Business Environment Reform Facility

Business Environment Constraints in Mozambique's Renewable Energy Sector: Solar PV Systems and Improved Cook Stoves

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Contents

Acronyms and Abbreviations

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ALER	Associação Lusófona de Energias Renováveis
ARENE	Energy Regulatory Authority
AT	Autoridade Tributaria
AU	African Union
ASEAN	Association of South East Asian Nations
AVSI	Associazione Volontari per Il Servizio Internationale
B2B	Business to Business
BECT	Biomass Energy Certification and Testing Centre
BER	Business Environment Reform
BERF	Business Environment Reform Facility
BoM	Bank of Mozambique
BoP	Bottom of the Pyramid
BRILHO	A DFID programme to address energy access challenges in Mozambique
BTC	Belgian Technical Cooperation
CDM	Clean Development Mechanism
CO	Country Office
CNELEC	Concelho Nacional de Eletricidade
CP	Community Plan
CPI	Investment Promotion Centre
CSR	Corporate social responsibility
CTA	Confederation of Business Associations of Mozambique
DESCO	Distributed Energy Service Company
DFID	Department for International Development
DNE	Direção Nacional de Energia
ECA	Economic Consulting Associates
EDENR	Strategy for New and Renewable Energy Development
EDM	Eletricidade de Moçambique
EIA	Energy Information Administration
EnDEV	Energising Development
FRELIMO	Mozambique Liberation Front
FUNAE	Fundo de Energia
FSDMoç	Financial Sector Deepening Moçambique
GoM	Government of Mozambique
GMG	Green Mini Grids
ICS	Improved Cook Stoves
INAE	National Inspectorate for Economic Activities
IPRC	Imposto sobrec o Rendimento de Pessoas colectivas
KfW	A German Bank
LNG	Liquefied Natural Gas
MAUS	Mobile Access & Usage Survey

Acronyms and Abbreviations	
MFI	Micro financing institutions
MIC	Ministry of Industry and Commerce
MIGA	Multilateral Investment Guarantee Agency
MIREME	Ministry Mineral Resources and Energy
MSME	Micro, small and medium enterprises
MVA	Mega Volt Amp
MWp	Megawatt potential
NAMA	National Appropriate Mitigation Action
NDE	National Directorate of Energy
NGO	Non-Governmental Organisation
NREL	National Renewable Energy Laboratory
OVE	Danish Organisation for Renewable Energy
PAYG	Pay As You Go
PEA	Political Economy Analysis
PNDB	National Program for the Development of Biofuels
POCA	Poupa Carvão (cookstove)
ProBEC	Programme for Basic Energy and Conservation
PRAP	Poverty Reduction Action Plan
PSD	Private Sector Development
PV	Photovoltaic
RBF	Results Based Financing
RE	Renewable Energy
RENAMO	Mozambican National Resistance
R&D	Research and Development
SACCO	Savings and Credit Cooperative
SADC	Southern African Development Community
SEIA	American Solar Energy Industry Association
SHS	Solar Home System
TBC	Tax Benefit Code
SNV	Stichting Nederlandse Vrijwilligers
TORs	Terms of Reference
TVET	Technical and Vocational Education and Training
VAT	Value added tax
UNEP	United Nations Environmental Programme

Executive Summary

This report was prepared in response to DFID Mozambique's request for the Business Environment Reform Facility (BERF) to analyse business environment constraints faced by private sector actors wishing to enter the off-grid renewable energy market, specifically for Improved Cook Stoves (ICS), Pico Solar Systems, Solar Home Systems (SHS) and Green Mini-Grids (GMG). The report reviews three issues: i) the policies/strategies, laws and regulations that govern investments in Mozambique's Photovoltaic (PV) and ICS sectors; ii) the organisations and institutions that operate and affect these sectors and iii) specific business environment issues that affect the performance of these sectors. Interviews were held with a range of stakeholders to identify the binding constraints to sector growth. The report concludes with recommendations on how to overcome such sectoral constraints.

Commonalities and Differences between the Solar PV and ICS Sectors

The market for off-grid electrification in Mozambique presents significant opportunities for private sector investment, as the addressable market for new connections can be estimated at 20.6 million, or 4.1 million households. Despite the size of latent demand, Mozambique's off-grid PV industry is still almost entirely undeveloped, with only a handful of companies that compete primarily for public tenders, only one of which has recently started selling directly to private consumers. The business environment, however, remains unfavourable to business, primarily because of policy inconsistencies, difficulties in accessing finance and rapidly deteriorating macroeconomic conditions. Since the Solar PV sector is strongly reliant on foreign technology, barriers to entry and the weak integration of the Mozambican market with international markets are severely constraining the sector.

The ICS market also provides good potential in the urban and peri-urban areas, where the majority of the population uses charcoal. The low density of the population and the use of firewood are a challenge to profitable business activity in rural and remote areas. The market for ICS is strongly segmented, with space for commercial interventions only above the bottom of the pyramid. The presence of public and donor activities to support the ICS sector is also strong.

The development of the ICS sector is dependent on the establishment of a local market system that can deliver products that match the needs of the users, and are industrially produced so that while use value increases, sale prices for ICS can become more competitive by taking advantage of economies of scale.

Women play a pivotal role in the development of the ICS sector, as users of ICS and as potential entrepreneurs. Women shape demand for ICS, since they are the custodian of cooking traditions and family rituals. Since women understand the value of an ICS, they should also be encouraged to participate actively in the industry.

Key Business Environment Constraints in the ICS and Solar PV Sectors

One of the key challenges facing both sectors is weak demand, because most rural consumers lack information and knowledge about ICS and Solar PV products, as well as the financial means to purchase them. Other root causes of depressed demand are: 1) where product awareness has been established by the government through handing-out or subsidising equipment, expectations have been raised for future subsidies, resulting in the crowding out of private investment; 2) lack of maintenance support for products installed reduces customer confidence in the quality and value of ICS and Solar PV systems; 3) consumer finance is almost non-existent.

On the supply side, the business environment is not conducive to companies deploying innovative solutions to overcome demand constraints. While the largest potential market is in rural areas, where the cost of reaching the last mile is high due to the current run-down state of infrastructure in Mozambique. A rapidly deteriorating macro-economic environment with raising inflation, a falling exchange rate and shortage of foreign exchange also makes it difficult for Solar PV start-ups to secure foreign investment. Lack of technical and managerial and challenges in obtaining temporary work permits to bring in foreign expertise, make it difficult to set up efficient distribution networks and customer support services to raise the value of the products to the consumer. Market interventions by the Government of Mozambique (GoM) and inconsistencies in the implementation of measures to catalyse private sector involvement in the industry create uncertainty and increase perceived risks of investing in the sector. Legislation to provide incentives to investment in sectors of national importance is not applied consistently. Public sector and donor interventions to sustain the sector tend to create perverse incentives and to crowd-out private investors.

Prioritising Reforms

The development of the ICS and Solar PV sectors should be driven by revised policy objectives.

The primary objective of developing the off-grid Solar PV sector is to deliver electricity to as many people as possible, by using the most efficient and cheapest technology available on the international market. In order to achieve this, reforms need to:

1) Catalyse international investments;
2) Eliminate barriers and reduce the cost of importing PV equipment and accessories;
3) Facilitate access to international expertise.

The primary objective of the ICS sector is to deliver large-scale adoption of ICS responding to local needs and tastes of users. In order to achieve this, reforms need to:

1) Support a national/regional system for Research and Development (R&D) based on testing and recognised industry standards;

2) Establish economies of scale in production and distribution so as to lower consumer prices;

3) Eliminate barriers and costs of importing components for locally produced ICS.

Feasible Policy Actions to Improve the Business Environment

A number of recommendations to mitigate the constraints identified above are summarised as follows:

1) With the Ministry of Mineral Resources and Energy (MIREME), the Energy Fund (FUNAE) and Mozambican national electricity company Eletricidade de Moçambique (EDM) GoM should develop a clear strategy for the development of the Solar PV sector to complement the (now dated) Strategy for New and Renewable Energy Development (EDENR) that is aimed at protecting investments in the sector and at creating a conducive environment for investment.

2) Regulations and requirements to apply for licensing of Solar PV installations and to obtain concessions for Green Mini-Grids (GMGs) should be simplified to allow for increased competition in the market and drive down end-user prices.

3) A public-private dialogue platform should be established to share information on the industry and discuss policy/ regulatory issues, improve clarity on policy direction and raise investor confidence.

4) GoM could reduce or exempt ICS and Solar PV equipment and components from import duties and VAT, and simplify the classification of duties. This is in order to avoid discretionary practices and uncertainty at border posts, and to reduce the end-user price of ICS and Solar PV electricity, thereby sending signals to investors that catalysing market activity is a priority for the sector.

5) FUNAE should establish a market information portal that monitors inflation in areas where solar investments are made or could be catalysed, to help companies update prices with prevailing economic trends.[1] The platform could also share information across government and development initiatives (such as agricultural promotion programmes), to help ICS and Solar PV companies target rural areas where incomes are rising.

6) GoM should facilitate access to investment financing by negotiating with the Bank of Mozambique (BoM) for lower interest rates for the existing KfW/BoM credit line. Donor funding should be made available to provide guarantees and reduce risks for energy companies using this credit line.

[1] No evidence has been collected to test how customers would respond to increasing PAYG charges. Business models that strengthen transparency and leverage trust from customers will need to be tested. It should be noted however, that due to the rapidly falling value of the Metical, the price of fuel and electricity tariffs have been recently increased, and are likely to be increased again in the future, setting a precedent for PAYG fees to also adjust to market conditions.

7) Support should be provided to pilots that test collaboration between financing institutions, Solar PV Pay-As-You-Go (PAYG) companies and mobile money companies such as M-Pesa, to test the effective use of existing telecom data to develop consumer profile risks, and test behavioural change advertising in the Mozambican contest, where mobile penetration is relatively low.

8) Support should be provided to mitigate restrictions in the repatriation of funds in foreign currency by helping international investors in the sector subscribe to the Multilateral Investment Guarantee Agency (MIGA) investment protection insurance.

9) Results Based Financing (RBF) should be piloted to incentivise market penetration in rural areas and servicing the Bottom of the Pyramid (BoP).

10) Seed donor funding (from programmes like BRILHO[2]) should be used to leverage matching impact investments by philanthropic initiatives by Liquefied Natural Gas (LNG) companies, to subsidise penetration of off-grid systems in less commercially viable areas of the country.

11) R&D in the ICS sector should be supported to deliver improved stove designs that meet local preferences, as well as fulfilling national, recognised quality standards.

12) The Solar PV sector should be supported to adopt improved quality standards through the creation of a voluntary quality certification system, quality awareness building and strengthening of the National Inspectorate for Economic Activities (INAE) to identify and target sub-standard products. Warranty standards of minimum 2 years should also be made compulsory to drive out sub-standard products from the market and incentivise companies to build stronger customer relations and after sale services.

13) The Technical Vocational and Education Training (TVET) curricula should be expanded to include more labour market oriented training, delivering relevant skills and strengthening cooperation with the private sector to bridge the skills mismatch. Concerted efforts should be made to prioritise the training of women in the use of renewable energy or energy efficient solutions as well as agents in the distribution of Solar PV.

14) Immigration requirements for temporary work permits should be relaxed, at least for the Solar PV industry, based on the submission of clear training plans to develop local capacity.

[2] Upcoming DFID programme focusing on the development of the off-grid renewable energy sector in Mozambique.

1. Introduction

1.1 Objective of the Assignment

DFID Mozambique is in the process of designing a new programme, BRILHO, which aims to address the energy access challenge in the country. The objective of the programme is to promote rural economic growth and human development by unlocking the potential of the private sector to provide off-grid renewable energy access in Mozambique. The programme will undertake a number of different interventions focusing on GMG, SHS, solar portable lights (lanterns), and ICS (biomass). DFID Mozambique has requested support from the Business Environment Reform Facility (BERF) to analyse the business environment constraints faced by the private sector wishing to enter the market for off-grid renewable energy, specifically in the areas mentioned above, and to make prioritised recommendations to overcome such constraints.

1.2 Definition of the Sectors under Study

This study focuses only on identifying the business environment constraints for Solar PV products and ICS that are being commercialised in Mozambique. This includes pico-solar kits, such as solar-charged torches, SHS, GMG as well as locally produced and imported ICS.

Although off-grid electrification includes a broader array of energy sources other than solar, such as hydro, wind and tidal, the Renewable Energy Atlas of Mozambique (2014) identifies solar energy as the most viable for rural electrification,[3] and for this reason, this study is limited to an analysis of business environment constraints in the Solar PV and ICS sectors.

1.3 Approach to Study

Two main research methods were used to collect data for this study: desk research and structured interviews. The desk research focused on reviewing three issues: i) the policies/strategies, laws and regulations that govern investments in Mozambique's Solar PV and ICS industries; ii) the organisations and institutions that operate affect the sectors and iii) specific business environment issues that affect the performance of businesses in these sectors. Sources reviewed included government reports, research papers and media articles. Interviews were held with a range of stakeholders, including representatives from government ministries, intergovernmental organisations, academic researchers and private sector companies operating in the renewable energy sector to identify the binding constraints to investment.

[3] See pg. 214 of FUNAE's Renewable Energy Atlas of Mozambique (2014). The Atlas identifies only 300 sites that are suitable for micro-hydro, and solar to be the most affordable type of energy generation.

2. Commonalities and Differences between the ICS and Solar PV Sectors

2.1 Demand Characteristics

All of the research publications consulted during this study broadly agree with Foley's Energy Demand Ladder Model (Hosier 2004:425), which explains that an increase in income corresponds to a more diversified use of appliances and sources of energy. The most basic form of energy, such as firewood, is used for cooking, heating and lighting. As income rises and those vital necessities have been filled, households start to buy basic appliances and make use of refrigeration, which requires electricity; meanwhile biomass is still used to fulfil the vital needs. The characteristics of demand for Solar PV systems and ICS, however, remain significantly different, as demand for ICS is strongly embedded in the social aspects of cooking. Recent assessments of the Mozambican market also show that latent demand for Solar PV systems exists at the lower tier of the pyramid (GreenLight, 2016), which primarily uses free firewood for cooking, and has little desire or incentive to change.

The main characteristics of demand for both ICS and Solar PV systems are presented below. An understanding of demand is important in order to define an analytical framework for the review of the business environment, and identify priorities for policy action, since investments in both sectors will depend on the existence of strong demand.

2.1.1 Demand for ICS

The determinants of adoption of ICS in African households have been studied in a number of countries, including in Mozambique.[4] The overwhelming evidence is that the choice of fuel and cooking technique (and consequently cook stove) are strongly determined by the level of income. This has three important implications for interventions that support the Mozambique ICS sector:

- First, exclusively market-based approaches for the diffusion of ICS fail to penetrate beyond a certain level of poverty because disadvantaged groups with limited education tend to perceive other household priorities as being more pressing. Substantial levels of public intervention for this segment of the market (the lower tier of the pyramid) are therefore justified, because of the significant public benefits that would be achieved in terms of a reduction of CO2 emissions and improved public health.
- Second, above the lower tier, demand for improved stoves and more convenient and cost-effective fuels (like liquefied petroleum gas - LPG) does emerge, and can be targeted effectively through market interventions to stimulate latent demand and respond to user/consumer preferences. It is for this segment of the market, and this type of intervention, that improvements in the business environment would have the most significant impact.

[4] See Rehfuess et al (2014) and Puzzolo et al (2013) for a comprehensive review of existing studies.

- Third, as the benefits of ICS only derive from continued use, responding to the preferences of as many individual users as possible is essential for adoption of ICS at scale. Supporting the private sector in segmenting the market[5] and responding to user preferences is therefore key to achieving impact at scale.[6] Poor households have strong preferences, and are more concerned about the safety, convenience and durability of ICS, and less with efficiency and reduced emissions.[7] A number of international studies[8] also reveal how stove design is dependent on the type of meals cooked and the cooking tasks applied.[9] The geographical and climatic characteristics of the area also play a role, since stoves may not only be used for cooking, but also for heating or drying foodstuffs.

In summary, the nature of demand for ICS provides a **framework to prioritise the business environment issues that should be addressed in the sector.** As it can be implied from the literature, policy and donor interventions need to be targeted at supporting a market system that supports innovations in design and distribution of ICS, a market that can provide a variety of stove models to respond to specific geographical or cultural needs and prices for higher- versus lower-income households. Financial subsidies should be limited as much as possible to the lower tier of the pyramid, and in remote areas, paying careful attention to avoid market distortions. Mitigating risks, lowering barriers to market entry, reducing costs for distribution (particularly to remote areas) and providing public support to R&D, knowledge dissemination

[5] In a new market like the Mozambique PV and ICS market, it is important to identify market segments that have buying capacity and that can be served first, in order to justify the cost of entering the market. Establishing a strong foothold in these segments allows companies to expand in less yielding or riskier segments, by achieving economies of scale and cross subsidising operations across market segments. Market segmentation, for instance is one of the key ingredients of M-kopa's market strategy. At the initial stages of penetrating a new market, M-kopa focuses only on the market segment of customers who are likely to reach full payment in approximately 12-14 months, so to ensure the establishment of a viable business and a sustainable contribution to margins to expand to new market tiers. In successive phases of expansion M-kopa segments its customer base further, by considering data on repayment rates as well as usage. In this process, slower-repaying customers will receive particular attention and support to identify potential repayment issues, segmenting this group of customers between those who cannot pay because of cash flow issues in the household and those who choose not to pay because the device is not matching their expectations, or they have problems with the payment system (such as network connectivity). Different market strategies and responses are then tailored for each group of these customers (M-kopa, 2015)

[6] Experience from years of development initiatives (for instance, see the systematic review in Puzzolo *et al* 2013) show that it is clearly important to move beyond the technological aspects of stove performance to provide an integrated, modern cooking solution that consumers find attractive, functional, appropriate to their needs and – most importantly – a measurable improvement on the system they currently use.

[7] Aspects that go beyond efficiency, such as durability and convenience are often overlooked across programmes in Mozambique. For example, the local artisanal stoves produced in Mozambique are made of ceramics and have an estimated life span of 3 years' maximum. More studies need to be done to ascertain their durability during use, and transport to remote areas.

[8] See Ekouevi (2013) for a comprehensive review of the World Bank Group Programmes aimed at sustaining clean cooking across multiple countries, but also Rehfuess et al (2014), and Puzzolo et al (2013).

[9] ESMAP has developed a Global Tracking Framework (GTF) for modern cooking solutions that rates access on a scale of zero to five against seven factors. Under the GTF system, the affordability and convenience of the cooking device receive as much prominence in defining a modern cooking solution as efficiency and emissions.

and skills are all necessary to catalyse more investments in the sector. Reforms to the business environment that can deliver these objectives have been prioritised in this report.

2.1.2 Demand for Solar PV systems

A Bloomberg report from 2016 estimates that consumers in Africa save on average USD $3.15 for every dollar spent on pico-Solar PV (Bloomberg, 2016). In Mozambique, however a consumer may not be able to reach this level of savings,[10] reducing the economic advantage for rural consumers to move to solar energy, and weakening demand. The **weak demand in rural areas**, coupled with the GoM's vision that private investments in the energy sector are primarily (if not exclusively) a means to deliver access to poor rural people are **the main constraints to businesses.** A lack of a coherent policy framework for the Solar PV sector significantly raises the perceived risk profile of investing in it.

The root causes of weak demand for Solar PV systems in rural areas are:

1) **Low willingness to pay.** A demand assessment recently carried out by GreenLight (2016) for M-Kopa[11] in the communities of Lizuveve, Muchia and Nhoqueiro near Moamba, in the Southern Part of Mozambique shows that 65 per cent of rural households make use of battery-operated torches for lighting, with monthly spend of MZN 221. Kerosene is not widely used for lighting purposes, and whilst there may be slight differences up and down the national terrain, it would appear that many households charge their phone for free.[12] The batteries sold are cheap imports from China that are distributed by small informal village shops. Although this sample is not representative of national consumption patterns, its findings are corroborated by similar market studies that have been carried out in northern Mozambique.[13]

   Changing these consumption patterns is very challenging, because, generally speaking, the expectation is for electricity to be cheap, since Mozambique has the lowest tariffs in the world. In addition to this, Portuguese is still not spoken by a substantial portion of the population, especially in rural areas.[14] This represents a challenge in raising awareness of the benefits of solar systems and in providing post-sales support, reducing

[10] This because compared to other African countries, Mozambique electricity tariffs are lower, and the current level of expenditure on mobile phone charging, torch batteries and kerosene is low (GreenLight, 2016; M-Kopa, 2016).

[11]There is no systematic assessment of energy demand and consumption patterns available that is updated to 2016, only recent spot market analysis conducted by perspective investors in solar energy.

[12] A recent Mobile Access Usage Survey (2016), part commissioned by DFID through FSDMoç indicates that the cost for mobile phone charge is between MZN 10-20. The survey does not offer further insights on the extent to which phone charging prompts a transaction.

[13] See for instance, GreenLight (2014), a market study in the province of Cabo Delgado that shows that 78 per cent of households that are not connected to the grid use torches as their main source of lighting, and buy 4 AA battery packs every three days for a total expenditure (in 2014) of 180-220 Meticals.

[14]According to UNICEF, 50 per cent of Mozambican adults (15 years old and above) are literate, with likely higher illiteracy rates in rural areas.

the perceived value for Solar PV products. For these reasons, government action should be directed to sustaining demand in a more concerted way, through education campaigns and by ensuring that products of quality are delivered to the market.[15]

2) **Weak ability to pay.** Weak capacity to pay is one of the reasons why solar products are currently used by only 9 per cent of the population in rural areas (GreenLight, 2016). 43 percent of the households surveyed in the GreenLight study earn below MZN 5,000 per month (USD $65 at the exchange rate of 13 October 2016), meaning that at current prices, a quarter of their monthly income would be needed to buy a solar lantern of average price (USD $15). The financial crisis currently faced by Mozambique is also exacerbating the issue, making solar kits more expensive, due to a rapidly falling exchange rate.

   For obvious reasons, the cost of operation in rural areas is a function of the costs of distribution, which in Mozambique are particularly high, due to the bad conditions of road networks, and the limited number of ports from which imports can enter (primarily Maputo and Beira). The country's road network spans approximately 30,000 kilometres in total, including primary, secondary, tertiary and side roads. The primary road network is 5,971 kilometres most of which are paved, whilst of the secondary (4,915 kilometres) and tertiary networks (12,603 kilometres) remain largely unpaved (80 per cent and 94 per cent respectively).[16] The situation is also exacerbated by the on-going armed conflict between Government forces and the Mozambican National Resistance (RENAMO) guerrillas, that de-facto cuts out the port of Beira from the country's road network, and makes travelling in the central regions of the country unsafe.

Given the nature of demand for Solar PV systems priority reforms to improve the business environment for Solar PV systems **should reduce investment risks and help import appropriate quality Solar PV products at low cost**.

2.2 Technological Considerations

The quality of ICS and Solar PV depends on technical design and technological content. The speed technology evolves is, however, very different for the two products.

2.2.1 Solar PV sector

Since 1998, the cost of Solar PV systems has fallen worldwide by an average of 6 to 8 per cent a year, according to the US National Renewable Energy Laboratory (NREL),[17] and the efficiency of solar panels increased constantly. The cost of batteries and inverters has also been falling significantly. As a result, the cost of solar energy has declined by more than 73

[15] Quality is important to build consumers' trust in PV products.

[16] Source: Integrated Programme of the Ministry of Development Planning and Investment (past administration), revision of June 2014.

[17] NREL website accessed on 15 October 2016 http://www.nrel.gov.

per cent since 2006. The International Renewable Energy Agency (IRENA) estimates the cost of traditional solar panels will decline by an additional 42 per cent by 2025, to a global average price of USD $0.30 to USD $0.41/Watt, and the cost of solar inverters will fall by 33 to 39 per cent over the same period (IRENA, 2015). In order to reap the benefits of these technological improvements, Mozambique should therefore keep an open market, facilitating imports at the lowest possible cost.[18]

[18] Improvement in PV technology is also coupled with increasing efficiency in electricity consumption. The Annual Energy Outlook of 2014 of US Energy Information Administration (EIA), for instance reports: "*typical 60-Watt incandescent lamps produce only 16 lumens of light output per Watt with useful lifetimes of 1,000 hours on average, while a comparable halogen incandescent lamp may produce closer to 20 lumens per Watt. An equivalent compact fluorescent lamp (CFL) provides about 67 lumens per Watt and lasts 10 times as long. Solid-state light-emitting diode (LED) lamps are even more efficient—currently producing around 83 lumens per Watt—yet are rated to last more than 30 times as long as a comparable incandescent lamp. LED lighting technologies have been advancing rapidly with projections for further improvements, resulting in lower cost, increased reliability, and reduced energy consumption. By 2020, EIA projects LEDs to produce more than 150 lumens per Watt*". See: http://www.eia.gov/todayinenergy/detail.php?id=15471 accessed on 3 November, 2016.

2.2.2 ICS sector

Design for ICS is driven primarily by local preferences, culture and geography. Demand has not been sufficiently studied in either a quantitative or qualitative fashion in Mozambique. Internationally, the Global Alliance for Clean Cookstoves and the World Bank have begun to emphasise how the sector requires market segmentation analyses supported by ethnographic and human-centred design research into consumer behaviour and preferences in order to improve adoption (ESMAP, 2015). Three successful primary models for product development and research have emerged based on local designs, international designs, or hybrids. Each model comes with distinctive challenges and advantages. Locally designed stoves can be created with a better view of the market in mind, respond to consumers' preferences, and can be cheaper, but often lack the finance or production capacity to develop high quality models. In addition, the adoption of one model of stove versus another may strongly depend on the availability and price of fuel in the local area (i.e. charcoal vs. firewood).[19] By contrast, international stoves may use high-end materials and yield greater efficiency, environmental and health benefits, but they are often poorly customised to local user preferences.[20] Hybrid models seek to take advantage of the best of both worlds, but are difficult to execute in practice given multiple remote designers.[21]

Locally produced and hybrid models assembled in the country are the only models that could be marketed on a purely commercial basis, having a lower (net of subsidy) pricing point.[22]

[19] In order to respond to constraints on the availability and price fluctuation of fuels, users may stack different types of stoves. The phenomenon of stoves stacking has been observed in many countries, including Mozambique. In order to reduce this phenomenon, it is important for the stove design to be versatile, and respond closely to user preferences.

[20] User preferences are determined by geographical and socio-cultural aspects, which vary across Mozambique, these include household preferences, food tastes, and cooking practices. For instance, mountainous areas or areas where temperature drops significantly at night, may prefer a stove that can also double as a heater at night. A great difference is also between the rural and coastal areas. The diet of rural areas is based primarily on mandioca, which is baked, dried in the sun or mashed with water to form porridge. In its most common form, it is ground into coarse flour along with corn and then mixed with cassava leaves and water. The resulting dough is served in calabashes. Corn is the other staple food. Along the coast, the cuisine is more varied and Portuguese-influenced than it is in inland areas. The diet there includes more fruit and rice as well as seafood dishes such as macaza (grilled shellfish kabobs), bacalhão (dried salted cod) and chocos (squid cooked in its own ink). These different dishes require different preparations, time of cooking and type of kitchenware. These differences are reflected in preferences for certain stoves designs versus others. Similarly, different ethnic groups and regional areas may have households of different sizes, and may require different size of stoves.

[21] The most common artisanal stove produced in Mozambique is the Mbaula Charcoal Stove, consisting of two main parts: A ceramic liner as heat resistant fuel recipe and a metal base as a support for the ceramic layer. Both parts are completely artisanally produced. A semi-industrial version of the Mbaula is also now being produced in aluminium. The efficiency of the Mbaula stove ranges between 40 and 42 per cent.

[22] This is particularly true because of the prevailing and continuing devaluation of the Metical, as explained in mode detail later in the document.

2.3 Gender Considerations

Women's empowerment and gender equality are, in general, scarcely addressed by renewable energy programmes in Mozambique. However, if specifically addressed in these programmes, they can make significant contributions to improving women's position and status. For this reason, the policy actions recommended in this report take the following gender considerations into account:

- **Women as users.** Women participate in the Solar PV and ICS markets in different ways. At the most basic level, women are primarily the beneficiaries of new solutions for cooking energy because of their traditional role of looking after their families and homes as caregivers. The female participation rate decreases when the work is more technical. For this reason, improvements in the ICS sector can more easily translate into improvements to the welfare of women. Demand for ICS appears to be influenced by gender-specific preferences with respect to stove attributes, with women valuing health benefits and men favouring fuel efficiency and monetary savings (Rehfuess et al, 2014). These should be taken into account in public campaigns to improve awareness of the benefits of ICS.
- **Women as producers.** In addition, women have a better understanding of what users of ICS want and the production of ceramic liners is suited to be popular amongst women, since it can be done from home and in their own time, allowing flexibility to adjust the schedule with other tasks. In consideration of the above, in order to achieve maximum impact in terms of dissemination of ICS, policies that reduce barriers to business for women to participate in this sector are particularly effective.
- **Women as economic actors.** Improved cook stoves generally improve women's well-being in terms of health (by reducing smoke) and workload reduction (by reducing fuel wood collection). However, only when women's time has an accepted economic and monetary value because of opportunities to earn cash income, is there an economic incentive to invest in an improved cook stove. Marketing such technologies is thus likely to be most effective when women's time is economically valued in real monetary terms or when there is a requirement to buy fuel. Areas where women are more likely to be involved in economic activities therefore provide greater readiness for the commercialisation of ICS.

2.4 Political Economy Considerations

The policy making process in Mozambique is framed by the prevailing political economy. Government has a history of strong public intervention in the market, and has shares in 109 companies across a wide number of sectors (from security to cold beverages). This, coupled with an increasing number of businesses owned by the Mozambique Liberation Front (FRELIMO) party members, discourage appetite for policies that support market openness and competition. The lack of support to the private sector is noticeable across sectors. The current economic and military crisis connected to the RENAMO insurgency also distracts attention and appetite from prioritising reforms in sectors that are perceived to be secondary, such as off-grid electrification and developing the ICS market.

The historical trajectory of the nation and socio-political norms render the public sector as unsure of the participation of private enterprise in delivering on the vast energy challenge. The notion that private interests can (if well directed by policy) delivers public benefits, such as cheap connections to electricity are not fully acknowledged by the public sector. An absence of clear prioritisation of policy objectives in relation to electrification,[23] as well as a limited demonstration of interest in catalysing the private sector to develop local knowledge and solutions in the ICS sector further underscores the disconnect. The consequence is that government and international non-governmental organisations (NGOs) and donors tend to intervene directly in the market often with distortionary rather than catalytic effects. Government will need to include the private sector in the vast energy challenge for realistic structural reform in the business environment to take place since access to energy is of primary national interest.

Security Considerations

The ongoing state of armed insurrection waged by the RENAMO party is also a major obstacle to business (albeit affecting primarily the central and northern regions of the country). The insurgency is part of the aftermath of the Mozambican Civil War and began in mid-2013, resulting in dozens of deaths in the first year. A ceasefire was announced between the government and the rebels in September 2014, but armed conflicts started again after the 2015 political elections, whose result were not fully recognised by RENAMO. The current conflict affects the PV and ICS industry in two ways.

First, it constrains supply along the country's major artery, the EN1 highway, disrupting the South-North flow of people and goods out of Maputo and South Africa, the main points of entry for imported PVs and ICS. Road attacks occur on a regular basis on large stretches of the EN1 south and north of Beira, often accompanied by military and civilian casualties. The resulting disruption to normal traffic patterns has been significant, forcing traffic to travel under escorted convoys considerably delaying transits.[24] Delays in organising such convoys can mean days, if not weeks, of delays in the shipment of goods from South Africa. This type of disruption presents a challenge primarily for the PV sector, as components are almost entirely imported. Truckers are increasingly reluctant to face the hardships of hauling goods from Maputo up to the Northern provinces. Operators interested in serving the northern regions are forced to use the port of Nacala for their imports, which is known to be less efficient and more congested than Maputo (SPEED, 2014).

[23] Whereby a tension exists, for instance, between keeping electricity tariffs low, and consequently making a loss and not being able to expand the network, versus providing more access to better-off strata of society by attracting private investments. Or delivering free or heavily subsidised (but badly maintained) off grid solar connections through public tender and control (concessions), versus encouraging private investments in a de-regulated market that is free of distortions.

[24] Discussions with bus operators indicate that north-south voyages, which normally required 24 hours, are now, because of convoy-related delays, taking 72 hours.

A second negative impact is that the violence is disrupting economic activities, and displacing populations, particularly in rural areas, and consequently depressing demand for ICS and Solar PV systems[25] in the rural northern and central regions of the country. These constraints make private sector investments in the Solar PV and ICS sectors to serve these regions highly unlikely at this time, until tensions are resolved and peace is restored.

2.5 The Laws and Organisations Underpinning both Sectors

The following legal instruments regulate the energy sector, and are important for both the Solar PV and ICS markets.

- **The National Energy Policy (Decree No. 5/98, of 3rd March, 1998):** This policy was adopted to guide the direction of Mozambique's energy sector. The National Energy Sector Strategy was established by Decree 24/2000 (3rd October 2000) to implement the policy. It was revised in 2009 to reflect changing priorities and actions. It is currently being revised to accommodate issues related to oil and gas activities;
- **Development of New and Renewable Energy (RE) Policy (Resolution No. 62/2009, of 14th October 2009):** RE policy was established to promote greater access to clean energy services through the use of equitable, efficient, sustainable and culturally sensitive sources of new and renewable energies**;**
- **The National Policy and Strategy for Biofuels (Resolution No. 22/2009, of 21st May):** This strategy identifies biofuel's capacity to deliver on economic and energy policy objectives and forms the basis of the National Program for the Development of Biofuels (PNDB). The objectives of the policy are: firstly, to promote agro-energy resources for energy and food security; secondly, to encourage socio-economic development (based on the multiplier effect and development of by-products); and, thirdly, to address the volatility of fossil fuel prices in the international market as well as to reduce the country's dependence on fuel imports;

Apart from legislation that is specific to the energy sector, another relevant legal instrument is the **Investments Law (Law 3/93) of 24th June 1993**. According to this law, investments that are of recognised public interest and support the economic development of Mozambique are entitled to fiscal benefits as defined in the Tax Benefit Code (TBC). The tax benefits include income tax deductions, accelerated depreciation, investment tax credits, exemptions and reductions of tax rates and the deferral of tax payments. Investors that establish companies that contribute to the introduction of new environmentally friendly technologies such as ICS are also eligible for deduction of the personal income tax rate.[26] A second non-energy specific

[25] For instance, the Mozambican Workers' Organisation has recently announced the loss of 1,200 jobs in the province of Nacala, due to the closure of 30 companies whose business has been affected by the ongoing military tensions (see: http://clubofmozambique.com/news/1200-jobs-lost-nampula-province-30-companies-close-mozambique/ accessed on 17 October 2016).

[26] These deductions are however seldom applied, due to lack of clear application guidelines and lack of understanding of the PV and ICS sectors by the tax authority.

legislation that establishes important provisions for the energy sector is also the **Land Law (Law 19/97) of 1st October 1997**, which establishes important instruments for the sustainable exploitation of biomass resources.

The following development partners support the sector:

- **UK Department for International Development (DFID):** DFID is about to invest GBP £33 million (USD $41 million at prevailing exchange rates) in a new programme to be operational over the period 2016-2022 with the objective of expanding market access for off-grid renewable energy products, ICS and related services to rural communities and businesses in Mozambique;
- **Energising Development (EnDEV):** The Energising Development Programme is an energy access partnership worldwide, currently financed by seven donor countries: The Netherlands, Germany, Norway, Australia, United Kingdom, Switzerland and Sweden. EnDev promotes sustainable access to modern energy services that meet the needs of the poor, being long lasting, affordable, and valued by users. In Mozambique, the programme has been supporting renewable energy interventions in different applications, namely solar home systems, including pico systems, hydro mini-grids (in Manica province) and improved cook stoves. EnDev takes a market approach in delivering support, although not all implementers in the programme always share the same view on interventions. The programme works in Manica, Inhambane, Sofala and Cabo Delgado provinces.
- **Belgian Technical Cooperation (BTC):** BTC has been funding renewable energy projects in rural areas and the undertaking of capacity building activities through FUNAE. It has included limited attention to the development of the private sector in the market.

3. Off-Grid Solar PV Systems Market Overview

3.1 International Technological and Market Trends

A recent report published by Bloomberg and Lighting Global (2016) shows that by mid-2015 more than 20 million pico-solar products (defined as having a PV panel smaller than 10W) have been sold to customers without modern energy access. In Sub-Saharan Africa, Kenya, Tanzania and Ethiopia are the leading markets, accounting for 66 per cent of unit sales in the whole of Africa. The success of pico-solar systems is grounded in cheaper and better-quality technology and innovations in distribution systems and payment methods across rural areas, often supported by public and donor funding.

In recent years, however, the strongest growth has been in the market for SHS.[27] The Bloomberg report attributes this success to technological development. Although SHS are more expensive, PAYG systems allow firms to sell solar kits against small instalments instead of a lump-sum payment with a technology that locks the functionality in the event of non-payment by the consumer. PAYG systems can also be applied to mini-grids, larger-size instalments that can serve a number of households from a single generating unit. Using this technology, 20 more companies are now providing consumer financing for the purchase of SHS, serving almost half a million customers, mainly in East Africa. A number of international venture capitalists and financing initiatives are paying increasing attention to this sector, as technology improves and investments become increasingly viable. The Bloomberg report states that in excess of USD $511 million has been invested to date in solar in Africa, with PAYG companies attracting almost USD $160 million in 2015, including a record USD $45 million single debt round by Off-Grid Electric.[28]

Successful off-grid solar energy sectors, however, do not simply rely on the strengths of individual innovative companies, but are the outcome of systemic interactions among a number of organisations and a sound, predictable, and transparent policy and regulatory framework. The typical supply chain for the off-grid solar energy sector comprises a number of actors and a wide range of business models. Companies use a variety of approaches to penetrate the market, which may include also selling pico-solar systems, or competing for public tenders to install mini-grids and even selling to the grid. Business models centred on PAYG have intrinsically more to do with micro-finance and extending consumer credit to the BoP, than they have with public utilities. Some of the common models are described as “DESCO” — Distributed Energy Service Companies that provide a given level of energy service in exchange for ongoing payments. Others are described as asset finance or micro-loan providers, with a transfer of asset ownership to the user after a limited payment period. Others act as business-to-business (B2B) intermediaries, supplying hardware and software support from global operations to last-mile energy service and payment logistics. The

[27] A bigger-size solution to the pico-solar system, with the capacity of powering several lights, phone charging station, a radio, and at times also a TV and a fridge.

[28] http://offgrid-electric.com/#home

development of the Mozambican off-grid solar sector will need to take into account that the establishment, survival and growth of companies in this sector depends on allowing the operators to adopt mixed market strategies, in order to diversify risks and develop the economies of scale that are needed to expand distribution and access deeper into rural areas.

3.2 The Off-Grid Electrification Market in Mozambique

The off-grid electrification market in Mozambique presents great opportunities. Mozambique's overall electrification access remains very low relative to the African average. As of 2014 (the last year presented in official statistics) grid access was only reaching about 26.3 per cent of the country, reaching (but not covering) 126 of the 129 districts in the country (EDM, 2014). As the population is currently estimated at about 28 million,[29] the addressable market for new connection can be estimated at 20.6 million, or 4.1 million households (using an estimate of five members per household) (updated from M-Kopa, 2016).

Like many other countries in Sub-Saharan Africa, however, most of this market is in rural areas, as grid access is not evenly distributed between urban and rural areas. Rural households suffer a 1 per cent connectivity rate against 82 per cent in urban areas (EDM, 2014). Although the national utility, Electricidade de Moçambique (EDM), is in precarious financial condition, and the grid infrastructure is in need of upgrades and repairs,[30] the Government remains focused on achieving the Sustainable Energy for All[31] target of universal connections by 2030. Connections to the grid are therefore growing at an unsustainable rate, for the state of the infrastructure, and raising expectations for cheap electricity, reducing the opportunity for private sector involvement in the sector. EDM has in recent years achieved an average of around 120,000 new connections per year, but much of this growth is restricted to the urban centres, and is pushing the system to quickly approach maximum production capacity. The geographical spread of the country and low population densities in rural areas make it however impossible to achieve universal access through grid extension alone, emphasising the need for a strong off-grid sector.

Despite the opportunities, the Mozambican off-grid market remains limited in size, because the prevailing business environment raises the risk profile of investing in the sector significantly. The number of companies currently active in the market is six, only one of which is directly targeting private customers, while most are entirely dependent on public tenders from the Fundo de Energia (FUNAE). This is in strong contrast with what is happening in the rest of Sub-Saharan countries, where the market for solar off-grid solutions is booming. In fact, a recent market survey by Bloomberg (2016) identifies more than 100 companies in Sub-

[29] World Bank data from http://data.worldbank.org/country/mozambique accessed on 28 September, 2016.

[30] The World Bank Mozambique *Energy Sector Policy Note* of 2013 reports: "The physical condition of the system is poor, with frequent breakdowns and high rates of electricity losses (approx. 23.2 per cent in 2014). There were over 59 hours of transmission interruptions in 2013 with the average interruption time increasing from 30 minutes in 2009 to 68 minutes in 2013. This is also caused in part because EDM lacks the technical staff to cope with the regular operation of the grid".

[31] http://www.se4all.org

Saharan Africa focusing on stand-alone solar lanterns and solar home system kits targeted at those without modern energy access.

3.3 Off-Grid Solar Sector Laws and Organisations

The following legal instruments regulate the PV sector, in addition to the instruments discussed earlier.

- **The Electricity Law or Act (Law 21/97, of 1st October 1997):** This law was introduced to regulate the production, transmission, distribution and commercialisation of electricity. It established the principle of granting individual concessions for specific activities and created the advisory body Conselho Nacional de Electricidade (CNELEC), as well as the Energy Fund (FUNAE), for the promotion of access to modern energy services in rural areas. The main regulatory functions in the energy domain are the prerogative of the Ministry of Mineral Resources and Energy (MIREME), while CNELEC as merely a consultative function. However, recently, CNELEC has been transformed into the Energy Regulatory Authority (ARENE), a fully independent body, with executive powers that extend from electricity to the whole energy sector. ARENE is however not yet operational.[32] The Electricity Law opened electricity production, distribution and retail segments of the market to private operators through concession contracts issued by MIREME;[33]
- **Strategy for New and Renewable Energy Development (EDENR) 2011–2025:** In 2011, the Strategy for New and Renewable Energy Development (EDENR) 2011–2025 was adopted to develop domestic renewable energy, diversify the energy mix, meet demand for energy and protect the environment. This is to be accomplished through on-grid and off-grid technologies, with the off-grid component linked to the Action Programme for Reduction of Absolute Poverty II and III (PARPA II/III) which promotes electrification to achieve poverty alleviation and economic development in rural Mozambique. The EDENR sets the following objectives:
  - "Improving access to energy services for improved quality, from renewable energy sources"

[32]However, the achievement of the objective of creating a strong and independent regulator in the sector, ensuring the effectiveness of its actions, in particular the electricity sector, necessarily involves the liberalisation of the market, allowing all players to compete on equal access to the same conditions concerning the production, access to the transmission system, distribution and commercialisation of energy throughout the national territory. Subsequently, the creation of an independent and active regulator should be seen as a corollary of the review of the energy sector legislation, which should allow the intervention of several players in the various subsectors (i.e.: management of the electricity grid, fuel procurement).

For example, under Decree No. 43/2005 of 29 November, EDM is the manager of the National Network of Electric Energy Transport, on an exclusive basis, also exercising the functions of distribution and sale of electricity to final consumers. In the current scenario, the EDM is managing the network and single borrower of energy produced by the energy producing utilities, a fact that places in a privileged position in the negotiation of energy sales prices, giving it a monopoly position.

[33]The management of the national grid is under EDM, as per decreto nº43/2005, from 29 November. However, at local level, for micro or mini-grids, the private sector can generate and distribute power.

  - "Develop the technology use and conversion of renewable energy sources"
  - "Promote and accelerate public and private investments in renewable energy resources" (MIREME, 2011: Chap. 3 Strategic Objectives).

- **Renewable Energy Feed-in Tariffs (Decree 58/2014, of 17th October 2014):** This legislation enables independent power producers of renewable energy electricity to inject power into the national grid. Although the decree is available, injection of power into the grid cannot happen yet as some regulation is still to be approved. In particular, while EDM has developed grid code for power from conventional systems, the grid code for injection of renewable energy power into the grid is currently being reviewed by the MIREME legal department.
- **The Regulations to License Electric Installations (Decree 48/2007, of 20th October 2007):** This decree classifies electrical installations in 10 separate categories according to the source of energy and whether the installations include distribution and sale, whether they are for self-consumption or for public use, as well as whether they are temporary or permanent. The decree establishes that each category is subject to a different licensing requirements and is subject to different levels of taxation. PV and hybrid self-contained systems fall under category 5, which require an inspection and license issued by MIREME,[34] filed through the local directorates of energy (at district and province levels). At the moment, there is lack of clarity on whether the regulations are actually applied for solar home systems. Larger solar installations, such as in hotels or small companies, are also not clearly regulated.
- **Concession Decree (Decree 8/2000, of 20th April 2000):** This decree establishes competences and procedures for provision of concessions for production, transport, distribution and commercialisation of power, including its importation and exportation.
- **Renewable Energy Atlas Project (with start in 2011):** This tool aims to identify potential sites for energy generation on the basis of renewable energy. This covers particularly the solar energy, wind, mini-hydro, biomass, water, geothermic and oceanic energy. A first Atlas was published in 2014[35] providing a good review of the energy production potential across the whole country.

The following institutions are major players in the Solar PV sector:

- **The Council of Ministers (or the Cabinet):** In charge of setting the energy sector policy and strategy, as well as for granting concessions for generation of 100 megavolt ampere (MVA) or above;

[34] The request for the license would include three copies of the installation's plan, with technical specifications, and a description of the use of the installation.

[35] Seewww.atlasrenovaveis.co.mz

- **The Ministry for Mineral Resources and Energy (MIREME):** MIREME is responsible for managing the energy sector in the country. The National Directorate of Energy (DNE) is the body in charge of both conventional and renewable energy systems. The DNE is a central technical body within MIREME that is responsible for the analysis, preparation and elaboration of energy policies. Its main tasks are to:
  - study, propose changes to and administer the country's energy policy;
  - promote the diversification of energy use and optimise the use of various energy sources;
  - determine environmental issues and provide the plans and programmes for the development of the sector, based on the development of the economic perspectives of the country;
  - promote and maximise the rational use of national energy sources with relevance to the installed capacity by encouraging investment; and
  - Promote cooperation between public and private institutions, whether national or foreign, in achieving the maximum potential in the technical development and regulation of the sector.
- **The Regulatory Authority for Energy (ARENE):** It is the electricity regulator and shares some regulatory functions with the MIREME. It is currently being operationalised.
- **The Energy Fund (FUNAE):** It is a state agency responsible for promoting off-grid energy access and fuel distribution to remote locations. FUNAE is subordinated to MIREME. It was created as a fund to supply financial aid and financial guarantees for economically and financially viable projects that are in tune with FUNAE's stated objectives. Nevertheless, it has been working as a renewable and rural energy agency through public tenders, and by directly implementing/funding of projects. It also owns a solar modules factory with a capacity of 5 MW_p per year.
- **Companies Operating in the Sector:** Companies producing energy are supervised by MIREME, like the power utility EDM, the independent power producer (IPP) HCB, the fuels company PETROMOC and the transmission electricity company MOTRACO, powering the aluminium smelter MOZAL. A company for assembling Solar PV modules is owned by FUNAE. A small number of renewable energy companies are based in Maputo. NGOs are operating in the field, some based in Maputo and others in the provinces, primarily subsidising the installation of solar systems through FUNAE. These activities, however, remain limited and do not appear to crowd-out private investments.

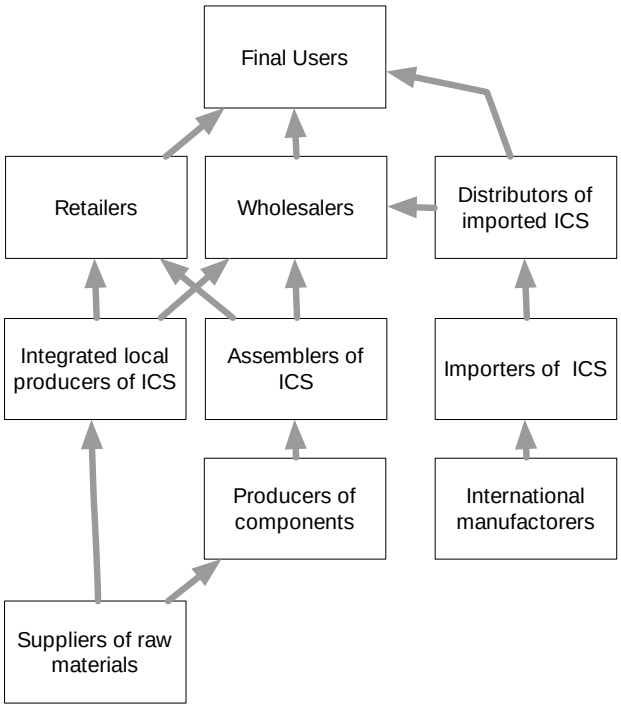
4. Improved Cook Stoves Market Overview

The market for ICS in Mozambique is limited in size. It is estimated that roughly 70,000 ICS have been distributed in the country, primarily through NGO intervention. This amount includes locally produced as well as hybrids and imported ICS. Given the size of the potential market and the fact that the life span of a cooking stove is estimated to be around 2 years, the need to deliver improvements to the market system at scale and to strengthen the involvement of the private sector is evident.

4.1 The ICS sector in Mozambique

The supply chain for locally produced ICS involves a number of different players, all of which face business environment challenges.

Figure 1: The supply chain for ICS in Mozambique



At the basis of the chain are companies supplying raw materials and companies supplying components. This set of companies comprises medium-sized importers of ferrous components (primarily from South Africa), as well as micro and small local companies delivering clay, refractory concrete, and producing pottery. The main constraints facing these sets of operators are the difficult access to credit for working capital, which prevents them from building stocks and creates disruptions in the supply chain, and the difficulty of dealing with customs and a rapidly falling exchange rate when imports are required.[36] The second tier of

[36] The business environment constraints are analysed in more details in the report.

players in the supply chain are vertically integrated producers of local ICS and assemblers of local and hybrid ICS. This set of players comprises of medium/small size formal ceramic and pottery companies as well as semi-informal handicraft groups. Given the number and size of producers, this level of the supply chain remains fragmented and disorganised; production is artisanal rather than in series, with significant variations in quality and no economies of scale. The lack of economies of scale is the biggest binding constraint for the growth of the industry, given the weak capacity and willingness to pay that characterises demand for ICS, as local production remains expensive, with no guarantee of quality. The biggest challenges to scale up production faced by this group of operators, besides access to credit (a problem cutting across all operators in the supply chain) is weak availability of qualified workforce, high costs of transport and the lack of an established and accessible industry standards and certification system, which has an impact on quality and demand and prevents local producers from accessing carbon credits.[37]

The supply chain for imported ICS runs parallel to that of local production. The international NGOs AVSI and SNV are the main players, the former importing assembled Envirofit Econochar from China and the latter importing components for the Rocket Works Chazam from South Africa that are then assembled locally. The Eduardo Mondlane University Foundation has also imported Envirofit CH 2200 from China. As these stoves are commercialised with the financial support of the EnDEV programme as well as carbon credits, their sale price is heavily subsidised, creating a disincentive for local producers to upscale their production.[38] In addition, since the retail price covers only a small component of the price of the stove (typically less than 30 per cent), these organisations are often able to provide a form of credit financing, by allowing customers to stagger the payment of the stove over a 30 day period. Given these constraints, our key informant interviews with operators in the sector, reveal that the current macroeconomic instability and the rapidly depreciating Metical are the biggest constraint faced by operators in the ICS market.

4.2 ICS Laws and Organisations

The following legal instruments and organisations make-up the ICS sector, in addition to the laws and organisations discussed earlier.

- **Mozambique Biomass Energy Strategy – BEST (2013):** This strategy promotes a sustainable use of traditional energies, namely fuel wood, charcoal, crops residues and

[37] Access to carbon credit is based on the reduction of emissions due to the effective use of ICS, rather than their sale. This means that it is limited to industrially produced cooking stoves that have a serial number and whose use can be traced after sale. In Mozambique, only international NGOs importing international stoves access carbon credit through the Clean Development Mechanism (CDM).

[38] Despite the low volumes, these distortions can be significant. This because the only commercially assailable market segment for ICS is the one that makes use of charcoal, given the growing price of charcoal and the potential savings that ICS can deliver to the user, in the long term. This market segment is however one where NGOs are already quite active. For instance, an imported Envirofit Econochar can be found in Maputo at the price of 500 Meticals, against 800 Meticals for locally produced aluminium Mbaula or 450 Meticals for a galvanised Mbaula.

dung. The Strategy addresses thermal applications of energy, primarily cooking. It covers domestic, institutional and industrial applications for biomass, and includes both commercial and non-commercial uses of fuel. In particular, the BEST focuses on the charcoal supply chain and addressing both the supply and the demand side by including:

  - regulatory and fiscal interventions and institutional changes for the production, transformation and distribution of wood fuels;
  - formalisation and monitoring of the charcoal supply chain;
  - promotion of improved cook stoves[39].

- **ADEL Sofala**: This is the local development agency for Sofala. ADEL is strongly involved in the biomass sector. They were actively working with the ProBEC programme to introduce and disseminate cooking stove technologies throughout the entire Sofala province. Today they are active in cooking stove production, training and promotion, PV dissemination and Improved Charcoal Production. They collaborate with a number of donor agencies.
- **Kulima**: Another NGO that was partner of ProBEC, focused on the regions of Maputo, Gaza and Inhambane. Kulima is active in the production and promotion of ceramic ICS stoves as well as, improved institutional stoves.[40] Kulima is also involved in the training of artisans and small entrepreneurs for the production of ICS.
- **The Eduardo Mondlane University (UEM)**: The University has been developing new types of stoves and is delivering training to rural communities on how to operate and maintain cooking stoves. The UEM also owns the Biomass Energy Certification and Testing Centre (BECT), which is the only testing facility in the country for ICS. Certification of locally produced Mbaula and Zavala stoves as well as Envirofit and Rocket Works stoves has been carried out to the tune of 30,000 stoves, as it allows the allocation of an identification number to the stove, tracking sale and monitoring effective use.
- Other organisations that subsidise the ICS sector are UNDP, the Swiss Energy Agency, and the Austrian Cooperation.

[39] See Ministry of Energy (2012).

[40] Larger stoves normally installed in public buildings such as schools.

5. A Framework for Prioritising Business Environment Reform

5.1 Solar PV market

The most important business environment issues are those that constrain the emergence of a market that is as open as possible to international investment and technologies, allowing Mozambique to capture the benefits of technological development in order to deliver the cheapest and best quality access to off-grid electricity. Reforms will need to:

- Protect international investments from government interventions that distort the market. This includes providing more clarity and consistency on policy action and direction;
- Reduce investment risks by facilitating access to international and national credit at concessionary rates and by making market information more readily available;
- Eliminate barriers and reduce the cost of importing Solar PV equipment and accessories;
- Facilitate access to international expertise.

5.2 ICS market

The issues prioritised are those that constrain the emergence of a strong Mozambican local industry for the manufacturing (including assembly) of ICS that can drive demand by delivering local preferences, while adopting technological solutions that minimise environmental impact. For the establishment of a local ICS industry, reforms will need to:

- Encourage a stronger market segmentation, whereby different products can be delivered at different pricing points, and fulfil the needs of different sets of customers;
- Support a national/regional system for R&D based on testing and recognised industry standards to improve trust in the products and applications for carbon credits;
- Reduce the operational costs of businesses by eliminating barriers and costs of importing components for locally produced ICS;
- Improve the availability of skills.

While improvements in the business environment will help businesses deliver ICS to segments that already use charcoal stoves and/or where women are engaged in productive activities, public support will be needed to raise awareness and subsidise the lower tier of the market.

A large body of literature on the *general* business environment constraints faced by businesses in Mozambique shows that compared with other countries, doing business is particularly challenging[41] for business in any sector. The advantage of a sectoral analysis of the business environment, however, is to narrow down reform and interventions to those areas that are essential for a market to grow in an inclusive way.

[41] In the 2016 *Doing Business* Ranking, Mozambique features at the 133rd position globally (was 128th in 2015), 13th in Sub-Saharan Africa and 8th in the SADC region.

6. Binding Constraints in the Solar PV and ICS Sectors

The following issues negatively affect the functioning of the market system and contribute to raising business risks significantly:

1) **Weak demand particularly in rural areas (ICS and Solar PV markets).** As we have seen the expansion of demand for both ICS and PV is strongly limited towards the bottom of the pyramid, where ability and willingness to pay are significantly weaker. For an off-grid BoP business to rapidly take-off in the market, the daily cost of access to electricity through a PV system should not exceed what the targeted population currently spends on lighting and phone charging combined.[42] The prospect of saving on fuel use over time is not enough to motivate the purchase of an ICS if the stove does not adequately fit with the local food tastes and social rituals. The margins available for competitively priced products are therefore narrow, particularly in rural areas, for a number of reasons, including:

- Low levels of literacy (linguistic and financial) are a significant barrier to valuing the savings that can accrue from a more efficient stove, and represent a challenge to operating and maintaining even simple solar systems.
- Very large distances between the ports of Nacala, Beira and Maputo and the interior increase distribution and maintenance costs of imported Solar PV systems, while the adverse condition of the road network increase transportation costs, and raises costs for both PV systems and ICS.
- In areas where FUNAE and development partners have directly funded the distribution of Solar PV systems and ICS, willingness to pay has been negatively affected (Greenlight, 2016). Similarly, the attention of the private sector has been catalysed towards public or donor-funded initiatives, rather than developing the market.
- Cheap (and low quality) batteries are well established in the market, and largely used, limiting the appeal of migrating to more expensive solar systems.

2) **Uncertainty of the macro-economic outlook.** Economic conditions in Mozambique have been progressively deteriorating after revelations that previously undisclosed loans pushed total public debt up to 85 per cent of GDP at end 2015, placing the country at high risk of debt distress. Consequently, the Metical has depreciated by 45 per cent over the first 7 months of 2016, inflation has reached 21 per cent in July 2016 (year on year) with food price inflation, at 36 per cent, being the driving factor.[43] While the currency depreciation raises costs on the import of equipment, the sharp growth in food price inflation reduces available disposable income, particularly in rural and poorer areas. This

[42] From consultation with a number of prospective entrants in the Mozambican market.

[43] World Bank, *Briefing Note*, September 2016, unpublished.

significantly affects the business case for new enterprises in the sector, making BoP targeted businesses remarkably riskier.

3) **Access to financial services.** Access to finance is by far the biggest constraint for the development of a local industry. On 21st October 2016 Mozambique's central bank raised its key rate by 6 percentage points to 23.25 per cent, the fifth increase since the beginning of the year, bringing commercial rates up to almost 30 per cent. The high interest rate and the stringent collateral requirements (more than 100 per cent collateral is often required) are insurmountable barriers for small and medium local companies that have no access to international markets, and take the biggest toll on the ICS sector, where the supply chain sees a bigger involvement of smaller players.[44] No affordable credit facility is available in the country, with the exception of a line of credit funded by the Bank of Mozambique and KfW and about to be (but not yet) operationalised by BCI. The lack of affordable credit is a severe constraint to extend outreach to more remote areas and poorer consumers, since it makes the establishment of consumer financing more difficult. Consultation with DFID-funded Financial Sector Deepening Moçambique (FSDMoç) indicates that the microfinance sector is still at an incipient stage of development. Furthermore, a lack of on-lending from larger commercial banks to smaller microfinance and community-based financial institutions means that the flow of capital to lower-income segments of the market is compounded. Rural and peri-urban segments of the market are poorly served by financial infrastructure compared with more developed financial markets such as Kenya where lower-income segments are well served by savings and credit cooperative organisations (SACCOs).

4) **Weak supply of skills in the labour market and complex labour law (ICS and PV markets).** The growth of the sector is hindered by the lack of local skills to develop renewable energy projects (notably hydro, wind, solar PV plants), including management, business, sales and marketing, and technical (supply chain, operations and maintenance). Without training certifications of recognised quality in the market, companies face high search costs to find suitable employees. At the same time, no incentives are in place for employing workers under the age of 25 and to provide in-house training to develop the skills and competencies of the labour force,[45] which affects upon youth employability and the ability to sustain innovation in the industry. While investors in this sector see employing foreign workers, at least on a temporary basis, as important in order to transfer expertise and know-how at the managerial and technological level, the recently approved regulations for hiring foreign workers have

[44] In the PV industry, most of the companies currently operating in the country either are self-financed or are raising international capital.

[45] See profile of labour market regulations from WB Doing Business site: http://www.doingbusiness.org/data/exploreeconomies/mozambique/labor-market-regulation (accessed on 29 September, 2016).

made this process substantially more cumbersome and expensive. This is a fundamental barrier for sectors like renewable energy, which are strongly dependent on maintaining a high level of skills for business development, servicing, maintenance and technological upgrade.

5) **Lack of clarity on the institutional[46] landscape for rural electrification.** Although the EDENR promotes the involvement of the private sector in renewable energy production and distribution at the local level, and the Electricity Law provides the legal ground for private sector participation, the sector for GMG, SHS and pico PV remains highly dependent on government funding, and interventions in the market. Government action is driven by different, and at times conflicting, policy objectives, such as increasing connections, ensuring that tariffs, whether off or on-grid, remain affordable, maintaining the (modest) revenue accruing from VAT and import duties levied on green energy equipment, protecting local manufacturing, such as the FUNAE solar panels factory. Without a clear and shared vision on what the priorities are for the development of the off-grid energy sector, uncertainty will continue to reign over the de facto[47] operationalisation of the sector, increasing the perceived risk of investment.

6) **Weak to non-existent system for quality certification and standardisation.** The Biomass Energy Certification and Testing Centre (BECT) at the University Eduardo Mondlane provides testing and certification services. BECT's outreach and capacity are however insufficient for the establishment of a recognised quality standard system in the country, and to serve a segmented and localised market that can respond to a diversified set of preferences.

Below is a detailed analysis of these constraints.

6.1 Institutional Constraints

The government programmatic documents show a strong appetite to involve the private sector in the provision of ICS and access to electricity in rural areas. The operating and business environment, however, is not yet conducive for business. This is because government interventions and regulations in the sector often pursue conflicting objectives, and policy priorities are not widely understood across government agencies. The lack of a shared vision on how to reconcile poverty reduction objectives with sustainable profit-seeking businesses is the source of considerable uncertainty, and it affects the market for independent solar kits and GMGs, as well as improved cooking stoves in different ways.

[46] The term "institutions" here is borrowed from institutional economics and defines stable, valued, recurring patterns of behaviour, or structures and mechanisms of social order, that govern the behaviour of a set of individuals within a given market. They include static written rules, such as laws and regulations, as well as the dynamic set of incentives and disincentives that shapes behaviour.

[47] Meaning the actual implementation of the rules and regulations, including informal rules, as opposed to the *formal* policy environment, as one may derive from the various laws and strategies put in place.

6.1.1 Solar PV market

Stand-alone Solar PV kits. Since a specific regulatory instrument for off-grid electrification does not exist, the sale of stand-alone Solar PV kits such as SHS and pico systems does not require any form of special licensing. The legislation that applies for this type of installation is therefore the one applicable to all electrical installation (including less environmentally friendly forms of generation like diesel generators), which is *Decreto* 48/2007 of the 22nd of October 2007. Under these regulations, stand-alone solar kits fall under category 5, or, *permanent electrical installations, that generate electricity and with electrical lines that do not extend beyond the property where they are installed*, and are subject to inspection and license by MIREME, as well as the payment of an annual tax levied on installed capacity. The request for the license is cumbersome and needs to include a detail plan of the installation and the technical description of each component, plus a description of the use.

Although these regulations are published on the *Boletim da República* and have been effective since 2007, they are not applied consistently. Larger solar and hybrid systems to power small, medium and large enterprises, instead are more tightly regulated, although the application of the law is exercised on a discretionary basis, and it is uncertain whether it applies to PV systems or generators alone.

The lack of a clear legislation for Solar PV systems is the source of considerable uncertainty in the market. While users are unable to understand clearly what the cost and time to operate a Solar PV or hybrid systems would be, investors feel that the regulatory environment for the sector is fluid, and that their investments are not sufficiently safeguarded.[48] Private sector operators also perceive that government de facto prefers Solar PV companies to operate in only rural and difficult areas where the grid will not be expanded any time soon. For this reason, there is some nervousness that regulations may change in a direction that would limit the capacity of businesses to operate freely in the market.

Green Mini Grids. Due to a lack of dedicated legislation, the tendering of concessions for small GMG follows the same process of big energy projects. This leads to a complexity in obtaining a concession contract that makes it virtually impossible for small local businesses or community-driven energy projects to operate on their own, rather than through FUNAE.[49] The only difference between larger electrification projects and GMG is that for the generation of energy less than 1 MVA concessions shall be obtained from municipalities. A common framework for municipalities to issue such concessions however does not exist, and, given the small number of investments in this area, capacity and understanding of mini grid setup

[48]Typically, a company selling solar kits, whether on a PAYG basis or through direct sale, would raise funds in a very similar fashion to any international start-up. It would first raise sufficient funds (typically from international investment funds) just to start operations in Mozambique and test the market, and once it has proved the concept, and set itself on a stable growth path, it would raise additional resources through subsequent funding rounds.

[49] Consultation with a leading law firm in Mozambique indicates that although Mozambican law stipulates that there should be public tendering, there have been limited instances of public tendering with the majority of projects awarded directly.

and viability is almost non-existent in rural areas.[50] The regulations set in *Decreto* 48/2007 that are discussed above also apply to GMG, requiring to submit more detailed information and plans for the installations.

Role of FUNAE in the Solar PV market. As established in the Electricity Law of 1997, FUNAE has a double mandate. On the one hand, the fund has the responsibility for delivering the GoM's objectives for rural electrification, providing renewable energy to targeted communities at highly subsidised cost. On the other hand, FUNAE's stated objective is also to catalyse private sector investment into off-grid electricity through the promotion of new off-grid energy technologies through training, marketing and other awareness building activities, often funded by donor initiatives. Although both of these policy objectives are commendable, the two mandates have evident trade-offs, particularly in an off-grid energy market that is still in its embryonic stages. The points of conflict are the following:

1) **Negatively affecting willingness to pay.** Having provided very low-cost electricity or equipment so far, FUNAE has created an expectation that the nominal fees charged were "fair" and that higher costs through alternative (market-based) schemes are therefore "unfair", leading some communities to refuse to engage with market-based initiatives (IRENA, 2012).

2) **Crowding out businesses.** To fulfil its social mandate, FUNAE has so far been funding a number of PV systems, in particular, decentralised mini-grids. When selecting locations for PV systems, priority is given to health centres and schools, as well as water pumping systems to provide potable water for community and agricultural purposes. Public buildings, police stations and households are also included in these rural electrification projects. These investments, although aimed at delivering a public service, could also catalyse additional private sector investments in the sector, by raising awareness in local communities of the benefits of solar systems. In order to achieve this, however, coordination between MIREME and other ministries, such as the Ministry of Education and the Ministry of Health, should be strengthened. Clear guidelines, would need to be provided on where the responsibility for overall maintenance and repairs lies. Although MIREME and FUNAE are involved in the electrification of schools and health

[50]The legal steps to establish a mini grid would therefore be the following. All activities in the electricity value chain (generation, transmission, distribution and supply) are subject to a regulatory approval by local authorities in the form of a concession agreement. Energy facilities across all sectors are also subject to licensing, as per the terms of the relevant legislation. Concessions in the electricity sector are subject to tender offers, in accordance with the Energy Concessions Regulation. Tenders must follow the guidelines set out in the terms of reference and are directed to the relevant competent authority (i.e., the local authorities in the case of mini grids). Tenders must also specify the technical and financial details of the project and provide sufficient evidence of the appropriate qualifications of the applicant. Hydroelectric projects require additional information on the characteristics of the hydroelectric use of the water resources. After the tender has been requested, CNELEC issues an opinion on the subject; projects that imply the acquisition of land use rights must also be preceded by a public consultation. After these steps have been undertaken, a decision by the relevant regulatory authority must be issued within 15 days. Such decision's effectiveness may be subject to conditions, such as expropriation or the granting of land use rights. This process may be simplified and shortened now that the regulatory powers are transferred to ARENE and CNELEC will no longer required to be consulted. A favourable decision by the authority will determine the entering of a concession agreement, where terms such as duration, applicable taxes and tariffs, conflict resolution mechanisms, guarantees, reversion and applicable law must be included.

facilities, they are rarely involved in maintaining the same. Meanwhile, the respective line ministries, having little ownership of the electrification projects, rarely set aside resources in their budget for maintenance and repair.

3) **The involvement of communities** in the planning process for GMG is expected to mitigate the problem of ownership and maintenance. The implementation of the EDENR is in fact necessary to the development of local Community Plans (CPs), which should be the basis for municipalities to issue concessions. Management Committees made up of local representatives and authorities are expected to guarantee the good performance of the installed systems and collect the monthly fees for the energy services, helping FUNAE to recoup part of the investment for the GMG. Some studies, however, reveal that CPs are seldom prepared and fail to deliver the maintenance services they are supposed to (Lyndrup, 2012). The result is that the way solar mini grids are currently being socialised raises expectations for free access to electricity, and lowers willingness to pay, reducing the opportunity to establish sustainable businesses, while sending negative signals to the market on the reliability of solar technology.

4) **Reducing the appetite for risk of private sector operators.** Within its role of financing new off-grid projects, the fund has been playing an increasing role in shaping the market through earmarking areas for projects, managing mini grids, and in some cases subsidising operation and maintenance in order to get projects in rural areas off the ground. This role has a strong impact on the market strategies that many market players have so far put in place in Mozambique, since most of the private sector activity is dependent on FUNAE's tenders, and does not invest resources in exploring the market independently.

5) **Increasing pressure to protect the solar panel market from foreign competition.** The opening of FUNAE's Solar PV panels production facility in the Beleluane Industrial Park near Boane in October 2013, although making access to Solar PV panels easier to local installers, is now providing an argument to maintain import restrictions and duties on Solar PV technology, limiting the scope for technological upgrades. The factory has the capacity to produce 5 MW_p a year of solar panels from components imported from India, and produces four types of solar panels with capacity of $10W_p$, $75W_p$, $100W_p$ and $150W_p$ respectively (GIZ, 2014). Despite the good quality of the panels produced in the facility, production costs and panel efficiency cannot compete with global technological upgrades, as well as the ever-decreasing price of solar panels to consumers. In other words, protection would seriously limit the market. Nevertheless, GoM has argued that factory production should be protected from competing foreign imports.

6.1.2 ICS market

The ICS market is small and characterised by a large number of donor initiatives that are often uncoordinated and do not share the same approach. The nature of these initiatives has therefore often been to intervene directly in the market, subsidising supply, and "imposing"

ICS designs that do not always match the preferences of users. The result so far has been of limited scale (70,000 stoves distributed to date). Some progress has been made in strengthening the national productive system for ICS, with the establishment of the BECT, by providing training to a number of local entrepreneurs and by carrying out awareness campaigns on ICS for local users. The lack of a shared vision on how to develop the sector and poor coordination among the key development institutions, however, do not facilitate the development of a resilient market system that can deliver change at scale over a prolonged period of time.

The current system of subsidies and support should be reconsidered. Support should be provided only to the lower tier of the market, in ways that are less distortive (for example through the use of a voucher system, stimulating demand and allowing consumers to choose according to their preferences). Direct public and donor intervention should be limited to raising awareness and demand, stimulating and supporting private sector innovations and facilitating the development of important market institutions, such as a national certification system.

6.2 Financing Constraints

Constraints on accessing finance affect both the supply side as well as the demand side of the PV and ICS markets.

Supply side constraints. While seed funding for start-up of Solar PV companies is often raised from the international market (a number of specialised international vehicles that fund green energy companies in Africa through equity and debt exist),[51] access to local credit for working capital remains a problem particularly affecting wholesalers and small retailers in both the ICS and PV market. Wholesalers and large distributors are constrained in managing high inventory levels, in extending credit to dealers, expanding their distribution networks, and undertaking promotional activities to stimulate demand. Small retailers face challenges in stocking equipment. The lack of access to credit represents a particular barrier for local producers of ICS, since it does not allow them to purchase the capital equipment that they would need and achieve the scale economies that would allow them to serve the market at a lower price point.

Many Solar PV or ICS operators would be classified as small medium enterprises (SMEs). Our interviews with operators in the financial sector indicate that the flow of capital to SMEs is negligible and internal strategies inside financial institutions are poorly aligned with this class of enterprise. As a result, the renewable energy industry has not yet been by financial institutions. Greater levels of competition within the financial sector can assist in a transition to serve SMEs but this will require a longer-term strategy and potentially the application of

[51] For instance, the Kenyan company has recently secured a 20 million US$ fundraising, which includes 10million US$ from a commercial-grade syndicated debt facility fronted by Commercial Bank of Africa (Kenya) and 10million US$ from Bill & Melinda Gates Foundation (USA), and LGT Venture Philanthropy (CH) as well as equity from Gray Ghost Ventures (US).

patient capital. Moreover, banks are not able to offer attractive lending structures to the private sector, with the cost of debt currently at 23.25 per cent and collateral requirements highly restrictive.

In order to overcome these challenges, the Bank of Mozambique (BoM) and KfW have, under the *Sustainable Economic Development* project, established a credit line of 16.7 million USD in 2014, directly targeted at micro, small and medium enterprises (MSMEs) and renewable energy suppliers. The credit line also provides access to free technical advice to the banking institutions to better understand the energy sector. Through this facility, BCI opened an energy desk in 2015, but so far it has delivered no credit, for two reasons: first, BCI claims that no bankable project has yet to be presented to them, and that it requires additional capacity building in order to assess projects; second, BCI is still in discussions with the central bank to get concessionary rates under this facility, in order to allow lower lending rates. However, a recent study by the DFID-funded Financial Sector Deepening Moçambique (FSDMoç) programme that has reviewed the effectiveness and impact of all the credit lines in the country, reveals how these facilities have not significantly increased appetite for lending to the BoP, because the Mozambican banking sector is not geared towards supplying all market segments (FSDMoç, 2015).

Consumer finance. Traditional financial institutions have so far shied away from lending directly to users of ICS and solar products for various reasons. First, transaction costs associated with managing small loans are high in comparison with returns – from USD $10 for pico-products or a stove to more than USD $250 for mini-grids (Alston *et al*., 2015). Second, the risk profile of the products is still largely unknown. Finally, traditional financial institutions do not have the internal technical capacity to extend credit for these products that are outside of their core business, while the microfinance sector is small and focused primarily on urban areas, with interest rates ranging between 50 and 60 per cent.

The lower tier of the pyramid in the ICS market is particularly constrained by the lack of consumer finance. This severely limits the opportunity to expand the marketing of ICS to these segments without public subsidies.[52]

In the Solar PV sector, a solution that is widely adopted internationally to provide consumer finance is therefore a form of value chain financing or PAYG, which allows consumers to spread the cost of purchasing off-grid renewable energy products over time. PAYG is an innovative mechanism for consumer financing, but it is not yet well established in Mozambique, partly because it remains unclear how leasing regulations would apply to a non-banking institution. In order to avoid complexity, the companies that are currently exploring PAYG in Mozambique have opted to retain the ownership of the equipment they distribute, and charge a fee for use, with the option of outright purchase after two years.

[52] Only NGO that are distributing internationally imported ICS provide a form of consumer financing, offering customers to stagger payments over a 30 days' period, but targeting poor customers without distorting incentives in other market segments is difficult to do.

The recruitment of customers in a PAYG system offers opportunities to use the PAYG system to understand the risk and consumption profile of the user and use this information to sell her/him additional products, including ICS, through *asset financing*. This form of financing involves providing customers with a pay plan that allows them to purchase a specific asset on an instalment basis while receiving the product upfront. The product, such as the ICS in this case, or *adjacent* products, such as the PV system that was initially sold through the PAYG system are used as collaterals (Global Alliance for Clean Cookstoves, 2014). Asset financing is strongly reliant on market segmentation, since it allows to associate different risk profiles to different customers bases (M-kopa, 2015). Companies like M-kopa have made use of this form as well as other forms of financing[53] very successfully, however this financing systems is a complex and challenging undertaking, since it requires the vendor to have the capacity to identify and manage credit risk, and in particular to assess the risk of low-income customers who have volatile income. This will include developing procedures for credit assessment, to account for interest charged to customers and to quantify and manage the risk of non-collection and of exchange rate fluctuations. These resources are difficult and expensive to find and retain, particularly on the Mozambican labour market.

Another challenge for the deployment of PAYG and asset financing at scale in Mozambique is due to the low level of banking and the weak penetration of mobile money. Financial inclusion levels are low in Mozambique compared with neighbouring countries. For example, 86 per cent of the population remains unbanked (FinScope 2014). Despite a mobile phone penetration of 58 per cent in Mozambique and two more established mobile money operators and a recent mobile money entrant, adoption of mobile money has been slow to date.[54] In addition, mobile companies are not yet accustomed to sharing their data for risk profiling. Mobile money to take off requires a number of factors to be aligned. An important factor though is the ability of mobile money operators to generate transaction pools at scale (high volume of digital money that can be cashed in and out). For that to happen, it requires investment in agency models that can be pegged to higher density of population and capital at scale. The infrastructural challenge and sheer length of the national terrain makes this is a larger investment for mobile money operators compared with success cases like Kenya. To penetrate rural areas remains a challenge. For example, a recent Mobile Access Usage

[53] For a good overview of the financing models used to provide credit financing in the PV and ICS sectors see *Consumer Finance Models for Clean Cookstoves* by Global Alliance for Clean Cookstoves, 2014.

[54] A recent Mobile Access Usage Survey (MAUS), launched in September 2016 (part commissioned by FSDMoç), with sample size of 2147 adults across Tete, Manica, Nampula and Zambezia offers some insights on the adoption of mobile money. These provinces represent high levels of population in the country and offer an indication of the North and Central part of the country. Results show that network coverage reaches 82 per cent, but universal mobile phone use was not evident. For example, only 61 per cent of respondents have used a mobile phone in their lifetime. A useful proxy for transactional behaviour is in the buying and selling of airtime and 49 percent of mobile phone users have bought or sold airtime. Mobile money transactions reveal that 32 per cent of the sample in the survey received money on the phone whilst 31 per cent used the phone to send money. Across the entire population and including those that do not have access to a mobile phone, the data point for using mobile money services is therefore 20 per cent. These data points are indicative of a low mobile money penetration in the country. By way of comparison, even as far as three years ago, Tanzania had one in three households with mobile money users (FinScope 2013).

Survey (2016) part commissioned by DFID-funded Financial Sector Deepening Mozambique (FSDMoç) across Manica, Nampula and Zambezia indicates 42% of those who have ever used a mobile phone have borrowed a phone. Borrowing is particularly high in Zambezia (20% of the national population). Borrowers must often travel long distances to access a phone, thus underscoring the complexities in generating sizeable transaction pools.

6.3 Import Duties and VAT Constraints

One of the issues that stakeholders identify as a barrier to attracting investors in the Mozambican PV and ICS sectors is the fact that **import duties and VAT are higher than in most other Sub-Saharan African countries**, increasing the price to end-users in a very price-sensitive market like the ICS market, and, in the case of Solar PV systems, making investments in other Sub-Saharan African countries more appealing.

Ethiopia, Ghana, Tanzania, Uganda and Zimbabwe have so far successfully applied tariff and VAT exemption regimes for solar products (Dieker, et. al, 2016). In Mozambique, no specific exemption exists for Solar PV systems of ICS components. However, in order to attract investments in sectors of the economy that are reputed to be of public interest, such as electricity, the Investments Law (3/93) and the Tax Benefit Code introduce a number of tax incentives. These include exemption from customs duties and VAT for the importation of capital goods as well as their respective parts and accessories, a reduction of the Corporate Income Tax (IPRC) for infrastructure investments by 80 per cent the first five years, by 60 per cent from year 6 to 10 and by 25 per cent from year 11 to 15. These benefits are obtained through the Investment Promotion Centre (CPI), and are granted upon evaluation of the investment proposal. Despite CPI's decision, however, the benefits are often not honoured by the Tax Authority and Customs.

The lack of specific provisions for investments in the Solar PV and ICS markets, and the weakness of CPI's instrument, make these incentives inadequate for these sectors. Because of the way legislation is applied, a VAT rate of 17 per cent applies to any product in Mozambique, including solar products, making the business environment significantly less friendly than many other Sub-Saharan African countries. For this reason, and upon request of the private sector, the Government is currently considering options and costs to establish a tariff and VAT exemption regime that is specific to the Solar PV and ICS sectors (Economic Consulting Associates, 2016).

A second obstacle related to import duties is inconsistency in applying duties. The Ministerial Decree 16/2012, of 16th February on Customs Clearance establishes a fast track channel (*Sistema Abreviado*) for the importation of spares or urgent replacement parts of energy supply systems, without any limitation on the amounts that can be imported. These provisions however are rarely applied to the Solar PV sector, due to the discretionary nature of the provision and a lack of knowledge of the same by custom officers. As a consequence, operators in the sector report that the duty system is too complex and leaves considerable room for discretion (opening opportunities for corruption).

As shown in the table below import duties vary from one product category to another with most renewable energy products having an import duty of 7.5 per cent.[55] However, stakeholders report that the total tax burden can be as high as 30 to 40 per cent if import agent fees and facilitation fees are taken into account.

Table 1 Import duties for PV products

Import tariff for PV products and cook stoves (2013)				
Code	**Description**	**MFN tariff**	**SADC tariff**	**Average**
PV based products				
850440	Static converters [eg rectifiers and inductors/inverters to convert dc to ac power]	5.0%	0.0%	2.7%
850720	Other lead-acid accumulators [Deep discharge (solar) battery]	7.5%	0.0%	2.6%
850760	Lithium-ion accumulators (excl. spent)			
851310	Portable electrical lamps designed to function by their own source of energy – lamps	20%	0.0%	16.5%
851319	Portable electrical lamps designed to function by their own source of energy – parts	20%	0.0%	7.6%
853710	Photovoltaic system controller [charger controller for voltage not exceeding 1000V]	7.5%	0.0%	4.5%
854140	Photosensitive semiconductor devices, incl. photovoltaic cells wether or not assembled or made up into panels; light emitting diodes (excl. photovoltaic generators)	7.5%	0.0%	7.2%
940550	Non-electrical lamps and lighting fitting, n.e.s.	20%	0.0%	8.6%

Source: Economic Consulting Associates (2016).

In case of the ICS, exemption from VAT would provide opportunities to lower the sale price for locally produced stoves. A rebate on import tariffs, however, would have a limited impact on locally produced stoves, unless stove components were also exempted.

6.4 Skills Gap

Operators along the ICS and PV supply chain indicate a lack of skills to be a major obstacle to doing business. The skills missing in the ICS are primarily managerial competences, including bookkeeping, business management, sales and logistics. The lack of after-sales support has three key implications for adoption and use of improved stoves:

1) Customers may be deterred from original purchase if there is uncertainty around how/when/if they will have access to repairs or support;

2) Without adequate after-sales training for consumers on proper use of the stoves, customers may believe that stoves do not work properly.

[55] Imports from Southern African Development Community (SADC) countries attract a 0 per cent duty, subject to the presentation of a certificate of origin.

3) Lack of after-sales support makes tracking and monitoring of cook stove distribution and use very difficult. This is a particular challenge for projects/programmes that are using carbon financing, as continued accreditation and receipt of carbon revenues is dependent upon monitored and continued use of the stoves.

Women are particularly suited to provide sales and after care services for ICS, since customers are primarily women, and the adoption of ICS requires some change in cooking practices.

Installation, repair and system maintenance are amongst the major barriers associated with the diffusion of Solar PV systems, as they have a direct impact on costs, the performance of the equipment installed, and therefore the willingness of end-users to pay. These challenges are greater when operating at the BoP, with high percentages of illiterate customers. For example, mishandling of the PV system often refers to the use of the battery, as people often want as much power out of the system as possible. This leads to overuse and bypassing of protective mechanisms (regulator) with subsequent more rapid deterioration of the life of the system. Ensuring efficient technical support and a strong customer service system is therefore key to maintaining quality and reliability in a nascent market like in Mozambique. Maintenance and spare parts are, however, relatively expensive, particularly given Mozambique's tariff and VAT regime, and may require specialised technicians, who are often not present in rural areas.

The biggest barrier identified by operators to the establishment of effective technical and customer services is the lack of skills in the market. On the supply side, the lack of technical skills prevents the private sector from growing, increasing operational costs. On the demand side, the lack of basic skills is a barrier to customer acquisition (SNV, 2016).

During stakeholder consultations, skills gaps were identified at the managerial level, including management, leadership, finance, procurement and legal expertise; and at the technical level, including financial, engineering, construction, logistics and maintenance.

The challenges companies face in procuring the skills they require from the domestic market are exacerbated by the difficulty of obtaining permits for foreign workers, even temporary ones. This makes the establishment of companies in innovative sectors like off-grid renewable energy onerous, since updated skills and know how cannot be imported to upgrade the capacity of the local work force. This is particularly important in the start-up phase of the company. Unfortunately, however, serious challenges for obtaining work permits exist both at the legal and extra-legal level. Decree no. 37 of August 2016 has made the legal process of hiring foreign workers more cumbersome than the previous regime[56] by adding a number of requirements, amongst which is the need for sourcing equivalence certificates for the educational degrees obtained from foreign institutions from the Mozambican Ministry of

[56]The previous regulations as set by Decree no 55 of 2008 had already established a lengthy and transaction-heavy process.

Education.[57] A report by Sal & Caldera dated October 2015 identifies an additional 16 extra-legal requirements associated with the process of obtaining work permits for foreign workers.

[57] The process of obtaining equivalency certificates is particularly long process due to the number of documents that need to be produced, such as: A certified photocopy of the certificate or diploma course or studies done; a certified photocopy of the certificate of courses taken which includes duration and results or marks obtained; certified photocopy of the certificate of completion of the degree previous to the degree for which equivalence is being requested; photocopies or original dissertation or thesis for cases in which the equivalence requests is for a master's degree or doctorate.

7. Recommendations for Policy Action

The analysis presented above, shows how strengthening the Solar PV and ICS sectors is dependent on addressing a series of constraints that can broadly be categorised into:

1) **Improving access to market information and clarity on policy direction**. This is important to clear policy inconsistencies and reduce investment risks. It can be achieved by developing overarching visions on how the private sector will contribute to rural electrification and the diffusion of ICS and by establishing open platforms for dialogue and market information.

2) **Supporting demand, to achieve sufficient market volumes for scale economies and to expand towards the bottom of the pyramid**. This can be achieved through publicly funded campaigns and by subsidising lower tier consumers, in a segmented market, and through less distortive mechanism, like voucher systems.

3) **Supporting technological upgrades**. In the ICS sector these need to respond to localised user preferences, and be integrated into local culture and customs. A localised technology system is therefore preferable. For Solar PV, the best and cheapest international technology is instead preferable.

4) **Support the sector to develop economies of scale**. In the ICS sector this means industrialising and standardising production as much as possible, this in order to avoid high variations in quality from one production batch to the other. This would involve strengthening the national research and development system and possibly the establishment of a few larger producers, rather than a supply chain that is too fragmented. In the Solar PV sector, economies of scale need to be developed in distribution and customer-care. This will require allowing companies to establish and consolidate their presence in the market by serving the upper tier of the market first, before helping them to extend to more remote areas. The provision of more affordable credit and investment guarantees will also play an important role.

5) **Upgrading skills.** While the ICS sector needs stronger business and management skills, the PV sector has specific requirements for technical skills. The improvement of targeted TVET courses will therefore need to be accompanied by the simplification of the immigration requirements for PV technical staff, in order to facilitate skill transfer.

7.1 Improving Market Information and Policy Coordination

7.1.1 Adoption of a National Strategy for the development of the Solar PV sector

Mozambican policies have so far looked at the off-grid energy sector primarily as a means to achieve rural electrification. Based on UNEP data, as shown by the Bloomberg report, however, the size of the off-grid population that lives under 2 dollars a day in Mozambique is twice as large as the share of the population having an income between 2 and 10 dollars a day, which is less than 7 million people. Ethiopia, Kenya and Tanzania have a much larger

size of population with higher income. This coupled with a low population density (36 people per sq. km, as per World Bank data, 2015[58] compared to 99 in Ethiopia, 60 in Tanzania and 81 in Kenya), makes Mozambique a challenging country in which to develop a sustainable rural off-grid solar market. The challenges are exacerbated by the prevailing economic conditions.

In the face of these challenges, and considering that the industry is still at its starting blocks, the policy vision should be one that incentivises and supports market operators to develop the market gradually, starting from segments where willingness to pay is higher, and operational costs are lower, such as the productive sector, or serving peri-urban areas with no access to the grid[59] in order to develop market-oriented competences and economies of scale that will allow servicing the rural areas in a more affordable way.[60] Stakeholder consultations indicated that a clearer policy vision with more openness to private sector enterprise would raise investors' interest in the Mozambican market and help the sector become more innovative and competitive, eventually resulting in lower end-user prices.

To achieve this policy vision, it is recommended that MIREME, FUNAE and EDM should engage the private sector to **develop a strategy targeted at the development of the GMG, SHS and pico solar system sector** to complement the EDENR, and aimed at incentivising and supporting investments and opening the market. It should also safeguard private investors from distortive interventions in the market and be the basis to coordinate activities between EDM and FUNAE to cover areas in which the grid will not be extended any time soon.

Table 2: Cost Benefit and Feasibility of Developing a Strategy for Solar PV

Information – PV Sector - Strategy for PV sector	
Impact	Reducing uncertainty for investment and bringing more players in the market with reduction of prices to end-users
Cost	Will require Cabinet approval – significant education, analysis of impact and advocacay involved
Time	Cabinet could pass it in less than one year
Difficulty	FUNAE and MIREME are working on clarifying opportunities for investors in this area. Discussions are focussed on issuing concessions rather than enabling investments.
Entry Points	Support to MIREME and FUNAE to work on the above document resurrecting the work done in 2015.

[58] http://data.worldbank.org/indicator/EN.POP.DNST

[59] The operators interviewed during field work recognise that companies that are selling solar home systems in Mozambique will require roughly 10,000 kits sold to reach business viability and have sufficient footing in the market to expand to difficult market segments.

[60] Such as, for instance, in the market segment of providing reliable stable power during the frequent power failures and in supplementing existing diesel grids in order to reduce fuel consumption (disagree – PAYG models, such as MKOPA, fall down if people only use system occasionally – takes a very long time to pay off system and recoup costs). A sector analysis carried out by GIZ in 2014, estimates that the technical market potential for stand-alone, mostly pico-PV, is 75 MWp, and the technical market potential for diesel-PV hybrid systems is 4.6 MWp.

In 2015FUNAE developed a *Strategy for the Involvement of the Private Sector in the Rural Electrification and in Providing Access to Renewable Energy in Mozambique.*[61] The strategy was finalised in January 2015, but was never adopted. It is proposed that FUNAE resumes the drafting and adoption of the strategy, and that uses the same to clarify how its mandate and functions with regard to catalysing the development.

7.1.2 Establishment of an open dialogue and information platform with the private sector

Interventions in the ICS sector need to be better coordinated in order to avoid the crowding-out of private investments. Government and the donor community need to agree on a national approach to the provision of subsidies to the lower tier of the market, and to shift their focus from subsidising ICS to strengthening the national market institutions. In the Solar PV sector, open dialogue with government, donors and NGOs is of fundamental importance to increase predictability and investor confidence in the sector. An open and public platform with strong leadership from the government (possibly FUNAE) should therefore be established to this end.

An Energy Sector Working Group already exists, including donors and government agencies. This work group, however, does not have a private sector interest, is not specific to the Solar PV or ICS sectors, and is focused on donor initiatives. A bridge between government and the private sector is needed to mix physical and virtual ways to share information through the use of IT tools and to discuss policy options in a timely and responsive way. Improved dialogue would improve trust between the private sector and Government, and would raise ownership for the introduction of reforms in the sector.

Table 3: Cost Benefit and Feasibility of a Dialogue Platform for Solar PV and ICS Sectors

Information – PV and ICS Sectors - Public private dialogue platform	
Impact	Would reduce uncertainty in the PV sector and raise investors' confidence. Would coordinate interventions in the ICS sector.
Cost	Would require ministerial decision, and initial support to establish the platform
Time	Ministry could establish it within the first 4 months
Difficulty	The National Directorate of Energy in MIREME is insisting that better coordination amongst stakeholders is necessary. Idea would easily be taken onboard
Entry Points	Working with National Directorate of Energy in MIREME as well as FUNAE

7.1.3 Creation of a market information portal

Market information is a major barrier for the development of both sectors. Penetrating markets in rural areas, is particularly daunting, as the income of users depend on agriculture, and remains low and volatile. Successful market penetration, therefore need to go hand in hand with broader policies and development interventions aimed at alleviating poverty more generally and promoting economic development. Market expansions in rural areas would therefore ideally be carried out in parallel with programmes for education, rural electrification and productive investments, and in particular, women's economic empowerment

[61] Estratégia para o Envolvimento do Sector Privado na Electrificação Rural e Acesso à Energia Renovável em Moçambique.

programmes, where the time freed up with the use of faster ICS can be productively reallocated.

The current setup of the off-grid solar market in Mozambique that targets private customers means that products are sold for cash by a small handful of premium brands and a large field of indistinguishable low-margin suppliers. While a lot of investor and community attention is devolved to the faster growth PAYG companies, the operational and financial challenges presented by this business model in Mozambique will prevent it from dominating the off-grid market unless start-ups collaborate successfully with organisations that already have a large and efficient distribution network in the country. These innovative distribution systems should also be tailored to the peculiarities of individual locations, after gathering considerable market information. For instance, in order to overcome challenges related to willingness and capacity to pay, a first step to expand into rural areas would be to target value chains (and locations) where farmers' incomes are growing, versus rural areas *in general*.

In order to gather, organise and provide market information for both the ICS and Solar PV sectors, and in order to coordinate market penetration with broader development interventions and investments in agriculture a **market information portal should be established, as part of FUNAE's web page.** The portal should collect and organise all public studies on the industry, information on legislation, licensing requirements, and companies operating in the sector as well as relevant market information[62].

Table 4: Cost Benefit and Feasibility of Establishing a Market Information Portal

Information – PV and ICS Sectors – Market information portal	
Impact	Allow better business modelling, and reduce uncertainty in the market
Cost	Need to identify committed host, design and setup platform
Time	Could be setup in three months from time host has been identified
Difficulty	No particular reasons exist for the idea to be challenged
Entry Points	The idea needs to be discussed with MIREME and FUNAE. FUNAE has sufficient capacity in place to own and manage the platform

Since currency volatility remains a critical risk factor in determining the actual cost of Solar PV equipment currency risks should be mitigated by **including in the market information portal data on local inflation in the various areas where solar investments are made**, so to help companies target PAYG instalments closer to prevailing economic conditions and incomes.

This information portal could also provide the IT platform for industry coordination and policy discussion as illustrated in section 7.1.2 above.

[62] An example of where this is being done effectively is the Tanzanian *Minigrid Information Portal* maintained by a Working Group comprising representatives of the Tanzanian Ministry of Energy and Minerals (MEM), the Rural Energy Agency (REA), the Energy and Water Utilities Regulatory Authority (EWURA), the National Environment Management Council (NEMC), the Tanzania Renewable Energy Association (TAREA), the Tanzania Bureau of Standards (TBS) and the Tanzania Electric Supply Company Limited (TANESCO) - http://minigrids.go.tz/en accessed on 3 November, 2016.

7.2 Sustaining Demand

7.2.1 Public campaigns to create awareness

The spending of public resources to sustain demand for ICS and Solar PV systems is justified by the positive externalities that derive from increased adoption. Donors and NGOs already have sensitisation activities in place. Improved coordination however could deliver more impact. In addition, new behavioural change techniques could be tested, particularly for cooking stoves. Historically, behaviour change approaches have been focused on cooking habits and behaviour patterns within the immediate kitchen environment. However, behaviour change strategies are needed at several points along the improved cooking value chain from manufacturers, to suppliers, promoters, and end users.

Table 5: Cost Benefit and Feasibility of a National Public Awareness Campaign

Sustaining demand – PV and ICS Sectors – Public awareness campaigns	
Impact	Expanding demand towards the lower tier of the pyramid. Experience proves that it is of fundamental importance
Cost	Will require doors direct funding, since government has liquidity constraints
Time	Could start within 3 months
Difficulty	None would oppose this in principle
Entry Points	Sensitisation campaigns are already happening, albeit on a much lower scale, and not backed up by a clear comprehensive communication strategy

7.2.2 Reducing VAT and import tariffs to make ICS and PV more affordable

As discussed previously, a number of provisions already exist in the law to provide incentives to industries of national interest. These provisions, however, are not specific to the PV and ICS sector and depend on the certification of the Investment Promotion Centre. Once granted, the incentives are also not always applied. The directionality in the application of the law creates uncertainty in the market, and unequal treatment among market players. **Government should therefore develop specific provisions that reduce or exempt import duties and VAT on Solar PV systems and ICS.** In particular, a recently concluded report by Economic Consulting Associates (ECA) for MIREME, with the support of DFID, recommends that the Government of Mozambique commit to eliminating VAT and import duties on eligible household energy products for a 10-year period, with eligibility based on meeting quality standards. Such provision would also have the effect to decrease the price to the end-user, stimulate demand and increase the margins for retailers and drive the development of the private sector.[63] Such reduction should happen in line with best practices applied in other Sub-Saharan African countries.

[63] The ECA report estimates that if tariffs and VAT were zero-rated, the number of PV units that would be sold would increase almost 11 times in 10 years (from 46,000 to 500,000), and the number of ICS sold will grow by 18% (from 679,556 to 799,753). The study assumes that the reduction in tariffs and VAT are translated in a reduction in price, and that the current structure of the market, in terms of number of players and volumes that can be processed, would have the capacity to respond to such increase in demand.

The reduction in duties should be accompanied by the consolidation of the categories under which Solar PV and ICS components are classified, so to include spare parts and product components under the same regime. This is to make maintenance cheaper and to promote the local assembly and repair of products. Duties and VAT exemptions have to be consistent and non-ambiguous across the different categories of product. A lack of clarity can create confusion and lengthen the sales cycle.

Table 6: Cost Benefit and Feasibility of Reduction or Exemption of Import Duties and VAT Simplification

Sustaining demand – PV and ICS Sectors – Reduction of duties and VAT	
Impact	Reducing time, cost and opportunities for corruption at the border posts. Reducing end-user prices for ICS and PV equipment, and improving appeal of Mozambican market to foreign investors
Cost	Will require agreement from Ministry of Finance and Cabinet approval. Extensive advocacy
Time	Could pass within a year, depending on challenges with advocacy
Difficulty	The Tax Authority and the Ministry of Finance are not yet fully supportive of the proposal, although they are open to being advised by MIREME. MIREME has mixed feelings. A revision of the Tariffs Code is on the way.
Entry Points	The idea is already on the table with MIREME and an initial study has been prepared by Economic Consulting Associates with support from DFID to evaluate the cost of removing VAT and import tariffs and the impact this would have on market uptake. Advocacy with the Ministry of Finance needs to be concluded, however and the Ministry of Commerce should also be brought into the discussion.

It should be noted that the National Policy Action Plan,[64] coordinated by the Ministry of Industry and Commerce (MIC) also includes the revision of the Tax Code. In collaboration with the Tax Authority, MIC has already initiated the process for such revision. This process presents a good opportunity to review taxation for PV and ICS products too, with the aim of providing incentives to these industries as it is foreseen by the Investment Law.

7.2.3 Simplifying licensing and concession requirements for Solar PV systems

Decreto 48/2007 and its inconsistent application are source of significant confusion among users of PV systems, on whether a license is required and on what taxation they will be subjected to. This decree should be modified to explicitly exclude SHS, and medium-sized solar systems (like those installed in lodges or small businesses) from the licensing and taxation process. The **regulations and requirements for concessions of GMG should also be simplified**, to allow more private sector penetration in the market (independent from FUNAE's tenders) and increased competition to drive down prices.

[64] This is a series of reforms that would have a positive impact on the business environment that has been drafted by MIC.

Table 7: Cost Benefit and Feasibility of Simplification of Concession and Licensing Requirements for SHS and GMG

Sustaining demand – PV Sector – Simplified concessionary and licensing regime	
Impact	Reducing time and cost required for SHS and GMG projects to be established. Increased offer of energy in rural areas
Cost	Will require Cabinet approval – significant education, analysis of impact and advocacy involved
Time	Cabinet could pass it in one year
Difficulty	There is little support since there are not many players in the industry. MIREME does not seem to be wanting to champion this
Entry Points	None specifically. Will need to be achieved by first carrying out a study on the impact of current procedures

7.2.4 Improving access to consumer credit

Delivering access to consumer credit can unlock potential demand. Consumer credit in the ICS sector is scarcely available in Mozambique and dependent on public funding. Carbon finance can play an important role in reducing the costs of better quality stoves in the short term but also imposes a business model, which can constrain growth, since it is dependent on foreign technology. No Mozambican ICS producer so far has the size and the capacity to provide consumer financing. Vouchers subsidised through development findings can be used as a short-term strategy to catalyse the market while complementary, longer-term solutions — such as value-chain financing — are being developed.

In the Solar PV sector, consumer credit can be extended through the use of mobile banking. **Collaboration between financing institutions and key partners in PAYG such as M-Pesa, could be catalysed through pilot projects that make effective use of existing data to segment the market for both PV and ICS products, and develop consumer profile risks**.

Table 8: Cost Benefit and Feasibility of Piloting the Use of Telco Data to Segment Markets and Create Consumer Risk Profiles

Sustaining demand – PV Sector – Strengthening access to consumer credit	
Impact	Allow companies and financial institutions to manage risks connected with consumer financing. Increase awareness in financing sector for PAYG models. Extend access to BoP of PV products
Cost	Will require piloting bringing PV, telco and financial institutions together.
Time	Implemented immediately. Discussions between SolarWorks! and M-Pesa are already on-going, within the context of their commercial agreement. Could deliver results in six months
Difficulty	No obstacles in principle
Entry Points	Existing agreement between SolarWorks! and Vodacom. Other agreements catalysed by BRILHO's funding

Finally, grants that help seed fund vendors and distributors in new geographies would also be highly catalytic in laying the groundwork for future, commercially viable companies. **Seed donor funding from programmes like BRILHO could leverage matching impact investments, for instance from Corporate Social Responsibility (CSR) programmes or foundations of LNG sector companies, to subsidise pilots and penetration in less**

commercially viable areas. In other countries, such as Nigeria, organisations such as the Shell Foundation and Doen Foundation[65] have played a particularly important role in grant supporting pioneers to test concepts and run pilots.

Table 9: Cost Benefit and Feasibility of Leverage Impact Investments from LNG CSR Programmes

Sustaining demand – PV Sector – Leveraging CSR funding	
Impact	Increase the viability of last mile distribution for Solar PV systems in rural areas
Cost	Will require engagement with LNG companies and other large companies to provide advice on how best to deliver impact from CSR spending. Some initial studies to produce evidence may be required
Time	It may require 18 months to see first results, as main LNG deals are still pending
Difficulty	Similar experiences already exist in other countries such as Nigeria. There are no obstacles in principle to realising this activity
Entry Points	BRILHO's grant funds could be used as a catalist for additional investments

7.3 Technological Upgrade

7.3.1 Establishing a national innovation system for ICS

Promoting the adoption of ICS is fundamentally a problem of technology upgrade and behavioural change, which should consider all the elements in the market system that determine the existing technology and current use. Instead of focusing on promoting one particular model of stove, interventions should focus on helping the industry as a whole to develop and adopt technological upgrades, responding to feedback from users, and reaching environmental objectives as set by policies. This means that every model of stove produced in the country could be supported to be upgraded, introducing gradual changes that are compatible with culinary and customary traditions.

To do so a national innovation system for ICS needs to be established, to support the private sector in the development of different stove models and prices for higher- versus lower-income households. This system will need to provide incentives for new stove designs and testing, and decentralise research at the regional level to ensure that the new design responds to local market needs. In such a system, R&D and research dissemination on efficiency should be subsidised, and paid for by government or donors, given that there are noticeable public benefits. Private financing would be used instead to develop and market specific products, and support activities such as field-testing (always accompanied by lab testing). A challenge is to determine what level of public funding is adequate and the timing to transition to a fully market-based commercialisation business model. On the back of this model, a national quality testing and certification system could be established based on the work already done with BECT.

[65]See: https://www.doen.nl

Table 10: Cost Benefit and Feasibility of a National Innovation System for ICS

Technological Upgrade – ICS sector – National Innovation System	
Impact	Develop market-oriented ICS models and increase willingness to pay
Cost	High, as intervention is at different levels, ensuring a recognised certification process, that can deliver prompt testing and certification, as well as providing incentives for decentralised R&D
Time	Long-period intervention
Difficulty	Difficult. Requires working with a moltiplicity of players
Entry Points	The BECT centre and the University Eduardo Mondlane is certified by the Global Alliance for Cooking Stoves. This experience can be leveraged.

Technological upgrade in the Solar PV sector is strongly dependent on the degree of openness of the market, to allow cheap importation of the newest, most efficient and cheaper technology available.

7.3.2 Setting minimum industry quality standards in the Solar PV sector

Since market penetration in the Mozambican Solar PV sector is very low, the influx of low quality systems is not yet an issue that government is particularly paying attention to. However, demand creation and willingness to pay for what is essentially a completely new product, strongly depend on how much its quality is trusted. It is therefore important to ensure that Solar PV companies are supported in delivering quality products and good customer care to their clients (ODI, 2016). To this extent, the following actions are recommended:

- The **adoption of improved industry quality standards should be encouraged**, through a combination of a voluntary quality certification system,[66] demand awareness building and strengthening of the National Inspectorate for Economic Activities (INAE) to identify and target sub-standard products. Giving import duty exemption to lighting global certified equipment is a way to guarantee quality.
- **Warranty standards of minimum 2 years should be established**.[67]

Table 11: Cost Benefit and Feasibility of Minimum Quality Standards in Solar PV Sector

Technological Upgrade – PV sector – Setting Minimum Quality Standards	
Impact	Raise perception for product quality and willingness to pay
Cost	Will require industry coordination, and setting up a standard certiication process
Time	Will nine months to one year to complet
Difficulty	There is support across industry players to establish the standards. Government seems to be comitted as well
Entry Points	Work with industry players (private sector), MIREME and university

[66]Building on the capacity that has been established at the Eduardo Mondlane University with the support of EnDEV.

[67] Extended warranty periods are becoming the norm in the industry. For example, companies like M-Kopa and Greenlight Planet already offer 2-year warranties; BBOXX and Mobisol offer 3-year warranties;

7.4 Improving Economies of Scale through Access to Finance

In the ICS sector, small-scale production prevents economies of scale and restricts cash flow leading to increased costs driving down quality. Standardisation and mass production is one way to lower costs. The challenge for ICS manufacturers is to access credit locally, in order to fund investments and working capital.

The challenges faced by the PV sector are instead multifaceted, and constrain operations at three levels. Firstly, restrictions on the use of foreign currency and repatriation of funds are becoming increasingly difficult, making it harder to source foreign capital. Secondly, access to credit for working capital within Mozambique is not yet viable, due to high interest rates and the fact that the credit sector is not equipped to cater for this market. Lastly, mobile-based consumer financing is not well established yet in the country, and a risky business in the off-grid solar sector, with the depreciation of the exchange rate and consumer behaviours distorted by the expectation that energy tariffs and solar equipment must be subsidised. The following actions are recommended in order to remedy to the constraints faced by the ICS and PV sectors in accessing finance:

- Government should be **facilitating access to investment financing by negotiating lower interest rates for the existing KfW/BoM credit line**. Access to investment financing in the local currency would sensibly reduce exchange rate risks. Additionally, donor funding could be made available to absorb part of the risks associated with lending to the ICS and PV industries, and unlock the credit facility. Collaboration and sharing of information should also be fostered between the private sector, government and credit institutions.

Table 12: Cost Benefit and Feasibility of Lower Interest Rates for the KfW/BoM Credit Line on Energy

Economies of Scale – PV and ICS sectors – Accessing concessionary credit line	
Impact	Reducing costs of financing from the local market
Cost	Will require Central Bank convincing and donor funding could be added to exisitng credit line as a guarantee absorbing part of commercial risk
Time	As discussion on this topic have been on-going for some time, this action could take off immediately and deliver results in less than 6 months
Difficulty	So far the Central Bank has shown no interest in agreeing to reduced rates
Entry Points`	Discussions with Central Bank set in motion by BCI, with support of KfW-funded TA

- Access to national credit would also ease constraints on working capital. Investors and lending institutions such as BCI should be supported to understand the ICS sector, the differences between on-grid and off-grid solar, and how the PAYG business model works (Lighting Africa, 2010).[68]

[68] For instance, in Kenya, CBA has accepted M-KOPA's future cash flows from its customer payment plans as collateral for additional loans to the company. This is an example of a remarkable securitization of a loan book composed of low-income

- In order to attract investors in the PV sectors, access to international funds should also be facilitated. Current restrictions in the repatriation of foreign investments funds, for example, could be mitigated by **helping investors in the Solar PV sector subscribe to the MIGA investment protection insurance.**[69]

Table 13: Cost Benefit and Feasibility of Support the Extension of MIGA Insurance

Economies of Scale – PV sector – Ensuring foreign investments from currency risks	
Impact	Reduction of foreign exchange risks and increased number of investors in the sector
Cost	Facilitation, dissemination, possibly supporting some study and co-funding
Time	Could happen immediately
Difficulty	Insurance costs could be a challenge
Entry Points	MIGA insurance is in place for Mozal and some other agribusinesses in the country

- Lastly, in order to mitigate the business risks associated with expanding in rural areas, **Results Based Financing (RBF[70]) could be piloted in Mozambique too** (SNV, 2016). RBF has been successful in funding investment pilots that can help stimulate uptake of business opportunities in the ICS and PV sector in a number of Sub-Saharan countries. In Tanzania, for example, RBF has not only provided financial incentives to start or upscale market operations, but has also helped leverage third party financing resulting in a substantial uptake of solar deployment through engagement with new and existing solar companies in Tanzania´s Lake Zone. The key success factor of the scheme is that it is able to provide a temporary incentive for further growth, and flexibility for the private sector to drive business modelling without distorting it. The introduction of the RBF in Tanzania has also had impact on the energy technology preference as perceived by (potential) customers. Solar electricity has gained popularity, as suppliers are able to apply unique and contextualised BoP approaches, which allow them to sell aspirational products tailored to the wishes of the customers.[71]

consumers, who are sometimes without bank accounts or fixed residence, but make payments entirely through the Safaricom M-PESA system.

[69]See: https://www.miga.org/documents/africa07.pdf and in particular, the transfer restriction coverage, which protects against losses arising from an investor's inability to convert local currency into foreign exchange for transfer outside the host country. The coverage also insures against excessive foreign exchange delays caused by the host government's actions.

[70] The fundamental idea behind RBF is that payments to a service provider are made contingent on the delivery of a pre-agreed result, with achievement of the result being subject to independent verification.

[71]In Tanzania, companies who have been benefitting from the RBF scheme include EnSol, Global Cycle Solutions, Off-Grid Electric, Sunny Money, Zara Solar, Lotus Africa, Mobisol, Ongeza, SimuSolar, Sollatek-Power Control. Four out of the 10 companies use PAYG models, others make use of alternative business models like rural commissioned agents, traditional retail, MFI agents, etc. As of mid-2015, 330 jobs were created (212 retailer staff and 118 solar company staff) because of RBF round 1. The availability of PAYG players has attracted other financiers and (impact) investors to the scene. Among them in East Africa are Khosla, ceniarth, SynergyEnergy, Persistent Energy Capital, Energy Access Ventures, Schneider Electric, Barclays, SunFunder.

Table 14: Cost Benefit and Feasibility of Results-Based Financing in Mozambique

Economies of Scale – ICS and PV sector – Establishing Results-Based Financing	
Impact	Provide an incentive to expand businesses to serve the BoP
Cost	Establishment of operations and creation of RBF fund
Time	One year before operationalisation
Difficulty	Market still too thin for fund to be effective. Need to catalyse more investments into the market first
Entry Points	Successful experience in Sub-Saharan Africa to draw from

7.5 Skills Upgrade

Skills shortage is experienced by both the Solar PV and ICS sectors. While the skills needed by the ICS sector can be supplied in Mozambique, Solar PV technology is constantly changing and technical skills to manage it will need to be imported from abroad.

7.5.1 Expand TVET curricula

TVET curricula should be expanded to include more labour market oriented training and strengthen cooperation with the private sector to bridge the skills mismatch. TVET educational institutes also lack coordination amongst themselves, which reduces their combined ability to respond to private sector needs.

Table 15: Cost Benefit and Feasibility of Updating and Upgrading TVET

Skills Upgrade – ICS and PV sector – Upgrading TVET curricula	
Impact	Reducing search costs to hire qualified personnel. Increased trust on ICS and PV products and willingness to pay
Cost	Will require significant consultation, review of existing curriculum, and training
Time	Sector coordination and delivery will take at least one year
Difficulty	No opposition in principle
Entry Points	Coordination with existing DFID initiatives on training like JOBA

In the ICS sector, TVET training should aim in particular at encouraging female entrepreneurship, as currently the majority of cook stove businesses are headed by males.[72] As the primary users of cook stoves, women's perspectives could play a central role in product design, quality assurance and research, as well as in training users. There have been some efforts to build the technical skills of women in ICS production, but it has not included or led to supporting women in establishing new ICS enterprises. To date, there has been a lack of long-term, women-focused training programs, incubation support to women entrepreneurs, and provision of follow-up services and resources to encourage women to be a part of ICS sector.

Companies should be supported to get "closer to their customers" by making it easier and cheaper for them to build technical and commercial support networks. Proximity is important

[72] Although women are involved in areas of the business, mainly liner production and assemble, whereas cladding is dominated by men.

in developing new BoP markets,[73] because customers are risk averse, and have no *consumer culture*, so they do not usually call to report problems.[74] In order to provide this level of service, companies will need to bridge the existing skills-gap, through in-house training and with foreign expertise during the start-up phase.

7.5.2 Relax immigration requirements

For this reason, **immigration requirements to issue temporary work permits should be relaxed for the Solar PV solar industry**, based on the submission of clear training plans to develop local capacity. An assessment of the current costs and time for start-up to secure work permits following the newly approved procedures should be the basis for such change.

Table 16: Cost Benefit and Feasibility of Simplifying Immigration Requirements

Skills Upgrade – PV sector – Simplifying immigration requirements	
Impact	Sensibly reduce operational costs and allow to invest in skills upgrading
Cost	Will require Cabinet approval – significant education, analysis of impact and advocacay involved
Time	At leat a year to advocate and pass regulations through Cabinet
Difficulty	Recent approval of more restrictive regulations shows that government is going in the opposite direction.
Entry Points	The new regulations provide an opportunity for new engagement on the subject. The Confederation of Business Associations of Mozambique (CTA) has been ineffectively advocating for simplification for some time

[73]BBOXX, for example, ensures that no customer is more than 3 miles from a shop with a trained technician in the areas in which we operate.

[74]Typically, more than 30 per cent of customers never call to report if they have problems with their solar kits (source: interviews with stakeholders).

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