THE NATIONAL STAKEHOLDERS' SOLAR ELECTRIC COOKING WORKSHOP

eCook - a transformational household solar battery-electric cooker for poverty alleviation.

24th and 25th April 2018

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ABBREVIATIONS

MNRT- Ministry Natural Resources and Tourism

TaTEDO - Tanzania Tradition Energy Development Organisation

MoE - Ministry of Energy.

CEEZ- Centre for Energy, Environment and Engineering Zambia

DIT- Dar es Salaam Institute of Technology

TANESCO – Tanzania Electricity Supply Company

NAFORMA- National Forest Management

WHO- World Health Organisation

TIRDO - Tanzania Industrial Research and Development Organisation

eCook – Battery-supported Electric Cooking

SHS – Solar Home Systems

PV - Photovoltaic

LPG- Liquefied Petroleum Gas

ITV- Independent Television

TV- Television

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EXECUTIVE SUMMARY

The National Stakeholders' Solar Electric Cooking workshop was held at TaTEDO office at Mbezi juu near KKKT Church, Dar es Salaam on 24th and 25th April 2018. The main objective of for workshop was to explore the opportunity for eCook in Tanzania. eCook is a potentially transformative household battery electric cooker that will soon be cost effective for households cooking on charcoal, LPG and kerosene. In addition it offers a clean cooking solution; provide reliable and affordable electricity access.

The workshop gathered participants from various organisations, companies and agencies for energy both inside and outside the country like the Ministry of Energy, Ministry of Natural Resources and Tourism and TANESCO, Mobisol, Ensol, TaTEDO, Gamos, CEEEZ, DIT, UDSM and some of the eCook project respondents.

The workshop was conducted for two days; on the first day participants were acquainted with the eCook concept, while on the second day attendees get the hands on experiments with eCook appliances. Attendees carried out hands on experiments with eCook appliances, whilst discussed how this new technology can be tailored to best meet the needs of Tanzanian cooks, in particular, those from lower income households, located in urban, pre-urban or rural areas.

eCook CONCEPT (Day one) involved various sessions which among others include;

- Introduction of the eCook and its potential contribution to Tanzania development objectives.
- eCook Tanzania research findings to date.
- eCook Zambia and Myanmar.
- Opportunity and challenges for the eCook Tanzania.

eCook IN PRACTICE (Day Two) basically included the following sessions:

- Design challenge Part I – Design & Assembly.
- Design challenge Part II – eCooking.
- Modelling eCook.
- Design challenge Part III – Economics.
- Design challenge Part IV – Presentation & Prize-giving ceremony.

The workshop was concluded by the closing speech from representative of Ministry of Energy, Mr. Jacob Mayalla who expressed gratitude to workshop organizers (TaTEDO, Gamos, Loughborough University, The University of Surrey, DfID / UKAID and Innovate UK) for providing the opportunity to the Ministry of Energy to close the workshop.

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1.0 INTRODUCTION

1.1 Background

Different studies show that about 3 billion people in the world cook and heat their homes with traditional stoves fueled by wood or charcoal, which accounts for a large percentage of the greenhouse gases that are polluting our planet. In Tanzania, cooking is keeping millions of women from reaching their full potential. Women and girls spend up to five hours a day cooking and collecting firewood. According to WHO, cooking with charcoal or firewood produce toxic smoke of which women and their families inhale, leading to over 20,000 preventable deaths every year in Tanzania.

According to National Forest Resources Monitoring and Assessment report (NAFORMA), Tanzania loses more than 1000 hectares of natural forest each day due to charcoal production and the loss is increasing fast.

Though there are efforts in place to combat the environmental challenges of the biomass emissions like the use of improved cook stoves which use less charcoal, still they are not sufficient enough to combat health problems associated with their uses. According to WHO, 4 million people die per year due to indoor air pollution (more than malaria and TB).

The eCook concept that advocate for solar electricity cooking, is a clean way to cook that requires only sunshine as fuel. As such, with this technology adopted on a large scale in the country, there will be no need to use firewood, charcoal or gas to the current quantity, only sunshine will be the national fuel instead of the biomass fuels which is the case now. Moreover, around 12$ used for biomass and charcoal will be saved per month.

Therefore, the National Stakeholders' Solar Electric Cooking workshop explored the opportunity and challenges for solar PV eCook in Tanzania, in the lesson learned from Zambia and Myanmar and way forward for its sustainability.

1.2 eCook Concept

The Solar Electric Cooking (PV-eCook) is a potentially transformative household battery electric cooker aimed to changing the society from traditional harmful cooking ways to new and clean cooking style. In addition to offering a clean cooking solution, it provide reliable and affordable electricity access whereby it can provide lighting and power device like, radios and mobile phones.

Figure 1: eCook Prototype

The proposition of PV-eCook is that by 2020 the cost of using solar photovoltaic panels to charge a battery, and then using the battery for cooking as and when required, will be a

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comparable monthly cost of cooking with charcoal and wood in most developing countries. The proposition sits at intersect of two major global challenges; the use of biomass for cooking which is harmful to the household and to the environment, and the challenge to extend modern energy access to all peoples (SDG 7).

2.0 WORKSHOP PREAMBLE

The workshop on eCook - a transformational household solar battery-electric cooker for poverty alleviation was conducted on 24th and 25th April 2018 at TaTEDO office, Mbezi Juu, Dar es Salaam, Tanzania. The workshop was organized by TaTEDO in collaboration with a research consortium, consisting of a development consultancy, Gamos Ltd., and two UK universities, Survey and Loughborough as part of the ongoing project activities which are financed by DFID and Innovate UK.

Different stakeholders was invited and about 34 participants who included the Representatives from the Ministry of Energy, Ministry of Natural Resources, private companies –which mostly deals with energy, the civil society organisations (CSO), Research Institutions, media people and ecook households' participants managed to attend the workshop. See the list of participants in Appendix 4

2.1 **Workshop objectives**

Main objectives of the workshop were: -

- To introduce and disserminate eCook concept to different energy stakeholders, discuss its objectives and come up with recommendations that could help to implement the eCook concept for the majority
- To share some of the findings of the eCook from Tanzania, Zambia and Myanmar

3.0 WORKSHOP PROCEEDING

The workshop programmes were organized in a manner that each participant could become aware and actively exchange views, experiences and new findings related to the eCook concept and existing opportunities and challenges to stakeholders. The participants started to arrive at the Venue from 8:30am for registration, and the Workshop activities started at 9:30am

The workshop were conducted for two days; on the first day participants were acquainted with the eCook concept, while on the second day attendees get the hands on experiments with eCook. The first day agenda contained five sessions which were the opening session, Introduction of eCook concept, research findings of eCook in Tanzania, Experience from Zambia and Myanmar, and the opportunities and challenges for eCook in Tanzania.

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The second day agenda consisted of five sessions; the design challenge part I, design challenge part II, Modeling eCook, design challenge part III and design challenge part IV. See the Workshop agenda Appendix 3

The moderator of the workshop Mr Jensen Shuma welcomed the participants which were followed by the self-introduction from all the participants. Then the host of the workshop, the Chief Executive Officer of TaTEDO Eng. Estomih Sawe gave the welcome remarks. In his remarks he expressed his appreciation for a good turnout of participants despite of their tight schedules, he said that is an indication that all participants recognised the importance of collaborative efforts to promote sustainable cooking energy for all through alternative sources of energy like solar.

He concluded in the welcome remarks by thanking the participants and informed them that the outputs from the discussions, dialogues and experience sharing during the workshop will be useful inputs for implementation of the following steps of the actual implementation of the project.

Presentations of different papers were done by respective resource person for each particular topic. There were plenary discussions, questions and answers by participants after each presentation where by these sessions were led by Mr. Jensen Shuma. Various questions were asked and answers provided.

At the end of the workshop, it was so pleasing to see that participants were very impressed with the eCook concepts, findings and practical applications of electrical appliances like pressure cooker, rice cooker, and thermo-pot and so on.

The two days' workshop was closed by representative from the Ministry of Energy Assistant Commissioner (Renewable Energy), Mr. Jacob Mayalla at 5:30pm.

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4.0 DAY 1 – OVERVIEW OF THE PRESENTED PAPERS

4.1 Introduction to eCook

This session was represented by Dr. S. Batchelor from Gamos who introduced the eCook concept. He started by explaining how smoke from the use of biomass kills several million per year (more than malaria and TB combined). Despite years and millions on improved biomass stoves, he said that there is a need for a paradigm shift which refers to a dramatic change in methodology or practice.

He continued by comparing the price of solar panel in 1980s to 2017. He stated that in 1980 the cost of panel was 10 USD per watt whereby in 2017, the cost of panel was 50USD per watt. For this it was informed that it is possible for the price of solar to further go down by 2020. The solar battery (lithium ion battery) prices have also stated to go down while the charcoal was on the rise in price.

He also compared household expenditure with what will be possible as a monthly (household) system cost. Based on research, he said that people pay 12 USD per month on energy for cooking. The question was on how to come up with a solar home system technology which will cost 12 USD per month or less including profit margin.

He pointed out that Africa is fast urbanizing with the population of 472 million and will grow to 659 million by 2025 and 1 billion by 2040. Even in urban setting he stated that people don't cook with electricity because there is no capacity at peak demand (needs demand side management), Brown outs – wiring not strong enough for drawing high current and people can't rely on electricity due to black outs (Load shedding, maintenance).

The solution of the above challenges was stated to be batteries which can be recharged as phone or computer. Charging a battery during night hours, the household would benefit by having reliable, stored energy for consumption whenever they wanted it, and the grid would benefit by effectively having decentralized storage built in to assist with load management. The question was is it possible to come up with portable technology at low price. This was stated to be possible using batteries which are now cheap and the price is going down.

He highlighted that, solar has gained some traction in lighting because it substituted for expenditure on Kerosene (and candles, and batteries). But solar next step is trying now television and refrigeration – because they are low energy consumers. While these enhance quality of life they are not direct substitutions for existing expenditure. To enter into cooking with solar system he informed that it just need a monthly expenditure that could be re-purposed to pay for modern energy infrastructure (giving investors better returns).

He concluded that, the next generation of clean cookstoves is not about biomass, it's about a paradigm shift.

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4.2 eCook Opportunity in Tanzania

During presentation, Dr. Jon Leary from Gamos highlighted findings of the preliminary market analysis which was done to assess the global market size and viability of the study for East and Southern Africa. The analysis for PV-eCook showed that;

- 68% of Tanzanians (38 million) live in rural areas, 96% of whom are off-grid (World Bank 2017)
- Market for pico-solar products and SHS is expanding rapidly (185,000 sales in second half of 2016, GOGLA et al. 2016.)
- Favorable environmental conditions (World Climate 2017), but large variation across vast national territory.

He also stated that, in Tanzania, monthly average solar irradiation ranges from 4.5-5.4kWh/m2/day with monthly average temperatures of 20-24°C.

Moreover, space heating with stoves likely to be minimal while battery lifetime/performance not likely to suffer from extreme temperature. Based on the market analysis for Grid-eCook he mentioned that currently only 16% of Tanzanians (9 million) have access to the national grid and only 1% (600,000) uses electricity as their primary cooking fuel. This means the key overlapping target market segments comprised of 9 million in urban slums, 11 million urban off-grid and 16 million charcoal/kerosene users. Based on his findings, 15 million Tanzanians (27%) cook primarily on charcoal, 4th biggest charcoal market in the world after DRC, Myanmar and the Philippines (WHO 2017).

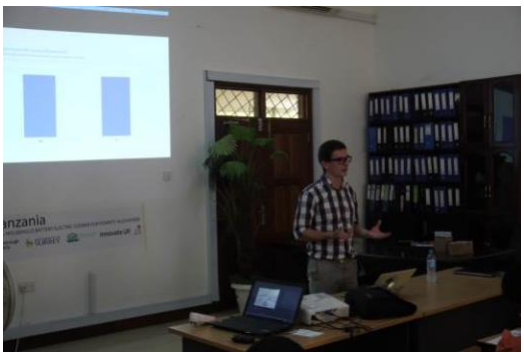

Figure 2: Dr. Jon Leary explaining the reasons for conducting eCook research in Africa, particularly Tanzania.

He concluded by pointing out the key messages from the preliminary market findings as follows:

- Cooking on batteries is possible as most of the Tanzanian cuisines are ecook compatible.
  - Battery-supported electricity will be cost comparable with charcoal (clean cooking, access to reliable electricity).
- eCook has a vast transformative potential in Tanzania, there is a need to build long-term partnerships to make this transition happen.

4.3 Potential Contribution of Tanzania National Development

During presentation Mr. Jensen Shuma presented on eCook potential of Tanzania. He started by pointing out key messages which include

- Tanzania is endowed with diverse forms of energy resources which have not been explored including natural gas, hydro, coal, biomass, geothermal, solar, wind and uranium.
- Biomass-to-energy, mostly for cooking is responsible for more than 84% of the total primary energy consumption in Tanzania

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- Tanzania has high potential for solar battery electric cooking (solar isolation ranging from 4.69 to 6.24 kWh/m2.day)
- Current trends in pricing indicate that by 2020 solar PV will supply electricity for cooking with 2-3 years payback,
- With proper delivery model both low, middle, and high income households can benefit from solar electric cooking
- With concerted efforts, a portion of the segment of population using biomass for cooking may switch to solar battery cooking in the future

He continued to inform that biomass (firewood and charcoal) is the predominant source of cooking energy in Tanzania which causes health problems to women and children due to indoor air pollution. Other cooking energy options are biogas, kerosene, LPG, electricity and Briquettes. LPG, electricity and briquettes were noted to be used mostly in urban areas whereas biogas is used in specific area depending on availability of feedstock and kerosene is mainly used in rural areas for lighting. He also informed that solar energy potential for cooking has not yet received much attention in Tanzania and thus the new area for intervention.

The contributions of Tanzania national development is as stated in the national policy, strategies and targets. Based on the national policy it was stated that the emphasis is on promoting utilization of alternative fuels to wood based fuels for cooking energy such as LPG, Natural Gas and Electricity. The other national contribution was mentioned on the SE4ALL Action Agenda, of which it target 75% of population with access to modern cooking solutions whereas MEM lead on the creation of a cross-sectoral initiative and define a strategy to foster the use of LPG as a cooking fuel to bring together different on-going efforts and improve coordination across agencies, private sector, CSOs and NGOs. The agenda also required to develop woodfuels (firewood and charcoal) supply and demand master plan for the main supply and demand centres. As for the Biomass Energy Strategy (BEST) it was stated that almost 90% of the demand comes from the household sector, with the remainder coming from household enterprises, commercial, institutional and some industrial demand. Increased charcoal demand over the past years (driven by rapid urbanization and high relative prices or scarcity of energy substitutes, particularly kerosene, electricity, biogas, biomass briquettes and LPG). One of recommendations from BEST is to make non-biomass charcoal and commercial fuel wood alternatives, particularly kerosene (LPG and electricity as well), competitive on a non-subsidized basis in terms of availability and price, with a target of reducing demand for charcoal by an indicative target of 50% by 2020.

He further informed that the most popular cooking appliances in Tanzania are traditional stoves (three stone fireplaces and metal charcoal stoves characterised by inefficient use of biomass fuels), Improved cookstoves (with thermal efficiency ranging from 30 to 65%), LPG stoves (second fuel for cooking in urban areas with distribution of 100-150 million tons), kerosene stoves, biogas stoves and electric cookers. The use of electricity for cooking purposes is still low in the country. It was stated that, based on the Energy Access Status Report 2016, about 0.1% of rural households and 1% of urban households are using electricity for cooking. Also eelectric cookers, ovens and microwaves are used in some medium and high income households and food

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businesses which is influenced by income and not affordable to the majority due to high appliance and electricity costs, vulnerable to blackouts.

He also pointed out cooking habit and method of cooking in Tanzania. He stated that people in Tanzania cook varieties of foodstuffs. The country's food portfolio is largely based on starches and proteins like maize, rice, bananas, cassava, potatoes, millet, beans, animal meat, milk, vegetables, etc. There are minor changes on types of food cooked but in urban areas people are eating from restaurant in the morning and afternoon while at home in the evening with limited variation in cooking technologies and practices across different areas of the country. He highlighted that although efficiency and fuel saving are very important factors but other requirements of the user should not be ignored. Some of the user needs include type of food, cooking comfort, portability and safety.

Moreover he said that there is potential for solar battery cooking in Tanzania which is favoured by various factors. These include increasing efforts of the government to extend national grid to peri-urban and rural areas, reasonable solar isolation for adequate solar electricity for cooking in off-grid areas, availability and affordability of efficient electric cooking technologies (electric cookers) in the country, favourable energy policies for alternative cooking solutions and availability of solar energy enterprises which can learn, import and develop battery electric cooking technologies.
Lastly, he recommended partnership with developers of battery electric cooking for a wide spread of this potential to low, middle and high income classes in the country.

Participants had time to reflect on the potential contribution of Tanzania national development, and the questions, and Answers were as seen below;

Qns. This is turn around efficiency for the battery charging, how about the prices, are they not expensive?

Ans:the battery prices are going down and by 2020 it is projected that the cost of a solar system will be able to substitute for an existing expenditure for cooking.

Qns. Batteries are measured in Ah, how do you convert to kWh?

Ans: Electric current is a component of an equation that helps to determine electric power. For instance the batteries rated 12V is approximately 1.2 kWh.

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4. 4 Launch of TaTEDO Institutional Stove

Figure 3: Participants of the workshop witness the institutional improved cook stove at TaTEDO premises.

During the workshop TaTEDO CEO, Mr. Estomih Sawe and Eng. Evarist Ng'wandu took advantage to introduce a new institutional improved cook stove that has been designed to accommodate schools, hospitals, prisons and hotels firewood cooking requirements.

This has come up as a result of improvements done from the previous versions of the stoves and awareness and knowledge on environmental effects of traditional cooking stoves, which together paved a way for its market.

The key features of the institutional improved cook stove are

- Improved combustion efficiency i.e emits less smoke and carbon dioxide**.**
- Improved heart transfer i.e. heat concentration
- Uses less firewood.
- Efficient in schools, prisons, hospitals and hotels.
- Less time to light.

Figure 4: Fire chamber of the Institution stove.

4.5 eCook Tanzania Research Findings to Date

The session shared the findings from the Cooking diaries, focus group discussions and choice modeling survey and concluded by answering the question on how the project will have impact on gender.

4.5.1 Cooking diaries

The cooking diaries part was presented by Mrs. Albina Minja from TaTEDO. She informed on key parameters and methods used during cooking diaries research. Based on her presentation, the cooking diaries involved 22 households who cooked with a range of equipment while keeping a 'cooking diary' for 6 weeks; Two weeks of normal cooking (Baseline) and Four weeks cooking with electricity (Transition). The participants of the cooking diaries were required to document, what they cook, when they cook, how they cook and how much fuel they used. The idea of

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cooking diary was to see how much energy a typical household consumes and what the cultural 'shape' of their cooking was.

Based on her presentation, the appliances used for the two weeks of normal cooking (Baseline) are charcoal stoves, LPG and kerosene lamp (Figure 5). Cooking with electricity (transition) involved appliances such as pressure cooker, rice cooker, induction stove, electric hotplate, thermo-pot and electric cattle as shown in Figure 8 and 9

Figure 5: Charcoal stove (Left) and LPG stove and cylinder (Right)

Figure 6: Pressure cooker (left), Thermo-pot (middle) and Induction stove (right)

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Figure 7: Rice cooker (left), Electric kettle (middle) and Electric hotplate (right)

She further informed the findings on compatibility of the electrical appliance with key cooking processes like boiling, steaming, pressure cooking and frying; and compatibility with key Tanzanian dishes; bananas, meat, ugali, rice, beans and vegetables. It has been revealed that the factors that contribute to energy use & cost are

- Fuel
- Appliances
- Cooking practices e.g
  - lids on pans
  - boiling vs. simmering
  - marinating (e.g prepare with lime sauce before cooking)
  - Soaking beans
- Foods prepared
  - E.g. beans vs. salad
- Number of people catering for
- Number of times cooking per day

Ms. Minja also shared her personal experience before and after cooking diary study. She informed that before the study, Gas and charcoal were her main source of fuel for cooking. She uses a cylinder of gas for one and half month which cost Tshs 45,000 and 15kg of charcoal per month ≈ Tshs 30,000 with long cooking time

During and after the cooking diary study she use an average of 2 units per day = Tshs 704, 60 units per month amounting to Tshs 21,127

Figure 8: Ms. Albina Minja explaining her experiences before and after cooking by using electricity.

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with little cooking time and the food taste the same for most dishes.

On her recommendations, she stated that:

- Cooking on charcoal and LPG is very expensive!
- Preliminary results suggest most HHs can cook with 2kWh/day
- Cooking practices can have as much influence on energy use as appliances and fuels, so could reduce this to below 1kWh/day
- Voltage affects cooking as much as blackouts
- Cooking with electricity is possible in Tanzania

4.5.2 Focus group Discussion

Mr. Shima Sago from TaTEDO presented findings from the Focus group discussion which was done in Ubungo district. The findings showed that different cooking practices are applied to different dishes together with their cooking appliances. For instance Matoke (Banana) with meat or beans, Ugali and fish- sato and Rice & meat are normally cooked on Gas stove or Improved Charcoal Stove or Kerosene stove. The study also found out that females are the main cooks in the households in which 7 out of 8 respondents (87.5%) said Female are the main cooks, 1 respondent said both male and female cook.

Based on preferred appliances, most people use charcoal and LPG stoves for cooking because of their availability and costs. Cooking with electricity is highly preferred only that people feared high costs of electricity and its reliability because of frequent power cut off .

Figure 9: Mr. Shima Sago explaining the ecook findings from focus group.

For future cooking, most people like to use a combination of gas and electricity because of convenience and health issues. It was stated that, if electricity would be available and efficient to every household, majority would use electricity as units can be bought through mobile payment making it easier than gas where you have to go to the vendor.

He concluded that if electricity is available for most households; Men will be involved in cooking; Women will engage more in economic activities to improve their livelihood save more money- and clean environment.

4.5.3 Gender and Energy

The session was led by Ms. Karen from GAMOS (Figure 10). The aim of the study was to assess the linkage between gender equality and energy, introducing gender and energy identify approaches or methodologies for incorporating gender in these works.

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From choice modeling findings it has been found that; Majority of females does the majority of the cooking (Figure 11) and on decision making, both male and female decides whether to buy or not to buy a solar panel, similar to bring a cooking device.

Figure 10: Miss K. Chepkurui explaining the impact of eCook on gender.

The stated Impacts of eCook on gender were highlighted as follows;

- Improved energy solutions like e-cook benefit all members of the household; women will have less drudgery and better time management, men will have light and entertainment whereas children will enjoy lighting for their studies.
- Improved health due to reduced indoor air pollution and reduced drudgery.
- Improved economic status of women; more time can be spent on income generating activities such as selling clothes, agriculture and so forth.
- E-cook will enable households with unreliable electricity supplies to cook at a time of their own convenient time.
- A solar home system can also be used for several things such as mobile charging, powering radio and TV and other connective applications.
- There is likely to be a loss of employment and income to men while women are more likely to be retailers.

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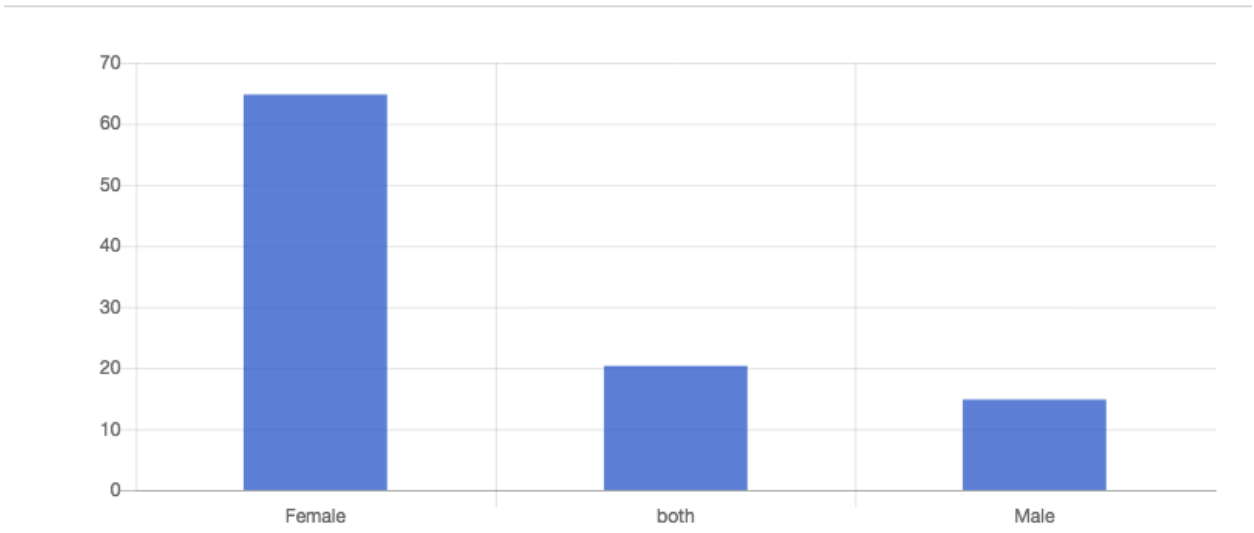

Figure 11: One of the graphs that show which gender does majority of the cooking. One of the scenarios that project dealt with.

On her recommendations she highlighted important things to be done in order to incorporate gender in energy (cooking) as follows;

- Invest in awareness rising using social marketing.
- Involve both men & women from the beginning to collect information on designing & marketing a product that will be beneficial & attractive to both men & women, as both are key HH decision makers in Tanzania. E.g. through single & mixed gender focuses groups and surveying both genders in the choice modeling.
- Empower women with knowledge and information on personal level concerning these new technologies.
- Most cooking diary respondents in Tanzania had a negative perspective of pressure cookers because they thought they are dangerous & use a lot of electricity. After extensive training and demonstrations, they all reported their new love for the appliance & now prefer the pressure cooker.
- Conduct parallel research into the best business opportunities for women with the time they save from cooking to help them transition from dependency to independency.
- E-cook should promote a "long term strategy to provide sustainable and affordable supply of clean cooking energy fuels" to prevent relapsing back to biomass fuels.

4.5.4 Choice modeling survey

Dr. Jon Leary (GAMOS) led this presentation. He stated that Choice modeling survey involved 200 participants in the Charcoal markets and it used smart phones to collect data. It aimed at evaluating relative value that participants place on specific features of a product that doesn't yet exist

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The findings showed that the electricity is not reliable because of

- Blackouts occurred several hours twice a week (Figure 11).
- Extended to the entire day during load shedding.
- Voltage is high enough for cooking, but likely to be much slower.

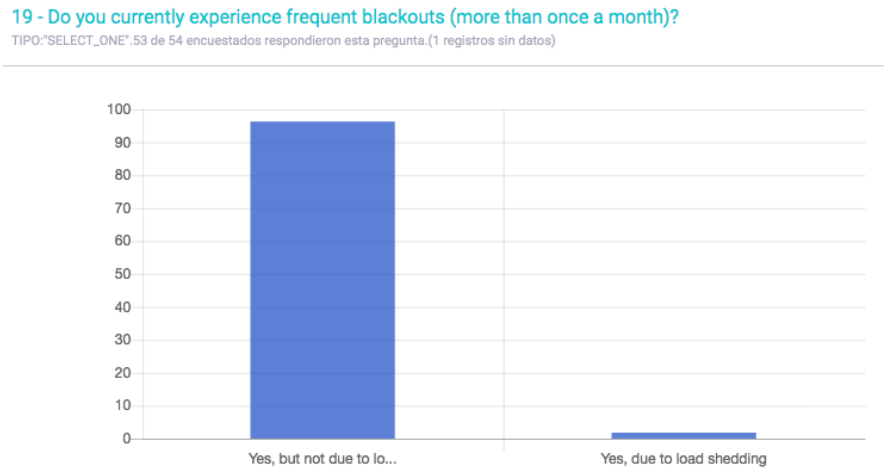

Figure 12: Graph showing the availability of electricity per month

- Business models
  - Monthly repayments & utility models seen positively.
  - Mobile money likely to be key payment mechanism, but shared meters may be challenging
  - Most popular appliances; phones, can easily be powered with surplus energy in an eCook device.

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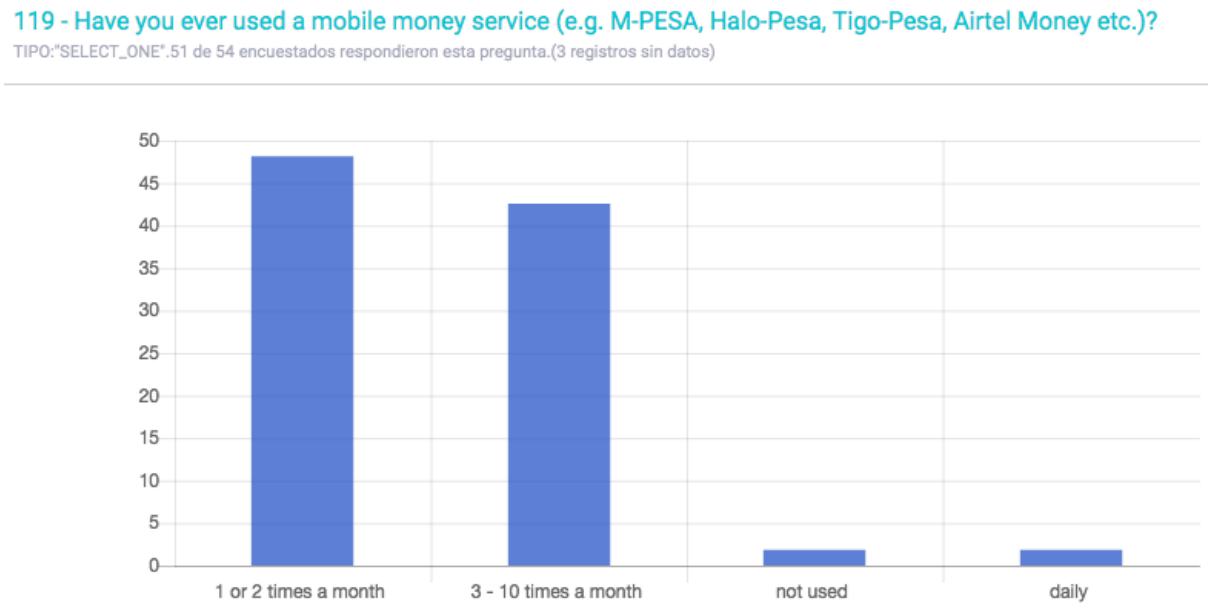

Figure 12: A graph showing the mobile money usability.

- Culture, perceptions & awareness
    - Social marketing required to demonstrate convenience & cost effectiveness of eCook.
    - Dinner almost always cooked at home, lunch least likely meal to be cooked at home.
    - Some foods may well taste better on charcoal, but they aren't necessarily the foods that people eat everyday and cost savings & convenience may well outweigh small differences in flavour except on special occasions.

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4.6 Key Learning Points from Ecook Zambia

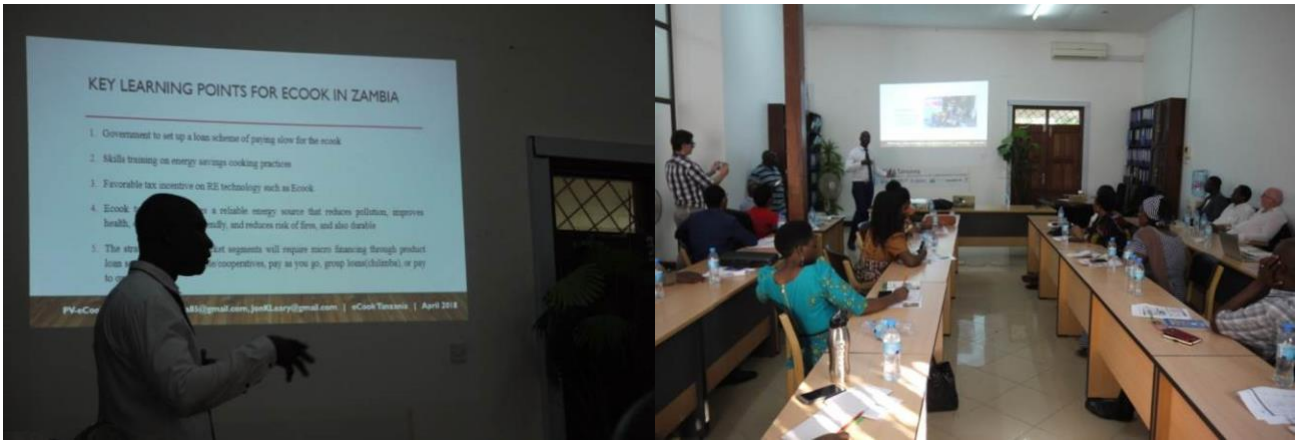

Figure 14: Participants following a presentation.

Mr. Francis Mwila from CEEEZ Zambia (Figure 16) shared the experiences he had on the eCook project from Zambian context. He stated that urban, peri -urban and rural areas are using grid electricity, charcoal and firewood to cook the prominent nshima, meat/fish/vegetable stew and fried/steamed greens. The big energy consumers were stated to be beans (2 kWh), roasted fish (1.5 kWh) heaters (1.5 kWh) and pork meat (2 kWh).

The factors that lead to the increase in the use of charcoal were stated to be:

- Frequently load shedding
- More blackouts
- Firewood becoming scarcer in many rural contexts.

Figure 15: Mbaula (a traditional name for a charcoal stove).

He pointed out that with the cost of electricity rising and increased load shedding eCook presents a great opportunity for Zambians to cook beyond 2020 cost effectively.

He finalized his presentation by highlighted the Key learning points for Zambia and Tanzania as follows;

Key Learning points for eCook in Zambia;

a) Government to set up a loan scheme of paying slow for the ecook
b) Skills training on energy savings cooking practices
c) Favorable tax incentive on RE technology such as Ecook

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d) Ecook technology creates a reliable energy source that reduces pollution, improves health, environmentally friendly, and reduces risk of fires, and also durable.
e) The strategies to reach market segments will require micro financing through product loan services, saving people/cooperatives, group loans (chilimba), or pay to own.

Key Learning points for eCook in Tanzania:

- Electrical appliances & social marketing campaigns are much cheaper than batteries, so eCook should be packaged with:
    - Energy saving appliances, such as multi-cookers
    - Training on energy saving cooking practices
- Energy = power x time
    - Focus efforts on dishes that use a lot of power, take a long time to cook and/or are cooked frequently
- Pay-as-you-go … or buy-as-you-go is the most preferred payment system.

Participants had time to reflect on the presentation on key learning for eCook in Tanzania, and the questions, and Answers were as seen below;

Qns. How is the modality of managing pay as you go in Zambia?
Ans: The solar company has structured a good system of which lower income customers are able to take advantage of high quality systems, whilst at the same time improving energy provision and local employment.

Qns. The pay as you go system, is it that a high cost that you pay for some time?
Ans: The pay as you goes allows you to pay some amount and do maintenance and replacing of the appliances

4.7 Closing of the 1st Day Workshop

The first day workshop was closed by Mr. Evarist Ng'wandu who expressed thanks to all the participants who represented their organisations, companies, privately and government owned by attending and actively participated, sharing experiences and gave out their views and recommendation on eCook. He quoted that "A bird sings not because it has answers but it has a song to sing". He said that people need energy for different appliances and that the resources we have on earth are enough to make people happy. He winded up by said that whatever we have done today we will continue with it tomorrow and we will have the song to sing.

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5.0 DAY 2 - DESIGN CHALLENGE

5.1 Design and Assembly

Participants of the workshop were asked to take part in a design challenge whereby they were divided into 3 groups (Figure 16) each with 4 to 5 people from various energy sectors. Each group had one cook and one person from the solar lighting/utility & clean cooking sector and where told to initial brainstorm a design solutions, which involved eCook hardware and Business models & marketing strategies.

Figure 16: Participants into groups

5.2 eCook Practices

In this part each group was given tasks as follows

- To prepare TZ meals using chosen appliances in small groups' i.e Banana with meat, ugali with meat and vegetables, rice with beans and rice with meat.
- To record energy consumption using plug in meters.
- Provide feedback from cooks on usability of chosen appliances
- Calculate the energy used by using design challenge modeling spreadsheet,

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Figure 17: Group participants executing design challenge tasks.

Figure 18: Group participants discusing design challenge tasks.

5.3 Economics

The group participants s were asked to

- Calculate actual energy used during eCook practice session.
- Modeling of battery/PV hardware required to support cooking.
- Refine eCook packages.

Figure 19: A panel of judges (from left to right) Dr. Ed Brown from Loughborough University, Eng. Ngwandu and Mr. E. Sawe from TaTEDO and Ms. Magdalena Muya from Ministry of Natural Resources and Tourism.

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5.4 Group Presentation & Prize-Giving Ceremony.

The session involved presentation of designed challenge of each group in front of the judges and participants. Each group were judged based on five criteria; i) Target market and impact ii) Business model, iii) Responding to cooks' feedback, iv) Technical viability and v) Innovation (Annex 2 illustrate). The winner group was "Nishati ya gharama nafuu" group (Figure 20). The features of their model were as follows

- The Cost and ownership
  - Low cost between Tshs 30,000-35,000
  - Pay as you go system implemented by a private company/agency and categorized according to the income level of the customer.
  - Initial payment of 20% which is about Tshs. 6,000-7,000 per month.
- Marketing strategy
  - social media campaigns
  - Local campaign.
- Cooks feedback
  - Energy serving
  - Time management
  - Tidy
  - No smoke and ashes
- Technical viability
  - Backup charging of batteries through grid.
  - Maintenance and replacement of parts to be taken care by private company/agency.
- Innovation
  - A system should have ports for charging other appliances like torch light, TV, radio and phones and cooking heating water capacity be around 1.5kW.

Figure 20: The winners of the eCook Design challenge; "Nishati ya gharama nafuu" group with their prizes.

6.0 WORKSHOP CLOSING

After all the discussions, and deliberation of the workshop, Mr. Jacob Mayala Principle geologist on behalf of the Ministry of Energy presented a closing speech. He expressed his gratitude to workshop organizers (TaTEDO, Gamos, Loughborough University, The University of Surrey, DfID / UKAID and Innovate UK) for the opportunity to the Ministry of Energy to close the workshop. He stated that about a decade, rapid spread of solar PV panels across many countries, particularly here in Africa was observed, which had already transformed millions of lives, however, it has yet to have an impact on the cooking energy needs of poor households.

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Based on the recently completed global market analysis he highlighted that, Tanzania has enormous potential for solar battery electric cooking primarily due to more than 84% of people who rely on unsustainably sourced charcoal and firewood for their cooking needs and staple foods that are highly compatible with battery-supported electricity. He added that frequent blackouts, voltage fluctuations, and emerging electric cooking market created a significant opportunity for Grid-eCook.

Moreover, he said that the research findings and demonstrations of solar battery electric cooking observed in TaTEDO during the workshop will have Paradigm Shift to the electric cooking using new and efficient technologies, especially solar electric cooking to thousands of Tanzanians. He requested that the research, workshop reports and recommendations to be shared to the ministry which will enable the Government and other stakeholders to effectively support the proposition into reality.

He concluded by conveying gratitude to the UK Government through their development agency (DfID/UKAID and Innovate UK) for the financial contribution of the research project and workshop.

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ANNEXES

Annex 1: Workshop Agenda

Agenda - Tuesday 24th April

Time	Session name	Description	Presenters/ facilitators
8:30-9:00	Registration	• Welcome & initial networking	
9:00-9:30	Opening session	**Speech** • Welcome remarks • Agenda & objectives for the workshop	Mr E. Sawe (TaTEDO)
		• Opening speech on clean cooking & electrification in TZ	Ministry of Energy
9:30-10:00	Introduction to eCook	**Presentation** • What is the eCook concept? • Overview of eCook research programme	Dr. S. Batchelor (Gamos, UK)
10:00-10:30	The opportunity in TZ & PV-eCook prototype demonstration	**Presentation** • Why TZ? **Demonstration** • PV-eCook prototype – solar powered and battery supported cooking	Dr. J. Leary (Gamos & Loughborough University, UK)
10:30-11:00	Coffee break	**Photo/hardware exhibition** • Share experiences from fieldwork • Showcase hardware	
11:00-12:15	TZ national development objectives	**Presentation & plenary discussion** • eCook's potential contribution to TZ national development objectives	Chair: Mr J. Shuma (TaTEDO)
12:15-12:30	Launch of TaTEDO institutional stove	**. Presentation** • Key features of new institutional stove	Mr. Sawe & Eng. Ngwandu, TaTEDO
12:30-13:30	Lunch	**Networking & discussion** • Lunch	
13:30-14:30	eCook TZ research findings to date	**Presentation** • Cooking diaries, focus groups, policy review, choice modelling, gender analysis	Miss K. Chepkurui (Gamos, UK) Mr. S. Sago, Mr. J. Shuma & Mrs. A.

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			Minja (TaTEDO)
14:30-15:00	Coffee break	**Photo/hardware exhibition** • Share experiences from fieldwork • Showcase hardware	
15:00-15:45	eCook Zambia & Myanmar	**Presentation** • Key learning points from Zambia & Myanmar	Mr F. Mwila (CEEEZ, Zambia) Dr J. Leary (Gamos & Loughborough University, UK)
15:45-16:45	Opportunities & challenges for eCook in TZ	**Presentation** • What behavioural change challenges are foreseen and how could we overcome them? **Small group discussion** • What are the key barriers & drivers for eCook in TZ? - Design Challenge groups will need to address each of these	Dr. Ed Brown (Loughborough University, UK)
16:45-17:00	Summary Day 1	**Summary speech** • Key learning points from the day	

Agenda - Wednesday 25th April

Time	Session name	Description	Presenters/ facilitators
8:30-9:00	Registration	**Photo/hardware exhibition** • Share experiences from fieldwork • Showcase hardware	
9:00-10:15	Design Challenge Part I – Design & Assembly	**Presentation** • Recap from day 1 & agenda for day 2 • Explanation of format for design challenge **Demonstration** • Demonstration of cooking appliances **Small group work** • Splitting into groups (each group	TaTEDO & UK team facilitating

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		should have at least one cook, one person from the solar lighting/utility & one person from the clean cooking spheres) • Initial brainstorming of design solutions • Designing & assembling eCook hardware • Business models & marketing strategies	
10:15-10:45	Coffee break	**Photo/hardware exhibition** • Share experiences from fieldwork • Showcase hardware	
10:45-12:30	Design challenge Part II - eCooking	**Small group work** • Preparation of a typical TZ meal using chosen appliances in small groups • Recording energy consumption using plug in meters • Feedback from cooks on usability of chosen appliances • Extra cook/s to use gas/charcoal for comparison	TaTEDO & UK team facilitating
12:30-13:30	Lunch	• Sampling dishes cooked by design challenge groups	
13:30-14:00	Modelling eCook	**Presentation** • How does the model work? • When might eCook be cost effective in TZ and for who? • Preliminary modelling results from eCook Zambia • Introducing the design challenge modelling spreadsheet	Professor Matt Leach (University of Surrey, UK)
14:00-14:45	Design Challenge Part III - Economics	**Small group work** • Calculation of actual energy used during eCooking session • Modelling of battery/PV hardware required to support cooking in this way • Refining of eCook packages	Professor Matt Leach (University of Surrey, UK) TaTEDO & UK team facilitating
14:45-15:15	Coffee break	**Photo/hardware exhibition** • Share experiences from fieldwork	

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		• Showcase hardware	
15:15-16:30	Design Challenge Part IV - Presentation & prize-giving ceremony	**Presentations** • Presentation of eCook packages by each group **Summary speech** • Announcement of Design Challenge winning team by judges	TaTEDO & UK team facilitting
16:30-17:00	Closing session	**Summary speech (prepared)** • Recap on key messages, next steps for eCook in TZ & beyond	TaTEDO & Gamos

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Annex 2: eCook TZ Design Challenge –Judging Criteria

Criteria	0	5	10
Target market and impact	The target market is unclear.	The target market is defined, but the social or environmental benefits of this choice are not clear.	The target market is well defined and there are clear social and environmental benefits behind this choice.
Business model	The business model is not credible.	The business model could be credible, but needs further work. Little mention of marketing strategies is made.	A proposal for a credible business opportunity is supported by a well-designed marketing strategy.
Responding to cooks' feedback	The cooks' feedback is totally ignored. No-one would adopt this product.	Some of the cooks' feedback is addressed in stove design. Some people may adopt this product.	Most feedback from most cooks is clearly addressed. This is a product that people would readily adopt.
Technical viability	The design would not work.	The design may work, but it may not be efficient.	The design is technically credible and would work efficiently.
Innovation	There is nothing novel about this design.	Some aspects of the technical design or business model are novel.	Both the technical design and the business model are novel ideas.

Annex 3: Website

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Annex 4: Opening Speech

THE NATIONAL STAKEHOLDERS' SOLAR ELECTRIC COOKING WORKSHOP

TaTEDO, near KKKT Church Mbezi Juu, Dar es Salaam

24-25th April 2018

WELCOME REMARKS

E.N. SAWE, CEO, TaTEDO

Chairperson,

Friends, Distinguished participants,

Ladies and Gentlemen.

On behalf of colleagues from TaTEDO, Gamos Ltd, and Universities of Loughborough and Surrey, the organizers of this workshop. I take this opportunity to warmly welcome all of you from within and outside the country. I am thankful for the opportunity to give these Welcome remarks,

Ladies and Gentlemen

I am glad and indeed grateful to have you as important participants and key stakeholders from the government, partners from UK, Kenya and Zambia and representatives of the Tanzanian Solar sector. I would like to thank you for accepting our invitation on a short notice. This is a clear indication that, we all recognize the importance of collaborative efforts to contribute in tackling the current challenges of very low access to affordable, reliable, sustainable modern energy for cooking in the country.

Ladies and gentlemen

As, we are probably aware, different studies show that about 3 billion people in the world cook food and heat their homes with traditional stoves fueled by wood or charcoal fires, which accounts for a large percentage of the greenhouse gases that are polluting our planet. Also in Tanzania, cooking is keeping millions of women from reaching their full potential. Women and girls spend up to five hours a day cooking and collecting firewood. And fires they cook with, fueled by charcoal, wood and farm residues, produce

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toxic smoke they and their families inhale, leading to over 20,000 preventable deaths according to WHO every year in Tanzania.

But solutions exist that can empower women and help them live their lives to the fullest. However due to lack of international and national political will and associated funding, the solutions have not been promoted and the problem continue to worsen year after year. The problem is clearly revealed by the amount of daily deforestation occurring in the country, According to National Forest Resources Monitoring Assessment (NAFORMA), Tanzania is losing more than 1000 hectares of natural forest each day due to charcoal production and the loss is increasing fast.

The objective of this workshop is to bring together key stakeholders from the solar lighting, cook stove and utility sectors, to introduce the Solar PV eCook concept and establish what contribution it could make to enhancing energy access and alleviate poverty in Tanzania. Solar electricity cooking is a clean way to cook that requires only sunshine as fuel. As such with this technology adopted on a large scale in the country, there will be no need t use firewood, charcoal or gas t the current quantity, only sunshine will be the national fuel instead of the biomass which is the case now.
The two days participatory workshop will explore the opportunity for solar PV ecook in Tanzania, Solar PV ecook is a potentially transformative household battery electric cooker that will soon be cost effective for households cooking on charcoal. In addition to offering a clean solution, it can also provide reliable and affordable electricity access. We expect, the participants to carry out hands on experiments with Solar PV ecook hardware, whilst discussing how this new technology can be tailored to best meet the needs of Tanzania cooks, in particular, those from lower income households, located in poorer urban areas, peri-urban and rural areas.

Chairperson, Distinguished Participants, Ladies and Gentlemen,
It is indeed a pleasure to welcome participants from Gamos Ltd, Loughborough and Surrey Universities (Jon, Mathew, Simon, Ed) and From Kenya (Karen) and Zambia (Francis) and from different institutions in Tanzania. I would like to convey our gratitude for the support extended to the project as a Grant from the Innovate UK (in cooperation with DFID UK Aid, and UK Science Research Councils) and partly from Gamos corporate funds.to ensure implementation of this interesting project with potential for high impact in our country. The workshop would indeed benefit from inputs of these national and international participants.

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On behalf of the Solar PV ecook project stakeholders, I would like to once again thank colleagues from TaTEDO, Gamos Ltd, Loughborough and surrey Universities, as organizers of this workshop led by Dr.Jon and Mr. Sago for all the efforts to ensure the workshop is successfully conducted today and tomorrow.

As mentioned above, this workshop has been organized Through a partnership between TaTEDO and the UK partners as part of the project entitled: "Solar PV eCook - a transformational household solar battery-electric cooker for poverty alleviation.

The current project project activity is trying to answer the Research question: What is the market potential for Solar PV eCook in Tanzania. Which specific market segments should be targeted and which marketing strategies are likely to be most effective? Over the past two months there has been a Tanzanian national market assessment with the objectives of evaluating, how the proposition might fit with national economic and policy environments, as well as cultural norms and practices; and also engaged with interested stakeholders by way of prepositioning for scaling up of the proposition. The overall project output is: Quantification & identification of key target markets in Tanzania and a detailed plan for how to reach them.

It is indeed clear, through this workshop, an important opportunity has been availed to the Solar PV ecook and related stakeholders in Tanzania to deliberate and agree on a strategy to promote solar PV ecook in Tanzania, hopefully led by the Ministry of Energy and indeed, the success of this workshop will be measured by the quality of the outputs which will emerge from the workshop, and thereafter be effectively implemented collaboratively towards achieving higher access to affordable reliable, sustainable modern energy for cooking with high positive impact on poverty reduction thus contributing to achieving the SE4ALL goals and the SDG 7 and related sectors goals.

I look forward to a fruitful and enjoyable workshop.

Thank you again for this opportunity and for your attention.

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Annex 5: Closing Speech

THE NATIONAL STAKEHOLDERS' KICK-OFF SOLAR ELECTRIC COOKING WORKSHOP
TaTEDO, TaTEDO Street near KKKT Church Mbezi Juu, Dar es Salaam
24-25th April 2018
CLOSING SPEECH
By Dr. Hamisi Hassan Mwinyimvua,
Permanent Secretary, Ministry of Energy

- **Moderator;**
- **Distinguished Partners from UK, Kenya and Zambia ,**
- **Distinguished Participants from the Government;**
- **Distinguished Participants from Private Sector;**
- **Distinguished Participants from CSOs;**
- **Ladies and Gentlemen**

On behalf of the Government of Tanzania, I would like to take this opportunity to convey my gratitude to the organizers of this workshop (TaTEDO, Gamos, Loughborough University, The University of Surrey, DfID / UKAID and Innovate UK) for availing the opportunity to the Ministry of Energy to close this important workshop. I am delighted to see many participants with strong interest in the burning issue of modern cooking energy and related environmental concerns.

This is a valuable opportunity for the government to share experiences with key stakeholders on the existing efforts the government is undertaking in addressing the challenges of energy for cooking.

It is gratifying to note that the agenda of the workshop covered a wide range of very interesting topics relating to solar battery electric cooking and especially those directly related to aspects of policy, strategies, regulations and environmental issues.

Ladies and Gentlemen

I am informed that this workshop is one of the components of the research project on eCook – A Transformational Household Solar Battery–electric Cooker for Poverty Alleviation. The research project is implemented in three countries of Tanzania, Zambia and Myanmar. The main objective of this project is to undertake research for a potentially transformative battery electric cooker (eCook), which is designed to extend access to electricity and clean cooking facilities to poor households.

For about a decade, we have observed rapid spread of solar PV panels across many countries, particularly here in Africa. This has already transformed millions of lives, however, it has yet to have an impact on the cooking energy needs of poor households.

The recently completed global market analysis highlights Tanzania as having enormous potential for solar battery electric cooking primarily due to more than 84% of people who rely on unsustainably sourced charcoal and firewood for their cooking needs and staple foods that are highly compatible with battery-

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supported electricity. Frequent blackouts, voltage fluctuations, and emerging electric cooking market create a significant opportunity for Grid-eCook, whilst the vast off-grid population and an established Solar Home Systems (SHS) offer highly favourable conditions for solar PV- electric cooking.

Ladies and Gentlemen

Securing a steady and reliable supply of modern energy is a major challenge for the country. That is why the Government, through the Ministry of Energy is looking for alternative innovative solutions to contribute to addressing the challenge of energy for cooking in Tanzania.

However, with research findings and demonstrations of solar battery electric cooking observed here in TaTEDO from yesterday, there is hope that thousands of Tanzanians will have Paradigm Shift to the electric cooking using new and efficient technologies, especially solar electric cooking being be one of them.

I am informed that the proposition of solar electric cooking (or PV-eCook) is that by 2020 the cost of using solar photovoltaic panels to charge a battery, and then using the battery for cooking as and when required, will be comparable to the monthly cost of cooking with charcoal and wood in most developing countries. As 2020 is now less than 2 years away, it is an exciting time to be talking about this potentially transformative technology.

Ladies and Gentlemen

I understand that, for a period of two months here in Tanzania, the project has managed to gather evidence on cooking energy through cooking diaries, focus group discussions, choice modelling surveys, policy reviews and more. The evidence from other countries has already shown that solar electric cooking offers the potential for emission free cooking, with time/money savings and broader environmental benefits from reduced fuelwood/charcoal consumption. We hope that the same is true for us here in Tanzania.

Ladies and Gentlemen,

It is my expectations that the research and workshop reports will be shared to the ministry and sound recommendations which will enable the Government and other stakeholders to effectively support this proposition into reality. It is our hope that the research will enable to come up with other programmes and projects to further disseminate findings of electric cooking in Tanzania.

Ladies and Gentlemen, whenever you see a well organised gathering, it means someone supported it by providing both financial and human resources. I would like to convey my special gratitude to the UK Government through their development agency (DfID/UKAID and Innovate UK) for the financial contribution of this important research project and workshop.

With these remarks, I have the pleasure to formally announce this workshop closed.

Asanteni Sana

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Annex 6: List of Participants

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31. Taramande Mfuru
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