Modelling eCook in Myanmar – a discussion of the outcomes of a participatory cooking workshop

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Acknowledgements

The authors are grateful to the entire team at REAM and the Department of Research and Innovation (DRI) who worked tirelessly to make the workshop a success. In particular, we thank the Director of DRI for his support and to U Myo Aung and his team of professional chefs who volunteered their time to facilitate the participatory cooking session.

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More information on this research available here: www.PV-eCook.org
This research is funded by DfID/UK Aid through the Energy Catalyst Early Stage Feasibility

Executive Summary

The aim of this document is to explain the modelling results presented during the '*Innovative Research on Electric Cooking and Beyond*', which took place at the Department for Research and Innovation, Yangon, Myanmar from the 29th to the 31st January 2018.

A brief introduction to the concept being modelled and the modelling approach is given. Repayment horizons of 3, 5 and 20-years are modelled to represent different private sector and utility business models. Under the private sector 'pay-as-you-go' business model, users would pay a monthly fee for 3 or 5 years. The monthly payments would be set such that after the 3 or 5 years, the supplier would have recovered their investment. At the end of the period the user would own the equipment. The equipment would still be functioning, and essentially the users would continue to cook for free. However, from this point onwards the users would be responsible for maintenance and replacement. Since batteries are expected to last 6 to 7 years, users would likely need to replace the batteries at that point. Even though energy storage costs are decreasing, so the price of batteries is expected to be cheaper by then, the user is likely to still require financing support for such replacements. Under the utility business model, the utility would set the monthly tariff to recover its investment over 20 years, and the user would never own the equipment. The utility would retain responsibility for replacement and maintenance and replacements for as long as the user pays the monthly fee.

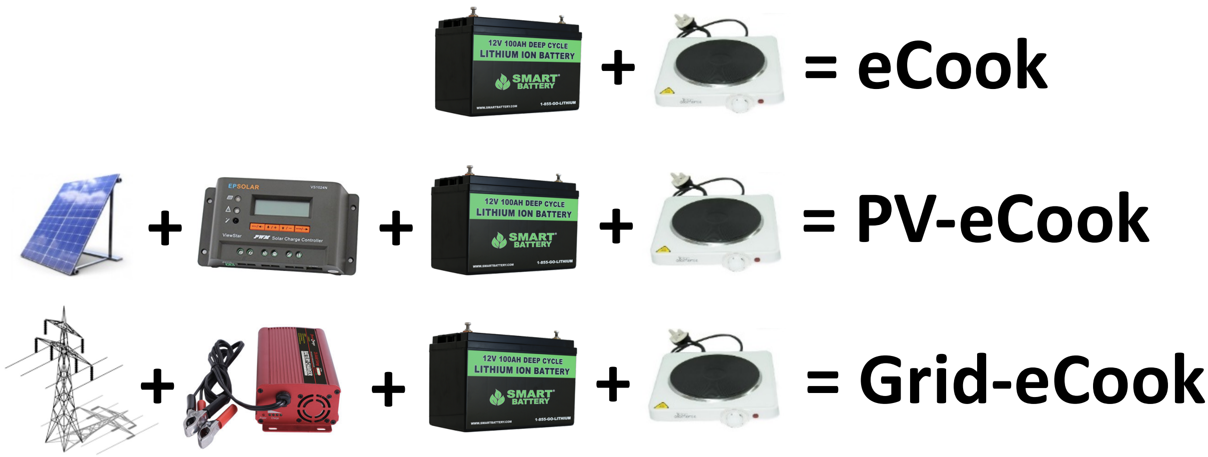
In order to feed into the model, and to give participants experience of how easy it is to cook traditional Myanmar food with modern energy, the workshop included a practical cooking design session. Participants were split into 3 groups and offered a range of cooking equipment with which to cook a typical Myanmar meal, consisting of rice, curry, soup and green tea. Energy readings were taken by the participants, and the quality of the resulting dishes, the experience of the cooking processes and the energy data were later discussed by the participants. Participants noted that their processes for cooking may not have been the most efficient, and given more experience they are likely to have been able to make significant energy savings. For instance, in one case the wrong pot was used with a pressure cooker, causing steam to escape throughout the cooking process, and resulting in significantly higher energy readings than expected. Extrapolating the data from the workshop and calculating monthly costs of cooking in this way, the results range from 18,000-50,000 MMK (US$13-$36) monthly cost for a system designed to meet a household of six's everyday cooking needs using different blends of electricity, charcoal and firewood.

However, as briefly discussed, some of the energy data obtained during this exercise was higher than one might obtain from a practiced cook familiar with the equipment. This highlights the need for eCook to be partnered with appropriate social marketing and training designed to enable users to cook efficiently with energy saving electrical appliances. The report therefore outlines two optimised systems based upon combining the data obtained during the workshop with comparable tests carried out in the REAM office. The first of which was also designed to meet a household's everyday needs, but with an optimised all electric system with monthly costs ranging from 7,000-18,000MMK (US$4 - $13). The second optimised system was designed to cook just rice two times a day and has monthly costs ranging from 1,700-7,000MMK (US$1.2 - $4). This single appliance based 'rice-eCook' system could be a gradual first step for many towards cooking entirely on battery electric systems, with the user adding more appliances as they gain more confidence in the technology and/or as more money becomes available.

Introduction to modelling eCook

In the context of falling global PV prices, recent advancements in battery technology and rising charcoal/fuelwood prices in severely deforested regions, the door is opening for a potentially transformative alternative: battery-supported electric cooking, or eCook (Batchelor 2013; Brown & Sumanik-Leary 2015, Leach and Oduro 2015, Slade 2015, Batchelor 2015). Initial investigations focused on a configuration comparable to the popular Solar Home System (SHS), referred to here as PV-eCook, and consisting of a cooking device, battery storage, charge controller and PV array. It has since been shown that using a battery charger and battery to support cooking appliances during blackouts in a similar way to a UPS (Uninterruptable Power Supply) could also strengthen unreliable national, mini-, micro- and nano-grids. For grid operators, it could also offer a form of demand side management and/or create additional revenue (Batchelor 2015a). This variant is referred to as Grid-eCook, variants of which may have particular application in Myanmar within mini and micro hydro grids. Figure 1 shows the key system components that define the three terms used throughout this document: eCook, PV-eCook and Grid-eCook.

Figure 1: Pictorial definitions of 'eCook' terminology used in this paper.



Leach & Oduro (2015) modelled the concept for SHS, and compared the resulting energy with that 'delivered to the pot' by charcoal and LPG. Like most renewable energy technologies, eCook has a high upfront cost, which does not compare favourably with conventional fuels until you look at lifecycle costs. Leach and Oduro's model estimates all the costs over the specified lifetime of an eCook system and uses a process called discounting to account for the fact that costs incurred in the future have a different value to those incurred today. This is because the money spent on those future expenditures could be invested in other things today. A parameter called the discount rate is used to model this effect, which varies according to the economic climate of interest. For example, a public utility can access capital at much lower interest rates, which could be modelled with a discount rate of 5%. In contrast, private sector actors have much higher pressure to repay their investments, so a discount rate of 20% is more realistic.

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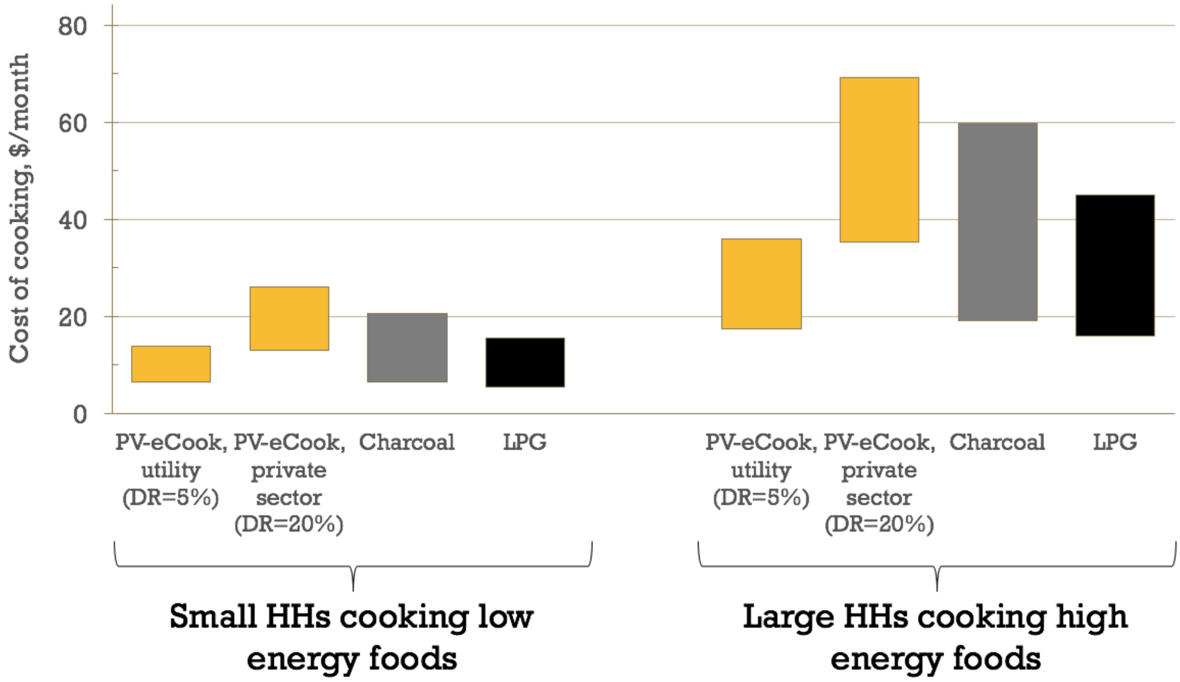
Leach and Oduro's modelling included a range of discount rates, possible system efficiencies and component costs; and assumptions on the solar resource and culturally distinct cooking practices, resulting in bands of predicted monthly costs. Figure 2 shows that although offset in 2015, by 2020 the bands of monthly costs for cooking with PV-eCook overlapped considerably with bands representing expenditure on conventional fuels, implying that it would be cost effective for HHs in this overlapping region to adopt PV-eCook by 2020.

Figure 2: Leach & Oduro's (2015) techno-economic modelling results, showing the crossover point in 2020, where it is predicted to become cost-effective for a significant number of HHs to transition to PV-eCook.



Since then, recent papers such as Kittner et al. (2017) have shown that the rapid learning curve in battery manufacturing has resulted in battery prices already dropping faster than expected. While Leach & Oduro (2015), reasonably estimated the ex-factory price of LiFePO4[1] batteries would be between \$200 and \$300 per kWh storage by 2020, Kittner et al. (2017) shows that they should reach \$200 per kWh by 2019. This suggests that PV-eCook will be even more viable by 2020 than predicted.

What is more, whilst Leach & Oduro's (2015) modelling included a range of system sizes from 2.2kWh battery storage and 350W PV up to, 9.8kWh storage and 1,300W PV, subsequent research has shown that much smaller systems could be possible using energy efficient appliances. For example, rice for 4 people can be cooked in a rice cooker with under 0.2kWh, therefore a small HH cooking rice as their main staple could upgrade their 0.2kWh, 40W SHS sized for lighting, TV and mobile phone charging to PV-eCook by upgrading their SHS for a 0.4kWh battery and a 100W PV panel[2].

[1] Lithium Iron Phosphate

[2] This would allow them to cook rice twice a day (once during the daytime with most of the power coming directly from PV and once during darkness totally from the battery) plus have enough left over for lighting, TV and phone

While these models demonstrate some theoretical possibilities based on economic and energy data, there has been remarkably little study on the practicalities of cooking in different contexts. As a part of this project REAM have been collecting real life data to feed into the models. A cooking diary study currently being carried out by REAM in Myanmar asked 20 households to record exactly what they cook, when and how for 6 weeks. They were asked to start by simply recording data on energy use and cooking practices using their traditional fuels and appliances. After a given time, they were encouraged to transition to electricity and record identical data for their cooking with electrical appliances. This latter data will enable much more detailed characterisation of the 'cooking load' on battery systems and the compatibility of a range of electrical appliances with specific cooking practices. It is hoped that the results of this study will shed further light on what, how and when people cook in different parts of Myanmar to enable the dimensioning of battery banks that can offer people affordable eCook solutions tailored to the way they cook.

Leach and Oduro (2015) only modelled a utility business model with a 20-year repayment horizon. In this business model, the utility is responsible for maintaining the equipment and recovers its investment in 20 years. The user never owns the equipment and continually pays the monthly fee. In this document, 3-, 5- and 20-year repayment horizons are modelled to represent both the private sector and utility business models. Under the private sector, 'pay-as-you-go' business model, users would pay a monthly fee for 3 or 5 years, after which the supplier would have recovered their investment. After this the user would own the equipment, and continue cooking with no further monthly payments, until a component needs to be replaced[3].

Participatory cooking at the workshop

In order to feed data into the model, and to give participants experience of how easy it is to cook traditional Myanmar food with modern energy, the workshop included a practical cooking design session. Participants were offered a range of cooking equipment and chose 4 appliances on which to cook a typical meal. Energy readings were taken by the participants, and the quality of the resulting dishes, the experience of the cooking processes and the energy data were later discussed by the participants. On day 2 of the eCook Myanmar workshop, participants split into three teams, each of which chose 4 appliances to cook the 4 dishes on the menu for the day chosen to represent the most typical Myanmar meal: rice, fish and rosal leaf soup, chicken curry and tea.

Group 1 used purely electric appliances, whilst Groups 2 and 3 chose charcoal and firewood respectively mixed with electrical appliances. Electricity consumption was measured using plug in energy meters, whilst charcoal and firewood consumption was measured by weighing

charging in the evening. If they wanted to cook all their food and heat all their water using energy efficient appliances such as insulated electric pressure cookers and therma-pots (insulated kettles), a 0.8kWh, 200W should be sufficient to cook 2 meals a day and reheat a third.

[3] The most significant of which would be the battery, which accounts for the majority of the cost of the system and is estimated to last approximately 6 years. When the battery requires replacing, wealthier users could purchase this themselves, however monthly repayment plans for battery replacement should be made available to users. Since battery costs are predicted to come down further we would expect replacement batteries to be at least at about 70% of the 2020 cost (unless over demand stalls the price descent).

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bags of solid fuel before and after cooking. Table 1 summarises the data recorded during this session.

Figure 3: Group 3's eCook set up under test.

Figure 4: Analysing the results of the cooking experiments.

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Table 1: Summary of energy use from cooking tests carried out on day 2.

	Menu item	Rice (5 cups)	Fish & rosal leaf soup	Tea (1000ml water)	Chicken curry (0.8 viss)
		COOKING DATA RECORDED ON DAY 2			
GROUP 1 – PETRA	**Appliance**	Rice cooker	Electric frying pan	Induction stove	Electric pressure cooker
	Energy per dish	0.256 kWh	0.14 kWh	0.11 kWh	0.488 kWh
GROUP 2 – THINZAR	**Appliance**	Rice cooker	Hotplate stove		Charcoal
	Energy per dish	0.258 kWh	0.342 kWh		0.30 viss
GROUP 3 – PHYU PHYU WIN	**Appliance**	Rice cooker	Induction stove	FREDA stove	Electric pressure cooker
	Energy per dish	0.129 kWh	0.35 kWh	0.1 viss	0.243 kWh

Assuming electricity prices of 35kyat/kWh, charcoal prices of 1000kyat/viss and firewood prices of 33kyat/viss, the meals would cost:

- Group 1 = 35 kyat
- Group 2 = 21 kyat + 300 kyat
- Group 3 = 25 kyat + 3 kyat

However, these figures could be misleading. While the groups were guided by a qualified chef, in the haste and context of an exercise in a time limited workshop there are a number of actions that one might consider 'mistakes' or something a householder might not do. What is more, most cooks are not particularly concerned with minimising energy use, particularly having lit a biomass fire. However, an eCook user should be, as cooking with the limited battery capacity defined by their budget will require some behavioural change.

For instance;

- The charcoal stove had considerable charcoal still burning after the dish had been cooked. It could have possibly cooked the whole meal for the same amount of charcoal. Even so though, it would still have been more expensive than Group 1, who used electricity alone.
- Similarly, the wood stove might have been able to cook the whole meal. Many users in Myanmar do not pay for their wood and although a nominal value obtained during fieldwork has been assigned for this calculation, it would be wrong to assume that everybody pays this much. However, the nominal price of wood is very low, so the trend of charcoal as the most expensive fuel, electricity significantly cheaper and wood cheapest (if not free) is still clear.
- Groups 1 and 2 used double the amount of energy to cook rice than Group 3 – indicating there was room for improvement in the rice cooking process in Groups 1 and 2.
- Groups 2 and 3 had a problem with the extension lead used to power their equipment. It had to be changed half way through the exercise, leaving the soup to cool for 5 mins and then requiring reheating – resulting in using more than twice the amount of energy to cook the soup than Group 1.
- Group 1s pressure cooker mistakenly had a rice cooker pot inside of it, meaning that steam was escaping out the top of the device for much of the cooking process. Group 3s pressure cooker also used extra energy. Being unfamiliar with the device, they de-pressurised it to check the contents during the extension lead change. The same curry cooked in the REAM office with the same process took half the energy of Group 3 and one quarter of Group 1.
- None of the groups used the therma-pots for heating water for tea - we know from REAM experiments that it can use 2/3rds of the energy that the induction stove of Group 1 used. It also keeps any water not used right away warm for several hours, reducing energy by reducing the need to reheat previously boiled water.

Annex 1 takes the groups' results and presents two scenarios. In scenario 1, used at the time of the workshop, the results of the groups cooking are taken as they are, and worked into the model. A simplistic assumption of two of these meals a day is made, and the numbers are modelled (other assumptions are given in the annex.). A second scenario is modelled, whereby for Group 2 the charcoal is assumed to be halved (either by using it for one whole meal, or by using it more cautiously) and where the energy used in the pressure cooker in Group 1 is adjusted downwards to eliminate the effect of the error.

The scenarios show that the range of monthly expenditure is between 18,000-50,000 MMK (US$13 – $36) monthly cost for a system designed to meet a household of six's everyday cooking needs using different blends of electricity, charcoal and firewood.

Group 2 had the lowest electricity consumption and as a result, their eCook systems are smallest and monthly repayments are cheapest. However, when adding in the cost of charcoal, the monthly costs of cooking on eCook systems designed to meet Group 1 and Group 2's electricity demand are comparable on a 3-year repayment schedule. Increasing the investment horizon further favours Group 1s system, as the cost of charcoal is modelled as constant, yet eCook monthly repayments significantly reduce over the longer time period. Group 3's system is the cheapest, as wood is very cheap and in many contexts collected for free.

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It should be noted that after the repayment period has been reached (3 or 5 years), the user becomes the owner of the system and the household can use the system for free (until a part needs to be replaced, of course). In contrast, charcoal and wood (if it is paid for) have an ongoing monthly cost.

While the analysis focuses on the economic cost of the fuel, it is worth remembering that charcoal and woodfuel have a health cost. Respiratory diseases caused by biomass burning lead to over 4 million annual premature deaths globally. This burden is mainly on women and children, and the added value of Group 1's eCook system is the opportunity to move further away from these harmful emissions.

Of course, with all the systems, with ownership comes the responsibility of maintaining the system. Replacement parts, particularly the battery which is expected to last for 6 years, can be too costly for many users to replace outright. As a result, there is likely to be a role for maintenance financing plans, under which the original equipment suppliers could offer a new monthly repayment plan for key replacement parts such as the battery. Such a plan would allow the user to repay the cost of the part over time, ultimately buying ownership of it in the same way as they bought ownership of the entire system before a replacement part was required.

Optimising eCook Myanmar

eCook is an economic proposition that specifically targets charcoal users, as these people have an existing expenditure on a polluting fuel that could be redirected into repayments on a battery electric system. It was noted earlier that all dishes could probably have been cooked on the charcoal used by Group 2, which means that monthly expenditure for a household cooking solely on charcoal are likely to be in the order of 18,000MMK. Only Group 3's set up on a 20 year utility repayment plan offered monthly cooking costs below this threshold, so a further analysis was carried out to estimate the costs of cooking more efficiently. For example, as this was the first time many of the cooks had used the electric pressure cooker, a number of mistakes were made during the cooking process that significantly increased energy consumption. **As a result, a new model was constructed using optimised values for each dish, to represent the expected energy consumption of a well-trained eCook user.**

Table 2 shows that this optimised system would have an electricity demand of 0.962kWh per day, slightly lower than that of Group 2. Charcoal and wood are not expected to be used on a daily basis, but may be required on an occasional basis when the cooking load increases significantly, such as when relatives are visiting. In this optimised PV-eCook system, it is expected that some cooking is done during daylight hours and therefore some of the power can be drawn directly from the PV panels, without having to be stored in the battery. In the optimised Grid-eCook system, it is expected that the battery can be at least partially recharged more than once a day.

Table 2: Energy demand for optimised system designed to provide 2 full meals per day with some cooking directly on PV/multiple grid recharging.

Menu item	Appliance	Comments	Energy per dish
Rice (5 cups)	Rice cooker	Group 3	0.129kWh

	Fish & rosal leaf soup	Electric frying pan	Group 1	0.14kWh
	Tea (1000ml water)	Therma-pot	Tested at REAM office. 0.131kWh for 1.8litres, so estimate 0.073kWh/litre	0.073kWh
	Chicken curry (0.8 viss)	Electric pressure cooker	Tested at REAM office. 0.139kWh for chicken curry	0.139kWh
Total energy per meal	**Electricity (kWh)**			0.481
Total energy per day	**Electricity (kWh)**			0.962
Fuel costs	**Electricity (kWh/month)**			28.86kWh
	Electricity (MMK/month)			MMK 1,010

Table 3 shows the system components required to meet this load and their associated costs. All monthly repayments are now equal to or below the monthly cost of cooking on charcoal estimated above, indicating that if, as predicted, lithium ion batteries of 183USD/kWh are available in 2020, and that energy efficient cooking appliances and practices can be adopted, then there is a real opportunity. Of course, the operational costs of running a business to design, assemble, sell, install, operate and maintain eCook systems would need to be factored into this analysis at a later date.

Table 3: Equipment specification for optimised system designed to provide 2 full meals per day with some cooking directly on PV/multiple grid recharging.

		PV-eCook		Grid-eCook	
Key equipment specification	Battery	0.96kWh			
	PV	0.3kW		-	
	Controller	20A		-	
	Capital cost	$490.00	MMK 661,500	$288.70	MMK 389,745
eCook monthly cost	Monthly repayments (3yr)	$13.80	MMK 18,630	$7.20	MMK 9,720
	Monthly repayments (5yr)	$9.00	MMK 12,150	$5.00	MMK 6,750
	Monthly payments to utility (20yr)	$6.50	MMK 8,775	$4.60	MMK 6,210
Total monthly cost (eCook + fuel costs)	Monthly repayments (3yr)	$13.80	MMK 18,630	$7.95	MMK 10,730
	Monthly repayments (5yr)	$9.00	MMK 12,150	$5.75	MMK 7,760
	Monthly payments to utility (20yr)	$6.50	MMK 8,775	$5.35	MMK 7,220

Figure 5 shows that on a pay-as-you-go 3-year model, the user is paying the same (slightly more) than they were with charcoal. However, after year 3 they own the system and have no further commitments to payment until batteries need replacing in about year 6 or 7[4]. For the 5-year model, the user pays less per month, but for the 5 years. Once again, they have to take responsibility for maintenance and replacement of the battery once the system is owned. In the utility model, the equipment is never owned by the user, and they pay a monthly tariff for its use. The utility takes responsibility for replacing any components that fail.

[4] In this case we have assumed $150 per KWh stored for the first replacement and $120 for the second – but models showing such price points are very uncertain.

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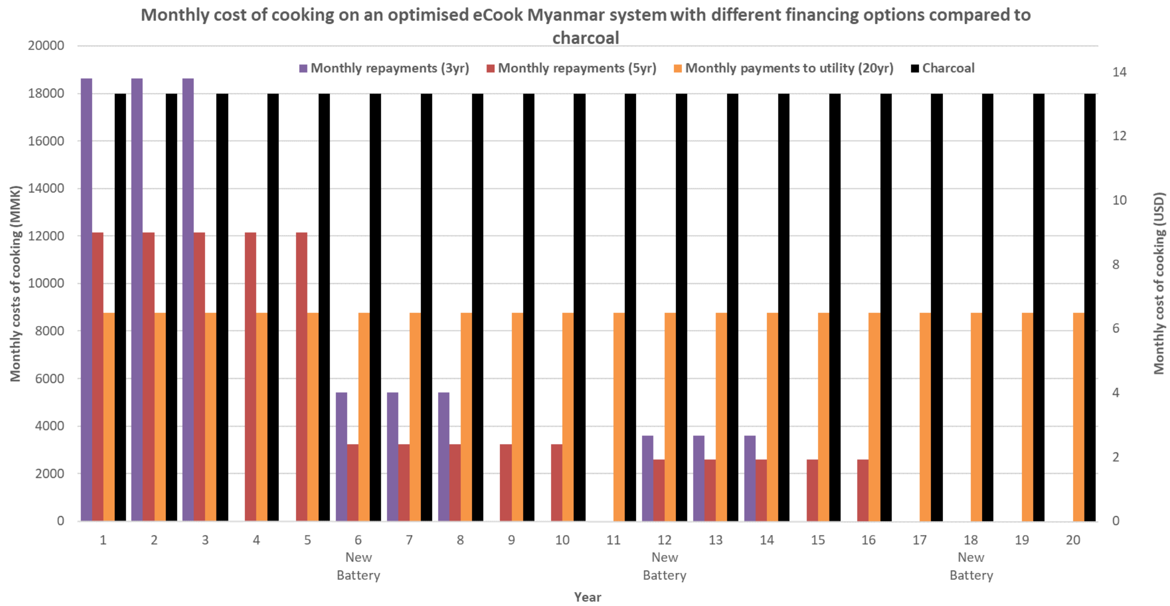
Figure 5: Payment schedule of optimal system.



Gradual optimization

Finally, a streamlined eCook system designed solely to cook rice, Myanmar's main staple, is modelled. Table 4 and
Table 5 show that the upfront costs of such a system are so much lower, that each cooking appliance could be designed with a battery integrated into it and purchased outright by users, with the rice cooker being the obvious starting point. This is how most electrical appliances are purchased today and would allow users to gradually convert their kitchen to electricity in a 'buy-as-you-go' business model. This single appliance system could be offered to potential users of eCook systems as the first step towards cooking on battery electric systems. Potentially, it could be as a one month trial, with the view to upgrading as soon as possible to a bigger system, or as a mixture of the 'pay-as-you-go' and 'buy-as-you-go' business models, enabling users to both repay the costs of the system over several years and either start repayments on a new appliance once the first is completely paid off or gradually increase these repayments over time.

Table 4: Energy demand for rice-eCook.

	Menu item	Appliance	Comments	Energy per dish
	Rice (5 cups)	Rice cooker	Group 3	0.129kWh
Total energy per day	Electricity (kWh)			0.258kWh
Fuel costs	Electricity (kWh/month)		7.74kWh	
	Electricity (USD or MMK/month)		$0.20	MMK 271

Table 5:Equipment specification and monthly repayments for rice-eCook.

		PV-eCook		Grid-eCook	
Key equipment specification	**Battery**	0.26kWh			
	PV	0.08kW		-	
	Controller	5.3A		-	
	Capital cost	$116.00	MMK 156,600	$57.90	MMK 78,165
eCook monthly cost	**Monthly repayments (3yr)**	$4.20	MMK 5,670	$1.90	MMK 2,565
	Monthly repayments (5yr)	$3.00	MMK 4,050	$1.30	MMK 1,755
	Monthly payments to utility (20yr)	$1.90	MMK 2,565	$1.10	MMK 1,485
Total monthly cost (eCook + fuel costs)	**Monthly repayments (3yr)**	$4.20	MMK 5,670	$2.10	MMK 2,836
	Monthly repayments (5yr)	$3.00	MMK 4,050	$1.50	MMK 2,026
	Monthly payments to utility (20yr)	$1.90	MMK 2,565	$1.30	MMK 1,756

Conclusion

The workshop organized in partnership with REAM and the Department for Research and Innovation was a successful gathering of stakeholders discussing new opportunities for Myanmar and the world. As the price point for eCook drops every year with advances in renewable energy and energy storage technologies, new opportunities arise for Myanmar households. There will be increasing circumstances when a household can switch from polluting fuels such as wood and charcoal and for the same cost or less, utilize electricity generated renewably for cooking.

This report has focused on the experiments undertaken during the workshop and used the data alongside other recent data gathering in Myanmar, to populate an economic model. As briefly discussed, some of the energy data obtained during this exercise was higher than one might obtain from a practiced cook familiar with the equipment. This highlights the need to combine the roll out of eCook technology with social marketing and training on how to cook efficiently on energy efficient appliances.

The report therefore outlines two optimised systems based upon combining the data obtained during the workshop with comparable tests carried out in the REAM office. The first of which was also designed to meet a household's everyday needs, but with an optimised all electric system with monthly costs ranging from 7,000-18,000MMK. The second optimised system was designed to cook just rice two times a day and has monthly costs ranging from 1,700-7,000MMK. This single appliance based 'rice-eCook' system could be a gradual first step for many towards cooking entirely on battery electric systems, with the user adding more appliances as they gain more confidence in the technology and/or as more money becomes available.

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Annex – Modelling the participants cooking data

Professor Matthew Leach and Dr Kok Siew of the University of Surrey redesigned the techno-economic modelling spreadsheet described in Leach & Oduro (2015) for use during the eCook Myanmar workshop. This tool was used to dimension an eCook system capable of supporting the cooking loads measured during the workshop.

The following assumptions were used in this modelling exercise:

- All systems are modelled as DC only (i.e. no inverter).
- The only significant component costs for a PV-eCook system are the battery, PV panels and charge controller.
- The only significant component cost for a Grid-eCook system is the battery (battery charger is modelled at a constant 10USD).
- Appliance costs are considered to be negligible compared to other component costs.
- Households are assumed to eat an average of 2 meals per day.
- 1350MMK=1USD
- Grid electricity price = 35kyat/kWh, charcoal price = 1000kyat/viss, firewood price = 33kyat/viss
- Grid-eCook charges once a day, at night time
- PV-eCook charges continuously during the day in between morning & evening meals
- Lithium ion batteries are modelled:
    - 2020 price of 183USD/kWh is used
    - Expected lifetime is 6 years
- Repayment horizons:
    - Utilities are assumed to work on 20 year repayment horizon, after which they have recovered their investment but always retain ownership of the equipment and therefore responsibility for maintenance and component replacements
    - 5 year investment horizon ends just before battery replacement. Users can then cook for free, but would have to purchase their own replacement battery or sign up for a new lease to repay the cost of battery replacement
    - 3 year investment horizon leaves the user with 2-3 years of free cooking until the battery lifeis expected to expire (note that following industry practice ‘end of life’ for the battery is regarded as being when it can deliver only about 80% of the as-new charge level…so at 6 years old most batteries will still have some useful life left, although they may continue to degrade increasingly rapidly.
- Chinese crystalline PV
- Costings using a 10% discount rate, representing a private investor viewpoint.
- eCook system designed to operate all year round with enough PV output to fully charge the battery each day with Myanmar's typical minimum monthly solar resource of 3.7 kWh/day/Wpeak
- In sunnier months the average is around 6, so will be lots of surplus PV-battery charge each day, for much of the year.
- Operational costs of running a business (marketing, R&D, customer relations, distribution, etc.) are not included in this model.

The results of this modelling are shown below, in the following format:

1. the specifications of the equipment required for PV-eCook and Grid-eCook systems designed to support each group's cooking load and the total capital cost of these components;
2. the monthly repayments that could be made to developers offering financing plans to potential users with:
    a. 3 year and 5 year repayment horizons, after which the user would own the equipment; and
    b. a 20 year investment horizon typical of a utility that would retain ownership of the equipment and collect monthly service payments from users;
3. the total cost to users including the fuel costs.

Scenarios

Scenario 1 :- Accepts the energy data from the workshop groups at its face value, with all the recognizable errors.

Scenario 2 :- makes two adjustments to the groups data based on two of the known exaggerations of energy use – where the pressure cooker in Group 1 had the wrong pot, and allowing for greater use of the charcoal.

Both scenarios present a range of monthly costs from 18,000-50,000 MMK (US$13- $36) monthly cost for a system designed to meet a household of six's everyday cooking needs using different blends of electricity, charcoal and firewood.

This research is funded by DfID/UK Aid through the Energy Catalyst Early Stage Feasibility

Table 6: Annex, Specification and associated costs of eCook systems designed to meet the cooking loads measured during the eCook Myanmar workshop.

		Group 1 - Petra				Group 2 - Thinzar				Group 3 - Phyu Phyu Win			
	Menu item	Appliance	Comments	Cooking time (mins)	Total energy	Appliance	Comments	Cooking time (mins)	Energy per dish	Appliance	Comments	Cooking time (mins)	Energy per dish
Cooking data recorded on Day 2	Rice (5 cups)	Rice cooker		27	0.256kWh	Rice cooker		27	0.258kWh	Rice cooker		28	0.129kWh
	Fish & rosal leaf soup	lectric frying pan		12	0.14kWh	Hotplate	Electricity blacked out for 5 mins, then for 1 min	38	0.342kWh	Induction stove	500W	12	0.35kWh
	Tea (1000ml water)	Induction cooker		5	0.11kWh		Did not make tea			FREDA stove		5	0.1 viss
	Chicken curry (0.8 viss)	tric pressure coo	Pressure cooker had a meltdown - rice cooker pot instead of original pot	59	0.488kWh	Charcoal	11:23 fire lit, 11:34 start cooking	41	0.30 viss	Electric pressure cooker	1000W. Electricity blacked out twice, so depressurised to check	10	0.243kWh
Total energy per meal	Electricity (kWh)				0.994				0.6				0.722
	Charcoal (viss)								0.3				
	Firewood (viss)												0.1
Total energy per day	Electricity (kWh)				1.988				1.2				1.444
	Charcoal (viss)								0.6				
	Firewood (viss)												0.2
		PV-eCook		Grid-eCook		PV-eCook		Grid-eCook		PV-eCook		Grid-eCook	
Key equipment specification	Battery (kWh)	2.83				1.71				2.06			
	PV (kW)	0.9		-		0.54		-		0.65		-	
	Controller (A)	58		-		35.3		-		42		-	
	Capital cost	$ 1,179.00	MMK 1,591,650	$ 653.00	MMK 881,550	$ 766.00	MMK 1,034,100	$ 434.00	MMK 585,900	$ 880.00	MMK 1,188,000	$ 501.00	MMK 676,350
Fuel costs	Electricity (kWh/month)			59.64				36				43.32	
	lectricity (USD or MMK/month)			$ 1.55	MMK 2,087.40			$ 0.93	MMK 1,260.00			$ 1.12	MMK 1,516
	Charcoal (viss/month)					18							
	Charcoal (USD or MMK/month)					$ 13.33	MMK 18,000.00	$ 13.33	MMK 18,000.00				
	Firewood (viss/month)									6			
	irewood (USD or MMK/month)									$ 0.15	MMK 198	$ 0.15	MMK 198
eCook monthly cost	Monthly repayments (3yr)	$ 36.70	MMK 49,545	$ 25.10	MMK 33,885	$ 23.00	MMK 31,050	$ 14.40	MMK 19,440	$ 26.90	MMK 36,315	$ 17.70	MMK 23,895
	Monthly repayments (5yr)	$ 24.10	MMK 32,535	$ 18.70	MMK 25,245	$ 15.10	MMK 20,385	$ 10.50	MMK 14,175	$ 17.60	MMK 23,760	$ 13.10	MMK 17,685
	lonthly payments to utility (20y	$ 17.40	MMK 23,490	$ 17.40	MMK 23,490	$ 10.90	MMK 14,715	$ 9.70	MMK 13,095	$ 12.70	MMK 17,145	$ 12.10	MMK 16,335
Total monthly cost (eCook + fuel costs)	Monthly repayments (3yr)	$ 36.70	MMK 49,545	$ 26.65	MMK 35,972	$ 36.33	MMK 49,050	$ 28.67	MMK 38,700	$ 27.05	MMK 36,513	$ 18.97	MMK 25,609
	Monthly repayments (5yr)	$ 24.10	MMK 32,535	$ 20.25	MMK 27,332	$ 28.43	MMK 38,385	$ 24.77	MMK 33,435	$ 17.75	MMK 23,958	$ 14.37	MMK 19,399
	lonthly payments to utility (20y	$ 17.40	MMK 23,490	$ 18.95	MMK 25,577	$ 24.23	MMK 32,715	$ 23.97	MMK 32,355	$ 12.85	MMK 17,343	$ 13.37	MMK 18,049

Table 7: Annex, Specification and associated costs of eCook systems designed to meet the cooking loads measured during the eCook Myanmar workshop, with some adjustments.

		Group 1 - Petra				Group 2 - Thinzar				Group 3 - Phyu Phyu Win			
	Menu item	Appliance	Comments	Cooking time (mins)	Total energy	Appliance	Comments	Cooking time (mins)	Energy per dish	Appliance	Comments	Cooking time (mins)	Energy per dish
Cooking data recorded on Day 2	Rice (5 cups)	Rice cooker		27	0.256kWh	Rice cooker		27	0.258kWh	Rice cooker		28	0.129kWh
	Fish & rosal leaf soup	lectric frying pan		12	0.14kWh	Hotplate	Electricity blacked out for 5 mins, then for 1 min	38	0.342kWh	Induction stove	500W	12	0.35kWh
	Tea (1000ml water)	Induction cooker		5	0.11kWh		Did not make tea			FREDA stove		5	0.1 viss
	Chicken curry (0.8 viss)	tric pressure coo	Pressure cooker had a meltdown - rice cooker pot instead of original pot	59	0.244kWh	Charcoal	11:23 fire lit, 11:34 start cooking	41	0.30 viss	Electric pressure cooker	1000W. Electricity blacked out twice, so depressurised to check	10	0.243kWh
Total energy per meal	Electricity (kWh)				0.75				0.844				0.722
	Charcoal (viss)								0.3				
	Firewood (viss)												0.1
Total energy per day	Electricity (kWh)				1.5				0.844				1.444
	Charcoal (viss)								0.3				
	Firewood (viss)												0.2
		PV-eCook		Grid-eCook		PV-eCook		Grid-eCook		PV-eCook		Grid-eCook	
Key equipment specification	Battery (kWh)	2.14				1.2				2.06			
	PV (kW)	0.68		-		0.38		-		0.65		-	
	Controller (A)	44		-		25		-		42		-	
	Capital cost	$ 820.00	MMK 1,107,000	$ 419.00	MMK 565,650	$ 766.00	MMK 1,034,100	$ 434.00	MMK 585,900	$ 880.00	MMK 1,188,000	$ 501.00	MMK 676,350
Fuel costs	Electricity (kWh/month)			45				25.32				43.32	
	lectricity (USD or MMK/month)			$ 1.17	MMK 1,575.00			$ 0.66	MMK 886.20			$ 1.12	MMK 1,516
	Charcoal (viss/month)					9							
	Charcoal (USD or MMK/month)					$ 6.67	MMK 9,000.00	$ 6.67	MMK 9,000.00				
	Firewood (viss/month)									6			
	irewood (USD or MMK/month)									$ 0.15	MMK 198	$ 0.15	MMK 198
eCook monthly cost	Monthly repayments (3yr)	$ 27.80	MMK 37,530	$ 18.50	MMK 24,975	$ 16.50	MMK 22,275	$ 9.60	MMK 12,960	$ 26.90	MMK 36,315	$ 17.70	MMK 23,895
	Monthly repayments (5yr)	$ 18.20	MMK 24,570	$ 13.60	MMK 18,360	$ 10.80	MMK 14,580	$ 6.80	MMK 9,180	$ 17.60	MMK 23,760	$ 13.10	MMK 17,685
	lonthly payments to utility (20y	$ 13.20	MMK 17,820	$ 12.60	MMK 17,010	$ 7.80	MMK 10,530	$ 6.20	MMK 8,370	$ 12.70	MMK 17,145	$ 12.10	MMK 16,335
Total monthly cost (eCook + fuel costs)	Monthly repayments (3yr)	$ 27.80	MMK 37,530	$ 19.67	MMK 26,550	$ 23.17	MMK 31,275	$ 16.92	MMK 22,846	$ 27.05	MMK 36,513	$ 18.97	MMK 25,609
	Monthly repayments (5yr)	$ 18.20	MMK 24,570	$ 14.77	MMK 19,935	$ 17.47	MMK 23,580	$ 14.12	MMK 19,066	$ 17.75	MMK 23,958	$ 14.37	MMK 19,399
	lonthly payments to utility (20y	$ 13.20	MMK 17,820	$ 13.77	MMK 18,585	$ 14.47	MMK 19,530	$ 13.52	MMK 18,256	$ 12.85	MMK 17,343	$ 13.37	MMK 18,049