MWANGAZA MASHINANI PILOT PROJECT BASELINE EVALUATION REPORT

Evaluation of the Mwangaza Mashinani pilot project in Kilifi and Garissa counties, Kenya

Volume I: Baseline results and discussion

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For further information, please contact:

Social Policy Section, UNICEF Kenya
United Nations Children's Fund
UN Complex Gigiri, Block Q Upper Level
P. O. Box 44145 – 00100 Nairobi

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This report was co-authored by Alexandra Doyle (Project Manager and Quantitative Analyst), Dr Michele Binci (Impact Evaluation Lead and Quantitative Expert), Tom Pellens (Team Leader), Dr Andrej Kveder (Sampling Expert) and Ishleen Sethi (Quantitative Researcher) with inputs and quality assurance from Virginia Barberis (Quantitative Analyst), Simon Trace (Energy Expert) and Patrick Ward (Principle Investigator).

All opinions expressed, and any mistakes, remain the responsibility of the authors.

The contact person for this evaluation at UNICEF Kenya is Yves Dublin.

ACRONYMS

ARI	Acute Respiratory Infection
ATE	Average Treatment Effect
BCC	Behaviour Change Communication
BWC	Beneficiary Welfare Committee
CC	Community Champion
CCTP	Consolidated Cash Transfer Programme
CT-OVC	Cash Transfer for Orphans and Vulnerable Children
DID	Difference-in-differences
E4I	Energy for Impact
FPC	Finite Population Correction
FSU	Final Sampling Unit
GoK	Government of Kenya
IGA	Income Generating Activity
ITT	Intention-to-treat
MIS	Management Information System
MTF	Multi-tier framework
NN	Nearest Neighbour
NSNP	National Safety Net Programme
OP-CT	Older Persons' Cash Transfer
OPM	Oxford Policy Management
PCA	Principal Component Analysis
PAYG	Pay-as-you-go
PSM	Propensity Score Matching
PSU	Primary Sampling Unit
PWSD-CT	Cash Transfer for Persons With Severe Disabilities
RCT	Randomised Control Trial
RGA	Research Guide Africa
SAU	Social Assistance Unit
SIDA	Swedish International Development Agency
SHS	Solar Home System
SL	Solar Lantern
SRS	Simple Random Sampling
TOC	Theory of Change
TOR	Terms of Reference
UNDSS	United Nations Department of Safety and Security
UNICEF	United Nations Children's Fund

EXECUTIVE SUMMARY

Oxford Policy Management (OPM) has been contracted by UNICEF to conduct an independent evaluation of the Mwangaza Mashinani pilot project. The Mwangaza Mashinani pilot project is providing cash top-ups to purchase solar home systems (SHS) and behaviour change communication (BCC) to poor and vulnerable households in Garissa and Kilifi. The purpose of the pilot is to generate evidence on the impact of solar devices on households' (particularly women and children) well-being in terms of education, health and livelihoods as well as to understand how a market for solar devices can be developed in underserved regions. This baseline report presents the findings from the quantitative baseline survey conducted between February and April 2019 as part of a one-year mixed methods evaluation.

Overview of the Mwangaza Mashinani pilot project

The Mwangaza Mashinani pilot project aims to enhance access to energy for the most vulnerable segment of the Kenyan population. The pilot project is targeting beneficiary households of the Cash Transfer for Orphans and Vulnerable Children (CT-OVC), the Older Persons Cash Transfer (OP-CT) and/or Cash Transfer for Persons With Severe Disabilities (PWSD-CT) that reside in off-grid communities, that have at least one child that is enrolled in and attending school, that do not have solar devices with more than one bulb and that are willing to pay a 250 Ksh deposit. By working with the local county governments, the pilot project plans to target at least 2,000 households in selected sub-counties across Garissa and Kilifi and will achieve impact through:

1. Improving customer affordability for solar products by providing households enrolled in the Mwangaza Mashinani pilot project with a bi-monthly cash top-up on their CT-OVC, OP-CT or PWSD-CT regular payments to be used for repayment of an SHS as chosen by the household;
2. Conducting a BCC campaign to improve households' awareness of solar products and provide messaging related to topics such as the benefits of solar energy, maintenance of solar products etc.;
3. Community engagement activities to raise awareness of the project for community leaders and the wider community, train beneficiary households on the use of the products, sensitise them about payment for the products, and promote interventions that reduce economic vulnerability.

Evaluation design and methods

The evaluation takes a theory-based approach which will methodologically guide the evaluation by drawing on the pilot project's Theory of Change (ToC) to identify the key issues the evaluation should address. The evaluation will draw on multiple research methods which will be sequentially implemented to achieve completeness of findings in order to bring together a more comprehensive account of the pilot project. To date, only the baseline survey of the quantitative impact evaluation has been implemented.

The objective of quantitative impact evaluation is to determine whether the Mwangaza Mashinani pilot project has had an impact on its beneficiaries in terms of access to energy, children's education outcomes, health outcomes and household livelihoods and to quantify the scale of any impact detected. The estimation of impact will be carried out within the context of a quasi-experimental design at the endline stage of the evaluation, as that is when the potential effects of the pilot project will have unfolded. Baseline is nonetheless a key stage of the evaluation to provide a descriptive picture of the pilot project target population before implementation and to match treatment and comparison households and assess their degree of comparability.

Main Baseline Findings

Energy Access

As expected, pilot beneficiary households do not have access to electricity and only a small minority currently own SHSs or solar lanterns (SLs). Among the sources of energy used for lighting in the last 30 days, dry-cell battery torches are most widely used followed by mobile phone torches, kerosene/paraffin/tin lamps and firewood. Interestingly, whilst the great majority of households use kerosene lanterns in Kilifi, this is not at all a light source used in Garissa.

In terms of cooking, the overwhelming majority of households cook using a traditional or improved stone fire with firewood. On average, households spent 241 Ksh on cooking fuel in the last month. However, in Kilifi, 95% of households do not spend any money on cooking fuel as they collect their own firewood resulting in significantly lower monthly expenditure on cooking in Kilifi than in Garissa.

The survey finds that 83% of households own at least one mobile phone and almost all households reported to have network coverage at least sometimes. Amongst households with a mobile phone, the majority (93%) of households are unable to charge their phones at home and, of those, 56% are able to charge their phones within 500m of their dwellings. The average fee for charging a mobile phone is 25 Ksh per charge

In terms of expenditure, households spent 561 Ksh in the last 30 days on energy for lighting and mobile phone charging which is significantly less than the 2,100 Ksh bi-monthly top-up with which they will be provided by the project. While the bi-monthly cost of the SHS is higher in absolute terms than households' energy expenditure, this cost is only incurred over five or six bi-monthly payment cycles after which the household will own the solar device.

Awareness of Alternative Energy

The survey results point to a high general awareness of solar energy solutions and their benefits. Specifically, 69% of households that have not used solar energy for lighting in the last 30 days are aware of solar energy solutions with awareness in Kilifi significantly higher than in Garissa. However, only 27% of households have been visited by someone promoting solar devices and there has been limited community discussion around the use and benefits of solar devices in the last 12 months.

Among households that do not currently own a solar system, 55% of households would like to buy one. The majority of households in Garissa cite the cost of solar systems as the main reason for not wanting to buy a device as well as lack of awareness of where to purchase a device and lack of knowledge of how to set up the device. In Kilifi, households note that they do not currently have the money to purchase a device.

Education

Overall, levels of school attendance are high in the treatment sample with 91% of children aged 6-15 currently attending school. The proportion of children who are regularly attending school (i.e. children who have not missed two or more consecutive weeks of school) is lower (84%). A majority of respondents cited lack of funds and illness as a reason for temporary withdrawal from school.

Overall, children spend around half an hour studying outside of school on a typical day (0.6 hours per day). Interestingly, out of the total hours spent studying outside the school, 0.1 hours are spent studying at home in daylight and the remaining 0.5 hours are spent studying at home in the dark hours. This confirms the project's assumption that children are not able to spend enough time studying during the day and hence study at night. The majority of children who study at night (89%) do so using kerosene lamps (particularly in Kilifi) and dry-cell battery torches (particularly in Garissa).

Health

Indicators concerning the health status of household members show that burns and symptoms of acute respiratory infection have limited prevalence (3% and 6% respectively) in the target population. Slightly more household members reported experiencing symptoms of eye irritation in the last one month and the findings indicate disparities in eye irritation by gender as women spend significantly more time in front of open flames whilst cooking. The majority of the cases of eye irritation happen while household members are cooking themselves or are present while someone else is cooking.

Livelihoods

Slightly more than two-thirds of household members aged 15 and above are engaged in work with significant disparities by county: 82% of household members aged 15 and above are involved in some form of work in Kilifi compared to 39% in Garissa. Furthermore, the gender differences are also striking with a significantly higher proportion of women engaged in work than men. In addition, less than 10% of working male household members work at home at night compared to half of working female household members. Overall, female household members are found to work more hours per week during the day and at night compared to male household members.

Findings on women's time use indicate that, on average, women spend almost 10 hours on a typical weekday working. The majority of this time is spent on unpaid labour (7 hours) while time spent on leisure activities was considerably lower (4 hours per day). The time use analysis explicitly focusing on women shows that around one third of adult female household members can be considered as time poor at baseline.

Propensity Score Matching Outcomes

The matching procedure based on PSM has achieved very positive results. The analysis indicates that, after matching, the sample is balanced across characteristics of interest in the treatment and comparison groups and across impact areas and indicators. Any remaining imbalance in some of the outcome indicators can be successfully dealt with at endline with the adoption of a Difference-in-Difference analysis. The quasi-experimental design underpinning the impact estimation is thus confirmed to be valid.

1 INTRODUCTION

Oxford Policy Management (OPM) has been contracted by UNICEF to conduct an independent evaluation of the Mwangaza Mashinani pilot project. The Mwangaza Mashinani pilot project is providing cash top-ups to purchase solar home systems (SHS), and behaviour change communication (BCC) to selected households currently enrolled in the Cash Transfer for Orphans and Vulnerable Children (CT-OVC), Older Persons' Cash Transfer (OP-CT) and Cash Transfer for Persons with Severe Disabilities (PWSD-CT) in Garissa and Kilifi counties.[1] The purpose of the pilot is to generate evidence on the impact of solar devices on households' (particularly women and children) well-being in terms of education, health and livelihoods as well as to understand how a market for solar devices can be developed in underserved regions.

This baseline report presents the findings from the quantitative baseline survey as part of a one-year mixed methods evaluation, combining baseline and endline quantitative household surveys with endline qualitative research. A comprehensive evaluation methodology was set out in an evaluation inception report (OPM, February 2019). The methodology was developed in consultation with UNICEF, the project implementing partners and national and district government actors. It was discussed during Technical Working Groups (TWG) with the Kilifi and Garissa district governments in January 2019 and at a workshop with national government departments in February 2019.

The baseline survey methodology and implementation has had to adapt to changing information about the target population of the intervention, which required adjustments in the initial sample frame, sample size and samples selected. Therefore, a first round of survey fieldwork in February 2019 had to be complemented with a second round in March/April 2019.

The objective of this report is to provide an analysis of the baseline situation of the project's outcome areas of interest as outlined in the project's theory of change (ToC). Furthermore, the report presents findings related to some of the assumptions underpinning the ToC and key characteristics of the target population prior to implementation. The report will not yet answer the evaluation questions. These will be addressed in the endline report drawing on the data collected from all of the research activities.

This report is presented in two volumes. Volume I presents the baseline findings and discussion and Volume II contains the technical annexes to the baseline report. The remainder of Volume I is structured as follows: Section 2 provides an overview of the pilot project including the objectives and scope, intervention strategy, target population, challenges during implementation and broader context. Section 3 presents the purpose, objectives and scope of the evaluation. Section 4 provides an overview of the technical details of the evaluation methodology. Section 5 presents the baseline findings and descriptive statistics and section 6 presents the matching and balancing results from the propensity score matching (PSM) approach. Finally, section 7 presents the conclusions and considerations for implementation.

[1] The evaluation focuses only on households enrolled in the CT-OVC or OP-CT as households enrolled in the PWSD-CT were included in the eligible population as an addition during sensitisation and enrolment after the baseline had concluded.

2 OVERVIEW OF THE PILOT PROJECT AND ITS CONTEXT

2.1 Context of the pilot project

In December 2018, the Government of Kenya (GoK) launched their National Electrification Strategy to achieve their goal of universal energy access by 2020. Achievement of this goal will require densification of the national grid services, expansion of grid services where economically possible and provision of off-grid energy solutions, such as solar devices and mini-grids, in areas where grid provision is not viable.

Kenya has seen rapid increases in electrification over the past few years increasing grid access for Kenyan households from a rate of 25% in 2011 to 64.5% in 2018, according to Power Africa (2018). Despite this, there remain large inequities in electricity provision with close to 95% of the population not having access to electricity in rural parts of the country (Willcox et al., 2015). These households typically use kerosene lighting, which come with high operational costs, provide low-quality light and can have adverse effects on household members' health and the environment (Rom et al., 2017). The UNICEF project proposal suggests that these areas of the country, representing about 2 million households, could be served by off-grid energy solutions as extending grid access to remote regions is very costly.

Kenya has a rapidly growing and innovative solar market. However, most of the large solar suppliers are concentrated in Western and Central parts of Kenya (Energy4Impact et al, 2018). Since the national grid does not fully extend into the Northern and the Eastern parts of the country, they remain underserved in terms of energy access. While solar suppliers exist in larger towns, including Garissa Town and Kilifi Town, their networks rarely extend into more rural parts of the counties. Although the GOK's KOSAP programme,[2] supported by the World Bank, will create incentives for suppliers to move into remote regions, which will help to increase the availability of solar products in general, the poorest households will remain excluded on the grounds of product affordability.

The GoK has made significant progress in building the National Safety Net Programme (NSNP) to expand the national social cash transfers to the most vulnerable segments of the population. In 2017/18, CT-OVC, OP-CT and PWSD-CT programmes transferred 4,000 Ksh to 757,000 households on a bi-monthly basis (Single Registry, 2018). Over the next five years, the GoK has prioritised the "Cash Plus Agenda" based on the assumption that the impacts on households are greater if cash transfers are complemented and linked with other interventions and programmes. The cash plus agenda hopes to help households to diversify their incomes as well as to access essential services, such as energy services.

2.2 Object of the evaluation: the Mwangaza Mashinani project

Objectives and scope of the project

The Mwangaza Mashinani project is an innovative pilot to expand access to energy, particularly to poor households, in line with the GoK's Cash Plus Agenda. UNICEF with funding from the Swedish International Development Agency (Sida) is supporting the GoK in piloting the project. It is implemented

[2] The purpose of the Kenya Off-grid Solar Access Project for Underserved Counties is to increase access to modern energy services through four components. The second component, which is of relevance to this project, is to increase access and ownership of stand-alone solar systems and clean cooking solutions for households in underserved counties.

by a consortium led by Energy4Impact (E4I) with Busara Centre for Behavioural Economics and Somali Aid.

Box 1: Key expected outcomes based on the Theory of Change

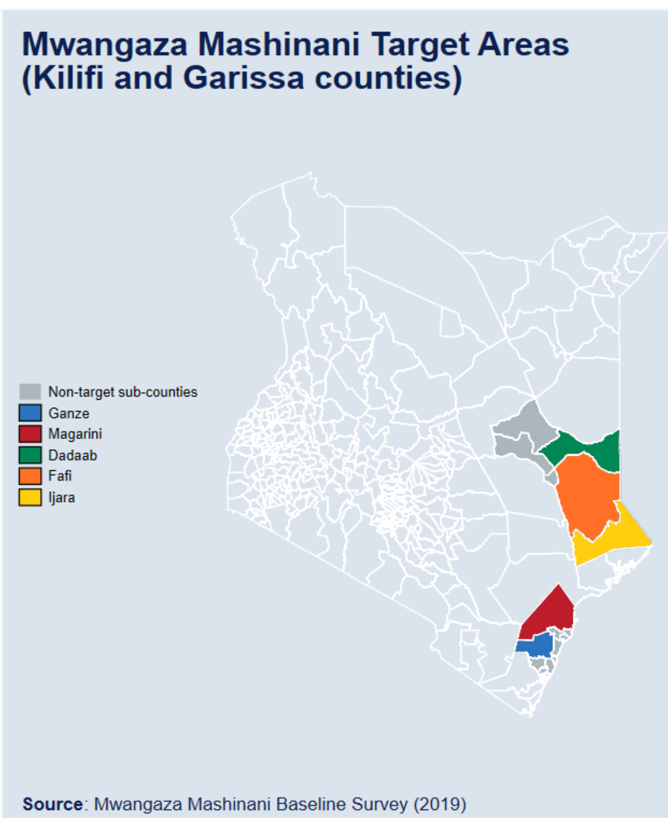
The pilot project's expected impact is to improve the wellbeing of beneficiary households in terms of:

- household members' health, in particular reduced acute respiratory infections (ARI), eye disease and burns due to reduced indoor air pollution and fire hazards;
- children's educational outcomes through increased study hours particularly after dark;
- household income by increasing and diversifying the livelihoods activities households engage in and reducing household net expenditure on energy.

The pilot project aims to contribute to this impact by enhancing access to and use of energy to the most vulnerable segment of the population, develop markets for solar energy and increase penetration of solar energy solutions in targeted communities. The solar energy solutions promoted by the pilot project are small SHSs.

The purpose of the pilot project is to enhance energy access to the most vulnerable segment of the Kenyan population in order to increase their wellbeing in terms of health, education and livelihoods with a particular focus on women and children. Additionally, the project seeks to develop markets for solar energy by increasing the penetration of solar products to previously underserved communities. Box 1 shows the key expected outcomes of the project based on the ToC. For a full presentation of the ToC, see Annex A in Volume II.

Figure 1: Map of project implementation areas



By working with the local county governments, the pilot project has set out to reach 2,000 households in Kilifi and Garissa counties. The project is being implemented in selected sub-counties in the two counties. Sub-counties were selected on the basis of a vulnerability assessment,[3] concluded in December 2018, which ranked sub-counties in each county based on a number of selection criteria.[4] In Kilifi, Ganze and Magarini sub-counties were identified as most vulnerable and seven locations within them were selected for implementation. In Garissa, nine locations across Dadaab, Fafi and Ijara sub-counties were selected. The selected sub-counties are shown in Figure 1.

The project will be piloted over a one-year period. Its design began in September 2018 and implementation was initially expected to begin in January 2018. However, due to a number of challenges (see below), particularly related to targeting and enrolment of beneficiaries, the project was officially launched in mid-April 2019.

Intervention strategy of the project

The pilot project will achieve impact through:

1. Improving customer affordability for solar devices by providing households enrolled in the project with a bi-monthly cash top-up of 2,100 Ksh[5] on their CT-OVC, OP-CT or PWSD-CT regular payments to be used for repayment of either an SHS as chosen by the household;
2. Conducting a BCC campaign to improve households' awareness of solar products and provide messaging related to topics such as the benefits of solar energy and maintenance of solar products;
3. Community engagement activities to raise awareness of the project for community leaders and the wider community, train beneficiary households on the use of the products, sensitise them about payment for the products, and promote interventions that reduce economic vulnerability.

The project is working through existing community structures, including beneficiary welfare committee (BWC) members and community champions (CCs).[6] To date, around 50 BWC members have been trained on the solar technology and their role in the project. Going forward, BWC members will support beneficiaries in the use of devices, encourage beneficiaries to make payments to the supplier, provide support in the case and grievance management process and follow-up on issues as they emerge.

The project is working with two private solar suppliers: Biolite and DLight,[7] which were selected on the basis of a competitive process and will supply the solar devices in the targeted communities. Neither supplier is offering an option of solar lanterns (see below). The specifications and price of their product are slightly different. The Biolite SHS includes four solar lights and costs 11,500 Ksh while the DLight SHS has three solar lights and costs 13,800 Ksh. Both products are repayable using PAYG,[8] however,

[3] For details on the methodology and recommendations, see "Energy and cash plus pilot project in Kilifi & Garissa counties. Vulnerability assessment report". December 2018.
[4] In Kilifi, these are 1) off-grid, 2) geographically remote from infrastructure and services, 3) school performance is poor, 4) sufficient numbers of households enrolled in the CT-OVC programme, 5) high levels of insecurity, 6) high rates of early pregnancy and rape, 7) areas prone to floods, 8) no livelihoods. In Garissa, the criteria were the same as those applied in Kilifi with the addition of the prevailing security situation.
[5] The first payment was slightly higher (between 2,850 and 3,050 Ksh) to cover the deposit depending on the device chosen by beneficiary households.
[6] The BWC is a group of representatives of beneficiaries of the various cash transfers which operates at the location level and serves as a link between the beneficiaries and programme officers on matters of development and changes in the programme
[7] The project initially partnered with three solar suppliers. Greenlight Planet was recruited as the third solar supplier but pulled out after the first few days of sensitisation for reasons that were not known at the time of writing. Greenlight Planet was the only supplier offering solar lanterns.
[8] DLight is offering the D31 which includes a 10 watt solar panel, mobile-charging cable, three solar lights, three light switches, and a 2 year warranty. Biolite is offering the Home 620 which includes a 10 watt solar panel which powers 4 hanging lights, USB charge-out, an MP3/FM radio system and a 2 year warranty.

given the difference in cost, the Biolite product will be repaid in five bi-monthly instalments while the DLight product will be repaid in six.

As of May 2019, sensitisation and recruitment of households had begun in both counties. The payroll data shared in June 2019 indicated that 1,356 households had enrolled in the project in Kilifi after two rounds of recruitment.[9] In Garissa, sensitisation and recruitment began on the 10th of May and 784 households were enrolled in the project by June 2019. Both solar suppliers were involved in the community sensitisation meetings where they were given a chance to provide information on the solar products to households. A first payment to enrolled households in one sub-country in Kilifi took place in April 2019.[10]

Target population of the project

The pilot project is targeting beneficiary households of the CT-OVC and/or the OP-CT and/or the PWSD-CT that reside in off-grid communities, that have at least one child that is enrolled in and attending primary school,[11] that do not have solar devices with more than one bulb and that are willing to pay a 250 Ksh deposit. While the evaluation has a specific focus on the impact of the pilot project on women and children, the pilot project is not explicitly targeting female-headed households or households with girl children.

Targeting of households took place in a number of stages. As described above, sub-counties and locations were selected for implementation on the basis of a vulnerability assessment and the selection was approved in each county by the TWG. The implementing partners then conducted a verification exercise in which all households enrolled in the CT-OVC and/or OP-CT according to the Management Information System (MIS) data were interviewed to establish whether they met the eligibility criteria for the project.[12] Households were deemed eligible for enrolment on the basis of the verification exercise. In addition, households in the NSNP that meet the eligibility criteria of the project but that were not on these verification lists are still eligible to participate in the project.

Revisions and challenges to the initial implementation plan

Implementation of the Mwangaza Mashinani pilot project has faced a number of challenges resulting in revisions to the initial implementation plan and some implementation delays.

Identifying eligible households: the planned vulnerability assessment, which initially was to be used to identify both the communities for implementation and the beneficiary households, was complemented with a verification exercise to be able to identify households that meet the project's eligibility criteria. The verification exercise was launched in December 2018 and an initial list of eligible households was available in February 2019, which delayed the baseline survey and project launch.

Changing eligibility criteria: the verification exercise indicated that much lower numbers of households met the eligibility criteria in the target sub-counties than initially anticipated. This led the implementing partners to revise some of the eligibility criteria:

- The amount of the deposit from households was reduced from 500 Ksh to 250 Ksh;

[9] The second recruitment round was targeted at households that were unable to attend the first round of recruitment.
[10] To date, beneficiaries in Mitangani, Kilifi, have received the payment as this is where the launch event took place and hence project implementation was prioritised in this area.
[11] Initially, only households with children aged 9-14 were eligible but the age requirement was later relaxed to households with school going children.
[12] Households enrolled in only the PWSD-CT were not interviewed as part of the verification exercise as this group was not part of the original target population.

- The age bracket (age 9-14) on primary school children was removed;
- The requirement that children be enrolled in primary school, specifically, was removed and replaced with the requirement that at least one child in the household is enrolled in school;
- Households with only one SL or small SHSs with only one bulb were still eligible for the project;
- Initially, the project only targeted CT-OVC households but later the OP-CT and PWSD-CT were added.

SAU migration: the Social Assistance Unit (SAU) is undergoing a data migration as part of the move to a new payment mechanism and updated database of beneficiaries. The migration entails a process of re-registering households enrolled in all of the NSNP's cash transfer programmes and moving their data to the integrated Consolidated Cash Transfer Programme (CCTP) MIS. This migration is taking place in phases and many households were not re-registered in the CCTP-MIS in the first phase. For the purposes of the pilot project, households that were not re-registered (and therefore do not appear in the latest CCTP-MIS data) are considered ineligible for the project as they have temporarily been withdrawn from the NSNP.[13] The first phase of the migration was finalised in March 2019 and almost 75% of the households initially deemed eligible for the Mwangaza Mashinani project were no longer found in the CCTP-MIS. This necessitated a second round of verification using the new beneficiary lists. The implications for the baseline survey are discussed in section 4.3.

Enrolment: sensitisation meetings were held in Kilifi in March where the project aimed to recruit 1,500 households. Because not all eligible households were present during the first round of recruitment and many potential beneficiaries did not have sufficient documentation to enrol, a second round of sensitisation meetings had to be conducted. Additionally, the implementing partners faced language barriers during the sensitisation meetings as not all attendees spoke Swahili.

Integration with the government's payment system: the project was unable to integrate their payment system with the NSNP's payment system as the budget cycle had been concluded before the project payroll was ready. As such, a parallel payment system through Equity Bank, KCB Bank, the Co-operative Bank of Kenya and Postbank has been set up and will be used to disburse the bi-monthly payments until the new financial year at which point the project's payment system is expected to be integrated with the government's payroll.

Selection of solar suppliers: the selection of solar suppliers took longer than planned as most of the suppliers did not provide quotes that met the specifications of the project (i.e. products with two bulbs). Discussions with the solar suppliers resulted in three or four bulb products being selected and the project offering SHSs exclusively after GreenLight Planet withdrew from the project as they were the only suppliers of SLs. A minority of households selected the option of three SLs prior to GreenLight Planet's withdrawal.

2.3 Context of the evaluation

An evaluation must be appropriate and responsive to the specific set of contextual circumstances and features of the project under evaluation. The following constitute project features and circumstances to which the evaluation has been tailored:

- **Beneficiary eligibility criteria:** the population of interest for this evaluation is shaped by the beneficiary eligibility criteria. The findings reported in the baseline report are therefore relevant to the

[13] While households may be re-registered during the implementation phase of the pilot project, they are not considered eligible for enrolment as they will not be on the government payroll for the first cycle of payments. It was unclear at the time of writing when the migration exercise would be concluded.

specific target population and cannot be extrapolated to any other population beside the pilot project target population.

- **Selection of sub-counties**: the sub-counties for the project and for the evaluation were purposively selected on the basis of the vulnerability assessment and were approved during the county TWGs. Due to the purposive selection of sub-counties, the evaluation was unable to randomly assign sub-counties to treatment and comparison status.
- **Security concerns**: the evaluation has taken security into account and did not select respondents in villages deemed insecure by the United Nations Department of Safety and Security (UNDSS). In some cases, field teams were advised by local leaders not to visit certain villages and these villages were replaced.
- **Number of targeted households in different counties**: respondents for the baseline survey are not evenly split between the two counties because the number of targeted households differs by county. In Kilifi, the project has enrolled 1,356 households while 784 households were enrolled in Garissa.

3 PURPOSE, OBJECTIVES AND SCOPE OF THE EVALUATION

3.1 Purpose of the evaluation

The primary purpose of the evaluation is to render a summative assessment of the impact of the pilot project and generate scientifically robust evidence on whether and how the project has impact on the recipients' sense of ownership of the solar products and quality of life of children and their families in terms of education, health and livelihoods. The final evaluation findings need to support a proof of concept that project stakeholders can use to advocate for and facilitate government decision making around the scale-up of the intervention.

The evaluation also has a formative purpose to improve the processes of the pilot project. The evaluation evidence needs to facilitate decision making regarding project implementation and eventual modification, by looking, in particular, at the project's coordination and operational modalities. Findings related to the processes of the pilot project will be part of the endline report after implementation has been rolled out.

3.2 Objectives of the evaluation

The primary objectives of the evaluation are threefold:

1. An assessment of the **impact** attributable to the pilot project on beneficiary households, with a focus on women and children;
2. An assessment of the **relevance** of the pilot project with respect to the needs of vulnerable households in Garissa and Kilifi;
3. An assessment of the effectiveness and efficiency of the pilot project **implementation process**, with a focus on operational lessons and recommendations for scale-up and **sustainability**.

3.3 Scope of the evaluation

The evaluation will assess the Mwangaza Mashinani pilot project according to the questions laid out in the evaluation framework (presented in detail in Annex B), which is structured around the criteria for evaluating development assistance formulated by the OECD Development Assistance Committee (OECD-DAC). The evaluation questions will be answered in the endline evaluation report by drawing on all quantitative and qualitative evidence generated throughout the evaluation.

4 EVALUATION METHODOLOGY

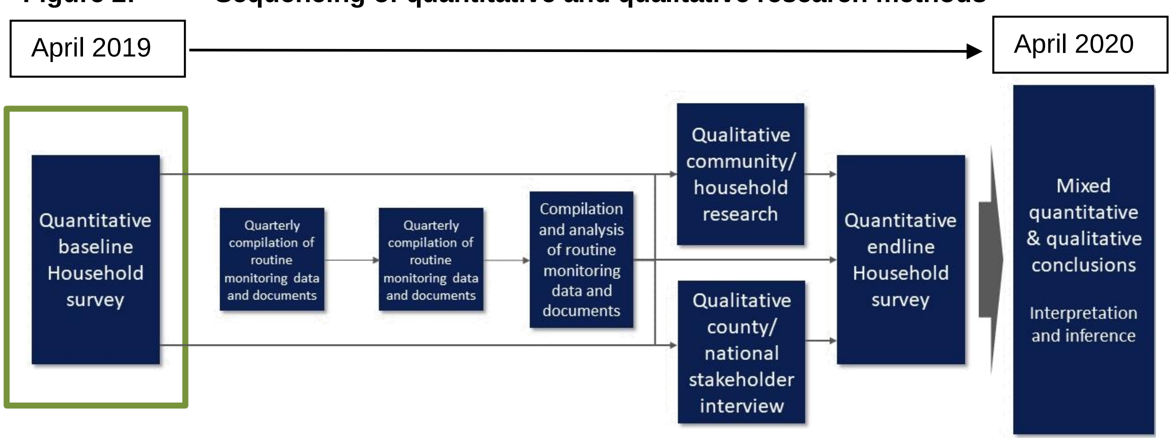
4.1 Overarching evaluation framework and design

The evaluation is guided methodologically by a theory-based approach which draws on the pilot project's ToC to identify the key issues the evaluation should address (i.e. evaluation questions), empirically verify key outcomes and assumptions posited along the impact pathways in the ToC, and draw conclusions about whether and how the pilot project contributed to observed results.14 The ToC has guided the formulation of ten Key Evaluation Questions (KEQs), which in turn guide the evidence generation. The KEQs are organised in an evaluation matrix according to five overarching evaluation criteria of relevance, effectiveness, impact, efficiency and sustainability (see Annex B).

Causal analysis and resulting impact attribution claims will foremost be based on a counterfactual approach (i.e. a quasi-experimental impact evaluation design discussed below). However, by combining this with a theory-based approach the causal chain to impact can be unpacked, which provides a better understanding of why change happens.15

The evaluation follows a mixed methods approach, combining different qualitative and quantitative research methods and primary and secondary data. Details on the research methods which will be used to generate evidence to answer the KEQs can be found in the evaluation inception report. The results and findings presented in this report are drawn only from the baseline household survey, which forms the basis of the quantitative quasi-experimental impact evaluation, explained in more detail below. The remainder of the research activities will be conducted once the project is in full implementation. Figure 2 presents an overview of how the different research methods will be implemented.

Figure 2: Sequencing of quantitative and qualitative research methods



4.2 Quantitative impact evaluation design

As discussed in the evaluation inception report, the objective of quantitative impact evaluation is to determine whether the Mwangaza Mashinani pilot project has had an impact on its beneficiaries and to quantify the scale of any impact detected. The estimation of impact will be carried out within the context of a quasi-experimental design. Impact estimates will be produced at the endline stage of the evaluation, as

[14] See Bamberger, M., Vaessen, J. and Raimondo, E. (eds) (2017) Dealing with Complexity in Development Evaluation. Sage. Chen, H.T. (2015) Practical Program Evaluation, Theory-Driven Evaluation and the Integrated Evaluation Perspective. Sage.
[15] See White, H. (2009) Theory-Based Impact Evaluation: Principles and Practice. 3ie Working Paper, No3.

that is when the potential effects of the pilot project will have unfolded. Baseline is nonetheless a key stage of the evaluation to achieve two objectives:

1. Provide a descriptive picture of the pilot project target population before implementation;
2. Match treatment and comparison households and assess their degree of comparability.

4.2.1 Descriptive analysis

Descriptive statistics are presented in this report for a range of indicators of interest pertaining to the impact areas that have been identified on the basis of the pilot project's ToC (i.e. energy access and awareness, education, health and livelihoods). The descriptive analysis provides a general idea of the pre-intervention characteristics of the pilot project target population, including a disaggregation of these characteristics by categories of interest. The latter include the gender of the household head, the location of the household and the cash transfer programme (i.e. CT-OVC or OP-CT) in which the household is enrolled. These categories are the strata through which the sampling frame was structured, which in turn ensures that their distribution in the sample is representative of the target population.

The baseline descriptive analysis will also form the basis for a pre-post trend analysis focusing on the evolution of key characteristics of treatment households, between baseline and endline. There are several indicators that will be investigated as part of this descriptive trend analysis, including whether awareness and knowledge of solar devices have improved and how household needs, especially in terms of energy access and consumption, have changed over the course of the evaluation period.[16] This pre-post trend analysis will thus be of interest to understand how some of the defining features of households enrolled into the pilot project changed over the course of the one-year evaluation period, but will not provide any attributable causality claims as it will be descriptive in nature.

4.2.2 Matching and balancing

Since the Mwangaza Mashinani pilot project beneficiaries are purposefully selected on the basis of a series of specific criteria, it is not possible to apply an experimental approach, such as a Randomised Control Trial (RCT), to the impact evaluation. Therefore, the impact attributable to the pilot project will be estimated through the use of a quasi-experimental approach based on Propensity Score Matching (PSM) and Differences-in-Differences (DID). Whilst the DID exploits the longitudinal nature of this study and will be used at endline to compare changes over time across the treatment and comparison groups, PSM helps to tackle the problem of selection bias by constructing appropriate comparisons to the pilot beneficiary households (i.e. the treatment group), thus building a valid counterfactual. This happens by matching and comparing outcomes for units in the treatment group with comparison units that are as similar as possible to each other according to a set of relevant observable characteristics. Assessing balance of covariates after matching is a key step for the PSM modelling. This comprehensive balance diagnostic testing is reported and described in more detail in Section **Error! Reference source not found.**. Further technical detail on the PSM is provided in Annex F.

4.2.3 Intention-To-Treat

Finally, it is important to clarify that the impact estimation methodology will allow to measure at endline an Intention-To-Treat (ITT) estimate. Unlike the Average Treatment Effect (ATE), ITT covers every household that is surveyed in areas defined as treatment (according to the implementation plan) and

[16] Impact will not be estimated in these domains because the comparison group is not expected to be exposed to the pilot or any other similar initiative that would affect their awareness, knowledge or need of solar devices.

ignores non-compliance or anything else that may prevent households from being treated. In other words, It cannot be ensured that all households included in the treatment group will actually be exposed to the pilot project (i.e. will receive the cash top-up and the solar devices) as this information was not available at the time of the baseline survey. Therefore, in the ITT analysis the impact estimates provide a measure of the effect of being offered, rather than actually receiving the treatment and is generally more conservative compared to the analysis of impact on observations that are all equally treated.

4.3 Sampling strategy and sample of the baseline survey

This section summarises the core features of the sampling strategy for the baseline survey. The full technical details concerning the sampling frame, sampling method and final sample distribution are reported in Annex C of Volume II.

The sampling strategy for the quantitative household survey has been shaped by the characteristics of the Mwangaza Mashinani pilot project. As discussed in section 4.2.2, since the counties, sub-counties and locations were purposively selected for the project, there was no possibility of randomly identifying treatment and control groups.17 Specifically, treatment sub-counties and comparison sub-counties deemed sufficiently similar to the treatment sub-counties were identified for the purposes of the evaluation by the implementing partners and TWG in each county.18

Due to sampling a high proportion of the total population (i.e. above 50%), the baseline survey uses a single stage sampling strategy by directly sampling households (the unit of analysis) from the sample frame in its entirety.19 In order to retain control over the structure of the sample and thus ensure representativity, explicit stratification combined with a simple random sampling (SRS) within each stratum was used. Strata were defined by sub-county, cash transfer type and gender of the household head. Consequently, the allocation of the sample proportion in each explicit stratum is proportional to the size of each stratum in the population.

However, during data collection, the first phase of the SAU migration to the CCTP-MIS was concluded resulting in a significant change in the list of eligible households (i.e. sample frame) that was used to draw the sample. Consequently, the initial baseline sample was reduced by 75% and was no longer representative of the revised target population in terms of structure. This necessitated the sample to be topped-up from the new sample frame. The top-up sampling procedure followed the same methodology as the initial sampling – i.e. the same definitions of the explicit strata were used as well as the SRS method to select the units within each stratum – to achieve a final sample size of 1,200 households. The combination between initial sampling and top-up sampling procedures ensures that the evaluation sample is representative of the revised target population of the pilot project.

The final sample distribution as well as realised sample is shown in Table 1 below.

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[17] Furthermore, it was also decided that comparison group households could not be selected from the same sub-counties as the treatment households because part of the BCC will be provided at the sub-county level and there is a high likelihood of spillover effects.

[18] Three sub-counties in Kilifi and four sub-counties in Garissa were proposed as potential sub-counties for project implementation on the basis of the vulnerability assessment. The final decision as to which sub-counties would be included in the project and which would be designated as comparison sub-counties was made during the TWGs in each county. Hence, sub-counties were assigned as treatment or comparison by the TWGs rather than this process being random as was the evaluator's preference.

[19] The sample frame is the list of all eligible households in all 7 sub-counties which was provided by the implementing partners.

Table 1: Final sample (target and actual)

County	Sub-county	Number of households in sample	Number of completed interviews
Treatment		**600**	**600**
Kilifi	Ganze	173	173
Kilifi	Magarini	214	214
Garissa	Dadaab	128	128
Garissa	Ijara	59	59
Garissa	Fafi	26	26
Comparison		**600**	**586**
Kilifi	Kaloleni	387	373
Garissa	Balambala	213	213
Total		**1,200**	**1,186**

4.4 Ethics and inclusion

OPM regularly carries out research studies that collect primary data from human subjects. As a value-driven organisation, OPM is always respectful of the rights of its research participants and respondents, and has a policy to ensure complete adherence to research ethics. The evaluation will be conducted in accordance with UNEG's Ethical Guidelines for Evaluation as well as the 2016 UNEG Norms and Standards.

The quantitative impact evaluation component of this evaluation was submitted to OPM's Ethical Review Committee and the research was approved on 15 January 2019. Specific details on ethical considerations related to the fieldwork are presented in Annex D.

The quantitative impact evaluation was designed to be sensitive to gender. In particular, all baseline findings are disaggregated by gender and the time use module was designed to focus on women's time use to investigate the issue of women's time poverty.

4.5 Limitations to the baseline findings

A key risk facing the evaluation is a low take-up rate from the potential beneficiaries targeted by the Mwangaza Mashinani pilot project. At this stage of the baseline evaluation, the evaluation team does not have the exact numbers on how many households, amongst those identified as being eligible beneficiaries, will actually be enrolled into the pilot project and therefore receive the top-up cash transfer and solar devices, together with the BCC activities. As discussed in the methodology section, this entails that the estimates of impact will be based on an Intent-to-Treat (ITT) analysis. Although the ITT can still provide robust impact estimates, if the number of actual beneficiary households within the treatment sample is very low due to low take-up, the dilution of impact in the sample will be marked and the estimates may severely underestimate the impact that the pilot would have on actual beneficiaries. This risk will be reassessed once there is more information about the take-up numbers.

Another risk to highlight at this stage of the evaluation is the possibility of a very large number of households dropping out of the sample between baseline and endline. The sample accounts for an attrition rate of around 10% between rounds (plus another 10% sample loss due to matching related issues). If attrition is considerably higher, this could have a detrimental effect on the estimation power. As a mitigation strategy, a strict and thorough household tracing protocol will be followed to find and interview households at endline and OPM will liaise with E4I and the TWGs on this matter. As explained in detail in a separate technical note,[20] the influence of the Finite Population Correct (FPC) on the sample also helps achieving more power than initially envisaged, which will therefore further mitigate unexpectedly high rates of attrition. Finally, the evaluation team is not expecting particularly high attrition in any case, as only one year elapses between baseline and endline.

A limitation of the descriptive analysis presented in this baseline report is its lack of external validity. In other words, the descriptive findings reported on the treatment sample characteristics and on impact indicators of interest cannot be extrapolated to any other population beside the pilot project target population. For instance, the findings on households located in Kilifi or Garissa (the two pilot counties) are not representative of all households living in Kilifi or Garissa, they are only representative of the eligible households targeted by the pilot project (i.e. households to which the intervention was offered). This is not a concern given the focus of the evaluation on the pilot itself.

Finally, it is important to highlight a limitation related to the matching approach. In line with the proposed sampling strategy, matching has been performed at baseline mainly at the household level. This is because households will be panelled,[21] whilst individuals may not be panelled over time (the same individuals may be interviewed at baseline and endline, but not necessarily). Therefore, matching performed at baseline can be used at endline to run impact estimations on household-level indicators as well as individual indicators aggregated at the household level. For impact indicators estimated at the individual level, another round of matching will have to be undertaken at endline since individual-level observations (i.e. adult and child household members) will be treated as repeated cross-sections. The evaluation team has extensive experience of applying matching on both panel and repeated cross-sections, thus any additional matching at endline does not represent a great concern.

[20] See 'Mwangaza Mashinani baseline survey revision proposal and budget' shared on 14 March 2019.

[21] The survey does not intend to panel (re-interview) individual members of each household. Whereas, at endline the survey team will aim to trace back the same dwellings where the solar devices (i.e. SHSs) have been received and interview the household head. This is based on the assumption that treatment effects will unfold mainly at the household-level.

5 BASELINE FINDINGS

This chapter presents the baseline descriptive findings for the 600 treatment households interviewed in Kilifi and Garissa.[22,23] Throughout this chapter, descriptive findings are presented for the treatment sample as a whole and also disaggregated across categories of interest such as the gender of the household head, the location of the household (i.e. county) and the cash transfer programme in which the household is enrolled. These disaggregations are informed by the way in which the sample is structured across strata (see Annex C). In some cases, additional disaggregations are used to facilitate the analysis and better understand the results.

In order to answer questions of equity, a household asset wealth index was constructed as a proxy measure for vulnerability.[24] Interestingly, the asset wealth index indicates that vulnerability and county are closely related with almost all households in Garissa falling into the bottom 50% of households as ranked by the asset wealth index.[25] Given that the asset wealth index distribution is skewed by county, the baseline findings are not further disaggregated by wealth index.

This chapter presents findings in the following areas: population characteristics, project implementation indicators, energy access and awareness, education, health and livelihoods. The sample size for different indicators may vary depending on the target sub-sample for each section of the analysis. The corresponding target sub-sample is displayed in the subtitle of each graph and the number of households is reported in the notes at the bottom of each graph. Across the impact indicators, the graphs display disaggregated results with 95% confidence intervals which indicate graphically where differences between groups are significant. Differences between groups are considered statistically significant when the confidence intervals are not overlapping.

Finally, it is worth reiterating that the quantitative baseline results presented in this report are representative of the target population of the Mwangaza Mashinani pilot project only. Due to the specific characteristics of this population, the quantitative results in this report are not generalisable to the broader populations of Kilifi and Garissa. Detailed statistical tables for the treatment group are presented in Annex E of Volume II.

5.1 Population characteristics

The purpose of this section is to set the scene for the baseline results. Across the analysis, there are significant differences between Kilifi and Garissa and, in line with this finding, population characteristics are also reported by county in Table 2.

[22] In total, 1,186 households were interviewed in the treatment and comparison groups. However, the baseline findings are only presented for the treatment group (n=600). This is because a straight comparison of treatment and comparison descriptive statistics is not robust and can be misleading. By design, the two groups are not expected to be comparable simply as a consequence of the sampling strategy adopted. In a quasi-experimental design, the comparison group only plays the role of constructing a counterfactual to the treatment group in order to determine whether any impact detected on outcome indicators is directly attributable to the treatment under evaluation.

[23] Descriptive statistics for the comparison group can be found in Annex H of Volume II. Note that these are unmatched point estimates and should not be compared to the treatment point estimates given the lack of comparability before matching takes place. These are presented for the purposes of full disclosure.

[24] The wealth index was constructed using principal component analysis (PCA) using data on household's ownership of selected assets.

[25] Specifically, less than 0.5% of households in Garissa fall above the median of the asset wealth index distribution.

Table 2: Population characteristics by county

Indicator	Total	Kilifi	Garissa
Number of household members	7.3	7.7	6.8***
Number of female household members	4	4.2	3.4***
Number of children enrolled in primary school	2.8	3.1	2.4***
Number of household members enrolled in school	3.6	3.9	3***
Household head is male	47%	42.9%	54.5%***
CT-OVC recipient	52.5%	51.2%	54.9%
OP-CT recipient	47.5%	48.3%	46%
Receives both CTs	1%	0.3%	2.3%*
Household is off-grid	100%	100%	100%

Notes: The overall sample size is 600 households. In Kilifi, n = 387 and in Garissa, n = 213.
Asterisks in the Garissa column indicate where significant differences between Kilifi and Garissa exist. The number of asterisks indicates the significance level: * significant at 10% level, ** significant at 5% level, *** significant at 1% level.

The average household size in the sample is 7 household members with households in Kilifi being significantly larger than those in Garissa.[26] In both counties, the average household size is much higher than the average household size measured in other sample surveys indicating that the target population for the project is not representative of the county populations. [27] Overall, just over half of household members are female with slightly more female members per household in Kilifi than Garissa.

Table 2 also shows that just under half of the households have a male household head (47%), with significantly fewer male-headed households in Kilifi than in Garissa. Compared to similar sample surveys in these counties, there are fewer male-headed households in the treatment sample. [28] It is worth noting that, for the purposes of the survey, household members (including male household heads) who do not reside in the dwelling at least four night per week, such as migrant workers in the nearest towns, were not recorded in the list of household members.

These results also indicate the extent to which the treatment sample reflects the target population of the Mwangaza Mashinani pilot project. Eligible households should be enrolled in the CT-OVC and/or OP-CT, be off-grid and have at least one child enrolled in primary school. The sample is almost evenly split between households enrolled in the CT-OVC (53%) and OP-CT (47%) with a very small percentage of households (1%) receiving both cash transfers. On average, households have 4 household members enrolled in school with slightly more household members enrolled in school in Kilifi compared to Garissa.

[26] A household is defined as a person or group of persons who have their meals managed from one kitchen, who have one common household head and who usually live together by sleeping four nights per week in the dwelling.
[27] Average household size in the 2014 DHS was reported at 4.3 in Kilifi and 5.5 in Garissa.
[28] The 2015/16 KIHBS found that 62.9% of households in Kilifi and 79.7% in Garissa had male household heads.

This difference is in line with the larger households found in Kilifi as well as higher school attendance rates in Kilifi (see section 5.4).

5.2 Project implementation indicators

This section presents indicators that are related to project implementation and the assumptions in the ToC.

Table 3: Project implementation indicators by county

Indicator	Total	Kilifi	Garissa
Household has a mobile phone	82.8%	80.1%	87.8%**
Household has network at home at least sometimes[29]	96.8%	96.5%	97.3%
Household knows of BWC in the community	18.8%	23%	11.3%***

Notes: The overall sample size is 600 households. In Kilifi, n = 387 and in Garissa, n = 213. For the indicator on network access, the sample size is 497 with n = 310 in Kilifi and n = 187 in Garissa. Asterisks in the Garissa column indicate where significant differences between Kilifi and Garissa exist. The number of asterisks indicates the significance level: * significant at 10% level, ** significant at 5% level, *** significant at 1% level.

While not a hard eligibility criterion, and therefore not applied as a strict sampling criterion, eligible households should own a mobile phone. The results indicate that 83% of households own at least one mobile phone. Amongst households that own a mobile phone, almost all households reported to have network coverage at least sometimes while 85% report having network most of the time. This is important for the project as households will be required to make their bi-monthly payments to the solar suppliers using mobile money under the PAYG system. Furthermore, households will receive some project communications on their mobile phones.

Households were asked whether there is a BWC in their community. As described in section 2, BWCs will play an important role in project communications by providing households with information on the solar devices, supporting the grievance and case management system and following up on issues as they arise. Overall, only 19% of households know of the BWC in their community with significantly more households knowing of BWCs in Kilifi than in Garissa. When asked about grievance mechanisms, only 1% of households mentioned the BWC as a method of lodging grievances and no households mentioned the NSNP hotline. According to the Mwangaza Mashinani operational manual, these are expected to be the two main channels for lodging grievances. The main channels used by households to raise grievances are local chiefs (36%), community leaders (15%) and rights committee members (8%).

[29] Households with a mobile phone were asked if they have network access at home 1) all of the time, 2) most of the time, 3) some of the time, 4) rarely or 5) never.

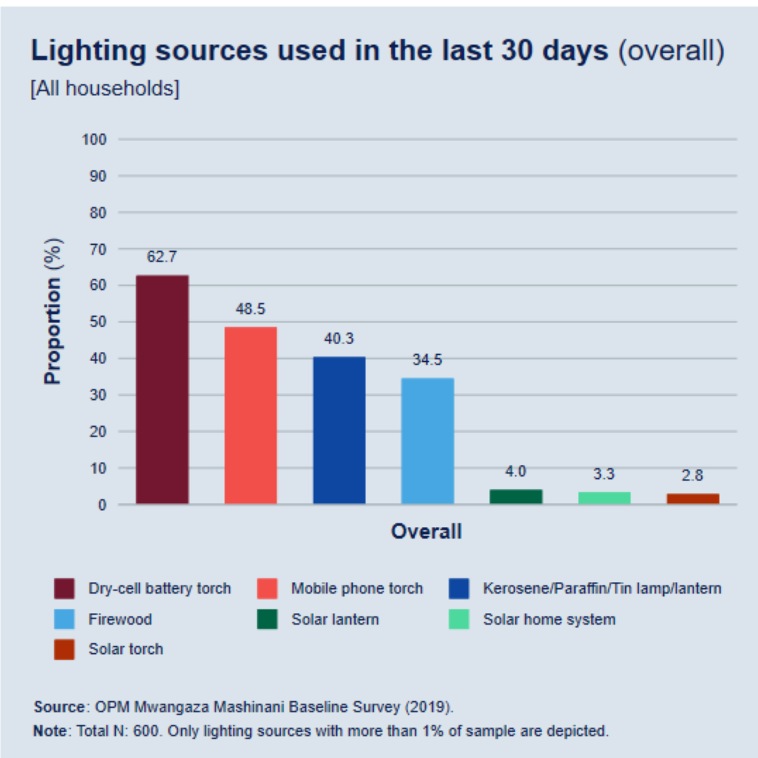
5.3 Energy

5.3.1 Access to energy for lighting

Among the sources of energy used for lighting in the last 30 days, dry-cell battery torches are most widely used,[30] with 63% of households using these for lighting. This is followed by mobile phone torches, kerosene/paraffin/tin lamps and firewood. All households in the sample are considered off-grid as no households have access to the national grid, mini-grids or generators as the sample follows the project's targeting criteria.

Overall, Figure 3 shows that 10% of households have used solar energy for lighting in the 30 days preceding the survey, with households most frequently using solar lanterns, followed by solar home systems and finally solar torches.[31] The use of solar devices is almost entirely driven by households in Kilifi, while the usage in Garissa is extremely limited. These results are not representative of the overall populations of Kilifi and Garissa, where solar energy use is far more prevalent, but are representative of the specific Mwangaza Mashinani target population which, by design, should have limited access to solar energy. This is one of the main indicators of interest that should show a significant change after the programme.

Figure 3: Lighting sources used in the last 30 days



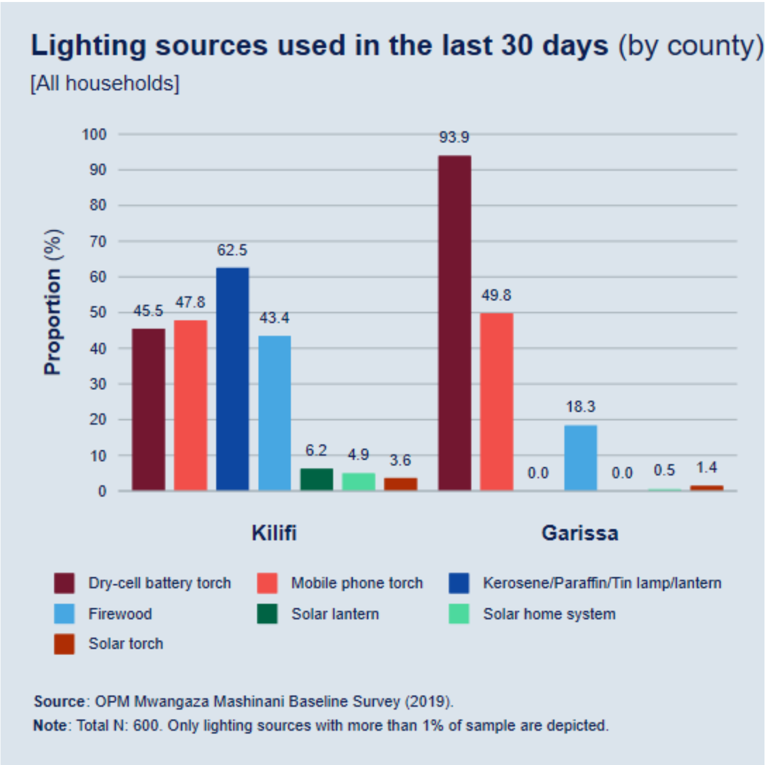
The difference in sources of energy for lighting between counties is stark as shown in Figure 4. Kilifi has significantly higher use of kerosene/paraffin/tin lamps (63%) compared to dry-cell battery torches (46%)

[30] This includes homemade torches where a bulb is connected to a circuit of batteries to resemble a torch.
[31] In line with the project's targeting criteria, all solar devices have only one bulb.

and also uses more firewood for lighting compared to Garissa. In Garissa, no households use kerosene/paraffin/tin lamps and only a small percentage (18%) use firewood for lighting.

Anecdotal evidence suggests that this is because kerosene/paraffin/tin lamps and firewood are considered a fire hazard in Garissa where dwellings are traditionally made from wood. Further, the Energy Regulatory Commission's recommended kerosene price for May/June 2019 in Kilifi and Garissa was 99.8 and 106.48 Ksh respectively and when the cost of transport to the sub-counties is included, the price of kerosene can be prohibitively high. In addition, firewood is generally collected in Kilifi while in Garissa firewood is purchased for a fee (see section 5.3.2) and it is likely that the cost associated with firewood makes it a less popular lighting choice than in Kilifi.

Figure 4: Lighting sources used in the last 30 days by county



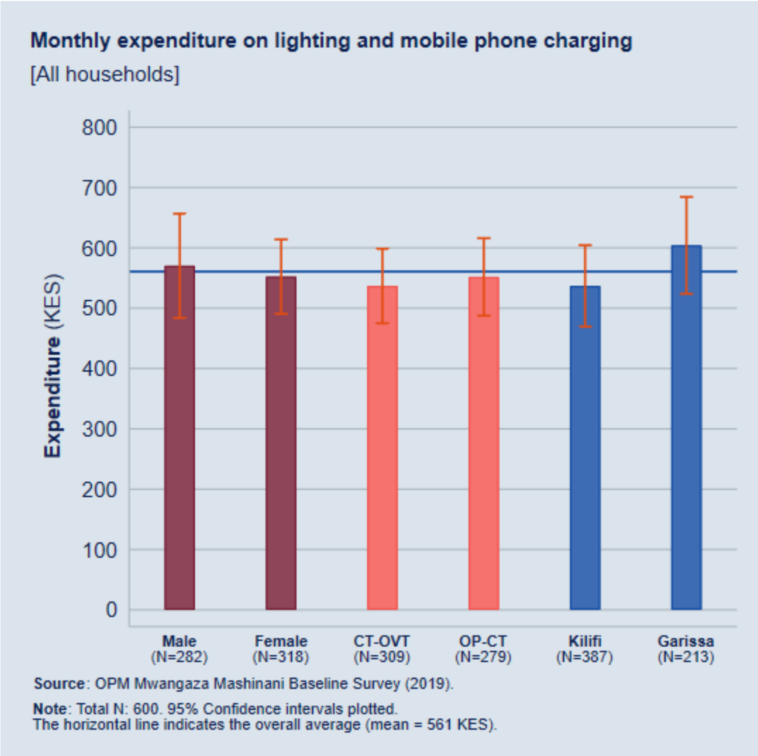
On average, households spent 358 Ksh in the last month on lighting.[32] There are no significant differences across gender of the household head, cash transfer programme or county. However, when considering expenditure on kerosene, batteries and candles only, there are interesting differences between counties. Households in Kilifi spent 315 Ksh in the last month compared to households in Garissa which spend 233 Ksh. This difference is driven by expenditure on kerosene which is more prevalent in Kilifi.

Furthermore, when accounting for phone charging expenses, households spent 561 Ksh in the past 30 days on energy.[33] These results indicate that households currently spend significantly less per month on energy for lighting and mobile phone charging than the 2,100 Ksh bi-monthly top-up with which they will be provided. While the bi-monthly cost of the SHS is higher in absolute terms than households' current

[32] This includes expenditure on candles, kerosene, dry-cell batteries, rechargeable batteries, solar lanterns, solar home systems, firewood, and solar torches.
[33] Interestingly, households that reported having a solar home system, albeit less powerful than those provided by the project, pay on average 787 Ksh per month for lighting services.

energy expenditure, this cost is only incurred over five or six bi-monthly payment cycles after which the household will own the solar device.

Figure 5: Monthly household expenditure on lighting and mobile phone charging



Multi-Tier Framework Classification

Following the Multi-Tier Framework (MTF) approach to measure quality of access to energy and capture key characteristics of energy supply that affect the user experience, households are classified against six rising tiers in terms of their access to electricity. Box 2 explains how each tier is computed.

Overall and as expected given the target population for the project, 98% of households fall into tier 0 for lighting. This is largely driven by the source of lighting used as few households have any access to modern energy sources. Amongst households with access to modern energy sources, few devices provide sufficient lighting for all household members to be classified in tier 1. All households with tier 1 lighting reside in Kilifi. This classification indicates that there is a large population that has no access to electric lighting at all and therefore this is an area in which a large impact is expected.

Box 2: Computing the MTF for lighting

MTF, considered an industry standard, is used to measure levels of electricity access before and after the Mwangaza Mashinani pilot project. Household electricity access is classified against 6 rising tiers of access, with tier 0 representing no access to electricity and tier 5 classed as an affordable, legal connection to 24-hour grid power or its equivalent. These tiers can be thought of in terms of the increasing levels of energy services that can be provided at different levels of access to electricity.

Given the level of technology the Mwangaza Mashinani project will supply (very small solar home systems), and the existing household lighting technology encountered in the survey, the levels of access likely to be encountered before and after the project will be between tier 0 and tier 1 on this scale.

Measurement is made slightly more complicated because three or four bulb solar home systems may not provide sufficient lighting to merit a whole household (say 5 members) being classified as having a lighting service that meets tier one requirements. This is because the smaller home systems or lamps provide relatively low levels of light that limit their utility – you may have to be quite close to the light bulb to be able to use it for reading for example and, in so doing, may exclude someone else from being able to use the light for another purpose. Also, the SHS may also come with points for charging mobile phones. If used, this will provide additional services (phone charging) but further limit the utility of the lighting (as it utilises battery power from the lamp).

Tier 1 requires a lighting system to provide 1,000 lumen hours of light for a household of 5 persons and requires access to a modern and clean source of light. Many of the cheaper SHS will not provide this level of light and so it is necessary to calculate an equivalent number of people rather than households that can be said to have access to a tier 1 level of energy access as a result of the project. This number will likely be less than the total population of the households that acquire solar home systems. Tier 0 therefore measures the proportion of the population with no access to modern sources of light or who have access to a modern source of light but whose electricity tier level is below 1.

In the survey the lumen output of existing lighting systems encountered were assessed from the relevant manufacturer's published technical data or matched to an equivalent known product when the manufacturers' name or data were not available.

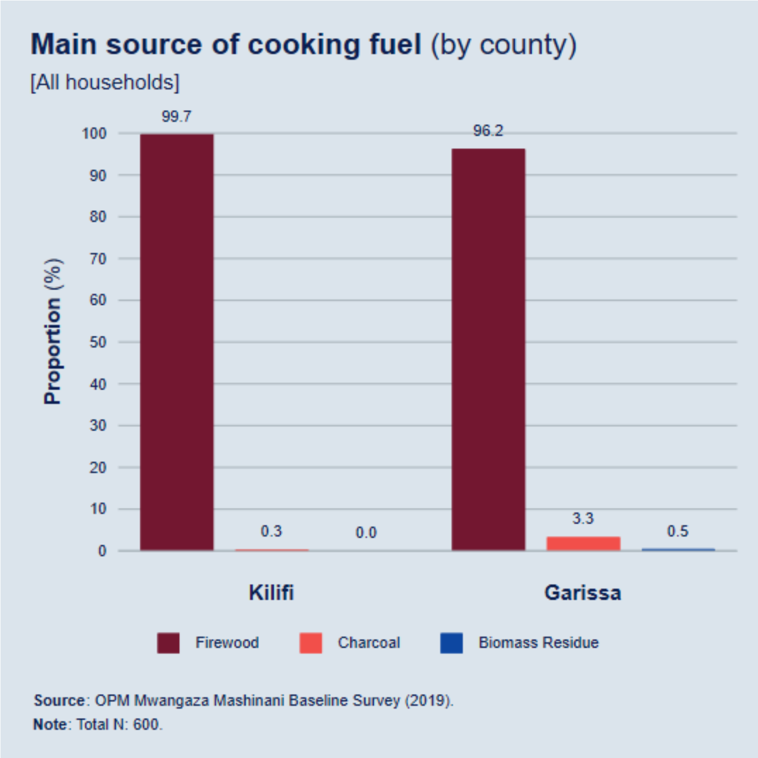
A technical methodology for assessing the equivalent number of people achieving a tier one service is given in Annex G.

5.3.2 Access to energy for cooking

In terms of cooking, the overwhelming majority of households, 97%, cook using a traditional stone fire with a further 2% of households using an improved stone fire.[34] In Garissa, the proportion of households using a traditional or an improved stone fire for cooking is slightly lower at 96% (compared to 100% in Kilifi). Instead, 3% of households in Garissa use a jiko for cooking. In terms of cooking fuel, firewood is most commonly used (99% of households) followed by charcoal which is used by 1% of households. The pattern of use follows the cooking technology used as firewood is used with a traditional stone fire and charcoal is used with a jiko.

[34] An improved three stone fire is covered by clay on two sides leaving only one side open for firewood. Improved stone fires use less firewood as less heat escapes than a traditional stone fire.

Figure 6: Main source of cooking fuel by county



On average, households spent 241 Ksh on cooking fuel in the last month. However, the differences across counties is striking. In Kilifi, 95% of households do not spend any money on cooking fuel as they collect their own firewood and hence average expenditure on cooking fuel in the last month was 23 Ksh. Amongst the minority of households that do pay for cooking fuel in Kilifi, their expenditure was 1,417 Ksh in the last month. In Garissa, while a large proportion of households (71%) use collected firewood for cooking, a significant number of households pay a fee for firewood. One explanation may be that due to insecurity in the county, women (who are typically responsible for collecting firewood) do not feel safe to walk long distances to collect firewood and therefore rely on purchased firewood. On average, households in Garissa spent 636 Ksh in the last month on cooking fuel and this figure was 1,487 Ksh amongst only those households that pay for cooking fuel.

In female-headed households, expenditure on cooking fuel is about one-third lower than male-headed households at 192 Ksh compared to 295 Ksh. Female household members are typically responsible for collecting firewood which may explain this difference.

Almost half the households interviewed cook indoors (47%) which includes inside the main house (with or without a partition), in an attached but separate room or in an outhouse. Significantly more households in Kilifi cook indoors (53%) than households in Garissa (36%).

5.3.3 Access to energy for phone charging

Similar to measuring access to energy for lighting, households are classified on a tier basis in terms of their access to energy for phone charging. Households that have the capacity to keep their phone continuously operational by charging the device in their own home are classified as having tier 1 access. If they have to charge their phone outside the house, they are classified as having tier 0 access.

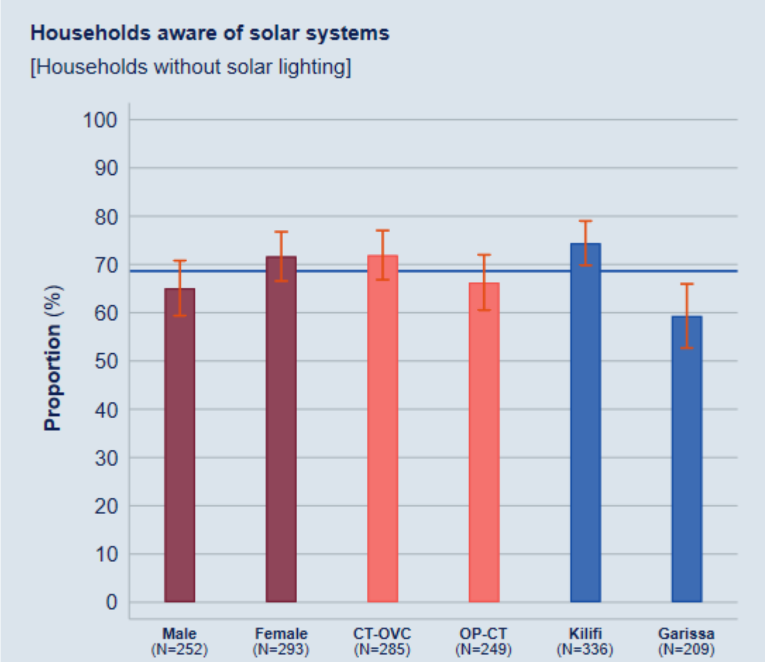
The survey findings indicate that 93% of households with a mobile phone have tier 0 access to energy for phone charging. In Garissa, slightly fewer households have tier 0 access (90.6%) while significantly more female-headed households fall into tier 0 (95%) compared to male-headed households (91%).[35]

Amongst households with tier 0 access to phone charging, 56% are able to charge their phones within 500m of their dwellings. The average fee for charging their mobile phone is 25 Ksh per charge although this is significantly lower in Garissa (19 Ksh) than in Kilifi (29 Ksh). On average, these households spend 279 Ksh per month on charging their mobile phones with no significant differences across counties.

5.3.4 Awareness of alternative sources of energy

The survey results point to a high general awareness of solar energy solutions and their benefits. Specifically, 69% of households that have not used solar energy for lighting in the last 30 days are aware of solar energy solutions (see Figure 7). Given the context of high use of solar energy in Kenya, this is not surprising.

Figure 7: Awareness of solar systems



Source: OPM Mwangaza Mashinani Baseline Survey (2019).

Note: Total N: 545. 95% Confidence intervals plotted.
The horizontal line indicates the overall average (mean = 69).

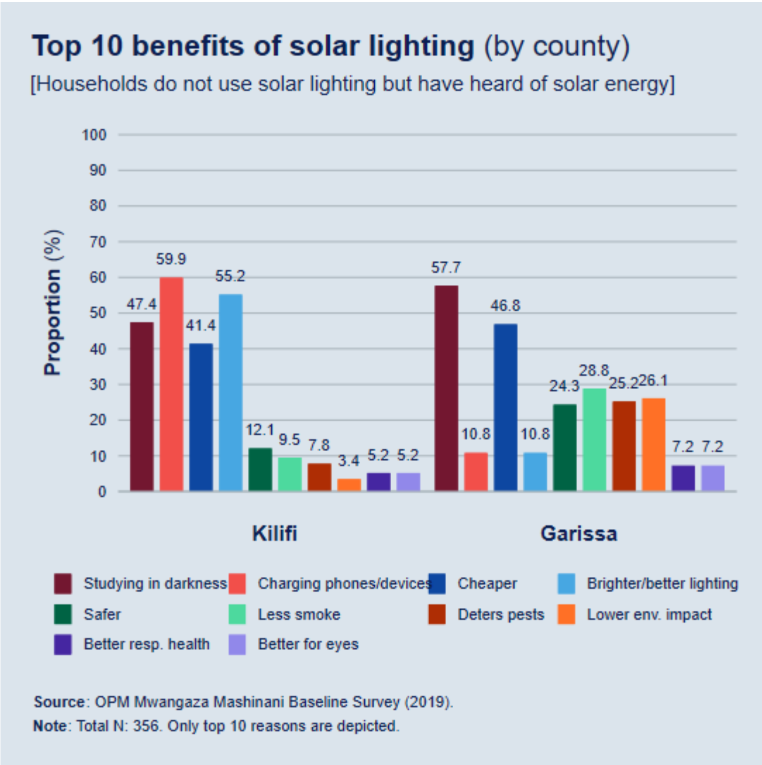
Although there are no significant differences in awareness by gender and programme status, awareness in Kilifi (74%) is significantly higher than in Garissa (59%). This may be due to the fact that Garissa has a less developed solar energy market than Kilifi evidenced by the finding that all household in the sample with solar energy solutions reside in Kilifi. Households also have a high level of awareness of the benefits of solar energy. Among the 55 households that do have a solar system, the awareness of at least one benefit of solar energy (for lighting or phone charging) is extremely high at 96%. This is comparable in

[35] Unless a household has a solar device, households were not asked how they are able to charge their phones at home.

households that do not have solar but are aware of solar, where 91% of respondents were able to cite at least one benefit of solar energy.

Interestingly, the stated benefits of solar lighting are different in the two counties which could be related to their lighting reference points. For example, households in Garissa use dry-cell battery torches as their main source of lighting while households in Kilifi use kerosene lamps more commonly. This could explain, for example, the finding that 55% of households in Kilifi consider solar devices to provide better quality lighting (in relation to kerosene lamps) while only 11% of households in Garissa consider this a benefit of solar lighting in relation to dry-cell battery torches.

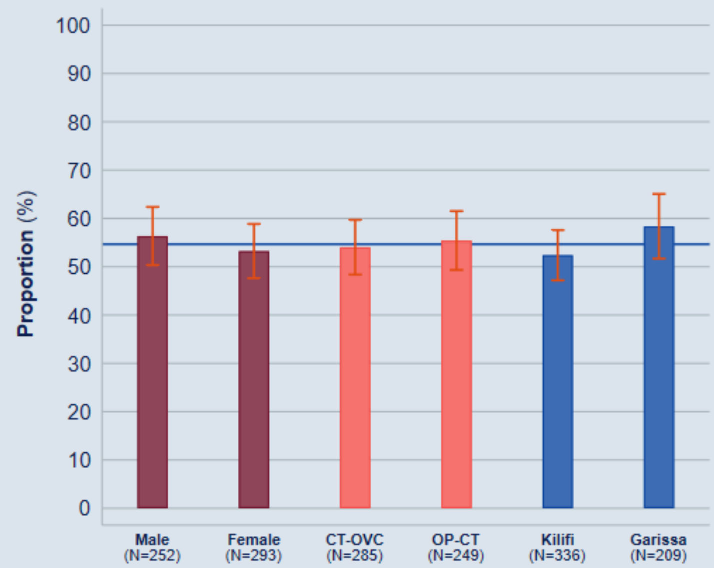
Figure 8: Top 10 benefits of solar lighting, by county



Despite high levels of awareness around solar devices, only 27% of households have been visited by someone promoting solar devices in the last 12 months. This finding could be because suppliers struggle to access these communities or due to suppliers' attitude to the lowest quintile. In line with previous trends, Kilifi had a significantly higher proportion of households visited by someone promoting solar energy (33%) than Garissa (18%).

Similarly, the discussion around the use and benefits of solar energy remains low within households. Only 21% of households have discussed the use or benefits of solar energy with other households in the community in the last 12 months. Among the households discussing solar energy, 50% have been visited by someone promoting solar energy. Household members in Kilifi have significantly more discussions (24%) than in Garissa (17%). In terms of programme status, those enrolled in the CT-OVC were also more likely to discuss the benefits of solar energy (24%) than those in the OP-CT (19%). No perceptible differences exist with regards to gender of the household head.

Figure 9: Household would like to buy a solar device



Source: OPM Mwangaza Mashinani Baseline Survey (2019).
Note: Total N: 545. 95% Confidence intervals plotted.
The horizontal line indicates the overall average (mean = 55).

Among households that do not currently have a solar device, on average only 55% of households would like to buy a solar device. This is fairly consistent across gender and programme status. It is, however, interesting to note that households in Garissa show a higher interest in buying a solar device (58%) compared to Kilifi (52%) despite having lower awareness of and discussion around solar energy although the difference is not statistically significant.

Amongst household that do not want to purchase a solar device, the majority cite the costs of solar systems as the main reason for not wanting to buy a solar device. In Garissa, 51% of households state that a solar device is too expensive (compared to 16% in Kilifi) while, in Kilifi, 41% of households note that they do not have the money right now to purchase a device (compared to 23% in Garissa). In Garissa, 12% of households mention lack of awareness of where to purchase a solar device and 9% of households mention that they do not know how to set up a solar device. Contrastingly, in Kilifi, only 3% of households do not know where to purchase a device and 1% do not know how to set up the device.

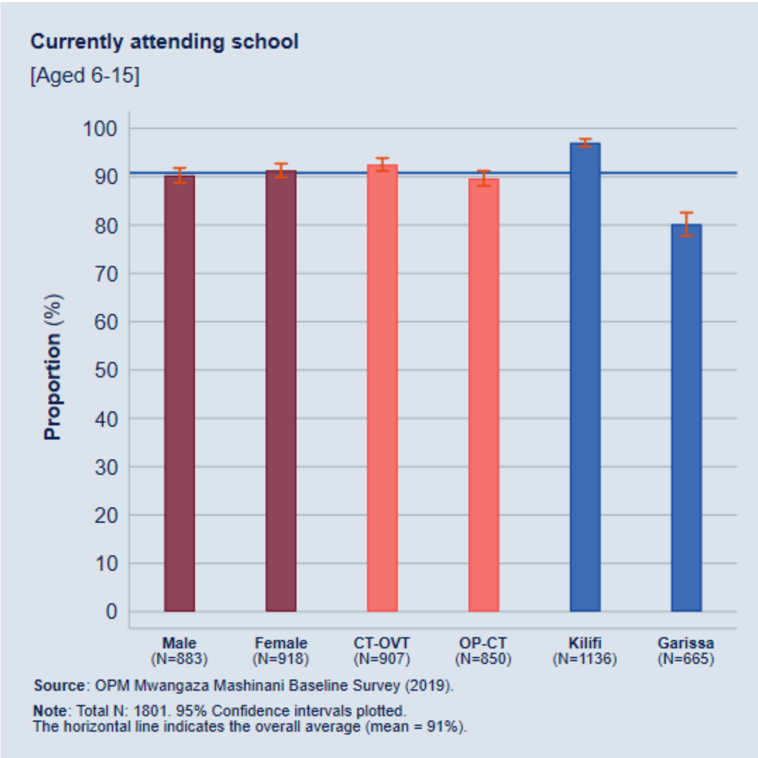
5.4 Education

Overall, the baseline levels of education indicators are high in the treatment sample and across all categories. The average school attendance among children aged 6-15 years is 91%.[36] While there are no significant differences by gender or programme status, Kilifi has almost universal attendance among children aged 6-15 years (97%), significantly higher than Garissa where 80% of children are currently attending school. This is in line with other findings from the survey related to education where the proportion of household heads who have never attended school is significantly higher in Garissa, over

[36] Findings are presented for children aged 6-15 as this is the primary school-aged population in Kenya in line with the original targeting criteria.

90%, compared to Kilifi (77%). More educated household heads are likely to place more value on education which is a contributing factor to better attendance regardless of other constraints. It is also worth noting that overall attendance figures may be higher than found in other surveys due to the specific characteristics of the target population of the Mwangaza Mashinani pilot project where having at least one household member enrolled in school is a hard criteria for inclusion.

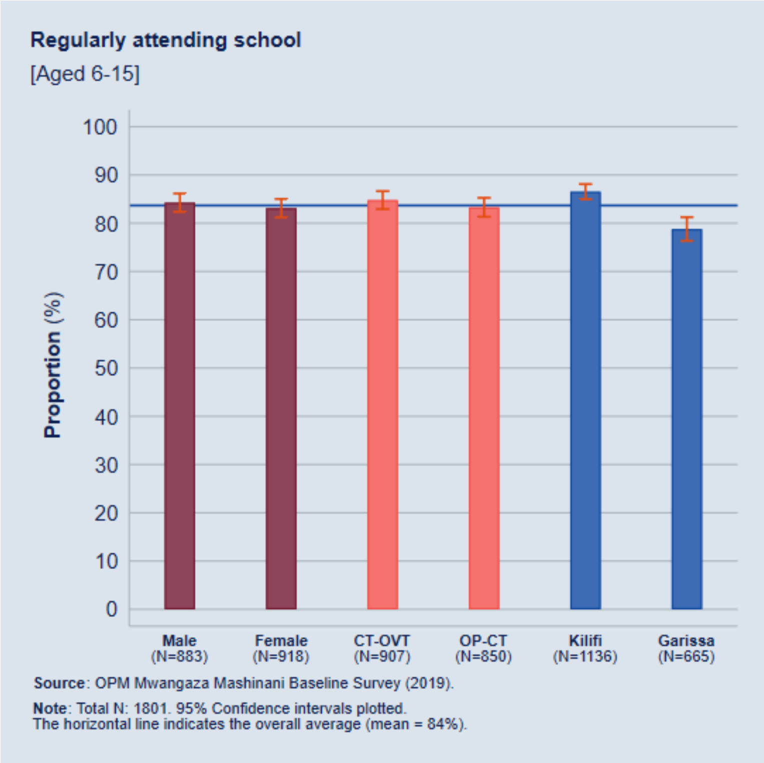
Figure 10: School attendance



Children who are regularly attending school are significantly fewer (84%).[37] In line with the trend in school attendance, no significant differences are observed by gender or programme status but significant differences exist by county, Kilifi having a higher proportion of children regularly attending school.

[37] Regular attendance is defined as someone who is currently attending school and has not withdrawn temporarily, i.e. missed more than two consecutive weeks of school days, in the last 12 months.

Figure 11: Regular school attendance

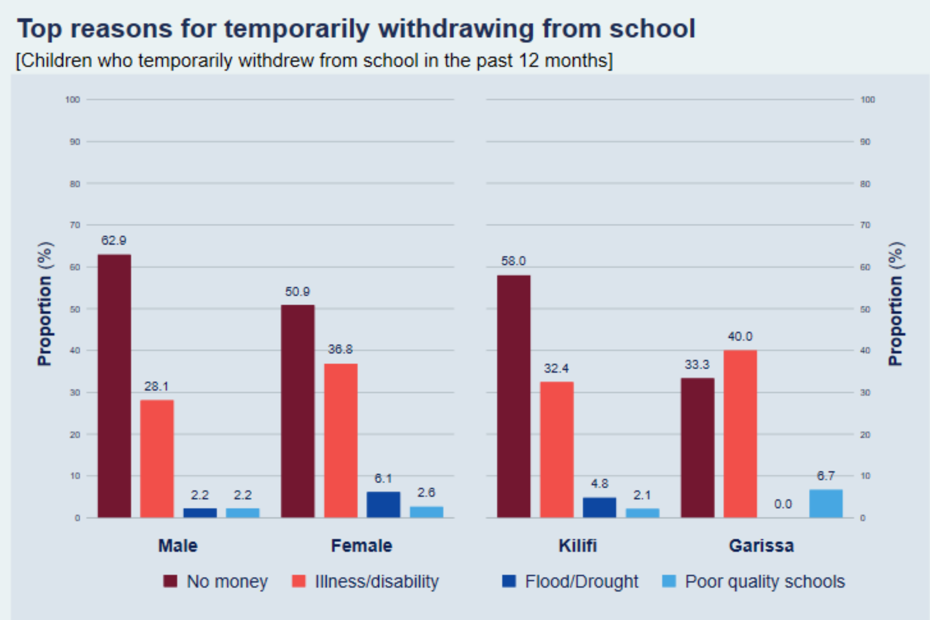


In order to understand the constraints to regular attendance, Figure 12 presents the reasons for temporary withdrawal. A majority of respondents cited lack of funds and illness as a reason for temporarily withdrawing from school. Cost is a significantly more important factor for male children and those who reside in Kilifi. It is possible that these reasons may change over the course of the project if, for example, access to solar lighting positively affects household income and subsequently reduces the number of children who have to temporarily withdraw from school due to lack of funds.

Promotion to subsequent grades is high in the treatment sample at 89%. While there are no significant differences by gender or programme status, it is interesting that Garissa has a significantly higher proportion of children promoted to the next grade (96%) compared to Kilifi (86%). A possible explanation for such high rates of promotion could be that automatic progression is more commonplace in Garissa, although there is insufficient information to make this claim for the households covered in this sample.

Although data on subject marks in five subjects for children who were enrolled in primary school last year was collected, the sample size for this is very small as many respondents could not find the school reports for all children in the household (see details in Annex D). These results will form a good base to assess the trends over time between baseline and endline; however, they will not be able to be used to make causality claims related to the impact of the pilot project on this, due to the limited sample size.

Figure 12: Reasons for temporary withdrawals from school

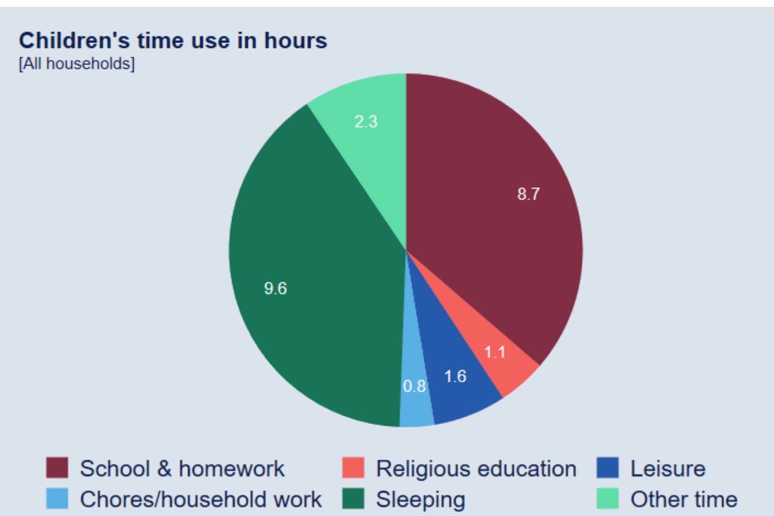


Source: OPM Mwangaza Mashinani Baseline Survey (2019).
Note: Total N: 203. Only reasons with more than 1% of sample are depicted.

5.4.1 Child time use

In each household, one child from all children enrolled in primary school was selected for the time use module. Children's caregivers were asked about how the selected child spends their time on a usual day (i.e. Monday to Friday). Overall, children spend, on average, 8.7 hours at school and doing homework on a typical day and 9.6 hours going to bed and sleeping. Children are also found to spend just over an hour and a half on leisure activities, 1.1 hours at religious education and 0.8 hours on household chores or helping out in the home.

Figure 13: Children's time use: overall



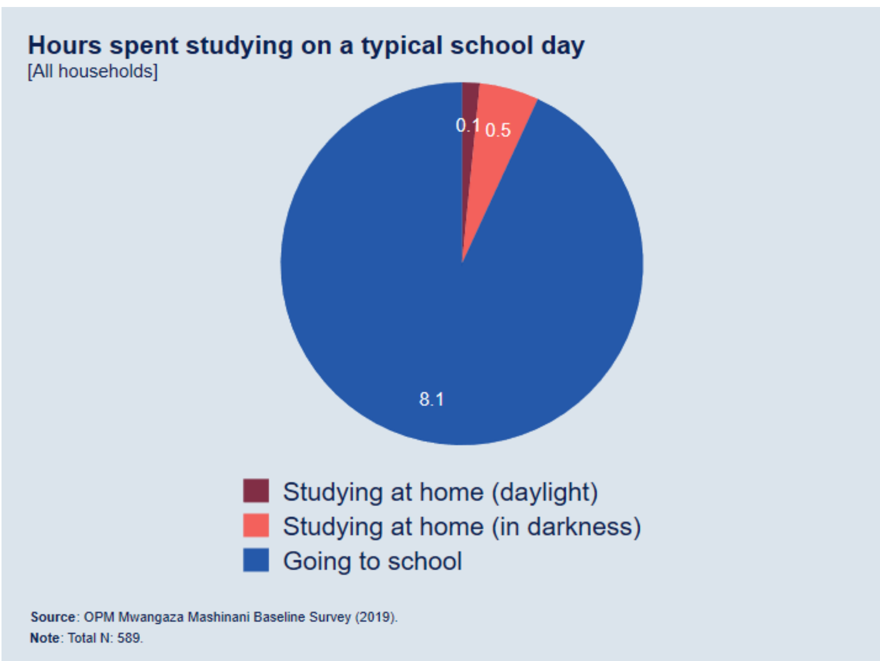
Source: OPM Mwangaza Mashinani Baseline Survey (2019).
Note: Total N: 589.

Specifically, looking at children's study time (see Figure 14), total time spent in school,[38] including travel time, averages 8 hours on a typical day amongst the sample of children enrolled in primary school. Children in upper primary spend significantly more time at school (9 hours) versus those in lower primary (8 hours). Overall, children spend around half an hour studying outside of school in total, with an average of 0.6 hours per day. Children in upper primary spend more time studying outside of school (0.8 hours) than those in lower primary levels (0.6 hours).

Interestingly, out of the total hours spent studying outside the school, 0.1 hours are spent studying at home in daylight and the remaining 0.5 hours are spent studying at home in the dark hours. This is because, in the daylight hours aside from attending school, children are found to spend an hour on leisure, 0.9 hours on religious education, 0.6 hours on household chores, 0.7 hours on other activities such as getting ready or preparing and eating meals and only 0.1 hours studying. As such, the remainder of study time takes place during the dark hours.

Time spent studying in the dark hours is significantly higher for children in upper primary levels, spending 0.6 hours on average each day, whereas those in lower primary levels spend 0.4 hours each day. This confirms the assumption in the theory of change that children are not able to spend enough time studying during the day and hence study at night.

Figure 14: Children's time use: study hours



The majority of children who study at night (89%) do so using a source of artificial light. In Kilifi, 46% of children use a kerosene lamp to study at night, 19% use a dry-cell battery torch and 12% use a solar device (SHS, SL or solar torch). On the other hand, children in Garissa (92%) predominantly use a dry-cell battery torch to study at night. Children in Kilifi using kerosene are therefore more likely to suffer adverse health effects and experience eyestrain due to the relatively poor quality light produced by

[38] This includes all time spent at school, including time in class, time spent studying at school, time spent on extra-curricular activities and time spent traveling to and from school. In Kenya, school hours are from 8am to 3.30pm and hence children spend 7.5 hours per day at school for classes.

kerosene lamps. Replacing kerosene lamps with solar lighting could induce children to study longer hours, particularly in Kilifi, as the quality of light used for studying improves.

5.5 Health

The survey measures three aspects of health related to energy use: experience of eye irritation in the past one month, symptoms of acute respiratory infection (ARI) in the past two weeks, and burns whilst using lighting fuel in the past six months.

Figure 15 indicates that 12% of household members reported experiencing symptoms of eye irritation in the last one month. There is a significant difference in this indicator by categories: females, older household members and Kilifi residents report much higher incidents of eye irritation compared to males, younger household members and Garissa residents, respectively.

Figure 15: Household members experiencing eye irritation

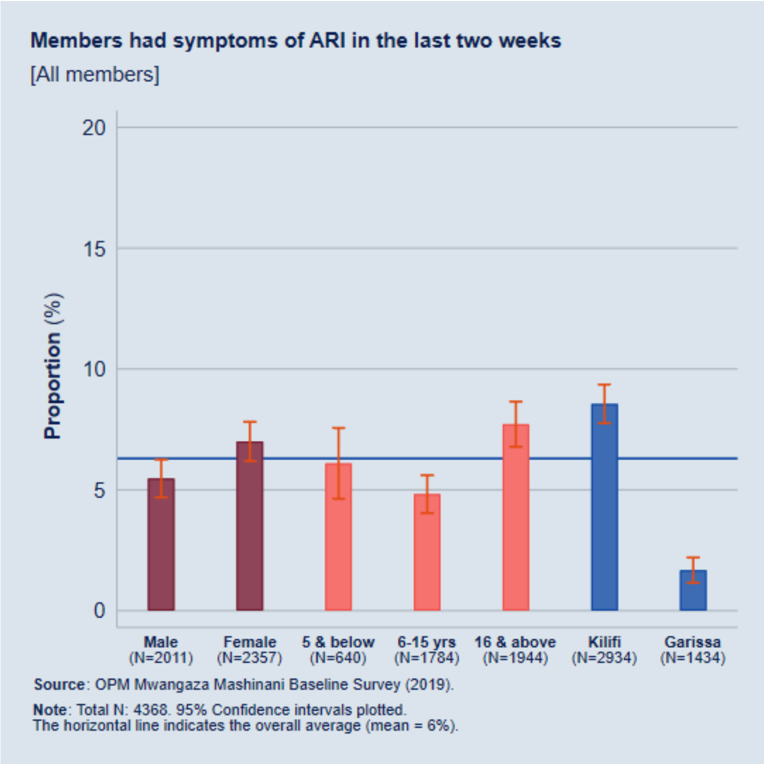
The majority of the cases of eye irritation happen while members are cooking themselves (61%) or are present while someone else is cooking (45%). Females are more than 3 times more likely to report eye irritation while they are cooking than males, while male members report much higher cases of irritation when someone else is cooking.

The proportion of household members reported to show symptoms of ARI is 6%. Higher rates of ARI symptoms in women are likely due to the fact that women spend more time in front of open flames, mostly burning firewood, whilst cooking and are likely to be accompanied by their younger children during this time.

Box 3: Measuring symptoms of acute respiratory infection

ARI is a leading cause of childhood morbidity and mortality throughout the world. Following the 2014 Kenya DHS methodology, the prevalence of ARI symptoms was estimated by asking the respondent whether, in the two weeks preceding the survey, each household member had been ill with a cough accompanied by short, rapid breathing and difficulty breathing as a result of a problem in the chest. These symptoms are consistent with pneumonia. It is worth noting that the data collected on ARI symptoms are subjective as they are based on the respondent's perception of the illness without validation by a medical professional.

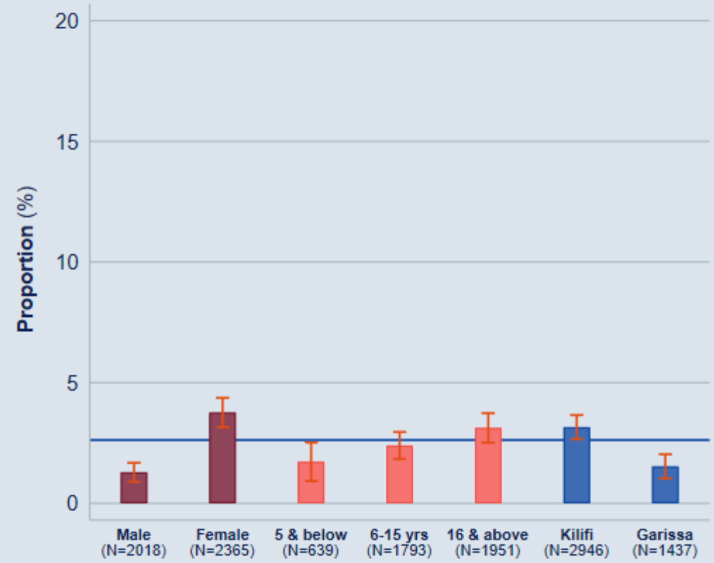
Figure 16: Household members displaying symptoms of ARI



Differences in the prevalence of eye irritation and symptoms of ARI between Kilifi and Garissa may be due to a number of factors. Firstly, the location of cooking plays a significant role in determining the average household members' exposure to indoor air pollution. The results indicate that significantly more households in Garissa (100%) cook outdoors or in a separate outhouse compared to Kilifi (74%). The average health risk to other members of the household (i.e. those not cooking) is lower when cooking is not done in the main house as their time in contact with high levels of pollution is less. Although the health risks may remain high for women and young children, the risk on average across all household members is likely to drop as cooking shifts outside of the main house. Further, kerosene is the predominant source of lighting in Kilifi with 63% of households burning kerosene inside their homes, while no households in Garissa use kerosene for lighting. However, this is likely to be a secondary contributor as burning kerosene for lighting contributes far less to indoor air pollution than cooking.

Finally, the proportion of household members reporting burns related to lighting fuel in the past six months is generally very low (3%). There is a significant difference in the number of burns by gender, with four times more females reporting burns than males.

Figure 17: Household members experiencing a burn from lighting fuel



Source: OPM Mwangaza Mashinani Baseline Survey (2019).

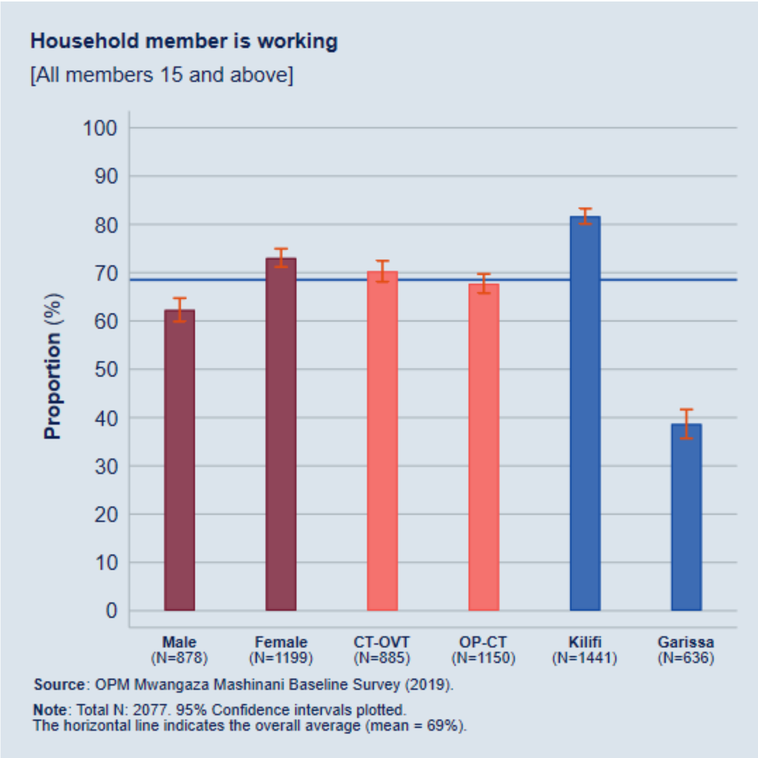
Note: Total N: 4383. 95% Confidence intervals plotted.
The horizontal line indicates the overall average (mean = 3%).

5.6 Livelihoods

Slightly more than two-thirds (69%) of household members aged 15 and above are engaged in work.[39] Given that work includes domestic work as well as working on one's own farm, the proportion of non-workers is relatively high. There is a large difference in the proportion of members working in Kilifi and Garissa as shown in Figure 18. While 82% of household members aged 15 and above are working in Kilifi, only 39% of Garissa household members are working. Furthermore, the gender differences are also striking with a significantly higher proportion of women (73%) engaged in work than men (62%).

[39] Work includes both paid and unpaid work either inside or outside the household.

Figure 18: Household members working



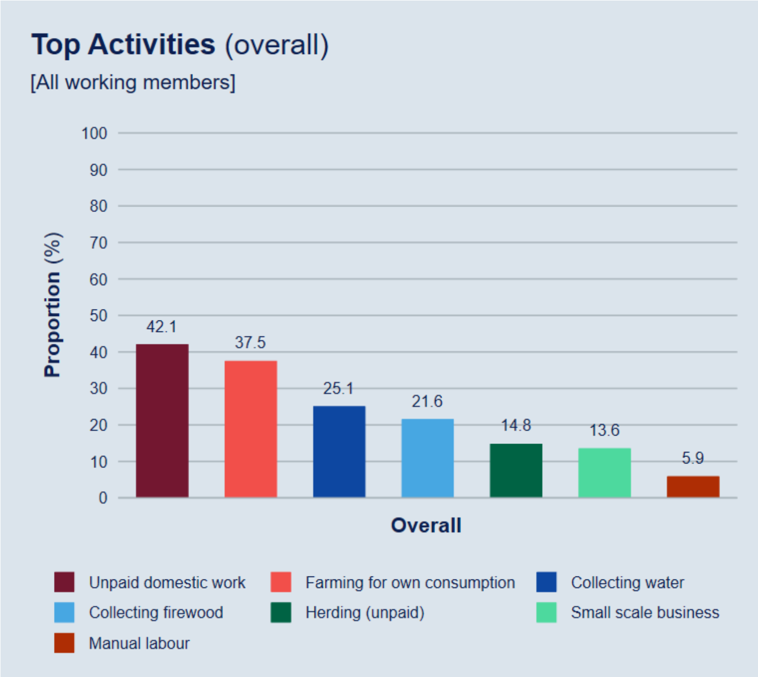
The type of activities that working household members engage in differ significantly across gender and county. Women are most commonly engaged in unpaid domestic work (62%), farming for own consumption (40%), collecting water (35%) and collecting firewood (32%) while men are engaged in farming for own consumption (33%), unpaid herding/livestock activities (24%), running small-scale businesses (16%), manual labour (10%) and unpaid domestic work (10%).

In Kilifi, the most common activities are farming for own consumption (45%), unpaid domestic work (41%), collecting water (31%) and collecting firewood (26%).[40] The most common paid activities are engaging in small-scale business (12%) and manual labour (7%). In Garissa, working household members mostly engage in unpaid domestic work (46%), small-scale business (21%) and unpaid herding/livestock activities (13%).

For those household members who do work, on average, each household member is engaged in 1.8 activities. Again, the difference between men and women is significant with women working in 2.1 activities on average compared to men who are engaged in an average of 1.3 activities. There are also significant differences across the counties with household members in Kilifi working on average in 1.9 activities compared to 1 in Garissa. Most of these activities (58.9%) are conducted outside the home with significantly more conducted outside the home in Kilifi (62.6%) compared to Garissa where only half of activities take place outside the home (50.5%).

[40] Activities such as collecting water and collecting firewood are often simultaneously paid and unpaid as household members collect water or firewood both for their own household and for other households for a fee.

Figure 19: Main activities



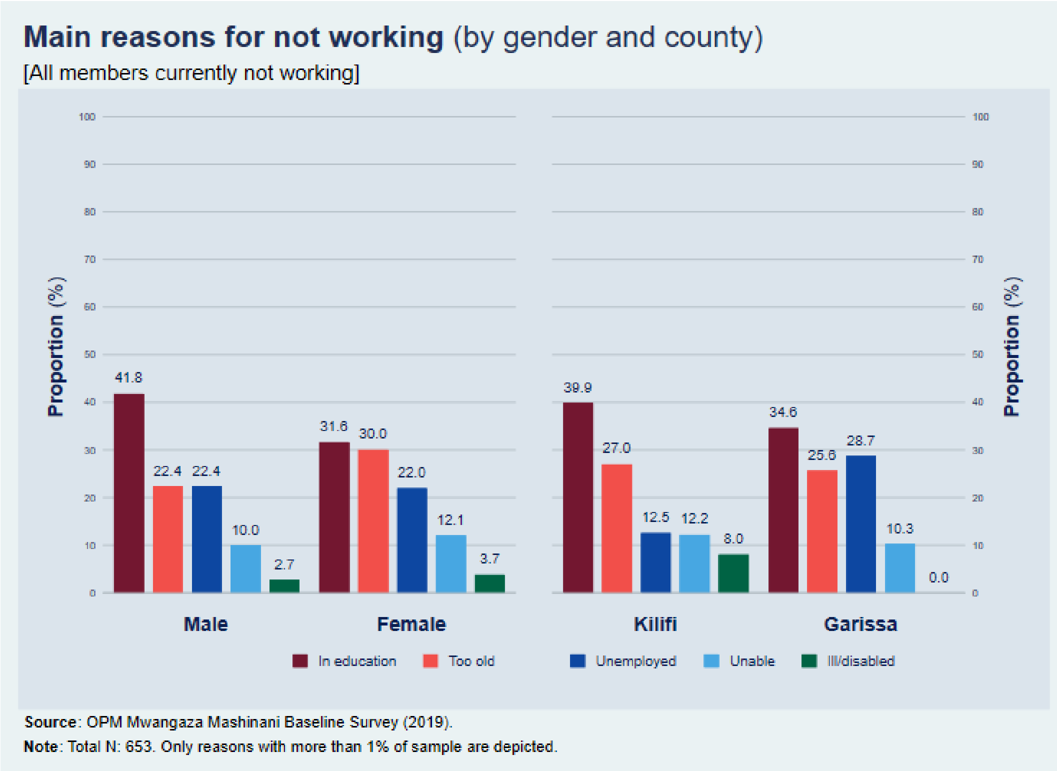
Source: OPM Mwangaza Mashinani Baseline Survey (2019).
Note: Total N: 1423. Only activities with more than 5% of sample are depicted.

The main reasons cited for not working, among non-working members aged 15 and above include still being in education (37%), being too old to work (26%), being unable to find work/unemployed (22%) and being unable to work (11%). These are shown in Figure 20.

At the household level, there is evidence that households diversify the number of activities[41] their household members are engaged in. In Kilifi, the average household engages in 6 activities compared to only 1.5 activities per household in Garissa. Of these activities, 1.5 activities were started in the last 12 months with small differences across counties (1.5 in Kilifi compared to 1.2 in Garissa). This indicates that households are willing to engage in new productive activities.

[41] Activities includes income generating activities and tasks undertaken during the day for the household.

Figure 20: Main reasons for not working



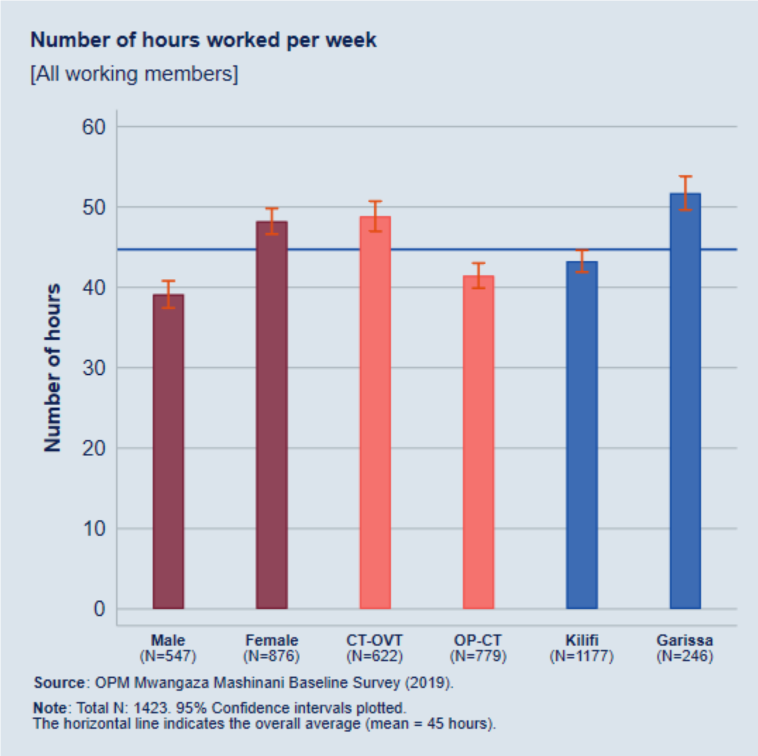
Source: OPM Mwangaza Mashinani Baseline Survey (2019).
Note: Total N: 653. Only reasons with more than 1% of sample are depicted.

5.6.1 Working hours

Overall, about one-third of all working household members work at home during darkness hours. A very small proportion of working male household members work at home at night (8%) compared to half of working female household members who work at home at night. There is also a significant difference across counties with 31% of working household members in Kilifi working at home at night compared to 44% in Garissa.

Working household members spent on average 45 hours working in the week prior to the survey. Figure 21 shows that there are significant differences in hours worked across all disaggregations. In terms of gender, female household members are found to work more hours per week (48 hours per week) compared to men (39 hours per week). Household members in CT-OVC households work significantly more hours (49 hours) than household members in OP-CT households (42 hours) despite similar proportions of household members working across these households, 70% and 68% respectively. This could be due to different demographics in CT-OVC and OP-CT households. Finally, working household members in Kilifi work 43 hours compared to those in Garissa who work 52 hours per week.

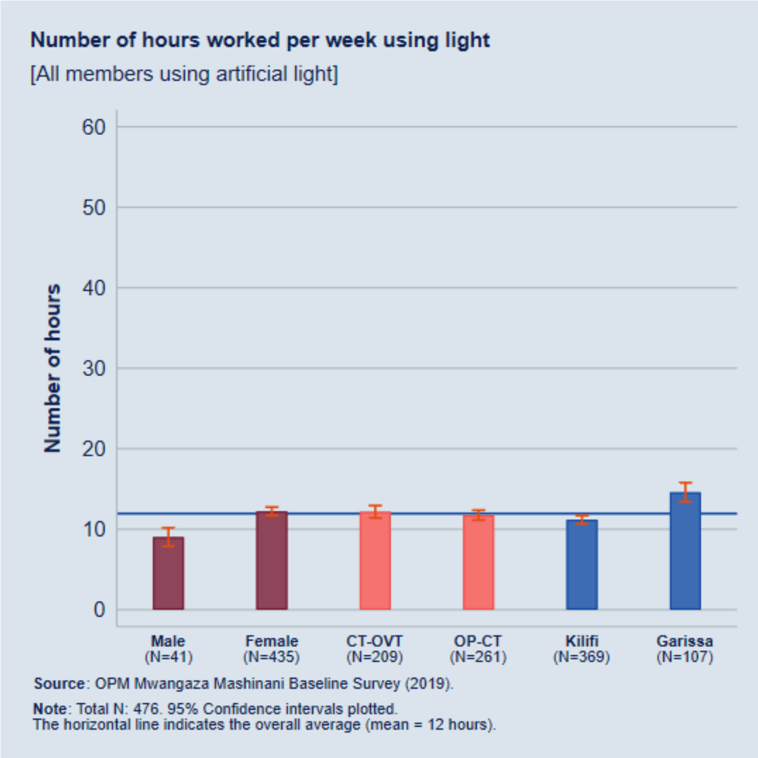
Figure 21: Total number of hours worked in a typical week



Amongst working household members, 33% worked at home using artificial light in the last week.[42] Similar to the findings of overall working hours, female household members worked for 12 hours using light compared to male household members who worked for 9 hours using light. There are also significant differences across counties with household members in Kilifi working for 11 hours per week using light compared to household members in Garissa working for 15 hours using light.

[42] It is assumed that household members would only use artificial light to work at home during darkness hours.

Figure 22: Total number of hours worked in a typical week using artificial light

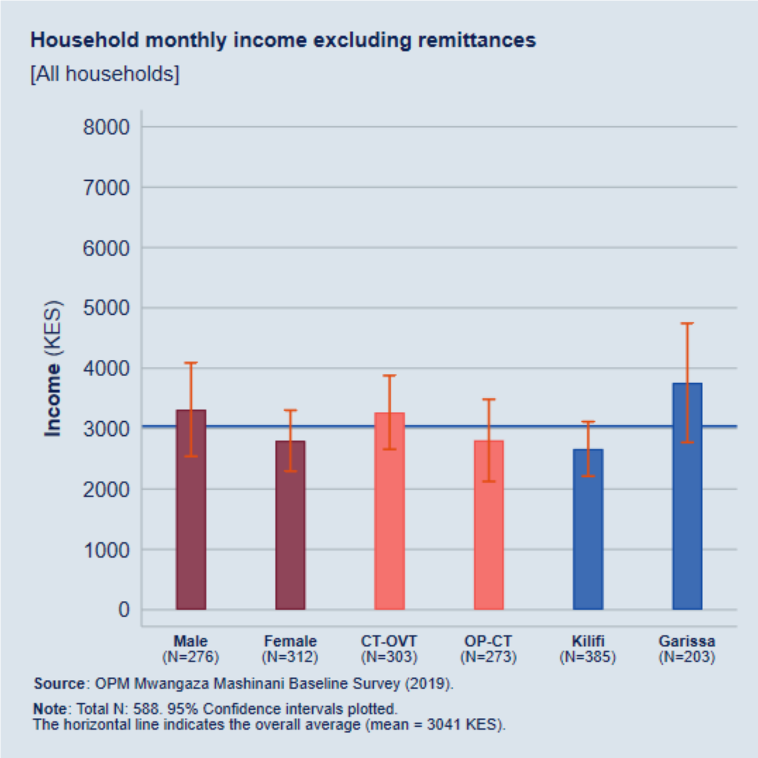


5.6.2 Income and Savings

Overall, Figure 23 shows that average household income (excluding income from remittances) is 3,041 Ksh. Although household income is significantly higher in Garissa, at 3,757 Ksh per month compared to 2,663 Ksh per month in Kilifi, the difference is not significant. However, when remittances are included, the difference between the counties becomes more marked as a large portion of the monthly income (31%) in Garissa is due to receipt of remittances compared to 11% in Kilifi. It is worth noting that reported income should be interpreted cautiously as reliable self-reported income data is difficult to collect and is usually considered unreliable by the literature.

Finally, the survey indicates that 11% of all household members aged 15 and above are part of a savings scheme. The results are significantly different for male and female household members with only 5% of male household members participating in a savings scheme compared to 16% of female household members. The difference is also significant between counties with 14% of household members belonging to a savings scheme in Kilifi compared to 4% of members in Garissa.

Figure 23: Total household monthly income (excluding remittances)



5.6.3 Women's time use

In each household, one female household member was selected to answer the time use module.[43] The purpose of conducting a detailed time use module was to understand how women spend their time and what the potential impact of increased light hours might be on women's time use.

As shown in Figure 24, on average, women spend almost 10 hours on a typical week day working.[44,45] Women above 21 years spend significantly more time working, an average of 9.8 hours, compared to women aged 16-20 years who spend 9.2 hours daily on work-related activities. Women in Kilifi also spend more time on work-related activities (10.3 hours) compared to women in Garissa (8.5 hours).

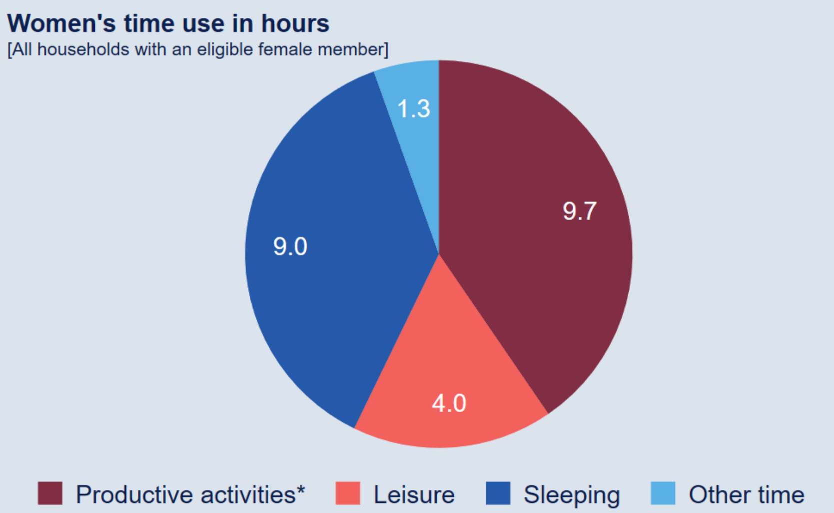
The majority of the time spent by women on work is spent on unpaid labour, with an average of 7 hours each day. In comparison, women are found to spend only 1.4 hours on paid labour each day. Women in Kilifi spend significantly more time on unpaid labour on a typical day (8 hours) compared to women in Garissa (5 hours).

The number of hours spent on leisure activities was considerably lower than time spent working, averaging 4 hours per day. Younger women aged 16-20 years spend significantly more time on leisure

[43] In order, one of the female household head or female spouse or a random female household member older than 15 was selected.
[44] Other time includes activities like getting ready, buying household goods (including travel time) and travel to and from work.
[45] This includes time spent preparing or eating meals, collecting firewood, going to the farm, working on the plot (unpaid), taking care of and feeding animals, cutting grass for fodder (unpaid), and time spent at work or on other leisure activities (needle work/knit/weave/make baskets/carve soap stones/tailor/repair clothes).

compared to those above 21 years. Women who are the household head or the spouse of the household head have, on average, one hour less leisure time per day than other female household members.

Figure 24: Women’s time use



Source: OPM Mwangaza Mashinani Baseline Survey (2019).

Note: Total N: 566.
*Productive activities include time spent preparing or eating meals, collecting firewood, going to the farm, working on the plot (unpaid), taking care of and feeding animals, cutting grass for fodder (unpaid), and time spent at work or on other leisure activities (needle work/knit/weave/make baskets/carve soap stones/tailor/repair clothes).

Women’s time poverty

This final section focuses on measuring women’s time poverty. Bardasi and Wodon (2006) define time poverty as a situation where “some individuals do not have enough time for rest and leisure after taking into account the time spent working, whether in the labour market, for domestic work, or for other activities such as fetching water and wood”. There is a risk that increasing the number of light hours, by introducing solar energy, could contribute to increased time poverty particularly amongst women who are usually responsible for domestic work and other activities such as fetching water and wood. Box 4 describes the approach to measuring time poverty that was used. Using 60% median of leisure time as the threshold, 33.9% women interviewed in the time use module are categorised as time poor. There are no significant differences by age and relationship to the household head. However, significantly more women in Kilifi (41%) are considered time poor in comparison to Garissa (21%) because women in Kilifi are engaged in significantly more activities than Garissa contributing to less leisure time.

Box 4: Measuring women's time poverty

The first step in determining time poverty is to set a threshold. Following Chatzitheochari and Arber (2012), the poverty line is set at 60% of the median of the distribution of free time. Free time is defined as the residual category of daily time that is not occupied by work (paid or unpaid) or personal care activities. Paid work refers to the time spent in the workplace and job-related activities like commuting. Unpaid work includes domestic work tasks like gardening and tidying as well as childcare activities. Personal care refers to those physiologically necessary activities such as sleeping, eating, and grooming.

The second step is to determine the poverty rate. In this case, women are considered time poor if their free time falls below 60 per cent of the median free time of the sample of respondents.

6 MATCHING AND BALANCING THE TREATMENT AND COMPARISON GROUPS

This section presents the results obtained from applying PSM to the Mwangaza Mashinani baseline data. PSM was applied at the household level across all impact areas of interest and across time use to assess balance of the sample. As explained in further detail in Annex F, the evaluation team matched using household level indicators because, at endline, the survey will cover a panel of households but not necessarily a panel of household members. In each impact area, matching algorithms are run using a headline indicator as well as a second indicator as a robustness check. The indicators used are presented in Annex F along with the comprehensive balance diagnostics for each indicator.

There are a variety of algorithms available to implement the second stage of PSM, i.e. to match comparison and treatment units to each other based on the propensity score estimated in the first stage. As described in Annex F, a matching algorithm is applied that uses the Kernel matching approach. Kernel matching with appropriate trimming and enforcement of common support was selected as a good compromise between alternative matching approaches. In order to find the optimal estimation model, the kernel matching algorithm was applied with different combinations of bandwidths and trimming levels. These different results were then compared with respect to the balancing properties, with the best performing approach being selected as the optimal. This was conducted for each outcome area.[46]

Overall, this analysis indicates that, after matching, the sample is balanced across characteristics of interest in the treatment and comparison groups and across impact areas. In addition, the selected models in each impact area are robust to indicator selection and remain balanced when the robustness check indicator is used. In cases where there is any remaining imbalance, this will be removed during the endline analysis using the difference-in-differences approach as outlined in the inception report.

The next section presents detailed balancing diagnostics for the energy impact area.

Example: Assessing balance against energy indicators

In this section, the balance diagnostics for the energy impact area are presented using the outcome variable 'MTF energy access'. The evaluation team ran the matching algorithm using different combinations of bandwidth and trimming to find the optimal PSM model in each impact area. The model parameters selected are shown in Table 4 and the balancing results are shown in Figure 25.

The first graph, on the left-hand side of Figure 25, indicates how individual variables balance before and after matching. The x-axis displays the standardised bias, which is the percentage difference of the sample means in the treated and non-treated (unmatched or matched) subsamples as a percentage of the square root of the average of the sample variances in the treated and non-treated group (Rosenbaum and Rubin, 1985). In Figure 25, the unmatched samples display large imbalances with standardised bias being present across many of the covariates of interest. However, once matching takes place, the standardised imbalances are diminished and the points are tightly distributed around the vertical line at 0% standardised bias.

The second graph, on the right-hand side of Figure 25, shows the distribution of propensity scores across treatment and control groups. This graph visually confirms that, after dropping observations that are off

[46] This extensive investigation of alternative specifications provided the opportunity to select the most appropriate and robust models which are presented in this report.

common support (in green), both treatment and comparison groups contain observations with propensity scores across the full range of the distribution, which is an indication for overall balance. Ideally, the distributions of propensity scores across treatment and comparison groups would be symmetric, which is more or less the case in Figure 25. However, the presence of some level of skewness does not put at risk the estimation procedure, as indicated by the balance achieved for each covariate and the overall values of Rubin's R and B after matching.

The indicators shown in Table 5 display information related to the PSM model. The table reports Rubin's R and Rubin's B values both before and after matching. Generally, a Rubin's B score under 25 after matching is desirable although a lower score is preferable. For Rubin's R, a score between 1 and 1.25 is the preferred range after matching (Rubin, 2001). The unmatched samples are particularly unbalanced; for instance, the Rubin's B for the baseline sample is 73.38. However, the Rubin's B score after matching, is well below 25 which shows how matching removes the previous imbalances. The table also indicates the number of observations on common support in the PSM model.

Table 4: PSM Model Parameters

Model Parameters	Value
Bandwidth	2
Trimming	3
Indicator	MTF energy access

Figure 25: Balance diagnostics

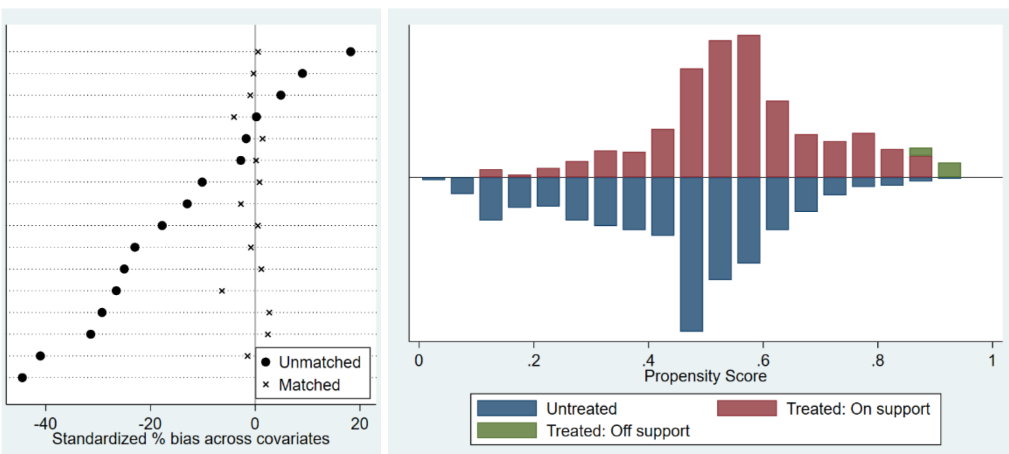


Table 5: Balance indicators

	Before Matching	After matching
Rubin's B	73.38	12.11
Rubin's R	0.79	1.01
N on common support		1,151

Detailed balancing diagnostics for all impact areas are presented in Annex F.

7 CONCLUSIONS AND CONSIDERATIONS

7.1 Conclusions

The baseline analysis presented in this report provides useful indications regarding both the pre-intervention characteristics of the pilot target population and the validity of the impact estimation approach that will be employed at endline. On the one hand, looking at the baseline findings for key outcome indicators presents a picture of the current state of the pilot beneficiary households and thus sets expectations on the potential impact of the intervention. On the other hand, the results of the matching procedure indicate whether the comparison group can be considered a valid counterfactual to estimate impact.

Before drawing the main conclusions related to these two sets of baseline analysis, it is also useful to highlight that the sampling strategy of the baseline survey was successful as the surveyed households reflect the profile of the population eligible for the pilot intervention. Practically all households are reportedly receiving either the CT-OVC or OP-CT, have at least one household member attending school and do not have electricity in the form of grid connection or powerful solar devices (more than one bulb). This was achieved by purposefully interviewing only sampled households that met the eligibility criteria.

With regards to outcome indicators, findings can be summarised as follows, by impact area:

Energy use: As expected, pilot beneficiary households do not have access to electricity and only a small minority currently owns SHSs or SLs. The latter consist of either a single solar torch or a device with only one light bulb, which are not as powerful as the solar devices that will be provided as part of the intervention. Dry-cell battery torches, mobile phone torches and kerosene or paraffin lanterns are found to be the most commonly used sources of lighting. Interestingly, there is a sharp difference on this between Kilifi and Garissa: whilst the great majority of households use lanterns in Kilifi, this is not at all a light source used in Garissa. This may be due to the fact that houses in Garissa tend to be made of grass and wood, which would therefore cause a fire hazard or that kerosene is relatively more expensive in Garissa. Whereas, households in Garissa use dry-cell battery or mobile phone torches. Overall, almost all beneficiary households fall into the lowest energy tier for phone charging and, especially, lighting.

Energy awareness: The great majority of households that do not have any solar device are aware of the existence of solar systems and almost all of them are able to mention at least one benefit related to their use. Allowing children to study in the dark hours as well as reducing the spending on other sources of lighting are amongst the key benefits mentioned. Whilst half the respondents would be interested in buying a solar device, the high cost of the device is reportedly a key issue for those not interested, particularly in Garissa.

Education: The main education indicators measured at baseline show a positive picture, with high levels of school promotion and school attendance amongst children aged 6 to 15, in line with both the pilot targeting criteria and the related evaluation sampling strategy. However, children who are regularly attending school are significantly fewer, especially in Garissa. The baseline analysis also shows that most of the time spent studying at home is concentrated in the dark hours. This corroborates a key assumption in the Theory of Change, which seems to confirm the relevance of the intervention.

Health: Indicators concerning the health status of household members show that burns and respiratory conditions have limited prevalence in the pilot target population. Only around 10% of school-aged children report eye irritation problems and the proportion is similar amongst all other household members. However, the findings indicate disparities in eye irritation by gender as women spend significantly more time in front of open flames whilst cooking. Both eye irritation and ARI symptoms are more prevalent in Kilifi than in Garissa, where burning kerosene wicks for lighting indoors as well as cooking indoors is also more common. This finding is also consistent with the already discussed geographical differences related to energy use.

Livelihoods: Around 70% of beneficiary household members aged 15 and above are found to be engaged in some form of work with one-third of those members using an artificial light whilst working. The proportion of people working is much higher in Kilifi than Garissa and it is also higher amongst women than men. Indeed together with the geographical differential that characterises most of the impact areas, the gender differential emerges as particularly relevant for indicators related to work. Female household members are engaged on average in more income generating activities, work longer hours and spend more time working using artificial light. The time use analysis explicitly focusing on women shows that around one third of adult female household members can be considered as time poor at baseline.

Overall, the baseline analysis suggests that the Mwangaza Mashinani pilot project offers a product that can be useful for beneficiary households to improve their outcomes across different areas. Energy use and awareness can be both enhanced and made more efficient and SHSs can be used to increase and improve study and work hours during darkness, which appears to be relevant for primary school children and female household members respectively. However, there are also risks related to the different needs and priorities in Kilifi and Garissa and the gender division of household labour. We discuss the impact potential of the pilot project and the risks it needs to address section 7.2.

Finally, the matching procedure based on PSM has achieved very positive results. The evaluation comparison and treatment groups have been matched at the household-level across a range of outcome indicators pertaining to the different impact areas forming part of the evaluation. An optimal set of variables on which to perform the matching has been selected through the integration of theory-based and data-driven approaches. A kernel algorithm has then been employed to perform the matching and a comprehensive series of balance diagnostic tests have confirmed that the comparison and treatment groups are now broadly balanced at the household level. Any remaining imbalance in some of the outcome indicators can be successfully dealt with at endline with the adoption of a Difference-in-Difference analysis. The quasi-experimental design underpinning the impact estimation is thus confirmed to be valid.

7.2 Considerations for implementation

On the basis of the key baseline findings summarised in the conclusions above, a number of points for considerations are set out by impact area. These are presented below, starting however with a set of considerations related to the implementation modalities of the pilot project, and are linked to the relevant literature where applicable.[47]

Implementation: Although not a hard criterion for inclusion in the project, beneficiary households are expected to own or have access to a mobile phone to make the repayments for their devices and receive BCC messages. However, only 82% of the sampled households own a mobile phone with 97% of those households having network access most of the time. This finding should be taken into consideration in determining how repayments are made and how BCC messages are delivered to enrolled households particularly for households without a mobile phone. Baseline findings also show that very few households were aware of the presence of BWCs in their communities. This poses a challenge for the project given the reliance on BWCs for providing BCC messaging and for lodging and reporting grievances. In addition, the baseline findings indicate limited awareness of the grievance mechanisms available to households.

[47] A detailed literature review can be found in OPM's inception report (February 2019).

Reassessing the presence and role of BWCs in beneficiary communities as well as raising awareness around grievance and complaints mechanisms will therefore be important. In addition, the project should consider how current channels used to raise grievances (i.e. local chiefs and community leaders) can support the project's grievance mechanism.

Energy use and awareness: Given that almost all beneficiary households fall into the lowest energy tier, this is an impact area where the pilot project can be expected to have a strong and visible effect, if eligible households receive and start using SHSs. The baseline findings also indicate that households currently spend significantly less per month on energy for lighting than the 2,100 Ksh bi-monthly top-up with which they will be provided. Given that their high cost is a key issue associated with solar devices by households, this seems to validate the focus of the pilot intervention, which seeks to address the affordability of the solar devices for vulnerable households. The BCC activities will be helpful to ensure that households become aware of a larger range of potential benefits associated with solar devices, including the potential savings from reduced expenditure on kerosene and batteries. While the benefits derived from access to lighting alone are likely to be limited this may also be an opportunity to raise awareness of other productive use solar appliances further up the 'energy ladder' (e.g. cookstoves), that people, having had a successful encounter with solar lighting, might be interested in pursuing in the future.

Education: Given that not all children attending school are attending on a regular basis, it is possible that the pilot project could address at least one of the key reasons for not attending regularly, which is the lack of financial resources. If energy costs are reduced (and the solar devices are paid for through the cash top-up), households may have more money as a result. In addition, the pilot project has the potential to have an impact on children's study hours. As found in similar studies (Gustavsson, 2007; Samad et al., 2013; Bensch et al., 2013; Grimm et al., 2017), providing solar devices for lighting could increase the amount of time spent by children studying at home in the dark hours. Some studies have also found that total study hours increase although this is only found for boys while two studies found no impact on total study time for girls (Grimm et al., 2017; Rom et al., 2017). Even if study hours do not change, the quality of the learning may be improved because of better lighting and less eye irritation. At the same time though, it will be important to ensure that more study hours during darkness do not lead to more child labour during daylight. The BCC activities can help prevent this risk by raising awareness on the detrimental effects of child labour.

Health: The impact of the pilot project is likely to be limited in this area and there are no studies conclusively linking cleaner lighting to improved indoor air quality and respiratory illness (Mills, 2016) although perception of air quality may improve after receiving solar lighting devices (Grimm et al., 2017). While it might be that eye irritation can be further reduced through the use of solar lighting systems instead of more polluting devices, as was the case in Graham and Tevosyan's (2018) study in Uganda, the effect on household members' health is likely to be limited as the predominant cooking fuel used, firewood, is a far greater contributor to indoor air pollution.

Livelihoods: There is some potential for impact of the pilot project in this area. While many activities take place outside the home (e.g. collecting water and firewood, farming), there is the possibility to extend working hours for activities conducted at home into the dark hours as has been found to happen in several similar studies (Hassan & Lucchino, 2014; Mondal & Klein, 2011; Obeng & Evers, 2010). However, it is important to highlight the risk that having the opportunity to work longer hours could lead to higher levels of time poverty too. In this case, BCC activities can be used to promote home-based livelihood activities, can play a role in highlighting the issue of time poverty and can also be used to promote a gender-sensitive use of solar devices without detrimental effects for women

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For further information, please contact: Social
Policy Section, UNICEF Kenya
United Nations Children’s Fund
UN Complex Gigiri, Block Q Upper Level
P. O. Box 44145 – 00100 Nairobi

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