Are solar home systems a more financially viable method of electrifying Ghana households?

A Dissertation

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Abstract

Africa still has the lowest electrification rates in the world with over 600 million people estimated to be living without access to electricity. What makes the challenge even greater for Africa is that the continent is so sparsely populated that building grid infrastructure is not viable in many cases. However, "pay-as-you-go" solar home systems have provided the continent with the opportunity to correct its electrification deficit. These innovations are not new and many of the costs of operating these systems have reached grid parity when one considers the Levelized Cost of Energy Model. However, these projects still fail to meet institutional investors' bankability criteria. The aim of this study is to try and understand whether solar home systems provide the investor with an opportunity to make a larger risk-adjusted return versus existing grid-based power station projects being considered on the continent. This study uses Ghana's recently built Kpone power station as a case study to complete this analysis. The study also seeks to assess what viability criteria is employed by a broad base of investors if they were to consider funding off-grid power. The study makes use of the Net Present Value model to compare the returns for Kpone and Zola Electric's Infinity solar home system. The study also conducts inductive qualitative analysis to try and ascertain what criteria is assessed for project viability and then builds a conceptual framework for assessing future projects. The study found that Kpone provided a better risk-adjusted return to that of Zola Electric's solar home system, largely because of Kpone's project finance structure reducing the risk of the investment. Our findings also show that investment ticket size, company track record and management track record are among the most highly considered criteria for investments into off-grid companies.

Key Word

Bankability, Grid Parity, Levelized Cost of Energy, Off-grid PV Storage solutions, Inductive Qualitative analysis, pay-as-you-go, Net Present Value, Institutional investors, Discounted cash flows

Abbreviations

SHS	Solar Home System
KWH	Kilo Watt Hours
LCOE	Levelized cost of Electricity
NPV	Net Present Value
CAGR	Compound Annual Growth Rate
DCF	Discounted Cash Flows
GWH	Giga Watt Hours
ESG	Environmental Social and Governance
CAPEX	Capital Expenditure
WACC	Weighted Average Cost of Capital
IPP	Independent Power Producer
SIDS	Small Island Developing States
LCO	Light Crude Oil
GOG	Government of Ghana
PPA	Purchase Power Agreement
PE	Private Equity
DFI	Development Finance Institution

Contents

Introduction/Problem Statement

It is by no mistake that Sub-Saharan Africa has earned itself the nickname “the dark continent”. A summary of key metrics quickly shows the extent to which Africa has a severely underdeveloped electricity grid. At the end of 2017 it was estimated that 600 million people were without electricity on the continent (Toman, M. 2017). Seven countries had electrification rates above 50% and the rest of the region had an average grid access of just 20%. The continent that has 14% of the world’s population had 48% of the people living without electricity. At 150 kilowatt-hours per annum our per capita consumption of electricity is just a fraction of what it should be by developing market standards (Castellano et al., 2015).

Poor access to electricity hinders Africa’s ability to develop as a continent. Power outages on the existing grid have the effect of disrupting business productivity. The direct costs of this disruption can often be seen in the cost of procuring back-up power. The average firm in Africa incurs an electricity outage cost of between $0.46 to $1.25 per KWH by 2012 estimates. This accumulates to an outage cost of $1343 to $3650 per KW (Oseni, M. 2012). To give these numbers context, if Nigeria would have a stable electricity supply the cost savings would allow Nigeria to employ an incremental 1.6 million people on the national minimum wage (Oseni, M. 2012). Studies have gone further to show the benefits of rural electrification when off-grid solutions are implemented. One benefit noted was the growth of rural enterprises (The World Bank Group. 2016). These enterprises had a positive impact on household incomes (The Independent Evaluation Group (2008)). There is overwhelming consensus that electrification of the African continent can accelerate the objective of bringing about prosperity. The true challenge, however, lies in the vast sums of investment needed to address the problem.

If one considers Africa’s potential energy mix, Africa requires more than $800 billion to develop its electricity generation capabilities (Castellano et al., 2015). However, if one were to break down this figure one begins to raise interesting questions. Firstly, $490 billion is needed for new generating capacity and $345 billion for transmission and distribution. Secondly, Africa has the potential to produce 10 terawatts of energy, and 8.8 terawatts of this can be purely generated from solar energy (Castellano et al., (2015)). It is with these figures in mind that questions arise as to why building a grid in Africa should be the only priority when recent studies show a more cost-efficient and time-efficient alternative methods of delivering energy to the continent.

Developments in off-grid solar and energy storage technology have brought the cost of electricity from these sources close to the electricity provided by the grid (Breyer, C. and Gerlach, A. 2012). However, in the African context where most households either have unstable or no electrification, the cost of full grid defection may already be economically viable due to high costs of back-up power such as diesel generators (Oseni, M. 2012). Thus, breakthroughs in solar energy costs and energy storage costs have delivered the same convenience the grid has been able to. This is mainly because the technology allows one to harness the suns energy then store it when not in use.

By building off-grid solar solutions we potentially avoid part of the $345 Billion cost of building a transmission and distribution network. Lastly, building solar capabilities has already been known to be a quicker route to market. The question thus becomes, why have we not prioritized off-grid solar and storage solutions to electrify the continent? One hypothesis this study has is that it might not be financially viable for an investor. Thus, the study seeks to understand what incremental investment returns an investor could earn if they invested in a venture that provided solar home system that have the ability to store energy. The study seeks to do this by conducting a risk-adjusted return analysis for a company that provides solar home system to a power station that has been recently developed. We also seek to understand the considerations taken by investors when they asses the bankability of an energy project. This study seeks to be the first of its kind by building a case for whether effort should be spent convincing investors to fund large electricity generating power stations or Off-grid solutions in Africa.

Theoretical perspectives

There are 4 main theories that underpin this study. The first two relate to Bankability and the last two studies relate to the underlying theory governing how profitability is assessed. Each of the studies' principles are explained below. The studies have been organised to reflect the advancements in the underlying theory. Thereafter an explanation of which underlying theory will be used by this study is explained.

Theories Underlying Project Bankability

The first theory is the Theory of Irreversibility, Uncertainty, and Investment by Pindyck, 1990. The theory states that investments have two underlying characteristics. The first is that investments are irreversible given that one cannot divest once an investment has been made. This means that investments are highly sensitive to risk. This is because once an investment decision has been made an investor is fully committed to absorbing that risk. Thus, an investment is seen as a sunk cost. If policy goals are to stimulate investment, then stability and credibility will be needed to stimulate this investment to prove to a potential investor that their investment is safe. The second principle put forward by Pindyck is that investments can be delayed, giving the firm time to consider their investment closely. The above underlying theories explain why investors choose to strictly employ bankability criterion that at times looks beyond the realms of basic financial return.

Mohamed and McCowan, 2001 Showed that investors rely on the NPV model to arrive at an answer of whether a project is bankable. Thus, if a project shows a return that beats a hurdle rate, that investment must be considered as viable. The study points out that the level of uncertainty underlying some of the assumptions made in a DCF are not accounted for. Possibility theory puts forward a method of evaluating a project by considering both monetary and non-monetary issues. It does this by accounting for the probability of monetary and non-monetary events taking place. Thus, if the probability of obtaining a NPV that beats a pre-determined hurdle rate is acceptably high, the project is seen as viable.

This study chooses to adopt Pindyck's perspective given its recognition of the fact that project bankability goes beyond just meeting a targeted financial return. This study is relevant given many institutional investors publish criteria that go beyond projects generating financial returns. By choosing to endorse a strictly returns based criteria we risk dismissing important salient points in project financing criteria.

Theoretical Perspectives Underlying Financial Viability

The Žižlavský, 2014 measure was created specifically for innovative projects. It makes use of the Net Present Value approach and details its pro's and con's, showing how the measure's weaknesses can be overcome. The study recognises that new, innovative, capital-intensive projects are inherently very risky due to their lack of revenue generating history. Off-grid solar projects fit this description. The measures it proposes to combat NPV weaknesses are three adjustments to NPV, of which only two are considered for purposes of this study. The first is the risk-adjusted NPV. Simply speaking, this measure multiplies the potential payoff (cash flows) from the project with a probability that payoff will be realised. It then subtracts the probability that the associated costs will materialise. Below is an example:

Figure 1

$$rNPV = \sum_{t=0}^{n} \frac{CF_t R_0}{(1+r)^t R_t} + \frac{R_0 CF_{n+1}}{(r-g)(1+r)^n}$$

Where:

- rNPV = risk-adjusted NPV
- NPV; CFt = cash flow in period t;
- R0 = the present probability of successfully concluding the development process and as a result of this realising revenue;
- Rt = the probability as considered in period t of successfully taking the product to market maturity (pt,8 with t>1);
- R0/Rt = the probability as considered today, of generating the cash flows arising in period t,
- r = discount factor;
- n = the last period for which costs and revenues are accurately planned;
- g = growth rate.

The Stochastic NPV considers each cash flow as a random variable that has a given distribution of probability (usually a normal distribution), mean value and a variance. The NPV thus becomes a stochastic variable with an associated probability distribution defined as below

Figure 2

$$E(NPV) = \sum_{t=0}^{n} \frac{E(NCF_t)}{(1 + r_f)^t}$$

Where:

- E(NPV) = expected NPV;
- E(NCFt) = the expected value of the net cash flow in each year t;
- rf = the risk-free rate.

The last theoretical perspective is that of the Levelized Cost of Energy (LCOE) metric. Given most power plants are subject to tightly regulated selling prices, this measure looks at the cost of producing a single KWH over a plant's lifetime to determine the potential profitability. This is obtained by comparing the newly obtained cost (LCOE) to the price per kWh hour sold to customers. Thus, the margin is determined by the selling price less the LCOE. Aldersey-Williams and Rubert, 2019 found in their theoretical review that the LCOE was the preferred metric due to its widespread adoption. However, the measure was shown to be weak in how it adjusts for changes in the discount rate, inflationary effects on costs and how sensitive it was to changes in future commodity prices.

For the purposes of this study we will be looking at using an NPV model as per Žižlavský study. We, however, choose to exclude the probability portion of the model given the complexities in establishing probabilities. The reason for choosing this metric is a recent survey run by PWC where it showed that this was the most common form of analysis among the top surveyed institutional investors PWC.2017.

Literature Review

Introduction

To further explore the viability of implementing standalone off-grid solar solutions, a wide body of research was explored. The review of the literature has been structured in such a way to reflect the area of research and the advancements in theory over time. The first literature review relates to studies that compare which energy generating technology is better.

Return on investment comparisons

Szabo et al commissioned a study in early 2011 to find out what the most cost-effective electrification methods are for rural households in Africa. These options were diesel generators, photovoltaic systems (PV or off-grid solar solutions) or an extension of the existing grid. They sought to understand which energy source was the most cost-effective. Using spatial mapping to understand potential electricity output and the LCOE model they were able to calculate the affordability of implementing off-grid solutions. They found that sparsely populated regions were better served by PV and diesel generators given that grid connections are only viable when many consumers can be connected. However, in densely populated areas grid connections delivered a better cost (Szabó, Bódis, Huld and Moner-Girona, 2011). The Szabo et al study is like this study in the sense that it seeks to compare what the optimal technology is. However, the measures used differ in what they are trying to compare. The Levelized Cost of Electricity (LCOE) model used seeks to understand what technology offers the optimal cost over the technology's lifespan. This Study, however, seeks to understand what technology offers the better risk-adjusted return for the same capital outlay and what would entice that investor to invest in off-grid solutions.

A study by Breyer et al seeks to understand the viability of implementing PV solutions in 305 markets. Viability in this study was defined as whether the cost of PV is the same as the grid (also known as grid parity). The method they implemented was the LCOE model. The study found that off-grid PV solutions were already viable in African markets that did not have a grid (Breyer, C. and Gerlach, A. 2012). Ondraczek et al ran a similar study to that of Breyer in that they mapped per country the LCOE. However, their study sought to understand where PV and storage reached parity with grid costs, but also based on the LCOE model, which markets offered the best cost for benefit (benefit being defined as electricity output). Their findings suggested that countries in the northern hemisphere offered the best cost benefit only because of the low cost of capital. However, if one were to strip these costs out, African countries offered the better cost benefit due to the amount of sun available on the continent (Ondraczek, Komendantova and Patt, 2013). The above studies partially answer the questions this study seeks to answer in that they show that off-grid is competitive versus other technologies. They do not tell us, however, which technology should be prioritised by investors based on a risk-adjusted return criteria. This study seeks to understand what technology offers the better risk-adjusted return for the same capital outlay and what would entice that investor to invest in off-grid solutions.

A study by Siddiqui in 2015 used the LCOE method to understand when micro grid parity would be reached in Germany, Pakistan and South Africa. The significance of this study is that it looked at the viability of micro grids and not only standalone off-grid solar energy and storage solutions. The study found that in Pakistan, where the grid connection is very low, implementing multiple micro grids was already viable from a consumer cost perspective. The study concluded that for South Africa, these parities would only be reached in 2040-2050 (Siddiqui, 2015). It also fails to explain whether this viability results in a significant incremental return for investors.

This study seeks to further the research by exploring whether standalone off-grid solutions also offer superior returns over and above being viable using a NPV model as opposed to the LCOE.

Yujia Tao and Finenko, 2016 investigated why renewable energy sources which had reached grid parity did not result in investors investing in these renewable energy projects. They explained this phenomenon in Small Island Developing States (SIDS). The paper's objective was to show that assessing viability by only assessing the LCOE was an incomplete benchmark in energy mix decision making. They used the NPV model to assess the viability of projects across various SID nations. The study showed that financing conditions, such as the split of debt and equity, had a strong influence on economic feasibility of solar projects. The second consideration was that the LCOE in the assessment of profitability was misleading due to its inaccurate accounting for revenue and financing considerations. Yujia and Finenko's paper is useful in showing us the flaws of LCOE in investment assessments. This paper intends to add to the body of literature by using the NPV model in its assessment for African off-grid projects and power station projects with the intention of establishing whether an investor stands to make more by investing in SHS companies.

Baurzhan and Jenkins, 2016 wrote a paper with the objective of understating the feasibility of off-grid solar PV systems in Sub-Saharan Africa. The paper looked at understanding five elements of feasibility. These were cost-effectiveness, affordability, financing, environmental impact, and poverty alleviation. With regards to cost-effectiveness and financing, the paper used the LCOE model to understand these metrics. They compared SHS to diesel generators. The paper finds that cost-effectiveness will only be reached in 8-16 years. The cost hurdle means firms will be expected to subsidize the electricity provided by these units into the foreseeable future for households to afford this form of electricity. It also sees the lack of financial history as a burden to allowing for the pay-as-you-go financing model. The paper judges feasibility based on the cost of electricity and not based on whether an investor stands to gain more in terms of return. Our study seeks to look at potential returns of off-grid solar to other technologies using a DCF model as opposed to comparing just costs.

The objective of a study by Yang and Yang, 2017 was to establish whether off-grid solar solutions were viable versus existing energy sources. The significance of the study is that they looked at energy sources used primarily in rural Africa. They used the LCOE model to try and understand the cost of kerosene and candle lamps, pay-as-you-go off-grid solutions and diesel power in Africa. “Pay-as-you-go” solutions, which are effectively SHS, offered the best cost per kWh and kerosene the worst. While the study helps us understand the viability of off-grid solar solutions in rural settings, it does not show whether SHS offers a better risk-adjusted return for investors versus existing energy sources. This paper intends to add to the body of literature by using the discounted cash flows model (NPV analysis) in its assessment for African off-grid projects and power station projects with the intention of establishing whether an investor stands to make more by investing in SHS companies.

In Atal and Shrimali’s 2018 study they sought to understand 1) whether renewable energy or fossil fuels offered better returns 2) investors’ risk perception of the two technologies and 3) what the factors were that contributed to the differing risk perceptions in India. They conducted their study by using empirical analysis of financial performance of power producing companies. They also conducted primary research with investors. They found that the renewable power sector was less risky than the fossil fuel sector when one considered systematic risk. They also find that the renewable power sector offered 12% higher annual returns 20% lower annual volatility, and 61% higher risk-adjusted returns. The methodology, however, is limiting given they only considered listed companies on the Indian stock exchange. The study answered the questions the study seeks to answer. However, the studies are only applicable to India and listed established companies. Our paper intends to add to the literature by using a discounted cash flows model to ascertain whether off-grid investments result in incremental return.

Nissen and Harfst, 2019 recently reviewed the LCOE model for evaluating renewable technologies. The objective of their study was to show how the model was an inappropriate model for making investment decisions on whether investments should be placed into renewable technologies. The reason they gave was that it neglected energy price changes over time. The study shows that the LCOE does not consider full price changes in electricity and thus does not account for the full NPV value a project can potentially deliver. This finding was consistent with the findings by Yujia Tao and Finenko, 2016. They proposed a new formula to consider the changes in energy prices and operating expenses over time. The formula was derived from the NPV formula. The study, although not related to understanding which energy producing technology provides the best return, does show us that a NPV approach is warranted in our analysis. This study will seek to further Atal and Shrimali's research by comparing the risk-adjusted returns for traditional power stations versus standalone off-grid solar power solutions.

Bankability

Introduction bankability

To date there is not a clear set of criteria that off-grid companies are required to meet before they can acquire the necessary funding needed to scale their projects. The literature and published information on the requirements needed to meet project viability is often unclear due to the lack of specific detail needed to meet bankability criteria. There is also no framework or established criteria that can be referred to when assessing what needs to be in place in order to have a bankable project. There is, however, a large body of interviews, reports and assessments that have been conducted to establish what is required to unlock institutional investment. The below literature review gives further insight into this.

Bankability literature review

An earlier report released by the International Finance Corporation (IFC) in 2012 looked at what the main barriers to off-grid project bankability were. The report identified that commercial banks' primary assessments constitute the transaction costs, cost of lending and risk return profiles. The report found that this drove commercial banks to reject projects that require small scale financing because they lacked the scale needed to cover the transaction costs (IFC, 2012). The alternative is project finance, but this requires large deal sizes to make the transaction costs associated with the project viable. Another barrier identified was the lack of track record by the management of off-grid companies and the company's profit history (IFC, 2012). This study is useful in that it highlights the criteria current off-grid projects fail to meet. The study, however, is only specific to one type of investor and only looks at a few issues with bankability. This study seeks to further the bounds of knowledge by consolidating all requirements into an easy-to-use bankability framework applicable to the largest investors across various investor types.

A Bhattacharyya, 2012 study investigated the barriers to further funding of energy access with a focus on off-grid projects. The study found that in all successful funding cases the state played a significant role in funding and providing policy certainty to the project. This study shows that the state is a significant influence on projects becoming financially viable. It adds to the literature by showing that regulatory certainty should form part of off-grid bankability criteria. The study, however, does not provide an exhaustive list of the criteria investors evaluate when assessing project viability. This paper aims to contribute to the literature by adding a bankability framework that includes an exhaustive list of criteria that large institutional investors could use to assess off-grid energy projects. The framework also seeks to clarify the specific government support sought by investors.

In an earlier report released by AT Kearney and GOGLA, 2014 investors and off-grid energy companies were interviewed. A series of questions were asked to try and ascertain what the barriers were to investing in off-grid companies. Some of the key findings were that small deal size, a lack of successful investments in the industry and better opportunities elsewhere were found to be significant barriers. The report findings are consistent with an earlier report released by IFC, 2012. The report, however, lacked detail on what exactly the investors were looking for under each mentioned criterion. There also is no clear understanding of who the assessed investors were and how much capital they had available to dispense. The study by AT Kearney and GOGLA is useful in that it provided a general overview of what the key criteria to investing were. It did not provide an absolute indication of what, for example, the consensus of what the deal size should be.

This paper aims to contribute to the literature by adding a bankability framework that includes an exhaustive list of criteria large institutional investors should use to assess off-grid energy projects. The framework also seeks to clarify the specific government support investors are looking for.

In a survey conducted by PWC in 2015 one of the questions utility directors across Africa were asked was what the barriers were to further investment in the sector. The common concerns were cost reflective electricity tariffs that cover the cost of production and allow the investor to make a return. The second was the inability to obtain finance due to high perceived risks. Thirdly, regulatory uncertainty and government planning on grid extension plans were cited. Lastly, offtaker risks and the ability of the offtaker to pay for power were the last common concerns (PWC, 2015). The PWC report was much more specific than the report released by AT Kearney and Googla in outlining what was needed to make energy projects viable. The report, however, related to traditional base load power stations as opposed to off-grid energy companies. The report, however, is useful in that it provides clarity on what regulatory certainty investors are looking for. This study seeks to rank the importance of each key criteria that institutional investors look at and provide detail of the specific amount or specifics assed in project bankability. Further to this, the study then seeks to use a newly developed framework to assess bankability criterion.

A Niraula, 2015 study looked at how standardizing the design of a microgrid could deliver the lowest cost of production of a PV solution. The PV solution would deliver the highest output of electricity and lowest cost of electricity. This was a key barrier to unlocking institutional investment. The study not only finds that standardizing the design helps to reduce this cost, but also if projects were to be aggregated, it would help achieve scale. The study went further to show that microgrids were viable in geographically dense regions when scaled. The study by Anjal is like this study in that it looked at addressing one aspect of project bankability which was the issue of scale. The study, however, did not go as far as to explain what all the barriers to bankability were, nor did it explain at what level a project can be deemed to be "scaled". The study is also limiting in that it only looks at micro grids and not SHS solutions. This paper seeks to add to the literature by taking the consistencies of what is needed to make off-grid projects viable and put them into a framework that is easy to use and provides a detailed understanding of project viability.

In Mckinsey's "A Brighter Africa" report the company looked at the key elements needed to make energy investment a reality on the continent. The report focused on the criteria needed to make traditional base load power stations bankable and not necessarily off-grid applications. The report concludes that there needs to be financial viability by government guaranteeing cost reflective tariffs and ensuring there is an off-taker agreement in place. Currently the challenges faced are a lot of utilities are selling electricity at below cost, there aren't significant off takers and there are challenges collecting money. These findings are consistent in the findings of the PWC report released in 2015. The second was to create an environment were other sources of financing can be utilised such as private-public partnerships and encouraging Independent Power Producers. Lastly, there needs to be the provision of clear and transparent regulation and the building of structures to allocate risks to the party best suited to absorb them via project finance structures. The report also called for the provision of credible off takers and risk guarantees provided by governments (Castellano et al., 2015). The report by Mckinsey provides further clarity to the 2015 PWC report on what regulatory certainty and support is needed. It also provides clarity on what risks are of concern which are namely tariff risks and off taker risks. The report however is very specific to traditional Utilities and not off-grid energy companies. Our study seeks to clarify these risks for off-grid companies. It also seeks to make this criterion clear in an easy to use framework.

A study by Shi et al in 2016 looked to understand the effect supporting instruments had on encouraging investment into off-grid solar projects in developing markets. Supporting instruments were classified as financial incentives (grants and loan guarantees), fiscal incentives (import duty and VAT exemptions) and elimination of market distortions (such as fossil fuel subsides). They planned to assess the effect these supporting instruments had by building an assessment framework. The framework used was a three-dimensional framework that assessed feasibility, sustainability and reproducibility. A survey was then run to understand which of the three dimensions were most important. The survey results suggest that feasibility, sustainability is more important than reproducibility. The instruments that drove feasibility and sustainability were local engagement, loan guarantees and start-up grants. (Shi, Liu and Yao, 2016). These metrics add to our study by showing us the key instruments that aide in helping off-grid projects achieve bankability. They do not, however, show us what criterion is assessed by institutional investors. This study fills this gap by providing both a framework and exhaustive list of criterions for assessing bankability

The Economist set out to conduct expert interviews, desk research and conducted field work to understand the barriers to further renewable investment in Sub Saharan Africa. The Economist concluded that there was a lack of appropriately priced off-grid solutions for African consumers, that a significant amount of governments fail to institute cost reflective tariffs, there is a lack of regulatory certainty and planning from central governments on where the existing grid is likely to extend to (The Economist Intelligence Unit, 2016). The report also notes off taker risks as a key concern for further investment. The Economist report is consistent with the PWC and Mckinsey reports. It, however, valuable in the sense that it was specific to off-grid applications and not just base load power stations. The report also highlights a new risk in that the off-taker risk in off-grid applications is the final consumer. Our study seeks to add to this body of literature by developing an exhaustive list of bankability criteria and establishing an easy to use framework to assess these criteria.

An off-grid Market trends report developed by the world bank group, 2016 looked at the challenges off-grid electricity companies faced when raising finance. The report segments the companies based on the stage in their company's lifecycle. It concludes that SHS companies lack the track record of both their business model and management's. These were seen as key drivers in a company's ability to raise capital due to its perceived risk. The report also placed a specific amount on what was a saleable project. This number was placed at $50-100 million for an individual firm. The report looks at using special purpose vehicles that are common to project finance capital structures to manage the debt levels needed for off-grid projects to reach scale. This is both to manage the debt risk and the business risk. It also proposes consumer debt become securitized so that it can trade on secondary markets in order to reduce the interest rate because of the attraction of more investors (The World Bank Group, 2016). The report is useful in that it clearly outlines the various stages of off-grid companies and what funding is needed in order for it to scale. In addition to highlighting the challenges to reaching bankability, it proposes solutions needed to aiding scalability to make off-grid projects more investor attractive. This study seeks to expand on this report by adding additional clarity to what bankability criteria is needed and providing this information in a easy to use framework.

A 2016 report commissioned by the Bertha Centre looked to understand what the further barriers were to scaling off-grid energy. One the barriers highlighted to extending the services were consumer affordability of the innovation, awareness of the benefits of the product and driving depth of distribution of the product. Additional barriers sighted to scaling projects were the relatively small deal sizes, limited track record of both the business model and entrepreneurs and policy uncertainty. The report goes further to agree with the Bloomberg report commissioned by the world bank that the life stages of many of these companies deem them inadequate for them to receive additional finance. Thus investors are looking for scale to make these projects project financeable. The Bertha centre suggests a framework that taps into the existing pool of funds. It does this by bucketing the existing funds into two pools. The first a fund to finance working capital and the second to finance innovation and the infrastructure needed to drive distribution and scale. The funds are said to address the current issues faced by off-grid companies. (Bertha Center for social innovation and entrepreneurship, 2016). The bertha centre's study supports the view of the world bank group, 2016 on what the key barriers to bankability are. It adds to the body of knowledge by proposing a framework that buckets money into two funds. The first fund is to finance working capital and the second to finance innovation and the infrastructure needed to drive distribution and scale. Our study adds to the above study by proposing a framework that helps bring clarity to what bankability criteria is.

Malhotra et al were seeking to understand what would drive the bankability of off-grid electrification projects in India. Their initial hypothesis was that projects needed to be aggregated and de-risked to achieve the investment volumes required to make a difference. By assessing investment risks, conducting qualitative analysis on investment risks and a quantitative analysis of the effects of assessed risks on the cost of capital, they were able to show that aggregating off-grid solar projects had a significant effect on de-risking these investments (Malhotra et al., 2017). The study deals with an aspect of the barriers to making off-grid projects project financeable which is scale. The study is also useful in showing that scale leads to a lower risk profile which in turn increases the likelihood of a project being bankable due to the improved adjusted risk return profile. The study, however, was specific to India and does not answer what the criteria to investing would be for Africa. Our study seeks to understand the same scalability criteria, however, specific to African off-grid projects. It also seeks to create an exhaustive list of bankability criteria and a framework for assessing project viability.

Yang and Yang, 2017 also looked at the key barriers identified for further growth of the off-grid sector in Africa. They assessed the high cost of electrification in East Africa, low affordability and lack of financial resource mainly due to the poor returns on offer. The study provided ways of making the off-grid sector more bankable. These were increasing scale to reduce costs (both the investment per unit and transaction costs), de-risking investments thus reducing the cost of capital and providing government support in the form of innovative legislation. The study is consistent with the findings in Malhotra study in that scale and de-risking investments increase the chances of achieving viability. The study is also helpful in so far as showing how scale and reduced risk effect African off-grid projects. The study, however, doesn’t provide an exhaustive list or a framework for us to understand the criteria needed to make a project viable for institutional funding. This study seeks to further the body of knowledge by creating a framework in which all off-grid projects can be assessed for project viability.

Poitrimolt, 2017, through interviews and industry reports found four key barriers to large scale deployment of off-grid solutions. The dissertation highlights regulatory uncertainty as the first given grid extension is far cheaper for a consumer than off-grid applications. Without knowledge of where the grid will be extended to poses a risk. The literature also points towards a balance between being too far away from urban areas where spending power is greater and too close where grid encroachment becomes a factor. The second barrier identified was business model validation and making sure the business model works. The study identifies the same challenges studies by the bertha centre and off-grid trends identified. These challenges are, off-grid companies find themselves in a financing stage where the amount they need to validate their business models are too high for impact investors and too low and risky for institutional investors. The study finds that the model validation phase struggles to achieve financing due to the small deal size. This is important given there are transaction costs associated with due diligence. These costs are fixed and often make the amount of financing required too small to recoup these costs. To combat this scale is needed to share those costs over a larger project. There is also a mismatch in investment horizons where off-grid companies seek 7-12 year periods while most investors are not willing to provide such a long horizon. Another barrier is the required rates of returns for risky projects. Given the consumer being serviced, there are worries returns will be too low. The study by Poitrimolt adds to the current bounds of knowledge by showing where the financing gaps exist, the misalignment in investment horizons and the significant business model risks. The study also identifies $10 million as the critical threshold for where a project has enough scale to attract investment. Our study seeks to bring clarity of the bankability criteria by establishing a consensus on all the bankability criteria that needs to be met to achieve project viability.

A recently published article released by IEEE Spectrum interviewed Daniel Bekker, Managing Director of E-ON off-grid solutions, and executives at Rafiki off-grid solutions. They cited that a barrier to gaining financing was reaching at least 10 000 electricity connections. Rafiki Off-grid solutions went further to state that 200 000 – 300 000 is when one could expect an off-grid project to reach the scale needed to realise cost savings (Fairley, P. 2017). One could assume that this is the same level a project meets the "scale criteria" needed to achieve project bankability. The above interviews help aide this study by giving clarity on one of the bankability criterions which is scale. The interviews are, however, not a complete set of bankability criteria. This study hopes to contribute to the literature by creating this complete criterion together with a framework for assessing project viability.

A report released by the international Finance Corporation provided an overview of the risk appetite, type of investee, deal size, return profile and conditions of Financing for off-grid projects globally. The findings detailed what each investor types preferences were for the above-mentioned categories (The International Finance Corporation, 2018). For off-grid projects to grow to levels seen by utilities they require commercial debt and financing from institutional investors. The report found that the average ticket size by investors typically ranged between $5-10 million. Commercial debt was seen to have a low risk appetite while commercial equity exhibited medium to high risk appetites. The report findings are useful in that they show what the average deal size was and the relative risk appetite. The issue with the report findings is that 1) it is global specific and not Africa specific and 2) it relies on past data on the investors who have been brave enough to invest into this industry. Our study seeks to understand both historical trends and what needs to be in place to unlock future funding. This will be achieved by get clear guidelines on what bankability criteria is needed and a framework to understand the importance of each metric.

A report by the UNDP and ETH Zurich sought to understand how best to de-risk off-grid solar projects. The study focused on solar mini grids as opposed to complete standalone off-grid solutions. Given the high capital outlay needed for solar mini grids in often what are deemed to be high risk environments, these projects viabilities are often penalised by the high cost of capital needed that comes with equity investments (ETH Zurich and UNDP, 2018). This is mainly because no lender is willing to give debt to finance these projects. The report draws on other reports to look at what the most effective method of de-risking projects. These are summarized as policy certainty, transferring risk to those best suited to deal with the risk via project finance structures, reward excess risk with either subsidies or tax breaks and diversify risk via scaling up these projects. The methodology used by the study was to identify the risk environment by conducting interviews with the private sector and quantifying the impact of the risk, identifying public de-risking instruments to mitigate identified risks and quantifying the impact the de-risking instrument has on reducing finance costs. The impact on the reduced cost of finance is then calculated using the LCOE (ETH Zurich and UNDP, 2018). The study is useful in that it establishes a methodology with which to understand risk. It is also useful in showing what the identified barriers to bankability were and how best to deal with them. The study conducted by the report, however, addresses risk and not what criteria is looked at to assess bankability on the continent. The study we are conducting aims to find all factors effecting the risk of projects and putting them into a framework to assess bankability thus adding to the body of knowledge.

Bilotta and Colantoni, 2018 looked at the key barriers to financing energy on the continent. What they found was that two of the biggest obstacles to energy bankability on the continent were the high-risk premiums placed on African infrastructure projects which in turn leads to a higher requested rate of return. However, to date models deem a lot of African energy projects unviable due to low return. The paper suggests that to combat this barrier firms need to reduce risk premiums by reducing risk. One way of doing this is by route of aggregation and another is by reducing the uncertainty of payment by implementing Pay-as-you-go payment methods and a pricing structure affordable to African consumers (Bilotta and Colantoni, 2018). The study shares the same findings as the UNDP report of 2018, Poitrimolt study of 2017 and Malhotra's 2017. It doesn't, however, provide a detailed overview of what are the key drivers of off-grid project bankability in Africa. This study aims to provide an exhaustive detailed list of what bankability entails for off-grid projects in Africa. We also propose a new framework to achieve this bankability.

The International Renewable Energy Agency released a report that investigated the key factors needed to create an enabling environment for off-grid investments. Some of the key issues highlighted were policy and regulatory certainty, the establishment of institutional frameworks to implement off-grid electrification strategies (International Renewable Energy Agency, 2018). This report has the same findings of earlier reports that policy certainty and a strong regulatory environment are key enabling factors for further investment in off-grid energy. The paper adds to the literature on this body of literature by calling for the establishment of institutional frameworks that encourage investment into off-grid energy. The paper however, only deals with policy and regulation and doesn't give a clear framework or exhaustive list of what is needed to enable a viable project.

In the Alliance for Rural Electrification's 2018 report, 15 companies across 10 countries that either directly offered off-grid technology solutions or offered support products for energy access were asked what the key barrier to achieving their objectives were. This was done by having each company send in their profiles to the organisation. What was found is that companies mainly cited three reasons for failing to scale their objectives. The first was the ticket size of the investments didn't justify the associated transaction costs. Thus, the projects lacked scale. The second issue raised was the misaligned investment time horizons of both debt and equity. Lastly, the policy and regulatory environment with regards to off-grid energy is vague or often non-existent. In addition to this, where there are support government institutions, the institutions in place often lack capacity and a clear strategy. This study adds to the body of literature by providing an investee view of what the barriers each investee has faced in attracting further investment. Our study adds to the literature by combining the views of both investors and investees to provide a clear bankability framework

Literature review conclusion

The existing body of literature has done well to show that standalone off-grid is already a cost-effective energy solution for Africa in the long run. The existing body of literature has done well to highlight the key issues in achieving bankability. However, there remains a gap in knowledge on whether standalone Off-grid solutions provide superior returns for an investor and not just a superior consumer cost structure. The importance of answering this is, financial resources are finite and investors need assurances that they finite resource will deliver the best financial outcome for them. The best way to show them that this is possible is to show them that SHS provide an opportunity to maximise their risk-adjusted return. To the best of our knowledge this question has yet to be answered. Secondly, the common criteria used to assess project bankability differs from investor to investor and there is no real consolidated framework to understand project bankability criterion. It is also unclear what the general criteria is for all institutional investors to invest in off-grid solar projects. This study seeks to bridge the current gap in knowledge by creating an easy to use framework that assesses project bankability based on the findings of the existing literature. Our study adds to the literature by combining the views of both investors and investees to provide a clear bankability framework.

Research Objective

To achieve the objectives set out in this study, the study intends:

- To use the DCF model to arrive at an NPV, to Compare the risk-adjusted returns of a natural gas power station (Kpone) to Zola Electric's infinity SHS unit.
- To conduct desk research assessing the criteria advertised by the largest private equity funds focused.

Research Questions

The questions this study seeks to answer is:

- What incremental investment returns can be earned if investors were to invest in off-grid solar storage solutions versus existing technologies?
- What are the key considerations to making off-grid solar solutions bankable?

Research Hypothesis

The hypothesis set out in this paper are:

- SHS provides investors with a better return.

- SHS projects have not achieved bankability due to the lack of maturity of the industry.

Research Limitations

The research will:

- Only focus on Ghana and will not seek to answer the question for all African countries.
- Compare SHS to one power generating technology, namely, a natural gas power station.

Data and Methodology

The study aims to understand which method of energy production makes the most commercial sense to electrify the African continent. In this section we elaborate on which research methodology will be used to answer the research question. This is done by explaining the research design, data collection methods, unit of analysis and the analytical techniques to be used.

Return on investment comparisons

Research design

This is a quantitative study that made use of the document review method for quantitative research to collect secondary data. The documents reviewed in this study came from public records with the most notable being the GOOGLA, The International Renewable Energy Agency, GOG, Cenpower, The World Bank and The Ghanaian Reserve Bank. The study then employed the DCF method to derive a NPV whose results were subsequently used in a Equivalent Annual Annuity formula to compare projects with different lifespans. The aim of this data collection method and analytical technique is to use hard evidence and existing data to draw accurate conclusions to how investment returns would behave when comparing the two methods of electrification using an already established method of assessing these returns.. The study seeks to understand, based on existing data of energy costs and energy production potential, what incremental value can be derived from SHS solutions. This incremental value is a calculation based on existing data and the value we seek to determine cannot be established by qualitative means. The above method is appropriate given it draws on data that is public and makes use of a method that is widely used and established.

Data collection Methods

The data collection method will be to use the document review method with a particular focus on documents that are public record. All sources will be secondary data drawn from from various existing studies and published data held by industry experts, think tanks and the existing bodies of published works. The databases identified for this study came from GOOGLA, The International Renewable Energy Agency, GOG, Cenpower, The World Bank and The Ghanaian Reserve Bank. Where data cannot be found reasonable assumptions will be made in their place.

Unit of analysis

The unit of analysis will be the NPV . Studies have identified Africa's potential generating capacity to come from Coal, Natural Gas Geothermal Energy and Hydro-electric energy (Castellano et al., 2015). For purposes of this, Ghana natural gas power station, Kpone, will be compared to Zola Electric Ghana.

Analytical technique

The key reason for choosing familiar metrics is that the point of the exercise is to "communicate in a language" used by all industry experts today. The metrics chosen have been widely adopted by industry. In a 2016/2017 PWC survey it was shown that the most widely preferred analytical techniques for infrastructure investments was the Net Present Value calculation (PWC, (2017)).

- Net Present Value (NPV)

A review of why the measure was chosen, what the limitations are of the measure, a breakdown of each key variable in the measure and a model to test the validity of the model are proposed below.

<u>NPV</u>

The NPV is calculated by subtracting the initial cost of investment from the discounted cash flows (DCF). This measure essentially helps us understand if an investment delivers more cash flows than what we initially paid for the investment. The measure is very sensitive to assumptions of potential cash flows and the discount rate. The smallest change to the assumptions can alter the results. The valuation is also very sensitive to changes in company expectations. The smallest changes in expected return, capital expenditure etc. can cause a change in the fair value calculation. The variable definitions can be seen below. These are:

FCF: these are the calculated cash flows that take both cash inflows such as revenue and outflows such as capital expenditure into account.

Rd: the interest rate

Figure 3

$$NPV = \frac{FCF_1}{(1 + r_d)^1} + \frac{FCF_2}{(1 + r_d)^2} + \frac{FCF_3}{(1 + r_d)^3} + \ldots + \frac{FCF_8}{(1 + r_d)^8}$$

or

$$NPV = \sum_{i=1}^{n} \left(\frac{FCF_i}{(1 + r_d)^i} \right)$$

Research design

A quantitative approach will be used to conduct the first research question of understanding what unit delivers the highest risk-adjusted return. The steps can be described as below:

Step 1:

The aim of this step is to understand what is currently being considered as a solution to closing the energy generation deficit on the continent. For purposes of this study Ghana's independent Power producer (IPP) built power station, Kpone, was chosen. Kpone is a model of how future project finance structures could take shape on the continent, hence why this study has chosen it as an example. The project is also situated in a region where Zola Electric, the off-grid company we seek to compare Kpone to, operates as well. This makes the comparison in generating potential optimal.

Step 2:

This step involves understanding how many households are expected to be connected by each PowerStation project being considered. This helps understand the overall expected impact the PowerStation will have on electrifying the continent

Step 3:

One needs to then find the number of Off-grid units needed to match the proposed power station electrification capacity. This helps us to hold the electricity generating capacity component of the study constant.

Step 4:

The capital outlay of each project needs to be established to get a sense of project value size for both the off-grid project and the traditional PowerStation

Step 5:

The timeframe an investor is expected to be part of the project needs to be established with the overall assumption being that an investor would participate equally as long in a PowerStation then they would in an off-grid project. This is to ensure that the effects of time impact our expected returns equally.

Step 6:

Establishing the investment risks will be done based on assessing what a survey of investors feels the risk of an investment are and what return they expect in return for this risk. This data will be ascertained by looking at the PWC 2017 survey of investment industry experts

Step 7:

Establish the weight of debt and equity in the overall financing structure for the two comparable projects. The weight of debt and equity will be based on historical weights for past projects

Step 8:

Understand the cost of debt and equity in the financing structure using data where applicable to ascertain facts such as the expected interest rates, historical market returns and market betas.

Step 9:

The revenue assumption of the project should be based on the current cost of electricity and the willingness to pay of the final consumer for each context to be considered.

Step 10:

The cost of operations for each project then needs to be established. The current expected costs can be drawn by making accurate assumptions based on past data for comparable power stations or based on industry reports prepared by experts.

Step 11:

Understand the amount of electricity to be consumed by each consumer by considering the current consumption rates and likely future consumption rates in each context.

Step 12:

Understand the effects of taxation, risk insurance and changes in working capital on the effects of the model.

Step 13:

Calculate the weighted average cost of capital in each year of the project based on the cost of debt and equity and weight of debt and equity established in steps 7 and 8.

Step 14:

Calculate the Net Present Value of each project under consideration.

Step 15:

Given we are working with projects of unequal length the Equivalent Annual Annuity will be used to make a fair comparison of the projects NPV's. The formula to be employed is:

C = (r x NPV) / (1 - (1 + r)-n)

Where:

C= Equivalent Annual Annuity

NPV= Net Present Value

R= interest rate per period

N= Number of periods

Step 16:

Analyse and interpret the results making sure to understand the quantitative and qualitative aspects of the projects.

Below is a step by step process detailing the framework to be used

Diagram1: Steps in methodology for return on investment analysis

Bankability

Research design

A qualitative approach will be taken by way of assessing the existing body of literature, previously conducted surveys, published information on the criteria the biggest asset managers employ when assessing the viability of a company and published information on the reason why previous off-grid energy companies management struggled to find funding. This is to understand the funding challenges off-grid energy projects in Africa face. One can then integrate the existing challenges of achieving project viability into a newly established framework for assessing bankability criteria. The research will follow an inductive qualitative content analysis approach. The research begins by assessing a wide body of existing literature and then attempts to filter the findings into a single conceptual model. This model will then be used to interpret what the possible bankability criteria is for standalone off-grid Energy solutions.

Data collection Methods

The data will be collected by means of gathering publicly available information on investment criteria published by large funds, reviewing existing literature and analysing publicly available surveys.

Unit of analysis

The unit of analysis will be to understand what criteria is employed when assessing whether an energy project is viable.

Analytical technique

The technique will be to conduct an inductive qualitative content analysis by analysing publicly available knowledge. The details of the step by step framework to be used are explained below.

Step 1: The first step of the research is to conduct an initial scan of the literature to understand what has been covered on the topic of bankability of energy projects with a focus on off-grid energy.

Step 2: This step involves understanding what inclusion criteria should be met before a study is included for analytical purposes. The inclusion criteria are as follows:

- Studies should not be older than 2012 given there has been several technological developments during this period
- Only reports from reputable industry bodies that have been reviewed will be considered
- Only studies that have been published in peer reviewed journals will be considered
- Studies must be free given there is no budget to be allocated for this thesis.
- Only the top 50 asset managers (by funds under management) will be considered
- All literature reviewed either needs to be relevant to Africa or at the very least developing markets.

According to Schreier,M. (2012) between 10%-20% of the literature must be reviewed in order to develop new concepts. Thus, for the purposes of this study between 10%-20% of the literature on bankability criteria for off-grid energy projects will be reviewed.

Step3: Once the relevant literature has been reviewed from multiple sources the next consideration is to sort the analysis into three categories

- Published papers on how to make projects Bankable.
- Published Surveys on bankability criteria with a focus on Energy
- Published information on what the asset manager expect to see when assessing an investment.
- Published information on the investments already made in off-grid energy

By sorting the body of knowledge into the above criteria we hope to find where the consistencies or inconsistency in understanding project bankability lie. By assessing actual investments made on the continent we gain an understanding of whether firms are living up to the assessed bankability criteria

Step 4: At this stage the relevant portions of the literature are extracted and summarised into key concepts. By documenting the key concepts in the body of knowledge we intend to gain an understanding of what the established criteria is.

Step 5: The commonalities amongst findings are then extrapolated into a criterion based on how often the criteria futures in the literature. Thus, we seek to count the number of times a key concept future in the body of knowledge. Based on the amount of times we see the criteria future we begin to rank the importance of that criteria in our new model assigning a weight to that specific criteria.

Step 6: This steps involves creating a framework that takes into account:

- The amount of times a theme featured in the literature
- Assigning a weigh of importance to an investment criteria based on the number of times it futures in the literature

Step 7: The final step is to do a write up of the key findings

The below diagram explains this process in detail:

Diagram 2: Steps of methodology for bankability analysis

Discussion of Findings

The following section provides insight to the key findings from the methods employed in chapter 3. The findings outline both the outcomes of our analysis on what drives project bankability and what technology (off-grid or grid) offers the best return to investors based on the discounted free cash flows model.

Return analysis

In this section we provide the key findings found during our analysis of which energy solution provides the better estimated risk-adjusted return. In our assessment of which energy solution provides the better risk-adjusted return, the Net Present Value model was used. The model takes factors such as the cost of capital, changes in the investment climate and changes in key inputs needed to determine the profitability of a project. Our study is based on Žižlavský.2014 theory of establishing the profitability of innovative projects. This theory is also premised on the Net Present Value model. For the purposes of this study we looked at the recently constructed Kpone Thermal power station in Ghana and the Zola Electric Infinity solar home system. A summary of how the assumptions were formulated are broken down into their key sections.

Basic information for comparative Purposes

In this section we highlight the electrification objective of each Power solution. Kpone was built to electrify Ghana mining companies and its general population. The power station was built to generate 350 Mega Watts, enough power to electrify 1 million households. Mining companies required 40% of this electricity output and would be supplied directly. The other 60% of this output would be provided to households via the Electricity Corporation of Ghana (ECG) who are the primary electricity distributor in Ghana (Uongozi Institute, 2017). Construction of the plant started in 2014 and was completed by June of 2016. The special purpose vehicle contracted to build Kpone was Cenpower and they had a 20-year Build Operate then transfer agreement with the government of Ghana (Eberhard, Gratwick, Morella and Antmann, 2017). The below table gives further detail of the basic information described.

Figure 1: Basic information for Kpone

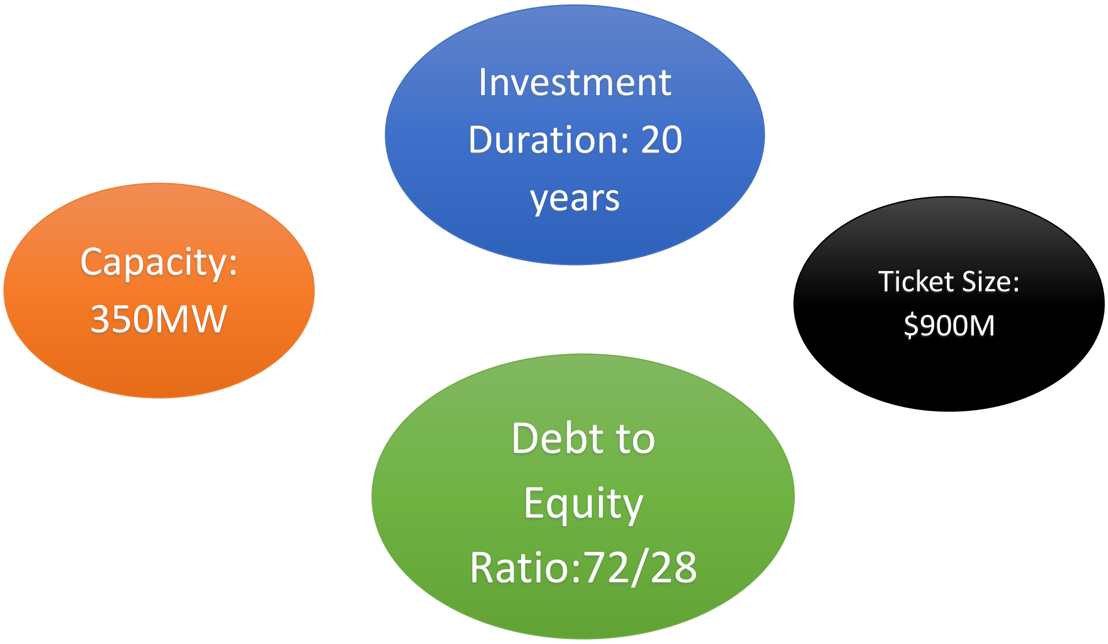


Figure 1 Source: (Eberhard, Gratwick, Morella and Antmann, 2017)

The Zola electric unit is hybrid energy solution that allows a household to completely defect from the grid. It does this by providing a solar panel and an inverter (energy storage solution) to store energy when the sun is not shining ("Zola Nigeria", 2019). That energy can then be used at a later stage. For purposes of comparison we assumed that Zola Electric's off-grid unit had a similar objective of electrifying 1million household in Ghana. One Household in Ghana requires roughly 5000 KW per annum Energy Commission, Ghana (2018). The Zola Electric Infinity Off-grid solution can give energy of up to 2800 KW per annum ("Zola Nigeria", 2019). Thus, roughly two of these units would be required for a Ghanaian household to meet its energy requirements. The below table gives further detail.

Figure 2: Basic information for Zola Electric

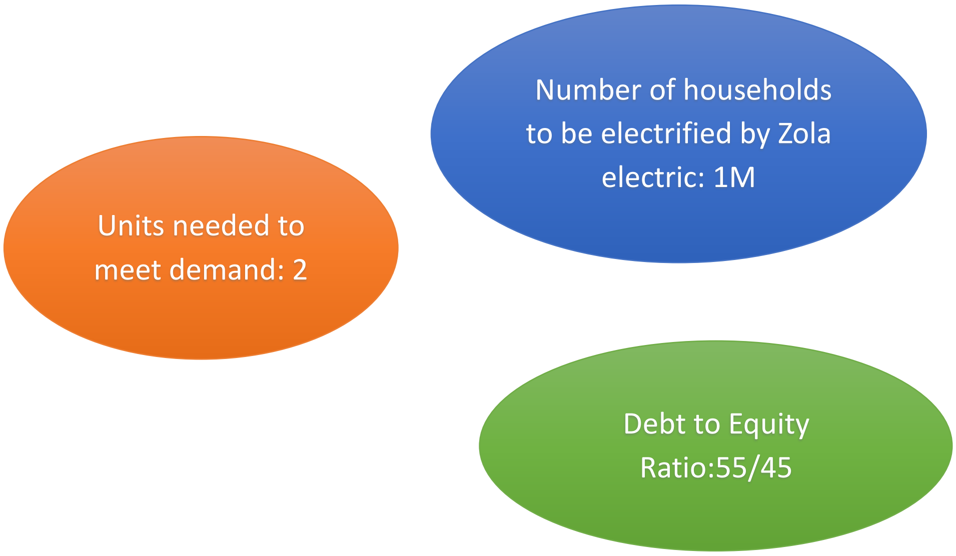
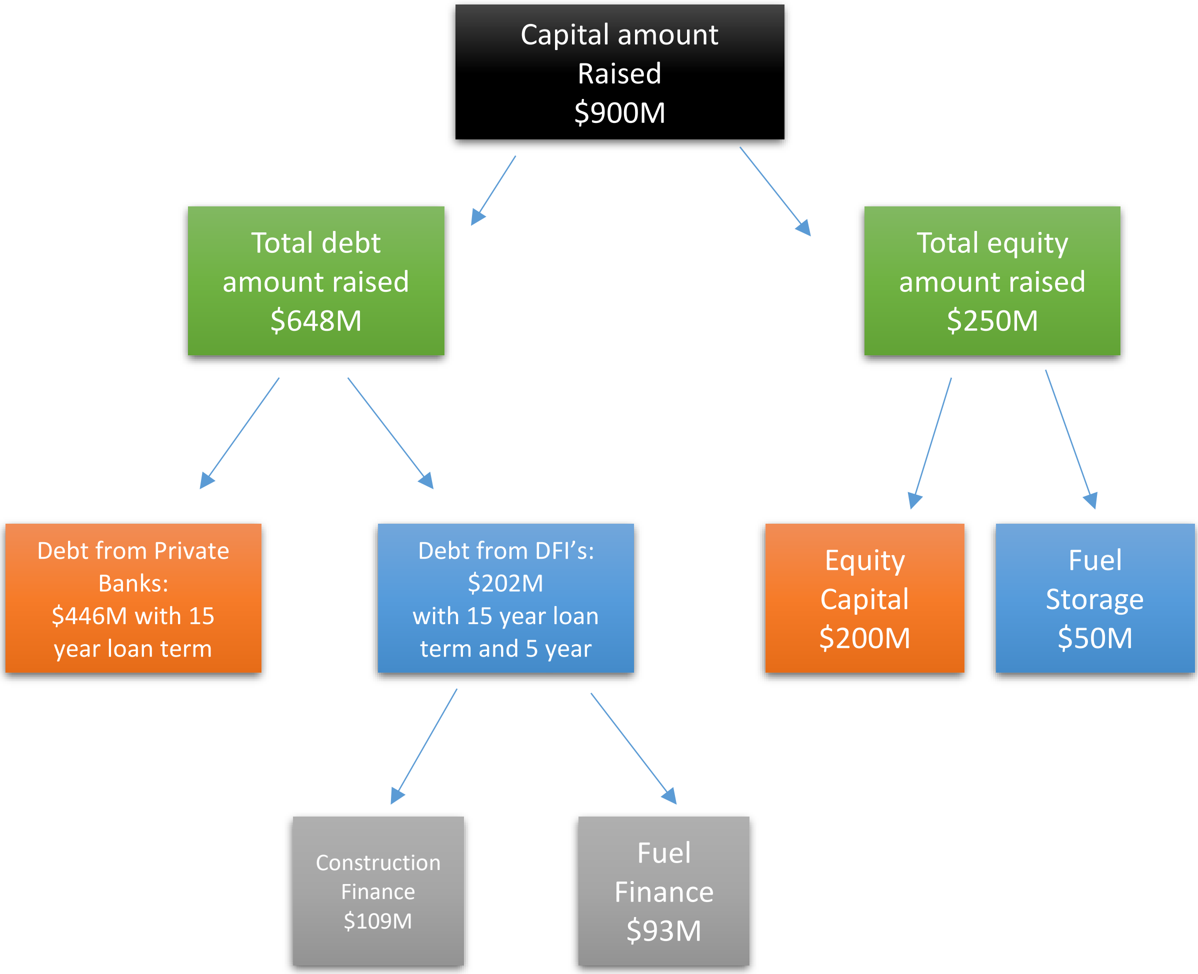


Figure 2 Source: ("Zola Nigeria", 2019)

Debt and equity assumptions

Kpone was financed using a debt to equity ratio of 72/28. The total capital raised to build and operate Kpone was $900M (Eberhard, Gratwick, Morella and Antmann, 2017). The syndicate of private lenders led by Rand Merchant Bank of South Africa provided $446M of the total amount to be repaid over a 15 year period. Development finance institutes provided $202M of the total capital requirements of which $93M was for a fuel facility needed to finance the first batch of light crude oil needed to operate the plant. The loan term for DFI financing was for 15 years with a 5 year grace period (Uongozi Institute, 2017). The main assumption is that all loans were repayable from the date of operation which was 2016.The below table summarizes the debt to equity assumption found for Kpone.

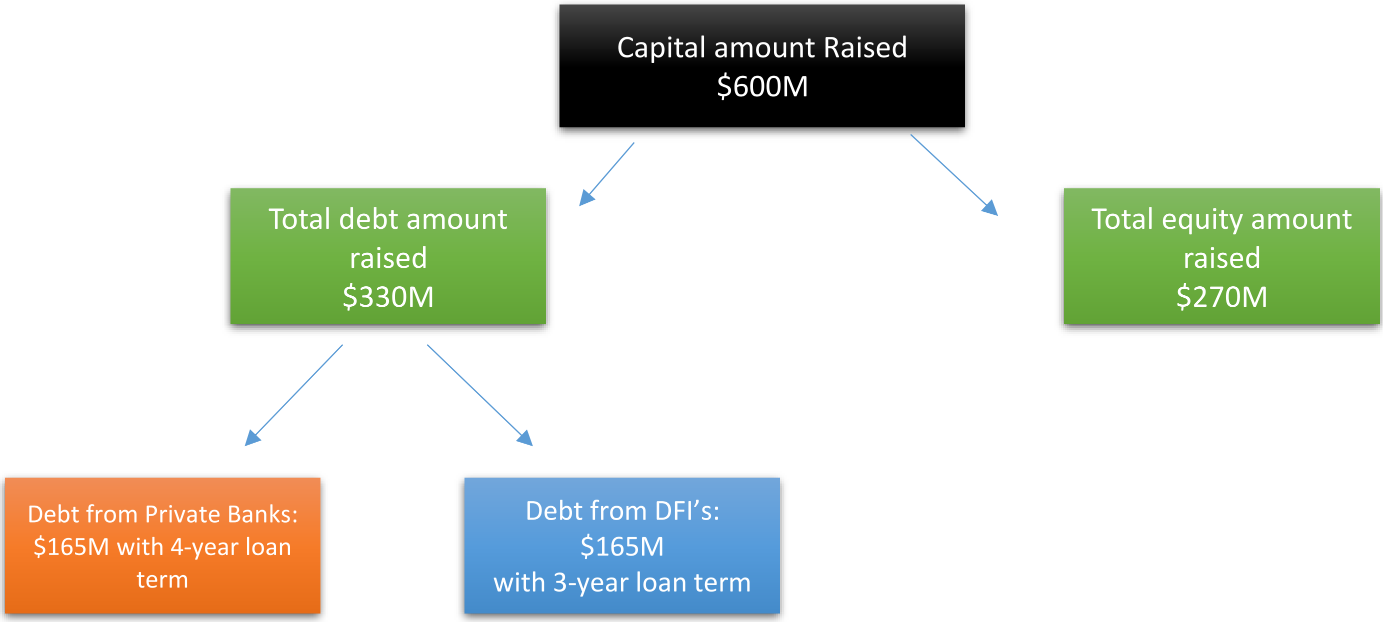
Figure 3: Debt Equity Assumption for Kpone



The assumptions for Zola Electric differ slightly to that of Kpone. The key difference is that Zola Electric would receive a corporate financing structure whereas Kpone would have implemented a project financing structure. Zola electric financing needs could be broken down as 66% to fund trade receivables, 25% to fund inventory requirements and 9% to finance capex (The International Finance Corporation, 2018). Thus, once the company's working capital requirements were established to finance 1 million households in Ghana it was then we established what the financing requirements were.

Our calculations showed that the company would need $600 million to finance ambitions to grow to 1 million households. The average debt/equity ratio reported by a study done by the International Finance Corporation. 2018 was 55% debt and 45% equity. It's important to note that equity is significantly more expensive than debt**.** This is especially true for off-grid projects which are predominately funded by venture capital firms that have a very high required rates of return (The International Finance Corporation, 2018). These facts could skew the net present value of a project due to the high returns required. The average debt financing term for off-grid companies was found to be 4 years. The long term split between debt from a commercial entity and a DFI was 50/50 (The International Finance Corporation 2018). Thus for purposes of this analysis we assume the same splits. Given the above Zola Electric would have to raise $165M in DFI funding, $165M in commercial debt and $270M in Equity. All debt carries no grace period. The table below summarizes the above stated facts.

Table 4: Debt Equity Assumption for Zola Electric



Interest rate assumptions

Kpone debt was financed at the cost of debt plus Libor. Given the risk involved in having your interest rate fluctuate RMB had made an offer to have a Libor cap. The facility provided by RMB capped how high the variable component of the loan (Libor) could go. This came at a once off cost to the SPV (Uongozi Institute, 2017). Given the long-term nature of the loans an attempt was made to find the long-term cost of debt in dollar terms. However, in Ghana only dollar denominated bonds run for 10 years and not the 15 years as stated in the commercial and DFI loan agreements. Further to this, the cost of debt was interpreted to be the cost of borrowing dollar denominated debt for Ghana. Given the sovereign is said to be the safest investee, we took their bond costs to be the cost of debt (PWC.2017). Thus for purposes of our study Ghana 10 year dollar bond was the cost of debt at 7.875% ("Ghana, Republic Bond", 2019). The study then looked at Libor for the years 2014 to 2019. We then projected forward what Libor could possibly be. This was done by establishing the 7-year moving average of Libor for years 2020 to 2032 ("6 Month LIBOR Rate - 30 Year Historical Chart", 2019). The assumption is that banks would only adjust their Libor rate annually. We also set the Interest rate cap at 1.5% for the Libor rate at a cost of 1% of the total commercial loan facility. The total once off cost came to $4.4M. The DFI portion of the commercial loans would be at the cost of debt. The below table summarizes the detail stated above

Table 5: interest rate assumptions for Kpone

Interest Rate Assumptions	Input Description	Actual Amount	Comments on assumptions
10 Year Bond	%	7.875%	We assume that lenders lent to Cenpower at 2013 10 year bond rate + Libor. The Uongozi Institute, 2017 stated that the SPV borrowed at the cost of debt +Libor. ("GHANA, REPUBLIC Bond", 2019)
Commercial Bank Interest Rate	%	7.875%+ Libor	We assume that lenders lent to Cenpower at 2013 10 year bond rate + Libor. The Uongozi Institute, 2017 stated that the SPV borrowed at the cost of debt +Libor. ("GHANA, REPUBLIC Bond", 2019)
Interest rate Cap	%	9.375%	We assume that if Libor rises above 1.5%, for every percentage point above the cap RMB will step in to cover the difference Rate assumed. The Uongozi institute stated that an agreement was in place to cap the interest rate if it went above a certain level
interest cap Lump Sum Fee		$4,460,000	A fee required to be paid in order to qualify for the interest rate cap facility. We assume this amount is 1% of the total commercial loan raised (Uongozi Institute, 2017)
Interest Rate Assumptions	**Input Description**	**Actual Amount**	**Comments on assumptions**
Year	Libor % rate		The interest rate on the debt raised for the project was based on the short-term money market rate (the London Interbank Offered Rate [LIBOR] for US dollars) because the lenders are using short-term funding. This means that the interest rate is reset to the then-current market rate every six months. (Uongozi Institute, 2017)
2014	Libor % rate	0.329%	("6 Month LIBOR Rate - 30 Year Historical Chart", 2019)
2015	Libor % rate	0.485%	("6 Month LIBOR Rate - 30 Year Historical Chart", 2019)
2016	Libor % rate	1.055%	("6 Month LIBOR Rate - 30 Year Historical Chart", 2019)
2017	Libor % rate	1.474%	("6 Month LIBOR Rate - 30 Year Historical Chart", 2019)
2018	Libor % rate	2.485%	("6 Month LIBOR Rate - 30 Year Historical Chart", 2019)
2019	Libor % rate	2.670%	("6 Month LIBOR Rate - 30 Year Historical Chart", 2019)
2020	Libor % rate	1.921%	from 2019 until 2034 we take the moving average from the previous 7 years
2021	Libor % rate	1.921%	
2022	Libor % rate	2.094%	
2023	Libor % rate	2.094%	
2024	Libor % rate	2.198%	
2025	Libor % rate	2.198%	
2026	Libor % rate	2.157%	
2027	Libor % rate	2.083%	
2028	Libor % rate	2.083%	
2029	Libor % rate	2.103%	
2030	Libor % rate	2.126%	
2031	Libor % rate	2.130%	
2032	Libor % rate	2.135%	

Off-grid energy financing trends show that off-grid companies typically gain local currency commercial loans at the cost of debt plus a risk premium between 4%-6% (International Finance Corporation, 2018). For purposes of our study we assumed that Zola Electric would be able charged a premium of 6% on the cost of debt due to the risky nature of the context it will be operating in. The cost of debt was based on the Ghanaian interest rates. This is forecast to be 16% between the years 2019-2023 (Ghana interest rate.2019). A forecast published by trade economics.2019 shows that there are expectations that Ghanaian interest rates will reduce to 14% over 2024-2028. DFI's have been known to provide funding to this sector at a cost of 20% per annum as a flat rate (international finance corporation.2018). Thus for purposes of our study we assume this rate in our calculations. After 2024 our analysis shows Zola Electric will not need any further commercial loans. The below table summarizes the above findings.

Table 6: Interest rate assumption for Zola Electric

Commercial Interest Rate Assumptions	**Input Description**	**Actual Amount**	**Comments on assumptions**
Ghana Interest Rate 2019-2023	%	16.000%	Based on Ghana interest rates in 2019. we take this to be the cost of funds for the next 4 years for a local currency loans ("Ghana Interest Rate", 2019)
Ghana Interest Rate 2024-2028	%	14.000%	Based on tradeeconimics forecast interest rates we take this to be the cost of funds for the next 4 years for a local currency loans ("Ghana Interest Rate", 2019)
Ghana Interest Rate 2029-2038	%	12.500%	We assume the long term interest rate will reach Ghana all time low rates. we take this to be the cost of funds for the next 4 years for a local currency loans ("Ghana Interest Rate", 2019)
Commercial Bank Interest Rate premium	%	6.000%	This Is the upper end of the interest rate cap placed by local banks when lending in local currency. They take the cost of funds (interest rate) plus a premium between 4%-6%(The International Finance Corporation (2018))
DFI Interest Rate Assumptions	**Input Description**	**Actual Amount**	**Comments on assumptions**
	%	20.000%	This is based on the average loan terms % reported. (The International Finance Corporation (2018))

Cost of equity assumptions

The cost of equity differed depending on what energy solution you were looking at. This mainly came down to the life stage of companies, investor expectations of what they expected for the risk they were taking on and the method of finance used. Kpone power station would not have been seen as an early start-up company. This is because Kpone used a project financing structure that secures its cash flows and allocates the risks to the parties best suited to deal with that risk. Thus, an investor's expectation of return would have been reduced. In the case of Zola Electric its equity would need to be priced as a start-up given it doesn't employ a project financing structure, is in a relatively new stage of its company life cycle, operates in a somewhat untested industry and relies on corporate loans without the benefits of being able to allocate risk the same way project finance can. All cost of equity was calculated using CAPM cost of equity formula.

Figure 4

$$r_e = r_f + \beta(r_m - r_f)$$

Where:
Re= Required return on equity or cost of equity
Rf= The risk free rate
Beta= The companies stock beta
Rm-Rf= The risk premium
Below is a key finding on what the cost of equity was in each instance.

Kpone risk free rate was taken to be the Ghanaian Treasury bill rate. Treasury bills are seen to be risk free mainly due to the certainty around a reserve banks ability to pay. Our risk-free rate was based on the local currency 2-year bond yields (PWC.2017). This was in line with a survey conducted by PWC.2017 that showed that 34% of industry professionals surveyed used these instruments when calculating their risk-free rate. The risk-free rates in 2016are based on the 10-year bond. We assume that the 7.875% on the 10-year bond % can be achieved into perpetuity. We thus use it as our rate for 2020-2032.

Betas for private companies could not be found. This is mainly due to the fact that a beta coefficient is a measure of the volatility of a particular company share price to the markets unsystematic risk (PWC.2017). Given private companies don't trade on a public market the industry norm is to calculate beta based on companies with similar features to the one you are running analysis on (PWC.2017). Given the Ghanaian stock exchange does not have a listed independent power producer we looked at oil and gas companies listed on the exchange to gain a sense of what the beta is likely to be. Three companies were compared to Kpone, Cenpower SPV. These were Tullow oil, Total Ghana and the state-run Ghana Oil Company. Each of the company's beta were weighted based on market cap to find our reference beta. This came to 1.56 showing that a company's stock would be volatile. This methodology is in line with industry practice (PWC, 2017).

The risk premium employed was based on the PWC.2017 survey. This survey tried to ascertain what risk premium investors used for each industry. Infrastructure had a risk premium that ranged between 6.4% and 9% (PWC.2019). We assume 7.4% for purposes of this study based on the average of the range presented by PWC. The cost of equity was then calculated for each year. Our analysis shows that the expected return averaged 19.4% which is common for African infrastructure projects (PWC.2017). The below table gives a summary of the cost of equity assumptions for the Kpone power station

Table 7: Cost of equity assumptions for Kpone

Cost of Equity	Input Description	Actual Amount	Cost of equity = risk-free rate of return + beta * risk premium
Risk-free rate of return:			
2016	%	7,875%	We assume that lenders lent to Cenpower at 2013 10 year bond rate. We therefore use Ghana 10 year bond as the risk free rate The Uongozi Institute, 2017 . ("GHANA, REPUBLIC Bond", 2019)
2017	%	7,875%	We assume that lenders lent to Cenpower at 2013 10 year bond rate. We therefore use Ghana 10 year bond as the risk free rate The Uongozi Institute, 2017 . ("GHANA, REPUBLIC Bond", 2019)
2018	%	7,875%	We assume that lenders lent to Cenpower at 2013 10 year bond rate. We therefore use Ghana 10 year bond as the risk free rate The Uongozi Institute, 2017 . ("GHANA, REPUBLIC Bond", 2019)
2019	%	7,875%	We assume that lenders lent to Cenpower at 2013 10 year bond rate. We therefore use Ghana 10 year bond as the risk free rate The Uongozi Institute, 2017 . ("GHANA, REPUBLIC Bond", 2019)
2020-2032	%	7,875%	We assume that lenders lent to Cenpower at 2013 10 year bond rate. We therefore use Ghana 10 year bond as the risk free rate The Uongozi Institute, 2017 . ("GHANA, REPUBLIC Bond", 2019)
Tullow Oil	Beta Coefficient	1,7	("GCB.GH - GCB Bank Ltd Profile | Reuters", 2019)
Tullow Oil Market Cap	in Millions USD	$ 2 883	("GCB.GH - GCB Bank Ltd Profile | Reuters", 2019)
Total Petroleum Ghana	Beta Coefficient	1,16	("GCB.GH - GCB Bank Ltd Profile | Reuters", 2019)
Total Petroleum Ghana market cap	in Millions USD	$ 321	("GCB.GH - GCB Bank Ltd Profile | Reuters", 2019)
Ghana Oil Company	Beta Coefficient	1,15	("GCB.GH - GCB Bank Ltd Profile | Reuters", 2019)
Ghana Oil Company Market cap	in Millions USD	$ 686	("GCB.GH - GCB Bank Ltd Profile | Reuters", 2019)
Beta	Coefficient	1,56	We took the weighted average beta of all companies in the oil and gas sector listed on the Ghanaian stock exchange. Oil and Gas companies were picked given they represented the closest industry to our Kpone IPP
Risk premium	%	7,4%	Based on the PWC annual survey for 2017 on expected risk premium for African equities. The average premium required ranged between 6.4%-9% for 2016. for purposes of this study we assume the middle between these two ranges (PWC, 2017)
Cost of Equity in each year:	%		
2016	%	19,4%	Calculated
2017	%	19,4%	Calculated
2018	%	19,4%	Calculated
2019	%	19,4%	Calculated
2020-2032	%	19,4%	Calculated

Zola electric's assumption on the risk free rate are exactly the same as those used for Kpone. The beta methodology employed for Kpone is also the same. However, the beta for Kpone has to be adjusted to reflect the incremental volatility you would find for a young company such as Zola Electric. The PWC.2017 survey found that a large proportion of the fund managers surveyed adjust their beta by 0.5 for companies that have revenues less than $200M. Given the start-up nature of Zola Electric the same assumption would apply to them. Thus, the new beta for Zola Electric would be 2.06

The risk premium used for Kpone would remain at 7.4%. In PWC annual fund managers surveyed they found companies employ additional risk premium of up to 2% for companies that lack track record and 2% for companies where there are significant growth expectations. This leads to Zola Electric having a very high cost of equity of that averages 44%. The table below summarise our key findings

Table 8: Cost of equity assumptions for Zola Electric

Cost of Equity	Input Description	Actual Amount	Cost of equity = risk-free rate of return + beta * risk premium
Risk-free rate of return:			
2016	%	24.25%	based on the 2 year fixed note ("Treasury Bill Rates – Bank of Ghana", 2019). In a 2017 survey by PWC investors 34% used the local currency bond yields as the Risk free rate (PWC, 2017)
2017	%	15.00%	based on the 1 year fixed note ("Treasury Bill Rates – Bank of Ghana", 2019). In a 2017 survey by PWC investors 34% used the local currency bond yields as the Risk free rate (PWC, 2017)
2018	%	14.50%	based on the 1 year fixed note ("Treasury Bill Rates – Bank of Ghana", 2019). In a 2017 survey by PWC investors 34% used the local currency bond yields as the Risk free rate (PWC, 2017)
2019	%	15.50%	based on the 1 year fixed note ("Treasury Bill Rates – Bank of Ghana", 2019). In a 2017 survey by PWC investors 34% used the local currency bond yields as the Risk free rate (PWC, 2017)
2020-2032	%	15.50%	We assume the same rate into perpetuity
Tullow Oil	Beta Coefficient	1.7	("GCB.GH - GCB Bank Ltd Profile | Reuters", 2019)
Tullow Oil Market Cap	in Millions USD	$ 2,883	("GCB.GH - GCB Bank Ltd Profile | Reuters", 2019)
Total Petroleum Ghana	Beta Coefficient	1.16	("GCB.GH - GCB Bank Ltd Profile | Reuters", 2019)
Total Petroleum Ghana market cap	in Millions USD	$ 321	("GCB.GH - GCB Bank Ltd Profile | Reuters", 2019)
Ghana Oil Company	Beta Coefficient	1.15	("GCB.GH - GCB Bank Ltd Profile | Reuters", 2019)
Ghana Oil Company Market cap	in Millions USD	$ 686	("GCB.GH - GCB Bank Ltd Profile | Reuters", 2019)
Beta	Coefficient	1.56	We took the weighted average beta of all companies in the oil and gas sector listed on the Ghanaian stock exchange. Oil and Gas companies were picked given they represented the closest industry to our off-grid companies
Beta Adjustment	Coefficient	0.50	Industry analysts surveyed state they adjust beta premium for companies with revenues less that $200M (PWC,2017)
Risk premium	%	7.4%	Based on the PWC annual survey for 2017 on expected risk premium for African equities. The average premium required ranged between 6.4%-9% for 2016. for purposes of this study we assume the highest range (PWC, 2017)
Risk premium: lack of track record		2.0%	We add an additional 2.0% for lack of track record which most companies engaged in off grd are in. According to a recent PWC survey this is the premium added by investment companies (PWC, 2017)
Risk premium: significant growth expectations		2.0%	We add an additional 2.0% for given off-grid energy has seen extreme growth indices and there are significant growth expectations. According to a recent PWC survey this is the premium added by investment companies (PWC, 2017)
Cost of Equity in each year:	%		
2016	%	52.9%	Calculated
2017	%	43.6%	Calculated
2018	%	43.1%	Calculated
2019	%	44.1%	Calculated
2020-2032	%	44.1%	Calculated

Fuel Supply Assumptions

The fuel supply assumptions apply only to Kpone Power Station. The background to this analysis is that Kpone was meant to be a power station that ran on Natural Gas. However, the transition to Natural gas could only take place by the year 2018. In the meantime, Kpone has had to use Light Crude Oil (LCO) to operate the PowerStation. This was mainly because the West Africa Gas Pipeline that would transport gas from Nigeria to Ghana had not materialized in time. It was for this reason LCO had been used as a temporary measure. The discovery of natural gas off the cost of Ghana meant the project would be able to use gas soon. Cenpower was also heavily incentivized to switch to gas in 2 years given their return on equity increased (Uongozi Institute, 2017). Thus, our assumptions assume that from the start date of 2016 Cenpower will switch to Natural gas by the end of 2018.

Cenpower bought LCO at the prevailing market price from Vitol (Uongozi Institute, 2017). To ascertain this price we found 2016 to 2018 actual prices Cenpower would have paid for LCO based on the price of Western Texas Intermediate. Thereafter to ascertain the cost of Natural gas, the futures price was used. The underlying assumption is Cenpower would enter into some form of hedging arrangement where they would purchase natural gas futures annually. Futures contracts could be found from years 2019 to 2023. Thereafter we use the moving average to ascertain the likely price of natural gas using a moving average. Zola electric had no assumptions pertaining to the purchase of fuel. The below diagram summarizes the above assumptions

Table 9: Fuel assumptions for Kpone

Fuel Supply Assumption	Input Description	Actual Amount	Comments on assumptions
Fuel Supply Agreement with Vitol structured on a take and pay basis			Under this agreement Cenpower pays the market price for light crude oil at the prevailing market price with ECG taking the risk for price fluctuations. This would be a fixed fee given the Electricity Corporation of Ghana would take the risk of price fluctuations (Uongozi Institute, 2017)
Additional Storage facility built by Vitol			This construction cost was not part of the orginal Engineering Procurement and construction contract. This cost is reflected in the loan under FMO Fuel Facility (Uongozi Institute, 2017)
Additional once off fuel required Cenpower at 50 days Stock on Hand of LCO			This construction cost was not part of the orginal Engineering Procurement and construction contract. This cost is reflected in the loan under FMO Fuel Facility (Uongozi Institute, 2017)
Distillate Fuel per Unit capacity : 5,157 barrels/GWh			("Volta River Authority | Kpone Thermal Power Station", 2019)
Natural Gas per Unit capacity: 11,800 MMBTU/GWh			("Volta River Authority | Kpone Thermal Power Station", 2019)
Number of Units	units	2	("Volta River Authority | Kpone Thermal Power Station", 2019)
Light Crude Oil Prices (Based on the West Texas Intermediate)			
2014	Average Price over the year in USD **Actuals**	$ 92.80	("Crude Oil WTI (NYM $/bbl) Front Month", 2019)
2015	Average Price over the year in USD **Actuals**	$ 48.90	("Crude Oil WTI (NYM $/bbl) Front Month", 2019)
2016	Average Price over the year in USD **Actuals**	$ 47.00	("Crude Oil WTI (NYM $/bbl) Front Month", 2019)
2017	Average Price over the year in USD **Actuals**	$ 50.80	("Crude Oil WTI (NYM $/bbl) Front Month", 2019)
2018	Average Price over the year in USD **Actuals**	$ 64.80	("Crude Oil WTI (NYM $/bbl) Front Month", 2019)
2016	**Futures** Price for Light Crude Oil	$ 46.00	assumption is contracts are purchased Annualy with the first purchased on the 1st of Jan ("Crude Oil WTI (NYM $/bbl) Front Month", 2019)
2017	**Futures** Price for Light Crude Oil	$ 52.37	assumption is contracts are purchased Annualy with the first purchased on the 1st of Jan ("Crude Oil WTI (NYM $/bbl) Front Month", 2019)
2018	**Futures** Price for Light Crude Oil	$ 64.30	assumption is contracts are purchased Annualy with the first purchased on the 1st of Jan ("Crude Oil WTI (NYM $/bbl) Front Month", 2019)
Gas Prices in MMBTU			
2019	Average Price over the year in USD measure in 1 MMBTU **Actuals**	$ 2.32	("Natural Gas Futures Price - Investing.com ZA", 2019)
2019	**Futures** Price for Natraul Gas	$ 2.92	assumption is contracts are purchased Annualy with the first purchased on the 1st of Jan ("Natural Gas Futures Price - Investing.com ZA", 2019)
2020	**Futures** Price for Natraul Gas	$ 2.54	assumption is contracts are purchased Annualy with the first purchased on the 1st of Jan ("Natural Gas Futures Price - Investing.com ZA", 2019)
2021	**Futures** Price for Natraul Gas	$ 2.69	assumption is contracts are purchased Annualy with the first purchased on the 1st of Jan ("Natural Gas Futures Price - Investing.com ZA", 2019)
2022	**Futures** Price for Natraul Gas	$ 2.60	assumption is contracts are purchased Annualy with the first purchased on the 1st of Jan ("Natural Gas Futures Price - Investing.com ZA", 2019)
2023	**Futures** Price for Natraul Gas	$ 2.61	from 2023 until 2034 we take the moving average from the previous 5 years
2024	**Futures** Price for Natraul Gas	$ 2.67	
2025	**Futures** Price for Natraul Gas	$ 2.62	
2026	**Futures** Price for Natraul Gas	$ 2.64	
2027	**Futures** Price for Natraul Gas	$ 2.63	
2028	**Futures** Price for Natraul Gas	$ 2.64	
2029	**Futures** Price for Natraul Gas	$ 2.64	
2030	**Futures** Price for Natraul Gas	$ 2.63	
2031	**Futures** Price for Natraul Gas	$ 2.64	
2032	**Futures** Price for Natraul Gas	$ 2.63	
2033	**Futures** Price for Natraul Gas	$ 2.64	
2034	**Futures** Price for Natraul Gas	$ 2.64	

Capacity Utilization and Volume Growth Assumptions

Kpone Power Station capacity was 350MW. This capacity was enough to power 1 million households. However, how capacity is used is dependant on mining companies consumption which accounts for 40% of the off taker agreement and with the remaining 60% designated for households. A study by Sarkodie, 2017 looked at exactly how they expected Ghanaian electricity consumption to grow. They factored things such as industrial, economic and GDP per capita growth. Their analysis showed that they expected annual electricity consumption to grow from 8.52 billion kWh Per annum to 9.56 billion kWh per annum by 2030 Sarkodie, 2017. This growth represents a 6% compound annual growth rate in electricity consumption. We thus assume this growth rate from 2020 until Kpone reaches a capacity of 85%. Based on our analysis this figure is reached in 2029. The actual consumption of electricity for the periods 2016 to 2019 were taken from the Volta River Authority, the state-owned entity responsible for the distribution of electricity in Ghana. The below table shows the assumption made:

Table 10: Capacity utilization assumptions for Kpone

Capacity Utilization Rate	Input Description	Actual Amount	Comments on assumptions
Hourly capacity	MWH	350	(Volta River Authority, 2017)
Yearly Capacity in GWH	GWH	3066	
Yearly Capacity in MWH	MWH	3066000	
Yearly Capacity in KWH	KWH	3066000000	
Distillate Fuel per Unit: 5,157 barrels/GWh	barrels/GWh	5157	Distillate Fuel per Unit: 5,157 barrels/GWh (Volta River Authority, 2017). Given this assumption we convert this figure into our cost of sales figure turning it into a KWH figure
Natural Gas per Unit: 11,800 MMBTU/GWh	MMBTU/GWh	11800	Distillate Fuel per Unit: 5,157 barrels/GWh (Volta River Authority, 2017). Given this assumption we convert this figure into our cost of sales figure turning it into a KWH figure
2016	% Output P.A	5.50%	(Volta River Authority, 2017)
2017	% Output P.A	6.60%	(Volta River Authority, 2017)
2018	% Output P.A	40%	("Volta River Authority | Kpone Thermal Power Station", 2019)
2019	% Output P.A	48%	("Volta River Authority | Kpone Thermal Power Station", 2019)
Capacity growth Assumption	We assume electricty capacity growth will grow as forecast from 8.52Billion KWH to 9.56 billiob KWH by 2030. This represents an incremental 118MWH needed by 2030. We assume this capacity is met by Kpone by 2030	6%	(Sarkodie, 2017
2020	% Output P.A	51%	
2021	% Output P.A	54%	
2022	% Output P.A	57%	
2023	% Output P.A	60%	
2024	% Output P.A	64%	
2025	% Output P.A	68%	
2026	% Output P.A	72%	
2027	% Output P.A	76%	
2028	% Output P.A	81%	
2029	% Output P.A	85%	
2030	% Output P.A	85%	
2031	% Output P.A	85%	
2032	% Output P.A	85%	
2033	% Output P.A	85%	
2034	% Output P.A	85%	
2035	% Output P.A	85%	
2036	% Output P.A	85%	

The assumptions made for Zola electric are around the depth of distribution that can be achieved with time. These assumptions try and understand at what point we can expect Zola Electric to reach 1million households. Based on a study done by the international finance corporation 2018, the expected compound annual growth rate of solar home systems are 87% between the years 2018- 2022. However, we assume that the growth rate will slow down to 45% in line with industry projections from 2023- 2032. The model seeks to make a comparison between Zola Electric and Kpone. Given this we stop assuming growth in distribution once the Zola Elctectric hits 2 000 000 units, roughly the equivalent amount of units needed to power the same amount of households Kpone can power. Based on the current growth rates we project Zola electric to reach this by 2024. The below table shows the assumptions made:

Table 11: Capacity utilization assumptions for Zola Electric

Growth Expectations in volumes sold	Input Description	Actual Amount	Comments on assumptions
2020-2022 annual CAGR growth rate	%	87%	The off-grid market trends report projects a CAGR of 87% in terms of units sold with revenues expected to rise faster (The International Finance Corporation (2018))
2023-2032 annual CAGR growth rate	%	85%	Based on Pico systems that are beginning to reach saturation (The International Finance Corporation (2018))
2019 total zola electric Unit Sales	Unit Sales	133333	Based on 2020-2022 CAGR growth Rates
2020 total zola electric Unit Sales	Unit Sales	266667	Based on 2020-2022 CAGR growth Rates
2021 total zola electric Unit Sales	Unit Sales	400000	Based on 2020-2022 CAGR growth Rates
2022 total zola electric Unit Sales	Unit Sales	748000	based on the fact that by 2022 24M units that are SHS and plug and play will be sold (The International Finance Corporation (2018))
2023 total zola electric Unit Sales	Unit Sales	1383800	Based on 2022-2032 CAGR growth Rates
2024 total zola electric Unit Sales	Unit Sales	2000000	Based on 2022-2032 CAGR growth Rates
2025 total zola electric Unit Sales	Unit Sales	2000000	Based on 2022-2032 CAGR growth Rates
2026 total zola electric Unit Sales	Unit Sales	2000000	Based on 2022-2032 CAGR growth Rates
2027 total zola electric Unit Sales	Unit Sales	2000000	Based on 2022-2032 CAGR growth Rates
2028 total zola electric Unit Sales	Unit Sales	2000000	Based on 2022-2032 CAGR growth Rates
2029 total zola electric Unit Sales	Unit Sales	2000000	Based on 2022-2032 CAGR growth Rates
2030 total zola electric Unit Sales	Unit Sales	2000000	Based on 2022-2032 CAGR growth Rates
2031 total zola electric Unit Sales	Unit Sales	2000000	Based on 2022-2032 CAGR growth Rates
2032 total zola electric Unit Sales	Unit Sales	2000000	Based on 2022-2032 CAGR growth Rates
2033 total zola electric Unit Sales	Unit Sales	2000000	Based on 2022-2032 CAGR growth Rates
2034 total zola electric Unit Sales	Unit Sales	2000000	Based on 2022-2032 CAGR growth Rates
2035 total zola electric Unit Sales	Unit Sales	2000000	Based on 2022-2032 CAGR growth Rates
2036 total zola electric Unit Sales	Unit Sales	2000000	Based on 2022-2032 CAGR growth Rates
2037 total zola electric Unit Sales	Unit Sales	2000000	Based on 2022-2032 CAGR growth Rates
2038 total zola electric Unit Sales	Unit Sales	2000000	Based on 2022-2032 CAGR growth Rates
2039 total zola electric Unit Sales	Unit Sales	2000000	

Political and credit Risk Insurance and credit risk guarantee's

One of the preconditions to raising finance for Cenpower was the fact that the lead bank, Rand Merchant Bank, insisted on political risk insurance. This insurance was to cover the risk of expropriation of the project, war, political unrest, the availability of US Dollars, ability to transfer US dollars out the country and most importantly the failure of the government of Ghana (GOG) to pay under its guarantee to the ECG (Uongozi Institute, 2017). Marsh JLT Specialty, 2019 specializes in providing political risk insurance for infrastructure around the world, including Ghana. The report stated that the typical insurance provided would be 2.5% of the value of the asset (Marsh JLT Specialty, 2019). We assume this to be the value of the premium paid over the life span of the project.

The other insurance taken by Cenpower was commercial risk insurance. Commercial risks are the standard risks that one can encounter from any project. These include but are not limited to construction risks, usage risks, revenue risks, operating risk and macro-economic risks to name a few. For purposes of this study we assumed a insurance rate of 0.5% of the asset value.

Cenpower was also obligated under its agreement with RMB to get some form of insurance against default from the ECG. Typically, a bank would often arrange a letter of credit to guarantee payment after a certain amount of time has lapsed or if default has taken effect. In the case of Cenpower this letter of credit was there to protect it from the ECG failure to pay for the fuel it had used on time. Letters of credit are usually charged at a fee of between 1% and 2% of the transaction value. In the case of Cenpower we have assumed a letter of credit would be given to Cenpower at 1% (Uongozi Institute, 2017).

Given that Zola Electric doesn't take on a complex project financing structure there are no added insurances that would be taken by Zola Electric. The below diagram provides an overview of the assumptions made.

Table 12: insurance assumptions for Kpone

Credit risk assumption	Input Description	Actual Amount	Comments on assumptions
Bank letter of credit		1.000%	This was used to cover Cenpower from non-payment for fuel from the Electricity Corporation of Ghana. Letters of Credit are typically between 1-2% in cost depending on credit risk. We assume this cost is 1% of revenue (Uongozi Institute, 2017)
Political Risk Insurance			
2016-2032	Risk premium P.A based on the cost of the value of the asset	2.50%	In addition to the sovereign credit risk pricing ranges, this Risk Outlook contains pricing information on confiscation, expropriation, nationalization and deprivation (CEND), full political violence and terrorism and sabotage insurance (Marsh JLT Specialty, 2019)
Commercial Risk Insurance	Risk premium P.A based on the cost of the value of the asset	0.50%	85%of the total asset is covered at a rate of 0.5% per year (Uongozi Institute, 2017)

Revenue

As stated before, with regards to the electricity output for Cenpower, 60% of the electricity output at Kpone will be supplied to the ECG. It is assumed this electricity is for households and business consumption. The other 40% of the output would be sold directly to mining companies (Uongozi Institute, 2017). The two entities don't attract the same Tariff rate. Actual Tariff imposed on mining companies between the years 2016 to 2018 were almost 2 times higher than those imposed on the ECG. The mining Tariff was $0.23 per KWH were as those imposed on the ECG were $0.12 (Energy Commission Ghana, 2018). Given the differences in Tariffs we blend the two tariffs based on their weight of how much power is used by each entity. The blended tariff we arrive at is $0.164 for the years 2016-2018

Part of the Power Purchase Agreement (PPA) states that the tariff awarded to Cenpower was meant to cover its debt obligations, fixed costs, variable costs, Fuel costs and allow it to make a return on equity (Uongozi Institute, 2017). The tariff was also awarded in US Dollars but payments would be made in Ghanaian Cedi. The initial tariff awarded was for $0.22 per kWh based on the price of LCO being $100. The tariff would adjust based on this benchmark price. The price of this tariff would reduce when the project switches to Gas. Based on the above stated set of facts we calculate an adjustment factor that uses the actual tariff charge and what has been agreed by Cenpower and the regulatory body of Ghana to establish what the likely tariff will be going forward. Thus, based on the predicted cost of fuel we ascertain what the likely tariff will be in going forwards. Once the project moves to using natural gas as its fuel source we adjust the tariff based on the natural gas fuel source used. Tariff for natural gas were

Table 13: Revenue assumptions for Kpone

Revenue	Input Description	Actual Amount	Comments on assumptions
2012 Average Cedi/US Dollar	Exchange rate	1.75	("XE: USD / GHS Currency Chart. US Dollar to Ghanaian Cedi Rates", 2019)
2013 Average Cedi/US Dollar		2.12	("XE: USD / GHS Currency Chart. US Dollar to Ghanaian Cedi Rates", 2019)
2014 Average Cedi/US Dollar	Exchange rate	2.79	("XE: USD / GHS Currency Chart. US Dollar to Ghanaian Cedi Rates", 2019)
2015 Average Cedi/US Dollar	Exchange rate	3.63	("XE: USD / GHS Currency Chart. US Dollar to Ghanaian Cedi Rates", 2019)
2016 Average Cedi/US Dollar	Exchange rate	4.085	("XE: USD / GHS Currency Chart. US Dollar to Ghanaian Cedi Rates", 2019)
2017 Average Cedi/US Dollar	Exchange rate	4.55	("XE: USD / GHS Currency Chart. US Dollar to Ghanaian Cedi Rates", 2019)
2018 Average Cedi/US Dollar	Exchange rate	4.65	("XE: USD / GHS Currency Chart. US Dollar to Ghanaian Cedi Rates", 2019)
Annual Compound devalution rate	%	14.98%	We assume that the Ghanaian cedi will continue to devalue at the compound devalution rate
2019 Average Cedi/US Dollar	Exchange rate	5.35	from 2019 until 2032 we take the moving average from the previous 3 years
2020 Average Cedi/US Dollar	Exchange rate	6.15	
2021 Average Cedi/US Dollar	Exchange rate	6.15	
2022 Average Cedi/US Dollar	Exchange rate	7.07	
2023 Average Cedi/US Dollar	Exchange rate	7.07	
2024 Average Cedi/US Dollar	Exchange rate	8.13	
2025 Average Cedi/US Dollar	Exchange rate	8.13	
2026 Average Cedi/US Dollar	Exchange rate	9.34	
2027 Average Cedi/US Dollar	Exchange rate	9.34	
2028 Average Cedi/US Dollar	Exchange rate	10.74	
2029 Average Cedi/US Dollar	Exchange rate	10.74	
2030 Average Cedi/US Dollar	Exchange rate	12.35	
2031 Average Cedi/US Dollar	Exchange rate	12.35	
2032 Average Cedi/US Dollar	Exchange rate	14.20	
Off Taker Agreement: 60% supplied to the ECG	%	60%	(Uongozi Institute, 2017)
Off Taker Agreement: 40% supplied to mining companies	%	40%	(Uongozi Institute, 2017)
Tariff per KWH based on a barrel of oil (LCO) costing $100. Tariff to reduce or increase based on this price	USD/KWH	$ 0.22	(Uongozi Institute, 2017)
Tariff Adjustement based on Price of LCO		$ 100	We reduce/increase the tariff based on the indcies of the new price of LCO to $100
Adjustment Factor		1.38	Based on the actual tariffs of 2016-2018
Tariff Adjustement based on Price of Natrual Gas		$ 4.065	We reduce/increase the tariff based on the indcies of the new price of natrual gas to the price of natrual gas in 2014 $4.065 (the same LCO was last at $100) ("Natural Gas Futures Price - Investing.com ZA", 2019)
Inflation Rate Ghana	%	9.58%	We assume that there will be no change to the Ghanian inflation rate over the investement period ("Ghana Inflation Rate", 2019)
Actual 2016-2018 Tariff: Mining	**usd/kwh**	**$ 0.230**	(ENERGY COMMISSION, GHANA, 2018)
Actual 2016-2018 Tariff: ECG	**usd/kwh**	**$ 0.120**	(ENERGY COMMISSION, GHANA, 2018)
Actual 2016-2018 Tariff	**usd/kwh**	**$ 0.164**	(ENERGY COMMISSION, GHANA, 2018)
2019 Tariff	**usd/kwh**	**$ 0.233**	
2020 Tariff	**usd/kwh**	**$ 0.211**	
2021 Tariff	**usd/kwh**	**$ 0.220**	
2022 Tariff	**usd/kwh**	**$ 0.215**	
2023 Tariff	**usd/kwh**	**$ 0.215**	
2024 Tariff	**usd/kwh**	**$ 0.220**	
2025 Tariff	**usd/kwh**	**$ 0.216**	
2026 Tariff	**usd/kwh**	**$ 0.217**	
2027 Tariff	**usd/kwh**	**$ 0.217**	
2028 Tariff	**usd/kwh**	**$ 0.217**	
2029 Tariff	**usd/kwh**	**$ 0.217**	
2030 Tariff	**usd/kwh**	**$ 0.217**	
2031 Tariff	**usd/kwh**	**$ 0.217**	
2032 Tariff	**usd/kwh**	**$ 0.217**	

The revenue assumption for an off-grid company are a lot more straight-forward. Typically, off-grid companies sell their solar home systems on a financing arrangement with the consumer. The typical length of these financing arrangements is 4-5 years. The typical structure of these arrangements is to make consumers to pay a once off deposit. Thereafter the consumer is expected to make monthly payments towards acquiring the system. The primary risk of this sales model is that of default. At that point should a consumer fail to pay, the system can be remotely switched off (The International Finance Corporation 2018). In the case of Zola Electric, they will be offering their new Zola Infinity unit after a deposit of $152 is paid. The payback period for the unit is 5 years with a monthly expected leasing fee of $14.13. Although all amounts are expected to be received in Ghanaian Cedi, these amounts are converted to US dollars. The below table shows a summary of the assumptions made to reach the Revenue number

Table 14: Revenue assumptions for Zola Electric

Revenue	Input Description	Actual Amount	Comments on assumptions
2012 Average Cedi/US Dollar	Exchange rate	1.75	("XE: USD / GHS Currency Chart. US Dollar to Ghanaian Cedi Rates", 2019)
2013 Average Cedi/US Dollar	Exchange rate	2.12	("XE: USD / GHS Currency Chart. US Dollar to Ghanaian Cedi Rates", 2019)
2014 Average Cedi/US Dollar	Exchange rate	2.79	("XE: USD / GHS Currency Chart. US Dollar to Ghanaian Cedi Rates", 2019)
2015 Average Cedi/US Dollar	Exchange rate	3.63	("XE: USD / GHS Currency Chart. US Dollar to Ghanaian Cedi Rates", 2019)
2016 Average Cedi/US Dollar	Exchange rate	4.085	("XE: USD / GHS Currency Chart. US Dollar to Ghanaian Cedi Rates", 2019)
2017 Average Cedi/US Dollar	Exchange rate	4.55	("XE: USD / GHS Currency Chart. US Dollar to Ghanaian Cedi Rates", 2019)
2018 Average Cedi/US Dollar	Exchange rate	4.65	("XE: USD / GHS Currency Chart. US Dollar to Ghanaian Cedi Rates", 2019)
Annual Compound devalution rate	%	14.98%	We assume that the Ghanaian cedi will continue to devalue at the compound devalution rate
2019 Average Cedi/US Dollar	Exchange rate	5.35	from 2019 until 2032 we take the moving average from the previous 3 years
2020 Average Cedi/US Dollar	Exchange rate	6.15	
2021 Average Cedi/US Dollar	Exchange rate	6.15	
2022 Average Cedi/US Dollar	Exchange rate	7.07	
2023 Average Cedi/US Dollar	Exchange rate	7.07	
2024 Average Cedi/US Dollar	Exchange rate	8.13	
2025 Average Cedi/US Dollar	Exchange rate	8.13	
2026 Average Cedi/US Dollar	Exchange rate	9.34	
2027 Average Cedi/US Dollar	Exchange rate	9.34	
2028 Average Cedi/US Dollar	Exchange rate	10.74	
2029 Average Cedi/US Dollar	Exchange rate	10.74	
2030 Average Cedi/US Dollar	Exchange rate	12.35	
2031 Average Cedi/US Dollar	Exchange rate	12.35	
2032 Average Cedi/US Dollar	Exchange rate	14.20	
Off Taker Agreement: 60% supplied to the ECG	%	60%	Our Assumption is that all of the energy sold to the ECG was for household consumption. We Therefore adjust the number of households Kpone actually powered to provide a fair comparison (Uongozi Institute, 2017)
Off Taker Agreement: 40% supplied to mining companies	%	40%	(Uongozi Institute, 2017)
Monthly Payment for Off Grid Unit based on the cost of Diesel	USD	$ 14.13	("Zola Nigeria", 2019)
Number of years for monthly repayments	Years	5.00	("Zola Nigeria", 2019)
Annual Payments for Off Grid Solution	USD	$ 169.60	This will be the annual payment for the next 5 years ("Zola Nigeria", 2019)
Deposit	Naira	55000.00	("Zola Nigeria", 2019)
Deposit	USD	$ 152.00	("Zola Nigeria", 2019)

Cost of sales

To find the cost of sales figure the Volta River Authority financial statements were used. We looked for what comparable power stations pay per Giga Watt Hour (GWH) in cost of sales in Ghana. Based on the Volta River Authorities financial statements 2018, this amount was found to be $42288 per GWH. Thus in every year where the production output changes for Kpone we apply this amount per GWH

<u>Table 14: Cost of sales assumptions for Kpone</u>

Cost of Sales	Input Description	Actual Amount	Comments on assumptions
Distribution costs for Northern Electricity Distribution Company (Nedco)	Cedi	238720000	Nedco distributed 1236 GHW of energy 40% of Kpone total capacity for the 2017 calendar year. We assume that the distribution costs are the same (Volta River Authority, 2017).
Distribution costs for Northern Electricity Distribution Company (Nedco) **per GHW**	USD	$ 42,448	This becomes the distribution cost for every GWH distributed

The assumptions surrounding off-grid energy differ. In formulating the cost of sales, the international finance energy 2018 report breaks these costs as 35% for the PV, 7% for the LED, 49% for the battery and 8% for the labour and circuitry required to connect homes. Overall the costs related to a small SHS that only produces 35 watts. Our unit, however, produces 320 watts. Thus, the assumption made was to convert the stated cost of sales for a 35watt unit into a cost per watt. This number was found to be $2.22 per watt. We then multiplied this cost by the 320 watts each unit produces to find the overall cost of sale per unit. This came to $711 per unit.

The international finance report shows that the cost of these units is expected to decrease with time at CAGR rate of 7% between the years 2016-2022 and again by 5% over 2024-2032 (The international finance 2018). We thus reduce the cost of these units until a point in time they reach $280 per unit. The below table details these key findings.

Table 15: Cost of sales assumptions for Zola Electric

Cost of Unit	Input Description	Actual Amount	Comments on assumptions
small solar home system output	watts	35	(The International Finance Corporation (2018))
Costs Per unit for a small solar home system	USD	$ 77.80	This is based on a system that produces 35watts
Cost of unit per watt produced	usd/watt	$ 2.22	A key assumption here is the cost per unit stays relatively the same as the output increases (The International Finance Corporation (2018))
Watts produced by Zola electric	watts	320	("Zola Nigeria", 2019)
Cost of manufacturing a premium unit	USD	$ 711.31	
Costs Per unit for a small solar home system cagr 2016-2022	%	-7%	(The International Finance Corporation (2018))
Costs Per unit for a small solar home system cagr 2024-2032		-5%	(The International Finance Corporation (2018))
2033-2038			we assume costs remain the same
2016	USD	$ 711.31	(The International Finance Corporation (2018))
2017	USD	$ 663.51	(The International Finance Corporation (2018))
2018	USD	$ 618.93	(The International Finance Corporation (2018))
2019	USD	$ 577.33	(The International Finance Corporation (2018))
2020	USD	$ 538.54	(The International Finance Corporation (2018))
2021	USD	$ 502.35	(The International Finance Corporation (2018))
2022	USD	$ 468.59	(The International Finance Corporation (2018))
2023	USD	$ 445.16	(The International Finance Corporation (2018))
2024	USD	$ 422.90	(The International Finance Corporation (2018))
2025	USD	$ 401.76	(The International Finance Corporation (2018))
2026	USD	$ 381.67	(The International Finance Corporation (2018))
2027	USD	$ 362.59	(The International Finance Corporation (2018))
2028	USD	$ 344.46	(The International Finance Corporation (2018))
2029	USD	$ 327.23	(The International Finance Corporation (2018))
2030	USD	$ 310.87	(The International Finance Corporation (2018))
2031	USD	$ 295.33	(The International Finance Corporation (2018))
2032	USD	$ 280.56	(The International Finance Corporation (2018))
2033	USD	$ 280.56	
2034	USD	$ 280.56	
2035	USD	$ 280.56	
2036	USD	$ 280.56	
2037	USD	$ 280.56	
2038	USD	$ 280.56	
2039	USD	$ 280.56	

Operating expenses

As part of the project financing arrangement all administrative expenses were to be handled by the Sumitomo Corporation of Japan. In return for the management of the power station Sumitomo would charge a fee. The operating expenses to be managed by Sumitomo were salaries and related expenses, material and spares consumed, repairs and maintenance, employee benefits, audit fees and other operating expenses (Uongozi Institute, 2017). No further information was published on how this fee would be paid to Sumitomo. Thus we looked at the VRA's actual expenses to get a sense of exactly how much this could possibly cost. The operating expenses cost is calculated based on a % of revenue. The VRA currently has its operating expenses at 10.4% of revenue. This cost is based on their 2018 financial statements

(Volta River Authority, 2018). Given Kpone will steadily reach its capacity over time we assume the Sumitomo cost is a fixed cost of 18% at the beginning of the project early life. The 18% is based on the fact that the project seeks to reach a operating cost as a % of revenue of 10.4% over time. This percentage is based on a capacity utilization of 80% being reached. Thus the 18% reflects the fact that the PowerStation operates at below capacity for a period of time. Once the project reaches its full capacity, this cost reduces to 9.5% based on the above stated logic. The below table shows the breakdown of how these costs reduce.

Table 16: Operating expense assumptions for Kpone

Operating Expenses	Input Description	Actual Amount	Comments on assumptions
Administrative Expenses handled by Sumitomo Corporation of Japan	%	8%	These include: Salaries and Related expenses Material and Spares consumed Repairs and Maintenance Other employee benefits Audit fees The % assumption of revenue is based on the VRA actuals over financial years 2016 and 2017 (Volta River Authority, 2017). we assume these costs start by being 18% of revenue and gradually reach a state where they are 10% as capacity increases. The VRA reported this cost line item as 10.4% of revenue
Administrative Expenses handled by Sumitomo Corporation of Japan	%	18.0%	This represents the top end of costs
2016	%	17.5%	
2017		17.3%	
2018		14.0%	
2019		13.2%	
2020		12.9%	
2021		12.9%	
2022		12.6%	
2023		12.3%	
2024		12.0%	
2025		11.6%	
2026		11.2%	
2027		10.8%	
2028		10.4%	
2029		9.9%	
2030		9.5%	
2031		9.5%	
2032		9.5%	

The cost assumptions for Zola Electric were established using a different set of assumptions. The first set of assumptions were based on the international finance corporation 2018 report on the off-grid sector. This report stated that off-grid companies spend roughly $10M a year on research and development. This cost is especially needed given the young nature of the technology used by off-grid companies. This cost remains fixed for the years 2019-2024.

Thereafter, as the company reaches maturity, we assume that the cost of RandD will resemble closer to that of other power companies in the sector. This cost was 3% based on a study by the craft company 2017. We assume this cost into perpetuity. The international finance corporation report highlighted that most of the operating expenses of an off-grid company can be captured under these terms as being soft costs. Soft costs are defined as corporate costs, marketing and transportation, customer acquisition costs, transaction costs and after sales costs. Each cost is explained in below.

Corporate costs are those costs associated with acquiring the skilled personal needed to successfully run an off-grid company. One of the biggest motivators for these high costs are the fact that off-grid companies working capital is poor if receivables are not sold. Thus, the presence of a skilled corporate team enables the company to use this personal to sell this debt. Marketing and transportation costs are the costs of building a brand that will resonate with consumers and all transportation of the units from where they are sourced to where they are finally sold to. Customer acquisition costs are the costs associated with acquiring one customer. This includes the payment of a sales force to sell the unit to consumers and install the unit. High transaction costs occur given you still need a large sales force to collect the monthly payment or conduct repossessions in the case of default. The after sales costs are the costs incurred to have service personal to conduct maintenance on the unit or call centre agents to assist with problems with the unit such as fault logging.

To ascertain what the above cost would translate to per unit we looked at the work done by the international energy agency.2019 on off-grid SHS. This cost was reported to be $1 kWh with a significant chance this cost would reduce over time. The international renewable energy agency stated the cost would reduce to $0.4 per kWh by 2025. There after it is projected to continue to decline by 7% over time. The below table gives a breakdown of these costs:

Table 17: Operating expense assumptions for Zola Electric

Operating Costs	Input Description	Actual Amount	Comments on assumptions
2019-2024 Investments in technology:	USD	$ 10,000,000	This cost represents the research and development costs that come with producing these units. We estimate an annual $10M per year based on recent estimates. This amount stays fixed thereafter it becomes a % of revenue (The International Finance Corporation (2018))
2025-2038 Investments in technology:	%	3%	This represents the average percentage of revenue spent on r&d (The Craft Company, 2017)
Marketing and Transportation	USD/watt	See soft costs	These costs are included in the definition of soft costs
High corporate costs:	%	See soft costs	Given the upfront investments and long-payment periods, suppliers that can sell consumer-receivables can access more working capital, reduce credit risk, and scale faster. This leads many suppliers to invest in skilled corporate teams to raise such debt.(The International Finance Corporation (2018))
High customer acquisition costs:	USD/watt	See soft costs	PAYGO SHS sales require a trained sales force to educate consumers on navigating and maintaining the technology, and on payment terms and procedures. Most suppliers invest in and maintain large, commissioned sales teams.for purposes of this study we assume the same go to market strategy(The International Finance Corporation (2018))
High transaction costs:	USD/watt	see soft costs	Suppliers often maintain a secondary team to recoup payments (through follow-ups/repossessions) (The International Finance Corporation (2018))
High after-sales costs:	USD/watt	see soft costs	Often, a third, localized team is required to undertake post-sales servicing. Unlike smaller products that can be sent to a central service center for repair or replacement, servicing larger products necessitates a decentralized team. Major suppliers typically invest in a callcenter and a local repair laboratory.(The International Finance Corporation (2018))
Total Soft Costs	**USD/watt**	**$ 1.00**	This figure represents the cost of Customer Acquisition, Transaction costs and after sales costs. IRENA reported this cost to be $1 per watt with a significant chance they reduce with time as scale is achieved (International Renewable Energy Agency, 2019)
Reduction in Soft Costs as scale is achieved 2019-2025	% CAGR	-12%	The Assumption is soft costs match those of mini grid with scale. These were reported to be $0.1-$0.4 per watt. To be conservative we assume $0.4 per watt. This represents a (International Renewable Energy Agency, 2019)
Reduction in Soft Costs as scale is achieved 2026-2038	% CAGR	-7%	
2019	USD/watt	$ 0.88	
2020	USD/watt	$ 0.78	
2021	USD/watt	$ 0.69	
2022	USD/watt	$ 0.61	
2023	USD/watt	$ 0.54	
2024	USD/watt	$ 0.48	
2025	USD/watt	$ 0.42	
2026	USD/watt	$ 0.39	
2027	USD/watt	$ 0.36	
2028	USD/watt	$ 0.34	
2029	USD/watt	$ 0.31	
2030	USD/watt	$ 0.29	
2031	USD/watt	$ 0.27	
2032	USD/watt	$ 0.25	
2033	USD/watt	$ 0.24	
2034	USD/watt	$ 0.22	
2035	USD/watt	$ 0.20	
2036	USD/watt	$ 0.19	
2037	USD/watt	$ 0.18	
2038	USD/watt	$ 0.16	

Capex

In order to ascertain the capex costs for a natural gas power station the US energy department has a comprehensive data set that looked at the capex charge for natural gas stations across the world. The departments analysis found that on average a natural gas power station has a capex charge rate of roughly $800 KW produced. However, with time this cost declines by 1% per year as learning takes place. This phenomenon is reflected in our assumptions.

Table 18: CAPEX assumptions for Kpone

Capex Charge	Input Description	Actual Amount	Comments on assumptions
% rate at which Capex declines in cost	**%**	-1%	These assumption are from the US energy department that assume that capex costs for a natural gas plant decline with time due to learning ("2017 ATB", 2019)
Power Plant Capacity in KWH	**kWh**	**350000**	
2015	$/kw	$ 800.00	These assumptions are from the US energy department that assume that capex costs for a natural gas plant decline with time due to learning ("2017 ATB", 2019)
2016	$/kw	$ 792.00	("2017 ATB", 2019)
2017	$/kw	$ 784.08	("2017 ATB", 2019)
2018	$/kw	$ 776.24	("2017 ATB", 2019)
2019	$/kw	$ 768.48	("2017 ATB", 2019)
2020	$/kw	$ 760.79	("2017 ATB", 2019)
2021	$/kw	$ 753.18	("2017 ATB", 2019)
2022	$/kw	$ 745.65	("2017 ATB", 2019)
2023	$/kw	$ 738.20	("2017 ATB", 2019)
2024	$/kw	$ 730.81	("2017 ATB", 2019)
2025	$/kw	$ 723.51	("2017 ATB", 2019)
2026	$/kw	$ 716.27	("2017 ATB", 2019)
2027	$/kw	$ 709.11	("2017 ATB", 2019)
2028	$/kw	$ 702.02	("2017 ATB", 2019)
2029	$/kw	$ 695.00	("2017 ATB", 2019)
2030	$/kw	$ 688.05	("2017 ATB", 2019)
2031	$/kw	$ 681.17	("2017 ATB", 2019)
2032	$/kw	$ 674.35	("2017 ATB", 2019)

No capex assumptions were established for off-grid companies. This is mainly because the products are sold as a consumer goods product sourced from third party suppliers as opposed to from their own manufacturing lines.

Working Capital

The working capital assumptions for Kpone were based on PWC report on working capital management. The report took a sample of Utilities across the world and looked at what their working capital positions are over time. The report then reports the day's inventory, receivables and payables were for each year from 2016 to 2019. For purposes of this study we assumed that the days inventory numbers would not change for 2020- 2035.

With regards to Zola Electric's working capital assumptions, we looked at what the income statement reported as sales. We then assumed that the days payable, receivable and inventory days would always be 90 days.

WACC considerations

Given the above stated assumptions Kpone's WACC started off as low in the first few years (9,2%) of the project with the expectation that this is set to increase with time due to the capital structure being more heavily weighted towards equity than towards debt (19,4% by 2035). The table below shows how the WACC changes over time

Table showing Kpone WACC

WACC schedule	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
kd	4,945%	6,199%	6,467%	6,684%	6,690%	6,681%	6,671%	6,673%	6,674%	6,676%	6,678%	6,682%
t	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
Wd	71%	72%	76%	75%	74%	72%	71%	69%	66%	64%	60%	57%
ke	19,4%	19,4%	19,4%	19,4%	19,4%	19,4%	19,4%	19,4%	19,4%	19,4%	19,4%	19,4%
We	29%	28%	24%	25%	26%	28%	29%	31%	34%	36%	40%	43%
WACC = kd (1-t) * Wd + ke * We	9,205%	9,885%	9,579%	9,885%	10,046%	10,212%	10,397%	10,656%	10,955%	11,302%	11,710%	12,196%

WACC schedule	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
kd	6,686%	6,693%	6,705%	6,730%	6,810%	0,000%				
t	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
Wd	52%	46%	39%	30%	16%	1%	0%	0%	0%	0%
ke	19,4%	19,4%	19,4%	19,4%	19,4%	19,4%	19,4%	19,4%	19,4%	19,4%
We	48%	54%	61%	70%	84%	99%	100%	100%	100%	100%
WACC = kd (1-t) * Wd + ke * We	12,786%	13,516%	14,445%	15,664%	17,336%	19,180%	19,408%	19,408%	19,408%	19,408%

Zola Electric SHS WACC was much higher than that of Kpone. This was driven behind the high cost of equity and equities high proportion of the total capital structure. He table below shows how Zola Electric WACC stays between 34.25% and 38.9% over the lifetime of the project.

WACC schedule	2019	2020	2021	2022	2023	2024	2025
kd	18,706%	19,200%	22,000%	0,000%	0,000%	0,000%	0,000%
t	25%	25%	25%	25%	25%	25%	25%
Wd	46%	34%	13%	0%	0%	0%	0%
ke	47,7%	38,5%	38,0%	39,0%	39,0%	39,0%	39,0%
We	54%	66%	87%	100%	100%	100%	100%
WACC = kd (1-t) * Wd + ke * We	34,255%	31,965%	35,850%	38,966%	38,966%	38,966%	38,966%

WACC schedule	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
kd	0,000%	0,000%	0,000%	0,000%	0,000%	0,000%	0,000%	0,000%	0,000%	0,000%	0,000%	0,000%	0,000%
t	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
Wd	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
ke	39,0%	39,0%	39,0%	39,0%	39,0%	39,0%	39,0%	39,0%	39,0%	39,0%	39,0%	39,0%	39,0%
We	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
WACC = kd (1-t) * Wd + ke * We	38,966%	38,966%	38,966%	38,966%	38,966%	38,966%	38,966%	38,966%	38,966%	38,966%	38,966%	38,966%	38,966%

Calculation of the NPV

To calculate the net present value of Kpone the below diagram shows the considerations implanted into excel based on the above described assumptions. Kpone's final NPV came to be $481,314,298.

Table 19: NPV Calculation for Kpone

CASH FLOW		2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
EBITDA		**$ (73 663 948)**	**$ (106 211 084)**	**$ (100 418 534)**	**$ (132 652 129)**	**$ (166 798 743)**	**$ (63 447 034)**	**$ 289 864 286**	**$ 615 552 397**	**$ 868 229 334**	**$ 1 018 312 271**
Tax											
NOPAT		-73 663 948	-106 211 084	-100 418 534	-132 652 129	-166 798 743	-63 447 034	289 864 286	615 552 397	868 229 334	1 018 312 271
Changes in WC		-	-104 237 404	-59 375 416	-124 884 266	-155 089 466	-105 415 797	-61 812 052	-47 316 732	-18 475 748	5 429 091
Free cash flows		-73 663 948	-210 448 488	-159 793 950	-257 536 395	-321 888 209	-168 862 831	228 052 234	568 235 665	849 753 586	1 023 741 362
Period		1	2	3	4	5	6	7	8	9	10
WACC: (assuming WACC changes as the debt to equity ratio changes)		34%	32%	36%	39%	39%	39%	39%	39%	39%	39%
Discounted cashflows at WACC		(54 868 726)	(120 844 155)	(63 735 102)	(69 055 877)	(62 109 439)	(23 446 451)	22 785 989	40 855 690	43 965 051	38 114 948

CASH FLOW		2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
EBITDA		**$ 102 673 717**	**$ 103 112 552**	**$ 105 103 378**	**$ 106 907 836**	**$ 256 117 454**	**$ 256 568 129**	**$ 256 400 305**	**$ 256 424 217**	**$ 256 390 727**	**$ 256 389 084**
Tax							$ 56 642 032	$ 56 600 076	$ 56 606 054	$ 56 597 682	$ 56 597 271
NOPAT		102 673 717	103 112 552	105 103 378	106 907 836	256 117 454	199 926 097	199 800 229	199 818 163	199 793 045	199 791 813
Add: Depreciation		30 000 000	30 000 000	30 000 000	30 000 000	30 000 000	30 000 000	30 000 000	30 000 000	30 000 000	30 000 000
Less: CAPEX		101 290 792	100 277 884	99 275 106	98 282 355	206 761 503	204 693 888	202 646 950	202 944 450	203 241 950	203 539 450
Working Capital		16701024	16873323	52840446	69189127	35646903	35606760	35620500	35620500	-32523066	-63497414
Changes in WC		111 845	-172 299	-35 967 123	-16 348 681	33 542 224	40 143	-13 740	-	68 143 566	30 974 348
Free cash flows		131 402 638	130 105 585	93 307 982	111 933 674	270 303 727	234 734 031	232 633 209	232 944 450	301 385 516	264 513 798
WACC: (assuming WACC changes as the debt to equity ratio changes)		13%	14%	14%	16%	17%	19%	19%	19%	19%	19%
Discounted cashflows at WACC		19 166 314	15 076 756	8 226 223	8 154 745	15 209 753	9 975 046	9 552 172	9 564 952	12 375 217	10 861 224
NPV: **(assuming WACC changes as the debt to equity ratio changes)**	**481 314 298**										

To calculate the NPV of Zola Electric SHS the below diagram describes how this calculation was performed. Zola Electric final NPV came to be ($161,884,942) indicating a destruction in value.

Table 20: NPV Calculation for Zola Electric SHS

CASH FLOW		2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
EBITDA		**$ 1 069 052 152**	**$ 1 116 929 154**	**$ 1 162 109 234**	**$ 1 204 748 452**	**$ 1 216 937 384**	**$ 1 228 273 090**	**$ 1 238 815 298**	**$ 1 248 619 551**	**$ 1 257 737 506**	**$ 1 266 217 204**
Tax			279 232 289	290 527 308	301 187 113	304 234 346	307 068 273	309 703 824	312 154 888	314 434 376	316 554 301
NOPAT		1 069 052 152	837 696 866	871 581 925	903 561 339	912 703 038	921 204 818	929 111 473	936 464 663	943 303 129	949 662 903
Changes in WC		4 537 855	4 392 433	4 248 580	4 106 615	-3 047 233	-2 833 927	-2 635 552	-2 451 063	-2 279 489	-82 679 925
Free cash flows		1 073 590 007	842 089 299	875 830 505	907 667 954	909 655 805	918 370 891	926 475 922	934 013 600	941 023 641	866 982 978
Period		11	12	13	14	15	16	17	18	19	20
WACC: (assuming WACC changes as the debt to equity ratio changes)		39%	39%	39%	39%	39%	39%	39%	39%	39%	39%
Discounted cashflows at WACC		28 762 991	16 234 699	12 150 571	9 061 375	6 534 836	4 747 514	3 446 456	2 500 244	1 812 676	1 201 768

NPV: **(assuming WACC changes as the debt to equity ratio changes)**	**(161 884 942)**

Calculation of the Equivalent Annual Annuity

Ordinarily one would have to do a Equivalent Annual Annuity calculation to compare projects of unequal lives, however, given we have already established that Zola Electric's SHS produces a negative NPV one can already tell that Kpone is the project the better return. Thus, it was deemed unnecessary to conduct the analysis any further.

Bankability

In this section we explore the key findings of what criterion large institutional investors apply when assessing the viability of making an investment. The methodology applied in this study is premised on the theory put forward by Pindyck. This theory states that investors need to be assured of credibility and stability given the irreversible nature of investments. This means the risk of an investment needs to be thoroughly assessed beyond just the financials. The theory also states that investors delay investments until such a point they feel comfortable they making the right decision. This is partly the reason why investments often take a long time to be approved. The methodology went further to look at exactly what are the key assessment points made by investors when assessing risk for them to feel the investment they seek to pursue are credible and stable. The methodology applies a new framework that draws on the learnings of surveys conducted with institutional investors, published literature on the topic of achieving bankability in off-grid, information in the public domain released by the biggest private equity firms on what criteria they apply before making an investment and how past investments made in the sector achieved bankability. In this section we will explain the results and show how they link back to the findings of this theoretical perspective. We also outline the similarities found in previous literature and the assumptions made were applicable.

In total the study looked at 12 published journals and reports, 7 previously conducted surveys, the top 19 private equity firms by funds under management and the top 9 investors into off-grid energy by investment size. The studies objective was to extrapolate the specifics in terms of what was required to reach project bankability. Where specifics were missing, we analysed press releases, speeches or company annual reports to further understand what criteria might have been applied to previous investments. Thus, in some cases one might find that, based on what has been said or written in the public domain, we interpret and infer what the criteria might be. Thus, in some cases assumptions have been made to reach certain conclusions'. Table 1 shows the overall concerns that were found in the literature. The results are broken down into each major section and explained.

Table 19: Table showing the overall results of the key concerns found to be a major barrier to achieving project bankability

	Overall Findings of what was a concern to Investors		
Key Concept	Number of points of analysis	Amount of times key concept appears in all analysis	%
Policy and Regulatory certainty	47	12	26%
Expected Rate of Return	47	15	32%
Investment Ticket Size	47	26	55%
Management Track Record	47	17	36%
Risk Tolerance	47	15	32%
Company Track Record	47	23	49%
Investment Duration	47	13	28%
Positive ESG'S impact	47	13	28%
Geography	47	14	30%
Investment types	47	2	4%
Investment structure	47	6	13%
Type of impact needed	47	2	4%

Table 20: showing the overall importance of each criteria based on the amount of times it features in the literature

Specifics of what is required from investors	
Key criteria	Criteria Weight Based on number of times it appears
Investment Ticket Size	17%
Company Track Record	15%
Management Track Record	11%
Risk Tolerance	10%
Geography	9%
Expected Rate of Return	8%
Positive ESG'S impact	8%
Investment Duration	8%
Policy and Regulatory certainty	8%

Investment Ticket Size

The investment ticket size was found to be the most important criteria investors looked for when assessing the bankability of an Off-grid solar company. Investment ticket size relates to the total financial value of an investment. The investment ticket size becomes important for 3 main reasons. The first one is transaction costs. Transaction costs are all the costs associated with making an investment. These costs include the costs of lawyers and personal conducting the due diligence. These costs are often fixed in nature thus if an investments size is too small to warrant the amount of effort put into making the deal a reality, investors may choose to not even entertain an application for investment. The second is the risk associated with the lack of scale. Given the inherent risk of having to finance these off-grid units to households that earn very low incomes, there is significant risk of default. However, studies such as Malhotra's et al, 2017 have shown that when these projects reach scale this risk reduces. The final key consideration was the absolute value of the return on offer. A high percentage may look attractive however the absolute return of that investment needs to be able to make a significant difference to the portfolio of investments return. If this is too low, then an investment could well be overlooked.

Our analysis shows that there are roughly 3 bands that may qualify an investment as financially viable. These are the $10M-$50M, $50M-$100M and $100M and above ranges. Our analysis shows that to meet the investment ticket size criteria over 50% of the sources assessed stated this was in the $10M-$50M range. 15% in the $50M -$100M and only 8% in the above $100M range. It worth mentioning that 27% of the sources assessed pointed out that projects need to be aggregated and scaled to meet investment ticket size criteria. Our study reaches the conclusion that any project in need of finance needs to at least be looking for between $10M - $50M and show strong plans on how to achieve scale.

Table 21: showing the key criteria investors look for in the assessment of an investment

Specifics of what is required from investors				
Key Concept	Key Criteria 1	Key Criteria 2	Key Criteria 3	Key Criteria 4
Investment Ticket Size	**$10k-$50M**	**$50M-$100M**	**$100M and above**	**Aggregate Projects to Reduce Risk Premiums**
Number of observations	**13.00**	**4.00**	**2**	7
% of total observations based on number of firms that confirmed this as a concern	50%	15%	8%	27%

Company Track Record

Company track record was featured as the second most important metric when assessing the viability of an investment. The table details at what stage institutional investors were willing to invest in off-grid companies. The stage an institutional investor is willing to invest in can also be a sign of what risk they are willing to take on in an investment. This is because the earlier a business is in its investment life cycle the higher the associated risk and thus the higher the expected return.

Our findings show that of the literature reviewed and of the top PE firms analysed, over 40% preferred mature companies with stable cash flows with the ability to still grow. The maturity of the companies required shows a high degree of risk averseness by institutional investors. 35% of the literature reviewed and companies analysed showed a strong preference for expansion stage companies or late venture capital. Companies at this stage have a proven business model and sometimes operate in industries where there is no clear market leader yet. Companies at this stage of the investment cycle are riskier investments than mature companies but still hold a good level of predictability in their cash flow capabilities. While over 70% of our analytical points showed this was the stage institutional investors were willing to invest almost no PE or asset manager was willing to fund start-ups unless this came from their venture capital business silo that tends to have far less assets under management. All companies willing to invest in the start-up phase of off-grid were either development finance institutions or impact investors. This was mainly because of how well-off-grid companies can address ESG factors and developmental impact issues. High risk levels for these types of institutions are also more acceptable. The finding here is that off-grid companies need proven business models and show that they can generate profits and stable cash flows to become investment attractive

Table 22: Showing what stage of a company life cycle institutional investors are willing to invest

Company Track Record	**Fund Start-Ups**	**Established expansion stage companies with potential for global market share leadership**	**Mature high growth companies with positive EBITDA and stable cash flows**
Number of observations	5	8	10
% of total observations based on number of firms that confirmed this as a concern	22%	35%	43%

Management Track Record

Management's track record featured as the third most important criteria. This criterion focuses on the managing team's expertise and how well they have delivered on those expertise in the past. All sources showed that investors needed a management team with both the expertise to manage the company and should have shown a track record for delivering great results. The main reason why this is such a significant phenomenon is investors require certainty. Part of the certainty they require is the fact that the company that they are investing in have the right skills in place to deliver on their mandate. Our study found that of the 17 sources we analysed all found the above criteria to be pertinent in their investment decisions.

Table 23 showing sources that confirmed management track record as a key criterion to project viability

Management Track Record	Management with a proven Company Track Record to deliver in their industry
Number of observations	17
% of total observations based on number of firms that confirmed this as a concern	100%

Risk Tolerance

The Risk Tolerance metric tried to understand what risk factors featured as the most prominent for institutional investors. The literature highlights that there is a lot of concern around the consumer financing aspect for off-grid solar companies. Given that the most successful business models to date have been around offering consumer financing, a lot of institutional investors worry about the risk associated with carrying so much consumer debt. Based on the literature reviewed 33% were found to highlight this as a risk. Unsurprisingly, this is the same risk faced by base load power stations. Investors often cite off taker risk as a key concern to investing in Power stations in Africa.

The second highest identified criteria came from that of private equity (PE) firms. They often have strict criteria that governs the type of companies they invest in. what was found was of those PE firms that made this information public all stated that they prefer to invest in investment grade companies. If one also looks at the top PE firms, they either preferred expansion stage/late stage firms and mature high growth companies with stable cash flows. Based on these two findings we interpret "investment grade" to mean companies that are in either of these three stages of their business life cycle.

The literature points towards the need for off-grid companies' products to be project financed. Project finance structures help limit risk by allocating risk to the parties best positioned to deal with that particular risk. Thus, risk such as consumer debt can be sold off to third parties by way of factoring arrangements. The last consideration was that of ESG risks. Of the respondents that highlighted ESG's as a key risk factor all were impact funds. These funds tended to have clear ESG criteria that had to be met. Thus, projects require grants or impact investor funding would need to meet key ESG criterion.

The below table summarises what an institutional investor needs before they ready to make an investment.

Table 24 showing most prominent risk factors identified

Risk Considerations	**ESG Risk**	**Consumer Default Risk**	**Use Project Finance to limit risk**	Only investment Grade Companies
Number of observations	**3**	**5**	**3**	4
% of total observations based on amount of firms that confirmed this as a concern	20%	33%	20%	27%

Geography

The geography metric looked at whether where Asset managers and PE firms could invest was an obstacle to achieving project bankability. This metric tries to understand whether there is a preferred geographical location in investing. Given we looked at the biggest asset managers and PE firms globally, some funds analysed had a geographical preference to where they ended up investing. There are various reasons why funds have specific geographies. The funds we assessed differed based on the type of investor they were. PE firms preferred companies that operated in geographies they had local expertise already present and were they understood the local investment climate. Whereas some asset managers ruled out geographies that had high political risk. However, of the funds assessed only 21% had a geographical preference that excluded Africa. Our study finds that Geography is not a true obstacle to achieving project bankability. The below table shows these findings

Table 25 showing geographical restrictions to investments

Geography	**Africa included**	**Excludes Africa**
Number of observations	**11**	**3**
% of total observations based on amount of firms that confirmed this as a concern	79%	21%

Expected Return

There is a lot of literature on what the expected return is by institutional investors on African investments. This study attempted to shy away from simply restating what that return is and focused more on understanding what the potential diagnostics were for trying to achieve this aspect of project viability. However, given the nature of the study was also to assess what the requirements are for institutional investors, we have included their requirements in our analysis. It is worth noting that all returns were based on dollar returns

Our findings show that of all the institutional investors assessed only one stated that they were happy with “a market related return” which generally falls between 7%-10% in private equity. All other asset managers and private equity firms had market related return expectations based on the geography they were investing in. Thus, based on PWC.2017 the entry level return expected for an African infrastructure project was 21%. However, our study on financing shows that this return is adjusted for company track record or stage of investment (up to 2.5% risk premium) and for the significant growth expectations required for companies in these early investment stage (up to 2.5% risk premium). Thus, our interpretation is that a market related return wouldn’t be less than 26%. This amount could be higher depending on the context of where the off-grid company seeks to operate in.

One of the most widely stated challenges for off-grid companies to reach project bankability is the unrealistic return expectations of institutional investors and most notably venture capital firms. The multiples in return required by them in the short duration (5-7 years) makes it extremely difficult for them to be attractive (Bertha Centre 2016). This finding is consistent with our own findings in an earlier portion of our paper. Our paper found that the expected return for a Zola Electric investment into off-grid in Ghana averaged 40% year on year. Thus, the true value add from our findings was establishing the consensus on what needs to take place in order for projects to reach bankability. Our findings show that aggregating off-grid companies or projects to achieve scale has a material effect on reducing the required risk premium. This is consistent with a study released by Baker Mackenzie 2019 that found that the consolidating off-grid companies based on what jurisdiction they operate in would make further investment into this sector attractive. This was mainly because aggregation reduces the risk premium required. 40% of the papers reviewed stated this as a key metric to achieving bankability. The second diagnostic was to implement innovative policy to encourage investment into the sector. 2 studies mention these to be tax subsidies to help reduce risk.

Overall our findings show that expected returns on African projects are still set to stay above 21% per annum. Thus, focus should be placed on finding innovative ways to reduce risk premiums of projects to help more off-grid SHS companies achieve project viability. The consensus on how this should be done is by way of aggregation and potentially innovative policy such as tax subsidies. The below table shows our findings in detail.

Table 26 showing required rate of return expectations

Rates of Return	**7%-10%**	**Rates of return equal to or above what is expected for Africa. Over 21% as published by PWC**	**Expected Returns are too high. Aggregate Projects to Reduce Risk Premiums**	Innovative Policy to reduce Risk Via Tax Subsidies
Number of observations	1.00	6	6.00	2
% of total observations based on amount of firms that confirmed this as a concern	7%	40%	40%	13%

Positive ESG's

A lot of the top asset managers and private equity firm subscribe to the United Nations Principles for responsible investment. This document covers a broad set of Environmental, Social and Governmental (ESG) criteria that subscribers should meet when assessing their investments. In recent years this definition has been expanded to include other areas such as fossil fuel investing and investments that have a positive impact on overall society. There has been a growing trend towards large institutional investors make sure this is a key consideration in their investment consideration (Bertha Centre for social innovation and entrepreneurship, 2016).

Considering the nature of the off-grid companies being assessed for this study we find that there should be no challenge in meeting this criterion. An analysis as to why is broken down by each component of the criteria.

Environmentally, the Solar Home Systems (SHS) all rely on solar power to charge the batteries that store energy. Some advanced systems such as Zola Electrics Infinity system can operate on a hybrid model where they make efficient use of grid power that relies on "dirty" energy, by storing power and disbursing it when needed. Thus, from an environmental perspective the SHS assessed by this study were found to meet the positive environmental impact criteria.

Socially, the SHS are intended for a class of consumer that does not have access to electricity. given Africa's challenges in building Power stations early estimates show that access to energy could only be a reality for most household by 2040 (Castellano, A.et al 2015).Thus growing distribution rapidly of these SHS allows the continent to accelerate its electrification ambitions and bring the population closer to its development goals. Another aspect of the SHS assessed is that of achieving consumer affordability. There is a big drive towards offering consumer finance by way of mobile money. Mobile money allows the unbanked to easily transfer money via basic phones and pay for thing such as utility bills, loans etc. By leveraging this platform SHS companies have been able to offer consumer financing in order to encourage uptake of the units.

Thus based on the SHS companies assessed in this study, one can see that SHS have the capability of meeting United Nations Sustainable Development goals 7 (access to affordable clean energy) and to a certain extent 13 (climate action) through how they produce power through clean energy. It is based on this set of facts we conclude that a significant amount of SHS meet the top assets managers ESG criteria.

Investment Duration

The Bertha Centre for social innovation and entrepreneurship, 2016 found that the financing duration needed by companies providing SHS were over 9 years. This time period would allow these companies to build scale, establish their brand and have a proven track record for collecting consumer debt. However, our study and previous studies show that the financing duration on offer by institutional investors, impact funds, DFI's and banks are not long enough to allow for the firm to establish themselves. Our study reaches similar conclusions. Of the institutional investors assessed 46% had stated that they typically only finance firms for 5-7 years. The other 46% showed that they were willing to invest for periods longer than 7 years provided other bankability criteria were met. However, of this number reduces to just 31% if you consider the fact that of those assessed some institutional investors excluded developing markets in their criteria. If we had to consider the fact that commercial lenders and Development finance institutions only finance for periods of 5 and 4 years respectively, this makes it harder for off-grid companies to achieve bankability (The International Finance Corporation, 2018).

The required Investment duration of investors can only be broken if governments or development finance institutions start implementing innovative policy solutions or start extending their loan terms. This might help crowd in investment Baker Mackenzie 2019. Thus our overall findings shows that the misaligned investment horizon poses challenges to further investment into the sector.

Table 27 showing investment duration investors expect to remain invested

Investment Duration	**Under 5 Years**	**5-7 Years**	**Over 7 Years**
Number of observations	**1**	**6**	**6**
% of total observations based on amount of firms that confirmed this as a concern	8%	46%	46%

Policy and regulatory certainty

The key barrier to achieving project bankability were whether there are plans to extend the grid, whether there will be any Tariff interventions that might negatively impact the return on investment and a vague policy environment. Grid extension is important in the sense that, grid power is always known to be cheaper per kWh due to the inherent below cost tariffs offered by many African state utilities (PWC. 2018). The subsidies distort the market pricing and render off-grid applications uncompetitive. However, more established energy sources such as coal, gas and nuclear have achieved the scale needed to reduce the costs per kWh needed to be charged whereas solar can still be a young technology that is on route to achieving a reduced cost. Thus an extension of the grid almost leads to a slower up take in off-grid applications. Vague policy and regulatory environments make it difficult for businesses to plan. A vague policy environment also adds to the risk premium investors apply when assessing the viability of an investment. These uncertainties result in additional costs such as political risk insurance.

Overall a vague policy environment may result in investors delaying their investment until such a time policy has been sufficiently clarified to bring certainty (PWC 2017). The above findings are consistent with those of Pindyck in the sense that investors choose to delay their investment if there remains a sense of uncertainty in the investment environment Pindyck, 1990.

The final key finding in the literature was the effect cost reflective tariffs have on an investment. Governments often regulate tariffs based on certain criteria. An example of these could be a tariff that is set based on the covering a fixed cost, debt servicing costs, variable costs and a desired return on investment for equity holders. However, if tariffs are not negotiated and aligned at the outset before an investment is made changes to the tariff can have a significant effect on the viability of a project PWC. (2015). While cost reflective tariffs apply to traditional base load power stations that have very high fixed costs its not to say these concerns don't exist for current investors into off-grid energy given one seeks to provide the same service.

Overall the results show that off-grid Policy and Regulatory concerns ranked last out of the 9 issues identified as an investment barrier to making off-grid bankable. This possibly could be attributed to the fact that standalone off-grid applications are seen to be a consumer product as opposed to a utility that often has an a lot more stringent regulatory environment. The key concerns identified within Policy and regulatory concerns were vague policy and regulatory environments, Grid extension and cost reflective tariffs respectively.

Table 28 showing the key criteria investors look for in the assessment of an investment

Specifics of what is required from investors				
Key Concept	Key Criteria 1	Key Criteria 2	Key Criteria 3	Key Criteria 4
Policy and Regulatory concerns	**Vague policy and regulatory environment**	**Clear plans on Grid extension and support for Off-grid**	**Cost reflective Tariff**	
	5.00	4.00	3.00	
	42%	33%	25%	

Overall on how to achieve project bankability

Based on the key findings above the study has formulated a framework on how best to assess project viability specific to off-grid companies. This framework is explained by the table below. The framework draws on the findings of the study. The key criteria is ranked based on how many of the assessed studies and top institutional investors highlighted specific barriers to achieving project bankability. This weighted is based on the total number of stated criteria assessed on off-grid. This weight is represented by the second column in the table. As can be seen from the table below the top 3 barriers to off-grid companies achieving bankability are investment ticket size, company track record and management track record. Reading from left to right, if we consider a single company trying to achieve bankability, they would assess the criteria based on how far their company was able to tick boxes going to the far right. For example, if a off-grid company seeking funding were to apply they could assess the viability of their proposal by looking at how much they require. Thus under investment ticket size if they were applying for $50M they would have achieved 65% of the 16% weighting.

Table 29 showing a framework to assess project bankability

Specifics of what is required from investors					
Key criteria	Criteria Weight Based on number of times it appears	Criteria 1	Criteria 2	Criteria 3	Criteria 4
Investment Ticket Size	16%	**$10k-$50M**	**$50M-$100M**	**$100M and above**	**Aggregate Projects to Reduce Risk Premiums**
		50%	**65%**	**73%**	**100%**
Company Track Record	15%	**Fund Start-Ups**	**Established expansion stage companies with potential for global market share leadership**	**Mature high growth companies with positive EBITDA and stable cash flows**	
		22%	57%	100%	
Management Track Record	11%	**Management with a proven Company Track Record to deliver in their industry**			
		100%			
Risk Tolerance	9%	**ESG Risk**	**Consumer Default Risk**	**Use Project Finance to limit risk**	Only investment Grade Companies
		20%	53%	73%	100%
Geography	9%	**Africa included**	**Excludes Africa**		
		79%	100%		
Expected Rate of Return	9%	**7%-10%**	**Rates of return equal to or above whats expected for Africa. Over 21% as published by PWC**	**Expected Returns are too high. Aggregate Projects to Reduce Risk Premiums**	Innovative Policy to reduce Risk Via Tax Subsidies
		7%	47%	87%	100%
Postive ESG'S impact	8%	**Strong Emphasis on the investment being ESG compliant**			
		100%			
Investment Duration	8%	**Under 5 Years**	**5-7 Years**	**Over 7 Years**	
		100%	46%	31%	
Policy and Regulatory certainty	8%	**Vague policy and regulatory enviroment**	**Clear plans on Grid extension and support for Off Grid**	**Cost reflective Tariff**	
		42%	75%	100%	

Conclusions and recommendations

The study has structured the conclusions and recommendations sections in two parts. The first part provides the conclusions reached into what the key insights were on the study on the return analysis. The second part provides insight on what the key findings were on project bankability. Overall, each section is structured in a way that provides a summary of the key findings and the recommendations proposed by this study. Both sections are summarised in bullet point form. Thereafter avenues for future research are proposed.

Return analysis

The aim of the study was to assess which energy technology offered the most superior return to potential investors. The study also had the aim of establishing a framework in which future studies could use to compare returns of differing energy technologies. In order to achieve this aim the study focused on using the recently built Combined Cycle Gas Turbine power station named Kpone in Ghana. In order to make fair comparison this technology was compared to Zola Electric's recently launched Zola infinity unit in Ghana. The objective of the study was to use the Net Present Value model to assess investment returns of a natural gas power station and a off-grid unit. The net outcome we seek to understand is which generation technology offered the higher return. Based on the assumptions stated in the discussion of findings section this paper has made a few contributions to the current body of literature. These are numbered below and explained in depth.

1) The Combined Cycle Gas Turbine Power station in Ghana (Kpone) offers a better risk-adjusted return than an investment into Zola Electric's infinity unit in the context of Ghana.
2) The combined effects of the debt to equity structure and the high expected returns for an early stage company make the cost of capital too high for off-grid companies to compete with investments into the grid

With regards to the first point, our study found that if an investor were to invest in Zola Electric unit with the aim of achieving the same electrification rates as Kpone, they would achieve a negative NPV of $161M. The key drivers of this negative return is the high discount rates employed on Zola electric. The average WACC was 38% over the same 20 year period. In comparison, Kpone average WACC was 18%. The key differing reasons behind such a high discount rate were the debt to equity structure and the high risk in investing in early stage companies with relatively untested technologies.

With regards to the capital structure, a well-known fact is debt is relatively cheaper than equity. Given Kpone relied on a project financing structure that is characterized by very high debt financing and allocation of risk to parties best suited to deal with that risk, Kpone cost of debt was never higher than 9.375%. This debt had a weight of 72% in the total capital raised. The equity portion cost averaged 15% with a weighting of only 28% of the total funds raised. In comparison, Zola electric debt costs were 20% with debt making up only 55% of the total structure. Equity cost 39% on average with a very high weighting of 45% in the total capital structure. Thus the effects of discounting and the higher portion of equity in the capital structure would have negatively affected the outcomes of the study.

Thus if one looked at the outcome of this study one concludes that, so long as off-grid companies are still deemed risky investments due to the early nature of their technology, investments in the grid will offer a better risk-adjusted return.

The recommendations put forward by our study is that there needs to be policies that actively attempt to de-risk off-grid investments such as tax subsidies, interest subsidies or factoring trade receivables to provide cash certainty. Further papers should explore whether the same findings are true in other jurisdictions such as East Africa where mobile money has allowed companies to assess the strength of consumers to pay based on history. This fact would go some way in de-risking the investment. There’s also scope to study further what the effect tax, interest and general subsidies have on de-risking an investment to provide optimal returns.

Bankability

The aim of the bankability study was to assess the criteria off-grid companies need to meet before investors invest in their ventures. Secondary to this aim was to establish a framework that could be used by off-grid companies to assess whether their projects are likely to meet project viability criteria. The objective of the study thus became to conduct desk research on what criteria the largest institutional investors by assets under management employ when assessing a company’s viability. Secondary to this was to create a framework that helped guide companies on how they can achieve project viability. Based on the discussion of findings on Bankability the following contributions have been made to the literature:

- The study has provided a ranking on what the most important bankability criteria for start-up's or off-grid companies
- The study has created a new framework on how best to assess this criterion

With regards to the first finding, the finding was established by looking at past interviews conducted with investors, published reports and literature and lastly by conducting research on information in the public domain on what criteria the largest fund managers apply when seeking to invest. The top three criteria that had to be met by off-grid companies were the investment ticket, company track record and management's track record. What was evident in the study was that, fund managers view off-grid energy companies as 'start-up" companies. This meant that a lot of the off-grid companies had not reached the level of maturity yet mainly due to the investment ticket sizes be too small and company track records being unestablished. Based on this, it was for this reason why the majority of investors were DFI's or impact investors were the above criteria is not always as important. Other issues that are evident were the fact that the required rate of returns for off-grid companies are too high resulting in many of institutional investors rejecting them. This is confirmed by our own study that shows that, due to the high associated risks with investing in relatively early stage companies, investors' required returns lead to the capital employed returning a negative NPV.

With regards to the second finding in this study, the framework should be used to assess to the strength of a company in off-grids ability to raise funding. This criteria, although not set in stone, can be used to validate the strength of a company's pitch for funding.

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