass fuels and the significant economic burden linked with butane subsidies.

The workshop, held over two days in Rabat, gathered relevant government stakeholders and international experts in order to explore the different facets of electric cooking and the opportunities it could bring, specifically to the Moroccan context. A total of 44 participants learned about how electric cooking – either connected to the grid or to a PV system, using a hob or an electric pressure cooker – could be a viable options in certain contexts. Studies by the Modern Energy Cooking Services programme (MECS) showed that both PV-cooking and grid-connected electric cooking could be cost-effective when compared to traditional alternatives in certain situations in East Africa due to falling PV and battery costs and rising costs of solid fuels. The participants also discussed the challenges to transitioning to electric cooking, which include the capacity and reliability of the electricity grid, the impact of increased electricity bills, and the adaptability of electric devices to Moroccan cuisine. Urban and sub-urban areas have stable power and 100% electrification rate whereas the grid is unstable or non-existent in many remote rural areas. The workshop went on to present and analyse the specificities of the Moroccan household, the differences between rural and urban contexts, issues relating to gender, and how these issues may impact upon the practical transition to electric cooking. It then outlined how public policy could have a vital role to play in paving the way for the transition to cleaner energy, more efficient use of energy and greater access to energy services.

The workshop succeeded in securing a consensus amongst those gathered on the best way forward to ensure that Morocco can make its intention to move to cleaner and more sustainable forms of cooking a reality. This will involve a two-step process: the first consisting of carrying out an in-depth study to accurately assess which types of electric appliances are best suited to the country’s cooking needs and customs, and analysing how such devices would impact on the country's existing power system; and the second, conducting a pilot programme in which a selection of households would be equipped with the appliances which would be monitored to determine their efficacy and practicability. This analysis would enable identification of policies to promote the growth and regulation of the electric cooking appliance market.

The conclusions led to the proposal for a second workshop, in collaboration with AMEE and MECS, to undertake practical testing of electrical cooking appliances and high efficiency butane ovens in cooking traditional Moroccan dishes, measuring the energy consumption and other impacts, and share the preliminary results with relevant government and non-government stakeholders. These tests would inform the design of wider trials using the most relevant devices in households in different regions of the country.

Background

The main drivers behind the Moroccan government's current interest in clean and sustainable cooking in Morocco are twofold: i) eradicating the unsustainable use of traditional biomass for cooking and ii) reducing the dependence on imported and subsidised butane that come at a high cost to the public budget.

The great majority of Moroccan households have access to electricity and to clean forms of cooking. However, according to the official statistics, 1.5% of the population continues to cook with traditional firewood (IEA, 2019a). Most of these people are in rural, low-income households. While this share is low compared to the majority of other African countries (IEA, 2019b), it still represents hundreds of thousands of households and is therefore one of the priorities of the Ministry of the Interior (source: scoping mission[1]).

Cooking with wood stoves has negative effects in terms of deforestation and environmental degradation, on health due to poor indoor air quality, and in terms of time and energy lost due to collecting fuel. These consequences are often more significant for women and girls who are more likely to spend time on domestic work, like meal preparation and firewood collection. The major reasons for the persistence of reliance on wood stoves include lack of access to the butane canister distribution network and lack of financial resources to purchase the butane canisters (source: scoping mission).

Butane cooking has been adopted by the vast majority of the population thanks to government subsidies. Standing at MAD 9.9 billion in 2017 (nearly EUR 1 billion), the subsidy bill represents a significant cost to the government and is the only fossil fuel subsidy remaining in the country (IEA, 2019a). While the government intends to reform the subsidy to limit it to low-income households (as approximately 50% agricultural pumps run on butane, therefore contributing to a significant share of the total demand[2]), it is conscious of the social and political dimensions, as well as the potential environmental consequences if households were to revert to traditional biomass, thereby worsening deforestation.

For these reasons, the government sees the transition to sustainable, clean, more accessible and more affordable cooking methods as a priority. Furthermore,

[1] Prior to the workshop, a scoping mission took place. On that occasion, IEA staff met with relevant stakeholders, including representatives from the Ministry of Interior.
[2] According to a Summary report on the current status of the market for solar pumps for agricultural irrigation (AMEE, 2019).

declining costs of solar energy systems, including both PV panels and batteries, provide new opportunities for a possible transition towards electric cooking.

A range of system configurations, such as cook stoves of various types connected to the grid, powered by stand-alone PV systems with batteries, or powered by solar rooftops with a grid connection (with or without batteries) could enable the development of electric cooking in rural and urban areas. Installing such systems for cooking could also further increase access to electricity in remote areas. This would simultaneously reduce the dependence on butane gas, reduce the public budget spend on subsidies, increase well-being and quality of life for households, and avoid households reverting to traditional biomass if the butane subsidy were removed.

The workshop

In order to investigate the opportunities that electric cooking could offer Morocco in increasing access to clean cooking and reducing the butane subsidy bill, the International Energy Agency (IEA), in co-operation with the Ministry of Energy, Mines and the Environment (MEME) and the Moroccan Agency for Energy Efficiency (AMEE), organised a workshop entitled "Towards clean and sustainable cooking: the outlook for electric cooking in Morocco" in Rabat, 4 - 5 September 2019. It gathered a range of government stakeholders and international experts in order to examine the implications and benefits of electric cooking in Morocco, and establish the next steps in identifying the role of electrical cooking appliances in Moroccan kitchens. A total of 44 participants from 12 government and non-government organisations attended the event. The agenda and a full participant list can be found in Annexes A and B. Moroccan governmental and non-governmental organisations in attendance were:

Table 1 Table of participants - Morocco

Acronym	Name	Acronym	Name
ENABEL	Belgium Development Agency	**MASEN**	Moroccan Agency for Sustainable Energy
GERES	International development NGO founded in France	**MEME**	Ministry of Energy, Mines and the Environment
HCEFLCD	High Commissariat of Waters and Forests and the Fight Against Deforestation	**DQAT**	Ministry of Housing and Urban Policy
IRESEN	Research Institute for Solar Energy and New Energies	**ONEE**	National Office for Water and Electricity (electricity distributor)

Acronym	Name	Acronym	Name
MAPMEF	Ministry of Agriculture and Fisheries	**SEDD**	Secretary of state for Sustainable Development (within MEME)
MASCIR	Moroccan Foundation for Advanced Science, Innovation and Research	**AMEE**	Moroccan Agency for Energy Efficiency

The following international organisations were also present:

Table 2 Table of participants - International

Acronym	Name
IEA	International Energy Agency
IISD	International Institute for Sustainable Development
MECS	Modern Energy Cooking Services Programme
TERI	The Energy and Resources Institute, India
World Bank	The World Bank

Overview of the sessions

Session 1: Opening and context setting

The workshop was opened on 4th September by Mr. Mohammed Ouhmed (Head of the Directorate of Renewable Energy and Energy Efficiency, MEME), Mr. Said Mouline (Director General of AMEE) and Ms. Rebecca Gaghen (Head of Division for Europe, Middle-East, Africa and Latin America, IEA).

Speakers from AMEE, the Commissariat for Forests and Waters, and the MEME set the scene for the discussion by providing an analysis of the current Moroccan context and challenges for the country, particularly in terms of energy consumption and security; deforestation rates and incidence of households relying on collecting firewood; and trends in photovoltaic growth and the fall in system costs.

Key messages:

- Morocco faces three parallel challenges:
  - reducing the rate of national deforestation, which is currently at twice the rate deemed sustainable (source: High Commissariat of Waters and Forests and the Fight Against Deforestation, scoping mission, February 2019);
  - improving the quality of life of rural households (representing approximately 500 000 people) that rely on firewood and other unclean forms of cooking; and
  - lowering the government butane subsidy bill which currently amounts to almost EUR 1 billion per year.
- PV system production is on the rise in Morocco and makes a compelling case for the exploration of electric cooking technologies in the country.
- Morocco is committed to making progress on energy efficiency, recognising its key role in the transition to a clean energy system.

Session 2: An international perspective on clean cooking

Ms. Gaghen (IEA) moderated a panel on the international perspective on clean cooking. Prior to the panel discussion, the IEA presented a brief introduction to the rates of access to clean forms of cooking worldwide, based on the SDG7 tracking report, where Morocco's access rates were compared to other African and developing countries. Mr. Mostafa Mostafa from IISD, the International Institute for Sustainable Development, then presented on fossil fuel subsidy reform experiences, including swaps for energy efficiency and renewable energy.

Mr Besnik Hyseni from the World Bank's ESMAP and Professor Mathew Leach then gave an overview of MECS, the Modern Energy Cooking Services research programme[3], and introduced the benefits of electric cooking and the technology options.

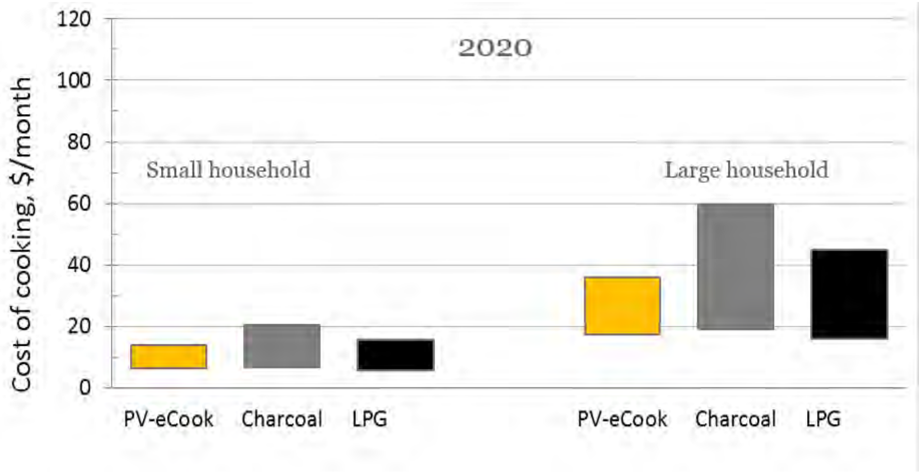
Key messages:

- While Morocco has rates of access to electricity and clean cooking far greater than the world average (above 95% for both), 35% of the world's population still did not have access to clean cooking solutions in 2018 (IEA, 2019b).
- Morocco's success in attaining high levels of clean cooking is largely thanks to the butane subsidy, which is not only very costly but also increases dependence on imports. Therefore, Morocco's challenge will be to ease the transition from subsidised cooking fuels while ensuring vulnerable consumers maintain access to affordable cooking rather than returning to the use of traditional biomass.
- Fossil fuel subsidies are counterproductive to the clean energy transition. Globally, fossil fuel subsidies are roughly four times higher than those available for renewable energy and account for public spending of around USD 260 billion. Between 2015 and 2018, 50 countries undertook some level of fossil fuel subsidy reform, including Morocco (IISD, 2019). However, reforms need to be undertaken with care to avoid negative repercussions. In the case of butane in Morocco, it must be ensured that the country's poorest are able to afford the proposed shift in technologies and that subsidies are better targeted. Subsidising a certain amount of kWh electricity consumption for vulnerable households, for instance, could encourage a switch to electricity.
- Access to clean cooking has many benefits: the World Bank has developed a "multi-tier framework" as a form of measuring key attributes of clean energy access: exposure to pollutants, cookstove efficiency, convenience, safety, availability and affordability. Electric cooking has the potential of meeting many of these attributes (The World Bank, 2019).
- Falling costs of both PV and batteries and rising costs of solid fuels mean that cooking with electric appliances is, for the first time, becoming economically feasible in certain developing contexts (MECS, 2019a). For example, modelling by the University of Surrey, UK, for off-grid cases in East Africa

[3] MECS is a multi-year partnership and research programme that started in 2019 and is led by Ed Brown at Loughborough University, UK, with research coordinator Simon Batchelor from Gamos, and is funded by UK Aid. MECS is not limited to electric cooking but also includes work on biogas, ethanol and LPG.

suggests that the costs of cooking using a PV system and battery system[4] could be lower than those of charcoal of LPG (see figure below).

Figure 1 Proof of concept results: monthly cooking costs, MECS, 2015



Source: MECS (2019a), Introduction to eCooking and MECS, by Professor Matthew Leach, University of Surrey

- Significant challenges to electric cooking remain in terms of technical implementation, behavioural change and affordability.

Session 3: Electric cooking technologies

Mr. Besnik Hyseni and Professor Matthew Leach presented the principal electrical appliances, including induction plates and electric pressure cookers, as well as possible options for their supply. The systems discussed included those connected to the grid with a trickle-charge battery (referred to as battery supported "eCook") and those using a standalone PV and battery system (PV-eCook) and were based on pilot studies carried out in Kenya. Costs of these configurations were modelled and compared with alternative fuels. Mr. Hyseni also gave a brief presentation on possible business models and cost trends for such systems.

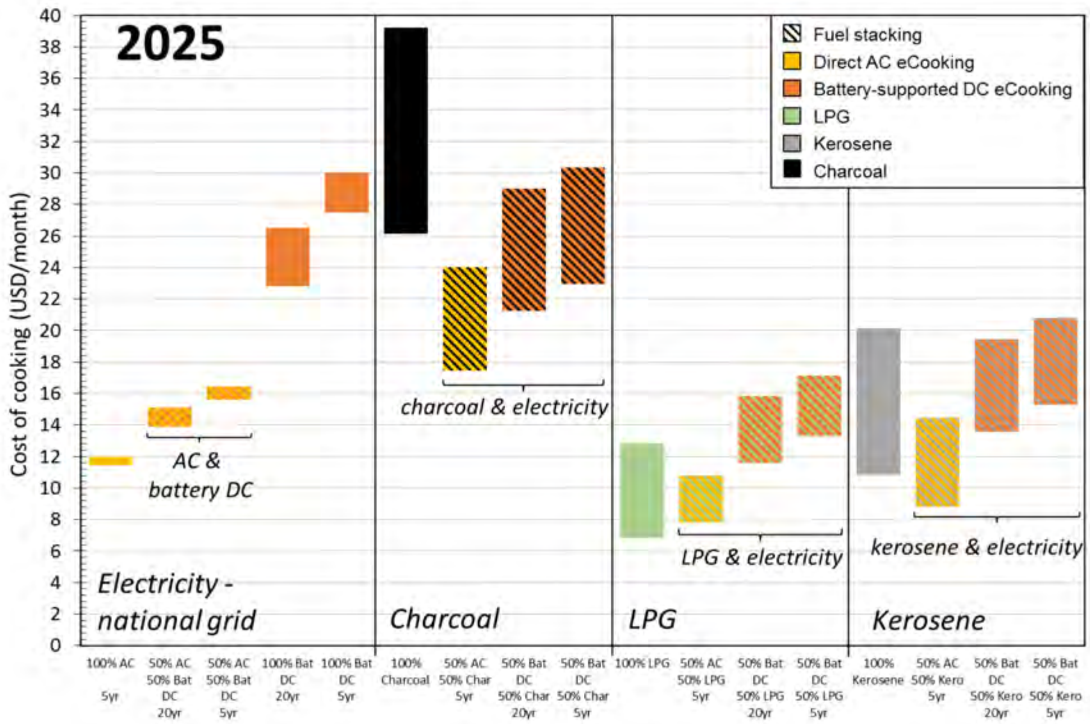
Key messages:

- Electric Pressure Cookers that are well insulated can be more efficient than induction hobs and possess other significant benefits: cleanliness, ease of use, versatility and speed. Their popularity is rising globally. However, induction hobs have a greater variety of uses as they can be used with various kinds of pots, pans and (non-insulated) pressure cookers.

[4]The monthly cost of the cooking system is calculated as the discounted costs of the PV panels, a charge controller, battery pack, inverter and electric cooking appliance, including necessary replacements, divided by the lifetime in months of the system.

- Electric ovens and microwaves offer additional possibilities, in particular for cooking bread and cakes.
- In urban contexts with high prices for solid fuels, both cooking directly with alternating current (AC) when the supply is reliable enough, and battery-supported cooking can offer considerable cost savings, as shown in the results from modelling of cooking costs in Nairobi, Kenya, shown in Figure 2, below. Fuel stacking, with a grid-connected system incorporating a battery trickle-charged from an unreliable grid has a lower cost than charcoal or kerosene. Electric cooking with no battery is comparable to the costs of LPG. If, as expected, the price of solid fuels continues to rise, electric systems will become more and more competitively priced.

Figure 2 Results from MECS case study: reducing use of charcoal in East African kitchens (MECS, 2019b)

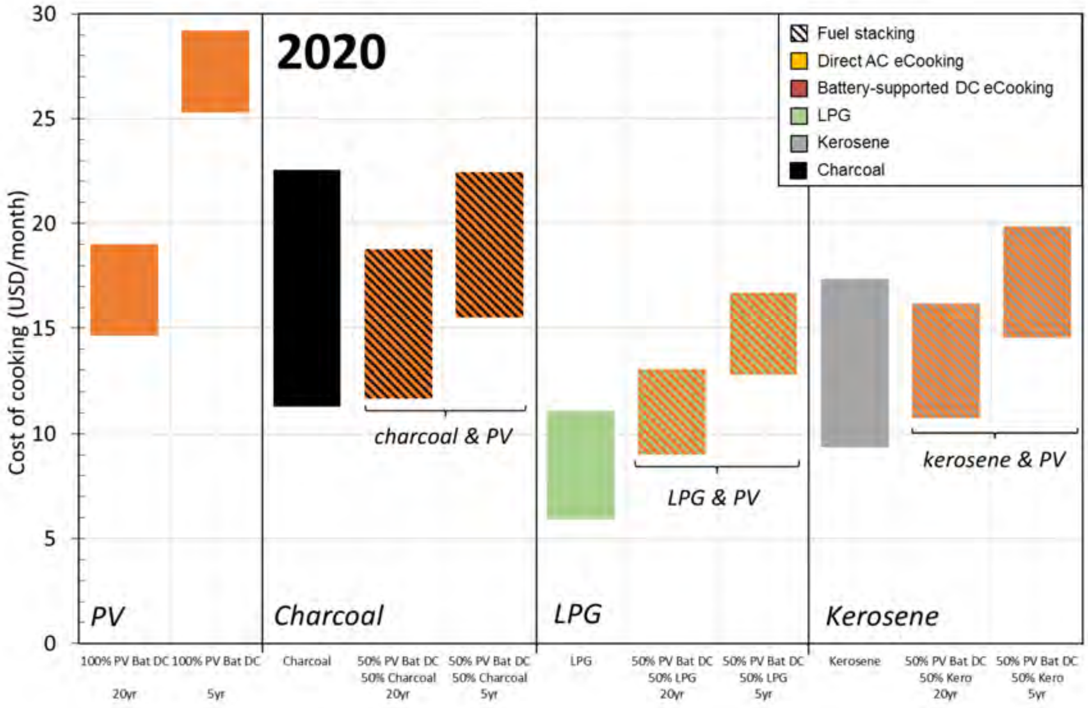


Source: MECS (2019b), *Electric Cooking Technologies: Case Studies*, by Professor Matthew Leach, University of Surrey, UK

- Continued falls in the price of PV and batteries means that individual solar electrical cooking appliances with integrated trickle charge batteries is nearly cost-effective in some markets, with appropriate business models. Solar eCooking also brings significant co-benefits of increased access to electricity for the household, whether in dedicated systems for cooking or as part of a wider solar home system.

- The figure below shows the results of modelled monthly cooking costs of PV systems with batteries as compared to costs of cooking with charcoal, LPG and kerosene in rural Kenya. The modelling is based on households preparing 50% of their meals with an electrical appliance supplemented with charcoal, LPG or kerosene.

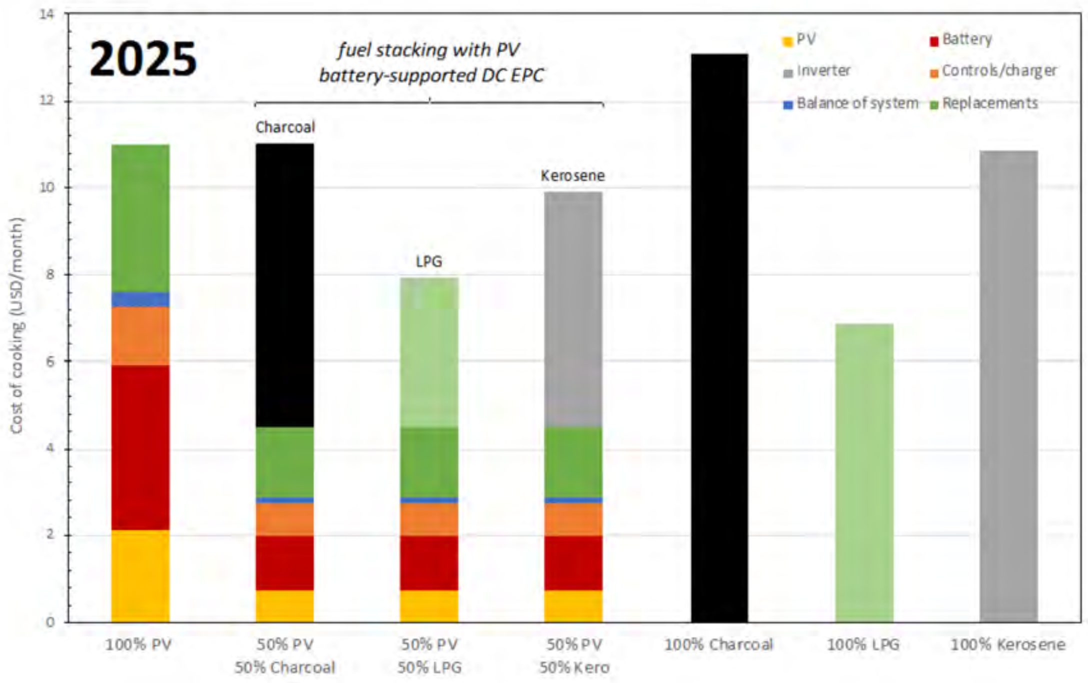
Figure 3 Results from MECS case study: PV-eCook in rural Kenya



Source: MECS (2019b), *Electric Cooking Technologies: Case Studies*, by Professor Matthew Leach, University of Surrey, UK

- The figure below shows a decomposition of PV-eCooking and fuel costs for systems sized to meet the needs of an average Kenyan household.

Figure 4 Results from MECS case study: next generation PV-eCook in rural Kenya



Source: MECS (2019b), *Electric Cooking Technologies: Case Studies*, by Professor Matthew Leach, University of Surrey, UK

- The figure shows that PV-eCook is cost-competitive with charcoal and kerosene, and approximately 50% more expensive than cooking with LPG.

Conclusions from MECS modelling:

- High and rising costs of traditional fuels paired with falling battery and PV costs are opening up potentially large markets
- Efficient cooking (e.g. using Electric Pressure Cookers) and the use of several cooking fuels in parallel (known as fuel stacking) can lead to smaller eCook systems
- Support is needed for utilities, mini-grid developers, service providers and policymakers to:
    - implement off-peak tariffs aimed at encouraging users to cook with electricity without significantly increasing peak demand; and
    - finance efficient cooking appliances for example through developing on-bill financing mechanisms.
    - As evidence for potential savings from electric cooking increases, commercial interest is rising.

Session 4: The “Moroccan House”

This session included presentations from Moroccan stakeholders, namely, Ms. Virginie Klein from the NGO, Geres[5], who presented on the common cooking practices and appliances in use today, with a specific focus on gender issues. These need to be taken into account when assessing cooking technologies and practices, as cooking is an activity more often than not carried out by women. Ms. Soraya Khalil from the Ministry Housing and Urban Policy and Mr. Abdelhaq Amahrouch from AMEE then presented an overview of rural and urban household expenditure and energy consumption.

Key messages:

- Families relying on firewood typically require four tonnes of firewood per year, of which two tonnes is used for cooking bread and meals. This firewood is often gathered by women and children. Time spared from collecting firewood and cooking with it would enable women and children to pursue income-generating or educational opportunities.
- The rise of gas cooking, due to its convenience and cleanliness, has led to unregulated low quality and inefficient cookstoves and ovens flooding the market. The energy efficiency and quality label FaranEco aims to measure and improve the efficiency of ovens and their installation.
- There is significant potential for increased efficiency of gas ovens in small informal bread bakeries and community ovens, a market which has grown significantly in recent years.
- The inclusion of women in decision making, communication campaigns, assessment of alternative appliances, as well as throughout the value chain of cooking devices, will contribute to increasing women’s wellbeing and economic outlook. Increasing their economic activity through, for example, the production and selling of bread offers significant potential.
- Quality assurance and testing protocols for appliances should be ensured in any promotion of electric cooking, to enable the development of a market for high quality appliances.
- There is a range of alternative cooking technologies fuelled for example by solar thermal energy, biogas, biomass pellets and “green” charcoal[6].
- While most households have access to butane gas, their consumption depends on their individual income: many will still complement gas with freely

[5] Geres is a development NGO that operates in Europe, Africa and Asia to improve living conditions and fight against climate change and its impacts.
[6] Carbonised agriculture waste material.

collected firewood. The estimated value of the freely collected firewood is approximately equivalent to total household expenditure on fuel.

- Energy efficiency measures being carried out by the AMEE include the promotion of the use of biogas and other organic waste, efficiency interventions in hammams (steam baths) and kitchens, thermal improvements in rural housing and improved cookstoves.

Session 5: Group discussion: stakeholder types and needs

A practical session was organised to provide the opportunity for discussion in groups on the applicability of the various technologies.

Through this guided activity, the groups identified and analysed the characteristics (or profiles) and needs of two distinct stakeholder groups: rural and urban households. This distinction reflected the fact that these two groups have different purchasing power, priorities, and in some cases, cooking styles.

Notes from the discussions are outlined below:

Rural households:

- Those with access to electricity are split between those relying on woodstoves or gas, or a mixture of both, depending on their capacity to purchase butane, which can vary on a monthly basis. Costs of butane in remote rural areas are higher than in urban areas due to a distribution surcharge.
- Those without access to electricity often rely on biomass, which they collect for free.
- The economic purchasing power of rural households is very low and they would not be able to transition to cleaner energy technologies without financial support.
- The types of foods cooked in rural households can vary across the regions. However, they are generally cooked slowly at low temperatures. This type of cooking is well suited to electric pressure cookers.

Urban households:

- Urban households are characterised as often having higher purchasing power, currently using gas devices but could be attracted to the benefits of electric cooking, i.e. time savings, enhanced security, cleanliness and convenience.

- High income urban households with the disposable income to overcome the initial capital cost and/or increased electricity bills could be potential stakeholders for a first trial of electric cooking.
- Cooks and chefs would need to be convinced to increase buy-in and develop modified recipes. Celebrity chefs and influencers could also have a significant role in promoting electric cooking appliances among this group of stakeholders.
- The national electricity supplier has an interest in developing electric cooking as they stand to benefit from increased electricity consumption. They could be involved in the development of financing schemes such as on-bill financing and equipment swaps.
- The electricity tariff system may need restructuring to enable adequate demand management.
- Barriers include inadequate electricity infrastructure, safety standards, potential significant changes in habits, and of course the capital cost of the devices.

Other reflections and issues:

- Bread baking is an activity that should be addressed, both in urban and rural contexts. It was questioned whether any of the electric solutions presented could adequately meet this need, common to all households.
- The purchasing decisions of households often lie with the male head of the household, who does not often suffer the full burden of the health and social implications of collecting firewood. Any pilots would need to explore ways of convincing this key stakeholder group of the benefits of the transition for it to be successful.
- Electric pressure cookers and induction plates both appear to be suitable devices for at least a portion of Moroccan cooking needs. Well-designed and well-monitored pilot projects will be key to identifying the real potential in Morocco.

Session 6: International case studies

In order to enrich the discussion, international experts presented case studies on experiences with electric cooking in other regions.

Case study 1: Electric pressure cookers in Sub-Saharan Africa

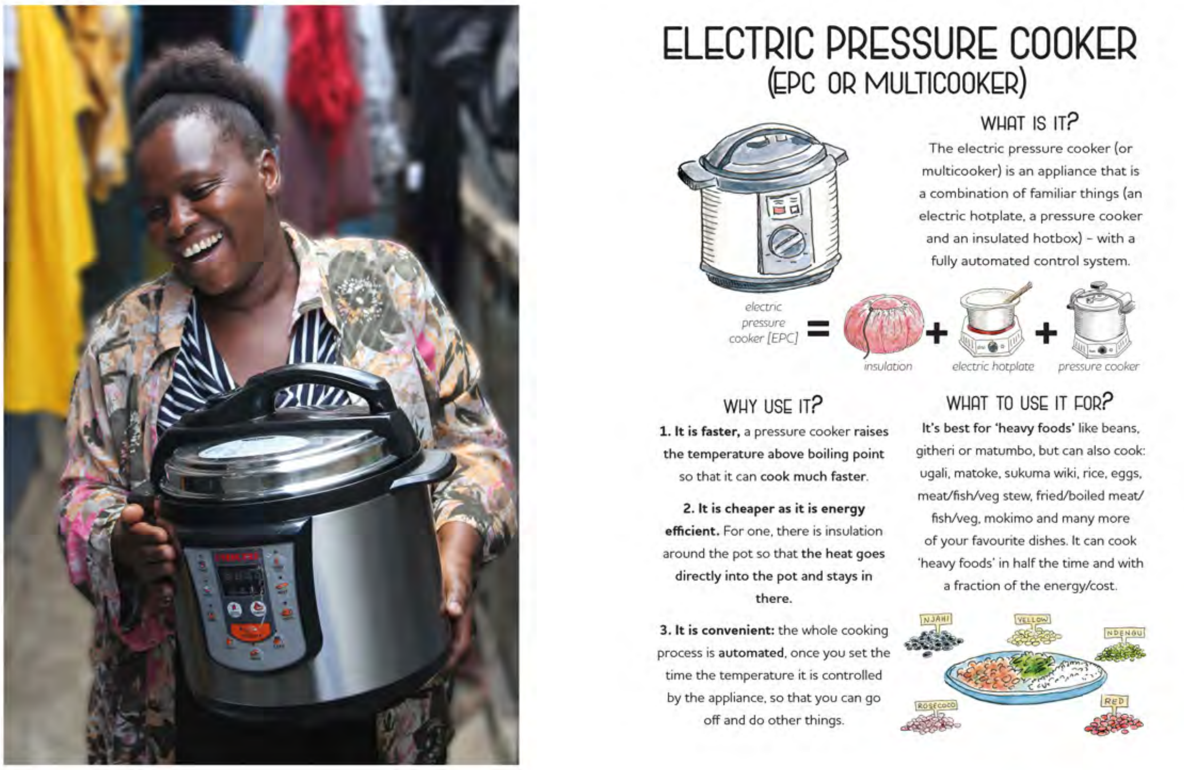
Mr. Jacob Fodio Todd from the University of Sussex, United Kingdom, and part of the MECS team, presented the user experience of electric pressure cookers

(EPCs) in Sub-Saharan Africa. He also presented the eCook book that was developed in close consultation with local population and cooks within the context of the project. The eCook book provides recipes that can be prepared in an EPC and their relative cost and cost-saving potential compared with traditional cooking methods.

Key messages

- EPCs consist of an electric hotplate, a pressure cooker, insulation and an automatic control system. They offer significant benefits including: time saving, safety and convenience (they can be safely programmed and automated), and versatility, as they can be used as a traditional hotplate as well as a pressure cooker. When compared to a stove burning solid fuels or firewood, the lack of indoor emissions and fumes is a significant added health benefit as indoor air quality is improved.
- Extensive cooking diaries undertaken with dozens of households looking at cooking habits suggested that while cooking methods are culturally entrenched, they are not static. After two weeks of recording usual cooking methods to provide a baseline, families were given an EPC and their adaptation was recorded in cooking diaries. High satisfaction with EPCs was recorded mainly for their time-saving, safety, convenience, and the fact that local meals prepared in them did not taste substantially different.
- Foods requiring a long cooking time adapt best to EPCs such as bean or meat stews because of the significant energy and time saving they can offer. Quick frying and boiling staple foods like rice, potatoes and pasta can also be done in an EPC, albeit with lower energy savings.
- An eCookbook was developed outlining modified recipes for bean and cereal dishes, along with the potential savings achievable with an EPC.

Figure 5 An extract from the eCookbook: beans and cereals edition (MECS, 2019c)



Source: MECS (2019c) *Electric Pressure Cookers (EPCs)*, by Jacob Fodio Todd, University of Sussex, UK.

Case study 2: Induction stoves in rural India

Ms. Manjushree Banerjee from The Energy and Resource Institute, India, presented a case study of an induction stove programme deployed in rural India. The objective of the project was to understand what alternatives were available to rural households in India relying on traditional cookstoves (using firewood, dungcake and agricultural residue) in order to offer cleaner solutions. A total of 4 000 electric induction hotplates were distributed to households in the Himachal Pradesh State through Energy Enterprises.

Key messages:

- A combination of fuels is often used for cooking in households. This is known as "fuel stacking".
- Induction stoves displaced traditional mud stoves, in about 5% of cases. A major shift was observed in the choice of the secondary cooking technology, where 84% of households replaced LPG with induction stoves.
- Induction stoves were not as highly adopted as anticipated because of fears of increased electricity bills, inadequate and unstable supply voltage and unsuitability for cooking foods needing a flame.

- The use of induction stoves shifted the peak household expenditure on electricity from a range of between USD 3.2 and USD 6.3 to between USD 6.3 and USD 7.9. Furthermore, the increased electricity consumption from induction stoves would require significant additions to electricity generation capacity and infrastructure.
- Field research is essential before deploying any large scale programme for electrical cooking appliances in Morocco, as infrastructure, electricity generation mix, and household affordability could all pose significant challenges.

Session 7: Policy Toolkit

Mr. Philibert and Ms. Jordan (IEA) then gave an overview of relevant policy tools for increasing the share of renewables and energy efficiency, and how they may be used to facilitate the introduction of electric cooking.

Key messages:

- Public policy has a vital role to play in:
    - ensuring a just reform of the costly butane subsidies;
    - increasing energy efficiency in buildings and appliances to reduce the impact of a potential increase in the price of butane and, in parallel, reducing the impact of increased electricity demand, and ;
    - increasing the share of renewables in the electricity grid and ensuring energy security.
- Key renewables policies:
    - Distributed PV can be promoted through procurement models. Several models exist including: buy all sell all, net energy metering and self-consumption with feed-in tariffs, and incentives.
    - Targets are important to give visibility and long term certainty to investors.
    - The integration of renewables, infrastructure costs, and perceived loss of revenue could be managed through measures including the restructuring of tariffs.
    - Batteries, distributed PV and demand side management will be key in making electric cooking feasible.
- Key energy efficiency policies:
    - Improving the efficiency of gas ovens through standards, labelling, audit and retrofit programmes, and capacity building could limit any impact of the increased price of gas.

- Ensuring efficiency and quality of new devices on the market such as EPCs through performance standards, testing protocols, labelling, and communication and information campaigns.
- Improving the efficiency of other electrical appliances through progressive MEPS and labelling, and reducing the energy demand for thermal comfort in buildings through buildings' policies such as building codes could limit the impact on the grid of increased electricity demand for cooking, while ensuring affordability and increased comfort for consumers.

Session 8: Cooking demonstration: chickpeas and couscous cooked in an EPC

Mr. Jacob Fodio Todd of MECS performed a practical demonstration of cooking in an EPC. He demonstrated the performance of the device in cooking a chickpea stew with onions, tomatoes and spices. During each of the different stages (frying and then pressure-cooking), participants were able to monitor the power draw, energy consumption and cost accumulated for the cooking of the dish. The chickpea stew was served with pre-cooked couscous, for which the energy consumption and cost had also been recorded.

Figure 6 EPC cooking demonstration by Mr. Jacob Fodio Todd, MECS, University of Sussex, UK

The total cost of cooking the dish was of Dirham 1 (1kWh electricity) for 1kg chickpeas, suggesting it could be competitive with other forms of cooking the same dish (further tests with alternative fuels would be required).

Chickpeas are a common ingredient in Morocco and this demonstration was therefore effective in proving that EPCs are suited to a portion of foods regularly cooked in Moroccan households.

Session 9: Discussion

For the remainder of the workshop, participants discussed what next steps would be needed in order to continue exploring the apparent suitability of electric appliances for some Moroccan households' cooking needs and what the conclusions of the two days of workshop were.

Outcomes

It was agreed that electric cooking devices appeared to potentially meet a portion of cooking needs in Morocco.

However, there was a consensus that, before recommending the deployment of electric appliances, and before analysing the impact of their mass deployment on the grid, a two phase in-depth study would be required:

- first, to identify which type of appliance or combination of electric appliances would best meet the needs of Moroccan cooks e.g. EPCs, induction cooktops, microwaves, ovens;
- secondly, assess how these devices could work in the context of the country's power system: off grid, on grid, with and without a battery, with and without a PV panel. Analysis is required regarding the impacts on household electricity consumption and bills, capacity of the in-house electrical system, impacts on the country's electricity supply system including those of increasing peak power demand, etc.

Only after this preliminary study is carried out could things move into a pilot phase, with a number of households equipped and monitored with different devices. Then the best combination of policies for deployment could be analysed, including assessment of the most effective financing mechanisms.

Recommendations and next steps

Electric cooking

The workshop reiterated the twin rationales for the development of electric cooking in Morocco: to replace biomass use in rural parts of the country and to enable the progressive elimination of butane subsidies. It is expected that this elimination of subsidies would also be key to unlocking the energy efficiency improvements currently dis-incentivised by the relatively low retail cost of butane in most of the country.

The next step would be to identify the best technology options that can be easily adjusted to the culinary habits of the Moroccan people. Induction cooktops, electric pressure cookers, microwave ovens and resistive electric ovens are the prime candidates, all corresponding to different needs and traditional recipes. Electric pressure cookers, which are available with good insulation and integrated time-programming devices, have proven extremely efficient in East Africa, for instance, where the staple food combines cereals and vegetables requiring long cooking times. It remains to be seen how EPCs would fare in Morocco, in particular compared with induction cooktops that could be coupled with a variety of pans, including pressurised ones.

This first step could be undertaken by AMEE with support from MECS, and would require instrumenting and testing a few dozen households, possibly in various provinces, to ensure wide representation of different culinary habits.

A second step would require assessing the consequence of the introduction of the selected appliance(s) on the electricity systems at all levels: in-house, local, on the distribution network, and the entire power system. Measuring both instantaneous demand (in kW) at all hours of the day, days of the week, etc, will be as important as measuring the overall additional electricity consumption (in kWh) and cost.

Then it will be useful to see how this additional demand can best be supplied, possibly with a mix of efficiency improvements in other devices, as well as additional generating capacity. Distributed PV capacity will be of primary interest, both on and off grid, with, from the outset, some capacity to exchange energy among neighbours, as is now the trend in countries willing to maximise self-consumption. The possible role of decentralised battery storage, both on and off grid, whether behind the meter or at a slightly higher level in the network, should also be considered closely during this phase.

This second phase may require the participation of a higher number of households in a larger pilot project, to represent a wider variety of situations and social and economic circumstances, in various parts of the country.

Based on the results of these two phases, it should be possible to design dissemination policies, either immediately at a very-large scale or with large-scale pilots in a variety of urban and rural areas.

Based on the workshop findings and the discussion, a series of more general recommendations regarding energy efficiency and the deployment of renewable energy can be formulated in order to support a transition towards clean electric cooking in Morocco.

Energy efficiency

The following policies would contribute to accelerating the efficiency of energy consumption in Morocco:

- Improve the efficiency of gas ovens to consume less gas, and therefore limit the impact of any increase in the price of gas:
    - Introduce Minimum Energy Performance Standards (MEPS) for gas ovens.
    - Strengthen performance labelling for gas ovens.
    - Deploy capacity building programmes and certification of trained professionals to undertake energy efficiency improvements.
    - Scale-up audit and retrofit programmes to improve efficiency of installed gas ovens.
    - Undertake data collection and monitoring of energy consumption of gas ovens.
- Ensure efficiency and quality of new appliances on the market:
    - Develop performance standards, testing protocols, labelling.
    - Promote the use of efficient electrical appliances through communication and information campaigns.
- Improve the efficiency of other electrical appliances in order to limit the impact on the grid of any increase in electricity consumption:
    - Enhance and strengthen progressive MEPS and labelling for electrical equipment and appliances.
    - Reduce the energy demand in buildings through policies such as building codes, labelling, disclosure and retrofits.
    - Redirect part of the butane subsidy to fund incentives for the purchase of efficient cooking appliances for the most vulnerable households.

Renewable energy

The following measures could be envisaged, in particular regarding the use of solar PV:

- Resolve the regulatory issues that currently still prevent the connection of distributed PV to the grid and accelerate the policy process to pass the decree on self-consumption. This would be most effective through inclusive processes involving all main stakeholders. Notably, distribution companies could be proactively involved, e.g. by entitling them the possibility to produce in a semi-decentralised manner.
- Promote medium-scale smart grids.
- Carry out a detailed analysis of the timing of cooking habits versus solar electricity supply and assess the possible hourly match between cooking electricity demand and solar electricity supply.

For grid-connected systems:

- In an early stage, a daily net-metering scheme could be envisaged, i.e. the surplus solar energy during the day could be given an economic credit to be used to pay the electricity demand for cooking at night. A pilot programme could be incentivised in this way.
- However, with increasing deployment of solar-based electric cooking over time, this may generate economic inefficiencies and unintended negative impacts on the system in terms of too much excess solar during the day and lack of supply at night. Therefore, when going for large-scale deployment, other more efficient policy and remuneration schemes should be introduced instead. For instance, introducing time-of-use electricity tariffs for domestic users, possibly not "(high) day and (low) night" but rather a peak tariff after sunset as already in place for industrial customers, so as to foster energy efficiency and solar energy simultaneously.

For both grid-connected and off-grid systems:

- Assess the potential for batteries to cover the gap between electricity demand for cooking and solar electricity supply.
- Carry out a survey comparing estimated costs of solar PV + battery systems in Morocco with international benchmarks.
- If economically viable, launch a pilot programme for the deployment of solar PV+battery electric cooking in both peri-urban areas and rural settings.

- In the longer term, carry out an assessment of potential impacts of a PV+battery e-cook programme on the Moroccan power system.

Additional resources

The following websites provide additional resources and further reading, most relevant to electric cooking, energy efficiency and renewable energy in Morocco:

- IEA website: www.iea.org
- MECS website: www.mecs.org.uk
- TERI website: www.teriin.org
- Geres website: https://www.geres.eu/nos-actions/nos-pays-dintervention/maroc/
- IISD website: www.iisd.org
- The World Bank website: www.worldbank.org

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The World Bank (2019), Transitions to Clean Cooking, by Besnik Hyseni. *Presentations from Workshop: Towards Clean and Sustainable Cooking: The Outlook for Electric Cooking in Morocco.* Retrieved from https://www.iea.org/events/towards-clean-and-sustainable-cooking-the-outlook-for-electric-cooking-in-morocco.

General annex – agendas, list of participants and presentations

Annex A – Agenda

ROYAUME DU MAROC

Ministère de l'Energie, des Mines et du Développement Durable

Towards clean and sustainable cooking

The outlook for electric cooking in Morocco

4 – 5 Septembre 2019
Centre d'Accueil et de Conférences
Rabat, Morocco

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 811145.

Workshop Agenda

DAY 1 – 4 SEPTEMBER 2019

08:30 – 09:00	Registration
09:00 – 09:30	OPENING • Ministry of Energy, Mines and Sustainable Development (MEMDD) • Said Mouline, Director General of the Moroccan Agency for Energy Efficiency (AMEE) • Rebecca Gaghen, Head of Division for Europe, Middle–East, Africa and Latin America, International Energy Agency (IEA)
09:30 – 10:30	CONTEXT AND CHALLENGES IN MOROCCO *This session presents the current energy context and issues related to cooking practices in Morocco, followed by a moderated discussion.* **Moderator:** Mourad Hajjaji, AMEE • **Energy**, AMEE • **Deforestation**, High Commission for Water and Forests and the Fight against Desertification • **Perspectives for PV in Morocco** – Ahmed Ghzaoui, MEMDD
10:30 – 11:00	Coffee Break
11:00 – 12:00	« CLEAN COOKING » – AN INTERNATIONAL PERSPECTIVE *This session presents clean and sustainable cooking from an international perspective including the latest available data and analysis on global trends and issues, followed by a moderated discussion.* • **The global context –** Rebecca Gaghen, IEA **Moderator:** Rebecca Gaghen, IEA • **International experience in reducing fossil fuel subsidies –** Mostafa Mostafa, International Institute for Sustainable Development (IISD) • **International initiatives**: o The World Bank approach to electric clean cooking – Besnik Hyseni, Energy Specialist, The World Bank o Modern Electric Cooking Services (MECS) – Prof. Matthew Leach, Energy consultant, MECS
12:00 – 13:00	Lunch

13:00 – 14:00	ELECTRIC COOKING TECHNOLOGIES *This session explores the latest developments in electric cooking technologies.* • **Induction cooking and electric pressure cookers –** Besnik Hyseni, The World Bank • **Battery–eCooking for mini–grid and weak grid applications / Standalone PV–battery eCooking –** Matthew Leach, MECS • **Business models and cost trends –** Besnik Hyseni, The World Bank
14:00 – 15:00	'THE MOROCCAN HOUSE' *This session explores contextual factors that will affect the applicability and selection of electric cooking appliance decisions in Moroccan households.* **Moderator:** Ahmed Himy, AMEE • **Cooking methods in Morocco / A gender perspective –** Virginie Klein, GERES / Project FaranEco • **Different categories of households and their needs** – Soraya Khalil, Ministry of National Planning, Urban Planning, Housing and Urban Policy • **Current residential energy consumption by end–use and fuel/ Biomass** –Abdelhaq Amahrouch, AMEE
15:00 – 15:30	Coffee and Tea Break
15:30 – 16:15	GROUP WORK – OBJECTIVES AND PROCESS • Stakeholder mapping • End user mapping • Identify key barriers and potential technological options for each user group.
16:15 – 16:45	REPORTING BACK FROM WORK GROUPS
16:45 – 17:00	SUMMARY

DAY 2 – 5 SEPTEMBER 2019

09:00 – 09:05	SUMMARY OF DAY 1 AND OPENING OF DAY 2
09:05 – 09:50	CASE STUDIES *This session presents case studies of electrical cooking programmes, followed by a discussion.* • **Electric pressure cookers in Africa –** Jacob Fodio Todd, Research Fellow, University of Sussex, UK and MECS • **Induction stoves as an option for clean cooking in rural India –** Manjushree Banerjee, Fellow, Centre for Impact, Evaluation and Energy Access, The Energy and Resources Institute (TERI), India
09:50 – 10:20	« POLICY TOOLKIT» – Maxine Jordan and Cédric Philibert, IEA *The IEA will present policy options that could be deployed to stimulate the uptake of cleaner and more sustainable cooking technologies.*
10:20 – 11:00	Coffee break & cooking demonstration
11:00 – 12:30	GROUP WORK *Guided discussions and interactive exercises with the aim to identify key policies and actions to accelerate the transition towards clean and sustainable cooking in Morocco.*
12:30 – 13:30	Lunch
13:30 – 13:45	SUMMARY OF KEY POLICY ACTIONS – IEA, AMEE
13:45 – 15:00	GROUP WORK *Guided discussions and interactive exercises with the aim to identify possible pilot projects to accelerate the transition towards clean and sustainable cooking in Morocco.*
15:00 – 15:30	Coffee break
15:30 – 16:45	SUMMARY OF KEY PILOT PROJECTS AND DISCUSSION NEXT STEPS CLOSING REMARKS - Said Mouline, AMEE

Annex B – List of Participants

Name	First name	Organisation	Position
Aamraoui	Mustapha	National Office for Water and Electricity (ONEE)	Mission head
Ahmarras	Amine	Moroccan Agency for Energy Efficiency (AMEE)	Engineer
Amahrouch	Abdelhaq	AMEE	Service for other sectors
Banerjee	Manjushree	The Energy and Resources Institute, India (TERI)	Research fellow
Benmbarek	Mouna	Secretary of State for Sustainable Development (SEDD)	
Bensfia	Asma	Belgium Development Agency (ENABEL)	
Bentaher	Ichrak	Moroccan Agency for Sustainable Energy (MASEN)	Project manager
Bricknell	Malcolm	Loughborough University, Modern Energy Cooking Services Programme (MECS)	International liaison manager
Chaouki	Samir	AMEE	Cooperation
El Bouzzati	Lydia	AMEE	Consultant
El Gharbi	Ghizlane	AMEE	Strategy and development division
El Mahri	Meryam	AMEE	
El Naciri	Siham	AMEE	Communications
El Younsi	Khalid	High Commissariat of Waters and Forests and the Fight Against Deforestation (HCEFLCD)	Researcher
Elalaoui	Nahla	AMEE	Engineer
Elattari	El Hassan	AMEE	Engineer
Elharizi	Jamila	Ministry of Housing and Urban Policy (DQAT)	Manager
Elyacoubi	Abdelkarim	AMEE	Director
Farhat	Lahcen	AMEE	Director
Fodio Todd	Jacob	University of Surrey, MECS	Research fellow
Ghzaoui	Ahmed	Ministry of Energy, Mines and the Environment (MEME)	Manager
Hajjaji	Mourad	AMEE	Director of the Strategy and Development Division
Himy	Ahmed	AMEE	Strategic studies service
Houkmi	Nabil	SEDD	Engineer
Hyseni	Besnik	World Bank	Energy economist
Khalil	Soraya	DQAT	
Klein	Virginie	Geres	Morocco representative
Leach	Matthew	MECS	Researcher
Lisser	Mohammed	MEME	C/S PEE
Makaoui	Mohammed	AMEE	Head of Division
Manar	Halima	AMEE	General affairs division
Mostafa	Mostafa	International Institute for Sustainable Development (IISD)	Policy analyst
Mouline	Said	AMEE	Director General
Omar	Benabdellah	AMEE	General affairs division
Ouchker	Jamal	ENABEL	Project manager
Ouhmed	Mohammed	MEME	Manager
Ouitassawe	Mounir	Moroccan Foundation for Advanced Science, Innovation and Research (MASCIR)	
Rachidi	Samir	Research Institute for Solar Energy and New Energies (IRESEN)	Director
Ramzi	Rachid	AMEE	
Schilling	Luc	Embassy of the Netherlands	Head of Economic Affairs
Smouh	Slimane	AMEE	Manager
Touil	Adil	Ministry of Agriculture and Fisheries (MAPMEF)	
Wahbi	Najia	MEME	Manager

Annex C – Workshop presentations by the IEA Secretariat

Session 2: Clean cooking – an international perspective – Rebecca Gaghen, IEA

International Energy Agency

Clean cooking – an international perspective

Rebecca Gaghen – Head of EMAL, Office of Global Energy Relations

Towards clean and sustainable cooking – the outlook for electric cooking in Morocco

4 September 2019, Rabat

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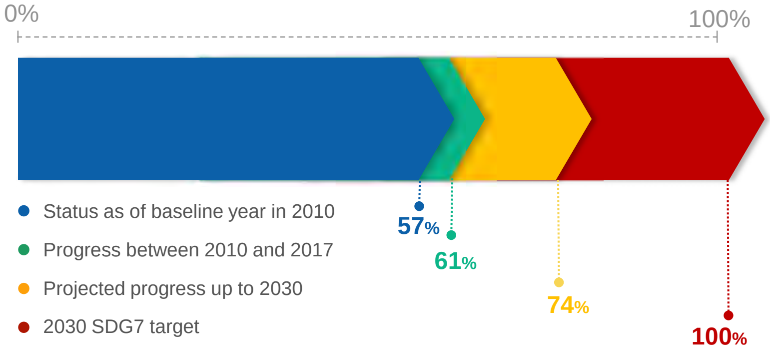
Access to clean cooking solutions is improving too slowly

Percentage of the global population with access to clean cooking solutions (%)



Source: WHO, IEA

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Morocco's sustainable development in the global context

- Morocco's policy response to energy challenges focuses on:
  - Successful subsidy reform
  - Increased focus on energy efficiency
  - Aggressive renewables strategy, including technology innovation
- High dependence on imports and changing energy security landscape require policy reappraisal:
  - Abundance of natural gas globally opens up new options for Morocco
  - Security of oil imports
  - Opportunities for renewables beyond electricity and better energy efficiency
  - Regional energy trade
- A new IEA family member, Morocco and the IEA have a broad work programme

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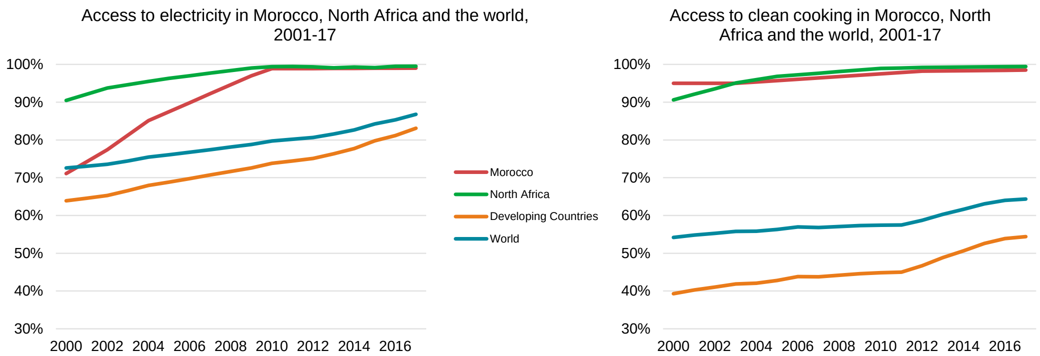
Morocco has made impressive progress in energy access

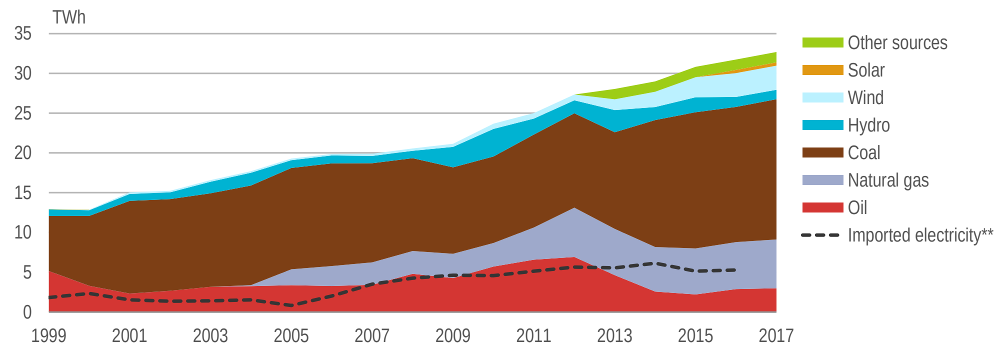


Note: Population is defined as villages not people.
Source: IEA (2018b), *World Energy Outlook, 2018*, www.iea.org/statistics/.

In 2018, the share of rural population with access to electricity reached 99.43%, up from 48.1% in 1990

Electricity is the critical driver of the transition

Electricity generation by source, 1999-2017



Morocco has great potential for large shares of wind and solar, thanks to flexibility from natural gas, electricity imports and solar storage.

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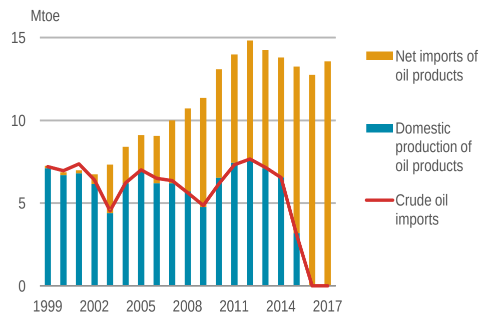
Morocco is strongly dependent on imports of oil products

Oil product supply. 1999-2017



The closure of Morocco's only refinery makes the country fully dependent on product imports, posing challenges for oil security.

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The status of cooking in Morocco

- **The good news:**
  - Access to clean cooking in Morocco was 98.5% in 2017, mainly liquid petroleum gas (LPG)/butane
- **The bad news:**
  - Subsidy drives high, inefficient consumption: 2-kg bottle priced at MAD 40 (around EUR 3.60) in 2018, below market price of MAD 96
  - LPG/butane was 23% of total oil consumption in 2017 and 60% of total energy demand in the residential sector – higher than all IEA countries
  - Very costly for the government: MAD 9.9 billion, (nearly EUR 1 billion) in 2017
  - Increases dependence on oil imports, weakened energy security
  - Subsidy not always reaching those most in need, others benefit

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Morocco's cooking challenge

How to ease Morocco's transition from subsidised cooking fuel to electric alternatives while ensuring that vulnerable consumers maintain affordable access and also avoiding return to use of traditional biomass?

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Session 7: Renewable energy policy toolkit – Cédric Philibert, IEA

International Energy Agency

Policy Toolkit

Cédric Philibert & Maxine Jordan, International Energy Agency

Rabat, 5/09/2019

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Renewables

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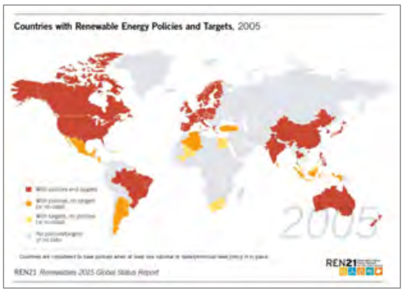
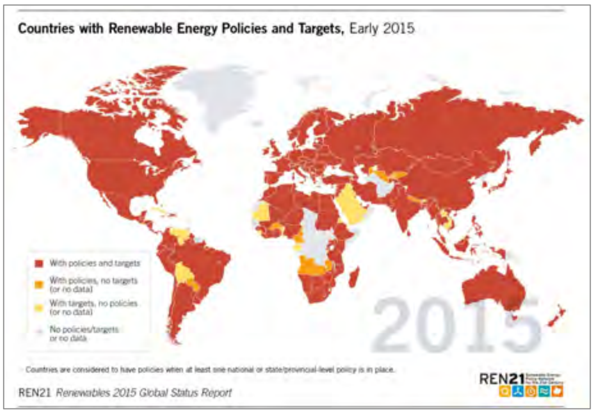
The spread of renewable energy policies





Renewable energy policies have become increasingly widespread. However, policy support remains focused on the power sector. As a consequence, heat and transport also lag behind in deployment.

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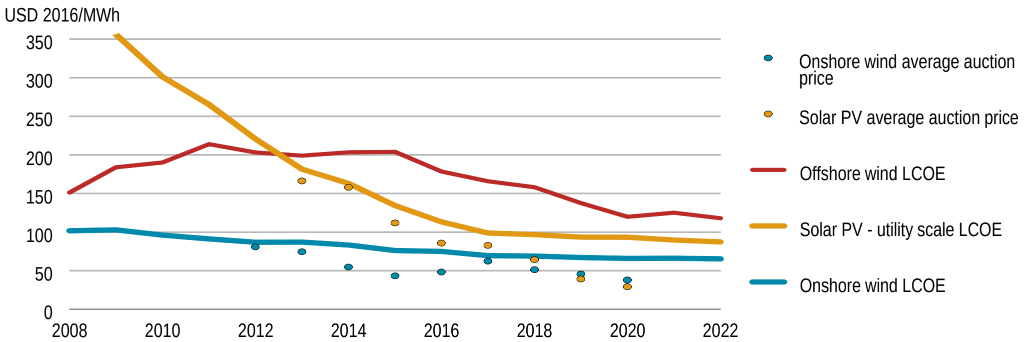
3

Wind and solar PV costs being driven down by competition

Wind and solar PV average LCOEs and auction results by commissioning date



[Source: Renewables Market Report 2017]

Price discovery through competitive auctions effectively reduces costs along the entire value chain, however some auctions may not reflect total costs and remuneration; average LCOEs are still dominated by administratively set tariffs

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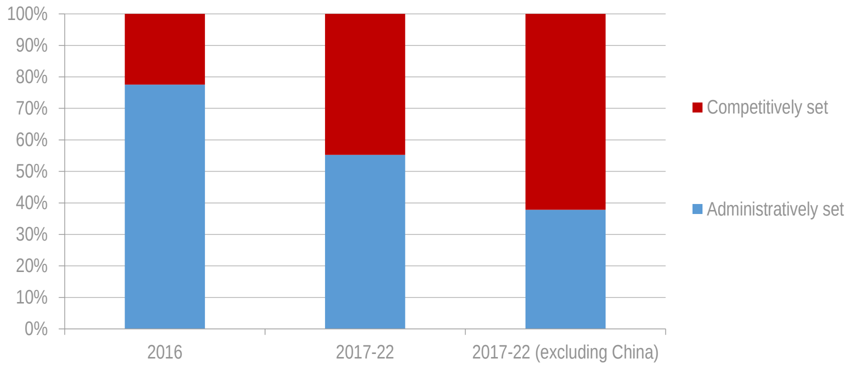
3

Renewable policies spurring more competition

Renewable capacity growth by type of policy defining remuneration levels



Competitive tenders with long-term contracts will drive almost half of new capacity growth globally; the timing of policy transition in China may accelerate further this trend

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Policies for distributed PV: support to sales

- Buy all sell all
  - If the producer is also a consumer
  - Feed-in tariffs and premiums de-risking investment
- Net energy metering
  - Set the buying price at the level of retail sales
  - According to the time period of NEM, uses the system as storage
  - Very effective to jump-start de ployment, hard to sustain for ever
- Self-consumption with sales of injected electricity
  - Tariffs for injection vary widely

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Policies for distributed PV - Targets

Country/State	Target	
India	40 GW	All rooftop PV by March 2022
UAE/Dubai		10% of all homes
United States	0.1 to 3.5% of total electricity	Carve-outs as % of State renewable portfolio standards in 14 US States
US/Maine	400 MW	
US/New York	6 GW by 2025	

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Policies for distributed PV: support to investment

Country	Policy	Impact
Australia	Rebate scheme based on small renewable certificates	High
Brazil	VAT exemption for small solar systems	High
China	State-level grants and low financing rates for industrial applications	Medium
France	Subsidy for self-consumption projects €190-390/kW depending on size	High
United States	Sellable 30% federal investment tax credit	High but...

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Case study: France

- **The 2017 law for self-consumption** acknowledges in particular collective self-consumption and makes mandatory for networks operators to facilitate self-consumption.
- A tariff for systems < 100 kWc sets the « sell all » price for PV electricity over 20 years and institutes investment grants for self-consumption with sales of injected electricity
- In practice there are two options: :
  - **Buy all sell all**: the client acquires a PV system and sells all of its production. Prices range from 11c€ to 15 c€/kWh
  - **Self-consumption with sale of the surplus: vec vente de surplus**: the client acquires a PV syste, consumes its production and sells the surplus to EDF OA (« Electricité de France Obligation d'Achat) if her production exceeds her consumption. A grant for investment is paid in five years and is set between 0.39 €/Wc and 0.09 €/Wc.
  - The electricity produced and injected is paid 10 c€/kWh for systems < 9kWc and 6 c€/kWh for systems < 100kWc.
- In May 2019, another low has broadened the notion of collective self-consumption
- Systems >100 kW are developed under competitive bidding

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Concerns: grid costs and integration

- T&D costs 30-50% of retail costs, but only 0-15% recovered through fixed payments for efficiency/equity reasons
  - Self-consumers pay less but still benefit from the grid
  - Self-consumption may call for some network tariff changes
    - *Preferably toward some time-based grid pricing structure, e.g. California bill adopted in September 2013: small fixed fee introduced, and time-of-use pricing forthcoming*
- Integration
  - When PV production and peak demand do not match, system costs may increase
  - When they do match, system costs may decrease

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Concerns: tax, surcharges, subsidies

- Forgone tax revenue concerns
  - Less energy sold, less taxes raised
  - Taxation of self-consumption problematic
  - ➔Evaluate taxation framework, avoid double taxation
    E.g. charging VAT on systems and on excess electricity
- Forgone renewable energy surcharge concerns
  - Tariffs often contain surcharge for RE
  - A RE surcharge on RE self-consumption?
  - ➔Contributing to learning investment that has lead to socket-parity
- Forgone cross-subsidy concerns
  - Customers with highest prices have biggest incentive
  - May be due to cross-subsidies to other consumer groups
  - ➔Anticipate impact on overall revenues

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General conclusions on self-consumption

- The competitiveness of PV for self-consumption allows to prolong its deployment while reducing subsidies where grid parity is effective
- The policy framework and market design remain key
- The challenges for electricity networks must be adressed
- Governments should:
  - Monitor self-consumption;
  - Assess and adress the consequences for electricity systems
  - Confront associated costs with the value of PV electricity
  - Introduce or strenghen incitations to a better time-matching of PV production and electricity peak demand

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In the case of Morocco…

- eCooking can provide an affordable alternative to LPG for cooking
  - If well managed to avoid excessive increase in evening demand peak
  - Behind the meter batteries and real-time demand response can help
  - The deployment of distributed PV can play a role in providing affordable electricity, and spare customers customers a shift to costlier tariff tiers
- This could make the progressive removal of LPG subsidies socially acceptable
  - For the good health of Morocco's finances and trade balance
  - And thus free the potential for energy efficiency improvements in the remaining usages of LPG such as gas ovens

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Energy efficiency

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The value of energy efficiency

What is the role of energy efficiency in the transition towards more sustainable clean cooking?

- Ensures that the choice of technology prioritises the efficient consumption of resources
- Reduces the impact of subsidy reform by avoiding additional energy use and cost
- Reduces energy imports
- Avoided investment in electricity transmission and distribution infrastructure
- Lower cost of access to clean cooking

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Energy efficiency in the context of cooking

1) Manage the impacts of a potential increase in electricity consumption

- For households: reduce the impact on energy bills
- For utilities: manage demand spikes

2) Reduce the impact of the increased cost in non-subsidised butane

- For households: maintain some gas for cooking (for bread baking), but using less

↓ kWh electricity

↓ kg gas

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What types of energy efficiency policy are possible?

- **Regulation:**
  - Legal requirements to improve energy efficiency or meet specified targets or standards
- **Information and capacity building:**
  - Providing information or training about the efficiency of products or how to improve efficiency
- **Incentives and finance:**
  - Rewarding or funding energy efficient choices and improvements

The ideal energy efficiency policy package contains a mix of regulation, information and incentives

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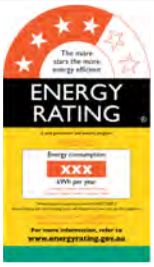
What are the efficiency policy options for appliances

Regulation	Information	Incentives
• Minimum energy performance standards • Phase-out and ban of inefficient products • Energy efficient procurement	• Energy efficiency labels • Consumer guides and websites • Certification of professionals	• Rebates for the purchase of energy efficient appliances • Assistance and grants for market transformation



ENERGY STAR

In the context of cooking

- **For gas ovens:**
    - Labelling
    - Refurbishment programmes
    - Audits by certified professionals
- **For new appliances such as electric pressure cookers:**
    - What security tests? What performance tests?
    - Communication, information, awareness campaigns
    - Labelling?
- **For other appliances:**
    - Standards and labelling
    - Demand-side management

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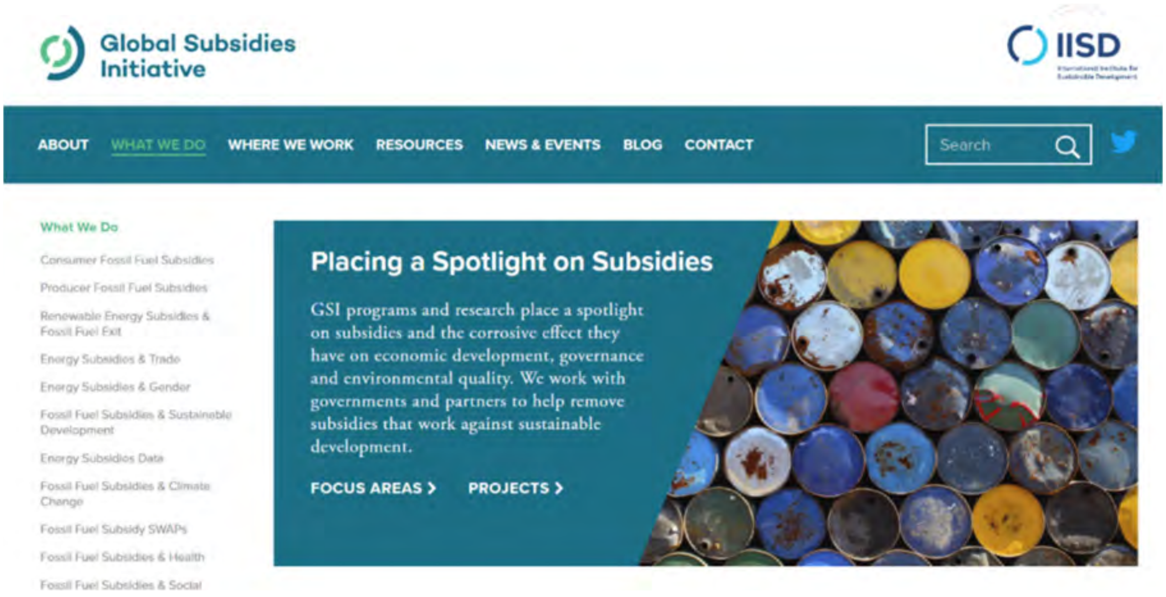
Annex D – Workshop presentations by other contributors

The opinions expressed and arguments employed in the contributions below are those of the author(s) and do not necessarily reflect the official views of the IEA Secretariat or its individual member countries.

Session 2: International experience in reducing fossil fuel subsidies – Mostafa Mostafa, International Institute for Sustainable Development (IISD)



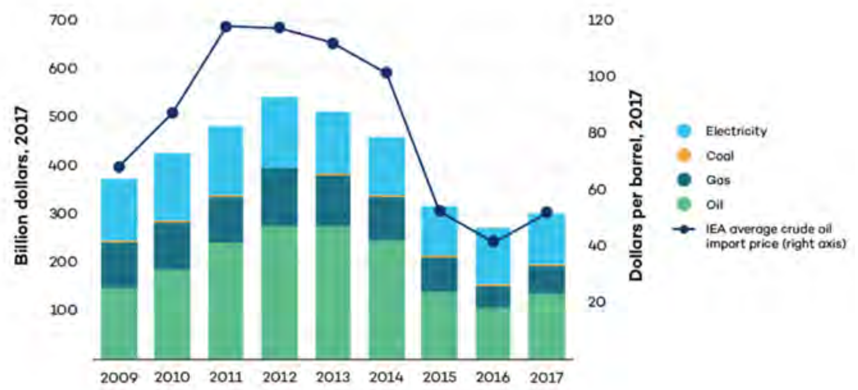
What are energy subsidies?

- A deliberate policy action by government that specifically targets a particular energy source (e.g. coal, oil, gas, electricity) with one or more of the following effects:
  1. Reducing the net cost of energy purchased
  2. Reducing the cost of production or delivery of energy
  3. Increasing revenues retained by energy suppliers
- Consumer subsidies distort the price for energy (the amount paid by consumers does not reflect the actual cost)

Fossil Fuel Subsidies are roughly:

- 4 times the level of renewable subsidies
- 4 times OECD Development Assistance
- 6 times the amount needed for meeting climate finance objectives
- 22 times the size of current donor adaptation funds

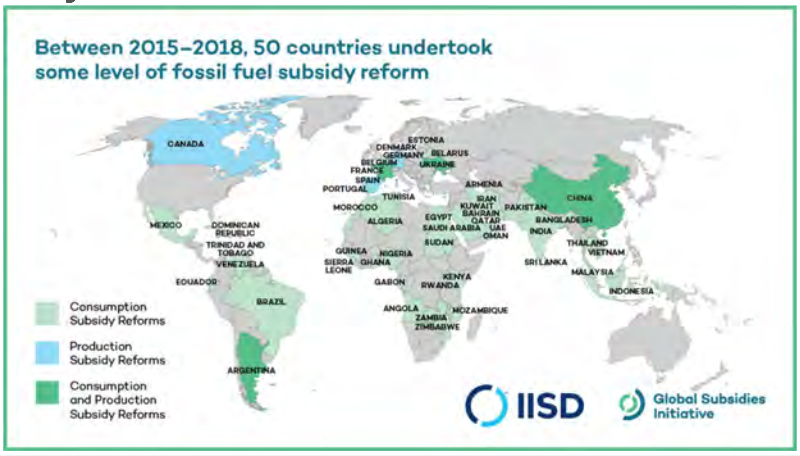
Consumer subsidies largely follow the global market price...



Source: IEA. (2018)

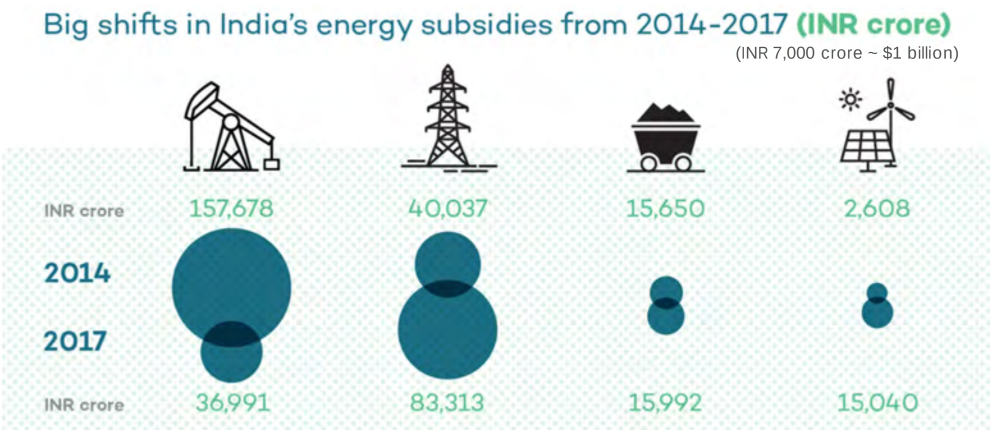
Reforming fossil fuel subsidies and shifting to renewable energy and increased energy efficiency offers governments protection from the volatility of international oil prices.

... but many countries are implementing subsidy reform



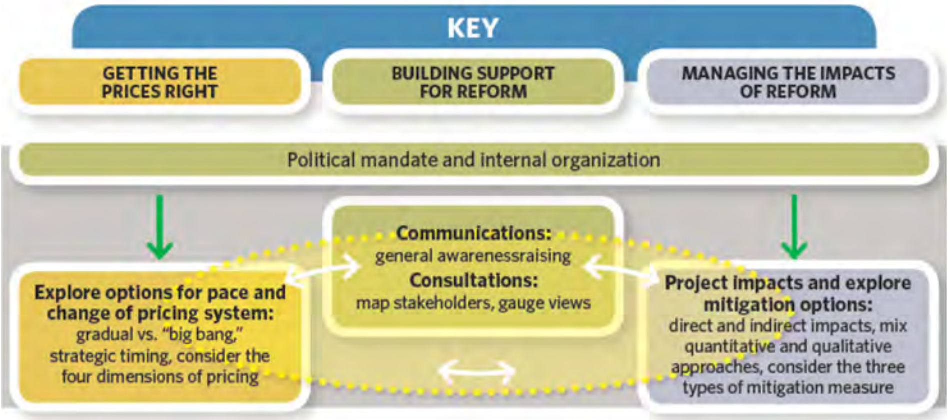
While this map is not an exhaustive picture of all subsidy policy change and does not cover all subsidies within a country, it does illustrate the broad engagement of countries in tackling the FFS issue.

Between 2014 - 2017 India reduced expenditure on energy subsidies by USD 17.2 billion (30% decline)



Big reduction in oil and gas subsidies while renewable energy almost increases six- fold.
Very little change in support for coal

What are the steps to reform subsidies?



All of these elements are connected. It is not possible to convince people that reforms are justified if they are considered to have unacceptable impacts on key groups.

Developing a Communications Strategy for Fossil Fuel Subsidy Reform in Egypt

Country Context: In 2013 fossil fuel subsidies (7%) were higher than health and education public expenditures combined (5%), and also mainly benefited the rich.

Key challenges for fossil fuel subsidy reform:

1. A lack of confidence in the Government
2. A serious lack of awareness regarding the existence, size and cost of energy subsidies and;
3. Resistance to reform among key stakeholders

Some level of support was built for fossil fuel subsidy reform through strategic communication between the Government of Egypt and all stakeholder groups around the process

Swapping butane-powered irrigation systems to solar pump systems in Morocco

Context: Around USD 260 million (40% of butane subsidies) goes to the agriculture sector (mainly pumping and heating)

SWAP Concept: In exchange for giving up butane subsidies; farmers could get access to low cost loans for solar irrigation

Results of reforming subsidies:

1. Increased deployment of solar pumps is expected to bring down prices;
2. Speed up the transition;
3. Financial savings

General Recommendations - Reviewing subsidy design and alternatives to LPG subsidy

- **Review subsidies to ensure the poorest can afford a proposed shift in technologies**
- **Better targeting of LPG subsidies is needed -** to provide greater access to all communities at affordable and competitive prices; measures to protect poor communities
- **Fuel stacking;** subsidizing "free kWh" per households to encourage switching to electricity
- **Improve education and alternative clean cooking options -** the size of LPG subsidies and commitment to promote LPG competes with electric cookstoves, biogas, solar and cleaner cook stoves

> **Subsidy reform needs to be undertaken with care to avoid negative energy access impacts**

Key Messages and Guiding questions on reforms

- Energy subsidies are a significant draw on public budgets
  - Around 261 billion USD around the world, with national share of GDP reaching up to 14%
  - Savings could be reinvested into a range of development priorities
  - "Swaps" into clean energy would increase positive impact of subsidy reform
- Energy subsidy reform is progressing across the world
  - Focus more on (larger) consumer subsidies rather than producer subsidies
  - Reducing public expenditure often a primary driver, not clean energy
  - Concerns center on the poor and vulnerable, and industrial competitiveness
- Guiding questions when reforming fossil fuel subsidies
  - What is the best way forward? (Remove, Targeting, Swapping)
  - Who are the winners and who are the losers?
  - What does this mean for butane subsidies in Morocco?
  - What does it mean for clean cooking in particular?

Thank you!

For more information
Visit: www.iisd.org
Contact: Mostafa Mostafa, IISD, mostafa. mostafa @iisd.net

SDG Indicator 12.c.1: "Amount of fossil fuel subsidies per unit of GDP (production and consumption) and as a proportion of total national expenditure on fossil fuels".

UN General Assembly Resolution A/RES/71/313

Table 1 Assessment of subsidy categories for monitoring of SDG Indicator 12.c.1

Subsidy category	Data availability	Complexity	Acceptance	Recommendation for SDGs	
				National	Global
Direct transfer of funds	++	++	++	Yes	Yes
Induced transfers (price support)	+	+	++	Yes	Yes
Tax expenditure, other revenue foregone, and under-pricing of goods and services	+	o	+	Yes, but optional[1]	Yes, but optional[1]
Transfer of risk	-	-	o	No	No

++ (green) means "excellent" or "low degree of complexity"
+ (yellow) means "good" or "moderate degree of complexity"
o (orange) means "neutral"
- (red) means "poor" or "difficult"

[1] Countries are invited to report existing information and build up information on this category progressively. In 2025 it should be considered whether this indicator can be fully included.

Session 2: The World Bank approach to electric clean cooking – Besnik Hyseni, Energy Specialist, The World Bank

TRANSITIONS TO CLEAN COOKING

Besnik Hyseni
Energy Specialist
bhyseni@worldbank.org

Rabat, Morocco
September 4-5, 2019

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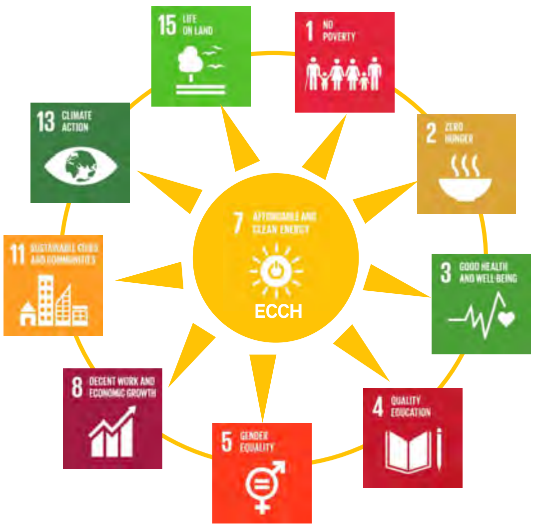
WHY DO WE CARE?



Strong link to the human capital agenda

Health:
- **~ 4 million premature death annually attributable to HAP; over 50% of deaths among children under 5 years**
- **Estimated annual welfare losses: $1.52 trillion**

Impacts on Gender Equality
- **Considerable time spent on fuel collection/cooking tasks**
- **Women/girls are disproportionally affected**
- **New opportunities for women in decision making and value chain**

Climate and Environment:
- **Cooking/heating with solid fuels is the largest source of black carbon emissions globally**
- **CO_2 emissions substantial where biomass harvested unsustainably or coal is used**
- **Contribute to ambient air pollution**

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MULTI TIER FRAMEWORK (MTF) IS MEASURING ACCESS TO CLEAN COOKING SOLUTIONS

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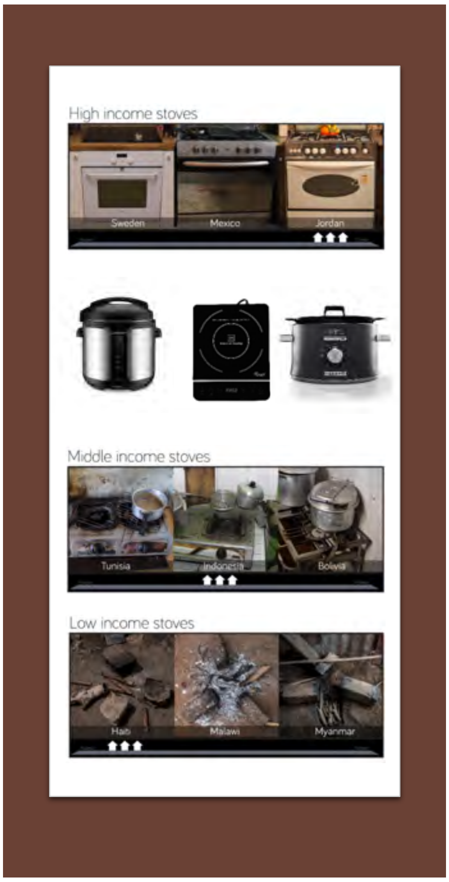
MULTI-TIER ENERGY ACCESS TRACKING FOR COOKING

		Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Cooking Exposure	ISO's voluntary performance targets (Default Ventilaton) PM2.5 (mg/MJd) CO (g/MJd)	>1030 >18.3	≤1030 ≤ 18.3	≤481 ≤11.5	≤ 218 ≤7.2	≤62 ≤4.4	≤ 5 ≤3.0
	High Ventilation PM2.5 (mg/MJd) CO (g/MJd)	>1489 >26.9	≤1489 ≤ 26.9	≤ 733 ≤ 16.0	≤ 321 ≤ 10.3	≤ 92 ≤ 6.2	≤ 7 ≤ 4.4
	Low Ventilation PM2.5 (mg/MJd) CO (g/MJd)	>550 >9.9	≤550 ≤ 9.9	≤252 ≤ 5.5	≤115 ≤ 3.7	≤ 32 ≤ 2.2	≤ 2 ≤ 1.4
Cookstove Efficiency	ISO's voluntary performance Targets	< 10%	≥ 10%	≥ 20%	≥ 30%	≥40%	≥50%
Convenience	Fuel acquisition and preparation time (hours per week)	≥ 7		< 7	< 3	< 1.5	< 0.5
	Stove preparation time (minutes per meal)	≥ 15		< 15	< 10	< 5	< 2
Safety		Serious Accidents over the past 12 months				No serious accidents over the past year	
Affordability		Fuel cost ≥ 5% of household expenditure(income)				Fuel cost < 5% of household expenditure (income)	
Fuel availability		Primary fuel available less than 80% of the year				available 80% of year	readily available throughout the year



WHY THE WORLD BANK IS STEPPING UP

- **Our comparative advantage:**
  - Focus on development and solutions for the poor (bottom 40%)
  - Multiple instruments: policy dialogue, technical assistance and capacity building, financing (loans, grants, carbon finance)
  - Convening power: working with other development partners and governments
  - Specialists working across sectors with cross cutting and hybrid approaches
  - Operational experience gained across the world and replication
  - Ability to drive scale (e.g. track record of scaling up electrification)

WHY FOCUS ON EFFICIENT ELECTRIC COOKING

- A number of client countries with goals of increasing access to clean cooking solutions to meet the SDG goals.

- Renewable energy generation means that cooking can be done with low or zero emissions offsetting environmentally detrimental fuels such as charcoal, kerosene, etc.

- Versatile electric cooking appliances means that now households can cook many of their main dishes with electricity, offsetting baseline fuels.

- Technical Assistance (TA) to countries and the upcoming electric cooking report will help identify countries where policy dialogue can lead to project design for supporting electric cooking and other clean cooking solutions; count
5 identification is in the process now.

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ADVANTAGES OF ELECTRIC COOKING

Disruptive and transformational value proposition for HH:

✓ Cooks faster and is carefree (free up valuable time)

✓ Automated heat control settings (doesn't burn food)

✓ Safer (no burning incidents)

✓ Cleaner (no toxic emissions, cleaner kitchen and pots)

✓ In many instances cheaper than baseline fuels (e.g. charcoal)

✓ Behavioral implications for switching can be significant but are attainable

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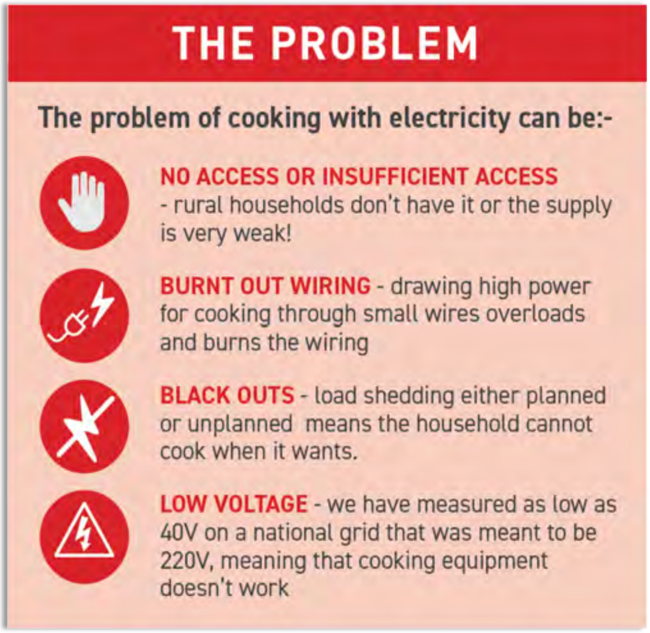
ELECTRIC COOKING HAS TECHNICAL IMPLEMENTATION BARRIERS



- Load shedding may be exacerbated by cooking episodes occurring at once for customers connected to the same grid.

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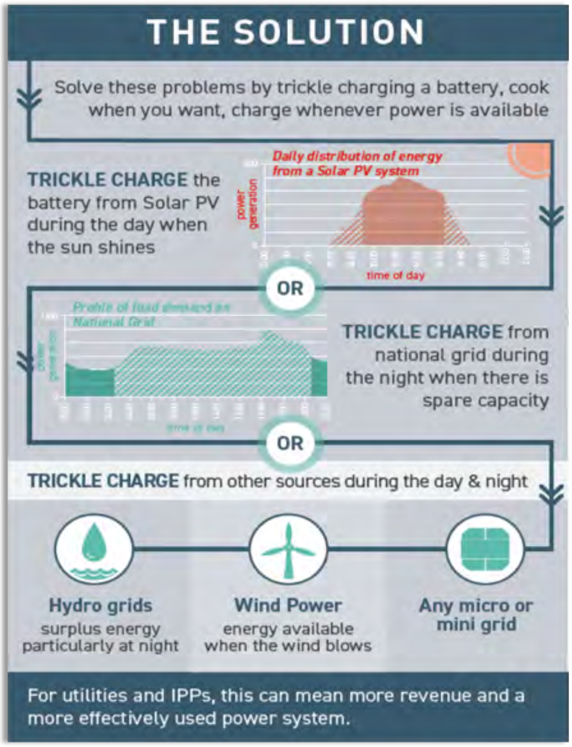
VIABLE SOLUTIONS ARE BECOMING AVAILABLE



- Load profile analysis and smoothing through demand side incentives
- Signaling through tariff discounts
- Utilization of smart charge controllers
- Power storage systems and consumer batteries

ASSESSING THE OPPORTUNITIES FOR SCALE-UP

ESMAP, Loughborough University and their partners are collaborating on a major new UK Aid-funded Modern Energy Cooking Services (MECS) program

One aspect of this collaboration is a report assessing the technological and market readiness of cooking with electricity

- The report provides new insights on the viability of cooking with electricity in specific country contexts through a technical and cost-based viability modeling in different power systems including: grid-connected, mini-grid, and standalone systems.
- Recommends priority countries based on a range of indicators where cooking with electricity would make sense

UKaid from the Department for International Development

Loughborough University

ESMAP Energy Sector Management Assistance Program

MECS Modern Energy Cooking Services

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Thank You

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Session 2: Modern Electric Cooking Services (MECS) – Professor Matthew Leach, Energy consultant, MECS

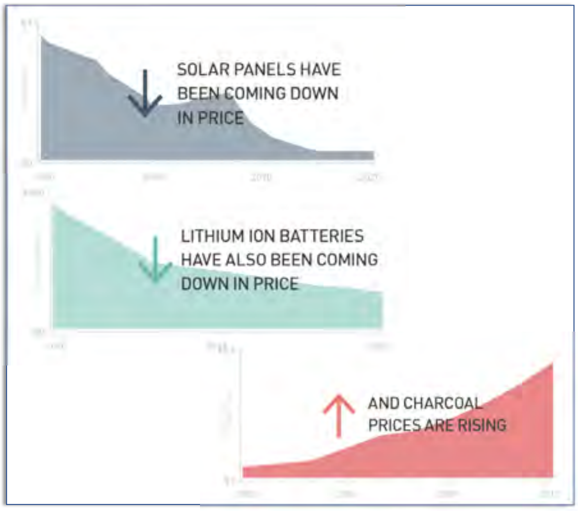
Modern energy cooking services

Prof Matt Leach

Introduction to eCooking and MECS

September 2019

2013: background trends



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New proposition….solar PV–battery cooking

Gamos

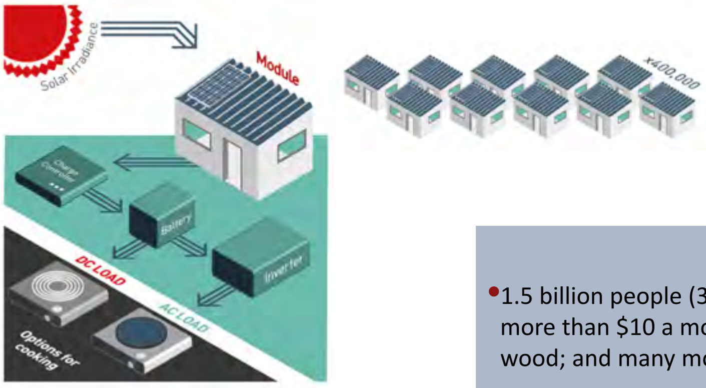

Image https://elstove.com/infographic/

- 1.5 billion people (300-600 million households) pay more than $10 a month cash to cook with charcoal or wood; and many more pay for LPG/Kerosene/coal
- Research question: **given the declining component costs, could we design a solar-battery cooker to compete with that?**

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3

Additional proposition….grid–battery cooking

- Even in 'grid-connected' cities, supplies can be erratic: demand is often higher than generation capacity available, and networks are not always robust

- By trickle charging a battery during night hours, the household would benefit by having reliable, stored electricity for consumption whenever they wanted it
- The grid would benefit by effectively having decentralised storage built in to assist with load management
- Has application on unreliable grids and independent microgrids

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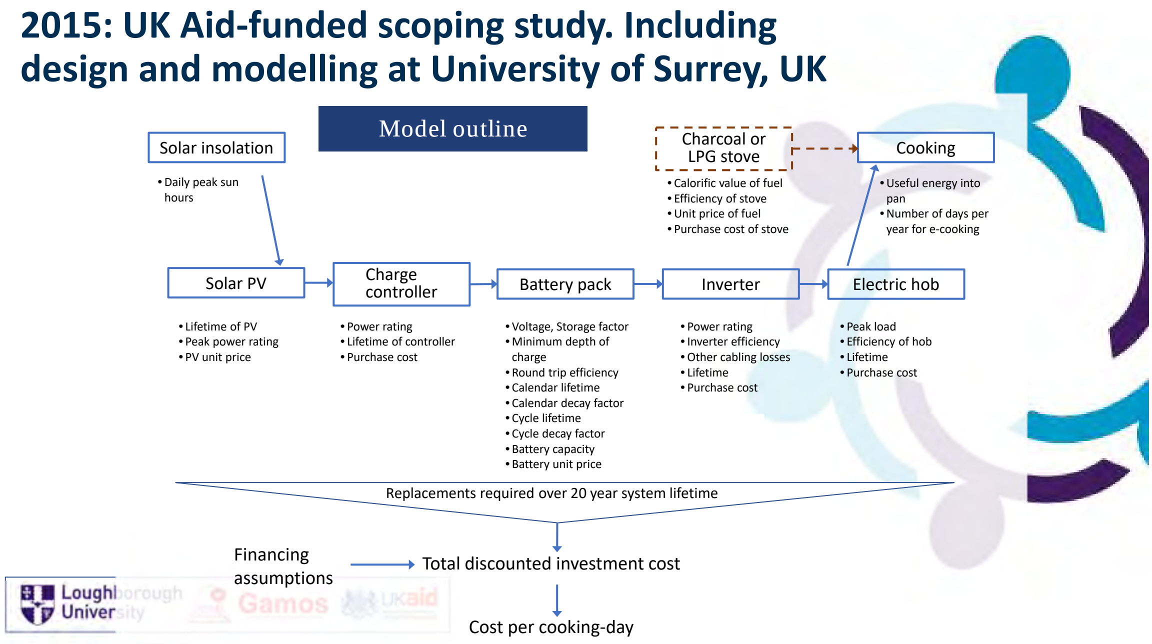
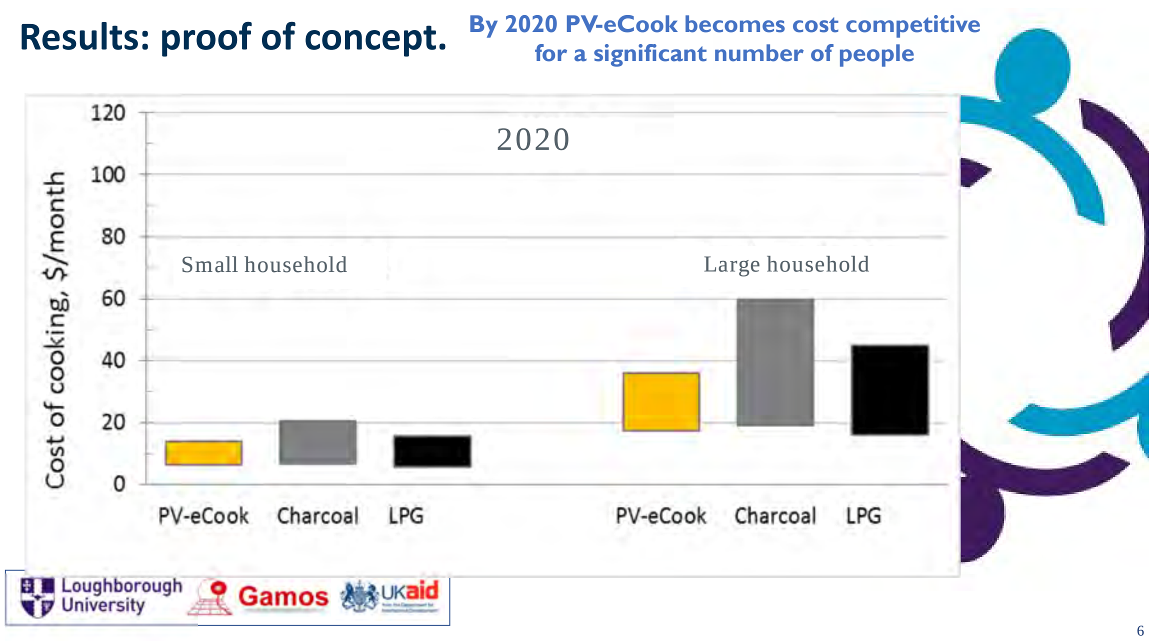


2015: UK Aid-funded scoping study. Including design and modelling at University of Surrey, UK
Model outline
Solar insolation
• Daily peak sun hours
Charcoal or LPG stove
• Calorific value of fuel
• Efficiency of stove
• Unit price of fuel
• Purchase cost of stove
Cooking
• Useful energy into pan
• Number of days per year for e-cooking
Solar PV
• Lifetime of PV
• Peak power rating
• PV unit price
Charge controller
• Power rating
• Lifetime of controller
• Purchase cost
Battery pack
• Voltage, Storage factor
• Minimum depth of charge
• Round trip efficiency
• Calendar lifetime
• Calendar decay factor
• Cycle lifetime
• Cycle decay factor
• Battery capacity
• Battery unit price
Inverter
• Power rating
• Inverter efficiency
• Other cabling losses
• Lifetime
• Purchase cost
Electric hob
• Peak load
• Efficiency of hob
• Lifetime
• Purchase cost
Replacements required over 20 year system lifetime
Financing assumptions
Total discounted investment cost
Cost per cooking-day



Results: proof of concept.
By 2020 PV-eCook becomes cost competitive for a significant number of people
2020
Cost of cooking, $/month
120
100
80
60
40
20
0
Small household
Large household
PV-eCook
Charcoal
LPG
PV-eCook
Charcoal
LPG
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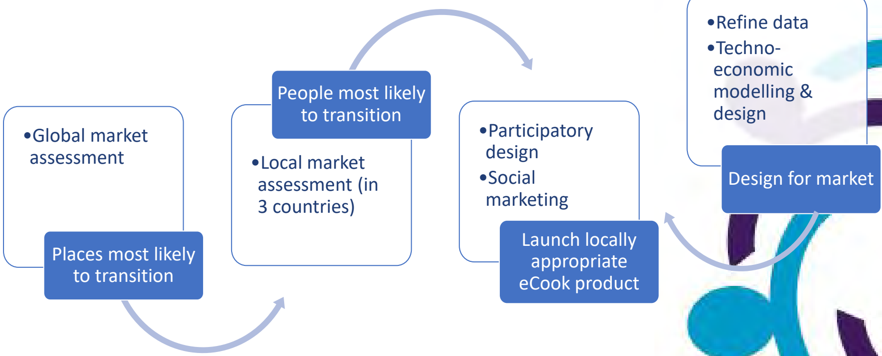
2018: led to Innovate-UK grant



- Building links with other clean cooking actors (GACC, WHO etc.)
- Developing an eCook practitioner network

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7

- To date researchers have tended to advocate induction hobs as a more efficient device than a hotplate. Evidence suggests this is only part of the picture.
- Recent eCook data suggests that a well insulated (electrical) multi- or pressure-cooker is an even more efficient device. Able to cook the majority of foods, it is desirable for its cleanliness and ease of use.

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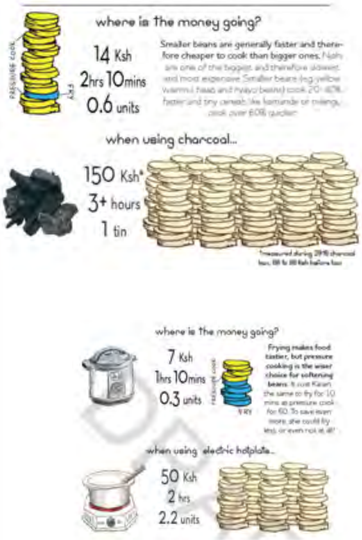

eCook book

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MECS
Modern Energy Cooking Services

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- We begin a coherent integrated multi-year research programme on **Modern Energy Cooking Services**.
- Led by Ed Brown at Loughborough University UK, Research Coordinator Simon Batchelor at Gamos
- MECS is broader than electric cooking and also includes work on new approaches to other fuels such as biogas, ethanol and LPG.
- The programme is funded by UK Aid, and begun in early 2019…but phased start

……MECS will seek to deliver

- **Evidence, research and insights** into the drivers and pathways for economies to transition to modern energy cooking services.
- **New technologies** that make using electricity and gas more efficient, more practical, more desirable and affordable for poor households.
- **Innovations** in business models, financing and private sector delivery of modern energy cooking services.
- SDG **global tracking** that includes modern energy cooking services.
- Inclusion of modern energy cooking services in **World Bank International Development Assistance** programming and lending.
- Collaboration with **Governments** seeking to embed MECS approaches within their electrification policies and clean cooking strategies.
- A **changed narrative on cooking** for those involved in wider energy access policy and programming.
- **UK leadership** in a new approach to clean cooking.

MECS Modern Energy Cooking Services

Starts and ends with people

(Not technology per se.)

(although does include lots of tasty food.)

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Key References

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- M. Leach and R. Oduro, “Preliminary design and analysis of a proposed solar and battery electric cooking concept : costs and pricing,” Evidence on Demand (prepared at the request of the UK Department for International Development), 2015.
- E. Puzzolo, D. Stanistreet, D. Pope, N. Bruce, and E. Rehfuess, “Systematic review Factors influencing the large-scale uptake by households of cleaner and more efficient household energy technologies,” London: EPPI-Centre, Social Science Research Unit, Institute of Education, University of London, 2013.

- These and other recent documents can be found at www.pv-ecook.org

MECS Modern Energy Cooking Services

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Session 3: Induction cooking and electric pressure cookers – Besnik Hyseni, The World Bank

EFFICIENT ELECTRIC COOKING TECHNOLOGIES

Besnik Hyseni
Energy Specialist
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Rabat, Morocco
September 4-5, 2019

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INDUCTION HOBS

- Induction heating only generates heat in the pan placed on the hob, no energy is wasted or used in heating up other parts of the cooking device, notably the hot plate itself.
- Electromagnetic field on an induction cooktop heat transfers from the cooking pot to the glass through conduction.
- Induction cookers may be more efficient than electric coil cookers depending on what is cooked but there are studies which show evidence that efficiency of induction over electric coil heating may not be as high as previously thought mainly due to improvements on efficiency of the latter.
- 15% of cooker sales in the USA 20% in Europe are induction stoves

  - Works only with pots of magnetic based material (cast iron, stainless steel, etc.)
  - Generally safer than hotplates, and easier to clean

Picture, copyright Bosch 2018

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ECUADOR'S EXPERIENCE WITH INDUCTION COOKING

Experience from a pilot programme in Ecuador that rolled out induction hobs found that the hobs were susceptible to poor quality power supplies, and often failed within 6 months (Gould et al 2018).

- With a target of 3 million households, all likely to be cooking at similar times of the day (also likely to coincide with periods of peak loads on the grid), the induction cooking programme represented a substantial increase in load on the grid. The program had to be accompanied by a hydro-electric power expansion program.
- The induction stove program has generated the sale of 740,000 induction stoves since its inception in 2014, short of the goal of 3.5 million.

Picture Copyright CuencaHighLife

An electric induction cooktop being assembled at Cuenca's Inudrama factory.

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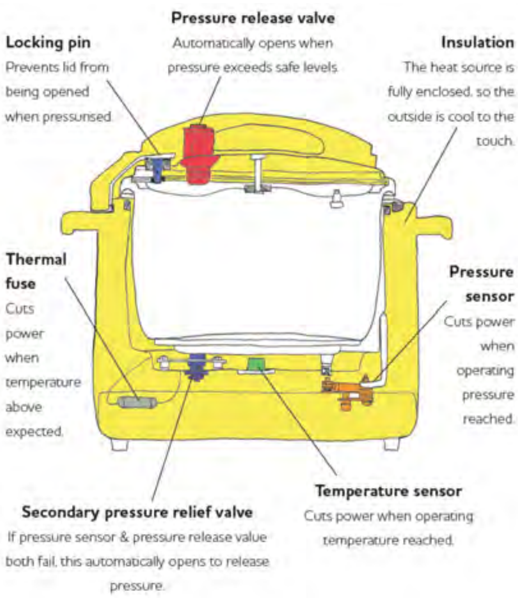
ELECTRIC PRESSURE COOKING

- Pressure cooking isn't a new concept, but electric pressure cookers have made it easier and safer to do
- To date researchers have tended to advocate induction hobs as a more efficient device than a hotplate. Evidence suggests this is only part of the picture.
- Recent data suggests that a well insulated electrical 'multi-cooker' or an electric pressure cooker is event more efficient. Able to cook the majority of foods, depending on context, it is desirable for its cleanliness, speed and ease of use.

HOW DOES AN ELECTRIC PRESSURE COOKER WORK



+ PROS

- **Fast** – a pressure cooker raises the temperature above boiling point.
- **Cheap** – it is energy efficient. There is insulation around the pot so that the heat stays in there.
- **Convenient** – the whole cooking process is automated. Once you set the time, the temperature is controlled by the EPC, so that you can go off and do other things
- Can **fry, boil, steam** and even **bake** a cake**!**
- **Safer** than ordinary sufarias – locks shut when pressurised.
- **Less stirring and water** needed – completely sealed during pressure cooking, so food cannot dry out
- **Lid can be taken on and off freely** when frying, boiling, steaming or baking.

– CONS

- Not ideal for certain dishes such as mandazis (deep frying) or chapatis, where you need to manually control heat or use a shallow pan.
- Not yet available in most Kenyan stores.
- The appliance costs about twice as much as an electric hotplate.
- Looks complicated at first, but once you get used to it, cooking becomes much easier
- Inconvenient to check on the food during pressure cooking stage.

EPC MAKES AND MARKET GROWTH

- Many leading manufacturers producing them: Cuisinart, Fissler, Breville, Instant Pot, All-Clad, Philips, etc.

- Many lesser known more inexpensive models produced and exported globally from China as demand grows globally.
- Global sales up 25% year on year (2017-2018)

- A lot of experience with slow cookers, rice cookers, water boilers, etc. in Asian countries.
- Electric pressure cookers are able to slow cook and hence their popularity will likely see adoption continue to grow.

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Session 3: Battery–eCooking for mini–grid and weak grid applications / Standalone PV–battery eCooking – Professor Matthew Leach, MECS

Modern energy cooking services

Prof. Matt Leach

Electric Cooking technologies: case studies

September 2019

MECS Modern Energy Cooking Services

Loughborough University Gamos UKaid

Cases to present

- *Battery-eCooking for mini-grids and weak grid applications*
- *Standalone PV-battery eCooking*

Based on cooking data collected by Jon Leary in 2018 in Tanzania, Zambia, Kenya and Myanmar

Using the eCook model developed by Matt Leach

Applied to cases developed by Jon, Matt and Besnik Hyseni for a MECS/ESMAP paper

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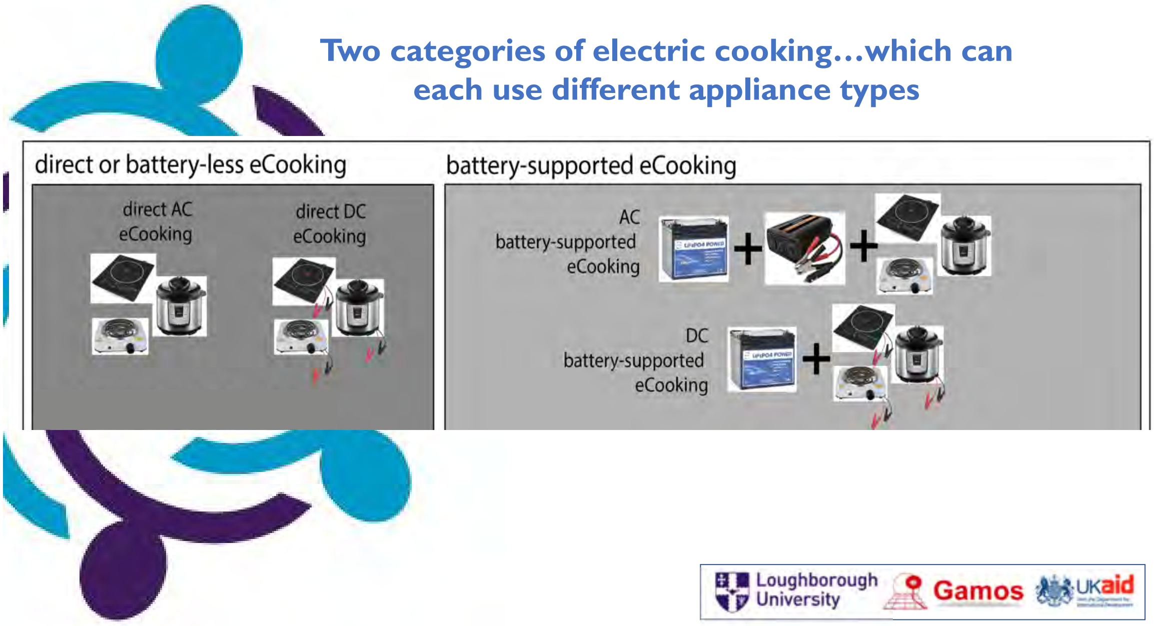

Two categories of electric cooking…which can each use different appliance types
direct or battery-less eCooking
direct AC eCooking
direct DC eCooking
battery-supported eCooking
AC battery-supported eCooking
DC battery-supported eCooking
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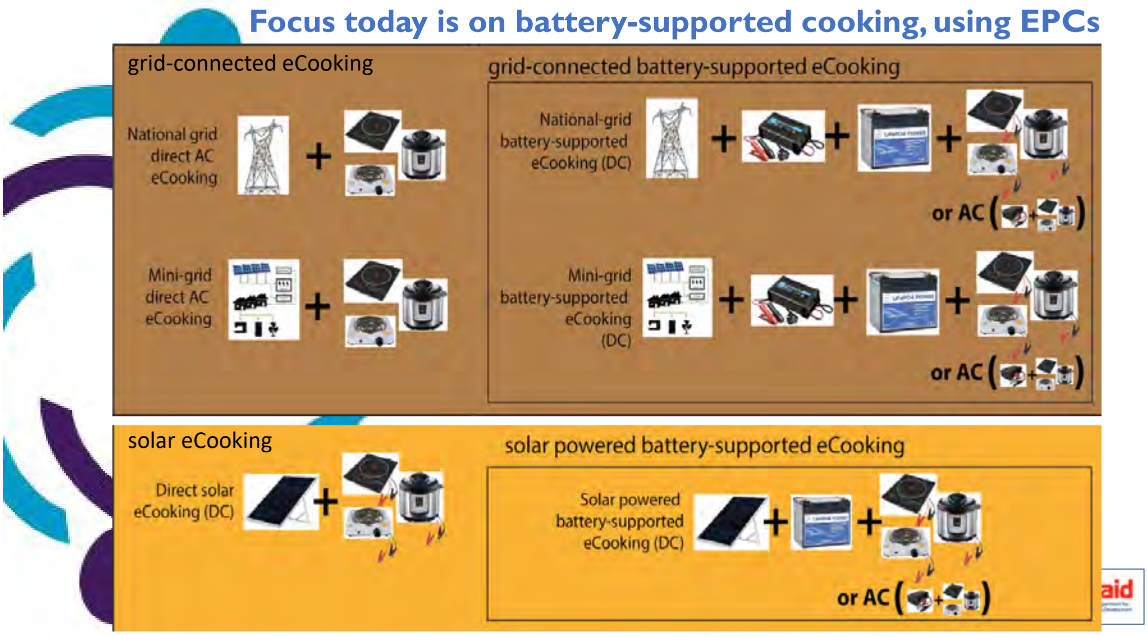

Focus today is on battery-supported cooking, using EPCs
grid-connected eCooking
National grid direct AC eCooking
Mini-grid direct AC eCooking
grid-connected battery-supported eCooking
National-grid battery-supported eCooking (DC)
or AC
Mini-grid battery-supported eCooking (DC)
or AC
solar eCooking
Direct solar eCooking (DC)
solar powered battery-supported eCooking
Solar powered battery-supported eCooking (DC)
or AC

Battery supported eCook

- Battery-supported cooking unlocks big market segments: unreliable urban grids; weak-grids more generally; mini-grids and off-grid
- Inclusion of energy storage could also mitigate peak loads for utility or minigrid and mitigate high currents (so household wiring quality less of issue)
- Our focus now has been on use of EPCs, to minimise the size and cost of the system, for early uptake
- Cases focused on cooking 50% of household’s food with an EPC & 50% stacking with traditional fuel

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Fuel stacking LPG with an EPC

Even when grid electricity is available in Zambia , charcoal is still chosen by many.

Inside the powerhouse at one of the many smaller and weaker micro-hydro systems in Shan state.

Echariria residents with a DC EPC at a community meeting

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Storylines for cases (in red presented today):

- Case study 1: Building upon the success of LPG to kick charcoal out of urban East African kitchens
- Case study 2: tackling load shedding in Lusaka by time shifting and reducing electricity demand for cooking
- Case study 3: Capturing more revenue from cooking on mini-grids in Myanmar
- Case study 4: opportunities for ultra-efficient eCooking in contexts with high tariffs and cheap biomass (micro-business bean pre-cook, in Tz)
- Case study 5: The next generation of cooking-enabled solar home systems has already arrived (PV-eCook in rural Kenya)

Context		System architecture		Appliances	Fuel prices				
					Electricity tariff (USD/kWh)	Firewood (USD/kg)	Charcoal (USD/kg)	Kerosene (USD/litre	LPG (USD/kg)
Urban	Nairobi, Kenya	National grid	Direct AC & battery-supported DC	EPC, rice cooker, hotplate	0.17	n/a	0.49	1.1	1.08
	Lusaka, Zambia	National grid	Direct AC & battery-supported DC	EPC, hotplate	0.01	n/a	0.21	n/a	2.07
Rural	Naung Pain Lay, Myanmar	Mini-grid	Direct AC & battery-supported DC	Rice cooker, induction stove, electric frying pan, EPC	0.16	0. 13	0.15	0.82	1.08
	Kibindu, Tanzania	Mini-grid	Direct AC & solar battery-supported DC	EPC	1.35	0.04	0.11	0.82	1.16
	Echariria, Kenya	Off-grid	Solar battery-supported DC	EPC	n/a	0.17	0.31	1.18	1.33

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Case study 1: building upon the success of LPG to kick charcoal out of urban East African kitchens

Explores an opportunity for East Africans to transition completely away from biomass and reduce the cost of cooking even further, by switching either fully to electric cooking or partially, using an EPC pus fuel stacking.

Nairobi, Dar es Salaam and Kampala are all regional deforestation hotspots, and as a result, the price of charcoal has been steadily increasing

Charcoal forms a much larger part of the fuel mix in urban areas and in Uganda, two thirds of the urban population use it as their primary cooking fuel. The statistics are similar in Tanzania, however in urban Kenya, kerosene and charcoal are equally popular.

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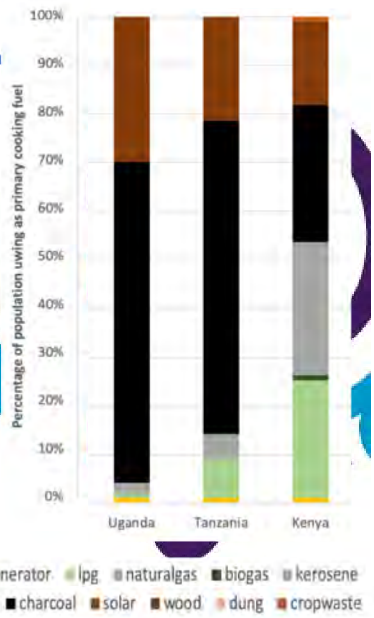
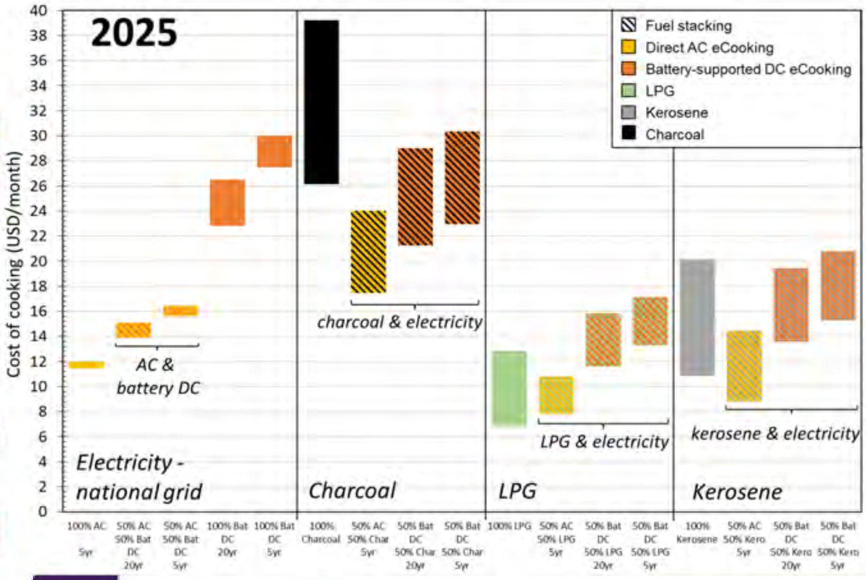
Primary fuel users in urban Uganda, Tanzania and Kenya





Fuel stacking with electricity decreases the cost of cooking for both charcoal and kerosene users

Fuel stacking with battery-supported devices is already a cost effective option for charcoal users

System comprises a lithium iron phosphate battery of 0.93kWh capacity,.

Case study 1: building upon the success of LPG to kick charcoal out of urban East African kitchens (Nairobi data)

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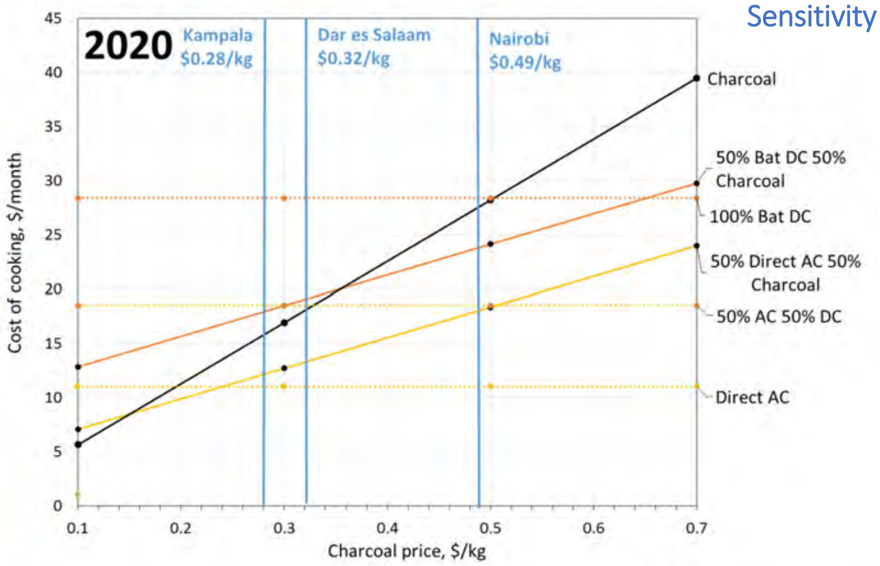
Sensitivity to charcoal price



Nairobi: high charcoal prices => all options cheaper

With even lower charcoal prices typical of Kampala, 100% direct AC cooking and stacking charcoal with direct AC electricity are both still cheaper than charcoal.

Case study 1: building upon the success of LPG to kick charcoal out of urban East African kitchens.

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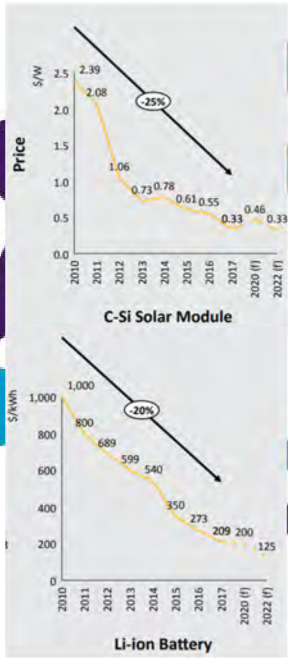
Conclusions on battery-supported eCook + fuel stacking

- In urban contexts with relatively high traditional fuel prices and average electricity prices, both direct AC and battery-supported eCooking can already offer considerable cost savings
- Will become more competitive if, as expected, fuel prices continue to increase over time.
- In contexts with well-established LPG markets, stacking with efficient eCooking appliances can offer an affordable and desirable pathway to move completely away from charcoal

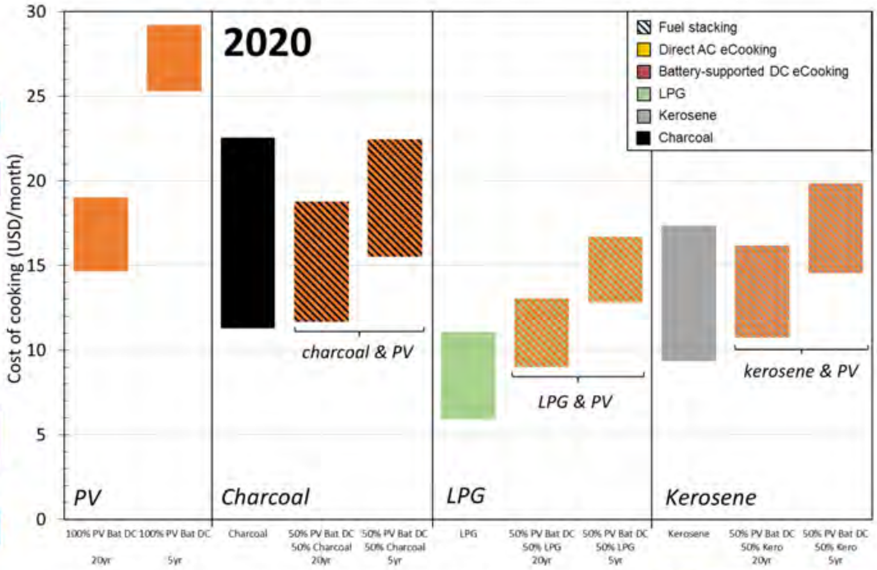
Source: https://www.lightingglobal.org/wp-content/uploads/2018/03/2018_Off_Grid_Solar_Market_Trends_Report_Full.pdf

Solar PV-battery eCook

- Until recently, an individual solar electrical cooking appliance with integrated trickle charge batteries would have been unrealistically expensive for families across the developing world
- However, continued falls in the price of PV and batteries mean that this is nearly cost effective in some markets, with appropriate business models
- Can also be implemented as part of a wider solar-home system, increasing capacity of PV and of batteries to add cooking capability



Source: https://www.lightingglobal.org/wp-content/uploads/2018/03/2018_Off_Grid_Solar_Market_Trends_Report_Full.pdf

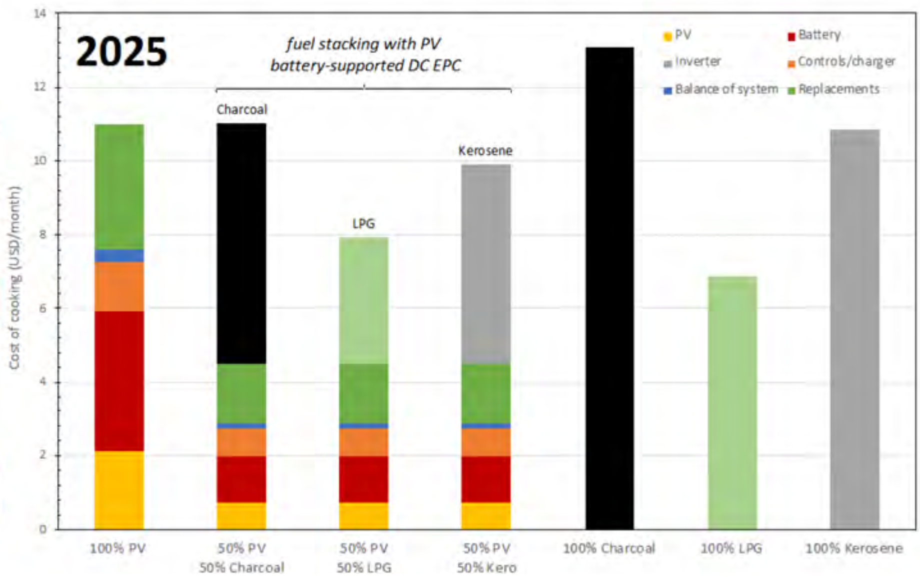


Modelling households preparing 50% of their menu on a DC PV-powered battery-supported EPC and stacking with charcoal, LPG or kerosene

System comprises a lithium iron phosphate battery of 0.74kWh capacity, charged by a 220Wpeak PV panel

.

Case study 5: The next generation of cooking-enabled solar home systems has already arrived (PV-eCook in rural Kenya)



Decomposition of PV eCooking and fuel costs for systems sized to meet the needs of the average Kenyan household using the lower bound costs in 2025 with a 20 year financing horizon

Case study 5: The next generation of cooking-enabled solar home systems has already arrived (PV-eCook in rural Kenya)

Conclusions on solar PV-battery eCook

- In deforested rural areas with relatively high biomass fuel prices, solar eCooking solutions are already cost effective
- Increasingly cost competitive in future as eCook component costs fall and traditional fuels prices increase
- Also co-benefits: access to electricity for other low power energy services typical of solar home systems "for free"

Source: https://www.lightingglobal.org/wp-content/uploads/2018/03/2018_Off_Grid_Solar_Market_Trends_Report_Full.pdf

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MECS Modern Energy Cooking Services

Overall conclusions

High and rising costs of traditional fuels, and falling battery and PV costs, opening up potentially large markets

Efficient cooking (eg use of EPCs) and fuel stacking leads to smaller eCook systems: low hanging fruit, kick-start the electric transition

Support needed for utilities, mini-grid developers, service providers & policymakers to:

- implement off-peak tariffs aimed at encouraging users to cook with electricity without significantly increasing peak loading
- finance efficient cooking appliances & develop on-bill financing mechanisms

Lots of commercial interest, trials starting (incl via MECS Challenge Funds)…evidence multiplying

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Session 3: Business models and cost trends – Besnik Hyseni, The World Bank

DELIVERY MODELS AND FINANCING FOR ELECTRIC COOKING APPLIANCES

Besnik Hyseni
Energy Specialist
bhyseni@worldbank.org

Rabat, Morocco
September 4-5, 2019

THE WORLD BANK
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ESMAP
Energy Sector Management Assistance Program

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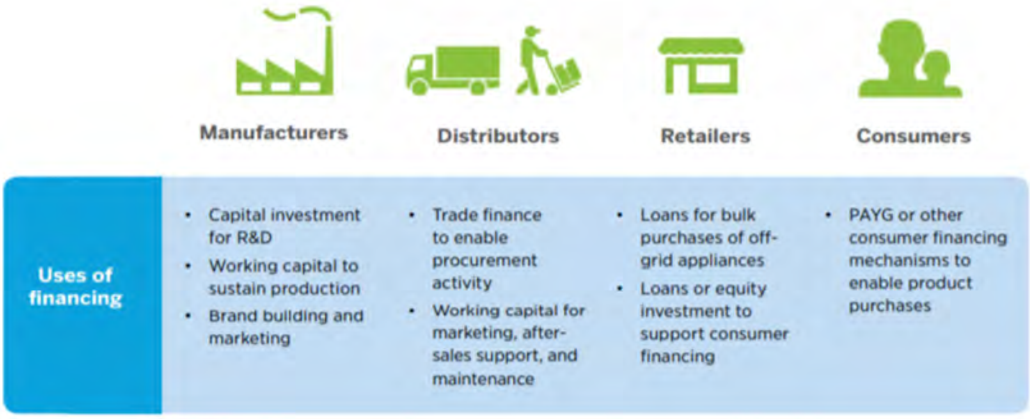
VALUE CHAIN FINANCING FOR HOUSEHOLD APPLIANCES



SUPPLY SIDE FINANCING

Financing working capital costs of service providers

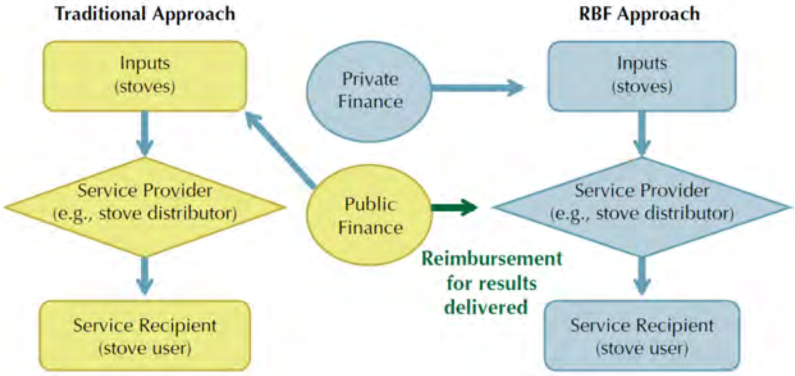
- loans, guarantees, collateralization, etc. to fund additional capex of firm due to locking in capital in repayment schemes with customers.
- Experience from Lighting Africa programs

- Results Based Financing (grants) tied to outputs or outcomes
  - number of verified units sold to customers (outputs); and/or
  - quantified and monetized impact units (health, environment, gender, etc.)

RESULTS-BASED FINANCING (RBF)

- Incentives, rewards, or subsidies are linked to the verified delivery of pre-defined results.

- RBF gives the potential to improve the efficiency and effectiveness of disbursing public resources and support of market-based interventions



INNOVATIVE RESULTS BASED FINANCING

1. **Attract climate, health and gender "impact $" by <u>demonstrating cost-effective impacts</u>**
   - Clearly defined impact unit(s)
   - Methodologies with broad consensus and credibility
   - Independent, credible third-party verification of impacts
   - Demonstrate cost-effectiveness.
   - WB piloting this approach in Lao PDR

2. **Use "impact $" to mobilize social and private enterprise innovation and investment through results-based approach with <u>firm commitment to "buy" verified impacts results</u>.**

3. **Continue to address policy, regulation, and awareness barriers to create enabling environment for market to grow.**

DEMAND SIDE FINANCING

- PAY-AS-YOU-GO (PAYG) integration by bundling electric cooking appliances in service packages or upgrading household system to the next 'tier' able to accommodate more appliances.

- ON-BILL FINANCING AND REPAYMENT for electric cooking appliances by electric utilities or outside administrators; bulk procurement of eligible appliances.

- CONSUMER FINANCE LOANS conventional concessional loans to customers through MFIs or savings cooperatives for eligible appliances

VALUE ADDED SERVICES (VAS)

- Value add-on services recognize customers' lifetime value beyond a single transaction relationship.

- Utilities may have internal energy product ladder that caters to customer preferences by introducing productive use appliances and other value creating services and appliances which can include EPCs

- These add on services can be provided directly by the utility or third party providers.

Thank You

bhyseni@worldbank.org

Session 4: Cooking methods in Morocco / A gender perspective – Virginie Klein, GERES / Project FaranEco

Atelier AMEE « Vers une cuisson propre et durable »

4- 5 Septembre 2019, Rabat

geres

GERES, une ONG de développement au service de la solidarité climatique

- Une ONG de développement et de solidarité internationale
- Créée en France, en 1976 après le 1er choc pétrolier
- Spécialisée dans le secteur de l'énergie durable

Une ingénierie de développement et une expertise technique spécifique	Préserver l'environnement et améliorer les conditions de vie…	Travailler en partenariat avec les acteurs et les communautés locales

- Siège à Aubagne (France) et des représentations dans 9 pays

www.geres.eu 03/09/2019

2

LES CHIFFRES CLÉS

73
PARTENAIRES FINANCIERS

110
PARTENAIRES TECHNIQUES

164 609
BÉNÉFICIAIRES DIRECTS

DONT **4 776**
ENTREPRENEURS SOUTENUS OU ACCOMPAGNÉS

860 000
BÉNÉFICIAIRES INDIRECTS

22
RÉSEAUX

200
COLLABORATEURS

10
REPRÉSENTATIONS PERMANENTES

64
PROJETS MENÉS DANS **17** PAYS

Sommaire:

Problématiques liées aux modes de cuisson

Entre tradition et modernité…

- Du four à bois…

Fours à bois traditionnels : consommation annuelle d'une famille rurale = 4 tonnes de bois dont 2 tonnes pour la cuisson (source : GERES).

Faible rendement : 1,3 kg de bois pour chauffer 1kg de pain.
Conséquences : pénibilité de la tâche, déforestation, fumées nocives

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Entre tradition et modernité…

- Au four à gaz

Des fours majoritairement de mauvaise qualité et énergivores…

Fours dits de « souk » : qualité médiocre, risque de brûlure, mauvais rendement énergétique (43 à 59g de gaz nécessaires pour 1kg de pain), émissions dangereuses dues à une combustion incomplète (monoxyde de carbone)

Un budget encore trop important pour les ménages et qui risque d'augmenter avec la fin de la subvention de la caisse de compensation (précarité énergétique)

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Chiffres-clés du marché marocain

Chiffres-clés

Fours domestiques :

Au moins **60 %** des ménages marocains possèdent un four à gaz (source : HCP)

Production annuelle* :
50 000 fours formels
100 000 fours informels

Fours professionnels** :**

Expansion du phénomène des petites boulangeries informelles/AGR (plus de 10 000 ?)

Utilisation de fours et plaques au gaz
Conso : **7 bouteilles**/sem

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*Etude de marché GERES (Fellah Conseil, 2016)
**Etude de marché GERES (Arkayn&Co, 2018)

Faraneco

FaranEco : une alternative vers la durabilité

FaranEco : un label d'éfficacité énergétique

- Partenariat avec des industriels marocains

FOURS AFIFI آفـران عفيـفـي DREAM GAZ DISPREL

- Accompagnement technique :

R&D réalisée avec les ingénieurs du GERES
Elaboration d'un protocole de tests pour mesurer l'EE
Cahier des charges FaranEco (normes, qualité des matériaux, Contrôle du CO)

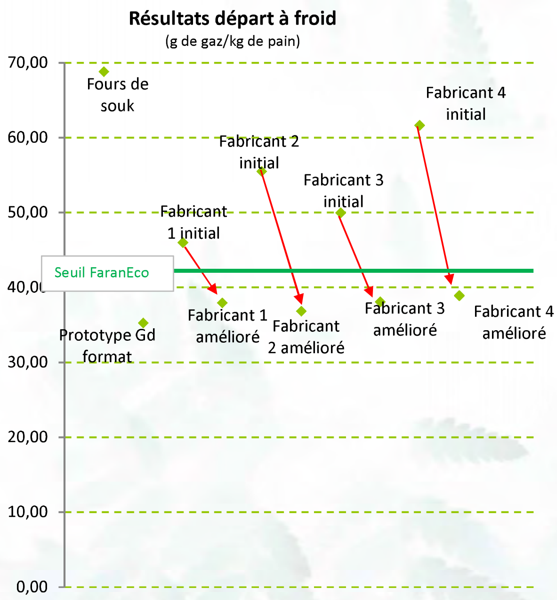
- Résultats :

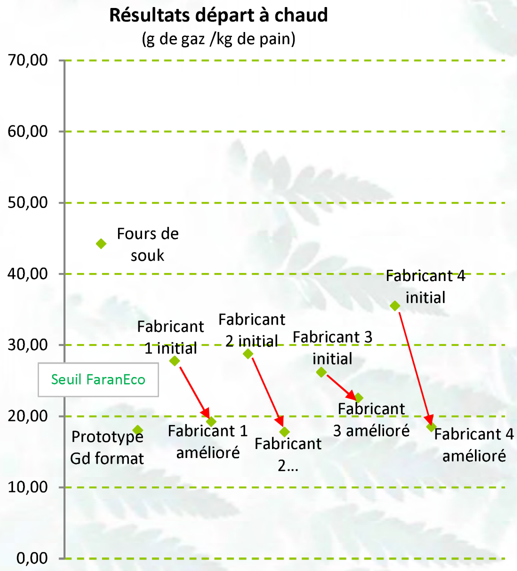
Nouvelle gamme de fours à gaz permettant des économies de 30 à 50 % pour les ménages et les professionnels

FaranEco : un label d'éfficacité énergétique



FaranEco : un label d'efficacité énergétique





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AMÉLIORATIONS TECHNIQUES APPORTÉES AU FOUR

RENFORCEMENT DE L'ISOLATION

Entre 2 et 3,5 cm d'épaisseur de la laine de verre ou de roche

Un double vitrage résistant à une température de 250°C

Pliage des tôles internes et externes pour éviter les ponts thermiques

CIRCULATION DE L'AIR

Optimisation de l'air pour obtenir des flammes d'une longueur inférieure ou égale à 1cm et de couleur bleue

Aération bien dimensionnée pour permettre une combustion optimale du gaz tout en limitant les déperditions thermiques

Le monoxyde de carbone (CO) est inférieur à 500 ppm pendant la phase de préchauffage et inférieur à 50 ppm pendant les phases de cuisson

BRÛLEURS

La distance entre axes des trous des brûleurs ne dépasse pas 15mm pour garantir un allumage rapide

Le brûleur médian est situé au moins 4cm en dessous de la plaque de cuisson

Les brûleurs sont dimensionnés pour un fonctionnement sous une pression relative située entre 30 et 60 mbar

DURÉE DE PRÉCHAUFFAGE ET CUISSON

La durée de préchauffage du four pour atteindre 200°C dans le compartiment haut de cuisson avec les deux brûleurs allumés ne doit pas dépasser 12min pour une température ambiante de 25°C ; la cuisson de pain quant à elle doit se faire en 8 min maximum

PLAQUE DE CUISSON

La plaque de cuisson est une composante importante pour une bonne cuisson du pain. Elle doit avoir soit une forte inertie thermique, soit une bonne capacité à répartir la chaleur.

PROTOCOLE, TESTS ET RÉSULTATS

Les tests d'efficacité énergétique des fours respectent un protocole et un mode opératoire précis.

Deux tests complémentaires sont faits pour obtenir une valeur brute de l'efficacité énergétique à laquelle ont été apportés des facteurs correctifs liés à la température ambiante et à l'hygrométrie

Le test de « consommation d'entretien » est un test qui a pour but de déterminer la consommation de gaz du four pour maintenir la température intérieure du four dans une plage déterminée, le four étant à vide

Le test de cuisson sert à calculer combien de gramme de gaz a été consommé par kilo de pain cuit.

Valeurs à mesurer :

- Quantité de gaz consommée
- Quantité de CO dégagé
- Températures intérieures (x2)
- Températures des 6 parois
- Temps de cuisson
- Quantité d'eau évaporée

Sont considérés comme énergétiquement efficaces, les fours consommant au maximum 25g de butane par Kg de pain cuit en départ à chaud*

Approche genre dans les projets de cuisson durable

Retour d'expériences du GERES

- Projet SCALE au Cambodge/Myanmar pour la diffusion des foyers améliorés

Partenaire : ENERGIA : réseau international sur le genre et l'énergie durable

Etude et Plan d'actions genre

Retour d'expériences du GERES

- Pourquoi une approche genre est nécessaire dans le secteur de la cuisson durable ?

➢ Les femmes sont les premières concernées par l'utilisation de l'énergie dans le foyer et l'approvisionnement (collecte bois…)

➢ Elles sont particulièrement vulnérables face à la précarité énergétique et sont impactées par la cuisson (brûlures, problèmes santé, perte de temps…)

➢ Elles ont moins d'opportunités, notamment professionnelles

L'approche genre permet :

➢ Demande : s'assurer que les produits répondent bien aux besoins des femmes (/hommes) pour les usages domestiques et productifs

➢ Offre/chaîne de valeur : améliorer la participation, mobilisation des femmes dans les activités de production, distribution des fours etc.

➢ Créer un levier d'autonomisation économique des femmes : production/vente pain

➢ Adapter la stratégie marketing et communication H/F afin de favoriser l'adoption des produits

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Intégrer le genre

Informations collectées :
Indicateurs généraux genre dans le pays
Indicateurs spécifiques au secteur de la cuisson (offre/demande…)
Capacités des communautés à accepter les questions d'approche genre
Capacités des équipes de terrain à mettre en œuvre l'approche genre
Canaux de com existants (H/F) sur les sujets cuisine, santé, énergie
Questions culturelles liées aux AGR des femmes

Méthodologie :
Enquêtes et focus groupe avec des femmes et des hommes
Aspects considérés dans les enquêtes : rôles et responsabilités des h/f, atouts et compétences, pouvoir et processus de décision, besoins/priorités et perspectives

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Et demain ?

Vers une cuisson durable…

- Fours à gaz : énergie fossile mais peu polluante, émet peu de GES > énergie qui contribue à la transition énergétique mais importance de l’EE pour minimiser les impacts (et pour palier l’arrêt probable à terme des subventions)

- Fours électriques : OUI, mais sous conditions : production d’énergie propre et EE

- Autres alternatives :

Cuisson solaire, cuisson à partir
de biogaz/projets de méthanisation
Briquettes de biomasse, charbon « vert »

geres Maroc

Faraneco

Merci pour votre attention

Contact : Virginie KLEIN
Chef de projet FaranEco
Représentante Pays GERES au Maroc
v.klein@geres.eu

Session 4: Current residential energy consumption by end-use and fuel/ Biomass –Abdelhaq Amahrouch, AMEE

Agence Marocaine pour l'Efficacité Energétique

amee
Agence Marocaine pour l'Efficacité Energétique

Aperçu sur le profil de consommation en bois de feu des ménages ruraux et les dépenses énergétiques

Atelier cuisson propre et durable
Rabat le 04/09/2019

Abdelhaq AMAHROUCH
- Amee -

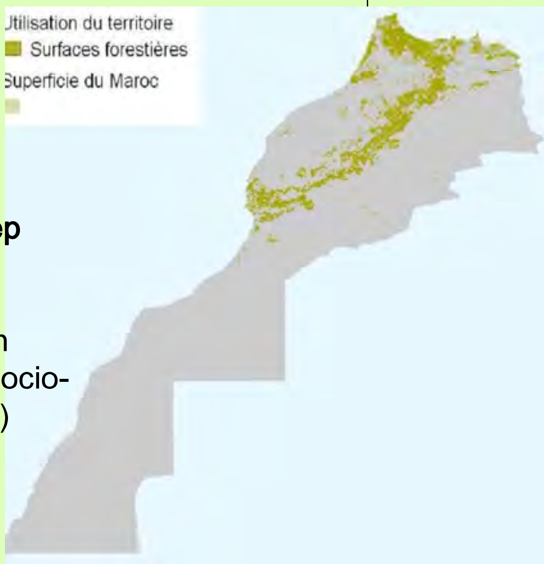
Plan

- Place de la biomasse dans la consommation énergétique nationale
- Aperçu sur le profil de consommation en bois de feu en milieu rural
  - Consommation moyenne totale BF en Eté
  - Consommation moyenne totale BF en Hiver
  - Consommation moyenne en gaz butane en Eté/hiver
  - Autres consommations énergétiques des ménages ruraux
- Dépenses énergétiques des ménages ruraux
- Interventions de l'AMEE pour l'économie d'énergie et la sauvegarde de la ressource
  - Actions réalisées et en cours de réalisations

Place de la biomasse dans la consommation énergétique nationale

La Biomasse énergie :

- Première ressource énergétique nationale, aux côtés de l'hydraulique, de l'éolien et du solaire,
- Forte contribution dans le bilan énergétique : ~ **3 Mio de Tep** (~15 % bilan énergétique global)
- Source d'approvisionnement énergétique prépondérante en milieu rural (cuisson, chauffage) et pour certains secteurs socio-économiques énergivores (hammams, poterie, ferranes, …)



Aperçu sur le profil de consommation en bois de feu en milieu rural

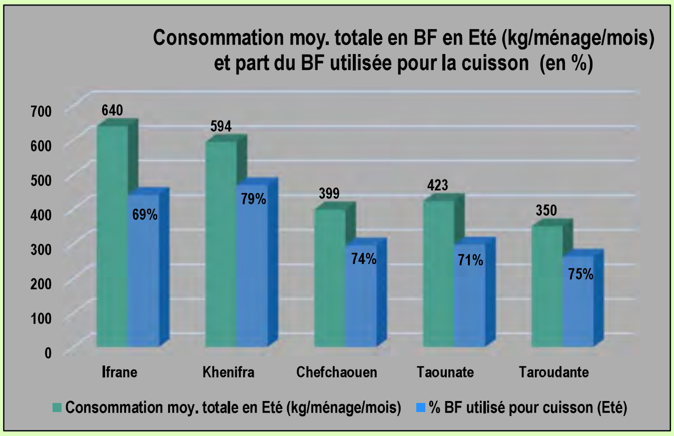
ETUDES SUR LA GESTION DE LA RESSOURCE ET LE PROFIL DE CONSOMMATION EN BOIS DE FEU EN MILIEU RURAL

- **Zones concernées par l'étude** :
  - le rif : Chefchaouen-Taounate,
  - le Moyen atlas : Khénifra-Ifrane
  - et l'Anti atlas : Taroudant
- **Objectif de l'étude** : mettre en évidence les usages et les besoins énergétiques et biomassiques, les modes d'approvisionnement, les dépenses énergétiques, l'analyse de l'offre technologique (foyers et fours améliorés, foyers à gaz, . etc).
- **Approche méthodologique** :
  - Collecte de données générales (Province, Cercle, Communes, Douars, …etc,)
  - Enquête directe, avec des mesures au niveau des différents types de bois consommés et pour chaque source de consommation (cuisson; chauffage, chauffage de l'eau sanitaire, …) .
  - Enquêtes de terrain, réalisée sur deux période différentes:
    - Période Eté;
    - Période froide (forte consommation de bois de chauffage).

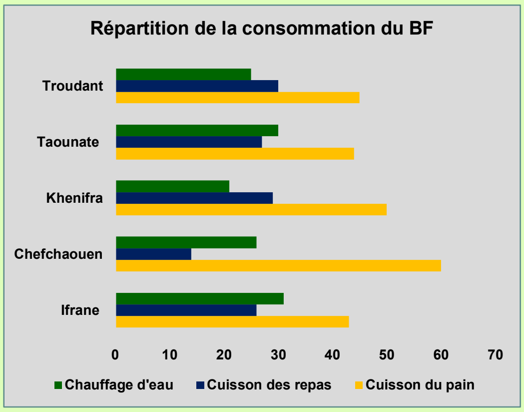
Aperçu sur le profil de consommation en bois de feu en milieu rural

❑ *Consommation moyenne totale BF en Eté*

- En Eté : Les quantités du BF consommées varient de 350 (Taroudant) à 640 (Ifrane) kg/ménage/mois.



- Part du BF utilisée pour la cuisson: 75% dont ~ 45% Cuisson du pain.

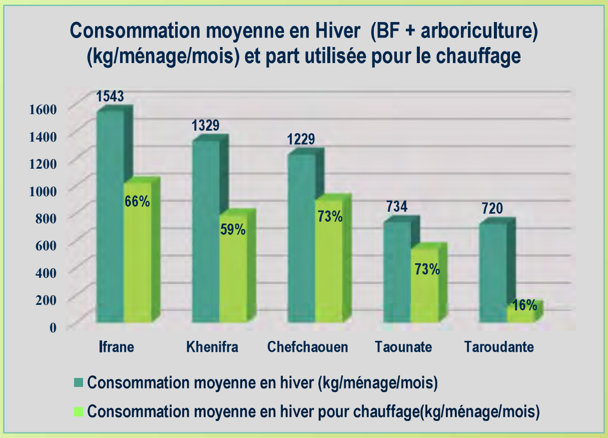


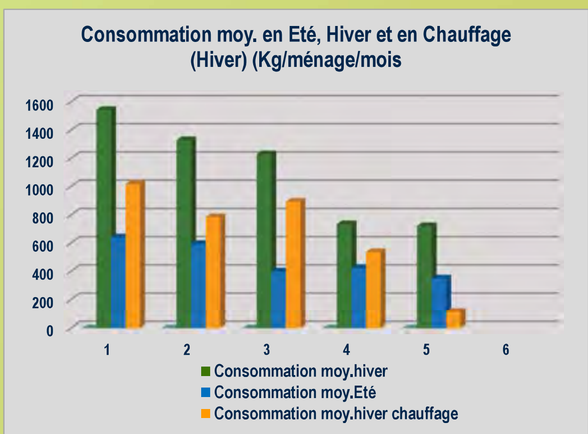
- Les cuissons du pain et des repas constitue les deux activités fortement consommatrices du BF.

Aperçu sur le profil de consommation du BF en milieu

❑ *Consommation moyenne totale BF en Hiver*

- **En Hiver, la consommation moyenne totale est de** :
  - 0,72 t à 1,54 t/ménage/mois et la majorité de la consommation en biomasse ligneuse est orientée vers le chauffage (60 à 73%);
  - La demande pour le chauffage est >> à la consommation totale moyenne en Eté.





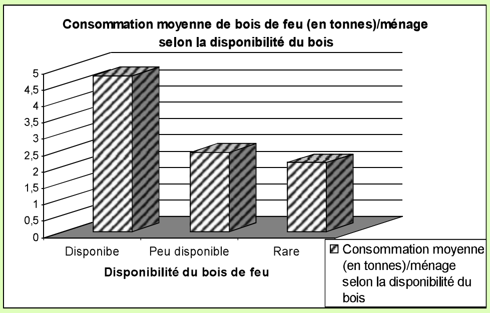
- Part du BF utilisée pour la cuisson (pain +repas) : 20 à 30% (120 à 416 kg/mois/ménage)
- A l'exception de Taroudant (67% pour la cuisson et 16% pour le chauffage).

Aperçu sur le profil de consommation en BF en milieu rural

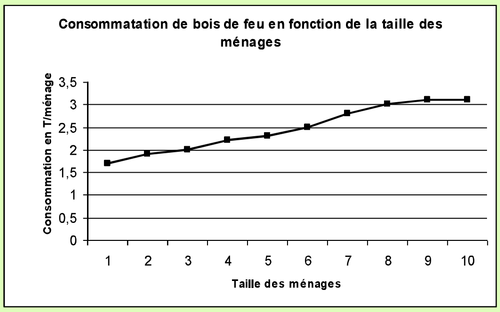
Le bois de feu reste donc la principale source d'énergie consommée par les ménages ruraux.

La consommation de bois de feu dépend, entre autres, des variables suivantes :

- La disponibilité de bois et l'accessibilité ;
- La taille du douar/ménage ;
- Le revenu, ou bien la superficie agricole utile d'un côté ou l'effectif du cheptel en Unités Petits Bétails (UPB) ;



En général la population est fortement dépendante du BF; mais si sa disponibilité fait défaut; les ménages s'adaptent aux réalités locales en se donnant aux autres sources d'énergie ; telles que le gaz butane.



Evolution de la consommation du BF en fonction de la taille du ménage (Taounate)

Consommation des ménages ruraux en butane et autres sources d'énergie

❑ *Consommation moyenne en gaz butane en Eté/hiver*

- Cette source d'énergie constitue le premier produit de substitution au bois de feu .
- L'emploi de l'énergie gazeuse est générée à tous les foyers. Cependant, le revenu constitue un facteur déterminant dans l'intensité d'utilisation du gaz butane (plus le revenu est grand, plus le ménage se permet d'utiliser le gaz butane)

Répartition de la consommation du butane selon les usages (kg/mois/ménage)

❑ *Période Eté*

Rubrique	Provinces				
	Ifrane	Chefchaouen	khenifra	Taounat	Taroudant
Cuisson du pain	2,5	2,9	0,6	2,5	3,3
Cuisson des repas	6,7	5,3	3,9	5,3	6,7
Chauffage d'eau pour le bain et autres utilisations	1,2	0,5	0,9	1	5
Eclairage	6,4	8,7	6,9	3,6	10
Total	16,8	17,4	12,3	12,4	25

❑ *Période Hiver*

	Provinces				
Rubriques	Ifrane	Chefchaouen	Khénifra	Taounate	Taroudante
	Qté en kg	Qté en kg	Qté en kg	Qté en kg	Qté en kg
Cuisson repas	14,07	23,81	10,07	1,3	8,86
Eclairage	2,31	2,48	1,9	1,3	8,86
Cuisson pain	1,47	12,9	0,73	18,85	4,3
Réchauffage d'eau	0,84	1,98	0,44	9,75	3,04
chauffages locaux	0,21	3,97	_	_	_
Alimentation supplémentaire	2,1	_	1,46	_	_
Hammam individuel	_	4,46	_	1,3	0,25
Total	21	49,6	14,6	32,5	25,3

- Les utilisations les + dominantes du gaz butane sont la cuisson des repas et l'éclairage des ménages non électrifiés.
- Les Quantités de gaz butane consommées par ménage et par mois pour la cuisson (repas et pain), le chauffage de l'eau pour le bain et l'éclairage varient de : 12,3 kg à 25 kg/ménage/mois en Eté et de 14,6 à 49,6 kg/ménage/mois en Hiver.

Consommation des ménages ruraux en butane et autres sources d'énergie

❑ Autres consommations énergétiques des ménages ruraux

- L'électricité occupe la plus grande part dans le bilan énergétique réservé à l'éclairage (29 à 34 kWh/mois),
- L'éclairage en milieu rural est essentiellement assuré par l'électricité, le butane et le pétrole lampant.

Consommations énergétiques pour l'éclairage (Eté)

Rubrique	Provinces					
	unité	Ifrane	Chefchaouen	Khénifra	Taounate	Taroudante
Bougies	unité	10	3	12	16	14
Plaques solaires	KWh	11	7	5	14	12
Gaz butane	Kg	6,4	8,7	6,9	3,6	10
Piles (grandes)	unité	3	2,5	3	3	3
Pétrole lampant	unité	5,4	5,4	5,34	6,52	12,3
Electricité	Kwh	32	29	34	34	34

Le tableau ci- dessus présente l'importance de chaque source d'énergie consommée mensuellement par ménage pour l'éclairage / Province en quantité.

Dépenses énergétiques des ménages ruraux

❑ Aperçu sur les dépenses énergétiques des ménages ruraux

Récapitulatif des dépenses énergétiques mensuelles en dhs par ménage (Phases : Eté, Hiver)

	Phases			
PROVINCES	Eté	Hiver	Total	Moyenne
IFRANE	158,4	350,9	509,3	254,7
CHEFCHAOUEN	165,4	296,92	462,32	231,2
KHENIFRA	146,1	265,7	411,8	205,9
TAOUNAT	162	161,9	323,9	162,0
TAROUDANT	209,5	201,4	410,9	205,5

Valeur estimée du BF consommé mensuellement (Eté) en dhs par ménage

PROVINCES	BOIS DE FEU CONSOMME (Valeur estimée en dh)
IFRANE	256
CHEFCHAOUEN	192
KHENIFRA	237
TAOUNAT	168
TAROUDANT	140

N.B.: Le BF n'a pas été pris en considération dans le récapitulatif des dépenses énergétiques.

- Les moyennes établies des dépenses par ménage varient de 162 dhs au niveau de la province de Taounat à 254,7 dhs au niveau de la province d'Ifrane.
- A Ifrane et chefchaouen, les dépenses en électricité puis en gaz butane dominent les dépenses des autres sources d'énergies. A Taroudant, Taounat et à Khenifra c'est le gaz butane et le pétrole lampant dominent les dépenses énergétiques.
- Pour le bois de feu, prélevé gratuitement, sa valeur estimée varie de 140 dhs à Taroudant à 256 dhs à Ifrane (moyenne de 0,4 Dh/kg).

Interventions de l'AMEE pour l'économie d'énergie pour la sauvegarde de la ressource

- **Economie d'énergie (BF)** à travers le développement et la diffusion des technologies améliorées :
  - Intervention sur les grands postes énergivores en milieu rural (cuisson repas et pain) et les systèmes de chauffages des hammams publics;
- Encourager l'utilisation des **déchets agricoles** en tant que **combustible de substitution** du bois de feu au niveau des systèmes de chauffage des hammams publics

- Sensibilisation à l'utilisation du biogaz comme énergie **de substitution** au BF
- **Actions en cours de réalisation** :
  - Développement d'un système de chauffage à bois efficient en énergie pour les habitations rurales;
  - Optimisation énergétique d'un four à bois pour la cuisson et le chauffage en collaboration avec le HCEFLCD;
  - Etudes sur solutions d'amélioration de la performance énergétique et de la conception des bâtiments ruraux existants.

Session 6: Electric pressure cookers in Africa – Jacob Fodio Todd, Research Fellow, University of Sussex, UK and MECS

MECS
Modern Energy Cooking Services

Electric Pressure Cookers (EPCs)

Jacob Fodio Todd, University of Sussex

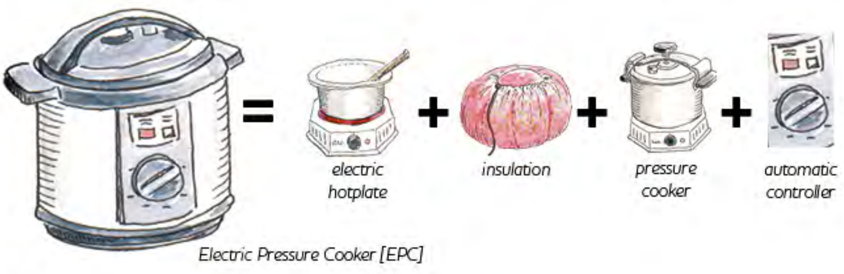
'This material has been funded by UK aid from the UK government; however the views expressed do not necessarily reflect the UK government's official policies.'

Outline

- EPCs
- User experience in SSA
- Cooking diaries
- EPC, a good fit!
- Foods that can be cooked on EPCs
- The eCookbook

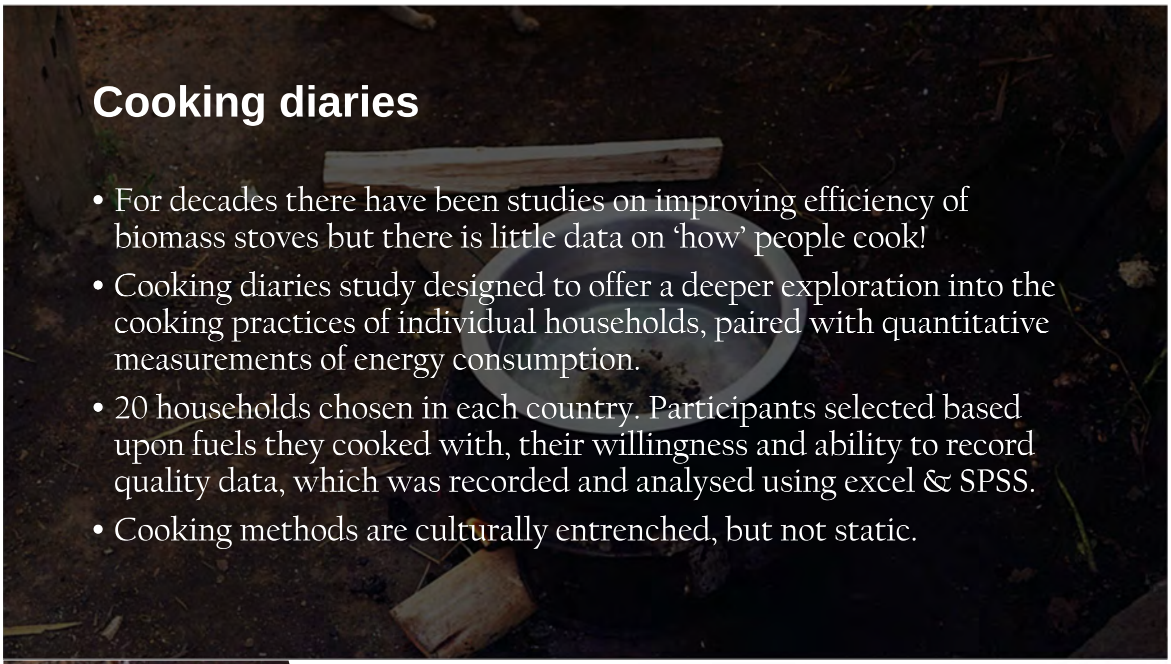
Electric Pressure Cookers (EPCs)

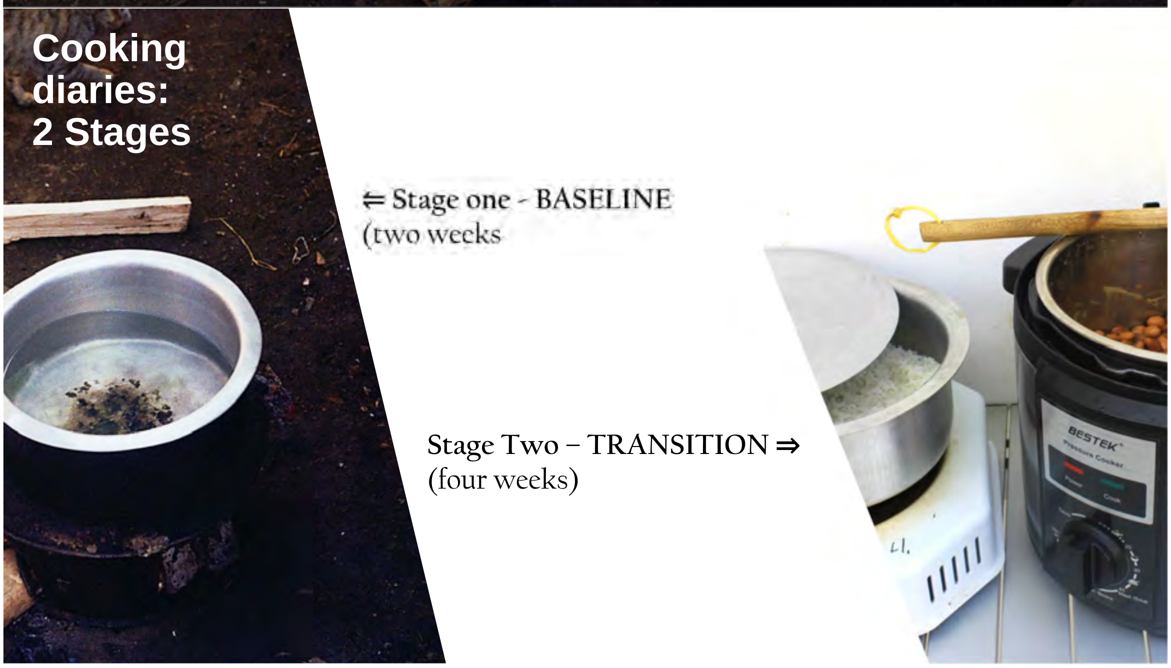
- Are the fastest growing kitchen appliance in the US and Europe
- They are popular there because they are fast and convenient (& automated)
- They are energy saving
- Combines an electric hotplate, a pressure cooker, an insulated box and a fully automated control system
- They cost between $35 and $120 but varying quality.



EPCs in sub-Saharan Africa

- Ecook research started with hotplates in mind, as it was thought that they would be the most attractive appliances since it required the least behavioural change from charcoal
- But in contexts where LPG was widely available, the electric hotplate could be a step backwards for most people. However, efficient electric appliances that offer automatic control give something that no other fuel can, making appliances like the EPC a truly aspirational product for most households once they've seen what it can do.
- Much of the past ecook work on EPCs in Africa has been undertaken in Eastern Africa (*Tanzania, Kenya, Uganda & Ethiopia*) & Southern Africa (*Zambia*) although many more studies planned across Africa (*eg. Ghana*) under MECS programme.
- Electric cooking has had limited uptake in Eastern Africa but has clear promise with good environment for adoption of energy-efficient products. Other sectors have already been revolutionised (such as lighting).
- Methods for gathering data on EPC use & uptake have been multidisciplinary (for example cooking diaries, focus groups, kitchen laboratories, interviews)


Cooking diaries
• For decades there have been studies on improving efficiency of biomass stoves but there is little data on 'how' people cook!
• Cooking diaries study designed to offer a deeper exploration into the cooking practices of individual households, paired with quantitative measurements of energy consumption.
• 20 households chosen in each country. Participants selected based upon fuels they cooked with, their willingness and ability to record quality data, which was recorded and analysed using excel & SPSS.
• Cooking methods are culturally entrenched, but not static.


Cooking diaries: 2 Stages
⇐ Stage one - BASELINE
(two weeks
Stage Two – TRANSITION ⇒
(four weeks)
BESTEK

The EPC – a good fit!

Among almost all participants in the cooking diary studies, the EPC was the favoured electric appliance. When given a hotplate, rice cooker and EPC, and minimal training, households choose to cook about half their menu with an EPC.

MAIN DRIVERS

- **Fast** – time savings of upto 80% due to increased pressure & temperature
- **Safe** – numerous inbuilt safety features
- **Convenient** – automated control, so able to multitask. Also considered clean.
- **Tasty** – Just as delicious!
- **Also seen as an aspirational device with** ability to do more with, above and beyond conventional stovetop cookers.
- **Most East African meals can be cooked with an EPC**

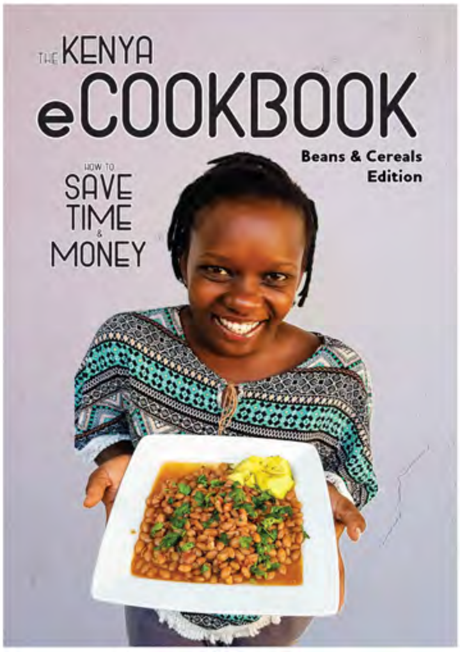
EPC - What is it good for?

'Heavy' foods like beans or meat stew generally require boiling for 60 minutes or more. Easy to cook on an EPC & can offer significant energy & time savings over electric hotplates, or a rice cooker with moderate energy savings. *Eg. Beans, meat.* **EPCs take the most energy intensive dishes and transform them into one of the least energy intensive. Especially important on grids with high peak loading and for battery-supported cookers**

'Long fry and deep fry' foods are very difficult to cook on an EPC as they require precise temperature control. *Eg. Donuts, chapati, flatbreads.*

'***Staple'*** foods and that require boiling for 15 minutes or more can also be cooked on an EPC, with moderate energy & time savings or rice cooker with moderate energy savings. *Eg Rice, pasta, noodles, rice*

'Quick fry' foods can also be cooked on an EPC, but some households may be reluctant to try and/or there are limited energy savings. *Eg. Eggs, fish, leafy veg*



WHO IS IT FOR?

- Originally conceived as conventional cookbook to inform everyday cooks on the time and money (energy) implications of the choices they make in the kitchen.
- Cookbooks not widely used in Kenya – most younger cooks now consult Youtube & local food bloggers to learn new recipes.
- More likely a collection of useful data on cooking and energy consumption presented in an accessible way (we hope!)
  - A reference document for those working in cooking and energy sectors
  - Modular design – pages can be split up and disseminated individually (e.g. as posters, shared on social media)

CHARCOAL

WHAT IS IT?

Charcoal is produced by **heating wood without oxygen** to remove water & other undesirable components. **Most charcoal stoves** are simple metal and/or clay devices designed to allow air to flow through the charcoal & funnel heat onto the pot.

WHY IS IT USED?

Firewood is bulky and difficult to transport – **turning it into charcoal makes it accessible to urban people**. It also burns **more continuously** & with **less smoke**. Charcoal stoves are widely available & cheap (500KSh+).

Charcoal used to be cheap too. It gives a unique **smokey flavour** & crispiness – great for nyama choma, but **doesn't do much for foods boiled in a pot**.

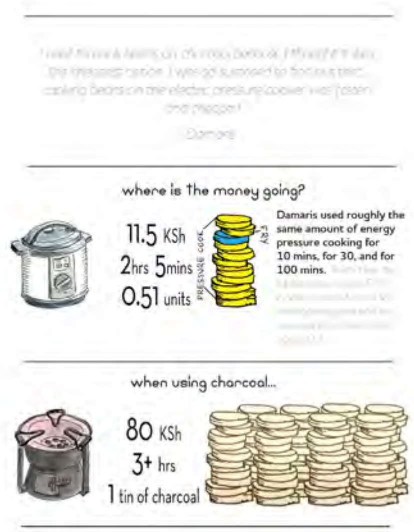
WHY CONSIDER OTHER OPTIONS?

1. Lighting charcoal is tedious, especially when wet.

2. Charcoal smoke may hurt your eyes less than wood smoke, but it contains far more **carbon monoxide**, which **can kill** in poorly ventilated spaces.

3. Charcoal prices doubled in 2018 because of the logging ban. **10kg of wood is needed to produce each kg of charcoal**, so the forests around Nairobi have been stripped & charcoal now has to be brought from further & further away.


DAMARIS*
YELLOW BEANS
WITH GREEN PEPPERS, ONIONS AND TOMATOES
method
YELLOW
500g
1 litre
PRESSURE COOK
110 mins
pressure cook for as long as possible without opening as cooking time & cost increases with every depressurisation
FRY
10 mins
PRESSURE COOK
5 mins


where is the money going?
11.5 KSh
2hrs 5mins
0.51 units
PRESSURE COOK
FRY
Damaris used roughly the same amount of energy pressure cooking for 10 mins, for 30, and for 100 mins.
when using charcoal...
80 KSh
3+ hrs
1 tin of charcoal


ELECTRIC PRESSURE COOKER
(EPC OR MULTICOOKER)
WHAT IS IT?
The electric pressure cooker (or multicooker) is an appliance that is a combination of familiar things (an electric hotplate, a pressure cooker and an insulated hotbox) - with a fully automated control system.
insulation
electric hotplate
pressure cooker
WHY USE IT?
1. It is faster, a pressure cooker raises the temperature above boiling point so that it can cook much faster.
2. It is cheaper as it is energy efficient. For one, there is insulation around the pot so that the heat goes directly into the pot and stays in there.
3. It is convenient: the whole cooking process is automated, once you set the time the temperature it is controlled by the appliance, so that you can go off and do other things.
WHAT TO USE IT FOR?
It's best for 'heavy foods' like beans, githeri or matumbo, but can also cook: ugali, matoke, sukuma wiki, rice, eggs, meat/fish/veg stew, fried/boiled meat/fish/veg, mokimo and many more of your favourite dishes. It can cook 'heavy foods' in half the time and with a fraction of the energy/cost.

ENERGY SAVING TIPS

'Heavy foods' like beans that need to be boiled for several hours are often the biggest energy users in the kitchen. These tips will help you reduce the time and money you spend cooking *'heavy foods'*.

USE ENERGY EFFICIENT APPLIANCES

An efficient appliance like an EPC ***can save you a lot of time & money.*** *Combined with other energy saving tips you could* ***save over 90% of the cost & 75% of the time*** *versus cooking inefficiently on a simple hotplate. However, if you don't have an efficient appliance, the rest of these tips apply to just about any stove using any fuel.*

SOAK DRIED FOODS

Soaking dried foods *until they have absorbed the water lost when dried* ***can reduce boiling times by half.*** *Usually, several hours is enough, or with beans, until the wrinkles have disappeared. Older cereals will have had more time to dry out, so are likely to benefit most from soaking.*

SIMMER WITH A LID ON

Steam escaping is energy & money escaping. *Trapping it inside with a lid can make cooking cheaper, but* ***you'll only save money if you also turn the power down and simmer.*** *You'll use less water too.*

GET A HEADSTART

Use ***leftover hot, or warm water*** *to save time & money. Getting water from cold up to boiling point can take up to 20 minutes. Cooking doesn't start until you get close to boiling. If you have hot water left over after making tea,* ***keep it in a Thermos*** *until you need it. If you don't have any left over hot water, save time by heating water with a* ***kettle.***

THINK SMALL

Smaller pieces cook faster *as they have a larger surface area to absorb heat & water. Cutting up ingredients like onions into* ***smaller pieces can also speed up cooking,*** *in particular, the energy-intensive frying stage.*

In fact, you can ***totally avoid frying*** *by putting all the ingredients in at the start, but it might not be quite as delicious as usual.*

Smaller beans/cereals, *like kamande,* ***cook in less than half the time of bigger ones,*** *like njahi.* ***The longer you cook for, the more it costs.*** *There is more information on the relative time & cost implications of different variety of beans on the following pages.*

nyayo
1hr 55mins *(average cooking time)*
2.2units / 50KSh *(units used/cost)*
Total cost (¼kg+units) **90KSh**

kamande
56mins *(average cooking time)*
1unit / 23KSh *(units used/cost)*
Total cost (¼kg+units) **113KSh**

wairimu
1hr34mins *(average cooking time)*
1.6units / 37KSh *(units used/cost)*
Total cost (¼kg+units) **74KSh**

mbaazi
1hr 57mins *(average cooking time)*
2.2units / 50KSh *(units used/cost)*
Total cost (¼kg+units) **85KSh**

njahi
2hr 38mins *(average cooking time)*
2.8units / 64KSh *(units used / cost)*
Total cost (¼kg+units) **104KSh**

ndengu
1hr 1min *(average cooking time)*
1.2units / 28KSh *(units used / cost)*
Total cost (¼kg+units) **86KSh**

yellow beans
1hr 50mins *(average cooking time)*
2 units / 46KSh *(units used / cost)*
Total cost (¼kg+units) **96KSh**

EPC PRESSURE COOKING TIMES

The times below apply only to cooking times from when the appliances have reached pressure. With **rotary dial pressure cookers add extra time as follows to reach pressure**: *7 mins for 250g; 12 mins for 500g; 20 mins for 1kg*

Very small, quick cooking beans
Dry: 15-20 mins
Soaked: 7-10 mins

Small, quick cooking beans
Dry: 45-55 mins
Soaked: 22-27 mins

Medium sized, quicker beans grains
Dry: 50-60 mins
Soaked: 25-30 mins

Medium sized, medium beans time grains
Dry: 70-80 mins
Soaked: 35-40 mins

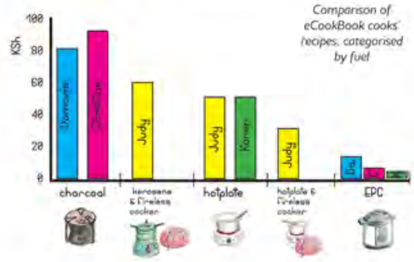
Medium sized, slower cooking beans
Dry: 80-105 mins
Soaked: 40-50 mins

Bigger, very slow cooking beans
Dry: 120-150 mins
Soaked: 60-75 mins

If you're pre-cooking or you like your beans to be firm, go for the lower time limit. If you like them soft or you've already put in all the ingredients at the beginning, go for the upper.

WHICH RECIPE IS CHEAPEST?

There are huge savings to be made by switching to electricity. Despite what most people believe, even boiling the beans, as well as frying the sauce, on the hotplate is cheaper than charcoal. In this section, we firstly compare the recipes of each cook and then carry out controlled experiments in our kitchen laboratory to explore which factors make the biggest difference to the time and money you spend in the kitchen.

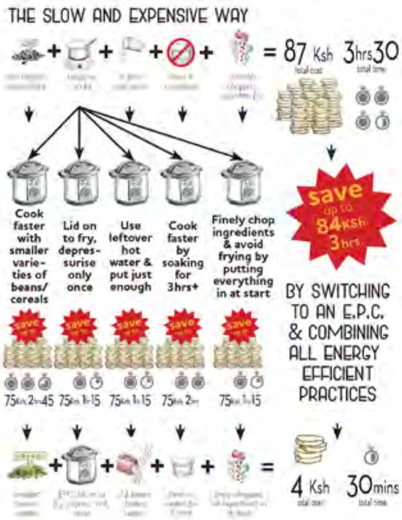


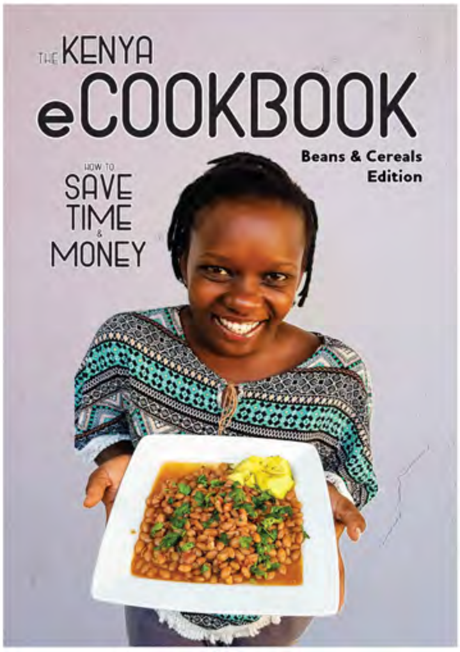
In the graph above, we can see that Judy cut the cost in half by using a fireless cooker to simmer the beans. This works equally well on charcoal, kerosene, an electric hotplate or even LPG.

However the real winners are clearly the EPC recipes, which are at least 5, and up to 20, times cheaper than charcoal!

HOW MUCH CAN I SAVE BY CHANGING THE WAY I COOK?

HOW MUCH CAN I SAVE BY CHANGING MY APPLIANCE & THE WAY I COOK?




THE KENYA
eCOOKBOOK
Beans & Cereals Edition
HOW TO
SAVE
TIME
&
MONEY


The Kenya eCookBook: Beans & Cereals Edition is the first of a series of eCookBooks designed to support you to make more informed choices about the fuels & appliances you use at home.
We will show you how energy relates to money & time so you can understand how to save both by using smarter cooking techniques, fuels & appliances.
The focus is on electricity & the time/money you could save by switching from other fuels.
We will then show you how to save even more, by adopting energy-efficient cooking practices (e.g. soaking beans) & energy-efficient cooking appliances (e.g. an Electric Pressure Cooker or EPC).
UKaid
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Modern Energy Cooking Services

Session 6: Induction stoves as an option for clean cooking in rural India – Manjushree Banerjee, Fellow, Centre for Impact, Evaluation and Energy Access, The Energy and Resources Institute (TERI), India

Induction stoves as an option for clean cooking in rural India

Dr. Manjushree Banerjee

Fellow, The Energy and Resources Institute (TERI), New Delhi

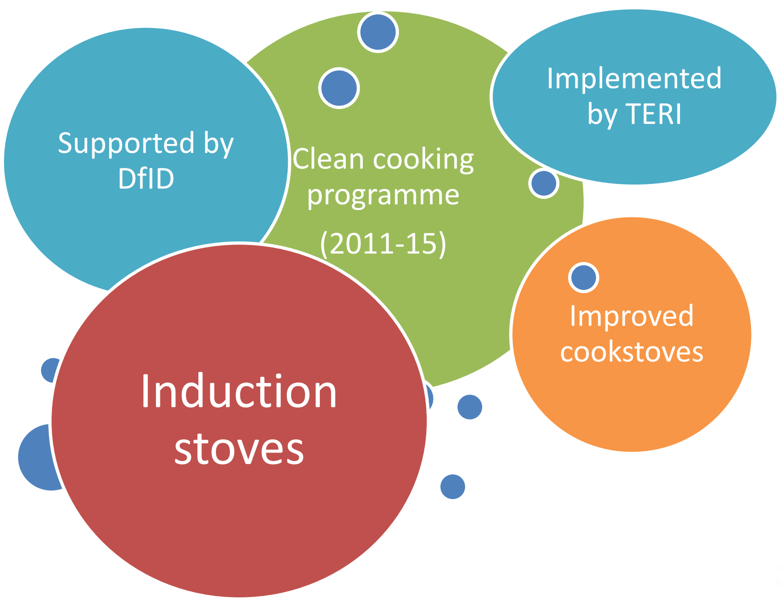
5th September 2019
Rabat, Morocco

teri

PPT structure

- Background- 1
- Description of the programme -
  - Why was done? -2
    - Why induction stoves?
    - Why we chose the state of Himachal Pradesh?
  - What was done? -3
    - The induction model
    - Project design
    - Research design
    - Concept of fuel stacking
- Results and analysis – 6
- What worked and what did not worked - 1
- Induction stoves in context of Morocco -1
- Recommendations – 1

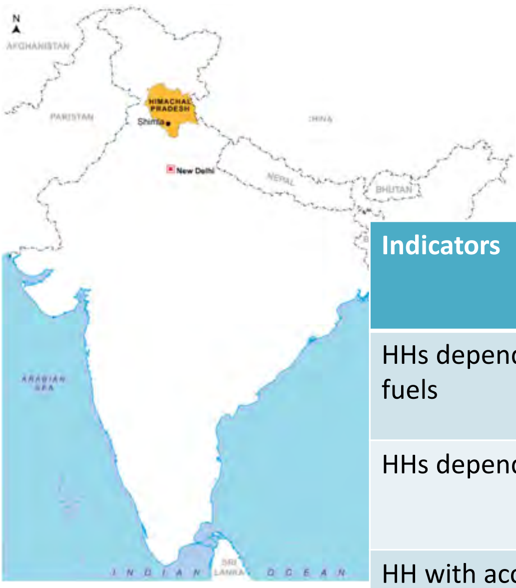
Background



- Covered 18 states in India
- Emphasized on market based models for improved cookstoves
- 75 Energy Entrepreneurs created
- 55K + forced draft improved cookstoves disseminated
- **4000 Induction stoves disseminated**

Why induction stoves?

Research Question 1: Does the intervention influence the existing household cooking fuel mix?
Research Question 2: How feasible is it to promote electricity based cooking from a policy perspective for rural areas of India?



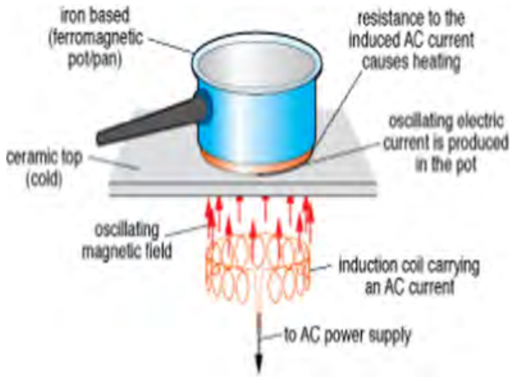
Number of rural Households
India: 168 million
Himachal Pradesh: 1.3 million
Total electricity generation in the state: 2.78 GW, 100% hydro power

2015
Why the state of Himachal Pradesh?

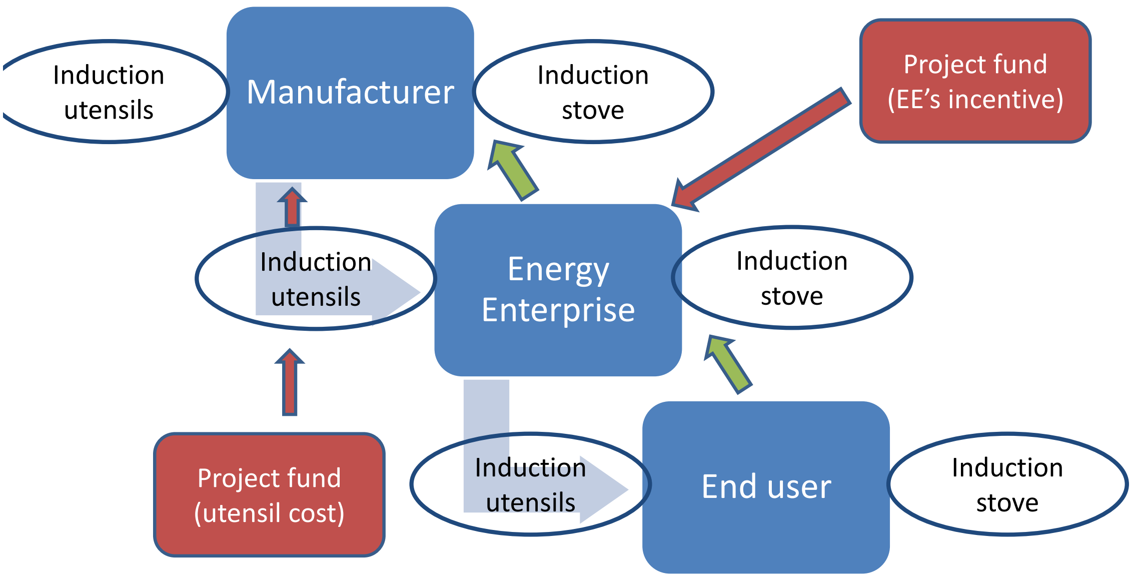
Indicators	Rural India	Rural Himachal Pradesh
HHs depending on solid fuels	86%	65%
HHs depending on LPG	11%	33%
HH with access to electricity	74%	98%
Av monthly per capita consumption of electricity	8.92 kWh	31.88 kWh
Av monthly per capita consumption expenditure	20.12 USD	29.14 USD

The induction stove model

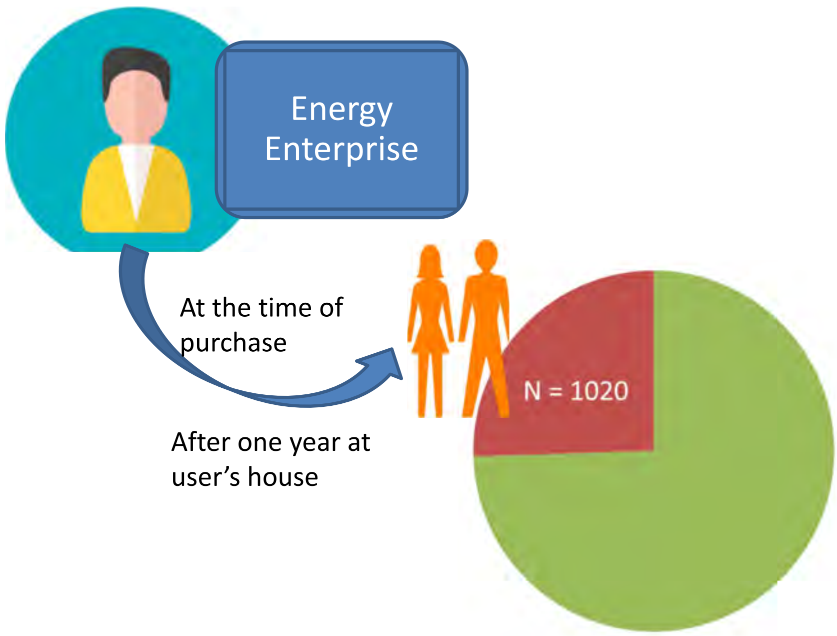
Philips HD4929



Project design



Research design



The concept of fuel stacking

Primary fuel - the fuel which is used more

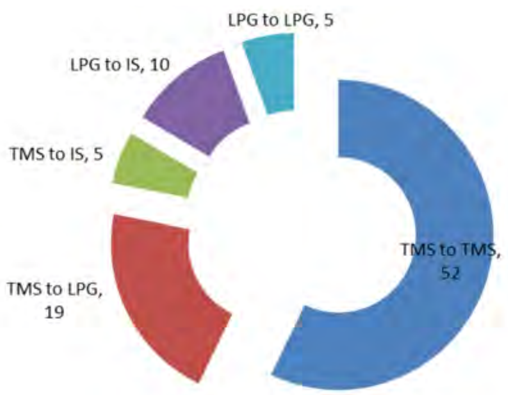
Secondary fuel - the lesser used fuel

Commonly used fuels in rural India – **Firewood**, dungcake, agricultural residue

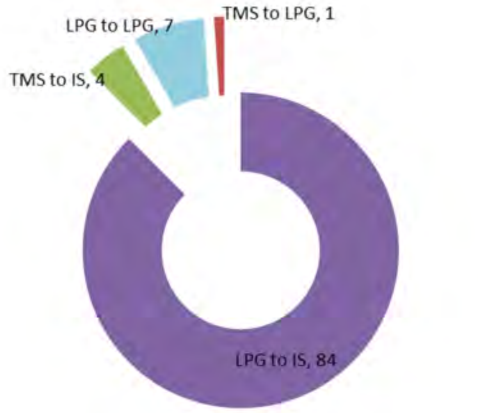
Result (1)

Shift in cooking technology

Figures are in percentage



Primary cooking technology



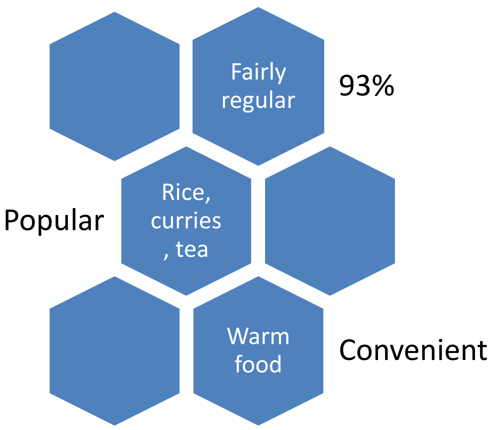
Secondary cooking technology

Induction stoves majorly attracted LPG users

TMS – Traditional Mud Stove, LPG – Liquified Petroleum Gas Stove, IS – Induction Stove

Result (2)

Adoption level



Main reasons for not using IS regularly:

1. Fear of increase in electricity bill
2. Inadequate voltage

Minor reasons for not using IS regularly:

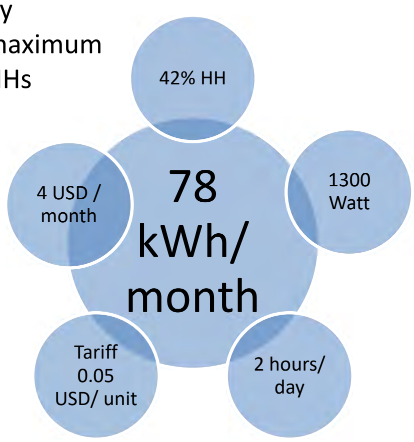
1. Faults
2. Uncomfortable with IS

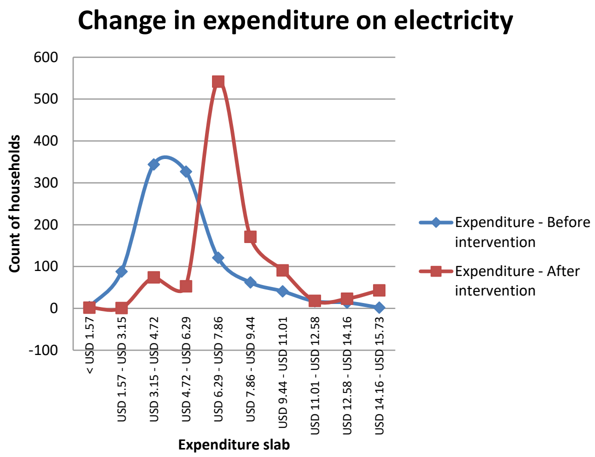
- **Induction stoves are suitable for many local food yet not suitable for the staple food which need direct contact with flame.**
- **The main reason for not using induction stove is fear of increase in electricity bill.**

Result (3)

Electricity consumption and expenditure

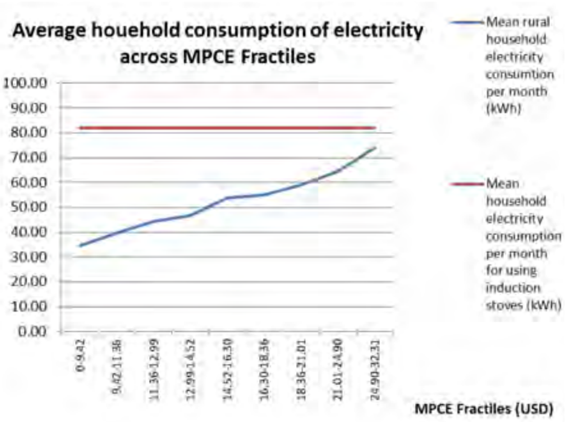
As reported by maximum HHs





Mean:
Consumption - 82 kWh per month
Expenditure - USD 4.2 per month

Affordability



2015

- **Electricity consumption -** 60-80 units a month (at 1200 Wattage for around 1 hour a day)
- **Electricity tariff per unit in Indian states –** Approx. between USD 0.028 to 0.10
- **Average monthly electricity expenditure for cooking using induction stove-** USD 1.67 – 8.37

2019

- Electricity consumption is higher than average electricity consumption in rural India
- Proposition costlier for the states with high electricity tariff

Result (4)

Saving on LPG and Firewood

Savings on firewood – Mostly collected
Average: 10 Kgs per month

Savings on LPG
Average: 7 Kgs per Monthly savings on LPG: USD 3.6

Infrastructure support

Access to electricity - Rural households	Installed capacity (utilities)	Share of grid interactive RE	LPG coverage (domestic) – (Rural + Urban)
2011 – 56%	2015 – 272 GW	2015- 39 GW	2015 – 56%
2019 – 99.99%	2019 – 344 GW • 27 GW required	2019- 73 GW	2019 – 90%

The pros and cons

+ (Pros)

1. Added a clean cooking fuel in the rural household fuel mix
2. Electricity infrastructure in rural areas are developing fast
3. Convenient to use
5. Usage of induction stove resulted in LPG saving

− (Cons)

1. Majorly replaced LPG (secondary cooking fuel)
2. Costly proposition for rural users
3. Needs investment in terms of electricity infrastructure
4. Not suitable for a local staple food

LPG and Induction stoves collectively will increase the share of clean fuels for cooking and reduce the share of solid fuels

Induction stoves in context of Morocco

Scenario - If 50% HHs use induction stove for cooking at 1300 volts for 2 hours a day	
Number of households	7590000
50% of the total HHs	3795000
Total connected load required	5.1 GW
Total installed capacity	8.3 GW
Residential sector consumption (33%)	2.7 GW
Gap	2.4 GW

From 2007 to 2017, LPG consumption increased by 50% and electricity consumption by 67%, replacing solid biofuels that were the major source for cooking and heating.

The government has plans to phase out the LPG subsidies after 2021 in favour of targeted social support to vulnerable consumer groups

Electricity consumption and expenditure for a household	
Average consumption of electricity in month for using IS	82 kWh
Electricity tariff	0.9 to 1.44 MAD
Electricity expenditure	74-118 MAD

The scenario indicates the need for improved infrastructure support and need to look at household affordability factor

Data source: Energy policies beyond IEA countries , https://www.helgilibrary.com

Recommendations

- Field research to be conducted before developing a policy for introducing induction stoves as an option for cooking in rural Morocco to understand the adoption and affordability pattern along with the infrastructure support.
- Induction stoves together with LPG has the potential to enhance the share of clean cooking in rural areas.
- Rural electrification programmes may include the aspect of induction stoves.
- In long run, more efficient RE based induction stove technologies are to be introduced.

Thank you

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