Community Solar

Financial Feasibility Study

February 2024

A feasibility study exploring the financial viability of community-owned solar PV

Project: *"Mobilising Social Movements for Energy Democracy and Sovereignty in South Africa: Towards socially owned renewable energy solutions". This project is led by groundWork and conducted in a partnership of organisations, namely South Durban Community Environmental Alliance (SDCEA), Vukani Environmental Movement (VEM), Abahlali baseMjondolo (AbM) and Sustainable Energy Africa. The project aims to empower communities to develop champions that will engage effectively with local government, and other actors, towards a just transition which promotes and enables community-led, renewable energy solutions."*

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2 THE NEED FOR ENERGY DEMOCRACY

South Africa urgently needs to address the call for energy democracy as part of its just energy transition. Our historical reliance on coal has contributed to significant environmental degradation and the structure of the energy system has entrenched socio-economic disparities. Energy democracy aims to decentralize energy production and ensure that control over energy resources is distributed among communities, rather than concentrated in the hands of government and a few large corporations. Socially owned renewable energy (SORE) can empower local communities, create jobs, and promote social equity. Such systems can facilitate access to clean, affordable, and reliable energy, especially for marginalized communities, thereby supporting economic development while addressing climate change. Energy democracy and social ownership (in a variety of forms) within the renewable energy sector is crucial for achieving South Africa's just energy transition, ensuring that the shift away from fossil fuels benefits all segments of society and leads to a more equitable and sustainable future.

2.1 THE POTENTIAL OF COMMUNITY SOLAR

Solar photovoltaic (PV) is a particularly viable form of renewable energy in South Africa given the rapidly declining cost of PV technology, the high amount of sunlight, and the continually increasing electricity prices. South Africa has seen a boom in solar PV investment since 2020 with over 5 GW of private solar being installed as of the end of 2023[1]. Most existing solar installations exists on the rooftops of businesses and wealthy households where access to capital is high.

Community solar has gained popularity internationally but has not been explored in South Africa. The fundamental concept of community solar is to pool the buying power, and aggregate debt risk across a group of households to benefit from economies of scale and attract creditors which significantly improves the business model. There are various potential configurations for community solar explored in this report – the traditional configuration is where the solar panels are installed on individual household rooftops (grid-tied or off-grid) or centralized solar plants that can feed the electricity into grid for consumption by the community.

Community solar is a business model that combines the buying power of a large group of households to de-risk the project and exploit economies of scale to make solar more affordable.

[1] SALGA Status of Embedded Generation 2024, available online: www.SSEG.org.za

3 STATUS OF RENEWABLE ENERGY IN SOUTH AFRICA

South Africa's energy transition is well underway, with decentralised electricity generation becoming increasingly competitive. The country's regulatory framework has been amended to allow customers to more easily install behind-the-meter generation to offset their grid electricity needs. Most behind-the-meter solar is in the form of rooftop solar photovoltaics (PV); a low-carbon energy source, which supports South Africa's climate change mitigation and green economy policy objectives. In addition, there has been a rapid uptake of front-of-meter centralised solar installations feeding into the national electricity grid. The diagram below shows the difference between behind-the-meter rooftop solar and front-of-meter centralised solar. For community solar, these two arrangements present different opportunities as will be discussed in the following chapter.

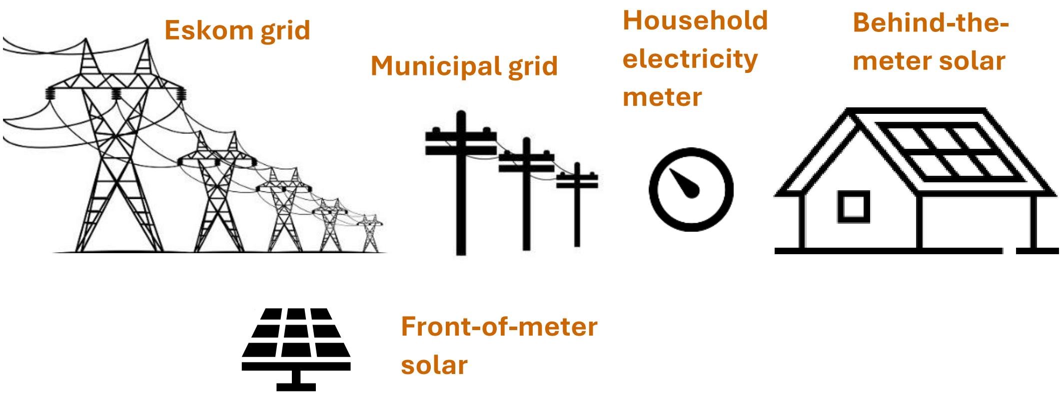

Figure 1: Diagram showing the difference between behind-the-meter rooftop solar and front-of-meter centralised solar

Solar installations in South Africa are accelerating rapidly, driven by increasing electricity tariffs and load shedding, combined with steadily decreasing solar PV technology costs. SALGA's Status of Embedded Generation Report estimates that 5GW of solar is already installed in South Africa, roughly 2.5GW of which is behind-the-meter and 2.5GW of which is front-of-meter. Solar has been identified as a pivotal role in alleviating the current energy crisis. South Africa's draft 2023 IRP released by DMRE includes a large allocation of distributed (embedded) generation, indicating that it will be a significant contributor to the country's generation portfolio. The IRP expects 900MW of distributed generation capacity to be added to the grid annually, and many industry experts have commented that this is an underestimate. An update to the Presidency's 2022 Energy Action Plan to end loadshedding and achieve energy security described five key interventions, two of which are directly related to solar[2]:

Intervention 2: Enable and accelerate private investment in generation capacity.
Intervention 4: Unleash businesses and households to invest in rooftop solar.

[2] Update on Energy Action Plan – January 2023: https://www.thepresidency.gov.za/download/file/fid/2677

4 SOUTH AFRICA'S ENERGY POLICY FRAMEWORK

Although energy/electricity is not explicitly listed as a basic right in the Constitution, municipalities have nevertheless increasingly treated it as a basic right. The Constitution Court ruled in 2010 that electricity is a basic municipal service which local government has a statutory obligation to deliver[3]. For low-income households the ***National Energy Act* (Act 34 of 2008) (NEA)** goes further: it requires *universal* access to appropriate forms of energy or energy services, and it highlights, the state's commitment to provide free basic electricity to poor households (Sections 5(1) and 5(2)).

4.1 NATIONAL GOVERNMENT POLICY FRAMEWORK

The ***National Framework for Municipal Indigent Policies*** (2005) **(NFMIP)** is intended to guide local government in the development of their respective indigent policies. The NFMIP is clear that 'Basic Energy' as one of a suite of essential services falling within a 'Social Safety Net' that a municipality is obliged to provide *for free* to indigent households, as a priority. Furthermore, it stipulates that Basic Energy should be sufficient to meet a household's lighting, media and cooking needs (water heating and refrigeration are not included in this definition). The policy also provides guidance on how to identify ("target") those households within a municipality are eligible of indigent support through free-basic services. Implicit in the policy is that, in the context of a stretched fiscus, those who are most lacking in the "necessities of life" should be priortised for indigent relief.

Notwithstanding the progressive, pragmatic and practical content of the NFMIP there is scope for updating this guiding policy, particularly the incorporation of renewable energy as a vital tool that municipalities can use to meet their statutory obligations. It is unfortunately not evident that municipalities are using this guide, nor that it receives any promotion from SALGA. Therefore there a need for some advocacy to up-date and actively promote this policy across local government.

The **Electricity Basic Services Support Tariff Policy (2003)** – generally known as the "***Free Basic Electricity" (FBE) Policy*** provides for municipalities to give at least 50kWh/month of free electricity to grid-connected indigent residents. The policy was written at a time when the rapid pace of electrification in urban areas (and prior to the South Africa's energy crisis) reinforced the expectation that this would soon reach 100%. (Sadly this has not materialised even 20 years later; the 2022 Census shows that approximately 1 million South Africa households still do not have access to electricity.) Therefore, the FBE policy does not explicitly address the needs of unelectrified urban residents. However, it does provide for the subsidisation (capital[4] and maintenance costs) of Solar Home Systems for unelectrified rural households while they wait for grid-electrification. The FBE Policy claims that 50kWh/month "*is considered adequate electrical energy to meet the needs for lighting, media access and limited water heating and basic ironing (or basic cooking)*". However, it is generally accepted that this is not sufficient to meet these basic needs. Therefore, there are a number of (better-off) municipalities that provide up to double this amount. As example, Stellenbosch Municipalities provides 100kWh/month. Stellenbosch was also an early trailblazer by incorporating in its indigent policy (from 2013 onwards) the directives of the NFMIP and FBE Policies to allocate subsidies for the use of Solar

[3] Joseph v. the City of Johannesburg 2010 (4) SA 55 (CC)

[4] The 2003 FBE Policy names the National Electification Fund as the source of capital funding for Solar Home Systems. In effect the funding comes from the Integrated National Electrification Programme (INEP) grant.

Home Systems by unelectrified households. Below is an extract form their 2020-2021 Indigent Policy, illustrating how simply this provision was incorporated:

> **5.7.2 Informal Settlement Households**
>
> Free basic services for Informal Settlement Households will consist of the following:
>
> (a) 100 kWh electricity per household per month; or
>
> (b) a maintenance and operations subsidy (equivalent in Rand value to 100kWh electricity per household per month) for off-grid solar home systems, operated by a municipal approved service provider or Energy Service Company (ESCo).
>
> (In the case of off-grid electricity subsidies as contemplated above, the Municipality may, subject to a detailed review by the Revenue Section appoint an authorised service provider to provide the maintenance and operations function for a group or groups of indigent recipients of off-grid electricity at a maximum rand equivalence of the value of 100 kWh electricity per household per month.)

Figure 2: Extract from the Stellenbosch Municipality Indigent Policy 2020/2021

The **Free Basic Alternative Energy (FBAE) Policy (2004)** makes provision for subsidised alternative energy sources (such as cooking fuels) for indigent households that do not have access to grid electricity or off-grid solar home systems. This policy is geared towards rural areas, but it does not explicitly exclude the application of the policy in urban areas where unelectrified households could, in theory receive a monthly Basic Energy Grant which could be spent on an alternative energy product or service of their choice. For example, the City of Cape Town is contemplating repurposing the FBAE Policy to assist unelectrified households in the city with a monthly grant. The city has assessed that the rand value of the grant in the 2004 FBAE Policy equates to between R150 and R200 (in 2023).

Both the FBE and FBAE Policies stipulate that the monthly contribution/subsidy towards alternative energy (including Solar Home Systems) is funded, in part, by National Government via the Equitable Share. However this is not the only source of funding that municipalities can use; the ***The Municipal Systems Act*** **(Act 32 of 2000) (MSA)** directs municipalities to subsidise basic services for poor households and clarifies that this subsidisation can come from sources other than revenues generated from the service provided. So for example a municipality use revenue from residential or business rates and taxes to bolster funds from the Equitable Share or surpluses from electricity sales to wealthier households. In practice, however, most municipalities are struggling to generate sufficient cost-covering revenue and find it politically difficult to further increase rate or top-tier electricity tariffs.

Despite the raft of progressive and explicit policies that provide for not only the subsidisation of basic energy for low-income households, but also the subsidisation of alternatives to standard grid electrification (including solar electricity technologies), the unfortunately reality is that for the vast majority of unelectrified households they simply do not get any energy poverty relief because they are not connected to the grid; their municipalities have not heeded the above laws and policies to ensure access to alternatives. This illustrates the need for a country-wide democratic push for action.

4.2 MUNICIPAL POLICY FRAMEWORK

The communities working together on this project are situated in eThekwini Metropolitan Municipality and Emalahleni Local Municipality. A review of the policy framework in these two municipalities is outlined below in order to inform the feasibility study.

4.2.1 eThekwini Metro electricity tariffs

eThekwini Metro is actively expanding its electricity network to connect more households to the grid. The municipality has a backlog of over 300 thousand households awaiting a formal grid connection. eThekwini Metro has a target of electrifying 10 thousand households each year, suggesting that the backlog will take well over 30 years to eliminate, factoring in ongoing urbanisation. It is understood that 255 000 households in Durban are on the subsidised indigent tariff receiving free basic electricity.

Grid connected customers pay the following tariffs for electricity in eThekwini:

Table 1: eThekwini Metro electricity tariffs 2023/24

Customer category	Qualifying criteria	Electricity tariff
Indigent tariff (Residential 12)	This tariff is currently available to indigent customers who consume less than 150kWh per month. All customers on this tariff will be eligible to 65 kwh free monthly. An online monitoring system is currently in place that identifies qualifying customers based on their previous history.	R1,93/kWh
Non-indigent residential tariff (Residential 3,4,8&9)	This is a single rate tariff pre-payment tariff without a fixed service charge designed for Small to Medium Residential Customers	R2,97/kWh
Net billing tariff (Residential 3&4)	This is a tariff for customers with an approved grid-tied solar system. A fixed monthly basic charge is introduced to recover grid costs and a feed-in-tariff compensates customers for feeding excess energy into the grid.	R381/month* + R2,97/kWh – R1,44/kWh feed-in-tariff

*Assumes a 3kW solar system, actual fixed charge varies with inverter size: R126 per inverter kVA

4.2.2 Emalahleni Local Municipality energy policies

Emalahleni Local Municipality is having challenges connecting new customers as the grid capacity of their Eskom intake points has been reached. Accommodating new connections will require expensive infrastructure upgrades and the municipality is currently encouraging off-grid alternatives to minimise grid congestion. Emalahleni Indigent Policy [5] states that indigent customers will be transferred onto a prepaid electricity meter. The tariffs for indigent customers and non-indigent customers are shown in the table below, and it is important to note that indigent and non-indigent customers pay the same for electricity in Emalahleni. Emalahleni does offer

[5] Emalahleni Indigent Policy, 2017, available online: https://www.emalahlenilm.gov.za/wp-content/uploads/2017/10/Indigent-Policy.pdf

FBE to indigent customers, and it is understood that roughly 8 000 customers are currently receiving FBE in Emalahleni.

Table 2: Emalahleni Local Municipality electricity tariffs 2023/24

Customer category	Qualifying criteria	Electricity tariff
Indigent tariff	This tariff is currently available to indigent customers who consume less than 150kWh per month. All customers on this tariff will be eligible to 65 kwh free monthly. An online monitoring system is currently in place that identifies qualifying customers based on their previous history.	0-50kWh: R1,89/kWh 51-350kWh: R2,38/kWh 351-600kWh: R3,14/kWh >600kWhkWh: R3,72/kWh
Non-indigent single phase residential tariff	This is a single rate tariff pre-payment tariff without a fixed service charge designed for Small to Medium Residential Customers	0-50kWh: R1,89/kWh 51-350kWh: R2,38/kWh 351-600kWh: R3,14/kWh >600kWhkWh: R3,72/kWh
Small-scale embedded generation tariff	This is a tariff for customers with an approved grid-tied solar system. A fixed monthly basic charge is introduced to recover grid costs and a feed-in-tariff compensates customers for feeding excess energy into the grid.	R190/month* + R1,52/kWh – R1,11/kWh feed-in-tariff

5 COMMUNITY SOLAR FEASIBILITY TOOL

What is generally unavoidable for any community solar scheme is that capital will have to be raised by the community (loans or conditional grants) to pay for the upfront cost of the solar infrastructure. Also, ongoing funds will be needed to keep the solar infrastructure well maintained. On the other side, any investment in solar will produce either *revenue* (from selling the solar electricity) or *savings* (from using the solar electricity instead of buying electricity or other forms of energy) - or both revenue *and* savings. Thus, a simple assessment of the financial feasibility of a community solar scheme is to calculate how long it would take to pay off any solar infrastructure loans using the revenue and/or savings (and any grants that can be raised), and then to compare that 'pay-back' period across different types (or 'modalities') of solar infrastructure, bearing in mind that it is only after the loans are paid back that the participating community members would start to see the financial benefits – in their pockets.

Using the above method of assessment, a tool was developed to assess the financial feasibility of three different community solar modalities and to illustrate broad-stroke differences between these options. There are a range of factors that must be considered for a given community to understand the most appropriate community solar technology and suitable arrangements to meet their particular needs. These factors include:

- **Grid:** is the community connected to the grid?
- **Energy budget:** how much is the average household currently spending on energy per month?

- **Land/rooftop:** does the community own open land which could be used for solar? Alternatively, are the roof structures of homes suitable for solar panels?

As with all models, there are a range of variables that are set by external conditions or role-players over which the community would have little or no influence. These include the cost of solar panels, the cost of operations and maintenance of a typical solar system, the solar irradiance in various parts of South Africa, and the cost of electricity in each municipality. However, there are other variables – or 'levers' that could be influenced by or decided upon by the community (such as co-payments and local subsidies). In the feasibility tool these variables can be adjusted to allow the user to assess the effect on the financial feasibility of the different solar modalities.

The four key variables in the model that the user can change to assess the viability of a community solar project are:

- **Variable 1: household monthly co-payments towards the system (R/month).** For a project to be financially viable, the household monthly co-payments should be within the household affordability threshold. (In the current version of the tool, this variable can only be adjusted for unelectrified households who participate in a Solar Home System or Mini-Grid scheme[6]. For grid-connected households the co-payment is limited to the revenue or saving that the household makes from the solar electricity generation – which has been calculated using a separate tool.)
- **Variable 2: solar capacity per household (kWp/household).** The size of the solar system determines how much electricity the system generates. Larger systems cost more but generate more electricity which impacts both the energy services provided and the amount of electricity fed into the grid. Grid-tied systems usually have a sweet-spot depending on the amount of electricity consumed by the household. (In the current version of the tool, this variable can only be adjusted for *electrified* households where the Solar PV can augment grid electricity supply. For unelectrified households - using SHS or MiniGrids - the capacity is determined by the chosen use-level (either 'lights&media' or 'lights,media&refigeration'.)
- **Variable 3: once-off capital grant per household (R CAPEX/household).** A once-off capital grant reduces the upfront cost of the system for the household which reduces the size of the loan required to pay the system off. Community solar projects are widely identified as contributing to South Africa's just energy transition meaning there is a likelihood these projects can qualify for capital grants.
- **Variable 4: ongoing municipal subsidy (R/household/month).** Municipalities provide their electrified communities with free basic electricity (FBE). There is a good case to be made for a municipality to subsidize off-grid community solar projects in lieu of their lack of access to free basic electricity. This subsidy would then contribute to paying off the capital cost of the solar system. For grid-tied solar projects, the subsidy mechanism proposed is a subsidized feed-in-tariff (FIT) which offers generous payment for electricity fed into the grid.

[6] The co-payment that an off-grid household makes should be a realistic figure that the household would be willing to pay, bearing in mind what they might previously have been spending on fuels or other energy sources.

By changing these four variables, the model calculates either the loan period required to pay off the system (for off-grid solar) or it calculates the payback period of the system relative to grid electricity (for grid-tied and centralized solar).

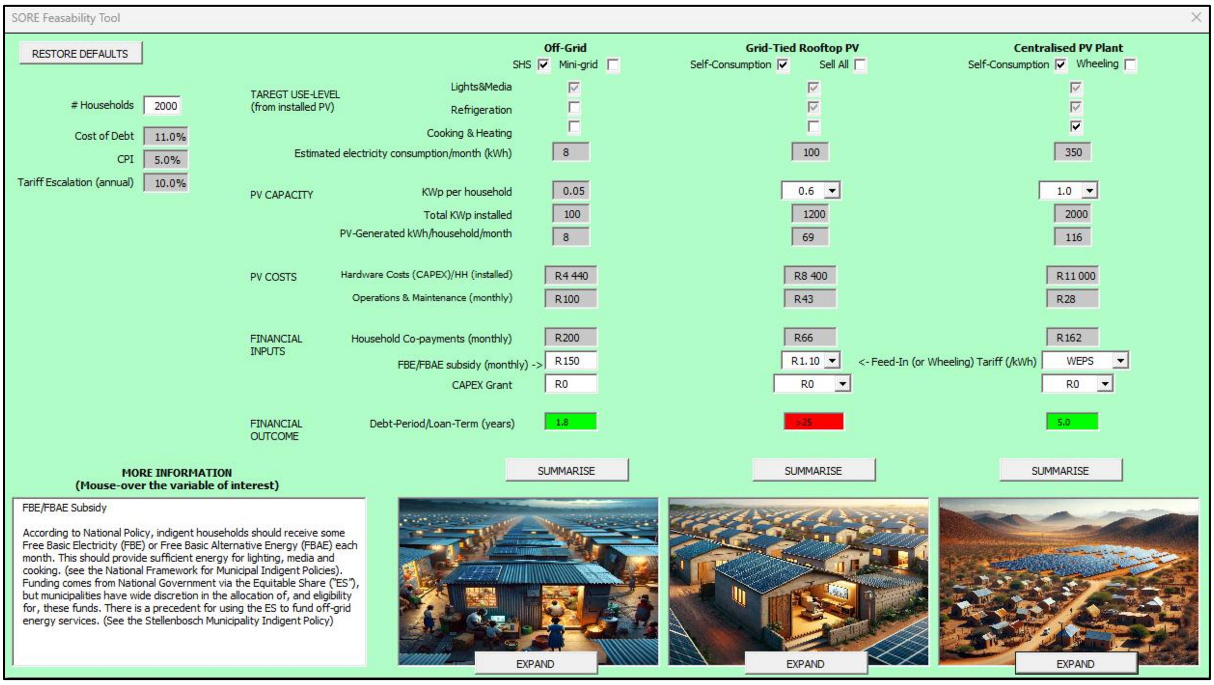

Figure 3: Screenshot of the Community Solar Feasibility Tool

5.1 THE THREE COMMUNITY SOLAR MODELS

The three modalities tested in the feasibility tool emerged from the first year of this project where interviews were conducted to understand the needs of three communities. It emerged that the three community solar arrangements worth comparing are, (i) off-grid, (ii) grid-tied, and (iii) centralized solar.

5.1.1 Off-grid solar systems

There are two technical options for unelectrified ('off-grid') households:

- Solar Home Systems ('SHS') are small solar generation units comprising a solar panel, battery and power-controller. Each household receives their own SHSwhich can provide 'low-voltage'[7] power for lighting and media devices (eg smart-phones, small televisions, laptops/tablets). See Figure 2. SHS are generally considered an interim solution for rural or urban communities while they await grid electrification. Although SHS can not provide cooking solutions, they can still significantly improve quality of life while awaiting grid connection, especially when the only alternatives are the use of candles and paraffin for lighting and when access to media is highly restricted. SHS should not be considered a long-term alternative to full grid electricity, nor should the provision of such a solution

[7] 'Low voltage' SHS are safe from electric shock and run on 'Direct Current' which is suitable for electronic devices. The appliances that are used with SHS (such as lights and TVs) are normally very efficient. They can not be plugged directly into 'grid' electricity (which operates at a much higher voltage and runs on 'Alternating Current'. The safety of SHS not only protects the household occupants from electric shock but also enables installation and maintenance without needing qualified electricians.

further delay a community's journey towards full access to clean, affordable electricity for all its energy needs..

- Mini-Grids (or 'Solar-Towers') comprise a number of solar panels (called a 'solar array') mounted on top of a tower with cables connecting to (up to 40) dwellings clustered around the tower. A large battery is installed on the tower and each house shares, via a meter, in the stored solar low-voltage electricity. See Figure 3. Depending on the size of Mini-Grid and the number of connected households, it can provide sufficient power for lighting, media and refrigeration. For an informal settlement a Mini-Grid might also be seen as an interim solution, however the financial feasibility of such an investment relies on it being used for at least 10 years. Technically, adjustments can be made in future to connect a Mini-Grid to the Eskom grid.

*Figure 4: **Fictional representation** of an off-grid solar home system*

*Figure 5: **Fictional representation** of an off-grid minigrid solar system*

Evaluating the financial feasibility of off-grid solar systems for unelectrified communities (eg informal settlements) relies on assessing whether the services provided by the solar outweigh the costs. It is important to factor in the energy- and related expenses that an unelectrified household could avoid if they had affordable access to a SHS or Mini-Grid. Avoided energy costs include candles, paraffin, generators. Related costs include food waste, more expensive 'non-bulk' food, the costs of safety and health hazards such as 'shack-fires' and poor indoor air quality. It is however difficult to quantify all these costs, whereas with grid-tied systems, the financial viability of the investment relies more simply on its ability to beat grid electricity prices.

Objective of the off-grid solar system: provide households with energy services while they await grid connection. These include lights, media and (optional) refrigeration.

Indicator of financial feasibility: the household monthly co-payments should be within the households' affordability threshold and the loan repayment period should be less than 3 years for a 'lights&media' solution or less than 6 years for a 'lights,media&refigeration' solution.

5.1.2 Grid-tied rooftop solar

Grid-tied rooftop solar systems comprise a solar array mounted on the roof of each house with hardware inside the house to link the generated solar electricity to the grid. These systems are suitable for communities that have formal, individual housing units. See Figure 4. The generated electricity can either be consumed by the household or fed into the grid (or a combination). Grid-tied systems are usually substantially more expensive than off-grid solar systems (for the same level of generation capacity) because they require an inverter to synchronize with the electricity grid. However, if the grid-tied system does not have batteries, then the total cost of electricity, per unit, over the lifespan of the hardware (known as the 'levelised cost of electricity') is likely to be somewhat lower than any off-grid system (which must have battery storage). Grid-tied systems must also meet the requirements of the local utility to which the household is connected, including installing suitable metering hardware, which adds to the expense.

The business case for grid-tied solar depends on whether the system is connected 'behind the meter' or not. Currently all existing domestic grid-tied solar in South Africa is connected behind the meter, meaning the electricity generated by the solar system is consumed by the household. Any excess electricity that is not consumed by the household is fed into the grid. This is known as 'self-consumption' as the primary purpose of the solar system is to generate energy for the household to save money on their utility bill. Installing battery storage alongside the solar system allows electricity generated during the day to be consumed in the evening which is when household electricity consumption typically peaks. However, even with the relatively high electricity tariffs and the relatively low feed-in-tariffs, the driver for installing storage is not to offset grid electricity costs, but rather to reduce the impact of load-shedding.

The potential of a 'sell-all' model for grid-tied rooftop solar

As was shown in section 4.2 on municipal electricity tariffs, when a customer installs solar, they are typically moved onto a tariff with a basic charge. This is to ensure that the municipality recovers the fixed costs of supplying electricity despite the household's reduced consumption. While the introduction of this fixed charge aligns with the principle of cost-reflective tariffs, and is defensible from a municipal perspective, it challenges the business case for low-income solar. A sell-all model for grid-tied rooftop solar may be a mechanism to overcome this challenge for low-income households. It would allow the customer to separate the consumption tariff from the generation tariff. Under this pricing approach, all the electricity generated is fed into the municipal grid, i.e. "sell-all". The utility then compensates the household for the electricity fed into the grid, and the household remains on their normal indigent electricity tariff for their electricity consumption which is normally highly subsided and should include up to 100 free units of electricity/month. By separating generation from consumption, there is a case to be made for the household to remain on their indigent tariff for electricity consumption rather than treating these households as typical grid-tied solar customers. Practically, this would mean that a separate meter would need to be installed for the solar system.

Introducing a 'sell-all' solar model in South Africa can improve the business case for low-income grid-tied solar. All electricity generated is fed into the grid and all electricity consumed is bought from the grid. By separating generation from consumption, a case can be made for these customers to remain on their subsidized lifeline tariff which has a significant impact on the business case.

*Figure 6: **Fictional representation** of a grid-tied solar system*

Objective of the grid-tied solar system: provide electricity cost savings by reducing each household's consumption of grid electricity or by feeding electricity into the grid for which the household is compensated.

Indicator of financial feasibility: the payback period should be less than 5 years (i.e. the amount of time taken for the monthly cost savings from installing solar to pay off the solar loan).

5.1.3 Centralized solar system

Centralized solar systems are large solar farms (or 'Solar PV Plant'), comprising multiple solar arrays laid out over a suitable piece of land or on a large industrial or commercial roof-space, and optimally orientated to maximise electricity generation over the year. See Figure 8. Typically, such a PV plant would feed electricity into the grid to be consumed elsewhere. The consumer, known as the 'offtaker' receives a rebate on their electricity bill for the solar energy transported to them. In South Africa, this model is known as 'wheeling' and refers to the transportation of energy from a private generator to a private customer via the Eskom or municipal grid. South Africa has a well-established wheeling market for commercial and industrial customers, with hundreds of megawatts of renewable energy generators already wheeling and thousands more under construction[8].

To-date, neither Eskom nor any of South Africa's municipalities have made the wheeling model available to residential customers due to the complexity of billing and metering for wheeling. However, there is a good case to be made for wheeling to households and communities as it enables access to centralized solar systems and enables cost saving through the efficiencies and risk-mitigation of collective ownership. The Community Solar Feasibility Tool explores the possibility of a community owned PV plant which wheels the generated electricity back to the community of households. The premise is that a large group of households collectively own a centralized solar system, and the energy generated by the solar system is divided among the households.

At the end of each month, each household receives a credit on their utility bill for their share of the generated electricity (at the agreed municipal wheeling tariff). The benefit of this is that, unlike

[8] SALGA Status of Wheeling Report 2023: https://www.sseg.org.za/salga-status-of-wheeling-report-2023/

normal tariffs for rooftop PV systems (known as 'Small-Scale Embedded Generation' or SSEG Tariffs), the households do not need to try to time their electricity use during the hours of generation, since they get the benefit of the wheeling tariff regardless of time of use. There are questions around the implementation of wheeling to customers with prepaid meters – innovative solutions will be needed to overcome these billing challenges.

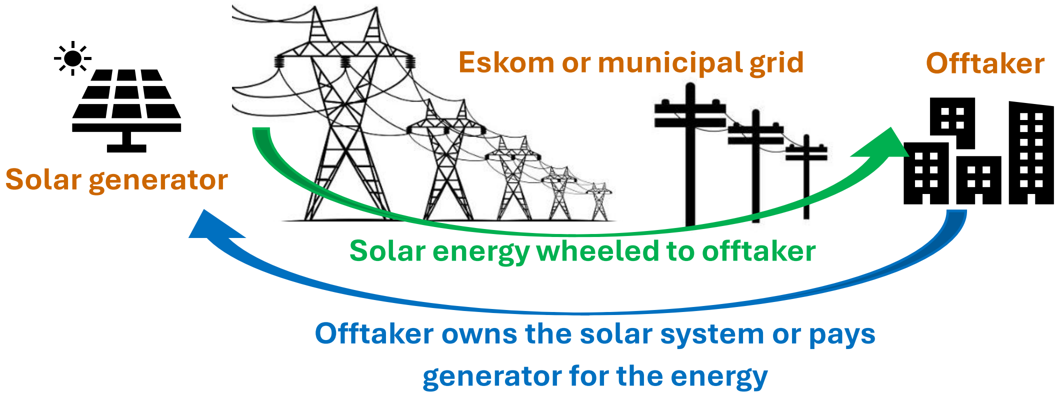

Figure 7: Graphical representation of a wheeling transaction

Wheeling from a centralised solar system unlocks a range of benefits including:

- **Location:** The solar system can be located in a sunny area to generate more electricity.
- **Orientation:** Solar panels can be perfectly orientated and tilted to maximise energy generation. Most roofs are not ideally orientated meaning solar panels generate less energy.
- **Economies of scale:** Large solar installations benefit from economies of scale which reduces the cost per household. It is well known that larger solar installations cost less per kW than smaller systems.
- **Reduced operating costs:** Large solar systems are cheaper to clean and maintain than several smaller systems.
- **Transferable ownership:** The energy generated by the solar system is allocated to a certain number of nominated households, meaning that the ownership of the solar system can easily be transferred to a different account. As such, if a household is to be removed from the scheme for whatever reason, their share can either be picked up by the remaining households or sold to another member of the community. This in turn will likely make the cost of debt lower because the risk of default is lower.

In addition to being cheaper and having a higher energy yield, centralised, well-secured solar systems may offer a practical alternative for communities with safety concerns where theft of panels from the rooftops of individual dwellings may be a risk. Centralised solar systems also offer an alternative in communities where the structural integrity of the roofs cannot handle the weight of solar panels.

*Figure 8: **Fictional representation** of a centralised solar system*

As with the grid-tied rooftop solar system which generates energy either for self-consumption or sell-all, the centralised solar system can generate energy either for wheeling to the households or for selling to another nominated/contracted offtaker. The financial feasibility is similar when the consumption is by the community or by another offtaker. The material difference is that the community either receives energy credits on their meter – an energy service – or the community receives cash payments from the nominated offtaker for the energy wheeled – an income generating asset. However it may be possible in some cases to find an offtaker who is prepared to pay a higher wheeling tariff than the national 'going rate' which is set by Eskom and is called the Wholesale Electricity Pricing System ('WEPS'). Such an offtaker may be a neighbouring or commercial/industrial entity that has a philanthropic and/or strategic interest in supporting the community. In some cases, the offtaker may still save on their normal electricity costs even if they pay more than WEPS; if they are unable or unwilling to invest in their own solar infrastructure then this may make sense to them from a purely financial point of view. Wheeling arrangements with third-party offtakers will however require long-term contracts in order for banks to provide favourable loans.

Centralized solar has not been piloted on a household scale in South Africa. This model explores the financial feasibility to determine whether it is worth exploring.

6 Results

In a project working session, the model was populated with data from each of the three community partners. Variables were then changed to try find a workable model that aligned with the typical affordability thresholds in each community. The results of these **initial** model explorations are detailed below.

6.1 The unelectrified Ekhenana community in Durban

Ekhenana is an informal settlement located in Cato Manor in the northeast of Durban. The Cato Manor area established in the mid-1800s, was named after the first Mayor of Durban, George Cato. The area has consistently experienced informal growth and sprawl. Through various developmental interventions over time, it is currently registered as a semi-developed township, with some access to water and sanitation services and remains a hotspot and a gateway for new informal settlements to develop.

Due to the lack electricity grids, the most appropriate community solar modality for this community is expected to be off-grid solar. Initial discussions pointed towards solar-home-systems being more suitable than mini-grids due to their cheaper cost. However, this meant that households would continue to go without refrigeration. Nonetheless, the range of benefits of electrifying lights and media through solar-home-systems are appealing for this community.

Having opted for off-grid SHS for lights and media, the remaining variables are the value of the municipality's monthly subsidy contribution towards the system and the capex grant. If the municipality provided R150 per month towards the system, and the household's monthly copayments are set to R200, then the debt repayment period is 1.8 years.

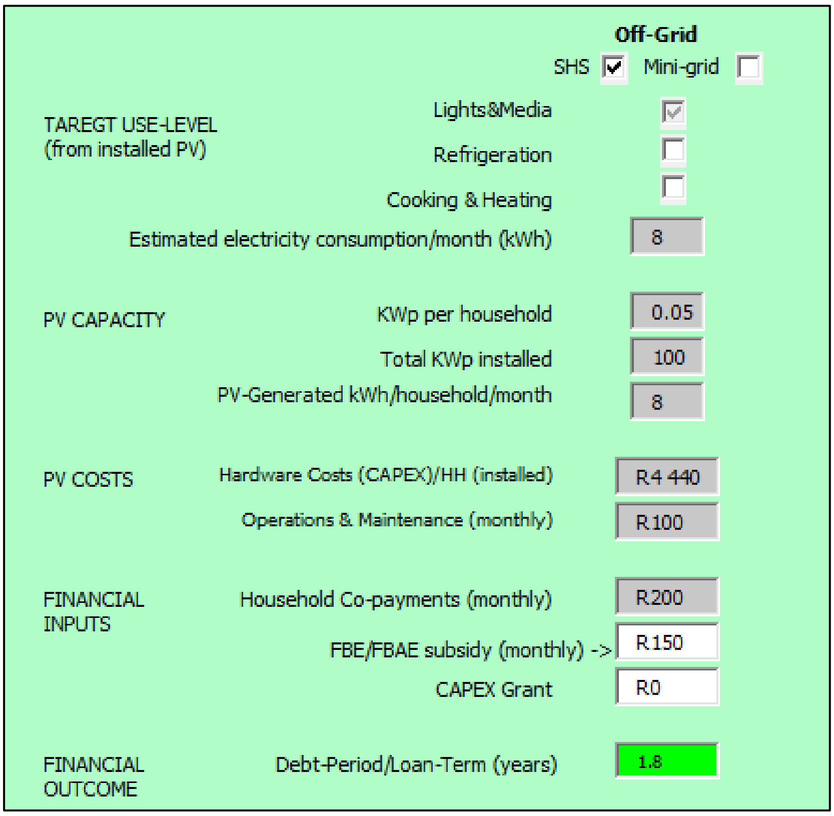

Figure 9: Financial estimates for a potential off-grid community solar project in Ekhenana

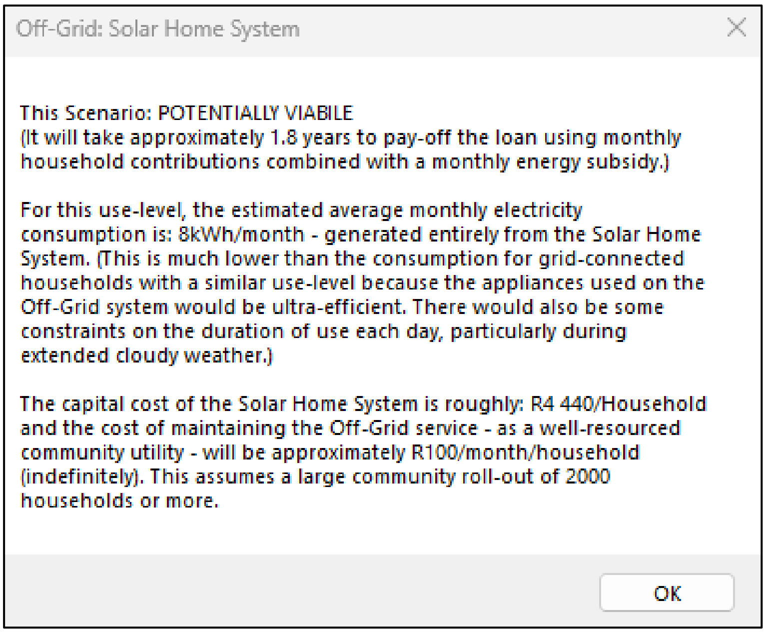

Figure 10: Summary of the viability of the off-grid SHS community solar project in Ekhenana

6.2 THE ELECTRIFIED APARTMENT BLOCKS IN AUSTERVILLE, DURBAN

Austerville is part of the greater Wentworth area, to the south of Durban. The Wentworth area arose in the 1930s as a military base and was later converted into a township for the coloured population, under the Group Areas Act. Over time it evolved into an industrial area, home to oil refineries, paper mills, landfill sites and water treatment sites. As result of this large industrial presence industries, Wentworth contributes to the larger share of Durban's greenhouse gas emissions and harmful public health conditions arising from high levels of air and water pollution.

This community already has an electricity grid connection meaning that the purpose of the community solar project is to reduce energy costs for the households. This can be done by either installing rooftop solar, or a centralized solar project that feeds electricity into the grid. The most viable modality for this community was found to be a centralized solar project that wheels electricity to the community where households receive a credits on their account for wheeled energy.

If each household owns 1kW worth of the centralized solar plant, and the households receive an energy credit to the value of WEPS (wholesale electricity pricing structure) – as is normal practice for wheeling in South Africa today – then the loan could paid off in 5 years. To clarify, the value of the household copayments towards the loan is set to the value of the savings generated by the solar system. This means that the household pays off the loan for the solar system without increasing their monthly energy expenditure. Once the loan is paid off, in 5 years, the household would realize the savings generated by solar, R162 per month.

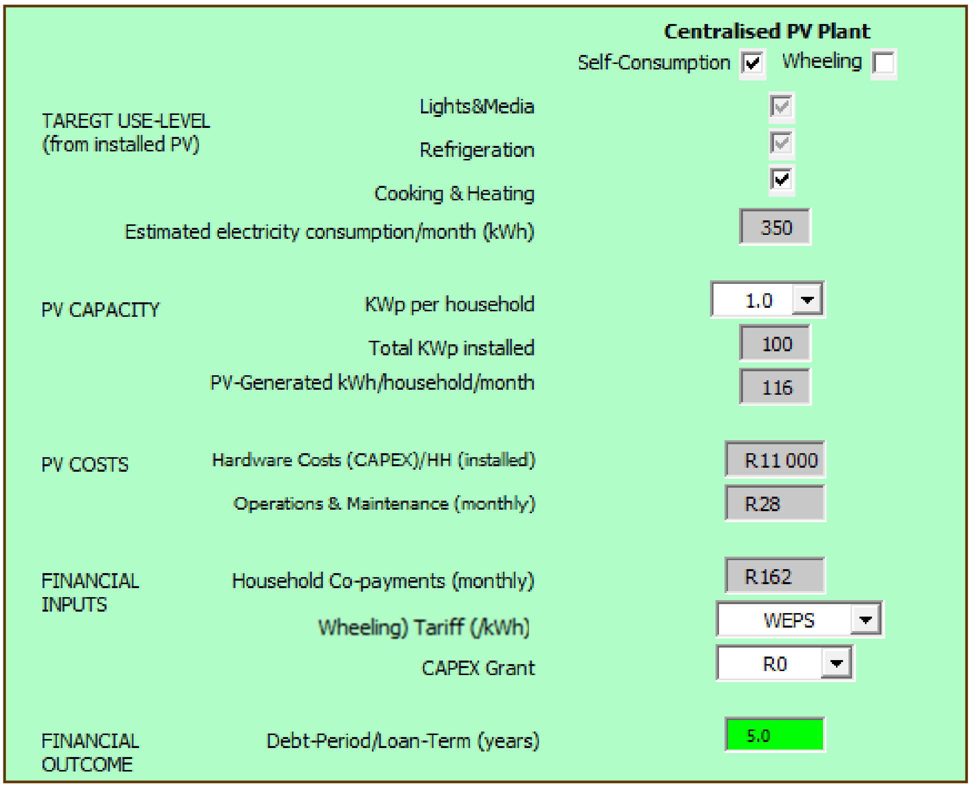

Figure 11: Financial estimates for a potential community solar project in Austerville

6.3 THE ELECTRIFIED RDP HOUSES OF THE KWAGUQA COMMUNITY IN EMALAHLENI

kwaGuqa Ext 18 is located in Ward 7, in the west of Emalahleni Local Municipality. It is part of two larger communities in the municipality, and home to approximately 8400 residents and 2113 households (StatsSA 2016). The community has mainly formal houses, comprising government delivered RDP homes and privately built housing including backyard rentals. The average combined annual household income in 2016 was R57 300. The area is located near the coal mines and as a result, is directly affected by the harmful emissions and pollution emanating from the mines.

The proposed kwaGuqa community solar project is similar to that of the Austerville project, since both communities are electrified and seek to reduce their electricity costs.

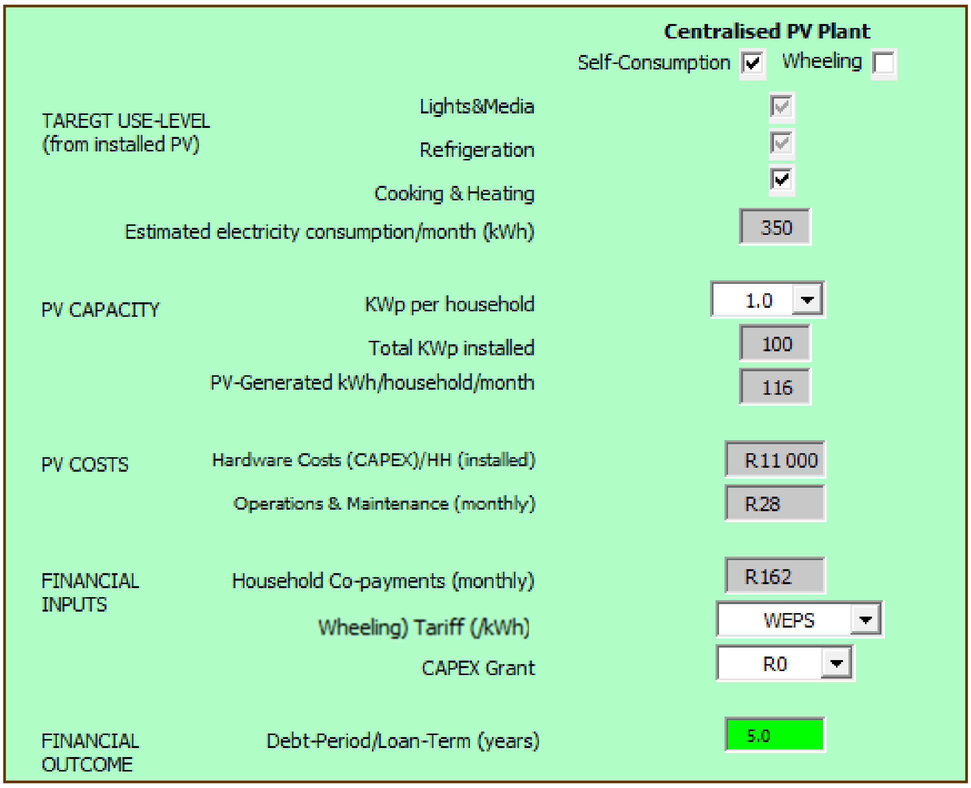

Figure 12: Financial estimates for a potential community solar project in kwaGuqa

A community solar wheeling project utilizing the WEPS-credit method is a potentially viable modality. Initial modelling suggests that the savings generated by the solar system could repay the loan in 5 years.

7 WHAT DO WE NEED TO MAKE THIS HAPPEN?

The results show that with government support, these critical community solar projects can be realized, unlocking a massive contribution to South Africa's just energy transition. Municipalities, Eskom and National Government can play a major role in making community solar projects possible by making the appropriate changes to their electricity policies and tariffs. The following policy changes can contribute to unlocking community solar projects:

7.1 CHANGING INDIGENT POLICIES TO ALLOW FBE GRANTS TO CONTRIBUTE TO THE PAYMENT OF AN OFF-GRID SOLAR HOME SYSTEM OR MINI-GRID

This allows off-grid communities who are eligible for free basic services to participate in solar energy investments without forfeiting their access to subsidised electricity tariffs and FBE. This will have a tremendous impact of improving lives and reducing the risks and hazards of traditional energy sources used by unelectrified communities such as candles, paraffin, wood, and dangerous 'illegal' connections. See Section 2.1 for how such provision was made in the indigent policy of Stellenbosch Municipality.

7.2 FUNDING A CAPEX GRANT FOR COMMUNITY SOLAR PROJECTS

While donor foundations may be able to provide a capex grant for initial pilot projects, a government mechanism will be required to scale community solar projects. National Treasury is already providing a tax incentive for rooftop solar systems up to a maximum value of R15 000. A tax incentive is not an appropriate mechanism for low-income community solar projects, but an alternative mechanism (with an equivalent cost to the fiscus) would significantly reduce the upfront cost of solar projects. Also, the eligibility for capex funding from the Integrated National Electrification Programme (INEP) – traditionally focused on rural off-grid solar projects – should be expanded to include any urban or peri-urban off-grid community in South Africa.

7.3 IMPLEMENTING THE SELL-ALL MODEL FOR ROOFTOP SOLAR PROJECTS

This would allow communities to separate consumption from generation thereby remaining on their subsidized indigent tariff for electricity consumption while being compensated for all the energy fed into the grid.

7.4 ALLOWING WHEELING TO HOUSEHOLD OFFTAKERS

This would unlock centralized solar projects and the range of benefits these larger systems offer. The challenges to implementing household wheeling relate to the cost of billing and metering. Finding centralized billing systems (such as Eskom's virtual wheeling platform) may reduce the administrative burden of household wheeling.

7.5 REDUCE THE COST OF SMART BI-DIRECTIONAL ELECTRICITY METERS

Both the grid-tied solar model and the centralized solar model rely on each household having installed a smart meter to measure the electricity consumption. At the moment these meters are prohibitively expensive. National Government must look at mechanisms to centrally procure a large amount of electricity meters to reduce the cost of these meters.

8 CASE STUDY ON THE TRAILBLAZING ISHACK PROJECT

8.1 PROJECT BACKGROUND

The iShack Project is a social initiative that provides off-grid solar electricity solutions to residents of informal settlements while they await grid-electrification. It was established as a not-for-profit social enterprise owned by the Sustainability Institute Innovation Lab (SIIL). The objective of the project is to develop and demonstrate a model for underserviced communities through building local enterprising capacity, developing skills, creating green jobs and contributing to the resilience of the communities. At the core of the project is a vision to ensure universal access to basic electricity and upgrading existing informal urban and peri-urban communities by installing off-grid 50-70Wp solar systems to power lights, cell phones and a TV, while these communities wait for electrification.

The project was first launched in 2013 in Enkanini settlement, Stellenbosch, Western Cape. The capital expenditure of which was largely covered by the Bill and Melinda Gates Foundation and the SA Green Fund. The iShack approach works on a pay-for-service model dedicated to cover operational costs, without ownership. Residents who voluntary opt for the system pay a modest deposit and installation fee to start, and then formally contract with the project where they go onto a pay-as-you-go system for usage. They then have free use of a standalone solar home system (SHS), installed on their roofs which can generate adequate daily electricity to power lights and energy efficient media devices.

8.2 STELLENBOSCH MUNICIPALITY INDIGENT POLICY

In addition to driving the initiative toward clean, reliable and affordable energy to indigent communities, the project has influenced policy changes in South Africa. Stellenbosch Municipality amended its Indigent Policy to enable the use of Free Basic Electricity (FBE) funds to be used to subsidise SHS for off-grid households. The iShack Project secured the payment for the subsidy from the municipality, which was paid directly to them. The municipality covered overhead costs through FBE (equivalent to 100kWh). As a result, clients only make co-payments toward maintenance or system upgrades if and when required. These arrangements render the service financially sustainable.

Extract from Stellenbosch Municipality Indigent Policy:

"a maintenance and operations subsidy (equivalent in rand value to 60 kWh electricity per household per month) for off-grid solar home systems, operated by a municipal approved service provider or energy service company (ESCo)"

8.3 PROJECT SUCCESS

To date, over 1700 households in Enkanini are now using the iShack solar service as an interim FBE provision while they wait to be connected to the grid. A small team of iShack 'agents', from the community, run the daily operations of the utility. Their work involves marketing and client contracting, to installing and maintaining hardware, and ongoing client management. Supported by a small management team, the iShack agents help to co-produce systems and policies as part of the project's continuous improvement strategy. Customised client management systems and databases have evolved over the years. The increasingly sophisticated SHS technology together with these operating systems create rich data that have enabled an efficient and fit-for-purpose utility management programme.

The success of the project is in line with progressive realization of services, as articulated in the South African Constitution and other laws and policies that prioritize basic service delivery to poor members of society. iShack has also run successful projects in the Freedom Farm, Longlands, Malawi Camp, and Siqalo settlements in the Western Cape.

Figure 13: Photos of iShack off-grid solar home system installations

APPENDIX: LIST OF ASSUMPTIONS

Assumptions for off-grid solar:

- The cost of a lithium-ion battery is included.
- The systems run on direct current (DC) to reduce costs, meaning that a DC fridge would be required for the minigrid refrigeration scenario, the cost of which is not included. DC fridges are slightly more expensive than normal AC fridges – costing roughly R5 000 – but the cost savings from not installing an inverter far outweigh this cost.

Assumptions for grid-tied solar:

- A battery is not included meaning these systems do not provide resilience to loadshedding.

Assumptions for centralised solar:

- The default wheeling mechanism is an energy credit at the WEPS (wholesale energy pricing structure) rate.