



Projektbericht

Rheinisch-Westfälisches Institut für Wirtschaftsforschung

Employment and Income Effects of Improved Cook Stove and Pico-Solar Interventions

**An Impact Evaluation of the EnDev Kenya
Programme**

Forschungsprojekt im Auftrag der Deutschen Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH



Impressum

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Projektteam

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List of Abbreviations

ATT	Average Treatment Effect on the Treated
CDI	County Development Index
DHS	Demographic and Health Survey
EnDev	Energising Development
EnDev-K	EnDev Kenya programme
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
ICS	Improved Cook Stoves
KCJ	Kenyan Ceramic Jiko
LME	Last Mile Entrepreneur
MSE	Micro and Small Enterprise
NGO	Non-Governmental Organisation
OLS	Ordinary Least Squares
RWI	Rheinisch-Westfälisches Institut für Wirtschaftsforschung
SERC	Strathmore Energy Research Centre of Strathmore University, Nairobi
SNV	SNV Netherlands Development Organisation

Note: Annex 1 includes a glossary of key income- and employment related terms used in this report.

Executive Summary

Background

This report presents results of an impact evaluation of a market-based energy access intervention implemented by the Energising Development (EnDev) programme in rural Kenya. The EnDev Kenya intervention seeks to establish and enhance self-sustaining markets for modern energy technologies in rural areas by training and mentoring individuals on how to run small businesses in improved cook stoves or pico-solar technologies.

The EnDev Kenya programme was established in 2006 and is composed of three core components: improved cook stoves, pico-solar and biogas. This report focuses on the first two components. Both are implemented by GIZ in cooperation with SNV who currently operate in 21 of the 47 counties in Kenya. The improved cook stoves component promotes the sustainable production, marketing, installation and use of the so-called 'Jiko Kisasa Stoves' and 'Rocket Stoves'. According to the EnDev monitoring system, over 1.9 million improved cook stoves are in use by mid-2015, effectively reaching over 4.5 million people. The solar component was launched in 2012 and promotes the use of small solar lighting systems that have been quality approved by the Lighting Africa Initiative. Up to June 2015, over 120,000 pico-PV lanterns have been sold by entrepreneurs cooperating with the programme.

Both components follow a market-based approach: Prospective entrepreneurs are mobilized in local communities and trained in technological, business and marketing skills related to either of these technologies. Following the training, active entrepreneurs gather at regular local meetings to report their sales figures to the local EnDev coordinator. These meetings also serve as a basis for exchange with the programme and other entrepreneurs, as well as the promotion of further training opportunities by EnDev. In addition, EnDev Kenya also performs a range of related activities in the target areas such as awareness creation, promotional activities, and consumer education.

Research questions and evaluation design

The main research question is whether the EnDev intervention has led to an improvement in the overall employment and income situation of EnDev trained entrepreneurs and related households. In light of the irregular, multifaceted nature of income generation common among individuals in rural areas, it is analysed whether active entrepreneurs shifted work hours away from other income-generating activities or increase and diversify their income sources with the new business. In particular, the study assesses whether business start-up translates into a diminished dependence on the agriculture-based rural economy. Several subjective indicators about employment, income and well-being are also analysed. Finally, individual- and business-level characteristics are scrutinized that may be related to differences in the impact for specific groups (specifically women).

The evaluation design is based on a mixed-methods approach: The main pillar is a quantitative survey that was conducted among 898 current and prospective entrepreneurs between June and August 2015. The quantitative impact study focuses on two specific key actors along the value chains: rural pico-solar resale agents (Last-Mile Entrepreneurs) in the solar component and Rocket Stove builders for the cook stoves component. The quantitative impact evaluation is complemented by qualitative, semi-structured interviews with entrepreneurs, meeting coordinators and other EnDev programme stakeholders. This qualitative part aims to enrich the quantitative findings, also with regards to possible indirect or induced effects stemming from the intervention; this could be multiplier effects along the value chain, but also displacement

effects on other entrepreneurs (e.g. non-improved cook stoves producers or kerosene sellers). These aspects are crucial to at least qualitatively gauge the overall effect on the local labour market given that they cannot be quantitatively assessed in the proposed framework.

A key element of a rigorous impact evaluation is to empirically identify which observed changes are genuine impacts of the intervention. The challenge is thus to filter out the changes caused by other external factors such as general market trends, or other government or donor programmes. A general approach is to use a “comparison group” that is supposed to differ from the beneficiary group (trained entrepreneurs) only in that it is not affected by the programme. The difficulty of finding an adequate comparison group in the case of the EnDev Kenya evaluation was that active entrepreneurs decided themselves to take part in the training and thus they presumably bear specific individual characteristics and capabilities. Many of these traits are inherently unobservable to the researcher, such as entrepreneurial mind-set. If these characteristics are correlated with the income impact of the intervention, impact estimates of the analysis may be biased due to so-called self-selection. As an example, if the EnDev intervention has a stronger income effect on well-educated training participants, but there more well-educated individuals in the beneficiary than in the comparison group, then the impact will be underestimated.

The impact evaluation design takes advantage of continuously offered trainings in newly targeted intervention areas to address this issue. In this “pipeline approach”, data is collected among newly trained entrepreneurs prior to taking part in the training and among active entrepreneurs already trained in the past. The underlying assumption is that the employment and income situation of new training participants resembles that of existing active entrepreneurs before the training. In this case, comparing incomes of new training participants prior the intervention to incomes among existing entrepreneurs, for example, will provide an unbiased estimate of the causal impact of the training.

However, the data shows that new and existing entrepreneurs differ in some characteristics which should not be affected by participation in the intervention, such as age or educational background. One possible reason may be that new intervention areas – though carefully selected – may differ with respect to their overall socio-economic situation, which may in turn bias impact estimates. Observed differences are accounted for in the empirical analysis by employing a statistical approach called “Entropy Balancing”. In essence, this technique gives less weight in the analysis to new training participants the more different they are to existing entrepreneurs. Assuming that observed characteristics are correlated with unobservable characteristics of entrepreneurs, the impact of the programme can be correctly estimated as the difference between the reweighted comparison group and the beneficiary group.

Results

The results of the impact evaluation – also summarized in Box 1 – suggest that the intervention did not considerably affect employment but rather had a distinctive impact on income-generation of entrepreneurs active in both the cook stoves and the pico-solar value chain: A large share of participants who start a business following the training derive a major share of their individual and household income from it. At the same time, other income-generating activities are not necessarily forgone. That is, evidence is found of an increasing diversification of income-generating activities among active entrepreneurs, with an increase in the overall number of income sources and total hours of work. On average, active entrepreneurs report roughly one income source more than new training participants and report around one hour more per working day.

Box 1

The 3 main results figures on each research question

EMPLOYMENT

- less than **10%** without income-generating employment before the trainings
- increase in total working time by **13** to **22%** for solar and stoves, respectively
- total hours of work of all entrepreneurs involved in the EnDev programme amount to **1700** full-time equivalents, the working hours of newly employed people to **100** full-time equivalents[‡]

INCOME

- for **70%** of entrepreneurs, the business became the main individual income source
- stove entrepreneurs achieve on average significant income improvements (+ **80%**), with a large variety in sales and thus earning potentials
- with on average 16,000 KSh (€ **150**), the monthly income of solar entrepreneurs did not increase significantly but is still higher than that of stove entrepreneurs

INCOME DIVERSIFICATION AND STABILITY

- the share of single-income earners dropped from **55** and **39** to **4** and **9%** for stoves and solar, respectively
- **35%** of entrepreneurs stopped other activities, most often farming
- the share of households for whom agriculture is the main source of income dropped from **63** and **30** to **23** and **6%** for stoves and solar, respectively; however, income varies strongly across the year in the agriculture-based rural economy

EMPLOYMENT PERCEPTION

- almost **50%** perceive their current economic situation as good or very good, which implies a significant improvement for stove entrepreneurs only
- the share of being proud to be working in their respective business increased from **75** to over **95%**
- no significant impact on perceived job security

FURTHER ACTORS ALONG THE VALUE CHAIN

- few sales through resellers (less than **15%**) and no impact compared to pre-intervention situation on number of people involved in business network
- the total number of people employed is **4270**, among whom **2750** are employed part-time[‡]; there is no evidence that entrepreneurs employ more people than in their previous occupation
- almost all entrepreneurs report that competitors are active in their market, around **3** for solar and **5** for stove entrepreneurs; some degree of displacement of jobs induced by the intervention is therefore to be expected, which, however, cannot be quantified

GENDER

- the share of women among active entrepreneurs is slightly above **50%**
- women have less income sources, lower sales in both technologies, work fewer hours on income generation and eventually earn **25** and **40** percent less than male solar and stove entrepreneurs, respectively
- males are **70%** more likely to have customers beyond their county borders

YOUTH

- no specific targeting of youth, selection of entrepreneurs instead requires them to have completed their education; in consequence, most entrepreneurs start business in their **30s** or **40s**

Note: [‡] These figures are based on findings of this study extrapolated to the whole programme based on EnDev monitoring information. Disaggregated data by technology and gender can be found in Annex 9.

In particular, the intervention appears to reduce the reliance on agriculture as a main source of income, although only few respondents give up farming entirely in favour of the solar or the cook stove business. This effect is particularly pronounced among cook stove trainees and those which appear to have little other opportunities for income-generation.

In line with these findings, the empirical analysis shows sizeable impacts on individual-level incomes of active entrepreneurs. Solar entrepreneurs experience an increase of reported monthly incomes of around 1,300 KSh (€ 11). Females gain more than males but impact estimates are not statistically significant. For cook stove entrepreneurs, the analysis suggests an impact estimate of 6,200 KSh (€ 56) in monthly incomes over the reweighted control group mean (or 80%). The increase is highly significant for both genders and appears particularly large among male entrepreneurs, both in absolute and relative terms. This is also reflected in a significant positive impact on perceived employment quality, and, to a lesser extent, overall reported well-being. More generally, the local added value of cook stove production is clearly higher compared to solar, for which only a minor part of the added value remains in the local economy. At the same time, it seems that entrepreneurs remain dependent on the overall agriculture-based rural economy. Many entrepreneurs report large fluctuations in demand throughout the year which seem related to seasonal factors such as incomes from farming in the local economy. In this line, no impact on perceived job security is found.

The data also shows that active solar and cook stove entrepreneurs substantially differ in their business operations, reflecting that solar is a typical retail business, while cook stoves may be considered a manufacturing business. Specifically, the average number of products sold and monthly revenue is much larger for solar entrepreneurs than for cook stove builders. Still, the latter report much higher per-unit profits: on average cook stove entrepreneurs keep more than two thirds of what is charged for a stove; whereas solar entrepreneurs keep roughly one fourth of the retail price as profits. While three quarters of solar entrepreneurs perform their business as own-account workers, a considerable share of cook stove builders also engages employees other than family members. However, employment seems to mostly involve temporary, rather low-paid jobs. A substantial share of cook stove entrepreneurs furthermore starts organizing themselves in producer groups with group-lending mechanisms, sharing input and labour, and joint marketing. A larger share of solar entrepreneurs makes use of commercial bank accounts or has already borrowed money for their business, which is also due to a larger pre-intervention experience with formal banking.

Furthermore, the data provides some insights which types of training participants are more likely to take up the solar or stove business as their main source of income. In short, the analysis suggests that individuals who are very dependent on a single, low-potential income source at the beginning of the training – such as agriculture – are more likely to pick up the respective business in full.

Despite significant impacts on the income of active entrepreneurs and related households, some considerations have to be made regarding the effectiveness of the programme: Firstly, information from available monitoring data indicates that around 60 per cent of initial training participants do not continue with the intervention by attending regular reporting meetings. While it can hardly be estimated how many of these actually abandoned the business or simply stopped reporting sales figures to EnDev, this points towards a high drop-out rate among training participants despite the thorough mobilization and selection process. Secondly, the overall net impact on the local labour market is likely lower than what individual-level evidence suggests. Some degree of substitution has to be expected, with competitors (e.g. producers of

traditional stoves) or entrepreneurs in related value chains (e.g. kerosene vendors) being negatively affected.

To summarize, the findings demonstrate how active entrepreneurs use the new business opportunity to diversify their income sources: While few trainees did not have an employment before, many of them adopt the business as a main source of income, few give up existing sources of income but rather increase working hours. This goes in hand with a sizeable improvement in overall income and perceived economic well-being. At the same time, entrepreneurs continue to be exposed to fluctuations in the agriculture-based rural economy which may limit the positive impact of such market-based approaches.

German Summary of the Evaluation design

(Deutsche Zusammenfassung des Evaluationsdesigns)

Diese Evaluierung befasst sich mit der zentralen Forschungsfrage, inwieweit die EnDev-Maßnahme in Kenia zu einer Verbesserung der Beschäftigungs- und Einkommenssituation unter den geförderten Kleinstunternehmern geführt hat. In den untersuchten ländlichen Gebieten wird Einkommen in der Regel aus unterschiedlichen, eher unberechenbaren Quellen bezogen. Vor diesem Hintergrund wird untersucht, ob die geförderten Kleinstunternehmer andere Einkommen schaffende Maßnahmen zugunsten des Solar- oder Herdgewerbes zurückfahren oder aufgeben, oder ob es alternativ zu einer Verstetigung und Diversifizierung von Einkommensquellen kommt. In dem Zusammenhang untersucht die Studie insbesondere, ob die von EnDev geförderte Existenzgründung die Abhängigkeit von der Landwirtschaft mindert. Verschiedene objektive und subjektive Indikatoren zu Beschäftigung, Einkommen und Wohlbefinden werden analysiert. Schließlich wird erforscht, inwiefern sich die Wirkungen zwischen bestimmten Untergruppen (insbesondere Frauen und Männer) durch Merkmale auf der Individual- oder Unternehmensebene erklärbar sind.

Zur Beantwortung dieser Forschungsfragen wurde ein Methodenmix gewählt, also die sich ergänzende Verwendung quantitativer und qualitativer Verfahren. Im Kern basiert die Studie auf einer quantitativen Befragung unter 898 aktiven oder sich in Trainings befindenden Unternehmern. Die quantitative Wirkungsanalyse konzentriert sich auf die zwei Hauptakteure entlang der Wertschöpfungsketten: im Solarsektor auf ländliche Verkäufer von Pico-Solar-Systemen ("Last Mile Entrepreneurs") sowie auf Hersteller des in Küchen fest installierten, sogenannten „Rocket Stove“ im Kochherdsektor. Die Ergebnisse der quantitativen Wirkungsanalyse werden durch teilstrukturierte Interviews mit Unternehmern, EnDev-Koordinatoren und anderen Programmbeteiligten qualitativ untermauert.

Kernelement einer jeden rigorosen Wirkungsevaluierung ist der empirische Ansatz, anhand dessen herausfiltert werden soll, welche der beobachteten Veränderungen in der Untersuchungsgruppe tatsächliche Auswirkungen der zu evaluierenden Intervention darstellen. Im konkreten Fall besteht die Untersuchungsgruppe aus bereits in der Vergangenheit ausgebildeten Unternehmern. Teilnehmer neu angebotener EnDev-Schulungen zum Zeitpunkt der Befragungen dienen als Vergleichsgruppe. Die Idee hinter diesem Querschnitts- oder "Pipeline"-Ansatz ist es, dass die angehenden Unternehmer den bereits aktiven und ausgebildeten Unternehmern ähneln, und zwar zum Zeitpunkt ihrer Schulung. Hiermit soll dem Umstand Rechnung getragen werden, dass für die bereits aktiven Unternehmer keine Baselinedaten vorliegen, die über die Situation vor deren Schulung Auskunft geben könnten.

Die Vergleichbarkeit zweier Gruppen aus verschiedenen Abschnitten der "Pipeline", im vorliegenden Fall den kontinuierlich angebotenen EnDev-Schulungen, ist jedoch nicht immer in ausreichendem Maße gegeben, z.B. aufgrund regionaler Unterschiede zwischen den verschiedenen Schulungs- und Tätigkeitsorten. Um diese Unterschiede zu reduzieren und einen angemessenen Grad an Vergleichbarkeit zu erreichen, wird in dieser Studie ein statistischer Ansatz namens "Entropy Balancing" angewandt. Bei dieser Technik werden im Wesentlichen neue Trainingsteilnehmer in der Analyse so gewichtet, dass sie mit den bestehenden Unternehmern vergleichbar sind. In einem ersten Schritt werden bestimmte Variablen ausgewählt, von denen angenommen werden kann, dass sie nicht (oder nur marginal) von der Intervention betroffen sind, gleichzeitig aber relevante sozio-ökonomische Charakteristika der untersuchten Unternehmer darstellen, wie zum Beispiel Alter, Geschlecht oder Bildungsstand. In einem nächsten Schritt werden Vorgaben bezüglich des gewünschten „Balancings“ dieser sogenannten

„Kovariate“ gemacht, also hinsichtlich der Gleichartigkeit der zwei zu untersuchenden Gruppen nach Anwendung des Entropy Balancings. Gleichartigkeit wird im Hinblick auf statistische Parameter der einzelnen Kovariate erzielt, insbesondere deren Mittelwerte und Varianzen (wogegen Entropy Balancing selber ein vollkommen nicht-parametrisches Schätzverfahren ist). Hierauf basierend werden in einem dritten Schritt jedem Unternehmer aus der Vergleichsgruppe Gewichte zugeordnet, die in der Summe dazu führen, dass vorherige Unterschiede nivelliert werden. Sind die Unternehmer in der Vergleichsgruppe zum Beispiel im Schnitt weniger gebildet, so werden besser gebildete Unternehmer unter ihnen tendenziell höher gewichtet. Da Entropy Balancing die Vergleichbarkeit sämtlicher Kovariate gewährleistet, erreicht es einen höheren Grad an „Balancing“ als klassische Matchingansätze wie z.B. das populäre Propensity Score Matching (PSM). Ein weiterer Vorteil gegenüber PSM besteht darin, dass Entropy Balancing dem Forscher das zum Teil willkürliche manuelle Anpassen der Matchingprozedur erspart.

1. Introduction

This report presents an assessment of impacts on employment and income of an energy access intervention in rural Kenya. The intervention is part of the global Energising Development (EnDev) programme that aims to provide poor people in developing countries with sustainable access to modern energy services. The intervention in Kenya focuses on improved cook stoves and small solar systems and is being implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and SNV Netherlands Development Organisation.

Cooking and lighting are the two most essential energy services provided by modern energy technologies. Rural Sub-Saharan Africa is still widely cut off from these technologies. 85% of the population lack access to electricity and 83% have to rely on very inefficient traditional stoves or open fire spots to prepare their meals (World Bank/ IEA 2015; Kammila et al. 2014). In order to alleviate these deprivations, the international community has promoted the use of improved cook stoves for some time, and recently started promoting small-scale lighting solutions. While several studies have assessed the benefits of these technologies on end-users (see, for example, Grimm et al. 2014; Smith et al. 2011; Bensch and Peters 2015), few scientific studies have analysed employment and income generation among local entrepreneurs in the respective value chains. This stands in contrast with the relevance of the topic: as in many developing countries, the labour market in rural Kenya is characterized by high levels of self-employment, a lack of economic opportunities outside of low-productivity, subsistence farming, as well as seasonal and insecure employment situations (Campbell 2013). The creation of sustainable and stable sources of income beyond agriculture is hence a key priority to improve welfare in rural areas.

Against this background, the GIZ sector programme “Basic Energy Services (HERA)” has commissioned Rheinisch-Westfälisches Institut für Wirtschaftsforschung (RWI) to conduct an impact evaluation of the employment and income effects of EnDev interventions. Based on an evaluability assessment for the activities in Tanzania and Kenya in early 2015, it was decided to focus the – more comprehensive – impact evaluation on EnDev Kenya and to produce in parallel a Rapid Assessment for the Tanzanian programme (RWI 2015a).

This report presents the approach and results of the impact evaluation of the EnDev Kenya intervention. The evaluation design is based on a mixed methods approach: the main pillar of this approach is a quantitative survey that is complemented by semi-structured interviews with relevant stakeholders. The survey data were collected between June and August 2015 among 898 current and prospective entrepreneurs. The present impact evaluation is expected to yield first rigorous insights into the employment and income impacts of fixed improved cook stoves and pico-PV, using a quasi-experimental evaluation approach based on the cross-sectional survey data. That is, project beneficiaries and a comparison group are compared in terms of their outcomes at one point in time.

The present study assesses both quantity and quality of employment. Quantitative dimensions are, for example, the income level and hours worked; the qualitative dimensions comprise job attributes, types of employment and income stability. The aim is to assess net outcomes, which implies that the analysis accounts for the fact that beneficiaries may forego alternative income-generating opportunities when they participate in the programme. In addition, business-level outcomes of entrepreneurs are captured. This includes both intermediary outcomes such as whether beneficiaries engage more in marketing activities and final outcomes (e.g. number of employees). Economic opportunities of women and youth are key issues to be addressed in the given context. Thus, outcomes are disaggregated by gender and age

where possible. The collected data additionally serve as a baseline for a medium-term longitudinal study, for which a second data collection phase is planned for mid-2016 or mid-2017.

This report is structured as follows: Section 2 provides a description of the EnDev intervention as well as rural labour markets and energy provision in rural Kenya. Section 3 lays out the evaluation objectives and quasi-experimental evaluation design. Section 4 discusses the empirical results; at the heart of this section is the impact assessment along the results chain of the development intervention. Section 5 briefly discusses main evaluation risks relevant for the additional data collection wave in 2016 or 2017. Section 7 concludes.

2. The EnDev intervention and its context

2.1 Energy sector and labour market in Kenya

Improved cook stoves were not new to Kenya when EnDev Kenya (EnDev-K) started operating. Stove research and development led to the emergence of an improved charcoal cook stove in the 1980s, the Kenyan Ceramic Jiko (KCJ), and subsequently a considerable number of artisans had been trained in producing this type of stove, partly with the support of former GIZ projects. Today people are becoming more aware of the concept and importance of clean cooking, and also ICS fuelled with firewood received more attention in recent years. Firewood is still the main cooking fuel for more than 80% of households in the country's rural areas (KNBS 2011). Overall, wood provides 70% of Kenya's national energy needs. This share has stagnated for decades, and wood is thus expected to remain the country's main source of energy for the foreseeable future. This puts additional pressure on Kenya's forests, which already exhibit the lowest coverage rate in the region. Forests represent merely 7.6% of the country's land surface (World Bank 2015). Related to that, one notices that firewood is increasingly being sold in the market. This encourages people to try to save on firewood by means of energy-saving stoves. In recent years, the technology and fuel mix has also increased with the emergence of gasifier and ethanol stoves. The private sector is furthermore becoming more dynamic. Supermarkets are selling energy-saving stoves and some international companies are locally manufacturing stoves (e.g. Burn Manufacturing and Envirofit) or import stoves directly from China or India (e.g. Ecozoom and Phillips). The entrance of carbon financing companies has also had a considerable impact so far. Nonetheless, the majority of enterprises across the cooking stove and fuels value chains are artisans and micro and small enterprises (MSEs).

Electricity access is a similar challenge in the country. At present, Kenya has an electrification rate of 30% at the national level and of only 10% in rural areas according to the Kenyan Ministry of Energy and Petroleum (MEP 2015). While the Kenyan government aims to have all villages connected by 2022 and has recently initiated a large-scale "Last Mile Connectivity Project"¹, it remains questionable whether individual households will always find the means to afford one-time connection costs and running electricity costs. In the rural areas, solar power may provide leeway to find affordable and sustainable alternatives to grid connections. Being astride the equator and extending four degrees on either side, Kenya receives an estimated 4 to 6 kWh per square meter per day of solar insolation. Again benefiting from a dynamic private sector, Kenya is one of the most developed markets for solar power solutions ranging from

¹ <http://www.kplc.co.ke/content/item/1120/last-mile-connectivity>

small solar lighting to higher-capacity solar home systems. The use of solar lighting has increased fourfold from barely 2% in 2009 to about 8% in 2013 (Lighting Africa 2015).²

The labour market in rural Kenya displays similar characteristics to those observed in many developing countries (cf. Campbell 2013, Fields 2012, Oya and Pontara 2015). This concerns, first, a high degree of informality and vulnerability (e.g. lack of social protection). Second, the predominance of self-employment, most often as own-account work rather than paid employment (wage-earning), which usually includes some form of unpaid and non-market work (see Annex 1 for a glossary of employment- and income related terms). Third, the significance of agriculture with a high share of low-productivity subsistence farmers (“survivalists”) and a high exposure to seasonality and weather shocks. A fourth characteristic is the abundance of labour and the scarcity of human capital. In addition, youth unemployment and underemployment is a striking feature of the Kenyan labour market: With merely 32% of the youth being employed in 2011, the gap between the youth and adult employment rates reached 43 percentage points – one of the largest in Sub-Saharan Africa (Escudero and Mourelo 2014).

These labour market characteristics translate into specific employment situations often encountered in the rural economy: Individuals in the rural areas of Kenya typically simultaneously engage in different income-generating activities (“multiple job-holding”) to supplement the inadequate and unstable earnings accruing from just one. As in many other developing countries, most rural households in Kenya combine farming with off-farm work for their livelihoods. For example, many individuals are simultaneously engaged in small-scale subsistence farming, seasonal agricultural wage labour and non-farm self-employment. As in many countries, the rural non-farm sector is growing (Oya and Pontara 2015). Generally, only a small proportion of Kenyan households appears not to engage in off-farm work at all (Mathenge and Tschirley 2015), but the type and level of involvement in off-farm work varies strongly across households. For most rural households, agricultural activities continue to be the most important source of income. The reliance of agriculture as a main source of income makes many, especially poor households vulnerable to external shocks such as weather and seasonal fluctuations in demand. Against this background, enabling poor individuals to start businesses beyond the agricultural sector can be an important step to diversify their sources of income. In particular, rural non-farm employment can provide a source of income to the landless poor and those who are unable to participate in agricultural activities. In addition, these entrepreneurs may create further off-farm employment opportunities for individuals within their business and along the value chain.

2.2 Description of the Kenyan EnDev intervention

The EnDev Kenya intervention is implemented under the umbrella of Energising Development (EnDev), which is a joint impact-oriented global programme of Germany, the Netherlands, Norway, Australia, United Kingdom and Switzerland, with additional co-funding from Ireland and the European Union. EnDev aims to provide poor people in developing countries with sustainable access to modern energy services. The focus is on establishing and enhancing self-sustaining markets for affordable energy technologies, fuels and services adapted to the needs of the local population. As of June 2015, the programme cooperates with governments, NGOs and the private sector in 26 countries in Africa, Latin America and Asia. According to EnDev’s reporting system, 14.8 million people have gained access either to electricity or improved cooking technologies in households since its start in 2005. In addition, 17,700 social institutions and

² For more details on the Kenyan energy sector see https://energypedia.info/wiki/Kenya_Energy_Situation

30,500 small and medium-sized enterprises have benefited from sustainable access to modern energy services. EnDev also has trained more than 37,000 stove builders, craftsmen, vendors and solar technicians.

EnDev-K was established in 2006 and is implemented by GIZ in cooperation with SNV. The programme currently focuses on two main energy technologies: Improved cook stoves (ICS) and small solar systems (pico-PV). After having pulled out of six counties, GIZ now covers 18 counties (of 47 in Kenya), which are grouped into three clusters managed by own cluster offices: Western, Central and Lake Victoria. These represent parts of former Nyanza, Western, Rift Valley and Central Province. SNV additionally covers in total 10 counties, 3 of which are outside the delimitations of the GIZ intervention areas. They focus on the pico-PV component. The SNV activities are planned to run until end of 2015, those of GIZ until mid-2018.

The ICS component supports access to modern cooking energy by promoting the sustainable production, marketing, installation and use of improved cooking stoves. The programme supports two types of stoves: The so-called 'Jiko Kisasa stoves' and 'Rocket stoves'. For each of the two types, two different models are marketed: Jiko Kisasas are either portable or fixed, i.e. stationarily installed in the customers' kitchen. Rocket stoves are always fixed, but can be found as brick Rocket stoves and Rocket stoves with insert (see Annex 2 for depictions of the different stove types). According to the detailed EnDev monitoring system, over 1.9 million improved cook stoves are in use by mid-2015, effectively reaching over 4.5 million people.

Together with the Ministry of Agriculture and local representatives, EnDev-K selects the people to be trained as stove builders and producers according to a number of selection criteria. Most importantly, basic handicraft skills are required, as well as the willingness to become self-employed and invest into the new business. In addition, each participant of a rocket stove training (i.e. the stove type that this evaluation concentrates on) is required to present a list of 20 interested households as initial customers prior to training. This training then involves a two-day group workshop, followed by practical on-site installation training for 8-10 of the initial customers. After that, trained ICS producers participate in bi-monthly meetings which are usually held at ward level, the second-lowest administrative level in Kenya above villages. The meetings serve to monitor sales figures on a regular and individual basis owing to the outcome-oriented character of the programme. The meetings are also used to liaise with the stove entrepreneurs and share experiences with one another. Currently, the number of active and reporting stove entrepreneurs fluctuates around 2500.

In 2012, EnDev-K additionally launched a component to promote the use of small solar lighting systems that have been quality approved by the Lighting Africa Initiative. Up to June 2015, over 120,000 pico-PV lanterns have been sold by entrepreneurs cooperating with the programme, most of them being low-margin entry level lights. The solar component includes training of private retailers and small-scale entrepreneurs in solar technology, business and marketing skills. Similar to the stove component, these Last Mile Entrepreneurs (LMEs) have been selected after meticulous mobilization through local organizations and extension officers from the Ministry of Agriculture. In addition, EnDev-K mobilized people already active in the stove component during their regular monitoring meetings. According to EnDev-K, around 1600 people participated in these trainings of which about 600 are currently involved in the programme and regularly report sales of solar products (see also SEARC 2014). EnDev-K estimates that 20 to 30 percent of the solar LMEs are as well stove builders. Solar entrepreneurs also gather for reporting purposes after being trained, in their case every quarter at the county level.

In both EnDev components, the initial training is part of a more comprehensive set of EnDev activities to support the entrepreneurs in establishing sustainable businesses. On the one hand, these are consumer-side interventions in the EnDev target areas such as awareness creation, promotional activities, and consumer education. On the other hand, EnDev-K offers continued support and follow-up trainings in technical or business skills to active entrepreneurs who keep in contact with the programme by attending regular reporting meetings.

3. Impact Assessment Approach

3.1 Objectives of the impact study

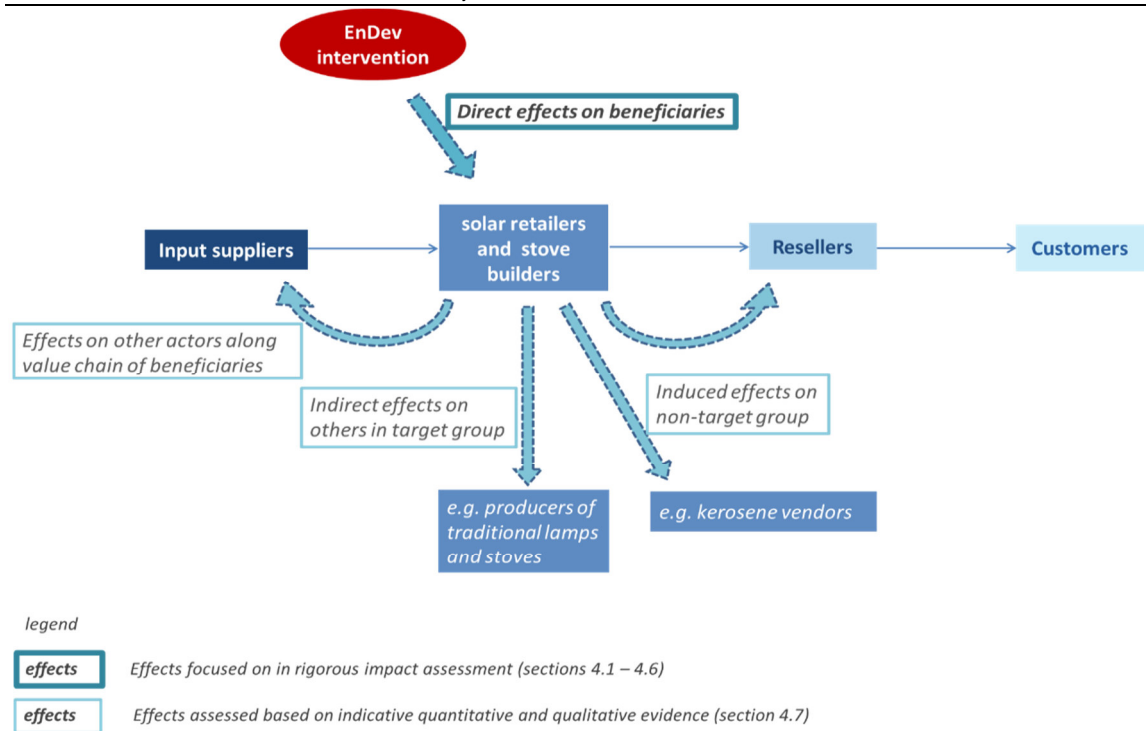
The overall objective of this impact study is to assess all positive and negative effects – intended or not – on income and employment of specific entrepreneurs active in the ICS and pico-PV value chains supported by EnDev-K. For both technologies, the quantitative impact analysis focuses on the *direct* effects of the intervention on *key actors* along the value chains, which are solar retailers (LMEs) for pico-PV and stove builders for the ICS component. These key actors are also asked to provide information on their input suppliers and resellers in order to get an indicative picture of impacts on further value chain actors.³ Similarly, information collected among key actors serves to gauge *indirect* or *induced* effects of the intervention.⁴ Figure 1 depicts the different types of effects and clarifies whether they will be assessed quantitatively based on collected survey data; or in a rather qualitative manner based on indicative evidence from the quantitative survey and semi-structured interviews. A brief typology of these different effect terms is presented in Annex 3.

In light of the multiple, simultaneous income-generating activities often observed among rural Kenyans (see section 2.1), the overarching research question is to assess whether the EnDev intervention as a whole has led to an improvement in the *overall* employment and income situation of EnDev trained entrepreneurs and related households. As explained in the Glossary in Annex 1, the overall employment situation includes not only the status of employment but also further aspects regarding the type and attributes of employment. Moreover, not only earnings from the respective business are addressed but the overall income as well. Earnings from wages from a job or a profit of a business are considered one of several sources of overall income of an individual. Other important income sources can be remittances or rents from property. That is, the analysis assesses to which degree the start of a solar or cook stove business contributes to individual but also aggregate household income. More specifically, it is asked whether the new business goes in hand with a reduction in the relevance of other income-generating activities of the individual or also those of other household members, to determine the *net* impact on employment and income generation.

³ The inclusion of other actors along the value chain in the quantitative impact evaluation is discussed in the *Evaluability Assessment Report for this assignment (RWI 2015b)*. It was found that, in the given context, an impact evaluation based on survey data collected among these entrepreneurs would hardly provide rigorous evidence on income and employment effects among these actors.

⁴ A rigorous assessment of these effects would require assessing impacts on the level of the local labour market, e.g. the village, in order to comprehensively capture in how far jobs and income opportunities have been created or lost as a consequence of the intervention. In this case, not only a “statistically sufficient” number of entrepreneurs would be needed, but also a sufficient number of villages, which was not feasible in the context of this assignment.

Figure 1
The EnDev intervention and its direct, indirect and induced effects



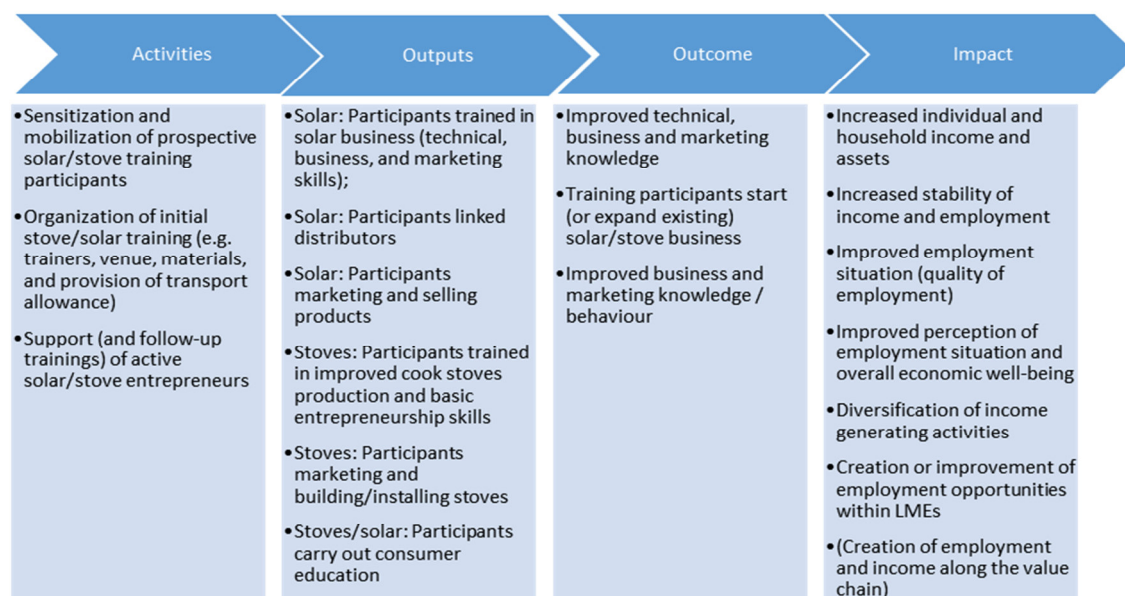
Source: Own representation.

Figure 2 delineates a simplified results chain to guide the specific research questions at the outcome and impact level: participants receive training in technical and business skills with the intention to enable them to successfully start their own business. In the rare cases in which trainees are already active in the respective business, trainings are aimed to improve this existing business. The goal is that these businesses provide a sustainable source of income to training participants. The final impacts are formulated in terms of an improved employment situation of training participants as well as an improved income situation at the individual-level as well as for the related household.

In line with this basic results chain, the impact assessment addresses research questions both at the outcome and the impact level. At the outcome level, this concerns questions related to business start-up and sales:

1. Did the business and marketing behaviour of trained entrepreneurs improve?
2. Do training participants start a business (or expand their existing business) in the respective technology? Which factors are associated with successful business start-up and/or drop-out?
3. What are potential constraints for business start-up and expansion (e.g. access to finance, lacking or fluctuating demand)?

Figure 2
Result Chain



Source: Own representation.

At the impact level, the analysis focuses on EnDev-trained entrepreneurs who started (or expanded) a business in the respective technology and report their sales to EnDev-K. The following five main employment and income dimensions and respective specific research questions are addressed:

1. Employment: What is the impact on the employment situation of EnDev-trained entrepreneurs in terms of the status in employment (unemployed, employed, self-employed) as well as various quantitative and qualitative dimensions, e.g. the type of employment (self/dependent, formal/informal, permanent/temporary, etc.) and employment attributes (e.g. hours, skill-level, payment, wage-level, provision of benefits, health/safety, stability, etc.)?
2. Income (as one attribute of employment): Did adoption of the respective business lead to changes in individual income? Do active entrepreneurs contribute a higher share to overall household income and does this lead to higher household-level income as well? Which individual- and business-level characteristics are associated with an increase in individual- and household level income?
3. Income diversification: Did the new business replace or complement the existing income sources of active entrepreneurs, in terms of relevance of income source and time? Which individual factors influence whether training participants take-up the respective business as their main source of income?
4. Income stability: To what extent can sales from the businesses provide a stable source of employment and income to entrepreneurs? Put differently, can the sales counter-balance fluctuations in other income-generating activities, specifically agriculture?
5. Perception: Do active entrepreneurs perceive improvements in their employment situation and overall economic well-being?

Finally, also at the impact level, the evaluation intends to assess to which extent employment was additionally generated or improved within existing stove and solar businesses as well as along the value chain (e.g. input suppliers or retail agents).

In order to assess how outcomes and impacts differ for entrepreneurs in each value chain, both value chains will be analysed separately. Furthermore, the evaluation aims to explore to which extent impacts may be explained by differences in business and marketing behaviour or socio-economic characteristics of training participants, such as their age or education. Most importantly, the impact study assesses whether heterogeneous impacts for men and women can be observed and, if so, explore possible reasons for gender differences.⁵ The accompanying qualitative evaluation will further assess whether any (unintended) positive or negative indirect effects along the value chain or in related value chains can be observed.

3.2 Identification strategy

The empirical strategy to identify impacts follows the same logic for the stoves and the pico-PV component. It will thus be jointly outlined in this section.

The key element of a rigorous impact evaluation design is to empirically identify which observed changes are genuine impacts of the intervention. Beyond the EnDev intervention, there are many factors outside of the programme's control that also affect outcomes – such as general market trends, economic shocks, weather conditions, and other government or donor programmes. The challenge of an impact evaluation is to filter out the changes caused by these external factors and isolate the changes that can be attributed solely to the programme's activities.

A general approach is to use a comparison group that is supposed to only differ from the beneficiary group (the 'treatment group' in impact evaluation terms) in that it is not affected by the programme. A group of individuals that closely resembles the treatment group can be identified more easily if the evaluation design is conceived prior to the start of the programme (a common approach being randomized controlled trials, assigning treatment and comparison group status to eligible individuals through a chance process). The EnDev Kenya activities, however, were already ongoing at the time the impact evaluation was planned. Since existing programme participants self-selected into the programme, they presumably bear specific individual characteristics and capabilities. This is especially important with respect to unobservable characteristics such as people's willingness and capabilities to engage in entrepreneurial activities. If unaccounted for, this self-selection effect may confound the impact estimation. Thus, a comparison group needs to mimic the characteristics of the treatment group (on average) as good as possible (the so-called counterfactual).

Against this background, the methodology of this study takes advantage of the continuously offered trainings in newly targeted intervention areas, giving rise to the so-called 'pipeline' (or 'staggered-implementation') research design. The trainings allow collecting data among a credible comparison group for both components of EnDev Kenya. As long as new intervention areas and recruiting practices are not systematically different from earlier intervention areas, participants of upcoming trainings can be expected to be comparable to former training participants. Consequently, the evaluation design had to take into account, in particular, that new and old intervention areas are comparable in terms of socio-economic and cultural factors.

⁵ *It had been planned originally to also assess impacts on youth entrepreneurs. However, the share of training participants aged under 30 in the sample is too small to conduct a sub-group analysis (see section 4.1).*

The pipeline approach represents the cross-sectional impact evaluation in this study: the treatment group are those people who participated in EnDev trainings in 2014 or before and continued to work in the respective business and with EnDev. They are referred to as *Active Entrepreneurs* in the following. *New Training Participants* are the comparison group. They are interviewed during the trainings and thus before being affected by the EnDev programme. As noted above, the soundness of this comparison depends on how well the new training participants resemble the already active entrepreneurs at the time when the latter joined the programme. Since no baseline data were collected among the already active entrepreneurs, this assumption cannot be verified conclusively. The assumption is indicatively tested by investigating whether the treatment and comparison group are balanced (i.e. similar) with regard to key characteristics (“covariates”) that are supposed to remain unaffected by the intervention (e.g. the education level, age, gender).

In order to account for potential imbalances between the group of *Active Entrepreneurs* and *New Training Participants*, not only simple differences-in-means estimates of programme impacts are presented (i.e. comparing the average outcomes of the two groups), but also estimates adjusting for imbalances in observed covariates (i.e. individual characteristics). One way to do this adjustment is an Ordinary Least Squares regression of the respective outcome variable (e.g. income) on programme participation and a set of baseline covariates. A second approach in this study is a statistical reweighting technique called ‘Entropy Balancing’ (see Hainmueller 2012), a data pre-processing method that generates weights to achieve balance in the covariate distributions between both groups. In other words, the information on background characteristics of entrepreneurs is used in such a way that the imbalances between the compared groups are removed. Observed differences in outcomes can thus better be attributed to the intervention, since biasing imbalances are ruled out. The method is hence similar to statistical matching techniques, but circumvents the potentially arbitrary back-and-forth process of identifying adequate balancing criteria in conventional matching. Still, the most common matching approach, Propensity Score Matching, is used as a third approach for sensitivity analyses of the results (see Caliendo and Kopeinig 2008). Throughout the report, these statistically adjusted groups are referred to as the *treatment group* related to Active Entrepreneurs and *comparison group* related to New Training Participants.

Moreover, to overcome potential selection bias, the evaluation design foresees a longitudinal difference-in-differences (DiD) approach, which requires fewer assumptions than the pipeline approach.⁶ Here, the participants of upcoming trainings represent the treatment group and will be assessed before and after the EnDev intervention. This difference in outcomes will be compared to the same before-and-after difference in yet another comparison group. Different from the cross-sectional approach followed in this report, one then avails of baseline data and can thus explicitly control for characteristics before programme participation in a before-after assessment. The data collected for this report builds the basis for this DiD approach and requires additional data collection in a second wave in 2016 or 2017. An impact evaluation based on this approach is expected to provide additional evidence in the second half of the respective year.

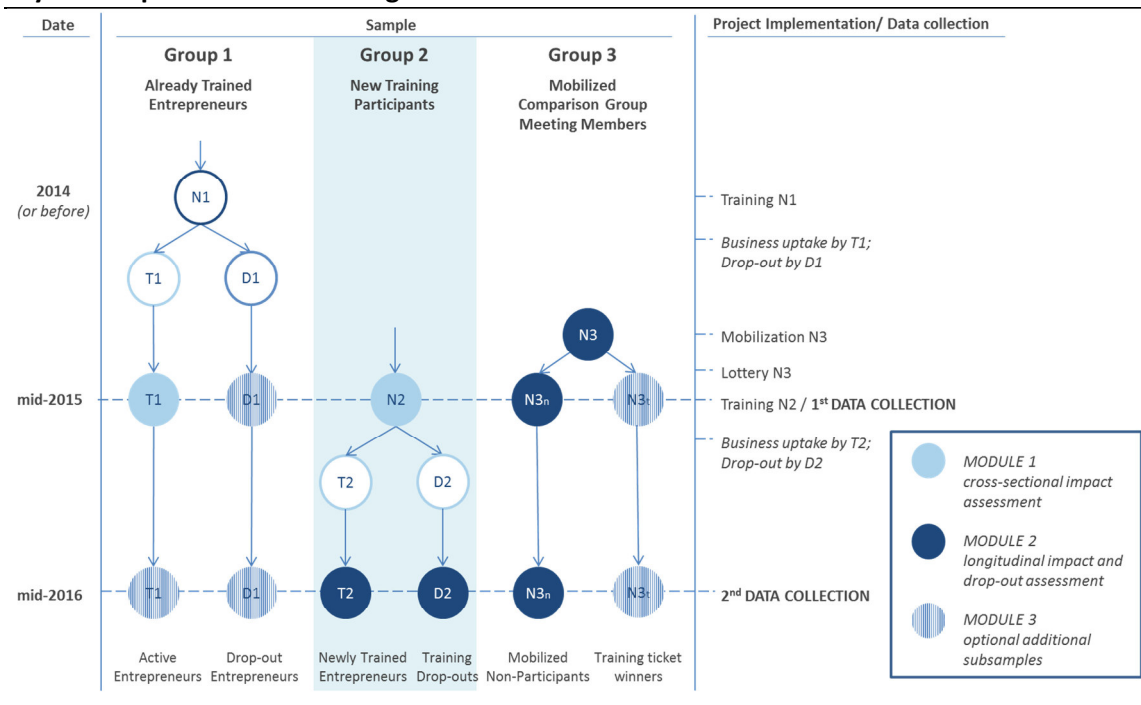
⁶ For delivering unbiased results, the DiD approach only requires that – in the absence of the intervention – the treatment group would have developed similarly over time as the non-treated comparison group. This is referred to as the ‘parallel trend assumption’, which, for example, implies that treatment and comparison group should not be affected in differential ways by e.g. weather shocks or regional economic growth between the two survey waves. In general, the more similar the two groups are at the baseline stage the more likely the assumption holds.

In order to function as a proper comparison group, the DiD comparison group (called *Mobilized Non-participants* in the following) should fulfil three main criteria: First, previous exposure to the ICS or pico-PV technology of the members of this group should be as limited as possible. Second, they should not undergo any intervention before the follow-up data collection. Third, they again need to be comparable to programme participants (including the abovementioned difficult-to-assess traits of entrepreneurship). In the absence of upcoming trainings as a convincing source of comparison units, a workaround has to be found in order to assure comparability. As will be detailed in the next section, this involves a mobilization of people in non-intervention areas to participate in meetings featuring a survey and a ballot lottery. Through this lottery, a fifth of the people are randomly drawn to win participation in an in-depth training course on either stove production or pico-PV with the same schedule and content as regular EnDev trainings. Using this mechanism, in particular those people are supposed to be incentivized to attend who are willing and capable to engage in the respective businesses. At the same time, the procedure makes the non-winning four-fifth represent a viable comparison group for evaluation, since they are supposed to be comparable to the EnDev-K training participants but do not undergo a training.

Whereas the identification strategy is conceived for the quantitative data collected for this evaluation (see next section), in principle it can also be applied to qualitative information. This is done in an integrated mixed-methods approach that benefits from the advantages of both quantitative and qualitative methods: the quantitative approach allows obtaining findings among the full sample of interviewees that can plausibly be assumed to represent what is happening among the totality of beneficiaries. The flipside of this is that the questionnaire has to be pre-structured in order to enable the quantification and thus cannot flexibly probe into different aspects of the interviewee's reality. This, in contrast, is the clear advantage of qualitative data collection methods comprising semi-structured key informant questionnaires and open interviews with selected beneficiaries. Here, the interviewer can decide to dedicate more attention to a certain aspect that seems to be more relevant or to give the interviewee the opportunity to respond in more detail according to her preferences. Combining these virtues of qualitative and quantitative methods gives a comprehensive picture of the multi-dimensional reality in the beneficiary group and aspects related to the intervention.

The integrated evaluation design can best be illustrated using Figure 3 which depicts the three main groups (1, 2, and 3) among the sample: *Already trained entrepreneurs*, *Training participants*, and the *Mobilized comparison group meeting members*. Their status is shown for three points in time: the period of data collection for this report (mid-2015), the period of the envisaged follow-up survey (mid-2016 or mid-2017), and a stylized point in time in the past (2014 or before). Their status changes either through trainings, business uptake, drop-out of the programme or through the lottery among the mobilized comparison group (right-hand side of the figure). The figure furthermore uses different shading of the circles to distinguish between the pipeline approach (Module 1) and additional information required for the difference-in-differences approach to be conducted in 2016-17 (Module 2). The data from these two modules would also serve the purpose of analysing drop-outs of the programme. Additional subsamples are subsumed under Module 3, which are not key to the evaluation and for which data not necessarily need to be collected in 2016-17. As such, the two groups at the heart of the analysis conducted in Section 4 of this report are *Active Entrepreneurs (T1)* and *New Training Participants (N2)*. *Mobilized Non-participants* are crucial for the research proposed for 2016-17 and will be discussed in the outlook in Section 5.

Figure 3
Stylized impact evaluation design



Note: In all three groups, N refers to the group of initially mobilized training participants, T to the sample of active and reporting entrepreneurs (at the time of data collection) and D to people who dropped out of the programme during or after the trainings. The subscripts n and t for the mobilized comparison group N3 refer to non-participants and training ticket winners.

Source: Own representation.

Table 1 summarizes how the various subsamples are supposed to contribute to the different analyses in 2015 and 2016-17 to answer the research questions laid out in the previous section.

Table 1
Comparison groups for impact and drop-out assessment

	Treatment group	Comparison group	Survey waves
Cross-sectional impact assessment	T1	N2(T2)	2015
Longitudinal impact assessment	N2, T2 and D2 participants	N3 _n drop-outs	2015/ 2016-17
Drop-out assessment	T2	D2	2015/ 2016-17

Source: Own representation.

With this cross-sectional impact assessment, the impact of starting a solar or stove business after completion of the training is estimated, the so-called Average Treatment Effect on the Treated (ATT). For two reasons, the resulting estimate will likely represent an upper bound of the ATT, i.e. rather overestimate impacts of the programme on programme beneficiaries. First, because the treatment sample T1 only includes those *Active Entrepreneurs* that reported in the monitoring period visited during data collection. These entrepreneurs are likely more successful than those T1 entrepreneurs who are still in touch with the programme but did not report lately, for whom efforts to incentivize participation in the study unfortunately proved ineffective (see next section). A second reason for potentially upward biased estimates is that the treat-

ment group of *Active Entrepreneurs (T1)* is compared to *New Training Participants (N2)* instead of the more comparable group *Newly Trained Entrepreneurs (T2)*. The reason for this is that one yet cannot know which training participants will actually take up the business (T2) and which will drop out (D2), since this process takes some time.⁷ It is also for these two reasons that a longitudinal impact assessment is recommended, which overcomes both shortcomings. To conclude, the cross-sectional analysis already allows drawing first rigorous conclusions on programme impacts. The robustness of these findings will, however, clearly improve through updated information on business uptake among *Training participants (N2)* and the additional survey wave to be conducted in 2016-17.

3.3 Data collection and sample composition

This section describes the sampling, the survey tools and the implementation of data collection in 2015. The survey procedure was originally outlined in an Evaluability Assessment Report (RWI 2015b) and Implementation Note (RWI and SERC 2015) and fine-tuned during an in-country mission from June 10 to June 20, 2015. In this endeavour, researchers of RWI collaborated with the local implementation partner Strathmore Energy Research Centre (SERC) of Strathmore University, Nairobi. As part of the mission to Kenya, the survey instruments and methodology were revised and a five-day training of enumerators carried out including two field pre-tests. Data collection took place as planned between June 23 and August 21, 2015. One survey team, which consisted of a supervisor and four to five enumerators, was assigned to each of the three GIZ intervention clusters (one of the teams also covered the SNV sites). An RWI junior researcher served as one of the three supervisors and maintained close contact with the RWI researchers in Germany, who backstopped the whole data collection. As such, it was assured that the data was collected in compliance with methodological requirements. The complete study schedule can be taken from Annex 4.

The sampling of survey participants first of all sought to achieve representativeness of EnDev-K intervention areas and comparability of survey sites across the three groups of Active entrepreneurs, New training participants and Mobilized non-participants. The main sampling parameters are summarized in Table 2. Comparability criteria included socio-economic and cultural factors as covered by the Kenyan County Development Index (CDI)⁸ as well as intervention-specific characteristics, e.g. local availability of inputs (e.g. raw materials such as clay). Interviews were supposed to be carried out during monitoring meetings for active entrepreneurs and during trainings for new EnDev entrepreneurs. Therefore, also the monitoring and training schedule of the programme had to be taken into account when selecting sampling sites. Monitoring meetings for stoves take place every two months, those for solar every three months and trainings are held upon demand. Generally, the study placed great emphasis on not interfering with the monitoring meetings or the training process.⁹ The final selection was taken in consultation with GIZ Kenya, SNV and local government representatives. Eventually, the survey

⁷ The original evaluation design intended to use attendance to the first reporting meeting after training as an indicator for business take-up. However, at the time of this report, no reporting meetings had yet been completed for the comparison group of new training participants.

⁸ The CDI has been developed by the Kenyan Commission on Revenue Allocation. It is a composite index constructed from indicators measuring the state of health, education, infrastructure and poverty in a county (CRA 2012).

⁹ In one case, when trainings days were already over before the start of the study, an additional meeting was convened particularly for the purpose of the survey.

was carried out in a sample of 19 among the 27 counties in which EnDev-K currently operates (or has operated until recently) and in three comparison counties. The geographical distribution of these survey counties is displayed in Figure 4.

For the ICS component, the evaluation focuses on one of the two stove types covered under the EnDev programme, fixed Rocket Stoves, for matter of comparability and sample size.¹⁰

Table 2

Main sampling parameters

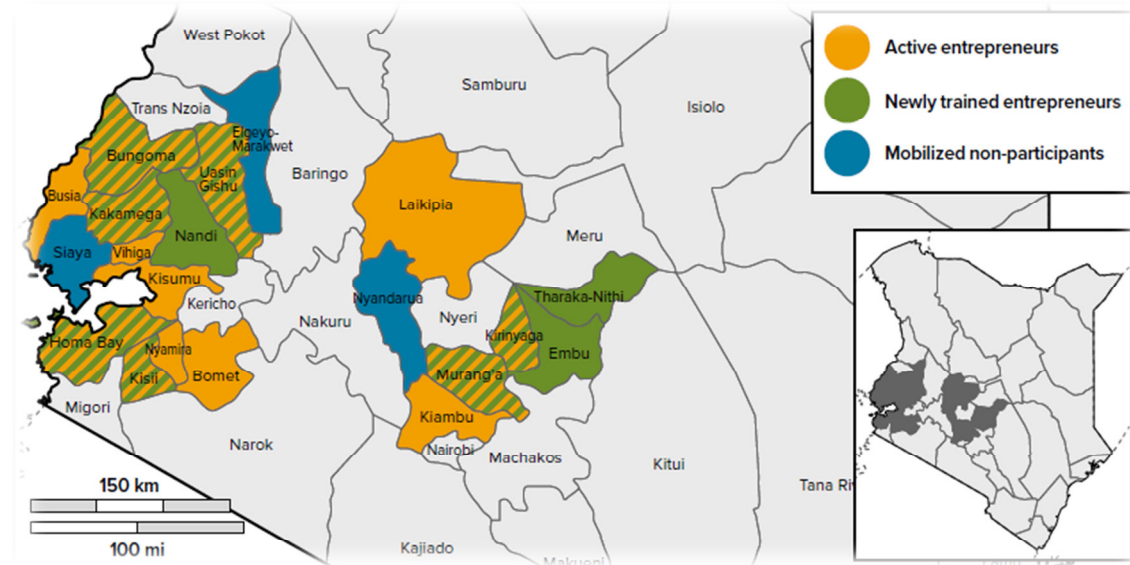
Study group	Active entrepreneurs (T1)	New training participants (N2)	Mobilized non-participants (N3)
main programme participation condition	active since 2014 or earlier	attending training during the time of data collection	mobilized, but not to be trained before follow-up data collection
survey region	existing GIZ intervention counties comparable to training sites for N2 in terms of socio-economic and cultural factors	GIZ or SNV pull-in counties	counties comparable to survey sites of N2 in which EnDev-K or similar actors do not yet operate
survey site and timing	at monitoring meeting held during data collection period	at start of training conducted during data collection period	special meeting venue
sampling frame	lists of active entrepreneurs in zones where monitoring meetings are held	participant lists of upcoming GIZ or SNV trainings	individuals mobilized based on selection and screening criteria (see text below)
timing of sampling	ad hoc random sampling at monitoring meetings*	ad hoc random sampling based on training participant lists	full sample of mobilized people
envisaged number of interviews per site	up to 20	20 (solar) 25 (stoves)	25 (solar) 30 (stoves)

*Note: Pull-in counties refer to counties, where the GIZ activities are about to start or have started only recently. * It was originally planned to conduct random sampling before monitoring meetings based on lists of active entrepreneurs. However, either the number of participants turned out to be too few for sampling or the lists were not comprehensive so that it was opted for ad hoc sampling during the meetings.*

Source: Own representation.

¹⁰ In particular, too few trainings for Jiko Kisasa stove production were scheduled for 2015. A sufficient number of trainings would, however, have been central to conduct both the pipeline and difference-in-differences approach selected for this evaluation (see section 3.2).

Figure 4
Location of survey sites



Note: A comprehensive list of survey sites can be taken from Annex 5.

Source: Own representation.

Particular attention had to be paid to the selection of the comparison group of mobilized non-participants as a basis for the longitudinal impact evaluation. First, counties had to be carefully selected in that they were comparable (see above) and that exposure to trainings in the respective technology (ICS or pico-PV) was as limited as possible. This included both previous EnDev-K activities as well as initiatives from other NGOs or governmental programmes. Second, and even more importantly, mobilized individuals should exhibit similar characteristics to the actual training participants of the EnDev-K activities, notably in terms of people's willingness and capabilities to engage in entrepreneurial activities related to modern energy technologies. In order to closely replicate the selection and screening process of individuals into EnDev trainings, the typical GIZ mobilization procedure was followed to the extent possible¹¹: after consultation with local offices of the Ministry of Agriculture, extension officers of the respective wards were trained to carry out the mobilization process. These extension officers received one day of training, which was led by an experienced GIZ mobilizer (usually an extension officer from an EnDev-K intervention county). The training was further facilitated by a representative of RWI and/or SERC.¹² Following the training, extension officers were given three days to mobilize suitable survey participants to achieve the foreseen sample size in the comparison group. Subsequently, mobilized individuals participated in a half- to one-day meeting, which involved the interviews and lottery in line with the design outlined in section 3.2.

¹¹ A major difference was that EnDev-K requires prospective stove entrepreneurs to identify their first 20 customers already before the training (see section 2.2). It was not possible to impose this criterion, since it would have meant to make the mobilized people to find customers who will eventually not receive the product, since part of the mobilized people would not undergo any training.

¹² The content of the extension officers training, including the mobilization criteria and approach can be found in Annex 6.

The main survey tool was a structured questionnaire administered to all study participants using a tablet-based data collection application (see Electronic Appendix 1). The questionnaire collected detailed information on a broad spectrum of employment- and business-related topics: (i) Participation in EnDev training and basic business information; (ii) Information about markets, customers and demand; (iii) Information about employees and other actors along the value chain; (iv) Data on the level and stability of sales, prices and profit; (v) Marketing and business practices, including access to credit; (vi) Individual-level and household income; (vii) Perception of the own economic and employment situation. The questionnaire concluded with a section about socio-demographic characteristics of the respondent and his/her household. In the design of income-related questions, several measures were taken to enhance reliability of the answers (see Box 2).

Box 2

Measures to increase the reliability of self-reported income figures

Various measures were taken in order to assure realistic answers about income. These include

- a) the use of specific showcards for income questions, which only ask for intervals and allow people to give their reply in a coded way. Referring to the letter displayed on the showcard allowed the interviewee not to directly disclose his or her income to the interviewer. See Annex 7 for an example of such a showcard;
- b) strong sensitization of coordinators and mobilizers of the different groups and meetings as well as officials, since they were the key people to gain trust of the individual entrepreneurs;
- c) specific explanations given during the interviews to reassure interviewees that the information would be treated fully confidentially in order to make them feel at ease;
- d) corroboration of income information through sales information provided by the interviewees;
- e) use of a wide range of proxies for income such as expenditures and assets/ wealth, both for business and private;
- f) use of the EnDev monitoring data to further corroborate the answers given by entrepreneurs already cooperating with the program;
- g) the circumstances that both EnDev and Strathmore university are trusted entities, which further increased the ease of interviewees.

Still, income information provided by interviewees were taken with caution. It has to be noted, though, that unreliable income information is only a problem for the impact evaluation if the treatment and comparison group differ in the extent of incorrect answers. While there is obviously no way to ultimately test this, the impressions gleaned during data collection do not provide reasons for suspicion.

While questions focused on the primary income source of respondents, the survey questionnaire was designed to capture all income-generating activities in order to adequately capture the multifaceted nature of income generation (in particularly in the case of minor solar or ICS involvement). Interviews were conducted face-to-face in a private setting to ensure confidentiality and privacy and typically took between 40-60 minutes. The questionnaire was in English and interviews were most often conducted in both Swahili and English; with regional languages being occasionally used as well. In total, 898 individuals were interviewed at 44 sites and target figures have been realized throughout (see Table 3). All sampled entrepreneurs were willing to participate in the interviews and only four interviews could not be completed.

Semi-structured interviews complemented the structured questionnaire. They were carried out by the RWI junior researcher using leading questions from an interview guide (Electronic

Appendix 2). Interviewees were GIZ and SNV trainers and coordinators, home economics officers and other representatives of the agricultural ministry, as well as input suppliers. The purpose of these interviews was better acquaintance with the ICS and solar business and to enrich and triangulate the quantitative data gathered. The following issues were addressed in the interviews: other actors along the value chain; perception of income effects; drivers of entrepreneurial success and business constraints; the role of the EnDev interventions.

Table 3
Number of completed interviews

			Entrepreneurs			Sites	
			Solar	Stoves	Total	Solar	Stoves
Active entrepreneurs	T1	achieved	118	149	267	9	9
		planned	110	110			
Active entrepreneurs (non-reporting)	(T1)	achieved	21	17	38		
		planned	*	*			
New training participants	N2	achieved	192	191	383	9	8
		planned	165	165			
Mobilized non-participants	N3 _n	achieved	82	74	156	5	4
		planned			140		
Training ticket winners	N3 _t	achieved	20	34	54		
		planned			‡		
Total					898	23	21

*Note: * T1 entrepreneurs are entitled to receive allowances by EnDev-K for attending the bi-monthly meetings, but only if they have not achieved the necessary sales of 10 stoves or pico-PV systems in the previous reporting period. It was originally planned to also include those non-reporters who did not achieve these figures. They were specifically invited and were paid the allowances through the survey budget. However, only few of them actually showed up at the interview days. They are therefore not further assessed in this study, since a sufficient and representative subsample could not be achieved. ‡ There was no envisaged subsample size figure for Training ticket winners, since they have only been included for methodological reasons only (as outlined above) and not included in the analysis.*

Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

4. Results

4.1 Descriptive statistics on socio-economic background

This section introduces to main socio-economic background characteristics of the treatment and comparison group analysed in this report, i.e. *Active Entrepreneurs* and *New Training Participants*. The presentation is carried out separately for the solar and cook stove business. This descriptive overview also serves to test for meaningful differences in observable characteristics between the groups that the subsequent impact estimation should adjust for. Note that the sample of active entrepreneurs (T1) represents regularly reporting entrepreneurs and thus not necessarily reflects the entire population of entrepreneurs that still cooperate with EnDev-K who partly only engage in the respective business on an irregular basis.

Solar Entrepreneurs

Table 4 focuses on main socio-demographic variables that are also used to balance the compared groups in the matching approaches used in the subsequent impact analysis. The table displays average values along with the difference between the two group means. Since the comparability of the two groups is a main concern here, exact p -values based on standard statistical tests are shown to investigate whether these means are not only by chance different from each other. While two groups with a p -value of 1 can be interpreted to have completely equal means, a p -value below 0.1 hints towards statistically significant differences. The last column shows the number of observations available and in this case illustrates that almost all respondents answered all questions.

Table 4

Balancing of solar treatment and comparison groups

	Active entrepreneurs	New training participants	Difference	p -value
Gender, share female in %	53	48	5	0.40
Age				
mean (in years)	37.72	36.61	1.11	0.37
younger than 25, share in %	7	18	-11	0.00
older than 49, share in %	14	15	-2	0.71
Education, share in %				
at most primary school	15	20	-5	0.30
at least secondary school	58	66	-7	0.21
college or university	39	34	5	0.37
Married, divorced or widowed, in %	90	77	13	0.00
Household size	5.21	5.24	-0.03	0.91
Single household, share in %	4	7	-3	0.25
Household with children, share in %	86	77	9	0.03
Flooring, share in %				
earth/mud	33	39	-5	0.35
cement	57	56	1	0.86
Electricity, share in %				
any	56	40	16	0.01
grid	39	32	7	0.20
DHS 2014 Wealth Index	3.03	3.28	-0.25	0.00
Number of observations	118	192	-	-

Note: The mean age is calculated by matching each age category with the mean of its boundaries. A mean age of 15 is assumed for the lowest category and a mean of 65 for the highest. The p -value is based on a t -test on equality of means between the compared groups and thus represents the statistical likelihood of obtaining the given results by chance if in reality the means were identical.

Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

Generally the characteristics are balanced quite well, and only for a few covariates the difference turns out to be statistically significant (highlighted in bold in the table). One exception is the share of trainees who are younger than 25 which is significantly larger in the comparison group sample. This obviously has to do with the fact that the training of active entrepreneurs

dates back some time, which is 2 years at the median. Generally, the share of youth (aged younger than 30 years) is comparatively small in the sample, which makes it difficult to analyse the impact on younger participants. In addition, one can observe a slightly lower share of households with children in the comparison group sample, and a lower share of individuals being married or divorced. Whether this difference is rooted in initial heterogeneity or reflects a particularly high drop-out rate among young entrepreneurs is a question of further interest, which will be discussed in section 5.

Another difference between both groups is the share of individuals with access to electricity. However, the large share of solar entrepreneurs with access to electricity is likely rooted in their business involvement, and no systematic differences can be observed with respect to other forms of electricity which may be related to a higher household status at baseline. For this reason, these variables will not be included as balancing variables in the impact analysis below but will (tentatively) be regarded as outcome variables. Other socio-demographic characteristics seem well-balanced in both groups. Importantly, no systematic differences in gender and educational attainment can be detected between active and new training participants. Since gender and educational attainment could potentially influence the treatment effect, this is an important and positive finding with regard to the cross-sectional analysis.

Beyond individual-level characteristics, another important comparability aspect is whether county-level socio-economic conditions are similar between the survey sites for the two groups. This is formally tested using new data from the nationally representative 2014 Kenya Demographic and Health Survey (DHS) that became available after the present survey. The DHS Wealth Index shown in the table is a composite measure of a county's average long-term standard of living.¹³ There is some evidence that implementation areas differ somewhat between early and new cohorts, with the latter being more wealthy according to the KDHS 2014 wealth index.

Cook Stove Entrepreneurs

Table 5 provides the corresponding summary statistics for cook stove entrepreneurs. Comparing this table to Table 4 above shows that in the case of cook stoves the treatment and comparison groups seem to show more pronounced differences than in the case of the solar component. While the group of active stove entrepreneurs exhibits a similar share of women as the solar sample, the group of new training participants includes a particularly large share of female entrepreneurs. This, to some degree, may be related to a specific mobilization mechanism given that a large share of new training participants indicate to have been mobilized through an association (e.g. a women's group) (not reported).

As for the solar component, only a small share of youth among active entrepreneurs can be observed, making it difficult to provide sub-sample results. Also new training participants appear younger than existing cook stove entrepreneurs, but the difference is not significant once the median time since training (which is 4 years among cook stove entrepreneurs) is taken into account. Educational attainment is lowest among newly trained stove entrepreneurs (of all

¹³ *The DHS 2014 is based on a sample of roughly 36,000 households, conducted between May and October 2014. Even though the survey focuses on health-related outcomes, data is also collected among a broad spectrum of household characteristics. The DHS wealth index is generated via a principal components analysis based on this data. It has been demonstrated to be consistent with expenditure and income measures. For detailed information about the survey design and the wealth index of the DHS 2014 in Kenya, see KNBS et al. (2015, p. 4ff and p. 17ff).*

groups including solar samples): Primary education or lower is most common in this group (52%), while education at college or university level is generally uncommon (7%). These differences persist even when respondents younger than 25, who may still receive schooling, are dropped from the analysis. Similarly, new training participants are less likely to be provided with electricity (15%) and more likely to live in households with earth or mud flooring (74%). Both asset variables are often regarded as important proxy variables for the overall economic situation of households. As will be seen later, new stove training participants turn out to earn less income and own fewer assets on average than any other group (treatment and comparison in stove/solar). However – as in the case of the sampled solar entrepreneurs – it cannot be ascertained to what extent these differences represent heterogeneity that had already been in existence before the EnDev intervention and to what extent they are impacts of the EnDev intervention. In contrast to the case of solar component, new and old stove intervention areas do not differ, on average, according to the 2014 KDHS Wealth Index.

Table 5

Balancing of cook stove treatment and comparison groups

	Active entre- preneurs	New training participants	Difference	<i>p</i> -value
Gender, share female in %	52	65	-13	0.01
Age				
mean (in years)	41.79	38.26	3.52	0.00
younger than 25, share in %	1	16	-16	0.00
older than 49, share in %	21	18	3	0.47
Education, share in %				
at most primary school	35	53	-18	0.00
at least secondary school	88	90	-2	0.50
college or university	10	7	3	0.30
Married, divorced or widowed, in %	95	82	13	0.00
Household size	5.29	5.86	-0.58	0.03
Single household, share in %	4	3	1	0.67
Household with children, share in %	77	83	-6	0.17
Flooring, share in %				
earth/mud	60	74	-13	0.01
cement	38	24	14	0.01
Electricity, share in %				
any	34	15	19	0.00
grid	25	12	13	0.00
DHS 2014 Wealth Index	3.06	3.00	0.06	0.19
Number of observations	149	191	-	-

*Note: The mean age is calculated by matching each age category with the mean of its boundaries. A mean age of 15 is assumed for the lowest category and a mean of 65 for the highest. The *p*-value is based on a *t*-test on equality of means between the compared groups and thus represents the statistical likelihood of obtaining the given results by chance if in reality the means were identical*

Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

In conclusion, one observes that actively reporting entrepreneurs to some extent display specific individual and household-level characteristics in comparison to the group of new training participants. While observable differences are rather small for the solar component, they appear more strongly systematic (e.g. an outcome of the selection mechanism) for the group of new stove training participants. The group is comprised of a larger share of females, with a lower education level and particularly low levels of income and assets. They are also often part of an existing group or cooperative and indicate to have been mobilized through an association. Some of the observed outcomes in the treatment group may be a direct or indirect effect related to their participation in the training (e.g. electricity). In the case of stove entrepreneurs, however, differences also appear relevant for pre-training characteristics which provides an important rationale for applying regression and reweighting approaches in the impact analysis. The following sections will discuss whether observed differences between treatment and comparison group can be credibly accounted for based on cross-sectional data. But already this section demonstrates the importance of conducting a more rigorous longitudinal impact analysis based on baseline and follow-up data (e.g. difference-in-differences).

4.2 Business take-up and income

Business take-up

The starting point is to analyse to which extent the EnDev intervention was able to establish the solar or cook stove business as a relevant income-generating employment. In this regard, it is important to remember that the treatment sample is composed only of active, reporting entrepreneurs. Hence, the findings do not provide a picture of business take-up and success among all training participants but among those trainees who have adopted and continued their business in the first place. According to EnDev, the drop-out rate is at about 40 to 60% for both components. Since EnDev-K does not systematically collect information on all initial training participants, it was not possible to specify or verify this figure. As noted in the methodological section 3.2, drop-out is also critical with regard to the comparison sample: the training participants still include some people who will likely discontinue participation in the programme in the future, so that the training participants as a whole are not fully comparable to the selected group of active, reporting entrepreneurs. This is controlled for by adjusting for observed differences in socio-demographic characteristics in the comparison group through the statistical matching approach Entropy Balancing.¹⁴ Thereby, comparability of the compared groups is sought to the extent possible. Still, it has to be kept in mind that this cross-sectional impact assessment likely represents an upper bound of the treatment effect (see also the discussion in section 3.2).

Table 6 displays statistics on survey responses regarding income-generating activities, and reports differences between treatment and comparison groups in both solar and cook stove businesses. The data thus provide information on how participation in the EnDev intervention shifts the composition of income sources among active entrepreneurs using the reweighted comparison group information as counterfactual.

Prior to the training, less than 8% of individuals in the comparison group do not have an employment. Most of them are students or doing household work, with a few without occupation and one retiree. Only roughly one in ten respondents of the comparison group is active in the

¹⁴ Note that due to this reweighting the outcomes of the comparison groups are not exactly identical to those of the original sample of new training participants.

respective (solar or stoves) business. The businesses are thus new for most prospective entrepreneurs. This is also reflected in what people consider their main income source (also referred to as main activity in the following): for only very few trainees the business in which they are trained already represented the main income source before the training. This share is slightly higher among stove trainees, since some EnDev training participants are already active in non-improved cook stoves production or selling prior to the intervention.

Table 6
Impacts on income-generating activities and working hours

	Solar			Stoves		
	Treatment	Comparison	Difference	Treatment	Comparison	Difference
Individuals in employment	100	96	4***	100	92	8***
Individual has respective business among income sources, share in %	99	12	88***	99	11	88***
Respective business is main income source, share in %	72	6	66***	69	7	62***
Number of income sources, mean	2.52	1.74	0.77***	2.40	1.37	1.03***
Only one income source, share in %	9	39	-31***	4	55	-51***
Contribution of main income source to personal total net income, mean in %	51	68	-17***	54	80	-26***
if main income source is solar or stoves, mean in %	60	68	-8*	60	80	-21***
Working time spent on main income source, means						
Days per week	4.6	5.2	-0.6**	3.30	4.92	-1.6***
Hours per day	7.0	7.7	-0.7*	5.8	6.9	-1.1***
Total hours per week	34.5	41.6	-7**	18.9	34.4	-15.6***
Full-time equivalents worked on solar or stoves [‡]	0.7	-		0.4	-	
Total working time per day in hours (all sources) ^{‡‡}	9.02	7.83	1.19**	8.46	6.91	1.55***
Farming is among income sources, share in %	53	50	2.1	83	79	4.4
Farming is main income source, share in %	6	30	-24***	23	63	-40***
Sells some or all of his/ her farming produce on the market, share in %	66	76	-10	88	75	13**
Number of Observations	118	192		149	191	

Note: Treatment group are Active entrepreneurs (T1); Comparison group are new training participants (N2). Comparison group means are reweighted based on Entropy Balancing weights. *, ** and *** indicate that the coefficient is significantly different from zero on a level of 10%, 5% and 1% respectively. All variables conditional on earning an income. [‡] Full-time equivalents calculated with a normal working week counting 45 hours in Kenya (ILO 2016); ^{‡‡} Information not available for all entrepreneurs.

Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

In general, training participants have very diverse backgrounds. To name a few, frequently observed current main income sources are farming, artisanal work such as carpentry among cook stove entrepreneurs and trade businesses such as kiosk or street vending among solar entrepreneurs. Assuming that the comparison group provides an adequate picture of the treatment group at the time when the latter were trained, this can be taken as an indication that the training actually establishes stoves and solar as *new* sources of income, rather than extending existing ones. More importantly, a large share of active entrepreneurs in both technologies seems to have successfully established their business as their main source of income.

At the same time, the data suggest that the new business complements other sources of income rather than replacing engagement in other income-generating activities. This is found most clearly by comparing the total number of income sources across treatment and comparison group: On average, active entrepreneurs report roughly one income source more than new training participants. The share of entrepreneurs with a single income source has gone down dramatically. For merely 4 and 9% of stove and solar entrepreneurs, the respective business is the only income source. In comparison to that, about half of income earners in the comparison group rely on one income source only. Likewise, one observes that significantly less of the total working time is spent on what is considered the main income-generating activity. This difference to the comparison group continues to be significantly negative even for those active entrepreneurs who regard the solar or stove business as their main activity. The effect is particularly pronounced for stove entrepreneurs, with a reduction of roughly 45% in total hours per week spent on the main activity. Stove entrepreneurs spend noticeably less time on their main activity than solar entrepreneurs. This can likely be explained by the fact that solar retailing is generally less time-intensive and can be performed simultaneously with other activities, not least other retailing. In general, the reported total number of hours worked per day is clearly higher for active entrepreneurs. The number of working days per week is similar (not shown in the table). For the average active entrepreneur in both groups, earnings from his or her business represent roughly half of the overall monthly income. At the same time, more than three quarters of the respondents in both components obtain 30% or more of their personal income from sources other than the respective business (not shown in table). In conclusion, there is a continued reliance on other sources of income after starting the solar or stove business, total hours worked are increased and distributed on more activities reducing the time spent on each activity. Consequently, the numbers suggest a diversification and intensification of income generation.

In line with these findings, the data indicate that most active entrepreneurs continue to be engaged in farming despite starting a solar or stove business: In both groups, the share of respondents who are engaged in farming remains roughly constant, with about half of the solar entrepreneurs and about four fifths of stoves entrepreneurs also engaged in farming. The dependence of individuals on farming declines considerably: the share of solar entrepreneurs who primarily depend on farming is reduced to a quarter of its original size (from 30% to 6%, see Table 6). Cook stove entrepreneurs seem generally more reliant on agriculture than solar entrepreneurs – both before and after the intervention. The cook stove business and agriculture are more similar activities as both require manual labour. In addition, stove entrepreneurs tend to work more locally and to be less mobile than solar entrepreneurs, which facilitates pursuing agriculture more extensively. Still, the reduced dependence on farming is even more pronounced for stove trainees (from 63% to 23%). The (entropy weighted) difference is highly significant in both cases. Interestingly, this shift is not reflected in a reduction of the share of individuals who sell some of their produce on the market. In contrast, the share of stove entrepreneurs who report to regularly sell their produce even increases by 13 percentage points. Hence,

while entrepreneurs become less reliant on their own produce, they do not give up opportunities to sell some of it on the market.

This goes in hand with data in Table 7 which displays whether active entrepreneurs have given up other activities since starting their respective business. Among active entrepreneurs in both businesses, around two thirds have not stopped any other activities when entering the business. Those who reported to have abandoned another income-generating activity often stopped engagement in farming – especially among cook stove entrepreneurs (56% among those who abandoned any activity). The picture is somewhat different among solar entrepreneurs, where transitions mostly occur from trade and service activities to solar retailing. At the same time, only 11% (22%) of active solar (stove) entrepreneurs report to have abandoned farming altogether since entering the business.

Table 7

Activities abandoned by active entrepreneurs since starting their business

	Solar	Stoves
Individual gave up previous income-generating activities since entering business, share in %		
Farming	11	22
Artisanal	7	3
Trade/Services	14	10
Total across all activities	33	39

Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

Taken together, the impact analysis concerning income sources provides a distinctive pattern regarding the shift to the stove or solar business as an income-generating activity: First, the intervention establishes the respective business as a new and important source of income, although other activities are not necessarily forgone. Second, there is evidence of an increasing diversification of income-generating activities among active entrepreneurs. Third, the intervention appears to reduce the dependence on agriculture, although most respondents do not give up farming entirely in favour of the solar or the cook stove business. This effect is particularly pronounced among cook stove trainees.

Income impact estimates

Table 8 shows the main impact estimates for monthly personal net income. Again, the estimates are based on reweighting the comparison groups using Entropy Balancing in order to make treatment and comparison groups comparable to the best possible extent in the given setup. The table shows considerable gains in income for both active solar and stove entrepreneurs. In the basic specification in the first row of the table, participation in the intervention is estimated to increase personal net monthly income from 20,200 to 25,700 KSh (185 to 235 EUR¹⁵) among solar entrepreneurs and from 9,900 to 18,900 KSh (90 to 170 EUR) among cook stove entrepreneurs. Though large in size, these impacts are statistically significant only for the stove component of the programme, which has to do with the large variation (standard devia-

¹⁵ At the time of the survey, the exchange rate between Kenyan Shillings and Euro was 110:1.

tion) of the income data among these entrepreneurs.¹⁶ These impacts therefore deserve intense scrutiny.

Table 8
Impacts on total income

	Solar				Stoves			
	Treatment	Comparison	Diff.	N	Treatment	Comparison	Diff.	N
Unconditional	25760	20275	5485	295	19000	9860	9140***	331
Conditional	25760	21220	4540	277	19000	10700	8300**	297
Conditional and censored	16000	15475	525	255	13740	8200	5560***	276
Unconditional and censored								
All	16000	14740	1260	273	13740	7530	6210***	310
Male	18415	18785	-370	136	17495	9110	8385***	126
Female	13990	11110	2880	137	10410	5900	4510***	184
Individual contribution to household income, share in %	68	61	7*	288	63	71	-8**	297

*Note: Treatment group are Active entrepreneurs (T1); Comparison group are new training participants (N2). Comparison group means are reweighted based on Entropy Balancing weights. N refers to the number of observations. *, ** and *** indicate that the coefficient is significantly different from zero on a level of 10%, 5% and 1% respectively. Income data were collected by 15 intervals. Mean income is calculated by matching each interval to a weighted average of its bounds. "Conditional" variables exclude respondents without any income. "Censored" variables exclude intervals containing the top 5%. This so-called 95th percentile is calculated using the unweighted data of both treatment and comparison groups with critical values of KSh 50,000 (solar) and KSh 40,000 (cook stoves). Household income was approximated based on individual-level net income (unconditional, censored) and the reported contribution to household income. Source: RWI-EnDev Kenya Entrepreneur Survey 2015.*

First, in addition to the "unconditional" treatment effect (i.e. all observations including those who do not earn an income), the effect "conditional" on earning an income is estimated. That is, the latter specification only considers income earners and thus disregards students, retirees and unemployed among the training participants. While this increases average incomes in the comparison group (and hence reduces the impact estimate), the impact remains large and significant for stove entrepreneurs. Second, it is tested whether the income estimate is driven by misreporting or outliers, given that a high dispersion in reported incomes in both treatment and comparison groups can be observed. At the outset, the income variable was cross-checked with other income- and sales-related variables. Based on that, merely 7 observations were identified as potential misreporting and omitted from the sample. In addition, the upper 5% of reported incomes are disregarded, leading to the omission of 21 observations from the entire sample. The resulting "censored" specifications are as well given in the table. Furthermore, the econometric specification is tested using linear regression (Ordinary Least Squares, OLS) (see Table A 1 in Annex 8). Although the magnitude of the effect is somewhat reduced in the OLS specification, the results generally remain the same for both business types. Finally, data on

¹⁶ The relatively large standard deviations are probably as well a result of the fact that individual incomes were elicited through income ranges (see showcard example in Annex 7), instead of exact values, which was one of the measures to improve the reliability of self-reported income figures.

annual income reported by the entrepreneurs essentially corroborate the findings based on monthly data, which is supposed to suffer less from recall error.

The analysis is concentrated on the unconditional treatment effect, as this estimate can be considered to most closely capture the programme's intended effect of providing a new source of income. In the most convincing specification, based on the unconditional, censored sample, the impact of 6,200 KSh still represents a statistically significant increase of 86% for stove entrepreneurs as compared to the comparison group. The impact for solar entrepreneurs is lower and statistically insignificant. As a consequence, it appears that stove entrepreneurs are able to reduce the income gap to solar entrepreneurs thanks to the EnDev intervention. Nevertheless, reported incomes of active stove entrepreneurs are still significantly lower compared to those of solar entrepreneurs as the former start out with particularly low incomes. This pattern is also reflected in the impact on overall household incomes, which is significant only among stove entrepreneurs. In fact, the increase in personal net income outweighs the slightly smaller share they report to contribute to the overall income of the household.¹⁷ Note also that the higher pre-intervention incomes likely relate to the fact that one of EnDev's selection criteria for the solar component requires prospective entrepreneurs to already follow a profit-oriented activity, which is not the case for cook stoves.

Further interesting results are found when disaggregating the income effects by gender: First of all, male entrepreneurs generally start out from a clearly higher income before the intervention. While both male and female stove entrepreneur observe a strong, significant increase in income, the increase is even stronger for male entrepreneurs, both in absolute and relative terms. A more in-depth analysis shows that this is partially related to active male entrepreneurs spending more time (around 10 percent) on more income-generating activities and being more educated (e.g. male entrepreneurs are three times as likely as female entrepreneurs to have attended college or university). For solar entrepreneurs, the data indicates the opposite effect: male solar entrepreneurs observe almost no impact at all with female entrepreneurs experiencing higher, but still insignificant, income increases. This is likely due to the fact that for females, retail is more often a completely new business and income-generating opportunity. While female entrepreneurs in both businesses earn less before and after the intervention, the solar component appears somewhat more successful at closing the initial gender gap.

The magnitude of the impact on income roughly corresponds to net earnings from the business (cf. Section 4.4). Nevertheless, these cross-sectional impact estimates have to be regarded with caution. Recall that the Entropy Balancing procedure may not achieve to fully eliminate socio-economic differences between new trainees and active entrepreneurs, given that the latter represent a selected sample (cf. Section 4.1). This may be particularly true for new stove training participants, who have a very low baseline income of 6,200 KSh (unbalanced, unconditional) and specific socio-economic characteristics (see again Section 4.1). Hence, remaining pre-training differences in income between comparison and treatment groups cannot be entirely ruled out and may represent a potential source of bias. While these estimates seem to point into the right direction, their magnitude should be verified by the proposed longitudinal difference-in-differences approach, which sufficiently controls for such differences.

¹⁷ However, the reported impact estimates regarding household incomes should be handled with caution, as these are even more prone to reflect underlying differences in household (beyond individual) characteristics between treated and comparison groups that cannot be accounted for by the balancing mechanism.

4.3 Business structure and workforce

Table 9 provides information on the type of employment and enterprise in order to gauge issues such as size and formality of the activities, which are important for their sustainability, among others. The majority of interviewees in both components perform their business as an individual. A considerable number of further cook stove entrepreneurs indicate to be organized in groups or cooperatives (38%), which is also the major change in the business structure that occurred after participating in the EnDev intervention. This is rarely the case for the solar entrepreneurs, who more often regard themselves as enterprise owners.

Table 9
Business structure and employees

	Solar			Stoves		
	Treatment	Comparison	Difference	Treatment	Comparison	Difference
Business performed as... , share in %						
individual	74	71	3	84	92	-8*
family worker	1	1	0	0	4	-4*
enterprise owner	18	10	8*	7	1	6**
employee	10	18	-8*	0	2	-2*
Member of (producer) group or cooperative	8	11	-3	38	8	30***
No employees, share in %	58	50	8	37	43	-6
Only family members as employees, share in %	17	12	5	12	10	2
Number of employees						
mean	0.94	2.94	2.00*	1.84	2.23	-0.39
lower quartile	0	0	0	0	0	0
middle quartile	0	0	0	1	1	0
upper quartile	1	3	-2	3	4	-1
Share of female employees in %	49	49	0	21	42	-22***
Weekly pay, median in KSh						
all workers	1000	700	300	500	600	-100
female workers	2000	600	1400	500	1200	-700
male workers	750	800	-50	500	-100	600
In-kind payment to any of the employees, share in %	17	11	6	3	10	-6

Note: Multiple answers allowed for interviewee's business type

Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

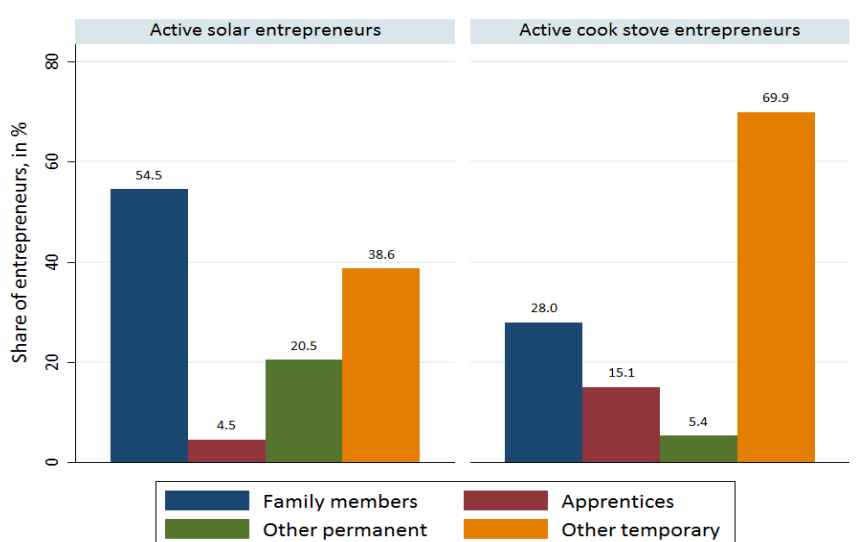
This observation is also reflected in the number and type of workers employed in solar and cook stove businesses: In general, employment of additional workers is more common among cook stove entrepreneurs. The majority (63%) of stove entrepreneurs have had at least one employee in the last three months and close to two workers are reported on average. In comparison, solar entrepreneurs less often engage employees in their business, and even among those who do, the average number of employees is much lower. Among solar entrepreneurs, 75% either work alone or employ only family members in their business. The data on the comparison group indicates that project beneficiaries already employed a similar, in the case of

solar even potentially higher number of employees in their previous business, which however seems to be driven by a few larger outliers.

For an assessment of income and employment effects, it is crucial to investigate the employment conditions of those employed by the beneficiaries of the programme. Again, differences between both businesses can be observed, here in terms of characteristics and payment of employees: First, while the gender composition among employees of solar entrepreneurs is roughly balanced, considerably more men are employed in the cook stove business (79% of employees are men). This is somewhat surprising, as the composition of entrepreneurs themselves is not biased towards either gender (see Section 4.1). Secondly, as Figure 5 shows, the stove and solar entrepreneurs generally engage their workers under different types of employment: While solar entrepreneurs more commonly engage family and permanent workers, this is less the case for stove entrepreneurs. Instead, temporary workers account for 66% of the work force in the cook stove business (Figure 6). Interestingly, these are predominantly male (roughly 5 in 6). Thus, the high share of male workers among cook stove entrepreneurs is related to the high number of temporary workers. 15% of stove entrepreneurs report to train apprentices, which is rarely the case for solar business.

Figure 5

Types of workers employed



Note: The shares reflect the number of entrepreneurs who had at least one employee in the respective category. Shares are computed only among entrepreneurs who reported to have had employees in the preceding three months (“conditional on having an employee”).

Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

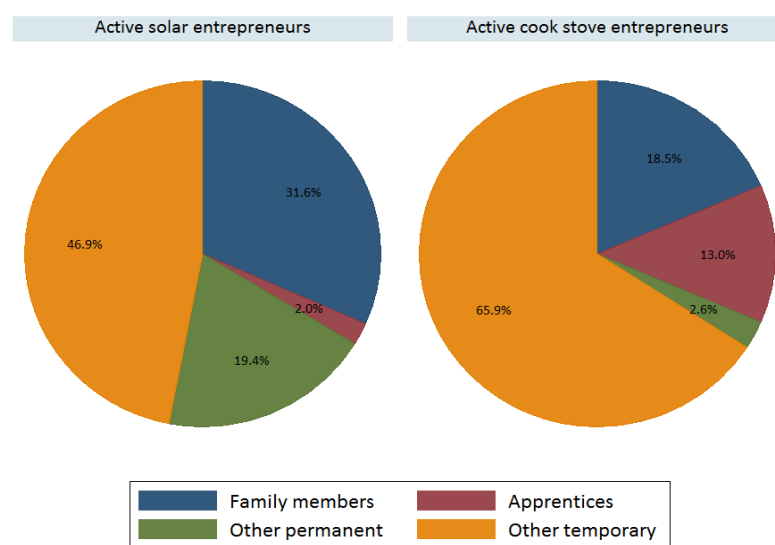
It can be further taken from Table 9 that the median weekly wage is higher in the solar business. A more detailed investigation shows that this difference applies to all types of employment and that it is particularly driven by workers in the solar business being more likely to be permanently employed. Permanent workers generally receive the highest weekly wage in both types of business. This further explains the low weekly pay for male workers in the solar business, as they are more likely to be temporarily employed. Looking at permanently employed workers only, this difference vanishes (not reported). In-kind payment in the form of meals or goods (including the solar lanterns) seems to be much more prevalent among solar entrepre-

neers than among stove entrepreneurs. Payment on commission basis seems to be rarely the case.

Taken together, solar entrepreneurs are found to perform their business as own-account workers without employees, while cook stove producers often work self-employed and/or organized in producer groups with a considerable share of them engaging additional employees. However, employment, in particular among cook stove producers, seems to mostly involve temporary, rather low-paid jobs.

Figure 6

Composition of employees



Note: The percentages refer to the share in the total number of employees added up across all entrepreneurs.

Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

4.4 Sales, demand and market environment

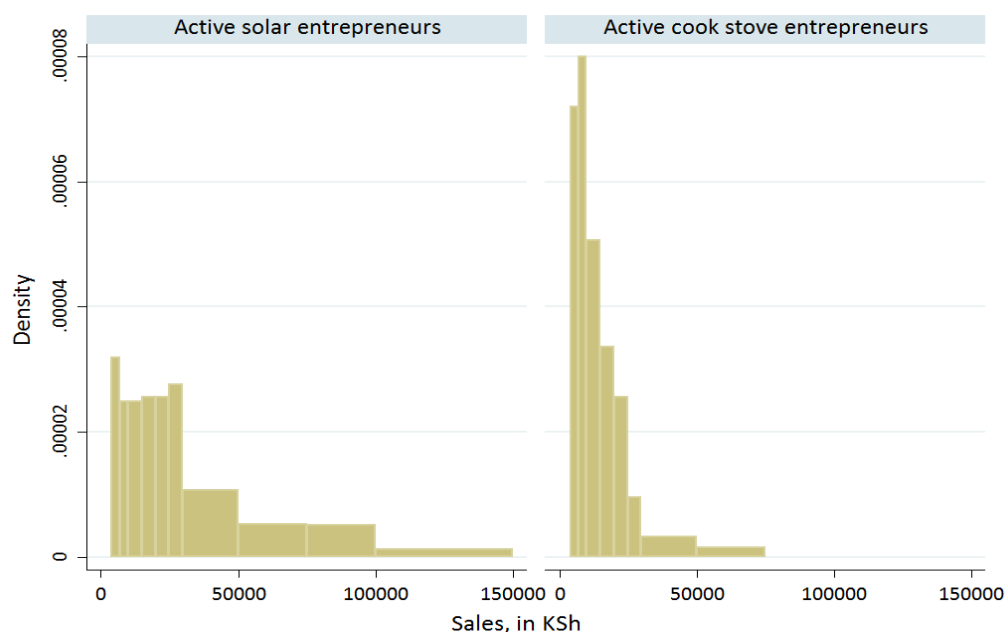
This section discusses sales and sales volatility as well as market access of the entrepreneurs to better understand some potential drivers behind the income and employment effects discussed above. Again, it has to be stressed that these figures are not representative for average revenue among all entrepreneurs actively reporting sales at monitoring meetings where they were surveyed.

The respondents were asked to provide an average figure of their sales in a typical month, in terms of the number of products sold, customers, as well as total revenue (not profit) in KSh. Responses indicate a considerable positive skew in the distribution of revenue and customers, meaning that most entrepreneurs report small or moderately large figures, while a small number of entrepreneurs sell a large number of products and serve a large number of customers. This is in line with the observation that some entrepreneurs adopt the business as their main activity, whereas others keep it as a side-line business in addition to other income-generating activities. The strong degree of skewness implies that information on mean sales is noticeably influenced by a few successful entrepreneurs. For this reason, Table 10 on sales and customers additionally contains information on median values and for revenues quartile figures, which are less sensitive to outliers. The average reported level of sales in KSh is much higher for solar entrepreneurs, with a median revenue of roughly 20,000 KSh per month. Moreover, for each

quartile, the level of sales in the solar business exceeds sales in the cook stove business by more than 100%. These differences in the distribution of sales and customers can also be taken from Figure 7 (the customer distribution depicted in Figure A 1 in Annex 8 gives a similar picture).

Figure 7

Sales distribution, by business



Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

Similarly, the number of customers and products sold per month appears lower among cook stove entrepreneurs. Half of the cook stove entrepreneurs serve less than 9 customers per month and more than a quarter of entrepreneurs do not have more than 5 customers.¹⁸ In both businesses, female customers account for roughly two thirds of total demand. There appears to be no sign of any gender preference of customers, since this composition does not depend on the gender of the entrepreneur. Yet, females achieve in general lower sales in both technologies.

However, this difference needs to be put in perspective of the different price structures: The last rows of Table 10 provide information on average mark-ups set in both types of businesses. Generally, mark-up is the relative difference between the selling price of a product and the costs incurred by the producer. In case of the solar entrepreneurs, unit costs are identical to the wholesale price of a product. In the table, mark-ups are expressed as a percentage of the unit cost reported by the entrepreneurs. As can be seen, reported margins are much higher in the improved stove business than in the solar business. In the group of cook stove entrepreneurs the average mark-up is 232%, which implies that the entrepreneurs keep more than two third of what is charged for a stove. In the solar business, both the median and the mean mark-up is roughly one third, which means that one fourth of the retail price is kept by the seller as a

¹⁸ The observation that the mean number of solar products sold exceed the number of customers is mostly related to sales through resellers (see above) who count as individual customers.

profit margin. That is, cook stove entrepreneurs achieve the same profit with clearly fewer sales. This difference between both business types is barely surprising since the cook stove business covers a greater part of the value chain and adds more value than the mere retail activity in the solar business. In fact, whereas the solar business is a typical product resale business, the cook stove business may rather be considered product manufacturing. This different nature of the businesses appears to be reflected in the data.

Table 10
Sales and customers

	Solar	Stoves
Number of products sold in last month		
mean	47.88	10.46
median	15	9
Customers in an average month		
mean	26.05	9.83
median	15	8.5
Revenue in an average month, in KSh		
mean	29070	11720
lower quartile	11670	5000
middle quartile (median)	20000	8000
upper quartile	35000	16000
Gender of customers, mean female share in %	67	71
Mark-up over input costs		
mean in %	34	232
median in %	36	160

Note: Mean and median of sales in KSh are calculated from interval data by matching each interval to a weighted average of its bounds. To mitigate potential distortions, 13 outliers are omitted (6 solar and 7 from cook stoves). In particular, information on sales (in KSh) and customers is disregarded if the absolute difference between the standardized number of customers and the standardized amount of sales exceeds two. Standardization is undertaken by subtracting the sample mean and dividing by the sample standard deviation.

Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

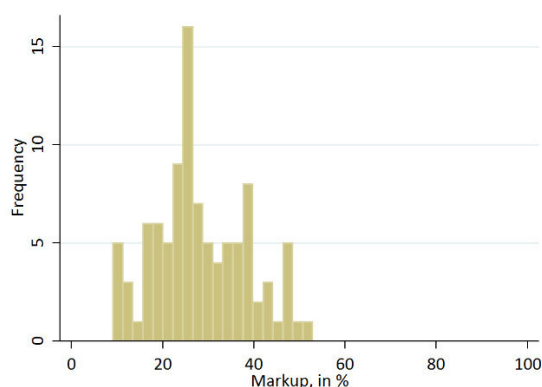
Interestingly, the difference in mark-ups between solar and stove entrepreneurs comes close to the difference in revenue in Table 10, where the sales of solar products amount to the double to triple of the cook stove sales. In fact, as also shown in the previous section, average profit levels in KSh prove less divergent across both types of business when the difference in mark-up is taken into account. However, as cook stove entrepreneurs devote more time to their business than solar entrepreneurs (see Table 6 in Section 4.2), the latter are still able to generate profits and income more effectively. At the same time, reported profit margins vary much more strongly among stove entrepreneurs (Figure 8). This can again be explained by a couple of factors inherent to the nature of the two business sectors. First, cook stoves like Rocket stoves are a less homogeneous and standardised product, which is why stove price setting differs more strongly. Second, mark-ups in resale are generally proportional to the input price, whereas mark-ups in manufacturing by self-employed producers likely vary according to different levels of labour input. Third, for some cook stove builders inputs may be provided in-kind –

either by the customer or builder. Input costs as basis for the calculation of mark-ups may thus vary more strongly among cook stove builders.

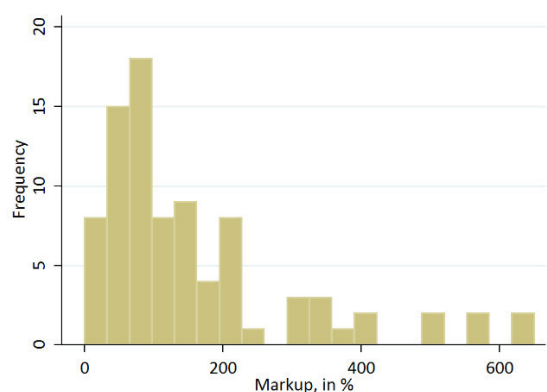
Figure 8

Mark-up over input cost

a) Active solar entrepreneurs



b) Active cook stove entrepreneurs



Note: The highest 5% of the mark-ups are not displayed in either group.

Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

To some extent, the difference in the price structure may also explain the difference in the scale and distribution of sales. In particular, the higher mark-up in the cook stove business suggests that entrepreneurs incur higher costs per unit (work time in particular), limiting the extent to which economies of scale can be exploited. In contrast, a large scale solar business may more easily be carried out even without a sizeable permanent staff, relying solely on resale agents.

Table 11 more closely investigates this question of market access, listing the three most important distribution channels and market places for both types of business. Roughly one third of active solar entrepreneurs indicate to sell their products first and foremost via groups (i.e. mostly community groups, such as women or self-help groups), whereas another 20% primarily sell their products in shops run by themselves. In general, the distribution approaches seem to be rather diverse and include various channels of similar importance. In contrast, cook stove entrepreneurs primarily sell their products at their customer's home, which is not surprising as rocket stoves require on-site installation.

Through these various distribution channels, entrepreneurs are able to reach markets with different geographical scope. In either type of business, sales reach beyond village level in most cases, and a noticeable number of entrepreneurs manage to penetrate markets beyond sub-county and county level (Table 11). In general, the market may be regarded as rather extensive in either business, although the market is somewhat more limited among cook stove entrepreneurs.

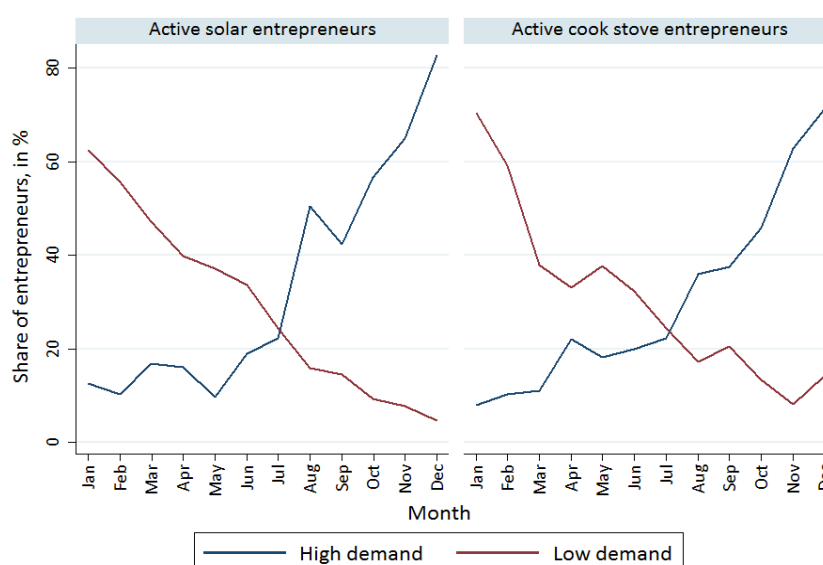
Table 11
Market access

	Solar	Stoves
Channels of distribution		
Most important	Groups (most important for 31%)	Customer's home (most important for 84%)
Second most important	Market place (most important for 20%)	Own home (most important for 9%)
Third most important	Own shop (most important for 19%)	Groups (most important for 3%)
Extent of the market, in %		
Sells beyond village	98	90
Sells beyond ward	83	74
Sells beyond sub-county	63	54
Sells beyond county	38	30

Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

Beyond the snapshot picture of income presented above, it is a critical question in how far the businesses also provide for a regular and predictable source of income. The analysis therefore additionally assesses the seasonality and volatility of sales. Figure 9 displays the share of interviewees who report that the respective month was high or low in demand and thus illustrates fluctuations in demand over the course of the year. Demand is found to increase over the year, being low in the first half and being high in the second half of the year. This pattern is the same for either type of business. In addition, the observed pattern suggests favourable conditions for the timing of this data collection in mid-August (a month with medium business performance) so that the sampled information may provide a good average of the year. Data on the monthly distribution for which entrepreneurs indicate the highest and lowest sales in 2014, respectively, corroborate these observations (see Figure A 2 und Figure A 3 in Annex 8).

Figure 9
Months with high and low demand



Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

Demand appears to be decisively influenced by specific events occurring in January and December. As can be taken from Table 12, the increase in demand in December is related to festivities such as Christmas as well as increased incomes among customers due to the end-of-the-year harvest season. Regionally relevant cash crops are coffee (harvest between May and June) and tea, for which bonuses are usually paid in November or December. Regarding the low sales in January, school fees, which are generally due in January or February, are revealed to be the single most important factor in reducing demand. Hence, the factors that exert the strongest influence on demand seem to be part of a general form of seasonality that affects both businesses similarly.

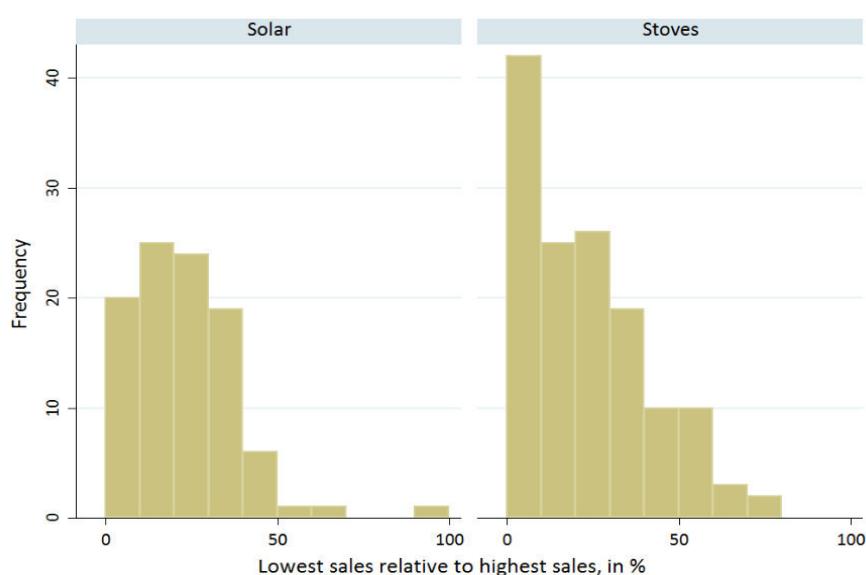
Table 12
Drivers of high and low sales according to entrepreneurs

	Solar	Stoves
Reason for high sales in best month, shares in %		
most important	Harvest season (60.6)	Harvest season (65.1)
second most important	Festivities (40.4)	Other (39.7)
third most important	Other (33.7)	Festivities (24.0)
Reason for low sales in worst month, shares in %		
most important	School fees (61.5)	School fees (60.1)
second most important	Other (43.3)	Other (42.6)
third most important	Farming period (31.7)	Farming period (28.4)

Note: The residual category of “other” reasons contains a substantial number of generic answers such as “demand was high” or “good cash flow”.

Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

Figure 10
Variation between highest- and lowest-sales month



Note: The figure reports the distribution of entrepreneurs according to the difference in sales of highest- and lowest-sales months. Sales in the lowest-sales month are expressed as a percentage of sales in the highest-sales month.

Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

In addition, to further investigate the magnitude of the observed volatility, Figure 10 shows the sales in the reportedly worst month, expressed as a percentage of the sales in the reportedly best month. The distribution reveals that most entrepreneurs experience a strong volatility of sales: Across both businesses, the vast majority of entrepreneurs report that sales in the lowest-sales month amount to 50% or less of the sales in the highest-sales month. The decline in revenue appears even stronger for cook stove entrepreneurs than for solar entrepreneurs, as many cook stove entrepreneurs merely sell less than ten percent of what they sell in high-sales months. For them, seasonal variation does not only affect demand, but also supply since stoves cannot be produced at times when it is too humid.

Taken together, while incomes from the stove and solar business do not appear very stable, the main factors determining fluctuations at least appear predictable to entrepreneurs. In fact, sales in both businesses seem to be strongly dependent on factors that drive the overall rural economy, especially farming incomes. At the same time, a considerable share of entrepreneurs complements their business income with farming (especially stove entrepreneurs), and it is questionable whether these entrepreneurs are able to insure themselves against fluctuations in the overall (agriculture-based) local economy. Moreover, the finding that active entrepreneurs diversify their income source when taking up the business indicates that entrepreneurs become more resilient to individual-level shocks to incomes from one of their income-source (e.g. farming). Since an improved resilience against macro-level shocks is hard to achieve without a broader diversification of the overall local rural economy, it is likely that an improved diversification at the individual level is of higher relevance to the EnDev programme.

4.5 Entrepreneurship and business development

Marketing

The EnDev intervention seeks to motivate beneficiaries to adopt marketing activities in order to promote their businesses. Table 13 summarizes the marketing activities carried out by the active entrepreneurs. Three points may be taken from the table: First, the vast majority of entrepreneurs engage in some type of marketing in both components of the programme (92% of the solar entrepreneurs and 84% of the cook stove entrepreneurs). Second, solar entrepreneurs undertake promotion and marketing activities to a greater extent than cook stove entrepreneurs. For example, solar entrepreneurs are considerably more likely than cook stove entrepreneurs to use marketing materials such as posters, flyers or business cards. Third, more sophisticated marketing material is available for solar products, which is why more cook stove entrepreneurs develop and create marketing materials on their own. Fourth, in light of the considerably lower comparison group values, the project seems to have succeeded in motivating and capacitating entrepreneurs to actively promote their own business. Their share increases considerably given that there are many project beneficiaries who only use marketing material provided by the project or the company of the respective product. The overall share of entrepreneurs who produce their own marketing materials, however, does not change considerably. It thus remains to be seen after the EnDev project ended in how far entrepreneurs adopted some sort of marketing mentality and maintain a higher level of marketing in the absence of materials provided by the EnDev project.

Table 13
Promotions, marketing and record keeping

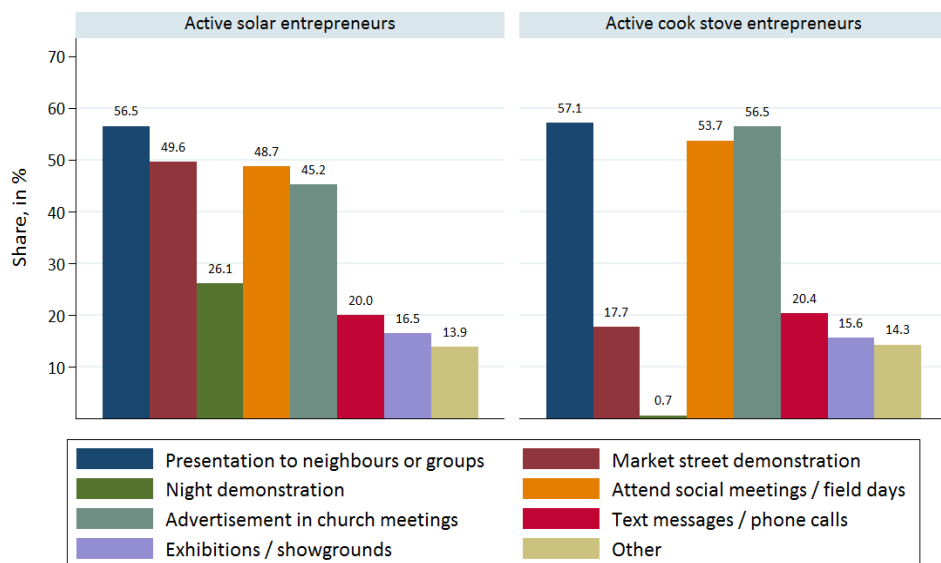
	Solar			Stoves		
	Treatment	Comparison	Difference	Treatment	Comparator	Difference
Carries out own promotion activities, share in %	92	49	43***	84	33	51***
Uses marketing materials, share in %	68	29	39***	41	15	27***
Produces any marketing materials on his/her own, share in % (of those who use marketing materials at all)	25	61	-	53	85	-
Record keeping tools used						
No accounting tool	1	30	-29***	11	46	-35***
Manual records of sales only	9	16	-7	20	13	7
Manual records of sales and further details (e.g. revenue, costs, production)	86	54	32***	69	41	27***

*Note: Treatment group is Active entrepreneurs (T1); Comparison group is new training participants (N2). Comparison group means are reweighted based on Entropy Balancing weights. *, ** and *** indicate that the coefficient is significantly different from zero on a level of 10%, 5% and 1% respectively*

Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

A breakdown of the particular marketing activities shows that solar and stove entrepreneurs follow very similar approaches (Figure 11). Social meetings, in particular field days convened for the local population and church gatherings, are especially popular besides informal meetings, where neighbours or groups are invited for a presentation of the products. More ambitious entrepreneurs also use exhibitions, text messages and phone calls to get in touch with potential customers. A major difference between stove and solar entrepreneurs is that the former less often rely on market street demonstrations, probably since it is harder to get the attention of potential customers there (this is more of a problem for stove entrepreneurs, since it takes more to expose the advantages of improved cooking). In addition, every fourth solar entrepreneur followed the advice of EnDev to conduct night demonstrations of the pico PV lamps, a strategy that is clearly not practical to market cook stoves. Male and female entrepreneurs appear to follow similar strategies (i.e., for none of the categories significant gender differences can be observed) and the diversity of marketing activities seems to have increased. In comparing the data presented in Figure 11 with the comparison group, it can be seen that solar entrepreneurs adopted further marketing approaches across the board, whereas stove entrepreneurs rather improved on localized marketing involving neighbours and church groups.

Figure 11
Marketing approaches followed by entrepreneurs



Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

Access to financial services

Table 14 summarizes information on the entrepreneurs' access to financial services that may be used to finance the business and its expansion. Given the retail nature of the business, solar entrepreneurs require an inventory of a certain size. The related larger capital requirements more often make solar entrepreneurs use commercial bank accounts and borrow money for their business, at least from informal sources such as friends or producer groups. More than half of them have at least once borrowed for their business as compared to one third of the cook stove entrepreneurs. The majority of those who borrowed for their business borrowed from a group to which they belong, some of them in connection with a group-lending micro-finance mechanism. Those who have not yet borrowed for their business mostly express their concern that repayment would be difficult, e.g. because of too high interest rates. Only few (28%) mentioned that they simply do not require a loan. The comparison group data suggests that formal banking experience for business purposes has been more prevalent among solar entrepreneurs even before the intervention.

Table 14
Access to financial services

	Solar			Stoves		
	Treat- ment	Compari- son	Differ- ence	Treat- ment	Compari- son	Differ- ence
Uses commercial bank account, share in %	81	70	10**	57	53	4
Has a separate commercial bank account for business purposes, share in %	50	40	9	24	21	3
Ever borrowed money for solar, stove other primary business, share in %	53	51	-2	34	52	-19***
Ever individually applied for a loan at commercial bank or microfinance institution for their solar, stove or other primary business, share in %	21	30	-10*	18	25	-7
Reason to not apply at commercial bank or microfinance institution, shares in % among non-apppliers						
Repayment would be difficult	37	37	1	44	52	-7
Interest rates are too high	26	32	-6	25	32	-7
Repayment period is too short	1	5	-4	8	7	2
Lack of collateral / guarantees	29	23	6	23	29	-7
Complex application procedures	20	26	-6	16	23	-8
No need for loan, sufficient money available from other sources	28	19	9	25	18	7

*Note: Treatment group is Active entrepreneurs (T1); Comparison group is new training participants (N2). Comparison group means are reweighted based on Entropy Balancing weights. *, ** and *** indicate that the coefficient is significantly different from zero on a level of 10%, 5% and 1% respectively.*

Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

Challenges

Respondents were asked to rank the three most important challenges their business faces. Table 15 lists information on different types of challenges. Since there are no significant differences to the comparison group, we only discuss challenges highlighted by active entrepreneurs. In both components of the programme, bad debts are reported to pose a major challenge to business. Among cook stoves entrepreneurs, bad debts appear to constitute the most important challenge, being ranked at least third by 49% of the entrepreneurs and ranked first by roughly one fourth. An investigation of the qualitative data shows that this includes both deferment of payments as well as full or partial default. Another major challenge for solar businesses, which may be linked with doubtful debt, is insufficient capital. While this may both be due to short-term liquidity and longer-term solvency of the business, the latter may well be the case recalling the considerable number of entrepreneurs who worry about being unable to repay their loans. This appears to be more severe among solar entrepreneurs as it proves to be difficult for many of them to gather the capital needed to build up such inventories.

Shortages of demand challenge businesses in both components of the programme. The strong seasonality of demand, which has been discussed in section 4.4, is in fact one of the three ma-

for challenges. Recalling the relevance of bad debt, it generally occurs that entrepreneurs are adversely affected by the limited liquidity of their customers. For cook stove entrepreneurs the fact that the rocket stoves are built in the customers' houses poses another main demand-side challenge: more than a third report difficulties covering long distances to their customers. Qualitative information indicates that this is mainly an issue of individual transportation considering also that input materials are mostly provided by the customers themselves. Interestingly, customer awareness and low profit margins are considered less of a problem. All in all, two types of challenges appear to stand out, which may be partly intertwined: First, a considerable number of entrepreneurs indicate to suffer from bad debt. Second, a substantial share of entrepreneurs report that a lack of capital poses a challenge to their business.

Table 15
Main challenges perceived by entrepreneurs

	Solar		Stoves	
	Most important challenge	Among three most important challenges	Most important challenge	Among three most important challenges
Not enough capital, share in %	27	46	13	26
Bad debts, share in %	16	39	26	49
Seasonality / customers can't afford the product, share in %	11	32	18	42
Distance to customers, share in %	10	22	12	38
Competitors, share in %	7	24	1	10
Customer awareness, share in %	2	14	4	17
Low profit margins, share in %	1	8	1	13

Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

The qualitative analysis suggests that mobility seems to be a particular challenge for women in the solar business. In order to expand the solar business, it is often necessary to extend one's outreach. This, however, involves travelling and even over-night stays. It was mentioned that this is a particular problem for women, as husbands might not allow such over-night stays and are hesitant about travelling in general. According to the qualitative interviews, the notion of women having to be close to home for taking care of the family seems to still persist. Only when spouses see how much income can be gained from this business, perceptions seem to change. This reluctance may be one factor why female cook stove entrepreneurs have less sales and, accordingly, experience lower income increases than their male counterparts. A gender-differentiated look at the extent of the respective market reach discussed in the previous section supports this: the reach beyond village borders is similar between the two genders, but clear differences can already be observed once the ward frontiers are crossed. For example, while 49 and 38% of male solar and stove entrepreneurs reach customers beyond their own county, the respective shares are merely 29 and 23% for female entrepreneurs. This market limitation may be one relevant factor for different outcomes between male and female entrepreneurs.

4.6 Employment quality and satisfaction

Perceived economic well-being

Beyond the quantitative assessment of impacts on income and employment conducted above, this study also seeks to find out to what extent qualitative indicators are affected by the intervention and to address the research question on perception. Respondents were asked how they perceive their economic situation, choosing from six categories ranging from very good to very bad. The current situation was also contrasted to the situation two years before the survey. The results are reported in Table 16.

Several features of the results in Table 16 are noteworthy: first, the current economic situation is generally judged as positive regardless of business type or treatment status. Across all four groups, the vast majority of entrepreneurs provide positive answers, i.e. they perceive their current economic situation as “rather good” or better. At the same time, strongly negative answers (such as “bad” or “very bad”) are only rarely given, never exceeding one tenth of the sample across all groups. Strongly negative answers, however, do frequently occur when respondents are asked about their economic situation in the past. For example, two in five participants in the cook stove comparison group provide such answers. This points to a third important feature of the table, which is that most active entrepreneurs indicate an improvement of their economic situation within the two years preceding the survey. To a lesser extent, this is also true for the comparison group (which did not yet benefit from the intervention), which entails that the difference between treatment and comparison group is not statistically significant. This implies that factors other than the intervention simultaneously exercise a strong influence on the general economic well-being of the participants. One likely explanation may be that overall economic conditions in the surveyed areas have improved during this time span.

Table 16 also reveals strong differences in perception between treatment and comparison groups. For example, treated cook stove entrepreneurs are more than twice as likely as untreated entrepreneurs to perceive their current economic situation as good or very good (49% in contrast to 23%). At the same time, the share of respondents perceiving their situation as negative or strongly negative is noticeably lower among treated individuals. In general, the current economic situation is consistently found to be perceived as more favourable among active entrepreneurs than among comparison group individuals. This is true for both types of business, though even more so with regard to the sample of cook stove entrepreneurs. This lends further support to the general impression that the intervention affects cook stove entrepreneurs more strongly than solar entrepreneurs (see Section 4.2 in particular).

However, it remains somewhat uncertain to what extent these differences in well-being may be attributed to the intervention. First and foremost, pre-existing differences in well-being must be ruled out to establish a causal interpretation. Although the reweighting procedure aims to eliminate any bias of this kind, pre-existing differences in economic well-being may prevail to some extent. In the present case, however, such heterogeneity can be further controlled for. This can be done comparing *changes* rather than *absolute levels* of well-being across groups. For this reason, the change in perception over the two years before data collection may measure the impact of the intervention more rigorously, since differences in perception that existed independently from the intervention are subtracted out. As can be taken from the table, the shift in perception is more favourable among treated individuals in either component of the programme. Yet, the differences are not strong enough to be statistically significant, thus likely reflecting instead incidental variation in the data (or that the sample size is too small to detect an effect that actually exists). This analysis is refined by only looking at individuals who

have been trained within two years before the interview. Their change in perception can be more clearly attributed to the intervention. These entrepreneurs show in fact larger increases in the perception indicator, though differences are not statistically significant (p -values of 0.18 and 0.14 for solar and stove entrepreneurs, respectively).

Table 16
Impacts on the perception of their economic situation by entrepreneurs

	Solar			Stoves		
	Treatment	Comparison	Difference	Treatment	Comparison	Difference
Perception of current economic situation						
very good or good, share in %	48	44	5	49	23	26***
bad or very bad, share in %	01	08	-7***	03	08	-5*
rather good or better, share in %	93	82	11***	89	74	15***
Perception of economic situation two years ago						
very good or good, share in %	17	18	0	22	18	4
bad or very bad, share in %	35	21	14**	20	41	-21***
rather good or better, share in %	47	46	0	57	44	13**
Current economic situation better than two years ago, share in %	77	70	7	64	58	6
Current economic situation better than two years ago, share in % (only those entrepreneurs who were not in business two years ago)	78	68	10	74	64	10
Number of Observations	118	192		149	191	

*Note: Treatment group are Active entrepreneurs (T1); Comparison group are new training participants (N2). Comparison group means are reweighted based on Entropy Balancing weights. *, ** and *** indicate that the coefficient is significantly different from zero on a level of 10%, 5% and 1% respectively.*

Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

All in all, this comparison of changes in perception provides indications that the intervention improves the well-being of its participants. The counterfactual analysis, however, reveals that these improvements are too weak to establish sufficient evidence for a clear impact of the intervention. Note that the results remain unchanged if one accounts for the subjectivity of such perception questions. People were asked to judge the situation of two fictional persons based on a brief profile in order to see whether there are fundamental differences between interviewees in what is perceived as good or bad. The answers to these calibration questions do not provide any reason for concern, as no systematic differences across the groups are found.¹⁹

¹⁹ Furthermore, respondents who participated in the intervention may generally feel obliged to report an improvement in well-being known as courtesy bias. While it was intended to minimize this risk through the formu-

Perceived quality of work

A further key quality dimension relates to working conditions. Table 17 summarizes to which degree respondents agree with various statements related to their job, and presents impacts of the intervention on perceived quality of work. The impact estimates are again based on re-weighting the comparison group using Entropy Balancing.

Table 17

Impacts on perceived quality of work, shares in %

	Solar			Stoves		
	Treatment	Comparison	Difference	Treatment	Comparison	Difference
"Proud to be working in this business"						
Agree	97	74	24***	95	75	19***
Disagree	1	3	-3	1	6	-5
"Afraid of losing job"						
Agree	23	22	2	12	17	-4
Disagree	68	62	6	79	69	10**
"Safety and health conditions are bad"						
Agree	11	20	-9	12	23	-11
Disagree	73	48	26***	67	51	17**
"I am well paid (incl. earnings from own business) for my work"						
Agree	65	51	15**	61	40	21***
Disagree	7	15	-8*	9	19	-10**
"My work allows me to have a stable economic situation"						
Agree	71	47	24***	69	44	25***
Disagree	6	6	-0	7	19	-13***
"Satisfied with working conditions overall"						
Agree	74	52	22***	76	54	22***
Disagree	4	9	-5*	3	22	-18***
Number of Observations	118	192		149	191	

*Note: Treatment group is Active entrepreneurs (T1); Comparison group is new training participants (N2). Comparison group means are reweighted based on Entropy Balancing weights. *, ** and *** indicate that the coefficient is significantly different from zero on a level of 10%, 5% and 1% respectively. Agree refers to the statements "agree" or "strongly agree" and disagree refers to the statements "disagree" or "strongly disagree".*

Source: RWI-EnDev Kenya Entrepreneur Survey 2015

Table 17 shows that the large majority of respondents report to be "proud to be working in this business". The share is particularly worth noting in the treatment groups, in which 97% (solar) and 95% (stoves), respectively, agree or strongly agree with the statement, indicating a very high degree of "ownership" or identification with the work they perform. These very high absolute values imply a significant difference to the comparison groups, even though these as well report high shares of agreement (74% and 75%, respectively). At the same time, it becomes clear that active solar entrepreneurs are to some extent concerned about unemploy-

lation of questions and a rigorous training of interviewers, such a bias cannot be completely ruled out. It would, in any case, only lead to a further attenuation of impacts.

ment: Roughly one quarter fear to lose their occupation within the next twelve months, which is almost twice as much as the fraction of cook stoves entrepreneurs sharing this concern. In general, the impact on employment security is found to be insignificant in both components of the programme.

Respondents were further asked whether they perceive the safety and health conditions of their work as bad. Across both groups of active entrepreneurs, more than two thirds disagree or strongly disagree, whereas roughly one in ten entrepreneurs agrees or strongly agrees. Participation in the intervention is estimated to significantly improve safety and health conditions: The share of entrepreneurs opposing or strongly opposing the statement that safety and health conditions are bad rises roughly from 50% to 70% in both types of business. In addition, two questions were posed in order to determine whether the objectively assessed indicators of income and income stability are also perceived by the entrepreneurs themselves. Both statements “I am well paid for my work” and “My work allows me to have a stable economic situation” receive significantly more agreement among programme beneficiaries. Overall satisfaction is high among active entrepreneurs with roughly three quarters agreeing or strongly agreeing with the corresponding statement. This is significantly more than among comparison group participants, who support this statement in slightly more than 50% of the cases. Moreover, the share of cook stove entrepreneurs indicating dissatisfaction (i.e. those who disagree or strongly disagree) is considerably reduced from 21% to 3%. This suggests that participation in the intervention most strongly improves work conditions for those who previously worked under conditions perceived as particularly bad.

Looking deeper into the data, there are no substantial differences in the positive perception levels between active male and female entrepreneurs. Still, it can be observed that impacts among females tend to be stronger for all perception indicators. Impacts on the satisfaction with their pay level and the stability of income as well as overall satisfaction with working conditions are all considerably stronger for females (not reported in table). Safety improvements are particularly strong among female solar entrepreneurs. This is in line with the impressions gleaned from qualitative interviews, that women appreciate the fact of being economically more independent.

In order to gauge the satisfaction with their workplace conditions, respondents were further asked whether they would recommend a friend to work in the business that serves them as primary source of income. Recommendation rates are high (90% or above) for both treated and untreated individuals, but even higher for the former group with rates close to 100%.

All in all, participation in EnDev intervention is estimated to significantly improve employment quality for its participants, although no impact on job security is found and potential “courtesy biases” may affect the reliability of these subjective, self-reported indicators. In general, the effect appears to be stronger for respondents who previously worked under particularly bad conditions.

4.7 Two stylized types of entrepreneurs: main-income and sideline entrepreneurs

In this section, the analysis looks at active entrepreneurs who regard the solar or cook stove business as their main source of income. For lack of existing terminology, these are referred to as main-income entrepreneurs (reflecting the fact that the data indicate that they are still deriving some share of their income from other sources). They are compared to those active entrepreneurs who perform the business only as a sideline (or secondary) income-generating activity, since they indicate to have a different main source of income. It was originally planned

to include an analysis of training participants who are not regularly attending reporting meetings into this section. Unfortunately, as discussed in Section 3, it was not possible to incentivize a sufficient number of them to participate in the surveys. According to qualitative inquiries in the field, this was mostly due to the fact that many of them have ceased to work in the respective business. Consequently, it is likely that many non-reporting individuals can be considered as programme drop-outs, rather than active entrepreneurs who simply do not report their figures.

Table 18

Comparison of main-income and sideline entrepreneurs

	Solar business		Stoves business	
	...is main income source	...is additional income source	...is main income source	...is additional income source
Age, mean	35.6***	43.1	40.0***	45.7
Share female, in %	55	48	56*	41
Education, shares in %				
secondary school or lower	59	58	86	91
college or higher	39	39	11	09
Previous main source of income, share in %				
farming	37*	21	57	43
student, retiree or household work	1***	24	8	15
Number of income sources, mean	2.3***	3.0	2.3*	2.5
Monthly personal total net income, in KSh	23759	31690	19552	17761
censored, in KSh	17376	20026	14437	16859
Contribution of business to personal total net income, in % of income	60***	28	60***	42
Sales in average month, in KSh	30296	25924	11727	11794
Days per week spent on business	4.6	4.8	3.2	3.6
Hours per day spent on business	6.9	7.3	5.7	5.8
Member of a group or cooperative, share in %	5	15	30***	54
Current economic situation perceived as good or very good	51	46	56***	33
Number of observations	85	33	103	46

*Note: *, ** and *** indicate that the coefficient is significantly different from zero on a level of 10%, 5% and 1% respectively. "Censored" variables omit values within or above the interval containing the 95th percentile. The 95th percentile is calculated using the unweighted data of both treatment and comparison group. Mean income is calculated by matching each interval to a weighted average of its bounds.*

Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

There are two reasons that make it insightful to compare active entrepreneurs for which their business is the *main* source of income to entrepreneurs who perform the respective business as a sideline business. First, it provides information on whether the two groups differ in their business outcomes and behaviour. Second, factors that are correlated with the decision to fully shift towards the solar or stove business can be identified. That is, this procedure describes subgroups of active entrepreneurs for which the intervention appears most effective in the sense that these groups are more likely to *fully* adopt the business.

Table 18 lists various indicators separately for both groups of active entrepreneurs. Interestingly, entrepreneurs who perform their business as main income-generating activity are found to be noticeably younger (5-8 years in both components of the programme) and somewhat more often female. At the same time, the extent to which the intervention shifts income sources does not seem to depend on educational attainment. In line with the above finding regarding the diminished relevance of farming, entrepreneurs who primarily relied on farming before appear more likely to take up the respective business as the main source of income. At the same time, however, participants out of the labour force (such as students, retirees or household workers) appear to be somewhat less likely to fully take up the respective business, possibly because they find alternative opportunities or because they have more difficulties in establishing a sustainable business.

As expected, the share of income that is derived from the solar or stove business is significantly larger among entrepreneurs who refer to the respective business as their main source of income. However, in contrast to expectation, there is no evidence that main-income entrepreneurs in either technology report significantly higher sales, or significantly more time spend in their business. Furthermore, after controlling for outliers, these entrepreneurs do not seem to report a larger overall personal income. The higher contribution of the business to an overall similar (if not smaller) income under similar working time at the business has to imply that other sources are rather dismal. This may underline the conjecture that those who adopt the business as their main source of income simply have fewer other sources, instead of a larger business potential. At least, it seems that cook stove entrepreneurs who obtain their main income from the business are considerably more satisfied with their current economic situation than those who produce cook stoves as a side-line business.

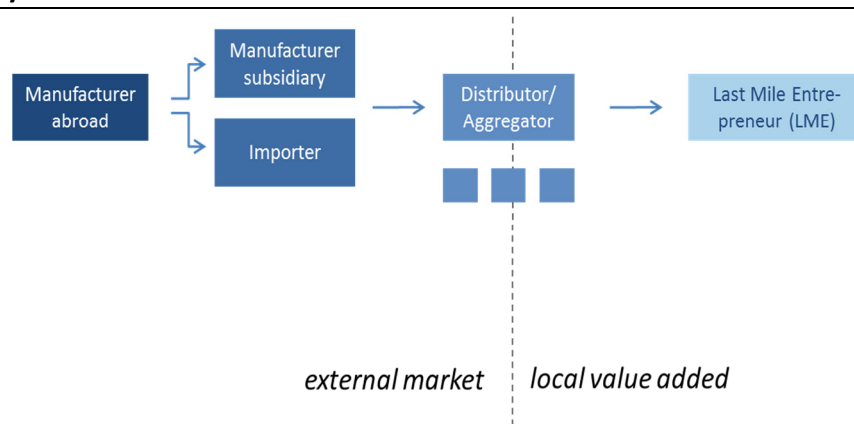
Taken together, the data provide some indication that the decision to regard the stoves/solar business as a main source of income does not much depend on the business prospects (e.g. the size of sales and income which is possible) but rather depends on outside options available to entrepreneurs (e.g. the opportunities of other income sources) and their entrepreneurial drive. Said differently, the analysis suggests that individuals who are very dependent on a single, low-potential income source at the beginning of the training – such as agriculture – are more likely to pick up the respective business in full. This will have to be further explored in the longitudinal impact assessment.

4.8 Further actors along the value chain

This section aims to shed some light on other actors that are involved along the value chains of the solar and stove components of EnDev-K. That is, it discusses ‘secondary’ actors upstream or downstream of the ‘primary’ entrepreneurs that are the focus of this study. Instead of interviewing secondary actors directly, it was decided that surveyed entrepreneurs would be asked for how they source the inputs and at which prices.

In the case of the solar value chain, most local value addition is expected among the entrepreneurs themselves and their network of retailers (if existing, see Figure 12). Since all pico-PV products currently sold through EnDev entrepreneurs are developed and produced abroad, the focus is on importers and distributors from which entrepreneurs source their products as well as potential resale agents.

Figure 12
Stylized value chain for Pico-PV



Source: Own representation.

Table 19 shows that most solar entrepreneurs source their products directly from national distributors or their local agents. Few entrepreneurs involve other local retailers or entrepreneurs as intermediaries. In effect, this is an intended outcome of the EnDev programme, which involves distributors in their training and connects entrepreneurs with direct sources for products. At the same time, it seems that most solar entrepreneurs rely strongly on one specific source for products: More than 80% buy their products only from these channels and, in addition, the majority of solar entrepreneurs report that they each source their products from only one (not necessarily the same) individual supplier (not reported in the table).

Table 19
Regular suppliers for entrepreneurs, in %

Solar		Stoves	
Local dealers / agents of distributors	40.5	Metal/hardware shops	53.7
National distributor	57.2	Liner producers	56.5
Other solar entrepreneurs	17.1	Other	17.3
Retail shops	8.5	Sand, clay or brick providers	56.5
Share of solar entrepreneurs with multiple supplier types	19	Share of stove entrepreneurs with multiple supplier types	45

Note: Multiple answers allowed for regular supplier types.

Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

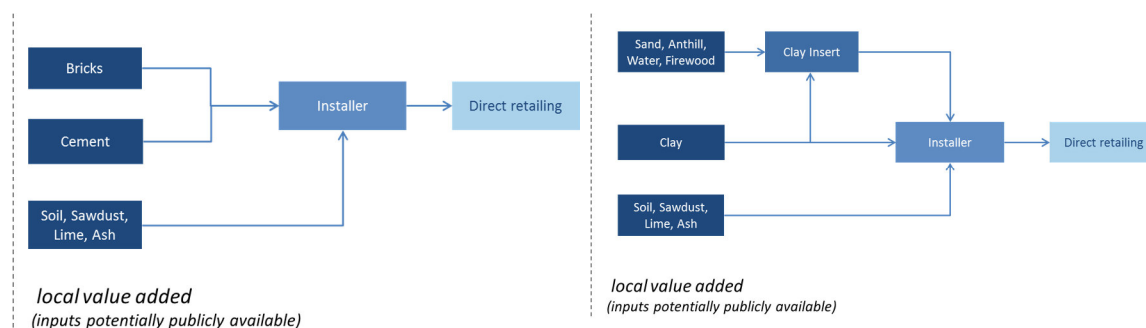
Two types of stoves are currently covered under the EnDev programme: Fixed Rocket stoves and Jiko Kisasa stoves. For the matter of comparability and sample size, the quantitative impact analysis focuses mainly on Rocket Stove entrepreneurs.²⁰ These stoves are constructed on-site from locally available material (mainly bricks, sand and cement), which are provided by the clients. In some areas under the EnDev programme, Rocket Stoves are constructed using a clay-based body plus a fired clay insert (Figure 13). The evaluability assessment (RWI 2015b) showed

²⁰ However, some existing entrepreneurs in the sample were also active in Jiko Kisasa stove production. In fact, 42 of 143 existing stove builders who answered the question on the types of stoves they sold in the last month also sold Jiko Kisasa stoves, and 13 of these only sold Jiko stoves. The findings reported in this report do not change when excluding surveyed Jiko Kisasa producers.

that in both cases, the added value is often strongly concentrated on trained stove builders, who in many cases produce liners or source materials for construction.

Figure 13

Typical value chains for Brick Rocket Stoves and Clay Rocket Stoves with insert



Source: Own representation.

Still, as can be seen from Table 19, a substantial share of stove producers does involve other actors along the value chain. In fact, many stove entrepreneurs appear to source inputs from several other actors equally. Among 126 stove builders who answered this question, only 17% said that they were not sourcing from any of these input suppliers. They get the inputs themselves (e.g. from clay deposits) or from their customers. More than half report to source from two or more different channels. However, as in the case of solar, most stove entrepreneurs only source from one or two actors for each type of input.

Table 20

Resellers among entrepreneurs' distribution network

	Solar			Stoves		
	Treatment	Comparison	Difference	Treatment	Comparison	Difference
No Resale Agents, in %	52	63	-11*	70	57	13*
Share selling to at least one of the following resellers, in %						
individual	35	32	3	27	38	-11
retail shops	15	9	6	5	4	1
groups	18	8	10**	9	6	3
institutions	12	5	7*	6	5	1
Number of resellers in total						
mean	3.55	3.34	0.21	1.70	1.45	0.25
median	0	0	0	0	0	0
Share of sales through resellers, in %	14.8	13.0	2	10.3	18.7	-8.4**

Note: Treatment group are Active entrepreneurs (T1); Comparison group are new training participants (N2). Comparison group means are reweighted based on Entropy Balancing weights. *, ** and *** indicate that the coefficient is significantly different from zero on a level of 10%, 5% and 1% respectively.

Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

Table 20 shows the degree to which entrepreneurs and individuals in the comparison group distribute their products via other retail agents, who thus indirectly profit from their business activities. In line with expectations, there are more solar entrepreneurs who engage with some

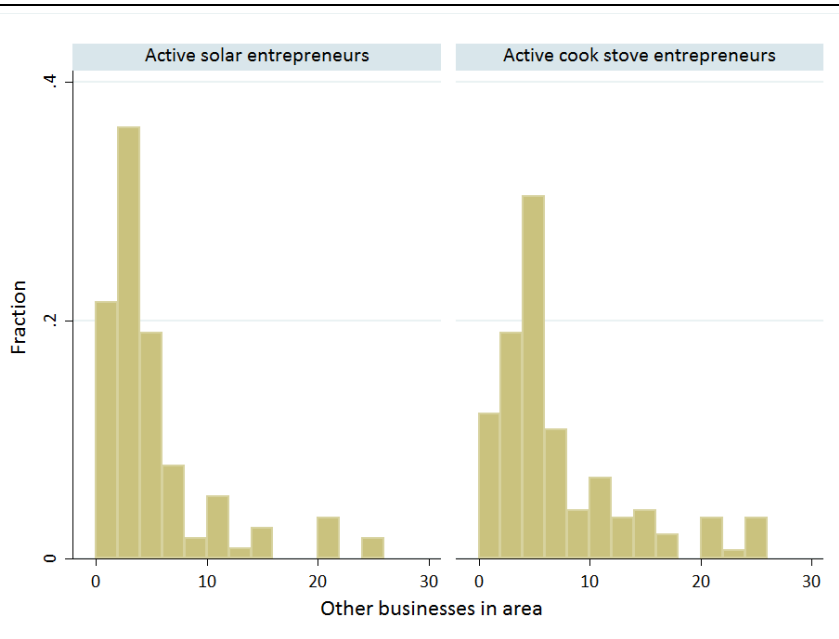
reseller. Overall, the share of sales through resellers is relatively low. The data of the comparison group indicate that solar training participants are already involved more frequently in retail, which naturally involves networks of resellers. The types of distribution channels only vary slightly between the solar and cook stove businesses. Even though most entrepreneurs are engaging individual resellers, solar entrepreneurs appear somewhat more diverse in the types of resellers they engage with, e.g. regarding resale through groups and retail shops. The most striking gender difference in reseller networks is that a few males manage to build up networks of 20 resellers and more, which is only the case for one female solar entrepreneur.

The survey also tried to shed some light on potential displacement effects induced by the EnDev intervention. Among others, it was asked for stove or solar businesses in the area where the entrepreneurs sell their products. Figure 14 shows that almost all entrepreneurs report that competitors are active in the market, usually around 3 for solar and 5 for stove entrepreneurs. Hence, some degree of substitution has to be expected if trained entrepreneurs reduce sales from active stove or solar entrepreneurs. However, this information can only provide a very rough indication of displacement effects.

In general, the survey shows that most stove and solar entrepreneurs are often engaged with other actors along the value chain. However, local value addition seems much less in the solar business, where a majority of entrepreneurs source products from one single retail agent, which is often the national distributor (in Nairobi). In addition, Rocket Stove entrepreneurs apparently sell a larger share on their own account, without further local intermediary agents.

Figure 14

Number of competitors in entrepreneurs' sales areas



Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

5. Baseline quality for longitudinal impact analysis

As discussed in section 3.2, the identification strategy of this impact analysis aims to extend the short-term cross-sectional results by a more rigorous difference-in-differences approach based on longitudinal data, i.e. data collected at baseline (before programme participation) and

follow-up. To this end, the data collected among the current comparison group of new training participants equally serve as baseline data for treated individuals in the longitudinal analysis. The main advantage compared to the sample group of active entrepreneurs is the possibility to observe new training participants at the time of business start-up. Active entrepreneurs are therefore not an integral part of the sample used for the longitudinal analysis.

Instead, the comparison group for this longitudinal analysis, which remains non-treated until follow-up, will be comprised of mobilized non-participants (see Figure 3 in Section 3.2). The longitudinal treatment group will consist of Newly Trained Entrepreneurs (T2).²¹ This section discusses the prospects and risks for the longitudinal impact analysis in light of the baseline data collection for both groups. A main issue is the comparability of the longitudinal treatment group of New Training Participants (N2) and this longitudinal comparison group of mobilized non-participants (N3n). In addition, the quality of a baseline and the feasibility of a longitudinal impact analysis depend on the consistency and completeness of the collected data and a few further aspects discussed below.

Comparability of mobilized non-participants (N3n)

Comparability between new training participants and mobilized non-participants as the comparison group for both EnDev-K components is discussed separately. Table 21 provides socio-demographic characteristics for solar entrepreneurs and mobilized non-participants. Participants of the comparison group are not disaggregated by the type of business training for which they were originally mobilized (stove or solar), as they will potentially serve as an overall pooled comparison group for new training participants in both components.²²

As can be seen from the table, there are significant differences between both groups: While both groups display a similar age structure (see also Figure 15) and a similar gender composition, education turns out to be significantly lower among mobilized non-participants, with a significantly larger share of low-educated individuals and a smaller share of college graduates (see also Figure 16). Moreover, basic household characteristics (such as size, marriage status and household composition) are similar in both groups. But regarding economic household characteristics (such as property, flooring and electricity supply), differences between active entrepreneurs and the mobilized non-participants can be observed: Compared to the former, mobilized non-participants are generally almost only half as likely to own specific assets (such as a car/motorcycle or a fridge) and few are connected to electricity (only 14% of them connected to grid).

²¹ As discussed in Section 3.2, there will be a difference between New Training Participants (N2) and Newly Trained Entrepreneurs (T2) because some training participants may not start a business (D2). While information on drop-outs among new training participants is not available for the current report, this should be the case in the near future. The longitudinal analysis will thus be able to account for drop-outs.

²² Whether it is appropriate to pool stove and solar participants or whether they should better be treated as separate comparison groups will be scrutinized in the upcoming longitudinal impact report in 2016.

Table 21
Descriptive statistics on solar entrepreneurs

	New training participants (N2 Solar)	Mobilized non-participants (N3n)
Age		
Average age	36.6 (11.9)	36.4 (12.4)
Share younger than 25, in %	17.7	21.9
Share older than 49, in %	15.1	16.1
Gender		
Share female, in %	48.4	53.6
Education		
Share primary education or lower, in %	23.5	34.3***
Share secondary education or lower, in %	65.6	85.2***
Share university or college, in %	33.9	12.9***
Household		
Average size	5.2 (2.7)	5.1 (2.6)
Share married†, in %	76.6	72.3
Share with children, in %	77.1	76.9
Share with car or motorcycle, in %	27.1	18.8*
Share with electricity, in %	39.6	22.9***
Share with earth/ mud flooring, in %	38.5	65.6***
Employment and Income		
currently earn income, in %	90.1	82.7**
unemployed, in %	3.1	5.8
Personal total net income, mean in KSh	16396	11851**
Personal total net income, median in KSh	11667	5000
Entrepreneurship		
Share performing business as		
individual, in %	69.0	94.6***
employee, in %	21.8	2.1***
enterprise owner, in %	10.3	2.3***
Share received other training, in %	56.3	44.1**
Other entrepreneurs in household, share in %	58.0	48.3*
Observations	192	156

*Note: The mean age is calculated by matching each age category with the mean of its boundaries. A mean age of 15 is assumed for the lowest category and a mean of 65 for the highest. (†) Also contains divorced and widowed respondents. *, ** and *** denote whether the difference to the group of new training participants is significant on the level of 10%, 5% and 1%. Standard deviations for continuous variables in parentheses.*

Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

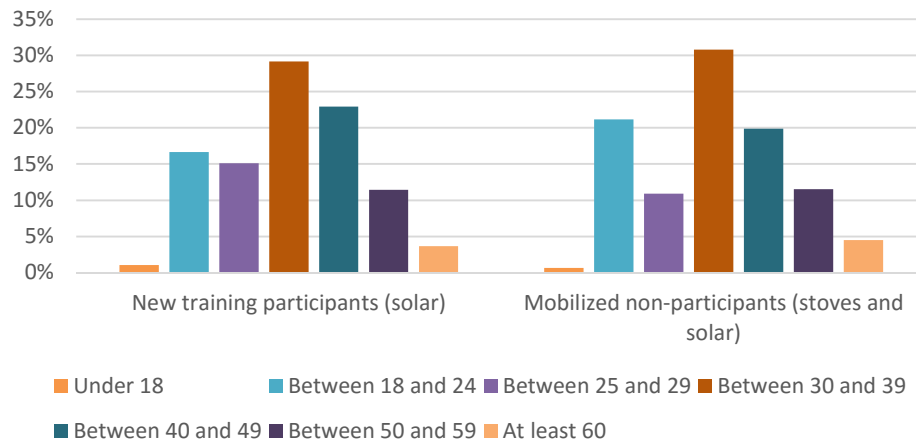
Most importantly, the two groups display significant differences in (some of) the baseline outcomes for which impacts will be assessed at follow-up. Specifically, a larger (but still relatively low) share of mobilized non-participants currently does not earn an income and, consequently,

Employment and income Effects on EnDev Kenya

average incomes are significantly lower. Incomes differ even among individuals in both groups which currently do earn an income. The overwhelming majority of mobilized non-participants are currently self-employed, and rarely any of them are enterprise owners or employees, as it is more frequently the case among new training participants. These differences observed in education appear to be to some extent non-random, which must be taken into account in the subsequent longitudinal impact analysis.

Figure 15

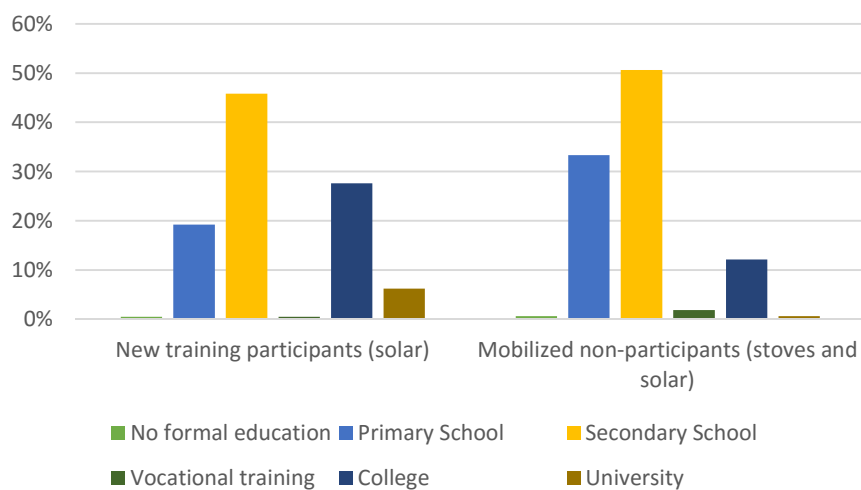
Age composition of new *solar* training participants and mobilized non-participants



Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

Figure 16

Educational attainment of new *solar* training participants and mobilized non-participants



Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

Table 22 mimics the previous table in that it compares new stove training participants to the (pooled) sample of mobilized non-participants.

Table 22

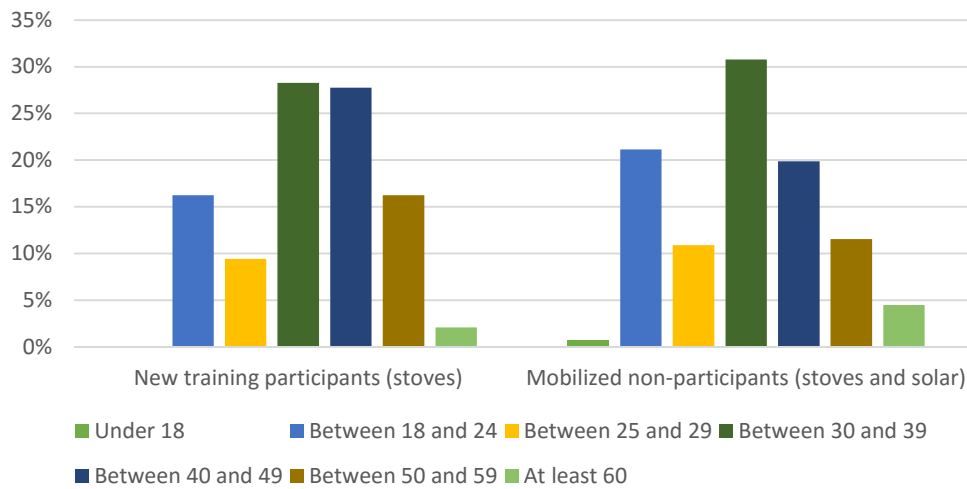
Descriptive statistics on cook stove entrepreneurs

	New training participants (N2 Stoves)	Mobilized non-participants (N3n)
Age		
Average age	38.3 (11.6)	36.4 (12.4)
Share younger than 25, in %	16.2	21.9
Share older than 49, in %	18.3	16.1
Gender		
Share female, in %	64.7	53.6**
Education		
Share primary education or lower, in %	52.6	34.3***
Share university or college, in %	6.9	12.9*
Household		
Average size	5.9 (2.7)	5.12** (2.6)
Share married†, in %	82.2	72.3**
Share with children, in %	83.3	76.9
Share with car or motorcycle, in %	10.6	18.8**
Share with electricity, in %	14.7	22.9**
Share with earth/ mud flooring, in %	73.8	65.6*
Employment and Income		
% currently earn income	81.7	82.7
% unemployed	2.6	5.8
Personal total net income, mean in KSh	9313	10796
Personal total net income, median in KSh	5000	5000
Entrepreneurship		
Share performing business as		
individual, in %	89.2	94.6
employee, in %	3.2	3.1
enterprise owner, in %	1.9	2.3
Share received other training, in %	39.7	44.1
Other entrepreneurs in household, share in %	54.4	48.3
Observations	191	156

*Note: The mean age is calculated by matching each age category with the mean of its boundaries. A mean age of 15 is assumed for the lowest category and a mean of 65 for the highest. (†) Also contains divorced and widowed respondents. *, ** and *** denote whether the difference to the group of new training participants is significant on the level of 10%, 5% and 1%. Standard deviations for continuous variables in parentheses.*

Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

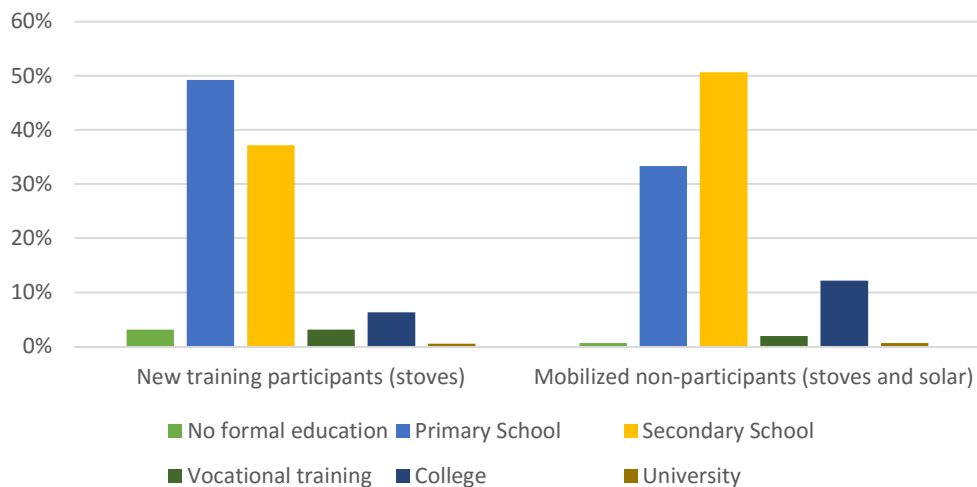
Figure 17
Age composition of new *cook stove* training participants and mobilized non-participants



Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

As in the case of the solar component, Figure 17 shows that the age structure of new cook stove training participants and mobilized non-participants appears comparable. Gender composition and education outcomes, however, are different between both groups. This observation is further underpinned by Figure 18, which depicts educational attainment by sample group. The observed differences largely relate to the specific characteristics of new stove training participants, which may be related to the mobilization mechanism, as discussed in section 4.1. Furthermore, there are differences in household characteristics, i.e. a larger household size on average, more children and very little economic assets (e.g. motorbike, fridge, concrete flooring and access to electricity). Again, this is likely related to specificities of the sample of new stove trainees. In contrast to the case of solar entrepreneurs, both groups do not appear to differ with respect to their current employment and income situation.

Figure 18
Educational attainment of new *cook stove* training participants and mobilized non-participants



Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

In conclusion, there are significant differences in the comparison group of mobilized non-participants vis-à-vis new training participants in both components. In general, differences between all groups appear less related to socio-demographic characteristics, but rather to economic status. In that regard, observed differences depend on the group to which the mobilized training participants are contrasted: In comparison to new solar trainees, they appear less educated and show worse baseline economic outcomes such as assets and income. In comparison to new stove training participants the mobilized group actually displays more favourable baseline outcomes with respect to education and assets.

In contrast to the cross-sectional impact assessment, however, the longitudinal analysis does not necessarily demand that treatment and comparison groups are identical at baseline. In fact, one of the biggest advantages of the difference-in-differences approach will be that observed differences between treatment and comparison group can be accounted for in the statistical analysis. The key assumption here is not baseline equality but only what is known as the “parallel trend” assumption, which posits that the average *change* in the comparison group represents the counterfactual change in the treatment group if there were no treatment. The results are robust to any possible confounder as long as it does not violate the parallel trend assumption. Whether this is the case will be scrutinized more extensively as part of the longitudinal analysis, together with an assessment of drivers for potential differences at baseline.

To conclude, the meticulously implemented approach of selecting a comparison group for the longitudinal analysis succeeded in capturing some of the self-selection inherent to the participation in trainings as those offered by EnDev-K. It is expected that the proposed methodology will be able to cope with remaining differences.

Data consistency and completeness

The detailed investigation of the data did not reveal signs of systematically missing information. Only two questions were accidentally skipped for part of the interviewees, leading to a loss of information for 10% of the sample for one of the two variables. This is still a very positive result given a total of almost 400 variables collected in this study, the complexity of the questionnaire, and its routing that was necessary to capture the diversity of employment conditions of people in the field. Beyond that, response rates appear high even for personal and sensitive questions: all income-earners in the sample provide detailed information on their sources and level of income. For example, for only 34 out of 809 individuals who reported to earn an income answers to the question on the level of income are missing (incl. cases where individuals could not or did not want to answer). Information on individuals’ characteristics could be successfully obtained in virtually all cases – response rates never drop below 95% for demographic questions at the end of the interview. Further, initial consistency checks across related variables did not detect any sign of inconsistent answering behaviour.

The data mirror properly the information that was intended to be collected

Generally, entrepreneurs were very eager to give the enumerators information on their business and livelihood. Yet, it turned out to be important that enumerators reiterated beforehand that there are no wrong or right answers in this survey. This minimized the risk of receiving answers of the interviewees, which they perceived as the “right” or “desired” answers for the enumerator and the study. Enumerators also managed to overcome this by explaining again that the survey is simply about finding out more about the interviewee, rather than a test.

Traceability of drop-outs

Beyond rigorously evaluating income and employment impacts, the second main goal of the longitudinal analysis is a drop-out assessment (see Table 1 in Section 3.2). Tracking drop-outs among previously trained entrepreneurs proved difficult in the data collection wave in 2015. It will thus be important to adopt a convincing strategy that incentivizes drop-outs among training participants to participate in the follow-up survey. This will likely work out given that interviewers have already been in touch with them and collected extensive contact information from interviewees, including the name and mobile number of a close person who is not member of the respondent's household.

Will the longitudinal comparison group (N3n) remain untreated until follow-up?

An important requirement for the feasibility of the longitudinal impact analysis is that members in the comparison group of mobilized non-participants do not take part in any other training on cook stoves or solar until follow-up data collection. Aware of this issue, counties were selected with little activities related to solar and cook stove business trainings. Researchers from RWI and SERC contacted government officials and NGOs in the respective counties during the preparatory phase of the 2015 survey in order to elicit current and prospective activities on solar or stoves. Nonetheless, since trainings cannot be ruled out, the follow-up survey will collect information on training participation during the past year.

Mobilized non-participants may similarly take up the respective business even without the training. As discussed in Section 3, the comparison group was mobilized through a short local sensitization campaign including a meeting at which the survey and lottery took place. Though it is expected that a thorough training would be necessary, there is some risk that this sensitization induced mobilized non-participants to take up the respective business. In any case, the analysis will again be able to test this assumption by collecting information about business activities during the past year.

6. Summary: Answers to the evaluation questions

This section provides a summary of the findings of the impact evaluation by giving point by point answers to each evaluation question as they are formulated in the Terms of Reference underlying this study. The evaluation questions focus on the three results dimensions of outcomes, impacts, and further actors along the value chain, and have been listed in Section 3.1. The corresponding sections in the report provide details of the main findings summarized here.

6.1 Outcomes

1. Did the business and marketing behaviour of trained entrepreneurs improve?

In the absence of information on pre-intervention business knowledge and marketing activity of active entrepreneurs (which would have allowed a pre-post comparison for that group), the analysis uses data on the newly recruited training participants to answer this question. The results indicate that the intervention was successful in motivating beneficiaries to adopt and diversify marketing activities in order to promote their businesses: the large majority of both solar and stove entrepreneurs engage in some type of marketing, with solar entrepreneurs being even more active than cook stove entrepreneurs. In both groups, the shares are two to three times larger than in the comparison group. Active entrepreneurs also seem to have become more professional in their business, a fact that is for example reflected in a significantly higher share of people who keep records for their

business, not least records that go beyond sales only. The use of commercial bank accounts has slightly increased, whereas borrowing money for their business is not strongly affected. The comparison group data particularly suggests that formal banking experience for business purposes has been more prevalent among solar entrepreneurs even before the intervention.

2. Do training participants start a business (or expand their existing business) in the respective technology? Which factors are associated with successful business start-up and/ or drop-out?

The training strongly induces participants to take up a business in the respective technology. Essentially 100% of active entrepreneurs – in either technology – report that the new business is one of their income sources (up from around 12% in the comparison group). Moreover, the new business has also become an important income source: in fact, it is considered the main source of income by 70% of active entrepreneurs in either business (the respective share in the comparison group is 7%). Most entrepreneurs complement this income with other sources, mainly agriculture. At the same time, there is a large variation in the reported level of sales and customer numbers, especially among solar entrepreneurs, indicating that most entrepreneurs report small or moderately large figures, while a small number of entrepreneurs sell a large number of products and serve a large number of customers. Interestingly, the size of the business in terms of sales and customers does not seem to determine whether active entrepreneurs regard the business as their main source of income; it is rather the availability of alternative income sources that appears to be an important factor associated with starting and continuing a business.

In order to assess additional factors associated with successful business start-up or drop-out, a longitudinal data collection would be required. That is, information that follows training participants over time and traces their business success or propensity to discontinue the new business. Indicative information from the monitoring system suggests that about 20-30% of training participants subsequently attend monitoring meetings, which can serve as a coarse indicator of the success rate.

3. What are potential constraints for business start-up and expansion (e.g. access to finance, lacking or fluctuating demand)?

Strong seasonal patterns characterize the local labour markets in which the intervention operates, and these patterns also influence the entrepreneurs in both technologies. In fact, pronounced seasonal fluctuations in demand are reported to be a major challenge for most entrepreneurs, and especially for stove entrepreneurs (49% rank this seasonality among the three major challenges). The data cannot fully disentangle, however, whether this acts as a constraint to business start-up or expansion, though likely both are affected. Another common challenge is “bad debts”, related to deferment of payments as well as full or partial default by the customers. In contrast, lack of customer awareness or other competitors are rarely reported as constraints. In line with the typically higher capital demand in the solar business, a lack of capital is also a common challenge among solar entrepreneurs. Against this background, trainings could prepare entrepreneurs specifically to deal with deferment of payment by customers, include some aspects of stock-keeping and inventories to secure themselves against lack of cash, so they can keep the business running.

Qualitative evidence furthermore suggests that the local markets for both solar and stoves may be quickly saturated. In this regard, more than half of entrepreneurs in both busi-

nesses report to regularly sell outside their sub-county, and many indicate that distance to customers is an issue for their business.

6.2 Impacts

At the impact level, the analysis focuses on the employment and income impacts on EnDev-trained entrepreneurs who started or expanded a business in the respective technology and report their sales to EnDev-K.

1. What is the impact on the employment situation of EnDev-trained entrepreneurs in terms of the status in employment as well as quantitative and qualitative dimensions of employment?

The quantitative impact of the intervention on employment status is small, since only few entrepreneurs (less than ten percent) did not have an income-generating employment before. Most of those were students or doing household work. The two technologies, however, appear to bifurcate entrepreneurs into two broad business models: On the one hand, solar entrepreneurs generally work as own-account workers, without additional employees. Stove entrepreneurs, on the other hand, more often work as self-employed individuals with additional employees and/or as a member of producers groups. In terms of hours of work, the data indicate an increase in total working time induced by the intervention; i.e. the overall effort dedicated to the labour market appears to rise – this may be a motivational effect to some extent, and given the shift in income source composition (see question 2 on “outcomes” above) and the rise in income (see next question) this can also be interpreted as an increase in the quality of working effort dedicated to the market. In line with this finding, active entrepreneurs are significantly more likely to perceive their economic situation as good or very good than the comparison group.

2. Did adoption of the respective business lead to changes in individual income? Do active entrepreneurs contribute a higher share to overall household income and does this lead to higher household-level income as well? Which individual- and business-level characteristics are associated with an increase in individual- and household level income?

The main results point to a differential impact of the intervention by component: For stove entrepreneurs, the impact on personal overall net income is large in magnitude, especially for male entrepreneurs. According to the study’s main impact estimate, active entrepreneurs are able to increase their monthly personal net income from 7530 to 13740 KSh (i.e. 55%) by adopting the stove business. In contrast, no significant impact can be found for solar entrepreneurs, neither males nor females. This is also reflected in the impact on (approximated) household-level income. This relative perspective shall, however, not disguise that in absolute terms solar entrepreneurs gain higher incomes than cook stove entrepreneurs. At baseline people starting the cook stove business tend to earn considerably less and to be poorer in general as compared to people who envisage becoming solar entrepreneurs. This likely relates to the fact that one of EnDev’s selection criteria for the solar component requires prospective entrepreneurs to already follow a profit-oriented activity, which is not the case for cook stoves. There is furthermore a large variety in sales and thus earning potentials meaning that most entrepreneurs achieve small or moderately large figures, while a small number of entrepreneurs sell a large number of products and serve a large number of customers.

These impacts are in line with monthly profits reported by entrepreneurs. Even though solar entrepreneurs report much larger sales figures and revenue, it seems that average

monthly profits do not differ strongly between both businesses once the business nature (reflected in the difference in per-unit mark-ups) is taken into account.

3. Income diversification: Did the new business replace or complement the existing income sources of active entrepreneurs (in terms of relevance of income source and time)? Which (individual-level) factors influence whether training participants take-up the respective business as their main source of income?

The findings demonstrate the ways in which active entrepreneurs use the new business opportunity to diversify their income sources: While the majority of trainees adopt the business as their main source of income, few give up existing sources of income, but rather increase working hours. Only 4% and 9% of stove and solar entrepreneurs, respectively, report the respective business to be the only income source, compared to 39% and 55% in the comparison group. In this line, the analysis observes a reduced reliance on this single source of income: The average entrepreneur derives around half of her/his income from what they consider their main source of income (which is their business for around 70% of entrepreneurs) - which is considerably less than in the comparison group. This is an important finding with regard to the effectiveness of the intervention, as the additional income may insure entrepreneurs against idiosyncratic shocks to one of their income source. In particular, the intervention appears to reduce the dependence on agriculture for income-generation. This effect is particularly pronounced among cook stove trainees and those who have few other opportunities for income-generation. However, most respondents do not give up farming entirely in favour of the solar or the cook stove business.

4. Income stability: To what extent can sales from existing businesses provide a stable source of employment and income to entrepreneurs (or counter-balance fluctuations in other income-generating activities, specifically agriculture)?

The empirical analysis indicates that sales are strongly volatile: across both businesses, the large majority of entrepreneurs' reports that sales in the lowest-sales month amount to 50% or less of the sales in the highest-sales month. To this extent, the solar and stove businesses do not appear to provide a source of income that is substantially more stable than other sources. At the same time, however, at least some factors that determine variation in income generation appear relatively predictable to entrepreneurs: in fact, fluctuations are mostly related to the seasonality in the agriculture-based rural economy and specific events, such as holidays or school fees.

Overall, the strong dependence of demand and sales on the agricultural-based economy has its downside, considering that a considerable share of entrepreneurs continues to rely on farming as one of their income sources; and hence it is unlikely that they can counter-balance these strong fluctuations with incomes from other sources. This is specifically the case also for the following reason: while the income source diversification induced by the new business does reduce the susceptibility to seasonal agriculture shocks for the individual entrepreneur (because he/she diversifies away from agriculture), he/she would still be affected by adverse agriculture shocks through a decline in demand for their products.

One implication of these findings is that the trainings or monitoring meetings could be specifically used to advice entrepreneurs how to foresee and insure themselves against seasonal fluctuations in their income generation.

5. Perception: Do active entrepreneurs perceive improvements in their employment situation and overall economic well-being?

In line with the impact on personal and household-level incomes, the impact analysis of subjective indicators indicates that the intervention improves the well-being of training participants. Moreover, the intervention is estimated to significantly improve employment quality for its participants. This impact is sizeable and significant for entrepreneurs in both the solar and cook stoves component. At the same time, there is no significant impact on perceived job security, which may be related to the strong seasonality in demand and sales.

6.3 Further actors along the value chain

1. Do active entrepreneurs create additional employment within or outside their business? What are the types and attributes of this employment?

The data show that additional employment creation, in terms of regular employees, is much more common among cook stove employees. In fact, 63% of stove entrepreneurs have had at least one employee in the last three months. Solar entrepreneurs, in contrast, rarely engage additional employees other than family members. Instead, they are more likely to engage other independent resellers (who are own-account workers themselves). But even among solar entrepreneurs the share of products sold through resellers is rather low. Moreover, few solar entrepreneurs involve other local retailers or entrepreneurs as intermediaries, but rather source their products directly from national distributors.

An additional result of the analysis is that employment in the cook stove business seems to mostly involve temporary, rather low-paid jobs. Even when accounting for employment type, the reported median weekly wages in the solar business are higher than in cook stove business.

2. What is the likelihood that active entrepreneurs displace existing business in the local economy?

Even though only few entrepreneurs regard other competitors as an important challenge to their business, almost all entrepreneurs report that competitors are active in the market (usually around 3 for solar and 5 for stove entrepreneurs). Hence, some degree of substitution has to be expected, if trained entrepreneurs reduce sales from stove or solar entrepreneurs already active in the market. At the same time, it is not clear whether these entrepreneurs are selling non-improved cook stove or counterfeit solar products, and hence some form of quality-improving displacement may, at least, be considered an acceptable side-effect of the intervention.

6.4 Gender

1. Which differences in business performance exist between male and female entrepreneurs? How can these differences be explained?

For starters, it is remarkable that there is a fairly even balance of male and female entrepreneurs in both technologies. Females make up 52% of the sampled active entrepreneurs. Income impact estimates, however, show a sizable gender gap. Females start out from clearly lower pre-intervention levels than males and stove entrepreneurs from clearly lower levels than solar entrepreneurs. In consequence, male solar entrepreneurs have by far the highest pre-intervention incomes, which seems to limit their earnings potentials from the EnDev intervention. Different from female solar entrepreneurs, they do not earn more than before. Female solar entrepreneurs are thus more successful in closing the ini-

tial gender gap but still earn 25% less than their male counterparts. This gap amounts to 40% for stove entrepreneurs.

First of all, this can be explained by women having lower sales and less income sources in both technologies, and by the fact that they work fewer hours on income generation (around 10% in both businesses), potentially because they simply have more duties beyond income generation than men. Women entrepreneurs follow similar marketing strategies and there is no sign of any gender preference of customers. Still, males seem to be more successful in building up larger reselling networks and particularly achieve a higher reach and thus a larger potential customer base: though the reach beyond the individual entrepreneur's village is similar across the sexes, there are already clear differences once one leaves the respective ward. Eventually, males are 70% more likely to have customers beyond their county borders.

Despite these persisting gender differences in relative income, improvements in the perception of employment quality tend to be slightly stronger among females, particularly safety. Females in general distinctively appreciate their higher economic independence.

7. Conclusion

This report presents an impact assessment of EnDev interventions in Kenya. It focuses on two components: training, mentoring and support for small-scale entrepreneurship in i) improved cook stoves production of so-called Rocket stoves and ii) pico-solar retailing. As a basis for the quantitative impact analysis, extensive survey data were collected between June and August 2015 among 898 current and prospective entrepreneurs in both businesses. These cross-sectional survey data allow for first rigorous insights into the employment and income impacts of interventions to establish energy-related value chains in a developing country. They also generate the basis for a more precise impact assessment, if follow-up data were to be collected in 2016-17. The quantitative survey data are complemented by semi-structured interviews with a subsample of training participants and other programme stakeholders.

The cross-sectional analysis takes advantage of the continuously offered trainings in newly targeted intervention areas, giving rise to a so-called 'pipeline' research design. The key approach to assessing the impacts of the EnDev activities in this context is the comparison between previously trained active entrepreneurs and prospective entrepreneurs taking part in new trainings during the survey period. The former comprise the beneficiaries of the intervention (the treatment group), and the latter the comparison group. Both groups are eligible for training and have self-selected into the intervention, with the key difference that the latter have not yet started their business. This comparability allows the comparison of these two similar groups to gauge intervention effects, by thus accounting for unobservable characteristics of trained entrepreneurs which otherwise might represent a confounding –i.e. biasing – factor in a simple analysis of active entrepreneurs. Despite the similarity of the two groups a priori, there remain some observed differences in baseline (pre-training) characteristics between them that provide a rationale for using a statistical approach that takes these differences into account. The empirical analysis therefore applies (a) regression techniques and (b) matching techniques, in particular Entropy Balancing, to adjust for any imbalances and identify impacts of the intervention.

The empirical findings suggest that the EnDev-K intervention has a distinctive impact on income-generation of active entrepreneurs in both components: For most training participants, the intervention establishes the respective business as a new and major source of income. At

the same time, other income-generating activities are not necessarily forgone. That is, there is evidence of an increasing diversification of income-generating activities among active entrepreneurs, with an increase in the number of income-generating activities and total hours of work. In particular, the intervention appears to reduce the dependence on agriculture for income-generation, although most respondents do not give up farming entirely in favour of the solar or the cook stove business. This effect is particularly pronounced among cook stove trainees and those who have few other opportunities for income-generation.

In line with this result, the analysis finds sizeable impacts on individual-level incomes of active entrepreneurs. For solar entrepreneurs, there is an increase of incomes of around 1,500 Ksh. Impact estimates based on Entropy Balancing, however, are only statistically significant for the cook stoves component. For this group, the analysis suggests an impact estimate of 6,200 KSh in reported monthly incomes over the reweighted comparison group mean (or 86%). The increase is significant for both gender but appears particularly large among male entrepreneurs both in absolute and relative terms. The magnitude of the impact on income among both solar and stove entrepreneurs is corroborated by reported sales levels and profit margins. Equally important, participation in the EnDev intervention is estimated to significantly improve perceived employment quality for its participants, and, to a lesser extent, overall reported well-being of its participants. Interestingly, the positive impact on perceived employment quality is much stronger among female entrepreneurs for all perception indicators (e.g. satisfaction with pay level, working conditions and stability of income). In general, the effect appears to be stronger for respondents who previously worked under particularly bad conditions.

At the same time, even though active entrepreneurs appear to be less dependent on a single source of income (e.g. agriculture), it is not clear whether the intervention can reduce strong fluctuations in their overall income throughout the year. The analysis shows that fluctuations in demand and sales can be sizeable in both businesses; since these fluctuations appear highly dependent on seasonal factors (related to cash-flow from farming), it is likely that overall incomes of most entrepreneurs still depend on the agriculture-based rural economy. While the analysis suggests that stove and solar businesses rarely provide a stable source of income, at least the factors that determine fluctuations appear predictable for entrepreneurs.

In addition, the analysis of the data on employees and additional actors along the value chain provides mixed results: whereas a large share of solar entrepreneurs performs their business as own-account workers without employees, cook stove builders, in contrast, often work self-employed and/or organized in producer groups with a considerable share of them engaging additional employees. However, employment generation seems to mostly involve temporary, rather low-paid jobs – in particular among cook stove producers. The survey also shows that most stove and solar entrepreneurs are engaged with other actors along the value chain – such as input suppliers and/or resellers of their products. However, due to the very nature of the business, local value added seems smaller in the solar business, where a majority of entrepreneurs source products from one single retail agent, who is often the national distributor (in Nairobi), and few engage additional resale agents. Related to that it is important to note that the analysis focuses on the direct effects on entrepreneurs and was not geared to assess the overall effect on the local labour market. This has to do with the fact that indirect effects, e.g. on producers of traditional stoves, or induced effects, e.g. on kerosene vendors, cannot be quantitatively assessed in the proposed framework.

Finally, even using advanced econometric methods the cross-sectional impact estimates presented here may not perfectly pinpoint the exact impact of the intervention but rather constitute an upper bound for two reasons: First, the treatment group sample comprises only those

original training participants who are still reporting their sales to EnDev-K during monitoring meetings (hence, presumably, the more “successful” ones). Second, it cannot be observed yet whether new training participants in the comparison group will take up the respective business. This also points to the importance of conducting a more rigorous longitudinal impact analysis based on baseline and follow-up data in 2016-17.

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Annex

Annex 1 Glossary of employment- and income related terms

Business, also known as an **enterprise** or a **firm**, is a privately-owned organization involved in the provision of goods, services, or both to consumers in exchange for other goods, services, or money. In this context business also includes one-person operations. **Micro-businesses** are small businesses employing 10 people or less.

Employment at the individual level is understood as the exercise of an income-generating activity during the reference period that can be classified according to the below definitions of “Status in employment”. Employed individuals have an explicit or implicit (formal or informal) contract with other individuals or organizations for performing a particular activity. However, it should be noted that the concept of employment does not necessarily imply to gain an income from this activity.²³ Rather, earnings are considered one of several *attributes* of employment (see employment situation below). **Unemployment** includes individuals (above the age of 16) who during the reference period did not work on a continuous basis (either as employees or self-employed) but who were willing and available to work. In contrast, **underemployment** includes individuals who, even though they classify as employed, are willing and available to work additional hours. This includes individuals who were willing to obtain another job (with more hours) or jobs in addition to the current job or jobs.

Employment situation refers to the overall work situation of an individual. This includes both their status in employment (unemployed, employed, self-employed) as well as various quantitative and qualitative dimensions of employment. Specifically, this can relate to the *type* of employment (e.g. self/dependent, formal/informal, permanent/temporary, etc.) and their *attributes* (e.g. hours, skill-level, payment, wage-level, provision of benefits, health/safety, stability, etc.). The latter can also include firm-level aspects such as the sector (esp. farm/non-farm) and the size of the firm (small/medium/large). Hence the overall employment situation of an individual can be improved if any of these dimensions of employment is improved. An individual’s **income situation** similarly includes a variety of aspects relating specifically to income, include (e.g.) the amount, stability, and the number of income sources.

Employment status (based on the International Classification by Status in Employment, cf. Campbell 2013):

Own-account workers are workers who, working on their own account or with one or more partners, hold self-employment jobs (i.e. jobs where the remuneration is directly dependent upon the profits derived from the goods and services produced) and do not engage any employees on a continuous basis.

Employers are workers who hold self-employment jobs (see above) and, in this capacity, have engaged, on a continuous basis, one or more persons to work for them as employee(s).

Employees get a basic remuneration not directly dependent the revenue of the employer (often defined as “paid employment jobs”), where the individuals hold explicit (written or oral) or implicit employment contracts.

²³ That is, unpaid workers are considered employed. This is in line with international definitions, e.g. the US Labour Force Survey.

Members of producers' cooperatives hold self-employment jobs in a cooperative producing goods and services, where the members take part on an equal footing in making major decisions concerning the cooperative.

Contributing family workers hold paid or unpaid self-employment jobs in an establishment operated by a related person, with a too limited degree of involvement in its operation to be considered a partner. Paid family workers are considered (family) employees as per above.

Workers not classifiable by status include those for whom insufficient relevant information is available and/or who cannot be included in any of the preceding categories

Entrepreneurs refers to economic entrepreneurs (in contrast to, e.g., social or political entrepreneurs) as individuals who start, organize or operate one or multiple business(es) with the motivation of generating profit. These businesses can be formal or informal businesses. Entrepreneurs generally make the operational decisions affecting the enterprises, or delegate such decision while retaining responsibility. **Last Mile Entrepreneurs** are entrepreneurs start a business to sell the final good to the end-consumer (often door-to-door in rural markets). Hence last-mile entrepreneurs can be own-account workers or employers if they engage employees in their business.

Income

Earnings are all incomes in the form of wages for employees or profit of their business for self-employed individuals.

(Overall) Income consists of all receipts whether monetary or in kind (goods and services) that are received by individuals from any income-generating activity. Additionally to individual earnings (wages, profits), this includes (e.g.) return on capital (interest) or property income (rents), and transfers received from governments, etc. (pensions). Excluded are windfall gains and other such irregular and typically one-time receipts as well as any receipts that reduce net worth of the household through reduction other financial or non-financial assets or an increase in its liabilities.

Income-generating activity refer to all activities which an individual (or household) carries out with the intention to generate some form of income through transactions with other individuals. (Hence pure subsistence farming is not considered an income-generating activity.) A specific form are rural income generating activities, both agricultural and non-agricultural, carried out by rural households.

References:

<http://laborsta.ilo.org/applv8/data/icsee.html>

<http://laborsta.ilo.org/applv8/data/hiese.html>

<http://www.ilo.org/public/english/employment/yen/whatwedo/projects/indicators/5.htm>

<http://www.ilo.org/global/statistics-and-databases/statistics-overview-and-topics/status-in-employment/current-guidelines/lang--en/index.htm>

Annex 2 Stove types marketed by the EnDev Kenya programme



Jiko Kisasa one pot



Jiko Kisasa two pot



Jiko Kisasa Portable



Jiko Kisasa Liner



Rocket Stove with Insert (RIS) one pot



Rocket Stove with Insert (RIS) two pot



Rocket Stove Inserts



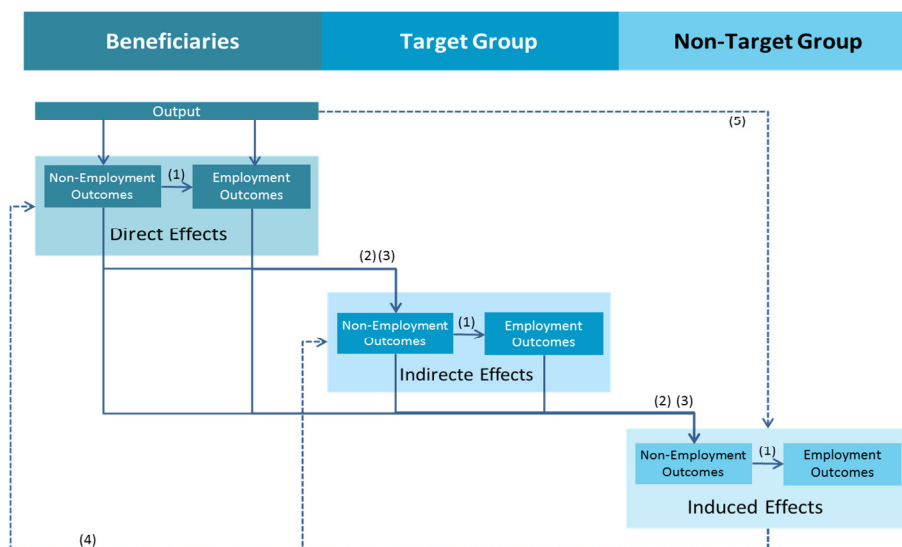
Rocket Stove with Brick and Cement (RSBC) one pot



Rocket Stove with Brick and Cement (RSBC) two pots

Source: EnDev Kenya; RWI.

Annex 3 Typology of employment- and income-related effects of development interventions



Notes:

- (1) Mediators: e.g. productivity, employability, knowledge,...
- (2) Indirect Effects: e.g. spillover effects, improved inputs, substitution, multiplier effects...
- (3) Induced Effects: e.g. spillover effects, business environment effects, displacement
- (4) Feedback loops: second- or third-order effects
- (5) externalities

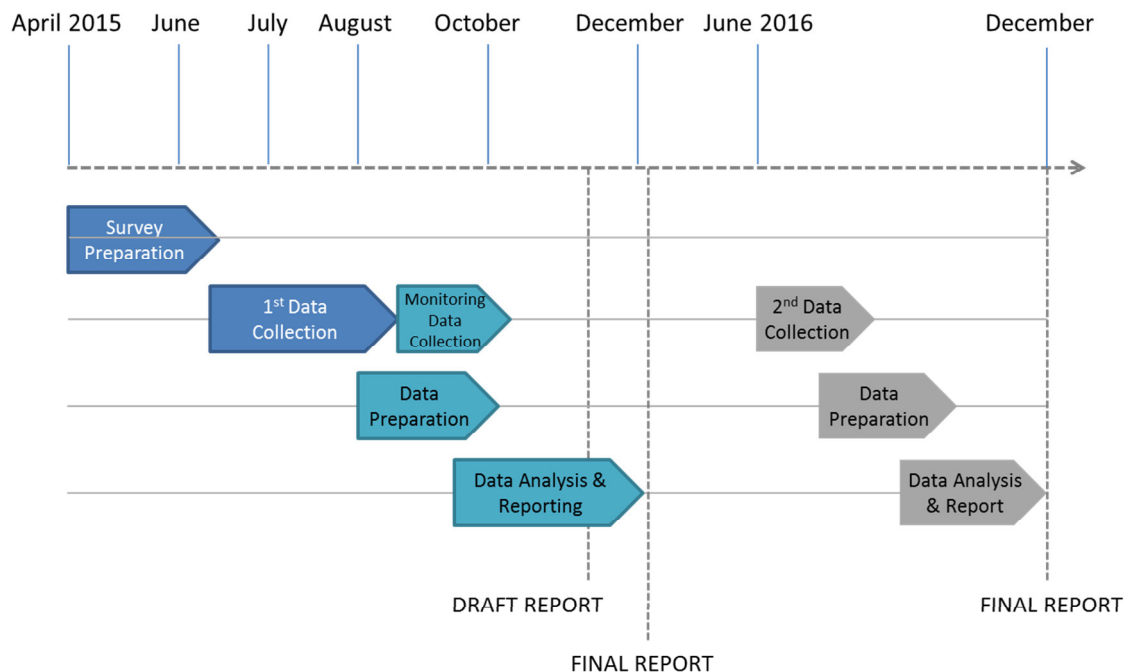
Direct effects describe all changes in outcomes that are caused by the outputs of the intervention among its beneficiaries. Trainings, for example, cause an improvement in job-finding rates among training participants. Although employment effects may be achieved, these are generally not a primary goal of the intervention like the improvement of energy access among households. Direct employment effects are often – at least partly – mediated by changes in other non-employment outcome variables such as productivity or sales. It is therefore important to emphasize that all effects on employment outcomes of beneficiaries are considered as direct employment effects, whether mediated or not.

Indirect effects are changes in outcomes among individuals and firms that are part of the target group of the intervention but which are not directly affected by the outputs of the intervention. Similar to the above case of direct effects, indirect effects are often mediated. In the case of cook stove interventions, other young whitesmiths in the intervention region, who do not participate in the trainings, may experience lower sales of their traditional stoves (negative indirect effect) or learn from programme beneficiaries to improve their stoves (positive indirect effect).

Finally, *induced effects* are all changes in outcome variables among individuals and firms that are not part of the target group of the intervention. For Pico-PV, for example, the non-target group may be kerosene or dry-cell battery retailers in the intervention region, who are affected by lower demand for their products. Induced effects are triggered by the direct or indirect effects of an intervention. Induced employment effects are generally not a goal of the intervention; they can be acknowledged as an intended or unintended consequence.

Reference: Kluge, J. and J. Stöterau (2014), A Systematic Framework for Measuring Employment Impacts of Development Cooperation Interventions. Deutsche Gesellschaft für internationale Zusammenarbeit GmbH.

Annex 4 Study schedule



April/ May 2015: survey preparation. Development of survey instruments (mainly questionnaires, specifically accounting for gender); Call for Proposals to implement the survey sent to local research institutions – Strathmore Energy Research Centre (SERC) of Strathmore University Nairobi was contracted on a competitive basis; recruiting one junior researcher (graduate student as Intern) that accompanies the complete survey implementation in the field.

June/ July/ August 2015: data collection. Surveys prepared by the RWI researchers during a prior in-country survey preparation mission including an enumerator training.

August/ September 2015: data preparation. Digitalization of the collected data, checking and transfer into a software package for data analysis.

October/ November 2015: data analysis and reporting. Draft report on the findings of the cross-sectional evaluation.

November/ December 2015: report revision and final cross-sectional report. Final report on the findings of the cross-sectional evaluation.

End 2015/ beginning of 2016: tracking of programme progress and follow-up survey. Programme implementation will be monitored in order to determine the best timing for potential follow-up data collection. At the same time, the desirability of this follow-up phase will be reassessed and funding would need to be secured for the follow-up survey. In order to allow for sufficient time for impacts to unfold and in order to avoid seasonality, it is strongly recommended to conduct the follow-up exactly one year (or alternatively exactly two years) after the first wave of data collection. This data collection would again entail data analysis and reporting.

Annex 5 List of survey sites

Survey Group	Technology	Cluster	County	Subcounty/Ward	Interview Location	Number of interviews
Active (T1)	Solar	Central	Kiambu	Kikuyu		1
		Central	Muranga	Muranga		15
		Central	Kirinyaga	Kagio		11
		Lake	Kisumu	-	Nyando	11
		Lake	Homabay	-	Homabay Town	17
		Western	Bungoma	-	Kimilili	18
		Western	Busia	-	Busia	18
		Western	Kakamega	-	Lurambi	15
		SNV	Uasin Gishu	Eldoret	Eldoret Town	21
		SNV	Laikipia	Nanyuki	Nanyuki Town	12
	Stoves	Central	Kiambu	Kikuyu		17
		Central	Kirinyaga	Kirinyaga East		25
		Central	Muranga	Mathioya		10
		Lake	Bomet	Chepalungu	Kapkwon	8
		Lake	Kisii	Bomachoge	Nyagancha	23
		Lake	Nyamira	Masaba	Nyankuba	17
		Lake	Homabay	Asego	Homabay Town	3
		Western	Vihiga	Hamisi	Shamakhokho	25
		Western	Bungoma	Bungoma North	Naitiri	25
		Western	Kakamega	Mumias south	Bukaya	13
Newly trained (N2)	Solar	Central	Meru		Nkubu	14
		Central	Tharaka Nithi	Nkubu	Nkubu	11
		Central	Murang'a		Murang'a	25
		Lake	Homabay	-	Oyugis	24
		Lake	Homabay	Oyugis	Oyugis	25
		Western	Bungoma	Mt.Elgon		23
		SNV	Uasin Gishu	Eldoret	Eldoret Town	25
		SNV	Nairobi			20
		SNV	Nairobi			25
		Stoves	Central	Embu	Manyatta	Manyatta
	Central		Muranga	Gatunguru	Gatunguru	23
	Central		Kirinyaga	Kirinyaga Central	Kirinyaga Central	27
	Lake		Homabay	Suba South	Sindo	22
	Lake		Homabay	Rangwe	Homabay Rangwe	19
	Western		Nandi	Mosop	Nyayo	24
	Western		Kakamega	Mumias	Matungu	30
	Western	Bungoma	Mt.Elgon		21	
Mobilized Non-participants (N3)	Solar	Central	Nyandarua	Central		19
		Lake	Siaya	Rarieda	South Uyoma	23
		Lake	Siaya	Rarieda	West Asembo	25
		Western	Elegeyo-Marakwet	Emsoo		17
		Western	Elegeyo-Marakwet	Tambach		18
	Stoves	Central	Nyandarua	Leshau Pondo		28
		Central	Nyandarua	Kirita		31
		Western	Elegeyo-Marakwet	Kamariny		25
		Western	Elegeyo-Marakwet	Kapchemutwa		24

Annex 6 Extension Officers Trainings Note

Aim of the training is to ensure that extension officers are well informed to identify and mobilize suitable individuals for the interviews and trainings in the comparison counties. Individuals who are invited to the interviews (and the lottery that determines who can take part in the subsequent training) should have similar characteristics as training participants usually trained by GIZ in intervention counties. This refers notably to each participant's willingness and capabilities to engage in entrepreneurial activities related to modern energy technologies. Consequently, the procedure and criteria to find individuals to participate in the interviews / lottery should resemble those followed by (e.g.) extension officers in GIZ intervention areas.

The extension officer training should therefore include –at least– the following elements:

Programme Background

Extension officers will need to be adequately informed about the purpose/content of the EnDev intervention as well as purpose/content of the RWI/SERC survey and final study. They should acquire a basic understanding of the purpose of the comparison group approach. This element of the extension officer training should be conducted by an SERC or RWI researcher.

Selection

The typical process followed by GIZ to identify solar and stoves training participants includes two main steps: Firstly, sensitization and awareness raising at local/village meetings: At these meetings, potential participants are informed about the training opportunity and asked to register their interest. In the case of stove trainings, interested individuals are asked to gather the required number of training customers (20 households where stoves will be installed) until a given date, when the training will be conducted. Secondly, initially interested individuals are re-contacted to inquire whether they have been able to acquire 20 training households. Once a sufficient number of training participants is ready, the training date will be set.

The selection of individuals via a minimum number of training households is an important step for the EnDev-K intervention to ensure that trainees demonstrate willingness and necessary resources for becoming stove entrepreneurs. This step, however, *cannot* be replicated for the comparison group, since it would be inappropriate to deny entrepreneurs the training after they have already gathered 20 training households. It is therefore vital that the selection of interviewees is even more thorough. The extension officer will have to ensure that selected individuals are sufficiently motivated to gather 10 training households if they are drawn (by lottery during the interview session) for the training. In total 65 people (5 from each of the 5 solar meetings and 10 from each of the 4 stove meetings) will be winning this participation.

To reiterate: It is important that each comparison group interviewee shows similar entrepreneurial aptitude as those that meet the training target of 20 initial customers in GIZ trainings.

Selection Criteria

Considering the selection criteria of GIZ in its interventions counties, potential stove/solar training participants in comparison counties are supposed to fulfil the following criteria²⁴:

²⁴ This list may need to be extended in consultation with EnDev-K coordinators and program extension officers.

Solar Trainings

1. existing profit oriented enterprise/activities (e.g. shop, freelance entrepreneur)
2. interest in getting engaged in solar business
3. availability of start-up capital needed to purchase an initial set of solar lantern
4. KCSE as the minimum education level
5. physical address in the locality and contacts (e.g. registered mobile phone number).

Stove Trainings

1. high motivation to start improved stove production
2. preferably previous knowledge in artisanal production (e.g. clay)
3. availability of start-up capital / tools needed to start rocket stove production
4. (KCSE as the minimum education level – to be verified with EnDev)
5. physical address in the locality and contacts (e.g. registered mobile phone number).

This part of the training should be conducted by an experienced extension officer of an existing GIZ intervention area.

Fairness

Fairness in this context implies that, first, survey participants should not be misinformed about the purpose of the gatherings held to conduct the interviews and, second, that there is a just process to determine training participants and, third, they receive any form of adequate recompense.

The extension officer needs to **inform** participants that the number of participants for final stove/solar trainings will be limited. Interested candidates will need to be informed that the initial half- to one-day meeting will consist of (i) an interview about their previous/current working situations; (ii) a (rather short) introduction to existing stoves/solar technologies where it has to be ensured that the introduction does not constitute a treatment in itself, as this may distort potential outcomes in the comparison group; and (iii) a ballot lottery at which training participants are randomly selected for the training. Extension officers should be trained to phrase this random selection process positively (e.g. as an opportunity) to interview participants. At the same time, the purpose of the survey/study should not be highlighted to interviewees as this may bias response by interviewees.

Through the **lottery** a fifth of the people are supposed to be randomly drawn to win as prize the participation in an in-depth training course on stove production or pico-PV selling (depending on the specific site). Through this procedure, people will be incentivized to participate in the meetings who are supposed to be willing and capable to engage in entrepreneurial activities that require basic handicraft skills (similar to the participants of EnDev trainings).

Interviewees will receive a **recompense** of 8 EUR per person for participating in the meeting. This may be communicated to participants by extension officers in advance. However, extension officers will have to ensure that the main incentive for participating in these meetings is the possibility of winning the participation in an in-depth stoves/solar training.

Annex 7 Income range showcard example

SHOWCARD 4

for Q55

Letter	Yearly Income
S	0 – 20.000 KES
H	20.000 – 40.000 KES
K	40.000 – 70.000 KES
Y	70.000 – 100.000 KES
P	100.000 – 150.000 KES
L	150.000 – 200.000 KES
D	200.000 – 250.000 KES
B	250.000 – 300.000 KES
E	300.000 – 400.000 KES
W	400.000 – 500.000 KES
Q	500.000 – 750.000 KES
J	750.000 – 1.000.000 KES
M	1.000.000 – 1.500.000 KES
U	1.500.000 – 2.500.000 KES
O	Above 2.500.000 KES

Annex 8 Complementary data

**Table A 1
Income impact estimates using OLS**

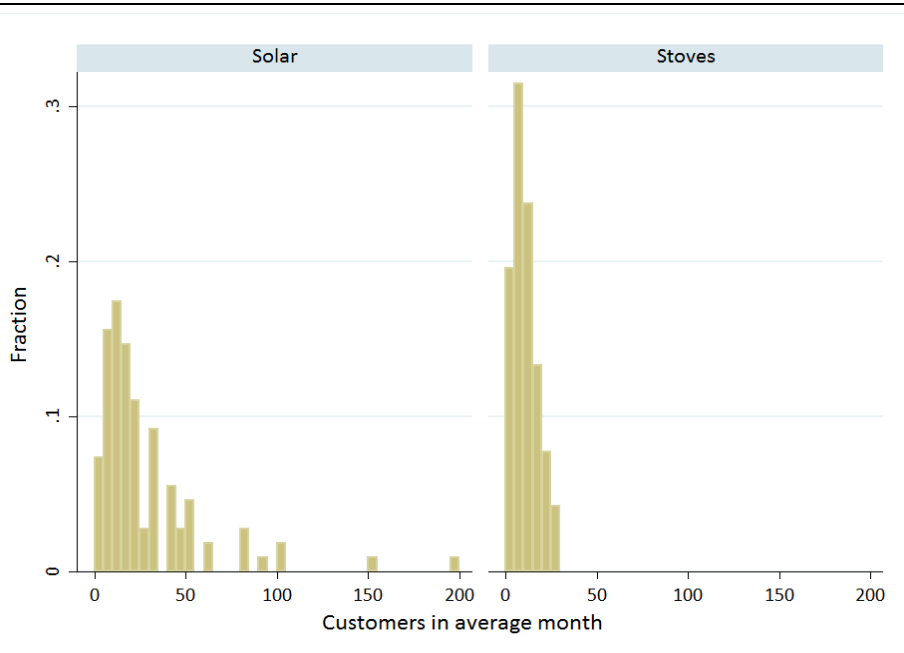
Monthly personal total net income, in KSh	Solar		Stoves	
	Diff.	N	Diff.	N
unconditional	4346	295	7518***	331
conditional	3467	277	5825**	297
conditional and censored	488	255	4540***	276
unconditional and censored				
all	1197	273	5419***	310
female	2835	137	4111***	184
male	-164	136	6990***	126

Note: (), (**) and (***) indicate that the coefficient is significantly different from zero on a level of (10%), [5%] and {1%}. Income data was collected by 15 intervals. Mean income is calculated by matching each interval to a weighted average of its bounds. “Conditional” variables exclude respondents without any income. “Censored” variables exclude intervals containing the top 5%. This so-called 95th percentile is calculated using the unweighted data of both groups with critical values of KSh 50,000 (solar) and KSh 40,000 (cook stoves).*

Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

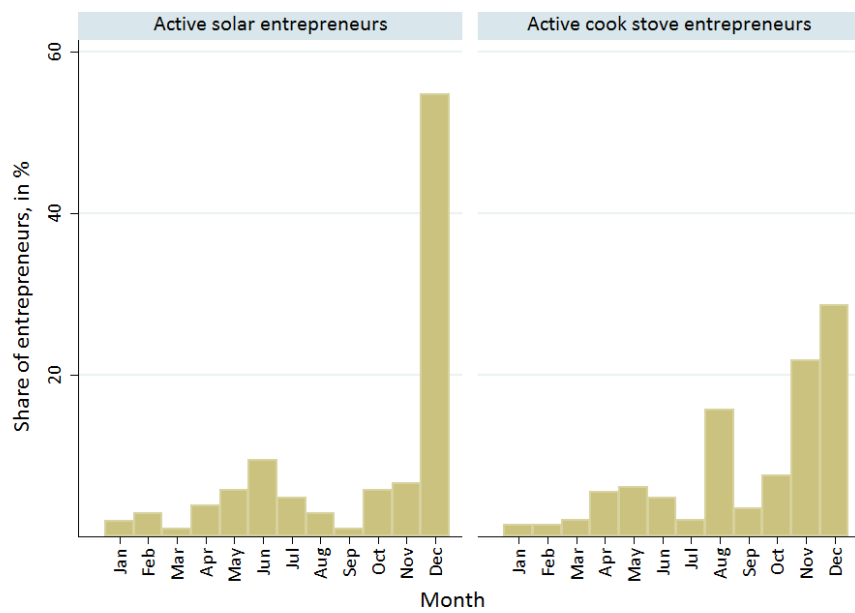
The empirical analysis implements a variety of alternative estimation procedures to test the robustness of the income results to the econometric method used – for example, using interval regression to take into account that income data was collected using categories. Since the magnitude and significance of the results remain unchanged, not all estimates are reported in this study.

**Figure A 1
Customer distribution, by business**



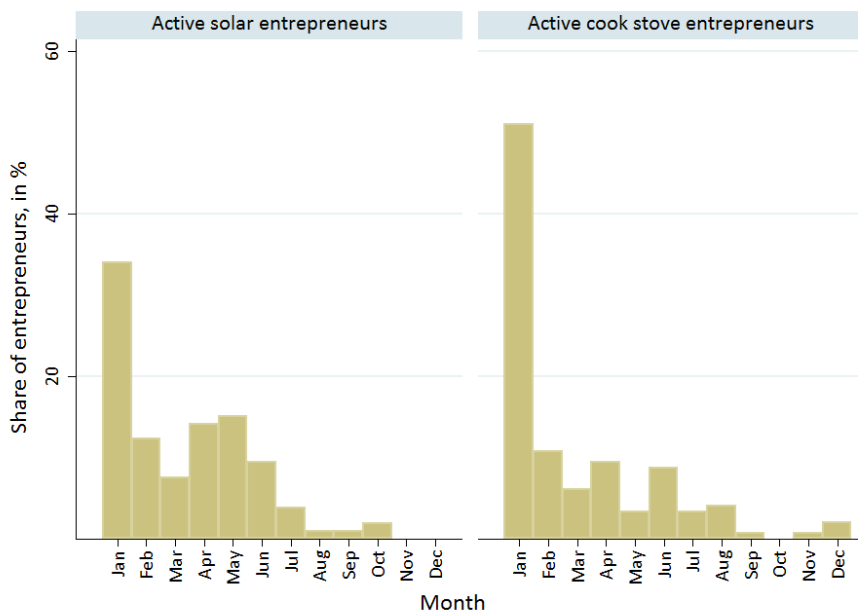
Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

Figure A 2
Month with highest sales according to entrepreneurs



Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

Figure A 3
Month with lowest sales according to entrepreneurs



Source: RWI-EnDev Kenya Entrepreneur Survey 2015.

Annex 9 Employment figures extrapolated to the whole EnDev programme

Table A 2

Aggregate EnDev employment figures

	Total			Solar			Stove		
	total	male	female	total	male	female	total	male	female
Number of reporting entrepreneurs	3100	1488	1612	600	288	312	2500	1200	1300
Working time of entrepreneurs, in full-time equivalents	1705	910	802	432	234	197	1013	508	508
Working time of newly employed entrepreneurs, in full-time equivalents	94	34	53	10	4	5	85	23	49
Number of employees	4273	1196	3077	498	224	275	4530	990	3540
Number of part-time employees	2745	2230	515	263	189	74	3007	2517	490

Note: Figures are based on variables presented in Table 6 and Table 9 and the number of reporting entrepreneurs across the whole programme according to EnDev. While the number of regularly reporting solar entrepreneurs could be verified based on monitoring data, the monitoring system does not provide the necessary information to do so for the stove component as well.

Source: RWI-EnDev Kenya Entrepreneur Survey 2015; EnDev Kenya monitoring.

Electronic Appendix

Electronic Appendix 1. Structured survey questionnaire

Electronic Appendix 2. Semi-structured interview guide