Sustainability of decentralised renewable energy systems

REPORT

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South African National Energy Development Institute

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REPORT

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Abbreviations

ABPP	Africa Biogas Partnership Programme
AC	Alternating Current
ADB	Asian Development Bank
CEF	Central Energy Fund
CFL	Compact Fluorescent Lighting
CSIR	Council for Scientific and Industrial Research
DBSA	Development Bank of South Africa
DC	Direct Current
DESCO	Distributed Energy Service Company
DFID	Department of International Development (UK)
DME	Department of Minerals and Energy
DoE	Department of Energy
DRET	Distributed Renewable Energy Technology
DRFN	Desert Research Foundation of Namibia
DTI	Department of Trade and Industry
EARP	Electricity Access Roll-Out Programme
EC	European Commission
EDI	Electricity Distribution Industry/Infrastructure
EEP	Energy Environment Partnership
EPWP	Expanded Public Works Programme
ERT	Energy for Rural Transformation
ESCO	Energy Service Company
ESD	Energy for Sustainable Development
EU	European Union
EWURA	Electricity and Water Utility Regulatory Authority
FBAE	Free Basic Alternative Energy
FBE	Free Basic Electricity
FRES	Foundation for Rural Energy Services
GEF	Global Environmental Facility
GHG	Greenhouse Gas
GIZ	Gesellschaft für Internationale Zusammenarbeit
ICS	Improved cook stoves
IDA	International Development Association
IDCOL	Infrastructure Development Company Limited
IEA	International Energy Agency
IEP	Integrated Energy Plan
IFC	International Finance Corporation
INEP	Integrated National Electrification Programme
IPP	Independent Power Producer
IRP	Integrated Resources Plan
JICA	Japanese International Cooperation Agency
KfW	Kreditanstalt für Wiederaufbau
LCC	Life-cycle Cost
LED	Light-emitting Diode
LPG	Liquified petroleum gas
MDG	Millennium Development Goals

MFP	Multifunctional Platform
NAMA	Nationally Appropriate Mitigation Action
NER	National Electricity Regulator
NERSA	National Energy Regulator of South Africa
NGA	Non-Grid Agency
NGDA	Non-Grid Electrification Agency
NGO	Non-governmental organisation
NPV	Net Present Value
NuRa	Nuon Raps Utility
OGE	Off-Grid Electric
PERZA	Renewable Energy for Rural Zones Programme
PPP	Public-private Partnership
PV	Photovoltaic
PwC	PricewaterhouseCoopers
REEEP	Renewable Energy and Energy Efficient Partnership
REFSO	Renewable Energy Finance and Subsidy Office
REIPPP	Renewable Energy Independent Power Producer Procurement
RERED	Rural Electrification and Renewable Energy Development
R&D	Research and Development
SABS	South African Bureau of Standards
SALGA	South African Local Government Assocation
SANEDI	South Africa National Energy Development Institute
SANS	South African National Standard
SAPVIA	South Africa Photovoltaic Industry Association
SE4All	Sustainable Energy for All
SESSA	Sustainable Energy Society of Southern Africa
SHS	Solar Home System
SME	Small and medium enterprises
SMWT	Small and medium wind turbines
SNV	Netherland Development Organisation
SoE	State-owned Entity
SPP	Small power producer
TAF	Technical Assistance Facility
TEP	Tsumkwe Energy Project
TOR	Terms of Reference
TWFM	The Wind Factory Madagascar
UNDP	United National Development Programme
UNIDO	United Nations Industrial Development Corporation
Unisa	University of South Africa
USAID	United States Agency for International Development
V	Volt
WfW	Working for Water
WfE	Working for Energy
WtP	Willingness to pay

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Executive summary

Access to modern energy services allows people to live better and more productive lives, and is a necessary precondition for achieving many of the Millennium Development Goals (MDGs). In fact, the Sustainable Development Goals, which are to replace the MDGs, explicitly list modern energy access as a goal in its own right. These modern energy services are a crucial ingredient to reducing global and local environmental impacts, while increasing opportunities for reducing extreme poverty and achieving economic development; for example, by providing communities access to running water, sanitation, efficient lighting, cooking, heating, mechanical power, modern healthcare, media and communications.

Globally, the energy access initiative is building momentum, driven by the decreasing prices of renewable energy technologies, coupled with the recognition of the vital role modern energy services play in enabling a basket of socioeconomic benefits. In addition, the need for the developing world to adopt a clean, low-emission development path to reduce global warming is providing added impetus and funding. Under the Sustainable Energy for All (SE4All) initiative of the United Nations, the target of universal access to modern energy services by 2030 has become a priority Sustainable Development Goal of the international development agenda. It is an ambitious goal that will require commitment from a broad group of stakeholders, as well as large amounts of funding. The SE4All Finance Subcommittee estimates that the achievement of the universal access goal will require $45 billion per year until 2030, up from the current $9 billion per year currently being spent on energy infrastructure.

South Africa has made impressive progress since the start of the democratic era in connecting households to the grid. Prior to 1990, about 30% of households were electrified. By the end of the decade, this figure had doubled. The current household electrification figures are somewhere between 80 and 85%. While this is more than double the continent's average electrification rate, in excess of three million households in South Africa remain without access to modern energy services. Addressing this backlog will require a different approach, including 'off-grid' electrification using renewable technologies.

There are not many examples of successful off-grid renewable energy programmes that have delivered sustained benefits at scale to poor communities in South Africa. Why have various initiatives failed and what can be learnt from past experiences so that mistakes are not repeated? In other parts of the developing world, off-grid renewable energy access programmes are building momentum and changing the lives of rural communities. What lessons can we learn from these programmes? What policies, business models, enabling environments, master plans and institutions have been put in place that have underpinned these emerging success stories? This report examines a selection of local and international renewable energy access case studies, highlights interviews with key players, examines policy and practice, shares lessons and experiences, and makes suggestions in attempting to provide guidance for the future.

It is clear that consistent policy and policy instruments create the certainty for an enabling environment for investment. Certainly, the policy environment in South Africa is supportive of distributed off-grid renewable energy, as evidenced in the major policy initiatives over the past 15 years. Apart from the policy thrust towards securing energy security through diversification, there is explicit reference to the goal of universal household access to electricity and off-grid renewable supply. The New Household Electrification Strategy, initiated by the Department of Energy (DoE) in 2011, recognises that a grid target of 90% of households is achievable, and that the remaining households will need to be electrified through high-quality, non-grid solar home systems or other technologies. However, there is a need for more effective implementation, supported by sustained political leadership, which speaks to a gap between supportive policy and implementation.

The interplay between public and private-sector actors is context-specific, making it difficult to provide a recipe

for success. Infrastructure Development Company Limited (IDCOL) in Bangladesh has delivered solar home systems (SHSs) to 3.2 million households, making it the most successful solar photovoltaic (PV) initiative in the world. It has specifically sought to insulate the programme from political interference by limiting direct government involvement. For the Nepal Biogas Programme, the opposite is true, with government taking a leading role. In the case of Off-Grid Electric (OGE), which is implementing 3 000 SHSs a month in Tanzania, policy certainty has been assured by building a business that is, in fact, not dependent on the policy environment – either for subsidies or other incentives. While the Tanzanian government officially recognised the achievements and importance of the programme recently, this has come on the back of the programme's success.

The off-grid concession programmes in the South African provinces of the Eastern Cape (KES Energy Services Company) and KwaZulu-Natal (Nuon Raps Utility (NuRa)) are the only examples of off-grid technologies installed at scale in the country. The success of these programmes has been undermined by the lack of coordination between the players involved. Moving forward, the various public sector agencies, Eskom and the private sector need to work together effectively if the goal of universal access is to be achieved. Stability of opportunity is essential to attract investors; and this requires consistent, unwavering long-term government support. The Renewable Energy Independent Power Producer Procurement (REIPPP) Programme, though yet to run its course, is a good example of what can happen when this is in place.

What is clear is that private-sector drive, efficiency, expertise and capital are crucial for success. The new breed of off-grid companies is delivering modern energy services to poor communities at a scale not seen before. A competitive environment ensures that the winners continually innovate, find new and more efficient ways of doing things, service their customers and keep their pricing competitive. Compare this to the concession programme in South Africa, where concession holders operate in the absence of competition, with off-grid areas being assigned to specific companies. The competitive aspect is immediately removed and, along with it, market forces that drive cost reduction, technological innovation, service-level improvement and customer satisfaction.

From the case studies reviewed, as well as interviews with industry leaders in the private sector, a number of themes emerge that point towards the key criteria for success when operating in this environment. These provide lessons for the South African context. Long-term sustainable business models are clearly vital for the success of a programme. Important elements of these models are affordable pricing structures that allow small mobile phone-enabled incremental payments and the use of technology to reduce communications and service costs. In addition, the focus of successful initiatives is on services (lighting, electricity to charge cellphones, etc.) rather than on the technology or size of the system.

The rural poor have a limited ability to pay for energy services, and so affordability issues need to be addressed through the use of innovative finance mechanisms. These may include subsidies for access, fee-for-service arrangements or part grant (poverty tariffs) and part microfinance, among others. However, care needs to be taken to prevent energy consumption subsidies from undermining business models or impacting on the commercial sustainability of the implementing companies, as documented in the South Africa concession programme case study.

Technology of a poor quality can undermine the acceptance of new technology and set back a market by years. The IDCOL case study demonstrates how the use of high technical standards and codes of practice, set and enforced by an independent technical committee, has played an important role in the success of these standards and codes of practice. It has also helped build local manufacturing capability. The OGE case study demonstrates how high-quality systems ensure the sustainability of its operations through the retention of customers and the penetration of new markets.

Lastly, we must not forget woody biomass and charcoal, which account for the majority of primary energy in sub-Saharan Africa. Toyola, founded in Accra, Ghana, sold more than 300 000 efficient biomass stoves between 2007 and 2013. Toyola recognises that while people may be spending a great deal on charcoal, they will not be able to finance the purchase of a more efficient stove without financial assistance. Toyola provides its improved cook stoves on credit, based on a 20%

initial down payment. In rural areas of South Africa, the use of firewood for heating and cooking contributes significantly to land degradation, ill health and rural hardship. Improved cook stoves are capable of wood savings of up to 60%, and provide a range of benefits, including reduced household energy expenses, reduced respiratory health impacts and a decreased burden on women and children in the collection of fuels. These technologies are worth supporting as a complementary (to electricity) decentralised 'energisation' option through pilot programmes and effective communication strategies.

The complex systemic nature of the energy access challenge provides insight into why energy poverty is so widespread in the developing world. Simply put, if people were not poor, dispersed and inaccessible, markets for energy access would already exist. With this challenge in mind, this report recommends that a dedicated off-grid management authority be established to build distributed renewable energy technology (DRET) implementation capacity to provide energy services to off-grid rural communities. This authority should have the mandate to facilitate, contract and manage programmes and initiatives within the off-grid space, and should be the first port of call for donor and private-sector investors. The authority should have a clear institutional identity, a governance framework, a standards and compliance framework that ensures a balance between the manner in which services are delivered and received, and the legal authority to enter into contracts with off-grid service providers.

In summary, the proposed entity should oversee the roll-out 'operations' by promoting and managing off-grid developments within the country and linking with (not duplicating) current research, development and demonstration activities.

Project purpose and objectives

The overall objective of the project, according to the terms of reference (ToR), was to assess the impact of decentralised renewable energy on livelihoods in South Africa and to identify measures to address issues that limit the sustainability of decentralised renewable projects by reviewing a selection of South African and international case studies.

The purpose of the study was to stimulate the sustainable roll out of decentralised renewable energy system solutions to mitigate climate change and provide energy access where there is no mains electricity; the ultimate goal being to drive sustainable development by informing government policy and strategy on these issues.

In order to achieve this, the ToR point towards the following specific objectives:

- Conduct a comparative study of decentralised renewable energy projects implemented in South Africa and other selected countries.
- Assess the past performance of decentralised renewable energy projects in increasing the access to affordable energy services of households, small farmers and rural communities with limited energy access in South Africa.
- Assess the socioeconomic impact of decentralised renewable energy systems in South Africa in areas that have no grid access.

- Highlight case studies in other countries where decentralised renewable energy systems are being successfully implemented, as well as the socioeconomic impacts of such projects.
- Identify issues that limit the sustainability of decentralised renewable energy systems in off-grid areas.
- Make policy recommendations on how decentralised renewable energy systems in off-grid areas could be sustained in South Africa.

1. Chapter 1: Introduction

Access to electricity in sub-Saharan Africa is around the 32% mark, with over 620 million people having no electricity connection (International Energy Agency, 2014). The close relationship between development and access to modern energy services is well understood (see, for instance, Tenenbaum, Greacen, Siyambalapitiya & Knuckles, 2014; International Energy Agency, 2010) and the absence of modern energy services is regarded as a serious hindrance to economic and social development. While South Africa's electrification rates are notably higher than most other sub-Saharan African countries[1], the country still has a significant electrification backlog and, because of this, the associated developmental dividends cannot be claimed. Relying solely on the extension of the grid network to connect unelectrified households will require huge financial resources and will take many decades to complete – assuming such funds are available. Instead, a twofold approach will increasingly emerge, ensuring the extension of the grid in addition to the distributed or 'off-grid' electrification of more dispersed and less accessible communities.

While much of the policy impetus behind improving access to energy within South Africa (and the developing world in general) is driven by these associated developmental benefits, there is a second tier of policy motivation, which focuses on the greenhouse gas (GHG) mitigating benefits of renewable energy in the context of increasing concerns surrounding climate change. The promotion of renewable energy solutions for distributed energy service provision is in line with the vision of a transition to a carbon-free economy.

The benefits of promoting DRETs are therefore clear. The challenge, however, is to ensure that the right policies and strategies are in place to promote the successful roll out of sustainable DRETs. While the benefits of the improved roll out of DRETs might be clear, the results are less encouraging. As discussed in the report, most DRET initiatives in sub-Saharan Africa tend to underachieve. There is a host of reasons for this, including technology maturation and adoption issues, and the policy and management framework within which these processes are governed. It is here, at the troubled interface between determined policy and tentative outcomes, that this report positions itself. Given the value of DRETs, what kind of intervention is required to ensure more positive and scalable outcomes?

1 South Africa has the highest electrification rate in sub-Saharan Africa. Other sub-Saharan African countries with higher rates are island states such as Mauritius, Reunion and Seychelles. The electrification rate for South Africa is in the region of 80 to 85%.

2. Chapter 2: Context and scoping

2.1 Definition of DRETs

For the purpose of this report, distributed renewable energy technologies are defined as:

- 'off-grid' systems in terms of the electricity network;
- which are powered by renewable energy sources, including small hydro, biomass, biogas, solar and wind power; and
- which deliver energy services to end users.

While these systems can be in urban areas, the ToR indicate that the focus for this report is on areas where there is no mains electricity. Therefore, the main beneficiaries of these decentralised renewable energy systems would be rural, low-income communities who are off the grid.

There have been significant developments showcasing lower-cost and higher-power micro-grids (see, for instance, the Devergy case study in Appendix A of this report, emerging interest in a 'swarm electrification' model and the interest of the South Africa National Energy Development Institute (SANEDI) in micro-grids). There has also been a resurgence in interest in (green) mini-grids[2]. So, the definition of DRETs should be one that is expanded to include mini and micro-grids. An expanded definition would also support the idea that the objective is a minimum level of energy service delivery. The strategy (in order to achieve this objective) should be as efficient and innovative as possible.

2.2 Output: incremental fiddling or alternative process?

Given the extent to which distributed renewable energy initiatives have underachieved both in South Africa and beyond, it was felt that the research outcomes presented here needed to do more than simply add an intelligent increment to the current body of knowledge regarding the sustainability of DRETs. A very distinct pattern emerges in the evaluation of the sustainability requirements of renewable energy technologies, which generally tends to identify a number of key pillars that, working together, will collectively address both the barriers and the incentives required to promote sustainable DRETs. These key pillars include the following:

- *A supportive policy framework and institutional capacity*: Where governments promote access in rural areas, it might include private-sector investment, power purchase agreements and active champions within government. Credible institutions with sufficient capacity are charged with leading and developing the sector (public and private). These activities are integrated at the various administrative levels (in South Africa this would include national ministries right down to local municipalities).
- *Technology*: This includes ensuring that sufficient technical expertise and training opportunities are available, that adequate technical standards are developed and policed, that integration with global and regional initiatives (for instance, Lighting Africa[3]) is strategically managed, and that technology

2 See, for instance, the Green Mini-grids initiative of the Department for International Development (DFID) http://devtracker.dfid.gov.uk/projects/GB-1-203990/.

3 Lighting Africa, a joint initiative of the International Finance Corporation (IFC) and the World Bank, accelerates the development of markets for clean off-grid lighting products in sub-Saharan Africa.

innovations (for instance, mobile money, light-emitting diode (LED) lighting and expended 12-volt (V) direct current (DC) systems) are integrated.

- *Access to finance*: This entails developing appropriate finance mechanisms to promote the provision of and access to renewable energy technologies and appropriate service delivery models (fee-for-service, progressive payment, cash sales, financed). It also entails ensuring that financial institutions participate in technology programmes, that subsidies are smart and effective, and that access to consumer loans, as well as access to capital (concessionary or commercial), for participating service providers is achieved.

- *Communication, awareness raising and market mobilisation*: This pillar aims to increase awareness and change perceptions among the general public, decision makers and rural consumers on the potential role of renewable energy technologies in modernising access. Relevant activities would include a visible champion, targeted marketing road shows, engaging with political and community leadership, visible technology demonstration initiatives and value chain development in terms of empowering suppliers, and small and medium enterprises (SMEs).

The above pillars will generally form part of a set of recommendations or guides that seek to understand and overcome the underperformance of renewable energy technologies. And rightfully so; they are all – to varying degrees and in varying contexts – important to ensure more productive outcomes.

This report addresses the core scope of the assignment and the above pillars by reviewing a selection of local and international decentralised renewable energy case studies and assessing these projects against the criteria identified in the ToR.

However, in addition to the fairly standardised evaluation template, what is really required is a strategy to promote and manage the performance of the off-grid sector. As will be demonstrated in this report, there is commitment at various levels, including policy, research and development, as well as technology demonstrations and pilots, but there is no strategy to ensure the roll out and future contributions of DRETs to achieve universal access in South Africa. For instance, while SANEDI is empowered "to direct, monitor and conduct applied energy research and development, demonstration and deployment, as well as to undertake specific measures to promote the uptake of green energy and energy efficiency in South Africa" (South African National Energy Development Institute, 2013), it is not SANEDI's mandate to undertake mass roll outs[4], which would enable DRETs to make the contribution that is expected of them.

There is a gap in the value chain. There is adequate policy, and there are organisations that conduct research and development (R&D). What is lacking is a management authority: an entity with a mandate to manage the operations of DRETs in South Africa; not to conceptualise, not to analyse, not to demonstrate, but rather to operationalise DRETs in South Africa. It is this operational strategy that is missing. To be sure, supportive policy, commercial technology environments and access to finance will all be part of the solution, but without an active entity to promote and manage the roll out of DRETs, this off-grid option will not deliver on its true potential.

2.3 Current policy overview

A policy is a statement of intent to guide a course of action towards a desired outcome. South Africa's energy policies on DRETs are comprehensive and supportive. This report, even if it wanted to, is unlikely to influence new policy formation. It rather focuses on developing strategies used to implement or assist in achieving the aims of energy policy as it applies to DRETs. For instance, if government policy was to ensure access to modern energy services for all households, and to include DRETs in the process, then the strategy would be a means of promoting sustainable DRETs.

The following shows that South Africa has the policy needed to promote the development of a vibrant off-grid sector, which is able to deliver universal access to modern energy services.

4 According to David Mahuma, SANEDI.

2.3.1 White Paper on Energy Policy (1998)

Some important features of the White Paper on Energy Policy (1998) (Department of Energy, 1998) that directly or indirectly support DRETs include the following:

- Perhaps the most significant shift is that energy security is now being achieved through greater diversification and flexibility of supply. One of the implications is that the energy sector is relying to an increasing extent on market-based pricing. Government is placing greater emphasis on commercialisation and competition. Competitive energy markets need sophisticated regulatory regimes.

- Global financial markets are also changing. Private finance is becoming increasingly important. Government needs to create policy that attracts investment, while ensuring the achievement of national policy objectives.

- Government will promote access to affordable energy services for disadvantaged households, small businesses, small farmers and community services.

- The trends indicate the complexity of multiple fuel use in many households. Beyond the home, energy is required for infrastructural services to communities. Energy services for low-income households have not been adequate, since the emphasis of previous regimes was to create a modern industrial urban society to meet the needs of the industrial sector and a privileged white minority. Households suffering from unemployment and poverty rely on less convenient and often unhealthy fuels. Grid electrification may not satisfy all the energy needs of low-income households. Although most household consumers are women, past energy policy has largely ignored their needs. Energy policy has also not adequately addressed energy conservation by high-income, electricity-dependent households.

- Energy security for low-income households can help reduce poverty, increase livelihoods and improve living standards. Government will determine a minimum standard for basic household energy services and monitor progress over time. People must have access to fuels that do not endanger their health. Basic energy needs must consider costs, access and health. Technological interventions are only likely to be used if they are introduced in consultation with households.

- The advantages of renewable energy are set out, particularly for remote areas where grid electricity supply is not feasible. Government believes that renewables can, in many cases, provide the least expensive energy service, particularly when social and environmental costs are included, and will therefore provide focused support for the development, demonstration and application of renewable energy. In particular, government will facilitate the sustainable production and management of solar power and non-grid electrification systems, such as the further development of SHSs, solar cookers, solar pump water supply systems, solar systems for schools and clinics, solar heating systems for homes, hybrid electrification systems and wind power. All of the above will be largely targeted at rural communities. Power from the Cahora Bassa hydroelectric scheme, and other similar options in southern and central Africa, will be tapped, provided that suitable agreements can be worked out between participants at government level. Government will also promote appropriate standards, guidelines and codes of practice for renewable energy, and will establish suitable renewable energy information systems.

- The present state of the electrification programme is reviewed and government is committed to implementing reasonable legislative and other measures, within its available resources, to progressively realise the goal of universal household access to electricity. Detailed policies are described to achieve this goal.

2.3.2 White Paper on Renewable Energy (2003)

South Africa's renewable energy policy to date has largely been driven by a 10 000 GWh target by 2013 and renewable energy project subsidies offered through the Renewable Energy Finance and Subsidy Office (REFSO).

- Renewable energy technologies: It is necessary to consider which technologies can be promoted by measures to stimulate the market. In the short term, it is important that technologies currently available in South Africa are implemented. The local content of equipment needs to be maximised in order to minimise the costs associated with implementation and operation, as well as the promotion of employment opportunities. The establishment of technology support centres within existing R&D institutions will facilitate the promotion and ongoing development of technologies, and will assist government in the certification of systems.

- Awareness-raising, capacity-building and education: The goal is to develop mechanisms to raise public awareness of the benefits of and opportunities associated with renewable energy. The objectives are to:

  – promote knowledge of renewable energy and energy efficiency, and thereby to increase their use;

  – promote and stimulate the renewable energy market through the dissemination of information regarding the economic, environmental, social and trade benefits of renewable energy technologies and their applications;

  – persuade the appropriate government and government-funded institutions to implement training and education programmes with regard to renewable energy;

  – actively involve women in decision-making and planning, and promote empowerment in renewable energy programmes or activities; and

  – improve communication and interaction between national, provincial and local government institutions on renewable energy policies.

- Government will develop the framework within which the renewable energy industry can operate, grow and make a positive contribution to the South African economy and to the global environment.

- The driving force for energy security through diversification of supply in South Africa has remained one of the key goals of the White Paper on Energy Policy (1998) (Department of Energy, 1998), since a major portion of the nation's energy expenditure is via dollar-denominated imported fuels that impose a heavy burden on the economy.

- Some activities in this regard have already been initiated; for example, government has, as part of its Integrated Electrification Plan, developed a scheme for providing solar PV systems to households in remote, rural areas. These systems are expected to replace candles, illuminating paraffin and diesel (for generators) to be used for lighting or charging batteries. What is being proposed is a strategic programme of action to develop South Africa's renewable energy resources, particularly for power generation, or reducing the need for coal-based power generation. Renewable energy has been recognised in the Integrated Energy Plan (IEP) (Department of Minerals and Energy, 2003) of the Department of Minerals and Energy (DME). The purpose of the IEP is to balance energy demand with supply resources, taking into account safety, health, affordability and environmental considerations. The IEP provides a framework within which specific energy development decisions can be made.

2.3.3 New Household Electrification Strategy

- If universal access to electricity by 2014 is not practical, what is the most effective and realistic time frame to reach universal access, given the various challenges in the electricity industry, such as the rising costs of electrification?

- A new approach to electrification is required – a New Electrification Roadmap (implementation plan) for South Africa was developed.

- In 2011, the DoE started with a new initiative where all the relevant stakeholders were invited to participate and agreed on the need for a New Electrification Roadmap.
- To improve the rate of electrification, the following basic elements are required:
  - Work from a common implementation plan
  - Improve the efficiency of implementers
  - Obtain additional funding
  - Utilise different technologies to define access to energy
- Cabinet approved the implementation of the New Household Electrification Strategy on 26 June 2013, based on the following focus areas:
  - Defining universal access as 97% of households (as full electrification is unlikely to be possible due to growth and delays in the process of formalising informal settlements)
  - The electrification of about 90% of households through grid connection and the rest with high-quality non-grid SHSs or other possible technologies based on cost-effective options in order to address current and future backlogs
  - Developing a master plan to increase efficiency in planning and the delivery process to ensure more connections, including a workshop on the implementation plan to which all members of Cabinet would be invited
- The way forward for the New Household Electrification Strategy:
  - Adequate funding for capital projects, managing the Integrated National Electrification Programme (INEP), skills transfer and training
  - Implementation in line with the Master Plan[5]
  - The need to solve the serious challenges in the electricity distribution infrastructure (EDI)[6]; it is difficult to run an electrification programme when the network requires significant upgrading
  - The need to solve some serious network constraints; connections cannot be rolled out in some parts of KwaZulu-Natal and the Eastern Cape where there are large backlogs
  - More political support for non-grid technologies
  - Good cooperation between national government and other spheres of government

It would appear that the national policy framework is largely in place. Additional policy, planning and programme initiatives reviewed include the following:

- **Non-Grid Electrification Policy Guideline:** This document reaffirms government's commitment to providing access to modern energy services, even in off-grid areas. While it centres on the concession model, it also opens up opportunities for the development of off-grid resources in non-concession areas.

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5 A number of 'static' master plans have been developed over the past few years, which are based on previous (excluding 2011) census data. They are of limited use in a dynamic implementation environment where social pressures (for instance, service delivery protests) rather than optimised planning tend to have the greatest influence. The DoE is currently working on a 'live' master plan that will guide all energy projects in the future, although this will take some years to develop.

6 This is a general reference to the 'electricity distribution infrastructure' and not to the more familiar abbreviation EDI, which refers to the electricity distribution industry restructuring process, which was terminated in 2010.

The guideline addresses issues such as the fee-for-service model, subsidies, the application process for municipalities and free basic electricity (FBE). However, the document only focuses on SHSs and does not address the introduction and development of other renewable energy technologies.

- **Integrated Resources Plan (IRP):** The IRP was intended as a 'live' document that would be updated every two years to capture the dynamics of new opportunities. While the IRP clearly outlines the role of renewable energy technologies, this is more in terms of its overall contribution to installed or generation capacity than capturing the complexities of small-scale DRETs. This is a long-term energy resource planning document that has little or no impact on the small-scale DRET sector to which this research addresses itself. The IRP projects the required generational mix, which will satisfy the dual objectives of a financially sustainable and reliable electricity supply, as well as ensuring a level of global commitment to a less carbon-intensive future. It is too far-seeing and base generation-focused to offer any kind of way forward with regard to more distributed and small-scale renewable energy technologies.

- **Free Basic Electricity:** This was introduced in 2003 to facilitate the delivery of free basic services by municipalities, set at 50 kWh per beneficiary household per month for electricity. The policy sought ways to provide an 'operational' subsidy that would enable poor households to consume more electricity and enjoy greater developmental dividends. The concept was extended to off-grid energy sources as well through the Free Basic Alternative Energy (FBAE) programme, which allowed unelectrified households to benefit from operational subsidies by reducing the costs of paraffin, liquified petroleum gas (LPG) and biofuels, for instance. This has had some – albeit very limited – success, and issues remain around the continuity of the subsidy and the application process. It would certainly be worth exploring whether a more controlled and dedicated FBE/FBAE subsidy might be applied to DRETs going forward. It is worth noting that the iShack Project (see case studies in Appendix A) has recently managed to secure an FBAE subsidy from the Stellenbosch Municipality.

- **Department of Trade and Industry (DTI) Solar/ Wind Development Strategy:** This is a strategy to promote the localisation of manufacturing opportunities surrounding the implementation of the REIPPP Programme. While there might be some benefit for DRET initiatives, this strategy is designed to feed off the large-scale investment and hardware/ infrastructure opportunities associated with the REIPPP Programme. Indeed, the large-scale focus of these initiatives would suggest large products (size and output), which may not be compatible with the smaller-scale requirements of DRETs.

- **Working for Energy (WfE):** The Working for Energy Programme focuses on the provision of energy and other related interventions to improve the livelihood of people in energy-starved communities. The initiative places emphasis on labour-intensive options, targeting employment opportunities for women, youths and people with disabilities. WfE is a cross-cutting initiative that has the potential for extensive public- and private-sector partnership, inter-governmental synergy and cooperative governance within the renewables sector.[7] This kind of initiative is more aligned with the DRETs that form the focus of this research initiative. A number of these project initiatives have been included in the case studies. It should be stated that WfE is not a policy, but rather a programme[8].

- **National Energy Regulator of South Africa (NERSA) and regulatory participation in off-grid activities:** NERSA plays a relatively important role in the off-grid concession programme with regard to setting tariffs. However, the general feeling among concessionaires is that the Regulator is not actively involved in the off-grid programme and is slow to respond to any direct engagement. There is little on the NERSA website to suggest a mandate beyond the conventional grid electrification environment. It is important for a thriving off-grid sector that the right

7 See http://www.sanedi.org.za/working-for-energy/.

8 Working for Energy was an offshoot of the Working for Water (WfW) Programme, which aims to eradicate invasive alien plants. The surplus biomass produced and the proposed value-adding industries that it might support gave rise to the WfE initiative.

amount of regulation exists. For instance, heavy-handed requirements may serve to prevent private-sector participation, while inadequate regulation may encourage the proliferation of substandard technologies. A balance is required – usually referred to as 'light-handed regulation'.

2.3.4 Summary: policy position

While there appears to be sufficient high-level policy support for improving access to modern energy services through 'off-grid' solutions, there is little representation with regard to how this might be achieved. This is understandable as these are policy rather than programmatic commitments. On the other hand, there are some institutions and policy components that can contribute to ensuring that DRETs play a more substantial role in achieving universal access. These include SANEDI and the WfE Programme, with its focus on alternative technologies, as well as – importantly – government's Non-Grid Electrification Policy Guideline, which both reaffirms its commitment to off-grid electrification and references a number of electrification and other subsidies and guidelines for off-grid electrification. The FBE and FBAE policies may also prove important in providing operational subsidies that would improve access to energy services by lowering tariffs.

On the whole, the policy thrust is towards securing energy stability through the right technology mix within the electricity supply industry. However, there is explicit reference to off-grid electricity, and there are certain policies and institutions that are well positioned to facilitate improved outcomes in the off-grid sector. However, there is clearly a need for a more purposeful and integrated approach. At this stage, the policy details, mechanisms and tools that are necessary to underpin a sustainable DRET market are not quite there yet. The policy status quo is adequate on commitment, but is left wanting on implementation details (how this is to be achieved) and processes. Addressing this needs to be a key outcome of this research programme.

2.4 Rural energy financing

The financing of the rural electrification connection of the final 13% of rural households is not being done on a cost recovery basis. Indeed, this is a purely social programme, justified only by economic cost benefits. There is certainly no financial payback on current rural grid extensions or the SHS programmes, as user consumption is too low to justify the capital expenditure.

Capital grants for rural electrification are financed by a special allocation from National Treasury, which goes to the INEP and is distributed from there to the various grid and non-grid initiatives. The INEP must therefore make the decision to fund grid or off-grid technologies in the key project areas. INEP currently allocates about R15 000 per rural grid connection, and about R6 000 per off-grid connection. In the case of the most recent non-grid concession programme in the Eastern Cape (KES Energy Services Company), most of the funding was actually provided by the German Development Bank, Kreditanstalt für Wiederaufbau (KfW), and channelled through the fiscus as 'earmarked budget support'. The INEP has also been receiving only about 50% of the requested budget, which means that the current electrification rate is only keeping up with the household growth rate, and therefore not resulting in a real increase in the overall electrification rate.

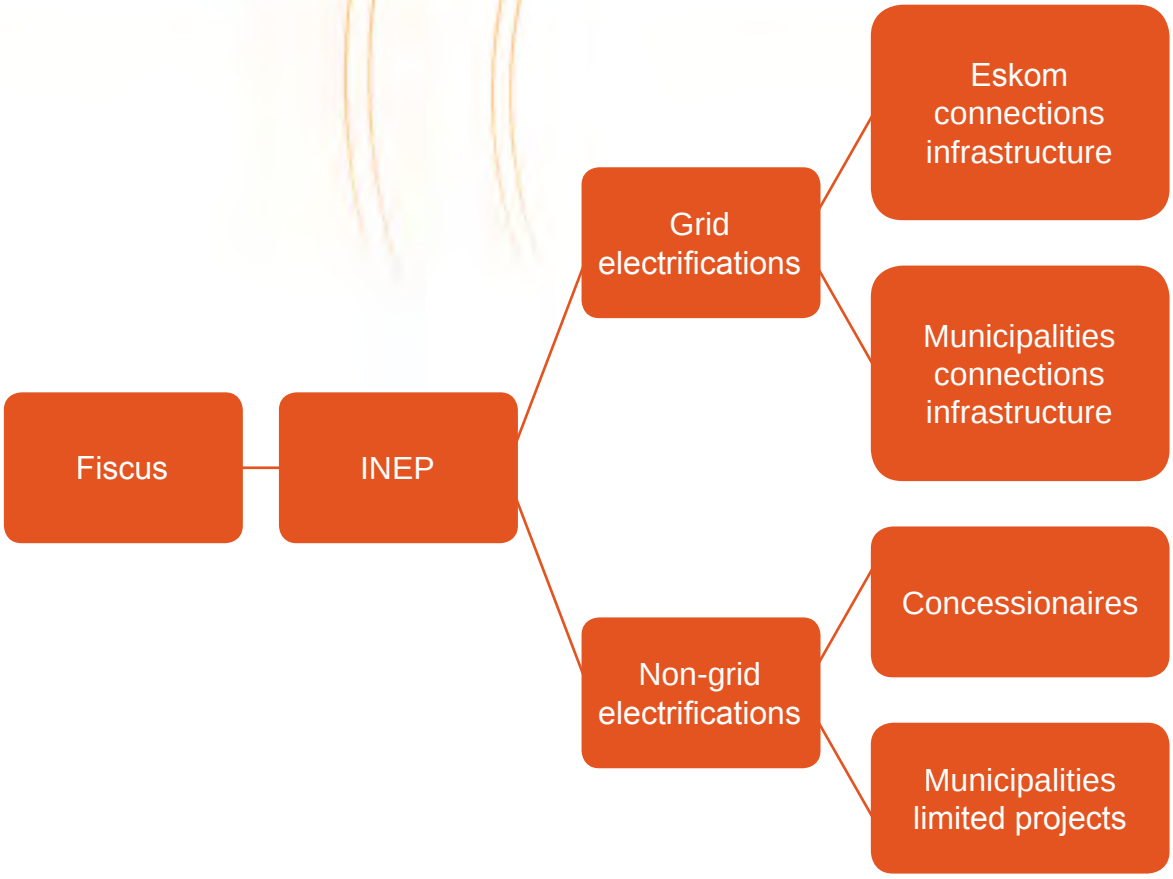


Figure 1: Rural electrification capital grant financing in South Africa

Operational grants for FBE are also allocated by the fiscus to the individual municipalities through the 'equitable share' – an unconditional grant provided to municipalities to assist them in providing basic services to low-income households. The FBE policy is capped at R48 per non-grid system per month. The municipalities have sole discretion to determine the amount of the FBE grant paid, and have their own indigent policies to ascertain who qualifies for the monthly FBE grant in each particular year. The effect of this is that there is not tremendous stability in the FBE grant policy at local level, which results in some customers being removed from lists from year to year. Plans are afoot to redirect the FBE grant in defined SHS concession areas direct from the fiscus to DoE and to the concessionaires to ensure stability, but this will take some time and is a highly contested proposal from a political perspective.

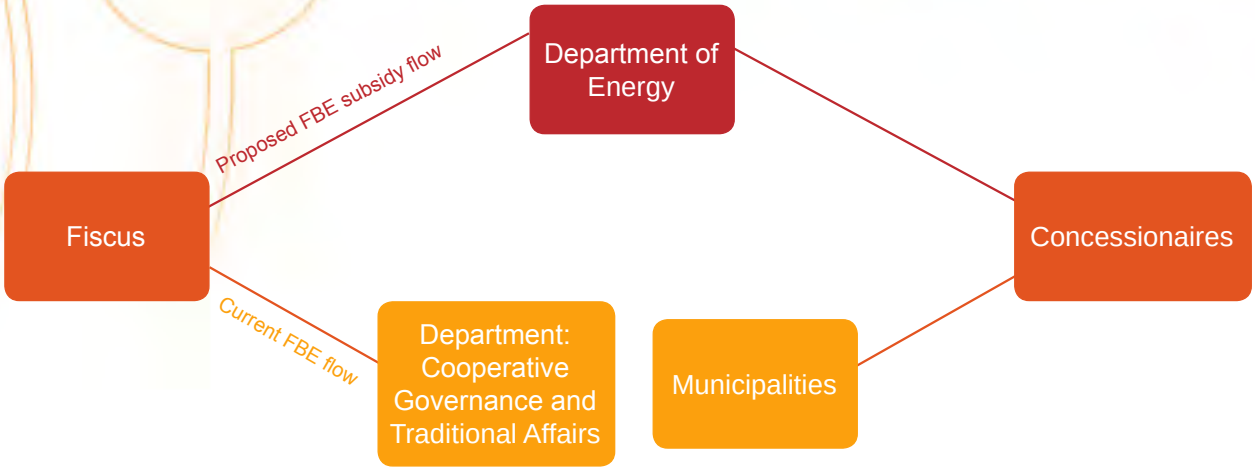


Figure 2: Rural electrification FBE financing in South Africa

The grid programmes enjoy almost 100% subsidy for both capital and operational costs, whereas the lower-cost, off-grid programmes do not. The result is that the customer contribution for the off-grid programmes is critical. Of course, from a customer perspective, and from a perspective of entitlement, the off-grid programme may seem like poor value for money when others in close proximity receive free grid connections.

Table 1: Grid versus off-grid costs and tariffs for 2012

Item	Grid connection (2003)	Grid connection (2012)	Off-grid 2012 post review
System size	20A	20A	95 Wp
System capital cost (installed)	R6 000	R15 000	R8 290
Capital subsidy	R6 000 (100%)	R15 000 (100%)	R6 633 (80%)
Customer connection fee/down payment	Zero	Zero	R110
Tariff/service fee before FBE	Zero	Zero	R89 per month
FBE grant from municipality	R48 per month (50 kWh per month)	R53 per month (50 kWh per month)	R53 per month (50 kWh per month)
Customer payment required (average)	Zero	Zero	R36 per month

From an economic perspective, it is clear that the off-grid programme is already a least-cost economic solution for the country, and system sizes could be expanded even more to include refrigerators and still represent a lower economic life-cycle cost than grid expansions. However, without the same generous subsidy treatment as grid expansions, the market and the acceptance of off-grid projects will remain a subject of debate.

Table 2: Economic life-cycle costs for off-grid versus grid projects

System		Array Wp	Included as project cost	Capital cost of complete package	Net present value (NPV) economic life-cycle cost (LCC) (20 years)
Off-grid SHS service	Level 1 service	50 Wp	Compact fluorescent lighting (CFL) lights	**R5 963**	**R14 373**
	Level 2 service	95 Wp	LED lights, DC television	**R9 738**	**R18 911**
	Level 3 service (20A grid comparable)	175 Wp	LED lights, DC television, DC refrigerator	**R19 634**	**R34 104**
Grid extension cost (20A service)	R13 000		Connection only	**R13 000**	**R29 584**
	R20 000		Connection only	**R20 000**	**R36 584**
	R25 000		Connection only	**R25 000**	**R45 144**

Source: Kreditanstalt für Wiederaufbau, 2012.

3. Chapter 3: How important is the promotion and development of DRETs?

This report needs to determine the importance of DRETs in order to define the extent of the intervention. If the anticipated contribution of DRETs to the stated goal of universal access is either limited or substantial, then this should impact on the complexity of the solution proposed. The importance of DRETs is influenced by the extent to which the grid can reach all households in South Africa and over what time period. As suggested in the tables below, the grid will probably never reach all households. In fact, unless funding for grid electrification or network expansion is massively increased, the number of unelectrified households is likely to grow.

Table 3: Household growth rate

	Number of households	Household growth	Percentage growth
2015	15 274 881		
2016	15 587 093	312 212	2.04%
2017	15 913 537	326 444	2.09%
2018	16 256 442	342 905	2.15%
2019	16 614 917	358 475	2.21%
2020	16 989 407	374 490	2.25%
2021	17 379 366	389 959	2.30%

Table 3 above indicates the estimated household growth rate based on a study by the University of South Africa (University of South Africa, 2007). With a current backlog of some 3.2 million households[9], the household growth rate will add to this backlog. The number of annual connections made will determine the extent to which this backlog will grow or diminish. The number of connections will be determined, to some extent, by cost (also by technical limits such as capacity constraints). The average cost per connection (in 2013) is indicated in the table on the following page[10].

9 This figure appears fairly often, perhaps most recently in the Cabinet-approved New Household Electrification Strategy, which was presented at the IEP Stakeholder Consultation Workshop: Overview of Universal Energy Access Strategy. Matlawe & Setlhoho (2013).

10 Ibid. This figure was determined based on the total INEP budget allocation and the number of connections made (2012/13).

Table 4: Average connection costs

Year	Households electrified	Budget	Cost/commection
2013	202 835	R3 117 211 000	R15 368

If we assume that the average cost per connection remains constant (the reduction of efficiencies offset by more remote households), and if we grow the number of connections by 5% per annum (assuming that more funds will be available for electrification), then the backlog grows rather than diminishes.

Table 5: The backlog at 5% connection growth rate

Year	Unelectrified households	New households	Electrified households	Estimated budget required
2016	3 200 000	312 212	234 807	R3 608 561 384
2017	3 277 405	326 444	246 547	R3 788 989 453
2018	3 357 302	342 905	258 875	R3 978 438 926
2019	3 441 332	358 475	271 818	R4 177 360 872
2020	3 527 989	374 490	285 409	R4 386 228 916
2021	3 617 070	389 959	299 680	R4 605 540 361

If we increase connections by 10% per annum, then the backlog starts to reduce, but universal access would be many decades off.

Table 6: The backlog at 10% connection growth rate

Year	Unelectrified households	New households	Electrified households	Estimated budget required
2016	3 200 000	312 212	234 807	R3 608 561 384
2017	3 277 405	326 444	246 547	R3 788 989 453
2018	3 357 302	342 905	258 875	R3 978 438 926
2019	3 441 332	358 475	271 818	R4 177 360 872
2020	3 527 989	374 490	285 409	R4 386 228 916
2021	3 617 070	389 959	299 680	R4 605 540 361

However, funding a 10% per annum connection growth rate would require more than doubling the electrification budget from 2013 to 2021. Beyond this, any further analysis is mere speculation. However, suffice it to say that an exclusively grid-based solution to universal access is many decades off, and DRETs can play a very important role in a more integrated and accelerated access plan.

4. Chapter 4: Research

4.1 Case studies

The following South African and international case studies were selected for this research. Each one was analysed according to a number of common themes as determined in the ToR:

- Assess the performance of decentralised renewable energy projects in increasing access to affordable energy services – lessons and experiences.
- Assess the socioeconomic impact of decentralised renewable energy projects in South Africa and internationally.
- Identify issues that limit the sustainability of decentralised renewable energy – funding policy, supportive policy, capacity, community alignment, business models, subsidies, beneficiary involvement, etc.
- Make policy or operational guidance recommendations on how systems and projects in off-grid areas could be sustained in South Africa.

Table 7: South African case studies

No.	Project	Location	Technology	Size	Rationale for inclusion
1.	Illembe Biogas Project	Illembe, KwaZulu-Natal	Bioenergy	26 active digesters	DoE is interested in biogas – important to understand dynamics.
2.	Mpfuneko Bioenergy Project	Gaula Village Giyani, Limpopo	Bioenergy	55 digesters	DoE is interested in biogas – important to understand dynamics.
3.	Tsumkwe Mini-grid (Namibia)	Tsumkwe, Namibia	Solar PV and diesel mini-grid	200 kWp	Closest operational mini-grid to South Africa (treat as South African case study – there is sufficient information and the research team has access to project documentation).
4.	Lucingweni and Hluleka Mini-grid projects	Lucingweni and Hluleka Game Reserve, Mthatha, Eastern Cape	Mini-grid powered by solar and wind energy	Lucingweni = 86 kW Hluleka = 15 kW	Mini-grids are making a return as a viable power distribution format. SANEDI's interest is to better understand the dynamics that led to the demise of the project as lessons for future DRET interventions. Complement Tsumkwe mini-grid, which is operational.
5.	KES Energy Services Company and NuRa	Eastern Cape and KwaZulu-Natal	Solar PV (SHS)	20 000 households	Solar PV is an important technology option for off-grid electrification.
6.	iShack Project	Stellenbosch	Solar PV (SHS)	300+ households	Innovative urban technology package. Large informal settlement off-grid market.

Note: Tsumkwe has been included as a South African study as South Africans were involved in the design and implementation. Its close proximity to South Africa also warrants its inclusion, as well as the fact that South Africa does not have any operational mini-grids. It will complement the study of the Lucingweni and Hluleka mini-grids, which are derelict.

While these six case studies provided the South African complement, a further 11 international case studies were evaluated as part of this research component.

Table 8: International case studies

No.	Project	Location	Technology	Size	Rationale
1.	Off-grid Rural Electrification Project	Nicaragua	Solar PV	7 000 rural households	Good solar PV example from different continent
2.	OGE	Tanzania	Solar PV (SHS)	35 000 households	Innovative 'pay-plan' approach to solar marketing and rapid upscaling
3.	IDCOL	Bangladesh	Solar PV (SHS)	3.2 million households	Most successful solar PV initiative in the world
4.	Africa Biogas Partnership Programme (Ethiopia)	Ethiopia, Kenya, Tanzania, Uganda, Senegal, Burkina Faso	Biofuels	70 000 biogas plants	Generate a more detailed understanding from a more mature biogas market
5.	United Nations Development Programme (UNDP) Multifunctional Platform (MFP) Programme	Sub-Saharan Africa	Diesel/ biofuels	Benefitting >3.5 million in 11 sub-Saharan African countries	Interesting concept – will reveal much about operating environments
6.	Biogas Support Programme	Nepal	Biofuels	260 000 households	One of the most successful biogas programmes in the world
7.	Toyola	Ghana	Cook stoves	100 000 stoves	Most successful private cook stove initiative in Africa – winner of Ashden Award
8.	Wind for Prosperity initiative	Kenya	Wind-based mini-grids	13 communities/ 200 000 people	Interesting energy source: wind. Mini-grids are certainly making a return.
9.	Wind Energy Solutions	Indonesia	Wind-diesel hybrid mini-grid		Interesting perspective on hybrids (renewable energy and non-renewable energy)
10.	Wind Factory BV	Madagascar	Wind-diesel hybrid	400 connections	As above
11.	Devergy	Tanzania	Micro-grids (solar PV)	Still piloting	Innovative micro-grid approach

4.2 Summary of results

A summary of each case study can be found in Appendix A. A summary of the key issues emerging across the case studies appears below. The key issues are discussed in further detail.

Performance

From a technology point of view, solar PV and improved cook stoves are two distributed technologies that are gaining increasing traction and are achieving commercial standing on the continent. Possible causes include the lowering costs of solar PV, its suitability to small-scale installations, its simplicity from a user training point of view and its support from governments and multi- or bilateral agencies. With regard to improved cook stoves (ICS), factors would include the work of the Global Alliance for Clean Cook stoves[11], extensive reliance on biomass fuel on the African continent, lower costs and the facilitating role of access to micro-credit. OGE is installing SHSs at a rate of 3 000 systems per month in rural Tanzania, while Toyola stoves are selling in the region of 8 000 units per month in Ghana. Other technologies, such as (distributed) wind and biogas have not achieved the same impact within South Africa and the continent. Certainly, biogas is at a very nascent stage of development and its potential long-term contribution remains uncertain. There are only a few examples of distributed wind power in South Africa (Lucingweni and Hluhleka are two mini-grids featuring wind), and the results from other international initiatives have not achieved successes in line with solar PV and ICS. The variable performance of the different technologies may be related to differing operational requirements, with wind requiring considerably more maintenance and support than solar PV, while the upfront acquisition of ICS is far cheaper than biogas solutions.

A further performance issue is that projects need to be embedded within the community, local economy and government policy. Isolated and ad hoc demonstration projects do not, by design, embrace these requirements. Energy efficiency was another common thread through the various case studies; lower power requirements generally lower the costs and increase the accessibility of initiatives. For instance, OGE offers customers small SHSs (typically 10 Wp) and therefore relies on very efficient LED lighting. Similarly, one of the challenges faced by the Lucingweni mini-grid was that these power constraints/limits were not introduced. Operational sustainability is considered important in the overall 'performance' assessment. Projects that presented affordable service offers and/or integrated sustainable (usually depreciating) subsidies, which included an element of customer investment, generally fared the best.

Sustainability

It is important that a long-term perspective is adopted when it comes to ensuring sustainability. Technologies take time to mature and settle, and project designs need to acknowledge this in terms of progressive expectations from DRET initiatives.

A crucial early step to ensure sustainability is sufficient consultation with project beneficiaries. There are many examples where this phase has been neglected, and the result is that the adoption process is undermined. Local examples include the Lucingweni mini-grid, which was vandalised by the community as a result of unmet expectations, operational problems and poor communication; and some of the biogas projects where households do not pay for the service[12] and, as a result, underuse it, which presents a number of challenges, including excessive methane production (no consumption) and, in some instances, improperly digested waste.

For long-term sustainability to take shape, the appropriate groundwork or first-phase work needs to

11 http://cleancookstoves.org/

12 This would include the Ilembe and Mpfuneko biogas projects supported by SANEDI. More detailed case study material is available in Appendix A. Suffice it to say here that there was no pronounced strategy to recover some of the costs from the digesters, which undermines the long-term sustainability of this technology and the true value of the pilot. The sustainability of DRETs needs to be evaluated. This will include a level of payment.

take place from a technology development point of view, but also from a policy point of view. What is the long-term intention of public policy with regard to specific technologies and DRETs in general?

Public-sector investment in technologies and programmes is important in addressing early risks, while private-sector capital should dominate at a later stage once these risks have been addressed and the business case is established. This requires substantial and sustained interaction between public policy makers and the private sector, so that they can learn to leverage each other's interests and optimise policy accordingly. Among the case studies reviewed, OGE and Toyola are attracting funding (commercial, concessionary and grant funding) and have business plans that incorporate significant future growth. OGE is particular noteworthy in that it has integrated innovative technologies and practices that have ensured that its commercial status is not at odds with the market's ability and willingness to pay. The integration of technologies that lower costs and make services more accessible is important for sustainability. Examples include improved payment models (fee-for-service, progressive payment, etc.), the use of mobile money, efficient LED lighting and 12 V DC appliances). These technologies reduce costs, increase performance and facilitate scalability, as the service is more affordable and desirable. Devergy is an example of how using online cloud data services, combined with new innovative mini- and micro-grids, allows remote monitoring by utilising mobile telephony infrastructure, which lowers costs and improves system performance and response times to deal with problems.

Many of the successful case studies are rural-focused initiatives where transport and transaction costs are high; using communication and payment technologies (for instance, mobile banking, data logging, remote monitoring, call centres and system optimisation), they can lower the cost of the service to end users. Increasing affordability, driven by economies of scale and intelligent use of technologies, is a key driver of the success of such technologies.

Socioeconomic impacts

There is an interesting split between productive and consumptive energy impacts. The productive use of new energy services allows for the generation of an income, as well as improved access to educational and healthcare services, which tends to have a productive impact. More consumptive activities include access to television and electricity to charge cellphones[13]. Lighting would typically fall somewhere in between. Productive use linkages are at times associated with greater project sustainability, although one would caution that access to a modern energy service alone is often a necessary but insufficient requirement for developing businesses. Successful entrepreneurship further requires access to capital, business support services, market research and access, as well as effective communication. These broader requirements can be built into access initiatives at a project level.

The positive impact on women and children, who tend to be the 'energy agents' within rural homesteads, is a key socioeconomic benefit. Indoor air pollution is a killer (four million deaths are associated with indoor air pollution annually) (World Health Organisation, 2014) and the opportunity costs (and dangers) associated with collecting fuelwood can be significantly reduced by a number of DRETs, including ICS. The replacement of kerosene and candles for lighting represents further improved safety impacts; as do the financial savings that usually result from improved modern energy access.

There are additional opportunities and benefits in the provision of the service itself. The provision of DRETs in rural areas can have significant local impacts, particularly on direct employment opportunities, as well as secondary service opportunities. For instance, OGE employs 170 full-time staff in often fairly remote areas (where there are few existing formal employment opportunities). NuRa, the off-grid concession company in South Africa, employs around 80 full-time staff members in remote rural towns. The biogas programmes provide work opportunities upfront in the construction of digesters, although the longer-term employment opportunities post-installation are less

13 There have, of course, been studies that highlight the developmental and productive impacts of communication/information technologies, such as providing farmers with up-to-date pricing information on their crops, or providing information on improved agricultural techniques.

clear. These employment opportunities varied in terms of skills levels, from technical qualifications in the case of OGE and NuRa to unskilled labourers in the case of some of the biogas opportunities. While quality and sustainable job opportunities are ideal, given the scarcity or rural income-generating opportunities in South Africa, it is not just skilled jobs that count. This integration is subject to future research in collaboration with the Department of Social Development, the Department of Agriculture, Forestry and Fisheries, DTI and the Department of Science and Technology, among others.

Policy considerations

Integrated and multi-departmental support is often a common factor of success. The goals have to be shared by government in general if DRETs are to succeed. A master plan defining opportunities and a process to characterise these opportunities would be very useful. A process of learning and re-incorporating lessons learnt needs to be established. A controlled opportunity to this end might be an incubation process that provides a management framework for maturing technologies and allows for lessons to be fed back into the maturation process. Champions for particular technologies or DRETs in general would raise the profile of these opportunities and mobilise the market. An honest and open commitment to the future role of DRETs needs to be expressed to create the necessary R&D environment, as well as the subsequent private-sector investment.

The development of DRETs needs to engage with aligned global movements, including the United Nations SE4All Programme. The European Commission (EC) is funding an initiative within South Africa referred to as the Non-Grid Electrification Agency, which is allied to SE4All. The IFC has attempted to assist the DoE with the development of an off-grid electrification plan[14]. The Global Cookstove Alliance is interested in promoting activities within the country. While the approach adopted to develop DRETs requires a strong national programme with attendant tools and processes, it also requires an outward-looking approach that aligns with and benefits from global initiatives and best practice.

14 One of the key expert contributions of the off-grid agency initiative (funded by SE4All) is the rationalisation of the need for a master plan and the specifications and requirements of that plan. The IFC's contribution did not result in a plan, but is the basis on which the Cabinet decision to support the New Household Electrification Strategy (4.3.3) was made – it was the IFC's recommendation that 300 000 households be electrified through SHSs – a figure that is confirmed in the New Household Electrification Strategy.

Summary of key issues

Table 9: Key issues from the case studiesP

Performance	Sustainability	Socioeconomic impacts	Policy considerations
1. Little information and case study material is available on decentralised wind mini-grids. Wind for Prosperity is set to change this, but it was too early at the time of this study. Due to the numbers of moving parts, wind turbines require considerably more maintenance and support than solar PV. In particular, access to spare parts is critical for ongoing functioning.	1. Long-term sustainability requires a comprehensive economic and social approach. It is not enough to provide technical assistance during project execution. To ensure sustainability in the long term, a continuing support programme for small businesses must be organised with a view to providing help beyond the closing date of the project.	1. It is crucial that electrification projects are supported with social initiatives to foster productive uses of energy, which develop livelihoods and ensure sustainability. The projects where this was done well stand in contrast to those where it was not.	1. Coordinated support across government departments is a common factor driving success.
2. Solar PV and cook stoves are the technologies being implemented at scale in sub-Saharan Africa.	2. Public sector upfront investments in early risk capital needs to be coupled with private-sector investment to help project scale once the early risks pass.	2. In particular, microfinance, coupled with capacity building around productive uses with an emphasis on agricultural activities in rural areas is important.	2. The policy and implementation lessons learnt from projects of this type should be incorporated into energy access strategies.
3. Biogas has not taken off in sub-Saharan Africa. Nepal Biogas has been long in the making.	3. Involving local communities in the project is crucial for long-term sustainability – early local beneficiary buy-in is critical.	3. It is important to build on existing structures instead of inventing new complicated all-embracing concepts and approaches, e.g. the MFP.	3. Demonstration projects or long incubation phases with well-defined project goals help lessons learnt to become incorporated into the design.
4. Rural electrification projects must adapt to local conditions; the mobilisation of local communities and local companies is essential. Consumers must be educated on their electricity use, and local installer and technician training is indispensable. Capacity building, therefore, is crucial to the success of implementing off-grid projects.	4. The private sector must look for economies of scale to distribute costs.	4. Women and children often benefit the most. Biogas frees women and children up from collecting wood for cooking. SHSs allow children to study at night. Television sets in the house means fathers stay home rather than go to a bar. Water pumping from the MFP saves women and children hours of toil.	4. Public-sector support is crucial during the early stages, i.e. project incubation and marketing periods. Thereafter, private-sector involvement will help drive innovation in business models and technology.

Performance	Sustainability	Socioeconomic impacts	Policy considerations
5. Energy efficiency must be a guiding principle right from the inception of the project.	5. Communication channels with customers are vital for support and billing communication.	5. Projects must have a strategy to address future energy demand. Energy supply in a rural centre often results in faster growth, putting an increased demand on supply, resulting in the need to further scale capacity. If tariffs are not reflective of real operating costs, this causes challenges that impact on supply.	5. Policy needs to specifically address rural energy supply tariffs and challenges.
6. Projects must ensure that operations and maintenance costs and processes are included. If consumers cannot afford to cover the full costs, appropriate financing schemes that safeguard the long-term operations are essential.	6. Reliance on continued donor funding is not sustainable. The business model of operating costs needs to be covered by revenues. Pricing should be set at a level that is comparable to or cheaper than the technology being replaced.		6. SE4All with energy access as a pillar represents an opportunity.
	7. The fee-for-service/ pay-as-you-go payment models seem to work best. Modern payment collection methods (mobile money, M-Pesa) help keep costs affordable.		
	8. Due to moving parts, maintenance is more of an issue with wind than with solar.		

4.3 Interviews

While the case studies provided rich perspectives on the challenges and opportunities associated with DRETs, the research process was further strengthened by interviews with a number of key agents within the global DRET industry. More detailed summary transcripts are appended to this report. These included the following:

Table 10: Interviewees

Name	Designation/company	Rationale
Wim Jonker Klunne	Programme Director: Energy Environment Partnership (EEP)	EEP funds and supports a number of energy-efficient and renewable energy initiatives across East and Southern Africa.
Dirk Muench	Persistent Energy Capital	Persistent Energy Capital took over from E+CO in terms of managing its portfolio of investments. Muench leads the investment strategy in the distributed energy services sector.
Simon Bransfield-Garth	CEO of Azuri Technologies	Azuri is a very innovative start-up solar PV company operating in East Africa with headquarters in Cambridge.
Zubair Sadeque	World Bank (Bangladesh), Energy Finance Specialist, World Bank	Sadeque is the task team leader for the successful Rural Electrification and Renewable Energy Development (RERED) project.

4.3.1 Summary transcripts

The key issues emanating from the interviews are the following:

1. Interviewees expressed a strong preference for sustainable, commercial business models. According to the interviewees, there is a keen focus on longer-term sustainability rather than shorter-term technology performance issues. It is about the bottom line.

2. There is a need for mechanisms/tools to ensure increased learning and reintegration of lessons in project management processes. There are many off-grid initiatives to learn from, but not enough learning material to do so.

3. Financial models could be the difference between success and failure – that is where the emphasis should be placed.

4. The private sector is important as it brings efficiency and an entrepreneurial mindset. They need to be brought into the off-grid energy service delivery space.

5. There should be a logical choice/appropriate technology framework. What is still unclear is: what defines logical choice? Should there be an overarching framework (like a master plan)?

6. Growth rates on display by off-grid companies like Bboxx, M-Kopa and OGE are on a different scale to anything that came before; it appears to be linked to the Distributed Energy Service Company (DESCO) concept.

7. Instalment sale/financing plans are crucial. We have moved beyond the outright sale of the past. Services should be accessible through regular small payments (which will be linked to successful business models).

8. Mobile payments – integrating new technology is crucial to overcome some of the challenges of rural energy access (for instance, distance from and between customers).

9. The talk is of services (end uses), not energy. There used to be a preoccupation about the size of the system rather than the end uses. That proved limiting. The successful players focus on services such as lighting, electricity to charge cellphones, etc.

10. Limiting factors: distribution (spatial), access (costs) and debt finance (access to capital) are the limits. These common challenges were all mentioned by interviewees.

11. Standardisation, maintenance regimes, set operational territories, independent verification – these were the key operational requirements that will contribute to success.

4.4 Literature review

Key issues emanating from the literature review are included in Appendix D.

5. Chapter 5: Analysis and evaluation

The following section provides an analysis of the research findings according to the terms of reference of the study, which included the following specific objectives:

Conduct a comparative study of decentralised renewable energy projects implemented in South Africa and other selected countries in order to:

1. assess the past performance of decentralised renewable energy projects in increasing access to affordable energy services for households, small farmers and rural communities with limited energy access in South Africa;

2. assess the socioeconomic impact of decentralised renewable energy systems in South Africa in areas that have no grid access;

3. highlight case studies in other countries where decentralised renewable energy systems are being successfully implemented, as well as the socioeconomic impact of such projects;

4. identify issues that limit the sustainability of decentralised renewable energy systems in off-grid areas; and

5. make policy recommendations on how decentralised renewable energy systems in off-grid areas could be sustained in South Africa.

To avoid duplication, Output 1 and Output 2 have been combined[15], while the other outputs remain the same. The effect is as follows:

1. Assess past performance and *the socioeconomic impact* of decentralised renewable energy projects in increasing access to affordable energy services for households, small farmers and rural communities with limited energy access in South Africa.

2. Highlight case studies in other countries where decentralised renewable energy systems are being successfully implemented, as well as the socioeconomic impact of such projects.

3. Identify issues that limit the sustainability of decentralised renewable energy systems in off-grid areas.

4. Make policy recommendations on how decentralised renewable energy systems in off-grid areas could be sustained in South Africa.

15 There is only a single notable off-grid project in South Africa. That is the concession programme. The socioeconomic impacts of this initiative have been assessed as part of the first output regarding the past performance of such initiatives.

5.1 Assess the past performance of decentralised renewable energy projects in South Africa: issues of access and socioeconomic impact

South Africa has much to be proud of in terms of improving access to electricity. Prior to 1990, less than a third of households had access to electricity. By the end of that decade, more than double this figure had access to electricity (66% access by 1999) (Becker, Eberhard, Gaunt & Marquard, 2008). This figure increased from 77 to 85% between 2002 and 2012 (Mavuso, 2014). Current levels of electrification remain around the 85% mark. These are significant achievements, which are unfortunately not mirrored in the off-grid sector. For decades, the national government and the DoE have focused on the extension of the grid, with considerable success, as opposed to off-grid electrification opportunities. While policy white papers refer to the option of off-grid electrification[16], these opportunities were never fully exploited: the underlying assumption always appeared to be that universal access would be achieved through grid electrification[17]. That said, there were a number of off-grid 'decentralised' initiatives that needed to be analysed in terms of performance and ensuring that these lessons are carried through.

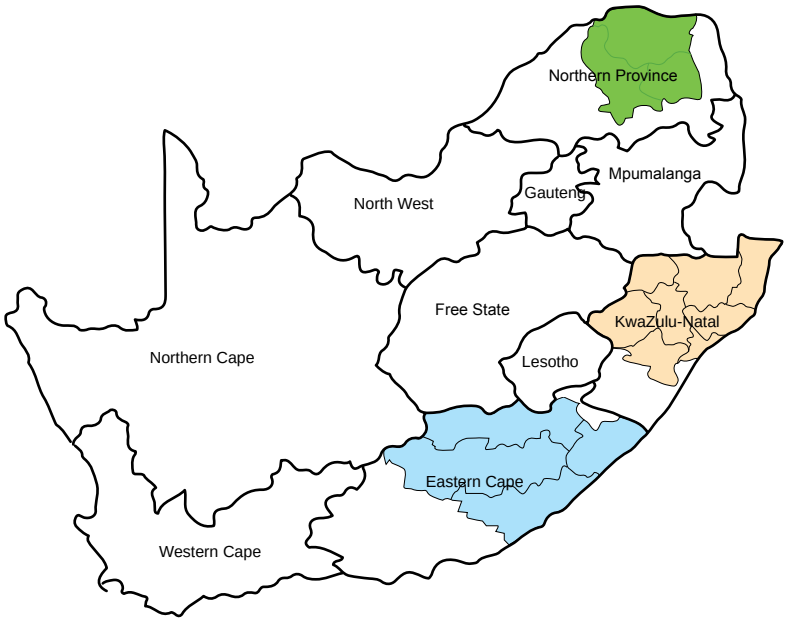


Figure 3: Off-grid concession areas

16 For instance, the White Paper on Energy Policy (Department of Energy, 1998) refers to the possible application of renewable energy "particularly for remote areas where grid electricity supply is not feasible".

17 This position has been put forward on numerous occasions, most recently at the Electrification Indaba.

5.1.1 The Off-Grid Concession Programme

The only significant programmatic decentralised initiative in South Africa is the Off-Grid Concession Programme. The programme was launched in 2001 and now has approximately 60 000 customer beneficiaries spread over three provinces, including KwaZulu-Natal, the Eastern Cape and Limpopo. Concessionaires were granted concessions through a competitive tender, and the first installations were made in 2001 (50 Wp SHSs). The installations are subsidised by the DoE[18], and more recently[19] comprise a 95 Wp solar panel with a 100 Ah battery that provides light, electricity to charge cellphones and access to a DC television.

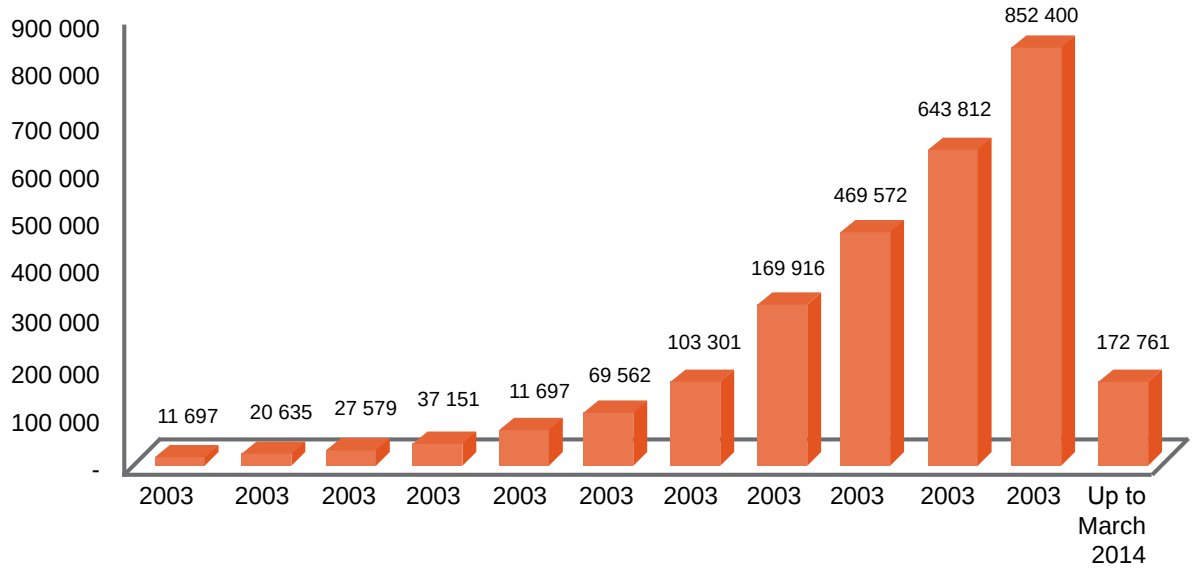


Figure 4: IDCOL annual connection rates

Opinions on the performance of the concession programme are mixed. While there are 60 000 households that now enjoy access to electricity, the overall numbers are somewhat underwhelming. The programme has been operating for 15 years, which presents an average annual installation rate of 4 000 households. By way of contrast, the grid electrification programme in South Africa is achieving an annual rate of in excess of 200 000 connections[20]. IDCOL, a solar PV programme evaluated as part of this research, is installing new systems at over 800 000 a year, while OGE is installing up to 36 000 systems a year. The connection rates are clearly inadequate given the programme's status as the country's oldest and most successful off-grid programme.

18 The current subsidy is 80% of the approved capital costs of the systems.

19 The specifications have increased from a 50 Wp module to a 55 Wp module based on the significantly lower costs of solar panels since the start of the project.

20 This was achieved in 2012/13 according to the New Household Electrification Plan. This was contained in a presentation, IEP Stakeholder Consultation Workshop: Overview of Universal Energy Access Strategy (Matlawe & Setlhoho, 2013), delivered on behalf of the DoE.

Table 11: Economic life-cycle costs for off-grid versus grid projects

System		Array Wp	Included as project cost	Capital cost of complete package	NPV economic LCC (20 years)
Off-grid SHS service	Level 1 service	50 Wp	CFL lights	**R5 963**	**R14 373**
	Level 2 service	95 Wp	LED lights, DC television	**R9 738**	**R18 911**
	Level 3 service (20A grid comparable)	175 Wp	LED lights, DC television, DC refrigerator	**R19 634**	**R34 104**
Grid extension cost (20A service)	R13 000		Connection only	**R13 000**	**R29 584**
	R20 000		Connection only	**R20 000**	**R36 584**
	R25 000		Connection only	**R25 000**	**R45 144**

An additional performance indicator would be the quality of the connection. Are the connections of sufficient quality in terms of services that are enabled, and are these connections maintained in a post-installation environment? Without these assurances, the issue of rates of installation is less important as this would not constitute meaningful 'access' and the argument for upscaling would be less convincing. Impact assessments undertaken by independent consultants have, on the whole, reflected positively on the impact of the programme in terms of household beneficiaries (Aitken & Qas, 2002; Gothard, 2003; Foundation Rural Energy Services, 2013). Beneficiaries regard the services as an improvement over non-electrical alternatives used prior to accessing the SHSs and that the modern services reduce the monthly costs or 'energy burden' for households. However, there is an overt preference for a grid connection (as opposed to a decentralised or 'off-grid' connection), which is something the concession programme has had to engage with over the past 15 years. Despite the grid preference, positive impacts have been recorded.

A detailed socioeconomic impact assessment, conducted by PricewaterhouseCoopers (PwC), indicated a range of positive socioeconomic impacts within the NuRa concession (PricewaterhouseCoopers, 2013). These centred on education, but also included safety, access to communication devices and confidence indices, among others. A summary of impacts appears in Table 12 on the following page. Table 13 captures SHS users' response to a 'satisfaction' survey conducted in 2003, which looked at utilisation, satisfaction, potential savings, safety, communications, etc. The responses are generally very positive and the benefits (impacts) are clearly felt by the target communities.

Table 12: Summary of the socioeconomic impacts of the NuRa concession

Summary of impact of electrification in Mali and South Africa (SA)	Category	Impact of electrification		
		Positive	Neutral	Negative
Share of respondents that have been involved in energy-related accidents	Health and safety		South Africa	Mali
Type of education of children	Education	South Africa Mali		
Respondents' highest education obtained	Education	South Africa Mali		
Percentage of children that study sufficiently	Education	South Africa Mali		
Average weekly study hours	Education	Mali	South Africa	
Usage of communication devices	Quality of life	South Africa Mali		
Respondents being able to charge their phone at home	Quality of life	South Africa Mali		
Confidence in future of children	Quality of life	South Africa	Mali	
Business improvement in the past year	Working climate		Mali	
Income changed over the past year	Household income		South Africa Mali	

Source: PricewaterhouseCoopers, 2013.

Table 13: SHS customer responses to socioeconomic impact assessments

	Yes	No	Not sure
I like my solar system a lot	90%	7%	3%
Life with the solar system is easier	89%	6%	5%
Having the solar system saves me money	76%	19%	4%
Since I have had the solar system, my energy costs me more	20%	76%	4%
Since we've had the solar system, we go to bed later	59%	32%	9%
The children study more at night	57%	32%	10%
We feel safer at home	70%	25%	5%
We watch more television	39%	57%	1%
Some of us do work at night	22%	77%	1%
We have the radio on for much longer each day	86%	13%	1%

The politics of service delivery in South Africa has played an influential role in the manner in which the off-grid programme has evolved. Given the overt preference among communities for a grid (as opposed to an off-grid) connection[21], expectations derived in part by the successful grid electrification programme, as well as pre-election promises to communities about imminent electrification, the off-grid concession programme has proved a difficult situation for the DoE to manage.

21 Personal communication: Sifiso Dlamini (NuRa) and Vicky Basson (KES Energy Service Company).

5.1.2 Key challenges

Some of the key challenges that need to be addressed in order to unlock the full potential of the programme include the following:

Intermittent contracts

During the conceptualisation of the concession programme, it was intended that each of the successful companies would install 50 000 SHSs over the first five years of the programme (Zak, 2002). This would enable the critical mass that the concessions' business models required and ensure a more robust off-grid programme. For many years, the concession programme appears to have limped along, benefitting from additional, yet intermittent, installation contracts from the DoE, as well as the ongoing support and continued investment of its foreign partners (Nuon/Foundation for Rural Energy Services (FRES) and EDF/total)[22]. Collectively, the concessionaires have only received subsidies for approximately 65 000 systems[23]. The installation contracts and associated subsidies are usually issued at short notice and require frenetic installations over short periods (for instance, 1 500 systems over two months) rather than longer-term processes that enable the more sustained development of installation teams, improved relationship-building with communities and local government structures, etc[24]. The intermittent nature of the contracts is a result of, at least in part, the wavering commitment of the DoE to the off-grid programme, as evidenced from interactions between the DoE and the author. While it has delivered reasonably well, the programme is a difficult political sell (to communities who for the most part expect grid services) for the DoE. The premise that it is owned and operated by 'foreign' companies[25] appears to be problematic for the DoE. As a result of the intermittent nature of the contracts, as well as the considerably lower number of installations vis-à-vis the original business plans, the concessionaires remain fairly precarious from a business sustainability point of view.

Lack of planning and churn

There is no electrification plan in South Africa, no hard and fast map that will determine grid and off-grid areas. While the planning process has been established (municipalities are working with Eskom and the INEP), this has resulted in short-term and ad hoc agreements rather than a long-term settled plan. In addition, there is no agreement between Eskom, the DoE, municipalities and concessionaires regarding long-term grid and off-grid areas and how the interface between the two should be managed; in some instances, there is anecdotal evidence of concessionaires having been actively undermined by Eskom. This has resulted in a significant amount of 'churn' (removal of off-grid systems with the arrival of the grid) and very little stability with regard to long-term planning and the resulting disruption to the concessionaires' business models. There is a critical lack of spatial and temporal planning that undermines the sustainability of decentralised energy access options. Without long-term planning, energy service companies cannot determine the long-term market opportunity and the extent to which they are prepared to invest.

22 Personal communication: Vicky Basson (KES Energy Service Company), Sifiso Dlamini (NuRa) and Jakes Jacobs (Solar Vision).

23 Not all systems remain installed and operational as Eskom has extended the grid into many of the original 'off-grid' areas within the concessions. Up to 5 000 of these systems are currently in storage and not deployed at households.

24 Personal communication: Vicky Basson (KES Energy Service Company) and Mr Sifiso Dlamini (NuRa).

25 KES Energy Service Company is a joint venture between Electricity de France, Total and a local empowerment company (26%), while NuRa is owned by FRES, as well as an employee shareholder scheme controlling 20% of the shares. Solar Vision is a wholly owned South African company. It should be said that none of these companies – with the possible exception of Solar Vision – return a profit and require ongoing investment on behalf of the shareholders. The investments made are largely considered 'social investments'.

Similarly, municipalities do not see the need for alternative technology interventions as they cannot map the future installation rate and location[26].

Technology specifications

The original technical specifications, including NRS 052, which guided the design of the SHSs installed under the off-grid programme, are out of date. For instance, the standards utilised CFLs as opposed to LED lighting, which is far more energy efficient. The standards and contract agreements with the concessions need to be updated frequently in order to integrate technology developments, particularly around lighting, storage and power generation technology[27].

Clear communication

The off-grid programme has never been widely endorsed by senior government representatives in a clear and consistent way. If the off-grid sector is expected to make a meaningful contribution to improving energy access in South Africa, then it follows that this expectation should be openly communicated both to the energy service industry (public and private) and the household market. IDCOL would not have achieved its off-grid results without an explicit commitment to the technology (SHS) and associated programme. Similarly, the biogas programme in Nepal would not have facilitated the emergence of 62 private-sector companies in the absence of explicit commitment to the programme. In South Africa, provincial and local government representatives, non-government organisations and – indeed – the private sector would have arguably embraced the programme and its intents more confidently if the off-grid programme had been publicly presented as part of government's policy commitment to universal access to electricity[28]. It is very likely that a programme will achieve its potential if it is embraced openly in terms of policy and vocal government commitment.

For the concession programme to succeed, it needs to be mainstreamed both in terms of service provision (private-sector opportunity/investment ratios, appropriate technology standards, adequate maintenance services and policy stability), as well as a more informed market in terms of grid/off-grid policy options, local government plans, consumer rights and subsidy options.

Consistent application of FBE

The Free Basic Electricity Policy (Department of Minerals and Energy, 2003) was designed to provide a subsidy to indigent households, a government acknowledgement that access to electricity did not guarantee use of electricity (based on affordability constraints). Poor electrified households were provided, free of charge, with an amount of electricity that was deemed sufficient to cover basic lighting, media access and water heating[29]. The challenge was to extend the same welfare service to unelectrified households, which resulted in the formation of the Free Basic Alternative Energy Policy (Department of Minerals and Energy, 2007). While the policy explicitly included SHSs, the application of this subsidy has been very inconsistent with regard to the concessionaires, with the subsidy being available within certain municipalities for short-term periods with an uncertain renewal. Where the FBAE is in place, customers can access the off-grid service at a 50 to 60% discount, which results in a significant increase in the number of customers.

26 This has resulted in significant delays to the KfW-funded off-grid concession in the Eastern Cape (the service provider is KES Energy Service Company). Planning uncertainty and the inconsistent embracing of the off-grid programme has left a €20 million investment hanging in the balance (Robert Aitken is one of the KfW monitoring agents).

27 This might include the participation of the Sustainable Energy Society of Southern Africa (SESSA) and the South Africa Photovoltaic Industry Association (SAPVIA), among other industry associations.

28 While 'universal access' has, in terms of policy, referred to 'an appropriate mix between grid and non-grid technologies' (Department of Energy, 1998), it has in the main implied access to a grid connection.

29 This has proved difficult to administer so in many cases all households within a service authority receive this allocation regardless of income levels.

However, the subsidy is renegotiated (or withdrawn entirely) on an annual basis, resulting in many customers having to terminate the service agreement as they can no longer afford the service, with resulting extra costs and reduced revenues impacting on the concessionaires (for instance, writing off internal wiring, as well as the system removal costs). A clearer and more consistent application of the FBAE subsidy would provide more stability to the concession programme and other initiatives.

Innovative business models

The fee-for-service basis that underpins the concession programme has increasingly become the standard method of operation for energy service companies globally. As noted in the case studies, the small annuity-type payments[30] are characteristic of the more successful solar PV initiatives like IDCOL and OGE [31; 32]. However, while the method of transacting around the service may align with international 'best practice', questions have been raised about the overall investment model, as well as the longer-term service and maintenance agreements[33]. It may be necessary that the energy service companies are required to assume a greater risk in terms of raising funding, engaging with stakeholders more directly (without the DoE as an intermediary) and introducing innovations in return for the 80% subsidy they currently receive. This is a longer-term issue that also speaks to long-term planning and the clearer institutionalisation of the off-grid programme within the overall energy service delivery strategy of government. With regard to the service and maintenance obligations, these are currently met by the concessionaires, but other alternatives, such as outsourcing services to local companies (empowering), as well as offering different 'maintenance packages' that speak more effectively to a varied socioeconomic market profile, need to be explored. It is a question of innovation and adaptation; the energy access sector has evolved considerably, while the concession programme appears to have been stuck within the foundation framework developed in the late 1990s. More introspection and innovation around the issues raised above is required.

Moving forward

While the concession programme has underperformed in terms of the founding expectations, there did appear to have been something of a turning point in 2011 at an 'off-grid' workshop held in the coastal town of Ballito in KwaZulu-Natal, South Africa[34]. The DoE, off-grid concessionaires and other stakeholders gathered to discuss the challenges faced by the programme. While no firm resolutions were taken, this workshop appears to mark an increasing interest in and commitment to the off-grid programme. Since then, there have been a number of meetings and initiatives[35], which have reinforced this position.

30 This transacting method is also referred to as 'incremental ownership', 'payment plans' and 'pay-as-you go'.

31 A recent World Bank study noted that the five most successful solar PV companies in Uganda all adopted some form of 'payment plan' (Aitken, Kruger & Tashonya, 2014).

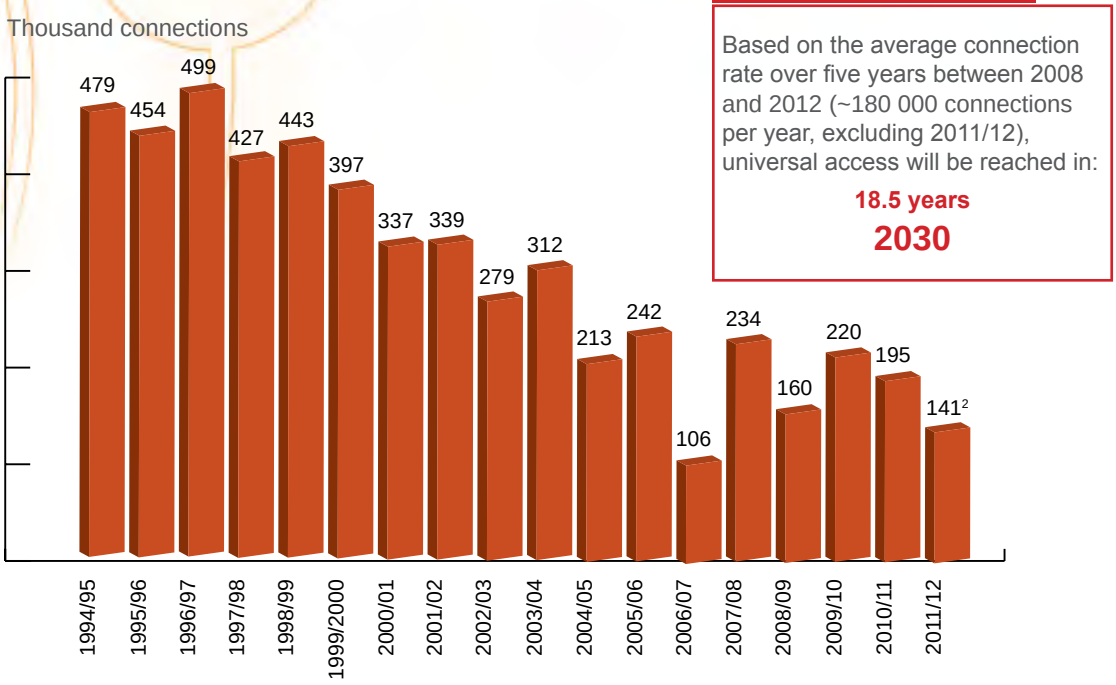
32 This fee-for-service model tends to address the entire value chain to the end user, making it more convenient and reliable.

33 The concessionaires have not realised the returns on investment they had anticipated. This has been attributed to the business model, including costs associated with maintenance, variable access to FBE, percentage of capex covered, etc.

34 This was organised by the DoE and one of the authors was present (Robert Aitken).

35 These include the IFC's support for the DoE, a review by McKinsey Consulting, the National Electrification Indaba (2012) and the purposeful participation of KfW as a funder/donor, among others.

Number of annual connections made



Time to universal access

Based on the average connection rate over five years between 2008 and 2012 (~180 000 connections per year, excluding 2011/12), universal access will be reached in:

18.5 years

2030

Connections are for the period 1 April to 31 March in each period from 1994 to 2012, excluding SHSs.
The time to universal access ignores growth of new unelectrified households.

Source: Noah, 2012.

Figure 5: Electrification rate slowing down

There are various reasons for the revitalisation of the off-grid programme, including the increasing realisation that grid electrification alone will not achieve universal access within the desired timetable. The date for universal access has been revised on a number of occasions from the original date of 2012 (Mbeki, 2004) to 2014 (Department of Energy, 2013) and then to 2025 (Department of Energy, 2013). As such, the off-grid programme is increasingly necessary if government's service delivery commitments are to be met. In addition, the costs per grid connection have increased significantly, from R6 000 in 2003 (Noah, 2012) to over R15 000 in 2013 (Barnard, 2013), while in rural areas, the average cost per connection has risen to R17 000 (some are as high as R25 000[36]). The government will not achieve universal access with these costs. As illustrated in Figure 5, the number of annual connections is slowing down and, as a result, the importance of the off-grid programme is correspondingly enhanced.

Clearly, with a backlog of some 3.2 million unelectrified households and the electrification programme slowing down, a greater role should be envisaged for off-grid or decentralised alternatives. While there are a number of pilot or small-scale initiatives under way in the country, these pale in significance when compared to the concession programme. However, there are a number of initiatives worth discussing in order to better understand the opportunities and how alternative energy access initiatives can play a more meaningful role in ensuring that the 'last mile' households have access to modern energy services sooner rather than later. The key additional technology options would include hybrid mini-grids (any combination of PV/wind/diesel), biogas (gas for cooking and/or electricity), improved cook stoves (offering energy efficiency for biomass fuels), etc.

iShack is a project started by The Sustainability Institute, associated with the University of Stellenbosch and funded through the South African Government's Green Fund. The iShack project does not focus on the traditional target beneficiaries of DRETs, the isolated rural household that is costly to connect to the grid. Instead, iShack provides access to electricity in informal settlements in urban areas: settlements that are either difficult to service or, more likely, are on unproclaimed land where the local authorities are not permitted to

36 Personal communication: Eskom representatives in the Eastern Cape (Robert Aitken).

develop service infrastructure. While not the classic 'off-grid' approach, it is an innovative initiative with the potential to deliver modern energy services to informal settlements within urban settlements to fill the service delivery gap. Impact at this point is minimal, given the very small customer base, but it has potential if managed within an energy access planning framework, and should probably be regarded as an 'interim solution' until grid services are able to access these communities. The system is a SHS with a 75 Wp module and approximately 100 Ah battery that allows households sufficient lighting, as well as sufficient electricity to charge their cellular phones and operate a colour television set (12 V). Households are required to pay a deposit and a monthly fee of R150[37], but this is available on a pay-as-you-go basis as well (smaller more frequent payments). iShack had a growing customer base of 800 households by April 2015 and the Stellenbosch Municipality has agreed to provide an FBE subsidy, which will supplement the business model going forward. There is no real 'impact' or 'past performance' to evaluate given the limited operating period and small number of beneficiaries. However, it is certainly an initiative to consider going forward and would require policy consideration about 'unproclaimed' areas, as well as the application of the FBE subsidy.

5.1.3 Mini-grids

There is not a rich (or rewarding) experience with mini-grids in South Africa. Between 2002 and 2003, the National Electricity Regulator (which later became the National Energy Regulator of South Africa), at the behest of the then Minister of Minerals and Energy, Ms Phumzile Mlambo-Ngcuka, began to explore the installation of mini-grids in the country.[38] The first of these were the two installations in the Eastern Cape. This included the village of Lucingweni, as well as the Hlulekha nature reserve some 10 km from the village on the coastline. The installations were made under the auspices of the Shell-Eskom concession[39]. The estimated cost was in the region of R20 million. Neither of these systems are operational and the village mini-grid has been seriously vandalised, resulting in significant damage to property. The technical details of each of these mini-grids are contained in the case study summaries and are not reproduced here. The key questions that need to be addressed relate to the performance of the technology and improving access.

Frankly, the two mini-grids never really performed well. The Lucingweni village mini-grid was vandalised soon after installation, while the one at Hlulekha never ran at full capacity and was relying wholly on diesel very shortly after being commissioned (it was designed as a solar-wind-diesel hybrid) (Becker, 2010). From a performance and energy access point of view, the two mini-grids were pretty close to being complete failures. Similar mini-grid installations were proposed in KwaZulu-Natal and the Eastern Cape around the same time, but after extensive feasibility studies, it was decided not to go ahead (Raps Consulting, 2003). Some of the issues that emerged from the case studies included the following:

- Ownership was never transferred to the local authority:
  - Capacity building to be able to maintain the system was not provided.
  - No maintenance was done on the systems – there was no long-term plan with regard to who would operate the mini-grid, tariff levels, usage levels, etc. It was technology push rather than supporting peoples' adoption of the service.

37 This is a fee-for-service without culminating in ownership.

38 One of the authors (Robert Aitken) was engaged with this process and was party to meetings with the National Electricity Regulator (NER) at the time. The NER representative was Dr Wolsey Barnard, currently Acting Director General in the DoE.

39 The Shell-Eskom concession was a joint venture between Shell (South Africa) and Eskom. It is no longer in existence.

- Flawed system design:
  - Households were able to connect large loads, which tripped the entire system and not only their household connections. Limits were needed – through social sanctions of technology interventions (fuses, for instance) in order to regulate the equity of use.
- Community engagement:
  - The project was 'parachuted' in, with limited community engagement. It was established that this was one of the reasons why the system was vandalised (as well as perceptions that the mini-grid development would prevent the national grid from arriving in the community).
  - The most significant problem in the area was the contaminated drinking water.
- High cost:
  - It cost R7,76/kWh (2007); Eskom: R0,16/kWh (2007).
  - Cost would not be recovered through local community use and payment; instead, it required large capital and operational subsidies. Adequate financial planning was not undertaken.
  - Storage made up 70% of capital and operational costs, which would have been a recurring 'operational' cost.
- Inclusion/exclusion:
  - No clear boundaries/criteria for households who were connected vs. those who were not. An issue of local level planning, including community consultation.
  - Many households were 'illegally' connected to the system subsequent to its installation. Again, there was very little evidence of control.

Despite a very questionable track record with mini-grids, this service delivery alternative should continue to be considered as one of the options in terms of promoting decentralised energy access. This is in part due to the ability of mini-grids to supply energy for productive use, which is a necessary input for economic growth and job creation in rural areas. The mini- and micro-grid concept are making something of a comeback as solar PV prices continue to fall and grid extension costs continue to mount. In addition, initiatives such as IDCOL and Devergy are successfully pursuing micro- and minigrids, and SANEDI has expressed an interest in micro-grids[40]. As indicated earlier, 'green mini-grids' are receiving significant international attention[41]. Yet, in order to achieve positive outcomes in this regard, more attention needs to be invested in developing mini-grid technologies in terms of the design and business model, as well as ensuring community buy-in.

40 Personal communication: IDCOL, Devergy and SANEDI.

41 http://www.se4all.org/hio/clean-energy-mini-grids/

5.1.4 Improved cook stoves[42]

Improved cook stoves are becoming established interventions for the reduction of biomass consumption (efficiency), as well as reducing indoor air pollution[43]. The Global Alliance for Clean Cook stoves,[44] which is hosted by the UN Foundation, aims to ensure that 100 million ICSs are installed or adopted by 2020. With over 700 million people in Africa (International Energy Agency, 2014) relying on the traditional use of biomass in terms of cooking, there should be significant scope for ICSs in Africa. The attributed level of usage for biomass in South Africa is seven million people (about 13% of the population). Although this figure appears quite low, it ties in with the results of Census 2011[45]. The DoE has no specific ICS or thermal household energy programme, although there has been some level of interest from the Department of Rural Development and Land Reform, which has published a number of tenders for ICSs in the country[46].

While ICS-based solutions do not provide access to energy, they reduce the use of biomass, which presents a range of benefits, including environmental (reduced consumption/deforestation), health (reduced indoor air pollution), as well as household energy use expenses as wood fuel is becoming increasingly commoditised in many parts of the country. This review cannot reflect to any meaningful extent on the impact of ICSs in South Africa given the low level of interest shown by the relevant authorities. However, given the global interest and the increasingly effective design of these products[47] and some success stories in East and West Africa (see case studies in Appendix A), it is certainly worth exploring as a complementary (to electricity) decentralised 'energisation' option. However, the technology will have to be mainstreamed through detailed pilot programmes and effective communication strategies if it is to have the desired impact. In addition, the DoE will have to explicitly widen its off-grid focus from a policy centred on SHSs to an approach that facilitates entrance into the market for a range of decentralised energy options. A more service-driven approach is needed that focuses on outcomes as opposed to the current, somewhat narrow technology approach that is centred on solar PV.

To accelerate the uptake of ICSs, the following activities are required:

- The DoE should acknowledge the possible role of ICSs in 'modernising' biomass fuel users' cooking/heating experience. This is a global initiative with attractive funding opportunities, increasingly innovative designs and a respected body of research on impacts.
- Pilot projects should be launched to assess product options and market reactions. There are a number of charity-funded initiatives[48], but they lack a programmatic framework that would lend itself to evaluation. A more formal pilot initiative is required.
- The technology should be advanced in terms of market mobilisation, design considerations and payment options. This would be a post-pilot process.

42 This would include both improved and advanced cook stoves.

43 The World Health Organisation suggests that over four million people die annually "prematurely from illnesses attributable to the household air pollution from cooking" (World Health Organisation, 2014).

44 http://cleancookstoves.org/

45 The census recorded a 12.5% usage of wood for cooking (although a slightly higher number of households used wood for heating – 15.3%). See: http://www.statssa.gov.za/publications/P03014/P030142011.pdf

46 For instance, Restio Energy delivered on a tender in 2012 that included 1 500 ICS products.

47 Improved cook stoves can reduce indoor air pollution by 95%, as well as decreasing biomass usage between 50 and 80%. See, for instance, the Africa Clean Energy stove (also Philips) at http://www.africancleanenergy.com/.

48 For instance, Siyanceda (a charity based in East London) bought and distributed around 300 ICSs, but these were not part of a specific programme and the impacts were almost impossible to assess. See: http://www.siyanceda.co.za/.

- Communications are a key part of market mobilisation by creating awareness around ICSs and integrating possible feedback.
- Customs duties should be reviewed, with a long-term view on local manufacturing, but with short-term importation options. Customs duties are currently 20%, which contribute to affordability issues. Without a fairly robust local market that takes time to build, it would be a risky investment to manufacture locally.

Siyanceda ICS recipients

5.1.5 Biogas

There are no utility-level biogas initiatives that are improving access to thermal energy services and/or electricity. There are a number of pilot initiatives (two of which were reviewed as part of the case studies[49]), which have benefited less than 100 households, so it is futile to discuss 'access', although the issue of performance should be considered. In the case of the Ilembe Biogas Project, 26 households benefited from the programme (slightly more than 100 people). While the digesters were installed successfully, there was little post-project planning in terms of 'where to next?' The project has been completed and the installation company has moved on. It is not clear what questions this initiative was meant to answer at the pilot stage and how these answers might assist in determining whether to support a larger role for biogas in South Africa.

While only a pilot, the Illembe project developed the units at a cost of over R50 000 per digester. These digesters only produce gas and are not linked to generators for the production of electricity. For the equivalent cost, households could have been provided with 5 kg of LPG a month for over 40 years[50]. At that price, specific questions should have been answered. There was no baseline undertaken in terms of thermal energy sources used (electricity, wood, paraffin, LPG) and what impact the introduction of biogas is likely to have on these patterns of usage (reduction in quantities, cost, issues surrounding preferences). The project could also not determine the consumer desirability of biogas as participating households were not required to make a financial contribution.

The second biogas case study reviewed (the Mpfuneko Rural Domestic Biogas Project) was explicitly prevented from charging customers[51], preventing it from developing a suitable business model within the funded project context. As far as the project manager was concerned, "the technology works, it's been proven for decades. What is needed is a sustainable business model based on supply and demand"[52]. It should be noted that there are a number of successful biogas initiatives in South and South East Asia[53], including China, India and Nepal.

Not being able to charge a fee, however nominal, seriously undermines the mainstreaming process of technology development. In the case of biogas, it is a proven technology. If further public funds were to be applied, then the project outcomes should offer more than a technical validation, but should rather seek answers around consumer desirability, adoption, payment methodologies (including subsidies such as FBEA), communication, end-user training requirements,

49 Illembe in KwaZulu-Natal and Mpfuneko in Limpopo.

50 Working on a cost of R20/kg of LPG.

51 Personal communication: Jotte van Ierland (Mpfuneko Rural Domestic Biogas Project). The specifics of this position have been contested by SANEDI. Although the general point that payment mechanisms are required has not been challenged.

52 As above.

53 See, for instance, http://www.unapcaem.org/Activities%20Files/A01/AsiaHitsTheGas.pdf.

utility business options, scalability and impacts. If the right questions are not asked, then the technology is unlikely to mature and develop in the required direction.

From a performance point of view, both projects have operational systems, with no overriding technical issues. In terms of impact, it is difficult to determine as no baseline studies were undertaken. It is assumed that households were using a mix of wood, electricity, LPG and paraffin, but the specific mix and subsequent impacts cannot be determined. The theoretical impacts of a successful biogas programme would include reduced biomass consumption, a decrease in the amount of time spent collecting firewood, lower indoor air pollution, as well as lower costs depending on the financial model and tariff structures applied.

Key issues in moving biogas forward include the following:

- Determine the role of biogas in rural energy access: to what extent is this energy source part of the future? This is a planning function. A settled vision and policy certainty will attract interest and investment[54].
- Agree on standards and technology design: this should have been determined already as organisations like Agama, Khanyisa Projects and Finishes of Nature have considerable experience within the sector[55].
- Make existing grants and subsidies available based on an informed financial analysis of the life-cycle costs of biogas options.
- Understand the maturation of biogas as a technology and service option, i.e. how to progress from pilot to sustainable intervention.

5.2 Summary of key performance issues: access and socioeconomic impact

There is only one established decentralised energy access programme that is of sufficient age and scale to reflect usefully on past performance. That is the off-grid concession programme. It has largely underachieved (60 000 connections over 14 years) as a result of a number of issues described in this report.

Key issues	Recommended solution framework
Inconsistent policy commitment resulting in contractual delays, investment uncertainty, the under-awarding of installation funding, etc. Stronger and more consistent communication (and commitment) is required.	• Establish a dedicated off-grid management authority. • Establish a grid network master plan. • Review current contracts of non-grid programmes.

Note: The recommended solution framework refers to the kind of intervention required. It does not address the absolute detail, but rather general requirements. The specifics are addressed at a later stage in the document.

54 SNV (Netherland Development Organisation), which is very prominent in the biogas sector, made contact with the DoE some years ago about developing a biogas industry in the country. This was ignored by the DoE as there was no appreciation of the potential of biogas in South Africa. Personal communication: Saroj Rai (SNV).

55 See: http://khanyisapr.co.za/, http://agama.co.za/ and http://www.finishesofnature.co.za/.

Key issues	Recommended solution framework
No clear public sector champion. It requires a level of confidence to advocate an option considered inferior by communities who have for many years expected the arrival of the grid.	• Leadership support. • Establish a dedicated off-grid management authority. • Establish a grid network master plan.
No clear grid and off-grid planning process has resulted in overall uncertainty with regard to the need (and geographic area) for an off-grid programme.	• Establish a grid network master plan developed by key stakeholders, and a process to keep this plan current. The master plan would provide both a grid and off-grid plan, with the former progressively replacing the latter.
The politicisation of energy access through party-based electioneering, which creates expectations that are often not fulfilled (a combination of opportunism and poor planning).	• Communication strategy – open integration of off-grid technologies into the INEP. • Establish a dedicated off-grid management authority.
The inconsistent application of free basic subsidies in most relevant (rural) municipalities, which has the effect of raising customer numbers when applied and shedding those new customers when the subsidy is removed. Consistency is critical.	• Political leadership • Establish a dedicated off-grid management authority (such an entity would provide public-sector support for a more consistent application of the policy).
The private sector not doing enough in terms of innovation, risk-taking, etc. To be fair, the opportunity for private-sector investment has always been uncertain given the above conditions. However, current investors have been quite conservative in their approach, without pushing for a possible alternative service delivery model.	• Engage the private sector to understand concerns and lessons learnt from their experiences. • Establish a dedicated off-grid management authority. • Review current contracts of SHS projects.
There is little diversity mix in terms of recent/current/future off-grid technology developments.	• Establish a dedicated off-grid management authority. • Establish a grid network master plan.
A more focused off-grid programme is needed that facilitates and supports greater investment in off-grid technologies. Unelectrified households will remain for decades to come – a commensurate response needs to be developed to address this reality. If the off-grid programme is not firmly directed, then the results will be predictably equally weak.	• Political leadership in DoE. • Establish a dedicated off-grid management authority. • Develop a technology maturation process.

Key issues	Recommended solution framework
Technologies need to be mainstreamed over time. R&D initiatives (Council for Scientific and Industrial Research (CSIR) and SANEDI) need to determine how technologies are introduced and required to mature over time, addressing successive sustainability issues along the way.	• Develop a technology maturation process. • Review financing options for existing and future electricity supply companies (the Development Bank of South Africa (DBSA), etc.). • Review current contracts of SHS projects and ensure business-model alignment.
Community consultation and communication is absolutely crucial; to get technologies to perform is one thing, to ensure that people benefit from this performance is another thing.	• Establish a grid network master plan. • Communication strategy – open integration of off-grid technologies into the INEP. • Establish a dedicated off-grid management authority.
Available subsidies need to be more innovatively applied to alternative decentralised energy options. For instance, biogas, ICS, mini-/micro-grids, etc.	• Establish a dedicated off-grid management authority. • Establish a grid network master plan. • Funding agreements with National Treasury.

6. Chapter 6: Successful international cases

6.1 Introduction

This section aims to identify global best practice in decentralised renewable energy projects, with a particular focus on highlighting the main success factors common to all. The approach begins by defining success, after which four best-practice example cases are presented in summarised form. Distinct success factors common to all four cases are then extracted and analysed in more detail, looking at the current experience with these in the South African context. It is important to determine how the South African market can reach rapid maturity in this high-risk technological sector, and as such, the focus will be on the features of these cases that speak specifically to how sustainable market growth was ensured.

6.2 Defining success

For the purpose of analysing the 'successful' international case studies, 'success' is defined according to the following three primarily quantitative characteristics:

- **Sustainability** refers mainly to financial and commercial viability, which allows the company or programme to sustain healthy economic growth and make a return on investment, or at least cover expenses. A number of other issues also feed into this, such as human resource capacity and turnover, operational capacity and access to capital. However, in a sense, sustainability is concerned with the 'bottom line' question: Is the company or implementing agent able to service its debts, raise capital and make a profit and generate a return? Sustainability includes the long-term ability to maintain and grow the services provided.

- **Scale** looks quite simply at the numbers in terms of service delivery and penetration of the market. How many households have been reached? How many products have been sold or installed? What is the real impact of these numbers in terms of market development? What is the likely size of the market, given the service offering and price?

- **Impact** is primarily concerned with socioeconomic changes at the household and community level, based on the service offered. A measure of success would be achieved if an initiative can show that it has had a significant impact in terms of changing energy use behaviour, improving household income, improving education levels and school attendance, and improving health within the household. Impact would also consider the secondary opportunities associated with providing the service, including employment and supply opportunities.

6.3 Case studies

Based on the criteria above, the following four successful international case studies have been identified. It is important to note that these are not the only examples of success in the sector. However, they are representative of global best practice within their respective energy service, energy technology and geographic areas. While these cases are discussed in more detail in the report, a brief summary of each case is provided below.

6.3.1 Off-Grid Electric

Based in Arusha, Tanzania, OGE is a company that provides SHSs on a fee-for-service basis (about $5 a month) to unelectrified households. The systems provided are relatively small compared to more conventional SHSs, but do not compromise on energy services or quality. The systems are closed, in the sense that only OGE equipment (television sets and radios) can be used with them. Customers need to load

'credit' for the systems to work, mainly through using mobile money payments. Mobile technology is used to monitor system performance and use in real time. OGE makes use of a call centre to field customer queries and complaints, and uses established businesses and entrepreneurs as agents.

The company was established in 2012, and has reached about 50 000 customers to date, more than South Africa's entire off-grid programme has achieved in 10 years. It is set to reach around 200 000 customers by the end of 2016, an unprecedented achievement in scale in the African off-grid energy context. OGE does not make use of subsidies or other government grants. The company has raised capital from traditional venture funds, as well as funding from development finance sources (e.g. IFC). It is an innovative company that has ambitious goals and a strong management team. It has also inspired the Tanzanian government and various development partners to support its 1 Million Solar Home Systems initiative.

6.3.2 IDCOL Bangladesh

The Bangladesh solar programme is driven by IDCOL, a parastatal institution. Concessional financing is provided to IDCOL, which in turn passes it on to participating microfinance institutions, also known as partner organisations. The partner organisations install and service the SHSs and mini-grids, and provide households with the micro-credit needed to pay for the system (usually one- to three-year loans). The systems were initially part subsidised, although this has been largely phased out (except for the smallest systems). The market has matured to the extent that customers do not see an investment in an SHS as a risk, and so the role of the subsidy has changed from being largely a risk-reducing measure to being an access-enabling measure. The smallest systems are being subsidised to make them affordable to the poorest sections of society.

IDCOL has reached more than 3.2 million households in Bangladesh and is undoubtedly the most successful off-grid programme in the world. Despite several factors unique to Bangladesh, which seem to limit the transferability of the programme to other regions (e.g. the high population density, the existence of extensive microfinance networks, the proximity to energy technology manufacturing bases and the availability of large amounts of public funding), important lessons can be learnt, which are discussed in more detail.

6.3.3 Nepal Biogas

The Nepal Biogas Programme started in the 1980s as a technological research project with a limited number of test models. It was expanded in the 1990s by the Biogas Support Programme into a successful market development programme with the active involvement of the business community. The systems are subsidised by the government and donors (in part also using carbon funds), and the rest of the costs are largely financed through microfinance institutions. The programme largely installs individual, household-level digesters.

Over 300 000 biogas digesters have been installed, with the current rate of installation exceeding 30 000 systems a year. There is a digester in every region of Nepal, and 39 companies are currently installing and servicing the digesters. Nepal has provided expertise to other Asian and African countries.

6.3.4 Toyola stoves

Toyola was started in 2003 by two cook stove artisans in Accra, Ghana, the city with the highest per capita consumption of charcoal in West Africa. The company produces and sells efficient charcoal-burning stoves, made from locally available scrap materials and fired clay liners. The stoves are 40% more efficient than their traditional counterparts. Toyola either sells the stoves directly to consumers (60%), or through retailers (20%) and sales agents (20%). A stove can cost anywhere between $6 and $33. Users are provided with two months' credit for the purchase of the stove, based on a 20% deposit. This credit is provided either directly by Toyola or via retailers. The savings in charcoal normally result in a purchase payback period of less than a year. Quality assurance, standardisation practices and rigorous recordkeeping have been essential in achieving this scale and accessing carbon funding.

Toyola sold more than 300 000 stoves between 2007 and 2013, 93% of which remain in use. It employs more than 200 artisans. Some 25% of the company's funding is carbon-based, through carbon-saving credits sold on the carbon market.

6.4 Success factors

Having briefly looked at the four cases above, success factors will now be identified that can be found across all four cases, and which are transferable across technologies, geographies and other contextual elements.

6.4.1 Management: capacity and commitment

All three cases illustrate the absolute necessity of having highly capacitated, committed people driving implementation. In the case of Bangladesh, this driving capacity could be found in IDCOL, where a completely new unit was staffed by young, highly qualified commerce graduates with a strong commitment to see the programme succeed. OGE was established by Oxford MBA graduates with significant experience in setting up and running technology companies. It has a board of directors, as well as investors who are leading authorities in their technology and investment fields. The Nepal Biogas Programme is led by a well-defined public-private partnership (PPP) between the Nepalese government, the private sector and international donors and non-governmental organisations (NGOs), with a strong technical role being fulfilled by the Netherland Development Organisation (SNV). Toyola stoves' founders are committed entrepreneurs familiar with the technology, their market and global carbon management systems.

Those managing all four projects recognised the need for high-quality staff in all tiers of the initiative, actively recruiting the best people from all sectors to ensure adequate capacity. What these examples show is that it does not really matter where these strong, smart leaders are located: it can be in the private sector, like OGE; a parastatal, like IDCOL; or a government/PPP initiative, like the Nepal Biogas Programme. What matters is their capacity and commitment, and the fact that they are in a position to make this count by having influence and authority. Management needs to have the capacity to understand the market, to respond to a very complex operating environment, and to put systems in place that are able to handle the challenges dealing with large-scale, high-volume energy technologies. In all cases, it is clear that innovative thinking, coupled with strong technical ability and analytical skill, was essential to unlock the possibilities of the particular markets: IDCOL staff needed to come up with a new financing system and institutional setup that competed with the existing rural energy agency; OGE staff had to develop not only the sophisticated technological back-end for the SHS management system, but also had to ensure that their business model was able to achieve scale through setting up its operations in a different manner than had been done anywhere else; Toyola introduced specialisation and supply chain management in what was until then a highly unregulated, informal industry. None of these innovations would have been possible had the leadership of these initiatives been under-capacitated and over-committed.

Contrast this with South Africa's own experience, where the off-grid programme is being implemented by one or two staff members in the DoE that simply do not have the time or resources to ensure the same level of outcomes[56]. The creation of a non-grid agency with a clear mandate, committed leadership and a well-resourced staff complement holds some promise for the sector, and could see real gains being made in the energy access field. One needs only look at the recently created REIPPP Programme office to see the impact that a well-capacitated, well-resourced programme can have: staff are sourced from different ministries (including National Treasury), the entity has more agility to operate as a quasi-independent unit, and a great deal of resources are committed to the actual operationalisation of this unit. As a result, South Africa now has a best-practice example of a fast-growing renewable energy power sector at vastly reduced costs.

An important lesson is that an environment needs to be created that ensures that innovation can thrive. This, in turn, requires long-term commitment, especially in terms of policy support from government, if a project is to attract the right people. None of the international cases started out as large-scale initiatives, but they were committed to reaching scale quickly, and were supported in this by their operating environment. This has a very real implication for South Africa where the current commitment to the off-grid programme is not sufficient to attract the same level of investment.

56 Personal communication: Mr Moeketsi (Department of Energy).

6.4.2 Innovative finance

In all four cases, it has been necessary to address affordability issues through the use of innovative financing mechanisms. These can be in the form of relatively straightforward subsidies (funded by carbon credits), as is the case in Nepal, fee-for-service arrangements where capital and operational and maintenance costs are covered through small monthly instalments, or part-grant, part-microfinance, as is the case with IDCOL in Bangladesh and Toyola in Ghana. Again, all four cases recognised that their customers have a very limited ability to pay for the energy services, and set about developing ways in which they could help customers use what they were already spending on energy to access better, cleaner alternatives. An important factor to notice is that there was an insistence on households paying for the energy products or services, coupled with a recognition that projects will need to enable them to do so. While people may be spending a great deal on charcoal, for example, they will not be able to finance the purchase of a more efficient, charcoal-saving stove without actually having the stove first. Toyola therefore provides its stove on credit, based on a 20% initial down payment only.

There is no real formula in terms of what these financing arrangements look like, or how they are applied. In all cases, there is some level of financing and credit involved, and most cases combine this with subsidies. However, it differs across regions, technologies and business models. OGE did not make use of any subsidies, instead opting for the already mentioned fee-for-service arrangement as a form of credit; the Nepal Biogas Programme provided a capital subsidy level of 30 to 50% initially, which has increased to 40 to 60% to ensure that the poorer households are reached. For IDCOL, capital subsidy levels decreased steadily over time, with only the smallest of systems now receiving a 20% subsidy to ensure market penetration at the lowest end of the spectrum, while loans provided through microfinance institutions financed the rest of the system costs. Despite the lack of uniformity, credit and grants have been used to lower the risks and increase affordability for all three cases. A smart, yet simple financing arrangement that lowers the risk for consumers and other actors along the value chain is important to achieve scale and impact. In addition, it is important that the grants or subsidy components, if used, do not cover a major portion of the system's capital costs, since this creates perverse incentives throughout the value chain: companies and implementers may become beholden to the subsidy provider, instead of the customer, adjusting their product offering to meet the needs of the institution instead of the end user. Companies might also build their entire business case around accessing these subsidies, never reaching a point of financial sustainability and being very vulnerable to the cutting of subsidies. While an initial, high-percentage subsidy might be provided to attract investors to the sector, it needs to decrease rapidly over time (or as a function of the number of systems or products sold or installed) in a way that ensures market maturation, innovation and financial sustainability.

While South Africa has been providing capital subsidies to decrease the costs of its off-grid SHSs (much like some of the success cases), it appears to have had the opposite effect, undermining rather than promoting the commercial sustainability of the implementing companies. For instance, solar companies are tied to the subsidy in order to roll out and attain commercial 'critical mass', but the subsidies are only available on a very ad hoc basis, holding the solar companies in less than optimal commercial positions with regard to customer numbers and densities. Due to the fact that 80% of the capital costs of the SHSs are covered by a government subsidy, the solar concessionaires have been tied into a very dependent relationship with a government that has changed its commitment to the off-grid sector repeatedly. The subsidy level has also not changed, which means that companies have built their entire business model around accessing subsidies. When government's commitment to the programme falters (which happens frequently), the companies face severe financial strain, which in the end impacts on customers who are not being adequately serviced. The concession programme also makes use of the DoE (national government) to provide capital subsidies, while operational and maintenance monthly fee subsidies are supposed to be provided by local municipalities. In addition, the programme uses quite a bit of old technology (large systems, CFL lights, inverters in some cases, outdated battery technology) to a large extent because the subsidies require specific (outdated) technologies. Ensuring that these system design specifications are up to date with the latest technology is a cumbersome and expensive bureaucratic process

in South Africa. There is no dedicated agency or committee responsible for this, as is the case in Bangladesh. It also means that solar concessionaires do not respond to changing customer needs as readily, since they are not the ones really paying for the system. In the end, it is a needlessly complicated programme that does not adequately reduce the risks for value chain actors.

All of this speaks to the need for consistent, smart subsidies, policy certainty and financing arrangements.

6.4.3 Technical quality/standards

The use of high-quality equipment, in many cases supported or necessitated by appropriate (and enforced) technical standards, has led to widespread market acceptance and impact. IDCOL is probably the leading case in this regard, as its use of high technical standards, set and enforced by an independent technical committee, has seen rapid improvements in energy storage solutions (batteries), continued system improvements and reduced costs, as well as the establishment of a local manufacturing sector built on the need to provide appropriate technologies for the programme's SHSs. In fact, almost all the components of IDCOL's SHSs are now sourced locally, which was not the case several years ago.

For both the Nepal Biogas Programme and the IDCOL Programme, the use of results-based financing adds another layer of technical quality control. This allows these initiatives to not only control the components used, but also to assess installation quality and customer education as prerequisites for subsidy and grant disbursement. This shifts the risk onto the service company, who needs to make sure everything works (and continues working) before the incentives are paid.

OGE's experience is slightly different, as it operates outside of any specific government initiative and therefore does not necessarily have to comply with a set of technical standards. However, the company recognised that it is in its own interest to provide systems of a high quality to ensure the sustainability of its operations, the retention of customers and the penetration of new markets. In fact, OGE is so adamant about quality control that its systems are entirely 'closed': only approved equipment, sold by OGE, can be used on its systems. In many cases, this equipment (DC television sets and radios) is financed as part of the SHS itself.

A frequent pitfall of initiatives in this field is to confuse energy with energy services, leading to technical standards that are unrealistic, resulting in expensive, bulky systems that are unsuitable for the market. When the guiding principle in developing technical standards is that the level of power (not necessarily the level of service) should be similar to that provided by the grid, standards will result in big, expensive energy systems, which are unsustainable in the long run. However, if there is a focus on energy services, and an appropriate matching of energy sources to services, cheaper, more efficient and effective systems can be implemented. OGE has avoided this pitfall, focusing on the smaller, high-quality systems that can deliver the energy services that are needed over a long period of time.

What this shows is that technical quality and standards are essential success factors, and these need to be directly related to customer energy service needs, while also being constantly updated. The danger is that this issue becomes politicised (especially in a country like South Africa), leading to irrelevant technical standards that are out of date and fail to deliver the appropriate energy services[57]. In addition, merely having standards is not enough: enforcing and policing these standards is essential. This speaks to the need for a large-scale programme with adequate momentum (like IDCOL), which can ensure adequate monitoring. A more established and regulated framework for off-grid implementation in South Africa can go a long way towards achieving this.

6.4.4 Policy certainty (or no policy)

A further success factor has been long-term policy certainty, but what this actually looks like for the different initiatives differs quite significantly. For the Nepal Biogas Initiative and IDCOL, there has been a long-term commitment from government to both these

57 South Africa only has NRS052, the standards for SHSs. There are no standards for improved cook stoves, biogas or other alternative technologies.

initiatives, with policy interest steadily increasing over the years. IDCOL specifically sought to insulate the SHS programme from political interference by limiting direct government involvement. For the Nepal Biogas Programme, the opposite is true, with government taking a leading role. In the case of OGE, policy certainty has been assured by building a business that is, in fact, not dependent on the policy environment, either for subsidies or other incentives. While there has recently been official recognition of the success and importance of the programme by the Tanzanian government, this 'support' has really been 'coming alongside' the initiative instead of integrating it into government programmes.

Contrast this with the South African experience, where service delivery is highly politicised, and support for the off-grid programme has been stop-start at best for the past 10 to 15 years, and it is not difficult to see why the off-grid sector has not taken off in the country. In addition, South Africa still does not have an integrated electrification master plan, which is a significant and real risk for commercial off-grid operators in a country where the off-grid sector is already relatively small to begin with. Stability of opportunity is essential to attract investors, and this requires consistent, unwavering long-term government support. The REIPPP Programme is a good example of what can happen when this is in place. The stability of the opportunity is essential to attracting private-sector investment, as well as support from multilateral development partners. As such, it is important that the South African government defines and commits to a long-term, large-scale off-grid programme.

6.4.5 Integrating new technologies

An important feature of all four case studies is consumer-focused technical agility: the willingness and ability to constantly integrate innovations that reduce costs and enhance service delivery, based on customer needs and technology improvements. This, for example, refers to the integration of mobile phone technology, which is used to address issues such as payment, customer communication, first-line maintenance, etc. One sees this happening through the highly respected Technical Standards Committee, as well as the Operations Committee, for IDCOL's initiative in Bangladesh, where technical experts, service companies, technology manufacturers and financiers all interact regularly around these issues in an institutionalised setting. This is one of the reasons that the IDCOL Programme has seen such dramatic cost reductions and increased service levels. In East Africa, OGE has integrated high-end technology in such a way that it makes the systems robust and enables the business model to work. This is the case with integrating mobile technology for service payments or mobile systems monitoring, for example. In Nepal, SNV has been instrumental in ensuring that feedback is being integrated, with the design evolution of digesters being a constant feature of the programme (for instance, looking at flow regulation for utility-type management models and having technical teams to update operations generally).

South Africa has unfortunately not seem the same level of innovation: most of the off-grid system designs hail from the project's inception period (circa 2000), which, although it has been updated, has not kept tread with the pace of innovation in the off-grid energy sector. As a result, customer payment levels are low, customer satisfaction is limited and public support is wavering.

6.4.6 Competition

An essential part of all four initiatives' success is the fact that they either actively encouraged or were just naturally operating in a competitive environment. IDCOL Bangladesh did not assign specific regions to specific service providers. Instead, service providers had to compete for customers wherever they were to be found. Similarly, the Nepal Biogas Programme included ever more companies and ensured that customers had a choice with regard to service providers and technologies. OGE was competing in a less competitive environment, but it was still operating in the backyard of Africa's fastest-growing off-grid solar market: Kenya. As such, the company's customer base was exposed to the technology and would almost inevitably be exposed to other service options in the near future. This served as an important driver in terms of reaching scale, ensuring customer satisfaction and keeping costs low. Toyola was also not the only improved stove manufacturer in Ghana. Its market success depended on its ability to provide high-quality stoves, and to deliver them at a reduced cost. All these cases show that competition in the market is essential for ensuring cost reductions,

increased service levels and long-term customer satisfaction.

The South African concession model has seen the opposite happening. With off-grid areas being assigned to specific companies, the competitive aspect is immediately removed and, along with it, incentives around cost reduction, technological innovation, service-level improvement and customer satisfaction. In essence, this model makes service companies primarily responsive to government (which provides the subsidies) and not to customers. The answer is not the removal of subsidies, but the opening up of the market to several players through removing the region-based concessions. Without this factor, a healthy, vibrant off-grid market will not develop in South Africa.

6.4.7 Conclusion

In conclusion, four international case studies have been examined that are rated as 'successful' based on their sustainability, scale and impact. The key success factors from these case studies are as follows:

- The importance of **management capacity and commitment**: This needs to be addressed by providing the right incentives (including long-term, large-scale public commitment).
- The critical role of **innovative financing arrangements** for reducing risk and increasing affordability: Government needs to look at providing access to low-cost capital for service providers, providing smart, targeted (and reducing) subsidies to households, and ensuring that credit or other financing arrangement are available as part of the service offering.
- The role of **technical standards and equipment quality** for ensuring market sustainability: This links to the issues of commitment, capacity and competition. In addition, standards need to be dynamic, keeping tread with technological developments and stimulating innovation (instead of stifling it).
- The necessity of **policy certainty** in a high-risk market: What is needed from government, more than anything else, is policy that is long, loud and legal. It is essential that a clear, long-term and large-scale commitment – with the necessary financial backing – is adopted and enshrined in official policy and legislation to attract investment in the sector.
- The need for **technological agility and innovation**: Technological advances should be integrated to ensure increased affordability and enhanced service delivery. This is strongly linked with the technical standards (and how these are set up and updated), the technical and management capacity in the sector, as well as competition in the market.
- The importance of a **competitive environment** for healthy market development: The concession-based model needs to be reconsidered and adjusted in as far as it limits competition between service providers.

These lessons need to be taken forward in shaping South Africa's own decentralised energy services strategy. What is needed is an environment that ensures rapid market maturation in a high-risk technological sector.

6.4.8 Solution framework

Issues	Solution framework
The importance of high-level/management capacity and commitment	• Establish a dedicated off-grid management authority.
The critical role of innovative financing arrangements for reducing risk and increasing affordability	• Review financing options for existing and future electricity supply companies (DBSA, etc.). • Review current contracts of SHS projects and ensure business-model alignment. • Engage National Treasury regarding FBE options.
The role of technical standards and equipment quality	• Establish a Technical Standards Committee. This may or may not, depending on the expertise available, be centred in the South African Bureau of Standards (SABS).
The necessity of policy certainty in a high-risk market	• Establish a dedicated off-grid management authority.
The need for technological agility and innovation	• Develop a technology maturation process. • Establish a dedicated off-grid management authority.
The importance of a competitive environment	• Establish a dedicated off-grid management authority. • Establish a grid network master plan.

7. Chapter 7: Issues that limit the sustainability of decentralised renewable energy systems

7.1 Introduction

Given the history of underachievement in the establishment of sustainable decentralised off-grid systems (Barnes, Singh & Shi, 2010), the evaluation of the limiting factors accounting for these poor results is crucial. Frankly put, these initiatives have to start learning how to succeed, for in many places and in many contexts, there are no alternatives[58]. The developmental value of access to modern energy services is well understood and has been supported by a number of global energy initiatives[59] that are aimed at improving access. It is therefore important to identify and address the barriers and issues that undermine, and indeed, those that promote, the sustainability of the decentralised programmes, and to ensure more successful outcomes into the future. This review looks at cases across the developing world, integrating the sentiments of experts that were interviewed for this purpose, as well as more analytic contributions from the 'energy access' sector generally. However, while the evaluation net has been cast as wide as possible, the authors remain mindful of the need to render these lessons practical within the South African context.

7.2 The key factors

It is often the case that those factors that limit or undermine the success of DRETs are only properly understood in terms of the key elements of *success* rather than failure. From this point, one can look more closely at underperforming projects and evaluate to what extent these key elements are missing, underdeveloped or constrained. If one is to understand the contours of success, the framework that makes success more likely than failure, then one must examine the key elements of the IDCOL Project in Bangladesh. While it is tempting to simply 'reverse engineer' these successful outcomes to the point where one has a clear view of the conditions that gave rise to them, this would not provide the necessary data corroboration and perspective that this report requires. Greater comparative depth and sensitivity is needed, which is why the data, experience and perspectives from a broad set of case studies, interviews and literature reviews have been included. While IDCOL remains the standard by which to be measured, one needs to work with the full range of experiences and outcomes in order to establish just how to navigate this.

There are a number of issues that limited the sustainability of DRETs, and these continually emerge through the research and evaluation process. These issues include inconsistent policy, a misalignment between the service offering and consumer demand, inadequate business models, failure to mature technologies more strategically in terms of sustainability and the suitability with policy objectives.

58 For instance, IRENA (2011) noted that, based on costing scenarios, 70% of existing rural areas would have to be services by 'mini-grids or off-grid solutions'.

59 Drawing attention to programmes such as the European Union-funded SE4All, the World Bank and IFC's Lighting Africa, as well as the South African government's commitment to universal access.

These issues fall into four major categories:

1. *Commercial issues*: These include issues such as the scale of the opportunity, business models and access to finance. Various key requirements contribute to the long-term commercial sustainability of DRET initiatives.

2. *Policy issues*: These include sustainability pressures associated with or derived from inadequate policy development and the application of that policy in terms of how the policy intent is operationalised.

3. *Technology and innovation*: This represents a recurring theme where the success of a DRET initiative has been undermined by technical issues. This speaks to both technical standards and the ability to integrate and benefit from technology innovations.

4. *Communication*: This is a broad category that includes communication from the national to the local level; how effectively national policies are published, championed and communicated to service providers and to the market as they make informed decisions. It includes how service providers communicate with their customers. Communication is crucial across the board.

These are not mutually exclusive categories, and tend to interact and overlap. However, they allow for some level of categorisation and offer a framework to analyse the key issues and communicate them in a logical format.

7.3 Commercial issues

There has been a noticeable change in the overall nature of successful decentralised solutions. In short, they have become increasingly commercial. From a general service delivery perspective, this is not new, as privatisation and the commercialisation of service delivery and infrastructure investment has been with us for some time in the form of PPPs[60] and with this, the corporatisation[61] of service delivery authorities. However, the difference here is that the commercialisation of the service delivery opportunity is taking place in the off-grid, decentralised sector and is increasingly not confined to large-scale, capital-intensive infrastructure as has been evident in the past. OGE's activities in Tanzania have raised over $7 million in investment for its SHS initiatives, and it is estimated that the initiative will leverage over $100 million in development finance and private capital investment into Tanzania[62]. While smaller on numbers, but as committed to the bottom line, Wim Jonker Klunne, who heads the EEP on behalf of a number of national donors, claims that "DFID is absolutely insistent on sustainable and innovative business models"[63], which shifts the focus clearly from technologies to sustainability. Dirk Muench of Persistent Energy Capital talks of "persistent transaction costs being really low" and "exceeding willingness and ability of customers to pay"[64]. There is a strong commercial theme from these conversations that is becoming increasingly central to the ability of DRETs to succeed.

This confirms something of a paradigm shift in the approach to renewable energy markets in developing countries. The table on the following page captures the shift from a focus on technology to one that focuses more squarely on market opportunities.

60 The increasing presence of PPPs is linked to the improved delivery of services and management of facilities associated with such agreements, as well as the increased mobilisation of private capital. See, for instance, The International Bank for Reconstruction and Development/The World Bank (2009).

61 Generally referring to public utilities owned by central government but managed in a semi-autonomous fashion – such as Eskom.

62 http://divatusaid.tumblr.com/post/111375714947/president-of-tanzania-announces-the-one-million

63 Personal communication: Wim Jonker Klunne. DFID is a funder of the EEP.

64 Personal communication: Dirk Muench (Persistent Energy Capital).

The old approach was very technocratic, facilitating access to technologies through supply-brokered arrangements all taking place within focused programmes. The new paradigm is more market- and people-centred, with policies supporting the development of the market through awareness campaigns and subsidies/finance and ensuring that delivery (and use) of technologies is financially sustainable.

Table 14: Paradigm shift in rural technology dissemination

Old paradigm	→	New paradigm
Technological assessment	→	Market assessment
Equipment supply focus	→	Application, value-added and user focus
Economic viability	→	Policy, financing, institutional and social needs and solutions
Technical demonstrations	→	Demonstrations of business, financing, institutional and social models
Donor gifts of equipment	→	Donors sharing the risk and costs of building sustainable markets
Programmes and intentions	→	Experience, results and lessons

Source: Martinot, Chaurey, Lew, Moreira & Wamukonya, 2002.

Within this general category of commercial issues, which limit the sustainability of DRET initiatives, the report now focuses on some of the specific issues that need to be addressed.

7.4 Scale

The original business models for the concessionaires assumed that each private company would service in the region of 50 000 customer households, which they would attain over five years (Kotze, 1999). This was the 'scale' of the opportunity around which the specific business plans evolved and business revenues and costs were determined. To date, some 14 years later, no single concession has much more than 20 000 customers. The inability to achieve scale has put significant strain on the sustainability of the business case[65]. While this is a result of a combination of issues, not the least of which is the failure of policy, it does talk to a more general need for larger-scale initiatives that have greater market flexibility and can achieve a level of financial sustainability. This is a point made very clearly in a contemporary thought-piece written by Pepukaye Bardouille and Dirk Muench, which looks at the requirements of 'highly scalable' businesses (Bardouille & Muench, 2014) in the off-grid energy service sector. Greater financial recovery and returns need to be permitted beyond the initial higher-risk, start-up investment. If upscalability is too limited[66], then energy service companies do not get to achieve the benefits/economies of scale where the average cost/customer is reduced, while average revenue/customer remains the same. The key to success is to manage costs relative to the respective revenues and without scalability. This will remain a challenge[67].

There are a number of practical examples from the case studies and other sources that attest to the importance of scale and a more commercial approach to managing and delivering energy services. For instance, while the MFP has been heralded as a success in West Africa, recent reviews suggest that the management model (largely community-based (women's) organisations) was inappropriate as the returns were considerably diluted across the group and that single groups or entrepreneurs should manage and operate a number of MFPs in order to achieve reasonable financial returns (Nygaard, 2010). A similar observation was made in the case of the Tsumkwe mini-grid in Namibia, where considerations around the management and operational model looked at integrating a number of these mini-grids under the control of a single management company in order to make the proposition more commercially viable[68]. Granted this was a pilot project; however, the small scale of the Ilembe biogas pilot meant that the high costs of each biogas digester (in the region of R50 000) makes the business case challenging. It was scale and dilution of overheads and transaction costs versus revenues that lay at the heart of the integrated rural energy utility concept developed for the Renewable Energy and Energy Efficiency Partnership (REEEP) (Aitken, 2010).

The key issue here is that governments must see the value of having the private sector involved in service delivery and ensure that the requirements (and responsibilities) are met. If they choose to go the PPP

65 Personal communication: Sifiso Dlamini (NuRa).

66 The opportunity might be prescribed in terms of extent or the availability of capital limited or the costs of capital too high, etc.

67 Successful entrepreneurs will integrate all cost-saving opportunities, including innovation and efficiencies – an issue that will be discussed separately.

68 Personal communication: Robert Schultz (Desert Research Foundation, Namibia).

route, then they need to open up the market space for businesses to achieve scale and become more operationally sustainable. The most successful DRET projects in the developing world are IDCOL, M-Kopa[69] and OGE, which are all scaling up very effectively. This is a key limitation exposed on South Africa's concession programme, where the originally proposed numbers never materialised and the DoE is now diverting investments from the concessions into smaller parallel programmes, which it hopes will be cooperatively managed by local women's groups.[70] While these actions feel more equitable in that they afford opportunities to local communities, they also appear to be moving in the complete opposite direction of the global 'upscale' trends where innovative energy service companies are expanding rapidly and providing a strong business and investment case.

69 M-Kopa was not one of the case studies, but is very similar to OGE. It is current installing 500 units per day in East Africa. See: http://solar.m-kopa.com/about/company-overview/.

70 Personal communication: Serame Moeketsi (DoE) and Vicky Basson (KES Energy Service Company).

8. Chapter 8: Business models

There has been a shift from technology to service, and from sales to customer relations. The predominant business models in the past were sales-based, providing access to hardware and, where required, some level of consumer finance either directly or through a financial intermediary. As Hankins (2004) notes, "there were a large number of cash purchasers (of SHSs) and they generally outnumber credit buyers" (Hankins, 2004). However, fast-forward 10 to 15 years, and the predominant way in which consumers access SHSs is through payment plans (which are variously referred to as instalment sales, 'pay-as-you-go' and incremental ownership). A recent review of the Ugandan solar PV programme noted that the most successful service companies were those offering payment plans (including fee for services) (Aitken et al., 2014). These instalments are kept low and competitive with what these households would have been spending for equivalent services prior to accessing the SHS. What is emerging are longer-term service-type relationships between energy companies and their clients, as opposed to the more ad hoc relationship between retailer and customer. Indeed, a utility-type arrangement is emerging based on providing agreed levels of service (as opposed to technology) for agreed ongoing payments.

A shift is evident in many of the successful solar PV companies currently operating in Africa. Solar Now shifted in 2012 from an outright sales model to a payment plan, having sold over 3 000 systems in 2013[71]. Similarly, Phoenix International was struggling along, having only sold 800 systems over a number of years, and after shifting to a 'pay as you go' model, picked up 8 000 customers in 12 months[72]. The question is: How are these changing relationships and approaches impacting on the way in which DRET opportunities are managed in South Africa? At least part of this response should be to ensure that opportunities encourage approaches where longer-term service (or payment plan) agreements are in place, which both ensure that customers can access the services at more accessible rates (asset is amortised over longer periods) and can use the access efficiently and affordably, and the service providers commit to longer-term after-sales services as longer-term maintenance and performance are key to ensuring that the developmental dividends are received. The upfront costs of most technologies are beyond the reach of rural households, so some level of annuity payment is essential in most cases. Appropriate legislative, financial and regulatory frameworks will have to be in place to ensure that such business models can operate effectively in the off-grid sector in South Africa[73].

A further feature of this shift from technology to services is a greater level of market awareness within the business model. The IDCOL Programme, OGE and Nepal Biogas Programme all understand their customers very well. No longer are rural households considered beneficiaries. They are rather consumers with varied choices, consumer rights and mixed abilities to pay. Companies need to do sufficient socioeconomic research in order to benchmark and understand willingness and ability to pay. OGE does this very well in East Africa. Monthly fees are determined in line with other similar value propositions, such as what people currently pay for 'pay-as-you-go' mobile phone payments or what they spend on equivalent services (for instance, paraffin for lighting and charging cellular phones at other businesses)[74]. Successful businesses understand their clients, and this drives the business model and success. A greater insight into technology adoption, along with service provision, should be considered.

71 Personal communication: Ronald Schuurhuizen (Solar Now).

72 Personal communication: Irene Abagi (Technical Systems Manager, Uganda).

73 It has been indicated that such frameworks and the associated flexibility and agility do not exist within the DoE at present. Personal communication: Dr Wolsey Barnard (DoE).

74 Personal communication with Graham Smith (OGE).

A further feature of service diversification is a focus on productive applications. It is not simply about supporting consumptive practices such as household lighting, charging cellular phones and watching television, but also about productive practices that might earn an income[75] .It is important to develop models that promote local economic opportunities, particularly in rural areas where non-agricultural opportunities are scarce. For instance, NuRa employs over 85 people, most of whom come from the small towns and villages of northern KwaZulu-Natal[76]. The Nepal Biogas Programme currently has 39 private companies that have entered the biogas manufacturing sector[77], while Toyola in Ghana employs 170 artisans and is credited with many more indirect jobs[78]. However, it takes time to achieve these impacts. Some of the local biogas initiatives complained of the broader socioeconomic responsibilities attributed to their funding, including the employment of local people under the Expanded Public Works Programme (EPWP), which added to the cost of building the digesters. While these socioeconomic responsibilities and impacts should be encouraged, they need to be done responsibly. Technologies, take-up and business models mature over time. Expectations surrounding the broader impact of these initiatives should be similarly managed.

75 Linking access to energy with income generation is certainly not an easy task, but as Brew-Hammond (2010) noted, “There is an emerging consensus, based on the evidence from many energy access interventions around the world, that too narrow a focus on expanding energy delivery without adequate attention to productive uses for income generation yields little by way of socio-economic development”. Brew-Hammond (2010).

76 Personal communication: Sifiso Dlamini (NuRa).

77 Personal communication: Saroj Rai (SNV).

78 See for instance, http://www.areed.org/downloads/reports/Cook_stoves_In_Africa_AREED.pdf.

9. Chapter 9: Access to finance

The shift from outright sales and intermediary finance to payment plans and service agreements has had an interesting impact on finance requirements. For decades, the focus was on developing sustainable microfinance solutions. Developing appropriate end-user finance products has always been a huge challenge based not just on the risks associated with the serviceability of the client[79], but also on the transaction costs of administering so many small loans or that the loan terms for larger financial instruments/ products are too long and therefore too risky for this market profile[80]. In addition, creating the necessary institutional infrastructure to support effective distribution and aftersales services is costly. However, the shift to payment plans and a more long-term utility-like service agreement directly addresses many of these challenges. It is no longer about each individual rural households accessing their own loan, but rather the energy service company pre-financing the technologies/assets and offering access to them on a payment plan basis. The need to access capital is the energy service company's risk. It is in a far better position to engage these risks than individual rural households. In addition, the energy service company needs to upscale as quickly as possible, so lower payments and longer-term relations are necessary. The importance of local infrastructure is enhanced as technology performance and customer satisfaction is directly linked to customers' willingness to pay; no power, no payment!

Financing modalities in the energy access sector appear to be shifting from an end-user microfinance focus to access to capital by the energy service company, where the technology is pre-financed and capital is tied up in assets, which have a slow return. For instance, most payment plans in Uganda are in the region of 18 to 36 months (Aitken et al., 2014). Once capital is tied up, there is little room for expansion (companies cannot invest in further assets without capital). While a payment plan is the approach most likely to achieve the rapid scaling up that is required, the effect of this is that solar companies require access to increasing amounts of capital in order to finance this approach. So the nature of the 'access to capital' shifts from households to energy service companies, from microfinance to debt finance. As Simon Brandsfield-Garth, CEO of Azuri Technologies, noted, "it is not possible to build a business on equity; one needs a debt vehicle to fund working capital"[81].

The question is: What impact does this shift have on the way in which we approach DRET programmes in South Africa? To start, the DBSA is exploring opportunities for debt/capital financing in various 'development sectors', including energy[82]. Project developers need to better understand the market and customers' willingness/ability to pay in order to design payment plans that appeal to the market. More detailed financial analysis of different DRETs is required and, upon this, payment plans are structured that reflect long-term costs[83]. Better off-grid planning and management (spatially and temporally) would accommodate the longer-term investment commitments required by energy service companies. One needs to accept that households should be paying something towards the costs of the service, which is a position not always fully embraced by public officials in

79 Rural incomes are often seasonal (agricultural), variable and low.

80 For further discussion on this subject, see, for instance, http://www.cgap.org/blog/can-microfinance-sector-help-deliver-clean-energy.

81 Personal communication: interview with Simon Brandsfield-Garth.

82 Personal communication: Jason Schaffler.

83 This is particularly true for the more pilot-stage technologies, such as biogas. Personal communication: Greg Austin.

the energy sector[84]. Informed service, financial package and/or technology choice and payment are important, as these enhance ownership, which is an essential ingredient of sustainability.

Additional financial issues include subsidies for the making of new markets. A better understanding of the long-term costs of providing energy services will allow a better understanding of the level and tenor of subsidies required. A more consistent policy (discussed in more detail under policy issues) with regard to the application of subsidies is needed, here referred to as FBE/FBAE. A better long-term costing of the various DRETs will indicate the level of subsidy required and hopefully a more consistent application of them. The application of FBAE should assist in making DRET services more accessible to rural communities. However, its inconsistent application and the inefficient manner in which indigent lists are developed and managed generates significant uncertainty and, as a result, the subsidy is often a burden[85]. The FBAE process needs to be strengthened, more consistently applied and its application to the full range of DRETs explored more purposefully.

84 Jotte van Ierland (Mpfuneko Biogas Project) noted that SANEDI (the project funders) were not focused on developing management systems in terms of maintenance and payments, but were rather still focused on 'piloting technology'. This technology is well established. There is a need to move beyond technology performance and focus on longer-term sustainability. Personal communication: Jotte van Ierland (Mpfuneko Biogas Project).

85 Personal communications: Sifiso Dlamini (NuRa) and Vicky Basson (KES Energy Service Company). For instance, when subsidies are applied, this reduces the costs to consumers so more households take up the service. When subsidies are subsequently withdrawn, often at short notice, these customers can no longer afford the service and are lost to the company. This variability makes long-term planning very difficult.

9.1 Policy issues

As touched on in the commercial issues discussed above, policy is an overarching issue in discussions on the sustainability of DRETs. It is really quite straightforward – without a strong and abiding policy framework, private investment will not be interested and the sector will not raise the necessary capital in order to achieve the outcomes. Policy needs to be what is referred to as 'loud, long and legal' (Hamilton, 2009).

- Long: sustained for a duration that reflects the financing horizons of a project or deal.
- Loud: incentives need to make a difference to the bottom line and improve the bankability of projects.
- Legal: a clear, legally established regulatory framework, based on binding targets or implementation mechanisms, to build confidence that the regime is stable, and can provide the basis for long-life, capital-intensive investments.

Within this policy framework, attention needs to be paid to precision in policy design. It is no use having a policy that does not accommodate the prevailing approaches to energy service delivery. For instance, the policy should address the 'scalability' of projects, as well as the more current payment methodologies, financing and subsidy requirements. Policy sets the instruments, ambition, scenes and commitments required to achieve the targeted outcomes. There are many issues that need to be addressed in an appropriate policy framework. Given that there is a separate analysis on the policy requirements for facilitating more productive outcomes, the key issues will be mentioned briefly under limitations, but these issues will be addressed in more detail under the specific review section relating to policy. The key considerations include the following:

- *Overarching policy:* A policy framework that clearly indicates a commitment to and an ability to achieve specific outcomes. This is a framework document that outlines the general national commitments and indicates a manner of achieving them.

- *Governance framework:* This is necessary to set the rules of how things are to be achieved, offering a more pragmatic bent, focusing more on the 'how to'. It sets out the rules that outline how an organisation is managed and controlled and how opportunities are to be regulated. For instance, in South Africa, the DoE has set down regulations to govern procurement specifically for new electricity generation capacity (Department of Energy, 2011). The regulations are under the Electricity Regulation Act of 2006, which was amended in 2007 (Department of Minerals and Energy, 2007). This governs, among other things, procurement from independent power producers (IPPs) (Martin & WInkler, 2014). The terms and conditions need to be able to effectively operationalise the policy. As suggested earlier, the DoE lacks the required agility, governed as it is by the mentioned legislation, to manage a more challenging and varied transaction framework, which a committed off-grid programme might entail[86].

- *Consistent application:* Where the policy application lacks consistency, uncertainties may arise that may well undermine the long-term sustainability of the initiative. Examples abound in the off-grid concession programme where, for instance, there were numerous delays in the renewal of installation contracts (Klimbie, 2013). A further instance would be the application of FBAE, as discussed elsewhere in this analysis.

- *Improved planning and delivery process:* An overall planning framework is required to coordinate investment and technology opportunities and determine high backlog areas. A network master plan would be ideal for managing the evolving interface between grid and off-grid systems, as well as the nature of the opportunities within the off-grid sector itself. Currently, there is a very shallow, simple plan that is not up to the specificities of this task.

86 Personal communication: Dr Wolsey Barnard (DoE) and Mr Mthokozisi Mpofu (DoE). Key issues here include tendering processes, project terms and National Treasury payments, among others.

- *Simplicity*: The policy plan should be simple to reduce complexity and variables that might add risk in terms of interpretation.

As suggested, a more detailed policy section is provided elsewhere in this report.

9.2 Technology and innovation

While this evaluation underlines a shift from technology to service provision, it also acknowledges that services depend on technologies. Technologies differ in quality, reliability and – importantly – price. A key feature of successful initiatives is the choices they make around technology; not just standards, but innovation and technology development as well.

9.2.1 Technical standards

Technical standards are important in regulating the quality of products and their installation, which underpins both performance and the development of the market. Performance is critical in making markets from both a user's perspective in terms of the value and use of the system, as well as from a business perspective in terms of product replacement, maintenance and – indeed – payment for services. Higher-quality DRETs will perform better and promote new and robust markets.

IDCOL is once again a leader in this respect, insisting on and ensuring compliance with a fairly high set of technical standards.[87] In addition, the programme has a Technical Standards Committee comprised of experts from universities, local and national government, as well as an IDCOL representative (about six people in total). The committee is responsible for SHS standards

87 For instance, five-year warranties are required on all batteries. (Aitken et al., 2014).

and design specifications, and essentially approves the inclusion (or not) of suppliers and specific equipment. The IDCOL Programme also features a call centre, which fields customer complaints. The call centre refers these complaints to the partner organisations in the Operations Committee meeting and, if serious enough, also to the Technical Standards Committee (Aitken et al., 2014). Much of IDCOL's success is attributed to the development and enforcement of such high standards[88].

The South African concession programme is also governed by a set of standards, the ISBN 978-0-626-27033-9 South African National Standard (SANS) 959-1:2012 Edition 1 and NRS 052-1:2012 Edition 2 SANS: Photovoltaic systems for use in individual homes, schools and clinics. Although there is some uncertainty with regard to the extent to which these standards are applied, they do not cover the sizing of the system[89]. For instance, the KES Energy Services Company concession in the Eastern Cape has an independent monitoring authority that assesses the compliance of installations, but this is not the case with the other concessions[90]. There certainly was a time in the not too distant past that the technical specifications of the concession SHSs prescribed CFLs and did not permit the use of LEDs; a case of the standards not keeping up with technology changes. Perhaps it is also indicative of the perceived importance (at the time) of off-grid electrification?

These technical standards relate to SHSs, but not to other possible DRETs. For instance, there are no technical standards associated with biogas digesters, improved cook stoves, micro-hydro installations or other mini-grid technology options. If the DoE is to promote more intensive and diversified investment in this sector, then this reality will have to be addressed. For instance, the digester initiatives (Ilembe and Mpfuneko) are still focusing on technology design issues[91] when over 300 000 digesters have been successfully installed in Nepal (suggesting that they should have moved on by now). The good thing about technical standards is that they already exist. What needs to be done is to establish a technical standards committee that can review and adapt the existing global standards to the off-grid realities and policies of South Africa. A further recommendation, discussed in greater detail below, is to outline and develop the technology maturation process within the off-grid programme. The practicality and embeddedness of technologies grow over time as the benefits, costs and design issues become more apparent. Technical design issues need to form part of that maturation process.

What is equally important about having standards is being able to enforce them. There is no point in developing them otherwise. This was a key issue in the Ugandan Energy for Rural Transformation (ERT) Programme, where standards were only applicable to participating energy service companies, while those companies that provided similar services in the country, but outside of the programme, were not held to similar standards (Aitken et al., 2014), in which case the good work done by the Ugandan Bureau of Standards and the World Bank was undone. Standards are only useful if they are enforced. There are many lower-cost and less-effective renewable energy technology products and components available on the market, which – if adopted on a wide scale – can have a negative and lasting impact on the market. In an energy market such as South Africa, where most households expect a grid connection, inferior components offered within an off-grid service already perceived as being inferior would not assist customer confidence and market development.

88 Monirul Islam (2014). IDCOL Solar Home System Programme

89 Personal communication: Christopher Purcell (one of the authors of the NRS 052 standards).

90 KfW is funding the Eastern Cape concession and has appointed an independent monitoring authority.

91 Personal communication: Nick Alcock (Khanyisa Projects) and Jotte van Ierland (Mpfuneko Biogas Initiative).

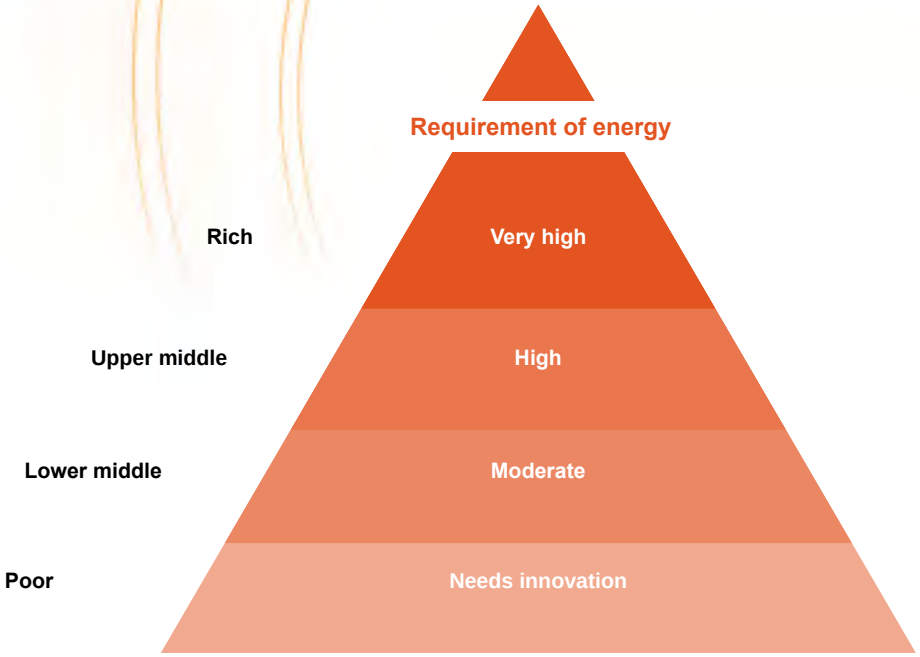


Figure 6: Innovation requirements for low-income household energy

Key issues relating to standards:

- Components are certified through an accredited testing and certification authority.
- A technical standards committee should frequently review and adopt suitable existing standards.
- Standards build market confidence in the performance of DRETs.
- Technical standards address any installer and end-user health and safety issues.

9.2.2 Innovation

The most successful service companies appear to have integrated the latest technology innovations into their business model. For instance, OGE uses mobile banking to collect payments, which significantly reduces the transaction costs. It further exploits the widespread ownership of mobile phones to communicate cheaply with its client base[92]. As Bardouille and Muench (2014) noted, "the proliferation of mobile phone technology makes it possible for the first time to manage, control and monetise distributed energy assets in remote settings while keeping costs low. We believe that this is also the reason that distributed electricity supply companies are finally developing rapidly" (Bardouille & Muench, 2014). Unfortunately, the concessionaires do not use this technology to any extent, meaning that the transacting costs associated with payments remain high, for both the company and the consumer. To be fair, mobile payment technologies are not well developed in South Africa, but given the widespread ownership and use of cellular phones in the country, mobile payment solutions are certainly available.

92 OGE has a call centre that handles over 1 000 calls a day. It further uses this communication platform to perform first-line maintenance with its customers, which significantly reduces the need for sending technicians to customer households (which is very expensive).

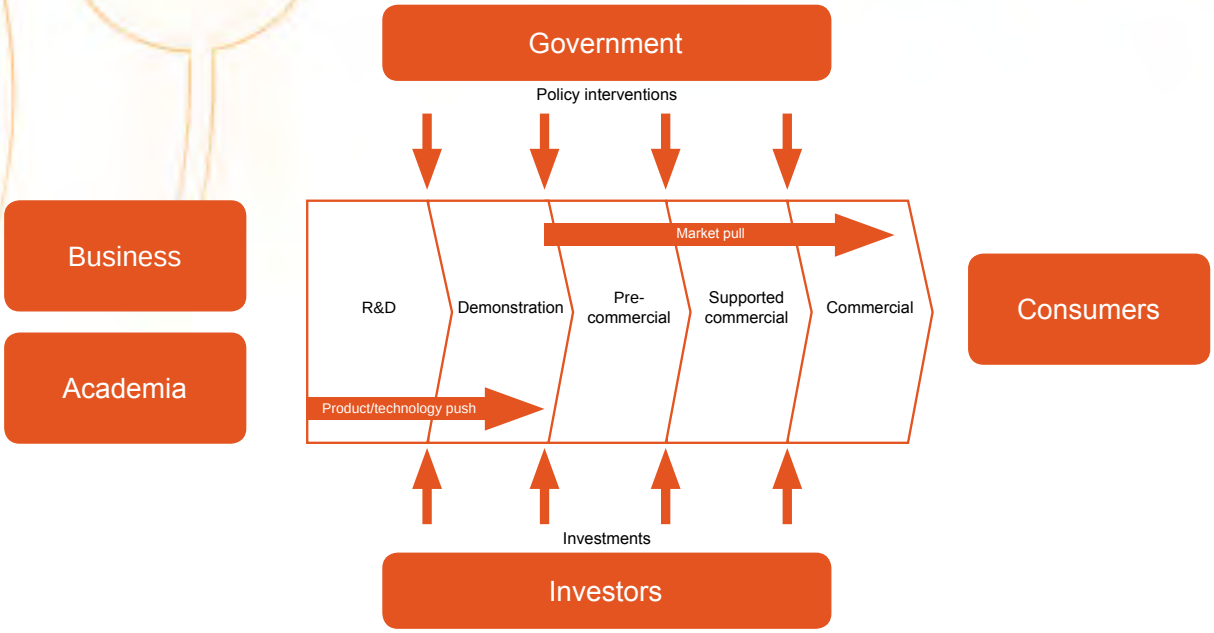


Figure 7: Stages of technology development (Foxon and Kemp, 2007)

Beyond mobile phones, the emergence of very efficient LED lighting has made DRETs potentially more energy efficient, reducing pressure on the energy inputs required, as well as the costs associated with storage capacity. To achieve sustainability in challenging markets that are characterised by high levels of poverty, dispersed settlement patterns and high transaction costs, initiatives need to seek out any cost reduction and business efficiency that is available. Until quite recently, LED lights were not permitted as part of the technical specifications of SHSs in the concession programme[93]. This appears to have changed. However, in such challenging markets, innovation needs to be adopted early in order to promote long-term sustainability. Additional innovation trends include the persistence with 12 V DC systems (as opposed to shifting to the less efficient, yet more versatile 220 V alternating current (AC) option) as more 12 V appliances become available (for instance, the concessions have now integrated 12 V colour television sets into their product offerings).

The issue here is that the off-grid market is a brittle one and any technical innovation that reduces costs and enhances the ability to do business needs to be carefully considered. Embracing innovation is important and should be addressed by the Technical Standards Committee (discussed in more detail under the policy section that follows). It should be incumbent on project developers to ensure that the latest technology options are deployed, and this becomes a commercial imperative that drives success in a competitive environment.

9.2.3 Maturing technologies

The concession programme has dominated the off-grid sector in South Africa. While there have been a number of other initiatives, as indicated by the case study selection, they have never progressed beyond the pilot phase. To put it bluntly, they have never really had to demonstrate any rigour and sustainability. For instance, the biogas programme in Mpfuneko has not been able to effectively test its gas management model (hampered by funder's insistence on not extracting payment from beneficiaries)[94]. Lucingweni also never got to the point of charging users or even limiting the amount of energy

93 Personal communication: Sifiso Dlamini (NuRa).

94 Personal communication: Jotte van Ierland (Mpfuneko Biogas Project).

users were entitled to. The challenge is to progressively demonstrate something more; to ensure incremental growth and long-term sustainability.

At the heart of this impasse is the lack of a long-term plan for off-grid technologies. While there are commitments – such as the New Household Electrification Programme – there is not an empowered management authority that can oversee the implementation and development of technologies to the point where they present sustainable alternative options to improve energy access and assist with achieving these off-grid targets. There is an encouraging level of R&D (by SANEDI, the CSIR, etc.), but there is inadequate infrastructure and capacity for mainstreaming DRETs to guide options beyond the pilot phase.

What is required is a technology maturation tool or process that can guide – against the backdrop of an overall master plan – technologies from pilot to sustainable roll out; a value chain that covers the span from concept to pilot implementation to roll out: a process that progressively asks more from technologies as long-term solutions. Unfortunately, we do not appear to be quite sure of where to take a technology once piloted. This is a result of lack of planning, a clear and shared vision about the role of DRETs and a practical and suitably empowered authority that focuses on implementation. A technology maturation adoption framework should probably look something like the framework presented in Figure 7.

Such a framework illustrates how technologies get progressively mainstreamed from the R&D phase through to commercialisation. This mirrors the transition from a product development/technology stage to one where there is a 'market pull' or demand for the associated service. The framework further captures the shift in funding sources, which initially rely on public sector funds to cover early development costs and increasingly rely on private-sector or 'investment' funding, as the technology is increasingly commercialised. This is something akin to the kind of tool required to ensure that technologies move from the R&D stage to assisting with improving access to energy on a more commercial basis. The value of the tool is linked directly to the perceived value of alternative technologies within the energy access field. If DRETs, not just SHSs, but other technologies and service packages as well, are to contribute to universal access in South Africa, a more structured approach to mainstreaming these options (particularly non-solar PV technologies) needs to be put in place.

9.3 Communication

Communication is a key feature of successful DRETs: from the national policy level all the way down to effective communication with customers. Some of the key communication features associated with success include the following:

- *A champion*: It would appear to help that off-grid initiatives are championed by prominent and credible individuals and organisations. For instance, IDCOL has always secured the support of the Bangladeshi Prime Minister (Prime Minister Sheikh Hasina and her predecessor Khaleda Zia)[95]. In Nepal, the Department of Agriculture has been intimately involved with the biogas programme since 1975[96]. Loud, clear and continuous support appears to be closely associated with success. That level of high-profile public support has not been a feature of South Africa's off-grid initiatives. There is very little evidence demonstrating such open high-level commitment to the concession programme.
- *Clear strategies:* Policies need to be accompanied by strategies that guide the development and roll out of DRETs. These strategies need to be clearly communicated to industry stakeholders. This evaluation has made this point repeatedly. The South African government's commitment to off-grid electrification and energisation is not clear. With the exception of the concession programme, the DoE

95 Exclusive interview with Prof Fouzul K. Khan, founder of IDCOL, conducted by Silvana Tiedemann. See: http://www.sun-connect-news.org/business/details/how-idcol-and-the-bangladeshi-shs-programme-started/.

96 See: https://sites.google.com/site/nepalbiogas/biogas/history-of-biogas.

and its affiliates have not openly presented an 'off-grid' strategy, and this has undermined activities within this sector. There is an institutional gap in the required value chain to promote DRETs in South Africa. While there are policy references to 'off-grid' and R&D institutions engaging with DRETs, there is no off-grid authority mandated with rolling out, supporting and managing DRETs in the country.

- *Community mobilisation:* Taking communications a few steps closer to the community, it would appear that a better-informed community (or potential market) opens pathways for energy service providers. In the case of the KfW-supported off-grid concession in the Eastern Cape, the contracting of a 'communications consultant'[97] established pathways for the energy service company by mobilising communities and addressing the 'Q&As' that are likely to emerge. Once the energy service provider arrived in communities, the level of knowledge and awareness was significantly enhanced. The Lucingweni mini-grid presents a less encouraging communication example, where the community felt they were not sufficiently engaged prior to the installation, nor informed about the future prospects of grid electrification[98].

- *Customer communication:* Both IDCOL and OGE run call centres as part of their customer communication and maintenance strategies (Aitken et al., 2014). In the case of OGE, over 25% of the full-time staff complement works in the call centre. These call centres represent platforms for ongoing customer communication and education, and very often reduce the need for maintenance visits by encouraging customers to undertake first-line maintenance. However, the concessions do not make strategic use of mobile communication technology, and maintenance visits are a considerable burden on their overheads. This is certainly something to be considered.

97 Personal communication: Chris Purcell (KfW-appointed monitoring consultant for the Eastern Cape concession).

98 'Free electricity' is commonly promised to communities and this is assumed to be on the basis of a grid connection. See: http://www.ai.org.za/wp-content/uploads/downloads/2012/05/No.-76.-Unfulfilled-promises-and-their-consequences.-A-reflection-on-local-government-performance-and-the-critical-issue-of-poor-service-delivery-in-South-Africa..pdf.

9.4 Summary of key sustainability issues

Key issues	Recommended solution framework
Facilitate and enable a more commercial off-grid environment. Exploit PPP opportunities, manage and regulate the sector, engage in fundraising, etc.	• Establish a dedicated off-grid management authority. • Establish a grid network master plan. • Review current contracts of SHS projects.
Ensure that project opportunities are designed with sufficient scale to allow for a more commercial and sustainable business opportunity.	• Establish a grid network master plan. • Review current contracts of SHS projects. • Develop a technology maturation process.
Payment plan-based business models (as well as fee-for-service) appear to be the most successful. The 'over the counter' sales options and third-party microfinance appear to be giving way to utility-type approaches where companies self-finance the assets (largely debt finance) and customers make annuity payments.	• Review current contracts of SHS projects and ensure business model alignment. • Review financing options for existing and future electricity supply companies (the DBSA, etc.). • Develop a technology maturation process.
Ensuring that FBE (FBAE) allocations can be effectively utilised in off-grid systems.	• Establish a dedicated off-grid management authority. • Engage National Treasury in FBE allocations.
Policy issues: • Overarching policy • Governance framework • Consistent application • Improved planning and delivery process	• Establish a dedicated off-grid management authority. • Establish a grid network master plan.
Technical standards	• Establish a dedicated off-grid management authority. • Establish a technical standards committee.
Ensure that technology innovation is adopted by electricity supply companies.	• Establish a dedicated off-grid management authority. • Establish a technical standards committee. • Develop a technology maturation process.
Technologies are successfully evolving post-pilot.	• Establish a grid network master plan. • Develop a technology maturation process.

10. Chapter 10: Policy requirements, recommendations and the way forward

Based on the review of the existing body of energy policies, it is clear that there is a commitment, at a policy level, to utilise and promote DRETs within the stated objective of universal access. However, what is less clear is how this is to be achieved. Policy is not procedure. Policy is not strategy. What the country needs is not more policy, but rather a greater capacity to implement it. What is required is a range of practical mechanisms to assist with and guide the mainstreaming of DRETs within the energy access environment. These recommendations include the establishment of a dedicated off-grid management authority and a grid network master plan, the development of a technology maturation process, reviewing the current concession contracts, establishing a technical standards committee, establishing a complete services needs analysis, reviewing financing options and developing a communication strategy.

10.1 A dedicated off-grid management authority

If the DoE is to expect the off-grid sector to make a meaningful contribution to the goal of universal access, a dedicated off-grid management authority needs to be established. The DoE currently makes only very limited resources available to support the off-grid concession programme, and this is focused on a single technology (solar PV). If the various distributed renewable energy technology and service options are to be leveraged and optimised within an off-grid framework, a dedicated management authority is required[99]. This authority should have the mandate to facilitate, contract and manage DRET programmes and initiatives within the off-grid space. It would need to rely on the network master plan, and have an informed understanding of best practice within the sector, as well as new technologies and innovations, while also cultivating relations with multilateral (World Bank, UNDP) and bilateral (the German Gesellschaft für Internationale Zusammenarbeit (GIZ), SNV, KfW) organisations.

The management authority should be the first port of call for donor and private-sector investors in order to gain a clear and reassuring understanding of the country's commitment to off-grid energy access. The authority should have a governance framework, as well as a regulatory, standards and compliance framework that ensures a balance between the manner in which services are delivered and received, and the legal authority to enter into contracts with off-grid service providers.

It is recommended that such an entity be housed outside of the DoE[100] (although still accountable to it). Alternative options would include SANEDI or the Central Energy Fund (CEF). The housing of the off-grid authority within an existing state-owned entity (SoE) would

99 This is already underway, approved by the DoE. It will be up and running by April 2016. It does not require legislation as it will be housed within an existing SoE and it already has a budget of 130 million, based on existing contributions to the SHS programme.

100 As has been noted in the evaluation, the DoE is almost exclusively grid-focused, and for off-grid programmes to achieve their potential, they should not be in the constant shadows of the grid.

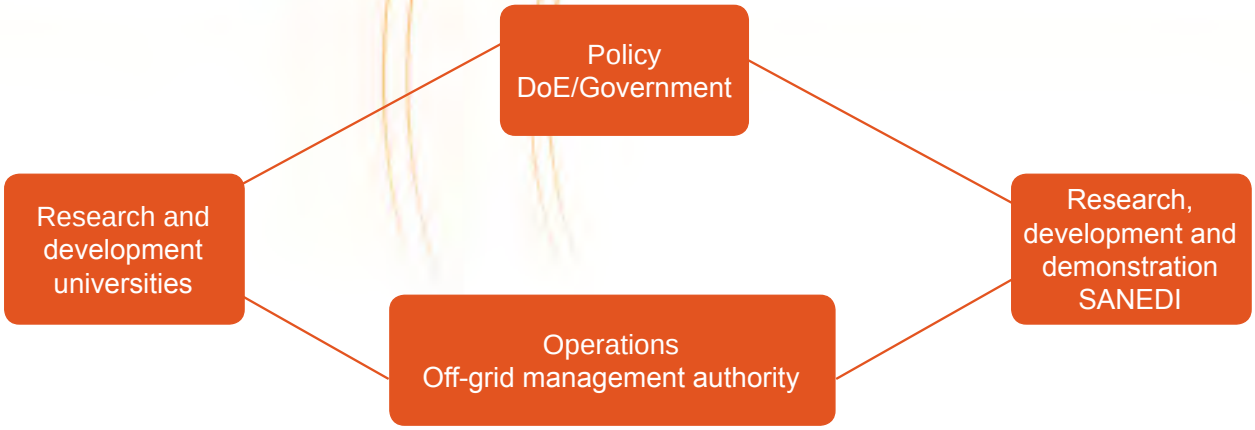


Figure 8: Proposed strategic fit of the off-grid authority: 'Operations'

simplify the administrative and legal requirements. The off-grid management authority would require a clear mandate, which would include a governance framework, a clear funding framework (agreement with National Treasury to ensure that funding can flow to the proposed authority) and a clear institutional identity. Strategically, it is proposed that the agency assumes the roll out of 'operations' by promoting and managing off-grid developments within the country and linking with (not duplicating) current research, development and demonstration activities.

10.2 Establish a grid network master plan

Without a grid network master plan, there can be little certainty about the spatial and temporal details of grid versus off-grid systems. What geographic areas are off the grid and how long will they remain so? Without this determination, the promotion of DRETs will remain too high-risk to attract private-sector investment. A level of certainty is needed with regard to opportunities. Only a detailed (and respected) master plan can provide this planning stability. This needs to be a 'living' document that determines the deep off-grid areas, and manages the inevitable interface between an expanding grid and a shrinking off-grid environment. Currently, the grid planning process has an unspecified priority as there are at least three different electrification initiatives (INEP, municipalities and presidential projects) – none of which are constrained by an overarching plan. Clearer grid plans mean an equally clear off-grid plan.

This is a priority, as indicated in conversation with the DoE. The master plan should be a 'living' plan that is grid-focused, which, in the process, determines off-grid locations. It should resolve the grid-off-grid interface as the grid develops and intensifies across the country. The geographic (spatial) and temporal (time) elements should be able to guide the level of off-grid investment and technology type. Areas that are indicated to remain off the grid for longer periods should attract technologies with longer-term return on investments (larger installations across the different technologies, as well as specific technologies, like biogas, and formats, like mini-grids). The master plan should determine the funding allocations, i.e. that allocations align with the master plan both in terms of location and timing. The master plan would take 12 to 18 months to develop.

10.3 Technology maturation process

A clearer understanding or process is needed about how technologies mature and develop from pilot status to the point where they can offer a more mainstream contribution to off-grid energy access. This is a review of the off-grid energy service value chain. As this research notes, there are reasonable R&D resources in the country to consider and evaluate new DRETs and possibly undertake pilots, but that is where it appears to end. The challenge here is being able to move beyond the pilot. The requirements are, at least, twofold. Firstly, there needs to be a demand for additional DRETs, which is what a master plan and off-grid authority will go some way towards convincing. Secondly, there has to

be a process that determines the suitability of specific DRETs over time[101]. For want of a better description, this would be a 'technology maturation process': a process governing the required steps that new DRETs need to take to demonstrate their ability to be mainstreamed and contribute towards the contribution of off-grid systems to universal access. This would include early technology demonstration in the pilot context: a pre-commercial phase where issues such as business models, revenue collection and subsidy allocations are explored, reviewed and tested. This would be followed by a commercial phase where these lessons come together, where key performance indicators and regulatory requirements are more firmly in place, and where levels of competition are encouraged.

There are a number of technology maturation or adoption tools that guide the development of technologies, from R&D to a more mainstream status. At this stage, it would appear that SANEDI is the most likely custodian of such a tool or process. An example has been presented in this report. The maturation process for DRETs needs to be mapped out. This would be fairly generic, starting with proof of concept in the form of pilots and then progressing towards greater sustainability in terms of determining levels of payment (tariffs), integrating available subsidies, providing end-user training, maintenance regimes (depending on the levels of maintenance required), more general after-sales service requirements, and options for scaling up, determining relevant technical standards, and ensuring greater levels of external or private-sector financing.

10.4 Review current concession contracts

The concession programme is the cornerstone of the current off-grid programme. Huge resources have been invested in the programme from both government and the private sector. Given that it has been almost 15 years since the agreements were signed and that there has been considerable disenchantment with the programme, it is recommended that the concession programme be closely reviewed in terms of the business models, current funding mechanisms and key performance indicators. Similarly, the non-concession SHS programme also requires critical review, as companies appear to be installing SHSs without considering a sustainable maintenance and business model in any significant detail. There are certainly lessons to be learnt for both programmes from such a review.

A consultant should be appointed to review the current installation contracts with specific ToR, which should include the following:

- Evaluation of the levels of subsidies (currently 80% of capital costs)
- Addressing non-payment within the concessions (currently between 30 and 50%)
- Reviewing the role of FBE/FBAE, promoting more long-term consistency
- Ensuring that greater levels of technology and innovation are introduced
- Reviewing the allocation of installation numbers to the concessions (currently the majority of the budget is being spent in non-concession areas)

10.5 Establish a technical standards committee

It is proposed that a technical standards committee[102] be established under the auspices of the off-grid management authority to provide guidance and oversight on the technical standards associated with different DRETs and programmes. This should be an ad hoc committee comprised of experts from appropriate fields, including universities, off-grid experts and

101 Not wanting to be technology-prescriptive, but different technologies have different costs and returns on investment, which should be taken into consideration within time frames and optimal investments.

102 There is no dedicated committee addressing renewable energy standards. The NRS 052 was a result of the once-off development of the standards involving a couple of renewable energy experts. A dedicated committee is suggested.

public-sector officials. There are technical standards precedents, such as the SHS standard NRS 052.

A technical committee framework needs to be drawn up in terms of its mandate. The functional requirements of such a framework should include the following:

- Mandate of the technical committee
- Membership of the technical committee
- Compliance, for instance, should it be mandatory for publicly financed (in part or whole) DRET initiatives

10.6 Establish complete services needs analysis

Complementary and supplementary services need to be determined to provide a complete basket of energy services to meet the needs of the poorest of the poor.

A coordination platform also needs to be created for all providers of basic services for the provision and maintenance of complementary basic services, including FBE.

10.7 Review financing options

A number of issues fall under the recommendation to review financing options. The first, which is linked to the proposed review of the concession programme, is to reassess the funding options for the concession programme.[103] Currently, 80% of the capital costs of the installation are covered in the concession programme, while 100% of such costs are covered in the non-concession SHS programme. This needs to be reconciled and reviewed to determine what the actual funding requirements should be (capital subsidies), ensuring at the same time that effective service delivery takes place, and that it does so in the most efficient manner possible. Of course, such a review should look more broadly than simply at the level of capital subsidy available. Other pertinent issues should include the question of ownership of assets as possible collateral for further fundraising (improve the balance sheet of concession companies), as well as the costs associated with the removal and/or redeployment of SHSs affected by grid encroachment[104]. The application of the FBAE subsidy needs to be more closely examined. This operating subsidy may have an important role to play in supporting a range of DRETs whose contribution to universal access is to become increasingly important. As the increased prominence of off-grid energy access becomes more widely accepted, municipalities will be required to consider FBAE funding for the various technologies. These levels of support need to be explored and guidance given.

Engaging with National Treasury (ensuring buy-in) is a further important financial consideration. National Treasury needs to ensure that public funding can be used within the context of varying kinds of service-level agreements that are likely to emerge across different technologies, scales and programme durations. Typically, public finance and private finance need to leverage each other to achieve policy and profit interests respectively. A forum for this may be desirable.

ToR need to be developed for the review of the financial formula currently applied both within and outside of the concessions. These should include the following:

- Review of current capital subsidies applied within and outside the concession programmeEngage with National Treasury and the South African Local Government Association (SALGA) to determine whether a more consistent application for FBE/FBAE is possible
- Engage with current/future private investors to review the stated risks

103 Over and above the significant investments already made in the operational concession areas, the concessions have a legal responsibility to continue to service their customers. A wholesale unbundling is neither legally viable nor advisable. The report is simply motivating for greater efficiencies.

104 These remain contentious and unresolved issues that contribute to the costs of the concessions. A similar intervention will be required for the non-concession area activities.

10.8 Communication strategy

Communication with regard to the off-grid programme in South Africa has always been somewhat muted. There appears to have been sufficient tension between those public officials for and against the programme that it was never markedly endorsed or profiled. Given Cabinet's approval of the New Household Electrification Strategy, it is assumed that this low-profile approach will need to change and a more widespread endorsement will have to be secured from all tiers of the public sector, as well as NGO and private-sector interests. It is proposed that a clearly defined communication strategy be devised in order to clarify the strategic advantages of a vibrant off-grid sector and to assist with 'selling' this programme to the powers that be. For DRETs to succeed, they need to be supported by all sectors, particularly government and champions.

Internal communication, which facilitates acceptance, is crucial – but equally so, is external communication, which puts the off-grid sector on the international map. There are many multi- and bilateral organisations with technical and financial resources that are dedicated to assisting developing countries to accelerate their off-grid energy access programmes. An effective communication programme to this end would leverage both resources and goodwill, which would be critical for ensuring a more diverse and effective off-grid programme. Policy commitment and stability have a habit of bringing with them increasing interest. For instance, IDCOL initially received funding from the World Bank. Later, GIZ, KfW, the Asian Development Bank (ADB), the Japanese International Cooperation Agency (JICA), the United States Agency for International Development (USAID) and DFID[105] also committed funding. Stability creates its own momentum, and this stability needs to be demonstrated and communicated if the off-grid initiative is to attract support and commitment both internally and externally.

105 GIZ/KfW are German funders, ADB is the Asian Development Bank, JICA is the Japanese International Cooperation Agency, USAID is the United States Development Agency, DFID is the UK Development Agency. This is similarly true for the Nepal Biogas Programme, as well as the activities of OGE in East Africa.

The communication strategy should consider the following:

- Develop an overarching communication strategy that will support the work of the off-grid management authority
- Facilitate buy-in for the off-grid programme and authority at the highest levels of government.
- Assist with marketing the off-grid authority globally in terms of international development and finance stakeholders.
- Market off-grid energy access within South Africa, particularly at the community level.
- Ensure that the off-grid management authority has the requisite capacity to manage communications on an ongoing basis

10.9 Synergies and opportunities

There is a limit to what a desktop study can secure in terms of impacts and outcomes. The recommendations listed above are broad and will require significant commitments and resources if they are to be implemented and the projected outcomes achieved. What is proposed is that the Sustainability of Decentralised Renewable Energy Systems project should link with a related initiative that is currently underway in South Africa, the Off-Grid Electrification Agency. The focus of this initiative is the creation of an off-grid electrification authority in South Africa with the mandate to facilitate and promote off-grid initiatives.

10.10 SA-EU cooperation on rural electrification

During the sixth South Africa-European Union (EU) Summit (July 2013), the EU and South Africa agreed on the development of a joint cooperation programme with a focus on rural electrification through renewable energy solutions that target 300 000 households in remote areas. To follow up on this agreement, with the support of the South Africa-EU Dialogue Facility, the EU delegation financed a high-level expert who, in

close consultation with the DoE, developed a concept for the implementation of off-grid rural electrification. This concept was presented in the report 'The non-grid highway' and submitted to the EC headquarters (DG DEVCO C5) as a request for support from the EU Technical Assistance Facility (TAF) for the SE4All initiative.

'The non-grid highway' report proposed a number of key recommendations, including the establishment of a Non-Grid Electrification Agency, as well as a number of operational issues relating to a review of the existing financial model, contracting authorities and different off-grid technologies. The proposed off-grid highway initiative has been redesigned according to the implementation modalities of the TAF, which includes a number of tasks outlined by specific ToR that, when implemented, will establish the key operational requirement of the agency and the initiation of an overall off-grid management authority in South Africa.

The ToR cover the following requirements for establishing this off-grid management authority:

- Grid and non-grid rationalisation – identifying grid and off-grid areas
- Regulation/Non-Grid Agency (NGA) governance – regulatory requirements, an operational charter and a governance framework
- Service delivery/sustainability – ownership and funding models, financial sustainability and transaction models
- Communications – a communication strategy in support of the operation of the authority
- Project management – ensuring that these different components are integrated into an overall operating entity

The project will be implemented over 12 months, after which time there should be a fully operational off-grid authority.

11. Chapter 11: Aligning the off-grid agency programme with report findings

The following table summarises how the observations made in this review of the sustainability of DRETs will be addressed by the process of establishing an off-grid management authority. It specifically breaks down the existing ToR of the off-grid agency programme and aligns the ToR with current recommendations:

Terms of reference	Proposed activities	Alignment with recommendations
ToR 1: ***Grid and non-grid rationalisation***	• Investigate if universal access will ultimately be achieved through grid extension – cost, time and political aspects. • The electrification network master plan should identify future areas that will be accessible through grid extension and those that will remain off the grid for a specific period of time. • Develop this into what will become the governance area of the Non-Grid Electrification Agency (NGEA), as well as gazetted concession areas. • The output should provide the DoE with a clear definition of grid and non-grid areas in an indicative time frame.	• Establish a grid network master plan. • Establish a dedicated off-grid management authority.

Terms of reference	Proposed activities	Alignment with recommendations
ToR 2: ***Regulation/ NGA governance***	Regulatory and compliance framework: • The regulation should work for sustainable, fast, efficient off-grid electrification. • A light-handed and simplified framework should be adopted. • The quality of service standards should be realistic, affordable and enforceable. • Both poor rural customers and investors should be protected. It should identify the following: • Who should be regulated? (jurisdiction) • What activities or parameters should be regulated? (coverage) • How should the regulation be performed? (methods) • Who should perform the regulation? (responsibility) Technical guidelines, norms and standards: • Appropriate or suitable standards and codes of practice of DRETs. • Practitioners/businesses, specifications and service levels should support all off-grid technology. Framework for the NGEA • Charter, governance and operational framework.	• Establish a dedicated off-grid management authority. • Establish a technical standards committee. • Establish a DRET industry association.

Terms of reference	Proposed activities	Alignment with recommendations
ToR 3: ***Service delivery/ sustainability***	Ownership model: • Off-grid equipment ownership (installations/ operations/maintenance/redeployment). Funding model: • Tariffs and subsidies (enable full-cost recovery of efficient operation). • Pre-financing – governance of money flow into and out of the NGEA. Allocation and control of FBAE: • Set of incentives that promote operational and financial sustainability. Service and technology options: • Definition of the minimum service levels. • Encourage innovation and efficiency. • Be an off-grid energy source and technology-neutral.	• Establish a dedicated off-grid management authority. • Review the current contracts of SHS projects. • Review financing options.
ToR 4: Communication	Overall programme public relations: • Develop a strategy to define all public relations activities from Cabinet to provincial and local level – communication to promote the programme, raise awareness and share information. • Broad participation in the execution of rural electrification projects can be an efficient way of extending access and mobilising additional financial resources. • Stakeholder buy-in and engagement (role of the national entity delivering at the level of the third tier of government). • The current approach leaves concessions 'with too much to do'. The strategy must address communication through the value chain. • Lessons learnt from information communication consultant activities in the KES Energy Services Company concession in the Eastern Cape.	• Communication strategy

12. Chapter 12: Closing remarks

The desktop study of international and local DRETs has revealed a number of challenges that South Africa faces if it hopes to enhance the sustainability and contribution of these energy service options to its goal of universal access. There is no doubt that off-grid energy options can play a meaningful role in promoting access to modern energy services and the development dividends that are implied. However, the country needs to address these challenges before this will become a reality. First among these requirements is the political will to create an off-grid environment that can yield these results. Fortunately, such resolve now appears to be there, evidenced in the form of the proposed NGEA. The process for establishing the agency will, fortunately, address many of the recommendations made by this desktop review.

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Appendix A: Table summaries of case studies

	Case study name and summary	Performance	Sustainability	Socioeconomic	Policy
1.	**Devergy** Village-sized smart micro-grids in six villages in Tanzania. A 24 V DC micro-grid system made up of custom components controlled by a clever software management system that allows for remote management. This has a low safety implication. A key feature is the ability to add capacity as is required. The system delivers an average of 250 W per customer. A key feature is that Devergy charges for energy services. Initial funding is via grants, and some convertible debt finance from Impact investors.	1. Deploys very little power per customer, measures demand and adapts supply to meet demand so that customers do not have to support spare capacity costs. 2. Balancing the energy demand across multiple users means that system efficiencies can be achieved. 3. The ability to move the complexity upstream for centralised management and troubleshooting means that costs on the ground are reduced, which allows the company to scale more efficiently. 4. Easy and cheap to install in a village 5. Currently six sites, targeting 3 000 by the end of 2015 and 10 000 by the end of 2016.	1. Each connection in a village costs $200 to $250. 2. Customers pay an average of $6 to $7 per month. The total cost to connect each household is between $200 and $250, which – at a discount rate of 10% per annum – gives a break-even of four years. 3. Customers can pay daily, weekly or monthly. $1.50 will allow a week of lighting and charging of cellphones. Can use television, but then power will not last a week. 4. A local agent collects cash in the village and does a transfer by mobile money (M-Pesa, Tigo Pesa, Airtel Money).	1. Children can study at night. 2. Small businesses are opening up, e.g. DVD stores because of television. 3. Some household expenses are freed up. 4. Locals are employed to implement the mini-grids in villages.	1. The regulatory environment in Tanzania is supportive. 2. The Electricity and Water Utility Regulatory Authority (EWURA) only requires IPPs with systems over 100 KW to apply for a licence. 3. There is also no tariff for small IPPs. 4. Parliament has legislated that specific items related to energy access, e.g. solar panels, are exempt from both VAT and duty.

	Case study name and summary	Performance	Sustainability	Socioeconomic	Policy
2.	**iShack** It is rolling out small 12 V DC SHSs into township near Stellenbosch. The project trained a small group of agents to do installation and support. The Sustainability Institute received grant funding from the Gates Foundation to implement a pay-for-use SHS electricity service. After success of the initial pilot, a R17 million soft loan was raised from the Green Fund in 2013 to upscale. Talks are ongoing with the Stellenbosch Municipality to use the FBE allowance as a subsidy (to replace the Green Fund loan). The product costs R7 000 from the supplier (http://www.specializedsolarsystems.co.za/). It comprises a 75 W peak panel, distribution box with SIM card and communications module. There is a client education process, and it enables lighting, television and the ability to charge laptops. It is piloting refrigerators at a R10 000 upgrade.	1. The service is positioned as 'while you wait for Eskom', i.e. it provides an interim solution as part of an incremental upgrading of homes moving towards formal housing. 2. Services provided include lighting and the charging of cellphones. Television is the 'killer app'. Refrigerators are being piloted – they require a R10 000 upgrade. 3. There have been technical problems, which have largely been fixed by local agents. About 20 television sets have been exchanged due to problems. In winter, batteries discharge and services become patchy. 4. Affordability – the project is signing up 70 new customers a month, who are willing to pay R150 per month, which indicates that the services are well priced. 5. Because of a shortage of money during the festive season, the project offers discounts to help households afford the service during this period.	1. Two revenue plans: R150 per month as a set fee or pay-as-you-go, which is seen as the preferred way forward. It generally works out to about R150 per month, but payment happens in small amounts. 2. Using a discount rate of 10%, each household takes six years to break even (compared to four years for Devergy). 3. Two local fish and chip shops take money and load accounts with a point-of-sale device. The iShack team uploads payments manually. 4. The device has a warning light, which indicates that credit is about to run out. Soon after this comes on, payments start coming in.	1. People are prepared to pay because the system saves people money (kerosene purchases and travel to charge cellphones). 2. There are anecdotal reports of fathers staying at home to watch television rather than going to the tavern. 3. The project employs agents who are self-employed and provide support and training. The agents undergo an extensive training programme to help them understand the technology so that they can support customers and install new systems. Agents also learn to use tablets to collect data. 4. There have been labour problems with the agents who recently went on strike. They wanted full employment rather than being entrepreneurs. They were all dismissed and new people employed.	1. Subsidy is likely coming through the local municipality. 2. There is currently no financial support, but the local municipality is keen to get involved to demonstrate their support for innovative energy-access projects. 3. No financial support from central government. 4. No tax breaks or reduced duties for importing the technology. 5. No licencing is required by the project.

	Case study name and summary	Performance	Sustainability	Socioeconomic	Policy
3.	**PERZA** The objective of PERZA (Renewable Energy for Rural Zones Programme) is the provision of clean energy services to low-income rural households living in remote areas in Nicaragua. Rural electrification is essential for economic and social development. In order to address this, Nicaragua started to embrace off-grid solutions for rural areas and PERZA was born in 2003 to provide sustainable electricity services to selected areas. International financial support and technical assistance came from the International Development Association (IDA) and the Global Environmental Facility (GEF). The outputs of the project consist of demonstration renewable energy projects and their surrounding support in the way of microfinance, business development and social awareness campaigns.	1. Electricity access alone is necessary, but there is not sufficient input for local development. The project design is innovative by including complementary services: business development, micro-credit, capacity development, as well as electrification. 2. The holistic approach meant an overly complex project design with a large number of indicators. This is complex. 3. A mid-term review showed a low disbursement ratio and consequent delay in project execution. However, the microfinance component was starting to show success. 4. Direct beneficiaries include 16 000 low-income rural households with more to come, as well as SMEs. 5. An important outcome is an increase in welfare from the productive, leisure and cultural activities.	1. Electrification needs the support of government agencies, the regulator and the national utility. 2. Long-term sustainability requires a comprehensive economic and social approach. 3. Involving local communities in the project is a key aspect of project execution. 4. The microfinance component was extremely successful, $900 000 in credits for rural dwellers.	1. Project design is innovative: business development, micro-credit, capacity development, along with the electrification drive to ensure sustainability. 2. The outcomes of the project consist of the associated increase in welfare. 3. The project had a strong capacity-building component – about 3 000 people received training. 4. The project was oriented towards the poorest strata of the population. 5. The social development components provided a clear demonstration on how to bring modern financial services to the poor. 6. Electrification of schools, clinics, local government offices and police stations improved the quality and accessibility of crucial public services. 7. Communication services have developed. 8. It has had a positive impact on education.	1. The project succeeded in part due to strong policy support from the Nicaraguan government to increase national rural electrification. 2. The project supported the preparation of a sustainable national rural electrification strategy. 3. In 2005, the law came into force and implemented several incentive mechanisms for renewable energy technologies. 4. In addition, PERZA assisted in the design of tax indicatives and the Development of Small-scale Hydropower for Productive Uses Project. 5. Rural electrification requires wide institutional support, together with a mini-hydro station.

	Case study name and summary	Performance	Sustainability	Socioeconomic	Policy
4.	**MFPs for Local Agro-processing** This is a case study about the productive use of energy and the ability of energy to create livelihoods for rural beneficiaries. Location: five West African countries: Burkina Faso, Ghana, Guinea, Mali and Senegal, mostly benefits women's groups. A small diesel engine of 8 to 12 hp; 6 to 9 kW. It is mounted on a chassis, to which a variety of food-processing equipment is attached. It is flexible and can be adapted to the specific needs of each application. The 'basic module', without water or a lighting distribution network, including the engine, mill, de-husker, battery charger, cooling system, shelter and installation, costs about $4 300, (United Nations Industrial Development Corporation (UNIDO)/UNDP).	1. Beneficiaries: Mostly women, but also households, private operators and SMEs, local-level institutions, metal artisans. Mechanical power is used by women (agriculture). The electric power is used mostly by men for battery charging and welding. 2. Employment beneficiaries: 6 600 in 2005 in 545 MFPs in Mali, and 285 in Burkina Faso. 3. Opportunity cost-savings: In Mali alone, 2.5 hours a day are saved for 10 000 women. 4. Demand-side jobs: 26 micro-enterprises for welding. 5. MFPs are more complicated to maintain than SHSs, plain diesel generator sets and hydro plants. 6. There were 514 sites by the end of 2004, and 1 800 sites by the end of 2012. 7. Communities are responsible for some of the capital costs, maintenance, salaries and tariff collection.	1. Aims to withdraw from involvement in a village MFP project after two years of support. 2. In Mali the project aimed to withdraw in 2004, by which time the technology had become sustainable. A women's Management Committee was elected, and members trained in managerial and entrepreneurial skills to ensure the technical and economic viability. 2. The project provides a once-off subsidy, which covers setup costs and some of the equipment costs. 3. Despite seasonal needs and the low ability to pay for services, all MFPs in Mali had positive cash flows by 2004. 4. A number of strategies have been implemented to make the platform more affordable.	1. The initial involvement of women almost exclusively has resulted in problems. A focus on a mixed group appears to be a better approach. 2. Platforms have provided alternative means for the villagers to handle the tasks that would otherwise be handled by girls, and have thus released them from burdensome tasks. 3. MFPs help improve the quality of life in rural communities, the health in the community, generating additional non-farm-related income, raising the total net income of households, and empowering women to participate in the economy. 4. Reduction in water-borne diseases due to the ability to pump clean water. 5. The project improves the capacity of existing mechanics and artisans to service platforms.	1. The weak policy environment in Mali has meant that there is no coherent government strategy for scaling the project and that results are not integrated into a broader rural poverty strategy. 2. Coordination across government departments and with other actors and stakeholders is vital to ensure the success of a project like this, e.g. gender, energy access and enterprise development.

	Case study name and summary	Performance	Sustainability	Socioeconomic	Policy
5.	**Ilembe Rural Biogas Programme** Ilembe is one of the WfE flagship projects situated in Ndwedwe in the Ilembe district of KwaZulu-Natal. Some 26 biodigesters were constructed and are now operational, producing gas used for cooking. The purpose of the Ilembe Rural Biogas Programme was established to test out biogas as a possible energy solution for rural areas.	1. This is a limited pilot project involving 26 digesters installed at selected, participating households. The extent of its contribution in terms of improving access was 26 households (±120 people). 2. The real question is: what potential does this technology hold in terms of increasing access to energy on a meaningful scale? Serious concerns/doubts remain. 3. The technology is at the pilot level (R50 000 per unit). 4. No progress has been made around the financial issues/ models. 5. The genuine demand for the technology cannot be determined. 6. Further biogas programmes will have to achieve more than this one. 7. At this stage, it is hard to see how biogas can genuinely contribute to 'increasing access to affordable energy services'.	1. There is a capacity difference between the district municipalities and the local municipalities, which had an impact on implementation. 2. This takes place in remote areas using unfamiliar technology, dealing with local government, so there are capacity issues. It is a big challenge. 3. Strong community engagement to keep councillors and the community informed. 4. It is grant funded, so does not really test the long-term sustainability. 6. Need clarity in terms of willingness to pay (WtP) or paying for itself. 7. Technology demo instead of a market demand issue. 8. The availability of water will always be an issue. 9. The upfront costs of household biogas digesters are prohibitive. 10. Individual versus community ownership is a key issue. 11. Maintenance: feedstock and water each day. End-user training is important.	1. Reduction in cost of energy supplies for households (but not paying for biogas). 2. Households previously used electricity and wood. The use of wood is down and there is less indoor air pollution, but no other impacts. 3. No baseline was undertaken, so the impacts are hard to determine. 4. Socioeconomic factors: construction took 1 000 to 2 000 working days, with four to six bricklayers mixing concrete and digging holes. A task approach was used as opposed to time remuneration. This has a positive impact on skills development, but one needs to consider the costs of local labour. 5. Part of the EPWP. 6. General impacts: - Cleaner fuels - Cheaper fuels – dung instead of commercial fuels - Less indoor air pollution - Convenience/time saved	1. Is the DoE and government interested in biogas? The technology is not really viable right now. 2. Need to consider linking the technology with FBAE. 3. Part of developing a matrix of service options that are optimal if particular conditions are met. 4. Might also rank alternative service options in terms of 'transitional' or permanent. General issues: - Technology incubation - Results needs to be progressive - Attribute different status to different technologies as they become increasingly commercial and sustainable - Needs a business-model focus.

	Case study name and summary	Performance	Sustainability	Socioeconomic	Policy
6.	**Mpfuneko Rural Domestic Biogas Project** The Mpfuneko Rural Domestic Biogas Project is a WfE project, which is being implemented by Mpfuneko Community Support in Giyani, Limpopo. The objective of this project is to further develop the rural domestic biogas activities near Giyani to gain more experience with and better understanding of the following: - Marketing biogas digesters and the willingness and ability to pay for biogas - The construction of larger numbers of biogas digesters - Training constructors through a more structured approach	1. It is a challenging project because there is very little experience with payment for biogas in rural areas and the project only makes use of local labour. 2. It is fairly low in overall energy access potential – there is potential, but at this early stage in the programme/ technology development, radical upscaling is unlikely. 3. It would need to be more firmly integrated into an access plan before offering real 'access' potential. 4. One of the key lessons here is that the DoE/SANEDI is not really pushing for sustainable business models. These issues are caught up in the politics/ideology surrounding services and payments. 5. A total of 55 biogas digesters would provide energy to between 200 and 250 people. 6. The key question: Is it scalable and how? 7. Only 12 units have been installed.	1. The project experienced significant labour problems associated with the EPWP requirements. 2. The business model still needs further testing. 3. Not interested in biogas – it works. 4. Working on a management system – paying a fee. 5. The poor collect and the rich have to pay. 6. There are no fee-for-service digesters operating at the moment. 7. There have been 75 contracts signed (R120 a month) 8. Digester costs/options (including materials): R15 000. 9. There is a service company, so accountability is not a problem. 11. Example of poor operations (end-user training).	1. This is much the same as Ilembe: cleaner fuels (from wood – gas): - Cheaper fuels – using dung instead of commercial fuels - Less indoor air pollution - Convenience/time saved 2. There is also skills training in terms of constructing the digesters – as part of the EPWP, but this is hugely controversial. The Department of Labour always rules in workers' favour – you cannot really hold them accountable 3. Further impacts might have been gained if the service company model was established – may have provided job opportunities. It seems that, given the level of interest in this service option, it may still be an option (75 contracts have been signed at R120 a month).	1. Working with EEP provided a more professional experience. There were milestones, clear documentation and time frames, which were all very clear and understandable. The experience was not quite the same with SANEDI, as problems with liquidity were experienced. SANEDI says they will pay within 10 days, but payment took two months. There was no feedback on reports. 2. The grant from SANEDI was for over R1.8 million, but they have only paid R650 000. 3. There does not appear to be a coherent plan with regard to the future role of distributed renewable energy technologies in South Africa. Therefore, the relevant steps, policy or framework is not available.

	Case study name and summary	Performance	Sustainability	Socioeconomic	Policy
7.	**Nepal Biogas** Nepal Biogas has had a long, eventful history. It was started in the 1980s as a technological research project with a limited number of test models. It was expanded during the 1990s by the Biogas Support Programme into a very successful market development programme with the active involvement of the business community. This case study reviews the successes and challenges associated with the programme and the kind of learning coming out of it. SNV is one of the founding supporters/ funders, having been involved for over two decades.	1. Over 300 000 biogas digesters were installed. More than 30 000 are installed a year. 2. The Nepal Biogas Partnership Project is a collaboration between government, donors and NGOs. 3. There is a digester in every region. 4. Nepal provided expertise to other Asian and African countries. 5. Key lessons: - Give yourself - Good mix of finance - Strong policy/technology industry - Carbon finance, micro-credit - Government interest 6. The business model Started with subsidy – direct investment subsidy continues (20 to 50%) – today the subsidy is 40 to 60%. 8. Key lessons - Partnership focus - Private sector in the front - Awareness at consumer and institutional level - Standardisation of technology - Continuous R&D - Scaling up in all dimensions	1. Strong PPP. 2. Strong private sector-industry association. 3. Also strong NGO support partners. 4. It has a strong agricultural base. 5. Of the energy used in Nepal, 88% comes from biomass. 6. Do they have an independent body? In 1992, SNV funded the project. Later it was funded by an NGO and various funders. The Nepalese government now contributes 40% with extra carbon finance (10 to 15%). 7. Nepal has a policy for promoting investment in the energy sector. 8. Carbon finance 9. Biogas has a high legitimacy in Nepal. 10. Success factors: There are success factors on both the supply and the demand side.	1. The Biogas Support Programme has helped open the market for the production and sale of biogas systems in Nepal. 2. The project claims to help reduce 7.4 tonnes of GHG per household per annum. 3. Health is improved through lower indoor air pollution. Toilets have been installed in around 77 000 households in conjunction with biogas plants. This can help reduce many common diseases. 4. Women and female children save time. 5. Each biogas plant replaces two tons of wood annually. 6. Slurry fertilizing fields provide better agricultural yields. 7. CO_2 is reduced by 4.6 tons annually per digester. 8. The private sector builds digesters. 9. Many components (not all) are sourced locally. 10. Some 85 listed biogas companies are working in the programme.	1. Technology push needs to be tied in with market realities in rural areas. For instance, Nepal has a strong/stable rural economy (agriculture contributes 39% of GDP), so investments make more sense. 2. Technology has significant legitimacy – that will be supported by a number of factors (including relevant potential impact, government support, etc.). 3. Not scared to use subsidies – and not sliding subsidies either. 4. You have to have a road map! 5. Technology and development partners (big time) – they also bring their own funds so ease the risks a bit. 6. Finance evolved from grant to commercial funding. 7. Baselines are measured and impacts quantified

	Case study name and summary	Performance	Sustainability	Socioeconomic	Policy
8.	**Off-Grid Electric (OGE)** OGE is an energy service company based in Arusha, Tanzania. It offers a small SHS to customers on a fee-for-service basis. The company was established in 2011, and began operations in 2012. It provides SHSs on a fee-for-service basis, using mobile money as a payment platform. Customers pay at least $5 per month for the service, as well as an additional once-off installation and service fee. The company had installed 35 000 systems by September 2014, and was set to reach 50 000 households by the end of 2014.The current installation rate is close to 3 000 systems per month. To put this into perspective, the off-grid concession programme has installed 60 000 systems over 14 years. OGE will exceed that in one year.	1. The rate of installation is impressive at 3 000 per month, which is unheard of in Africa. 2. Smaller systems – more accessible upfront (a few dollars to get going). 3. There is no other modern competitive alternative. 4. There is a strong technology and behavioural focus. 5. It has a closed technology system (less tampering). 6. Strong end-user education (ongoing through a call centre). 7. There was not a close relationship with the Rural Electrification Agency/ government, but this has now changed with the One Million Solar Homes initiative. 8. The initiative is well publicised and attracts investors. 9. It is a game changer – there has not been any public initiative that has made so many connections that quickly. 10. It has moved on from the sustainable solar marketing packages-type environment to something very commercial.	1. Customer communications: An important feature of OGE's operations is the call centre. 2. Appropriate technology; the technical back-end is advanced. 3. Risks – customer credit quality, technology, currency (liabilities in US$; receivables in local currency). 4 What changed? - WtP customers to pay. - The ability to collect payments was not there. - Enter mobile payments. - The trick is to make sure the customer pays, and to do so cheaply. 5. Fee-for-service reduces credit requirements. 6. The largest constraint is access to capital (for OGE) 7. They did not get stuck on small system issues. 8. Significant funding 9. IFC is investing.	1. The company has an agent network in the communities. 2. There are 170 full-time staff members – many in the call centre. This will increase significantly with 1 million households. 3. Improved access to lights and communications – hard to quantify, but good. 4. Reduction in the use of paraffin – CO_2/ environmental issues 5. Improved household communication options (cellular phone usage). 6. [Potentially] lower costs in terms of household energy. 7. Maybe need to divide impacts: The standard types are improved lighting, health and communication. Other types are modernity and opportunity, which comes from a brighter, more modern and accessible environment.	1. Need to acknowledge that the off-grid space in East Africa (OGE is in Tanzania) is large and self-defining. 2. Maybe one needs to define what access means in terms of level of service. 3. Access to capital will be an issue. 4. The large-scale roll out presumably required the support of government. 5. It would require a whole lot more commitment from government and policy to attract this kind of investment (in the region of $100 million) in South Africa. 6. The model relies on the latest technology and efficiencies. 7. Payment options are critical. 8. These new companies offer financial paths. Persistent Energy reviewed 50 different businesses in Africa, but none had the margins.

	Case study name and summary	Performance	Sustainability	Socioeconomic	Policy
9.	**Africa Biogas Partnership Programme (ABPP): Ethiopia** The ABPP is a partnership between Hivos and SNV in supporting national programmes on domestic biogas in five African countries. The programme aims at constructing 100 000 biogas plants in Burkina Faso, Ethiopia, Kenya, Tanzania and Uganda, providing about half a million people access to a sustainable source of energy by 2017. During Phase 1 (2009–2013), the programme constructed 8 063 biogas plants, against a target of 14 500 in 163 woredas (districts). In the second phase (2014–2017), the programme plans to install 20 000 plants. In 2014 alone, 1 762 plants were constructed, totalling 9 825 plants constructed since 2009. The focus is on Ethiopia.	1. In its first phase, the Biogas Programme will be executed in four states. Currently, the Biogas Programme is being implemented in 163 wordas (districts) of the four states. 2. Key implementation strategies: - Multiple actors: government, the private sector, civil society, cooperatives, donors and users. - Public-private partnership: the government, NGOs and the private sector are involved, which makes for strong partnerships. - Market oriented/ commercial: users buy the inputs. There has been a significant growth of biogas production from 2009 to 2013. 3. Key implementation challenges: - Weak private sector - Lack of credit facilities - Poor commitment of stakeholders at regional level - Rising cost of construction - Households are overfeeding digesters - Health issues linked to premature slurry	1. Very closed society – it is government-controlled, and for this to succeed commercially, more open opportunities are needed in the private sector. That is the SNV experience. 2. Key implementation challenges: - High cement price (500 Birr/Qt) - High investment cost - Inadequate promotion of the programme - Lack of credit service 3. This project will develop a Nationally Appropriate Mitigation Action (NAMA) 4. Costs are important: unit costs are about $1 000 in Ethiopia, but around $3 500 in South Africa 5. Consumers are responsible for local construction materials 6. Challenges: - Delayed start - Late credit facilitation - Price rises in cement - High investment - Initial lack of widespread promotion	1. The programme trained over 5 600 users on maintenance; 2 560 of them were female. 2. Improve health and living conditions within households. 3. Reduce use of firewood and charcoal for cooking. 4. Improve soil fertility, agricultural production and reduce GHG emissions. 5. Create new jobs through the development of a robust biogas-related business sector.	1. Needs a strong private-sector role 2. Don't 'go it alone'. 3. Also needs some customisation to succeed in Africa, but some are better than others (for instance, Rwanda). 4. Must be a government institution to develop/own, to execute at policy level, but not to implement. 5. Also needs time to develop capacities outside the system. 6. Absolutely needs a road map. 7. Find balance to implementing developing world solutions at developed world prices. 8. Biogas should not be seen simply as energy, but rather as fertilizer, etc. 9. They have a long lead time, which started in the 1970s. Needs to be part of the incubation/mainstreaming process.

	Case study name and summary	Performance	Sustainability	Socioeconomic	Policy
10.	**Off-grid rural concessions (South Africa)** Launched in 2001. Concession areas: private companies Subsidies: Capital subsidy: 80% (DoE/KfW) Operating/Fee-for-service subsidy FBAE subsidy Service features: - Fee-for-service model - Ownership remains with the company - User pays for electricity service 55 to 95Wp - SHS - Lighting - Television/radio - Cellular phone charging	1. Some 60 000 SHSs have been installed (2001–2014) The original plan was to have installed 300 000 systems by 2006. 2. The New Household Electrification Strategy has a target of 250 000 SHSs to be installed by 2025.	1. Grid encroachment/absence of Electrification Master Plan 2. Lack of clear policy/political commitment to off-grid programmes 3. No high-level, dedicated champion 4. Community expectations about the programme frequently tend to be inflated, 5. Customer non-payment is a threat to commercial sustainability, with almost 50% of customers of the bigger concessions more than three months behind in payments. 6. Components' quality/ standards seem to be causing more problems, with batteries not lasting as long as they should.	1. Surveys for the Results-based Financing Programme with KfW (KES Energy Services Company): - Shows household savings on energy; amounts not clear. - Biggest impact: education (studying at night). 2. Average more than two hours extra study time per week. 3. Quality of light/safety is most frequently mentioned as a benefit. 4. Health impact: No clear perception from the household level.	1. Local industry involvement should be prioritised. 2. Dedicated staff and agency for the off-grid programme is required. 3. System sizes/costs should be re-evaluated in light of technological developments. 4. A lack of competition in the market (brought about by the concession area model) is limiting service levels. 5. Household ownership of SHSs, once it has been paid off, should be investigated.

	Case study name and summary	Performance	Sustainability	Socioeconomic	Policy
11.	**IDCOL Bangladesh** Started in 2003 with funding from GEF and the World Bank. Implemented by IDCOL. Initial target: 50 000 SHSs by 2008. Revised to six million SHSs by 2016. October 2014: 3.2 million SHSs installed. Partner organisations install, sell and maintain SHSs. Compete for customers. Subsidies and grants: 20% capital subsidy provided, but phased out. Results-based financing. Loans/financing: Loans provided to the government, which passes it on to IDCOL, passing it on to partner organisations, which finally provide credit to end-users. Technical standards and warranties are important. Institutional setup: Three committees: Technical Standards Committee, Partner Organisation Selection Committee and Operations Committee.	1. More than 3.2 million households have been provided with an SHS. System sizes range from 20 to 100 Wp, and provide lighting, television and radio as energy services.	1. Large amounts of concessionary finance are available. 2. Institutional setup and champions have proven essential to the success of the agency. IDCOL SHS staff members were all new and relatively young, coming to the programme and problem with a fresh approach and enthusiasm. IDCOL has existing regional offices spread over Bangladesh. 3. Bangladesh has an existing network (and culture) of microfinance institutions all over the country. 4. Bangladesh also features very high population density figures (even in rural areas), which is not usually the case in African rural settings. This high density reduces the costs of servicing.	1. Systems have had an economic impact at household level. Anecdotal evidence suggests that households are able to purchase replacement batteries after their initial battery has lasted for five years, without any financing being required. The SHS also means that households are not using kerosene for lighting, reducing the associated health and safety risks. It also has the benefit of modernity.	1. Local industry development was a cornerstone of the programme. 2. A dedicated staff and agency proved essential. 3. Technical standards (and enforcement) have been essential. 4. Innovative financing structure. 5. Partner organisations (implementing organisations) are locally based microfinance institutions, with strong social capital. 6. Households are trained on basic maintenance. 7. The programme ensured public-sector support at all levels (national and local) throughout the programme's life, but without public-sector implementation. This ensured that political support was provided, without political interference.

	Case study name and summary	Performance	Sustainability	Socioeconomic	Policy
12.	**Lucingweni hybrid renewable energy mini-grid** Located in the rural province of the Eastern Cape in South Africa. Lucingweni (community) hybrid mini-grid: - Funded by NERSA - Ministerial project; i.e. high-level support - Implemented by Shell Solar Hluleka (nature reserve) mini-grid: - Also installed by Shell Solar - Located close to Lucingweni Wind and solar PV hybrid off-grid system (Lucingweni): - 97 kWp system - 125 W continuous - 50 kW array of 100 Wp PV panels Vision: A network of mini-grids in the area, linking to the national grid. The system only worked for a few weeks. It was later vandalised and panels stolen.	1. The system is not working. 2. Some 220 households would have been electrified by the Lucingweni mini-grid. Later reports state that it was only 125 households 3. Original intent: - Max 1 Amp - Daily limit per household: 1 kWh (24 hours) - 230 V supply to two shops and a community centre; also intended to power two boreholes.	1. Ownership was never transferred to the local authority. Local capacity building to maintain the system was not provided. 2. Flawed system design. People were able to connect big loads. 3. The project was parachuted in, with limited community engagement. 4. High cost: - R7,76/kWh (2007) - Eskom: R0,16/kWh 5. Cost would not be recovered through local community use and payment. 6. Inclusion/exclusion. No clear boundaries/ criteria for households who were connected as opposed to those that were not.	1. Original intent: - Community centre powered, with education facilities. - Water pumping linked to agricultural production 2. Negative impact of the non-functioning system. 3. Distrust of renewable energy in the community and area.	1. There are no standardised, plug-and-play/modular models for hybrid mini-grids, which means that they have to be designed each time. This results in high costs and complicated technical problems. 2. They require substantial upfront capital and capacity building. 3. Local capacity building, especially for maintenance, is essential. 4. High levels of public sector support/(pressure?) initially. This support disappeared once problems emerged. The local authority was keen to be involved, but was not engaged or capacitated.

	Case study name and summary	Performance	Sustainability	Socioeconomic	Policy
13.	**Cleanstar Mozambique** Founded in 2010 as a partnership of CleanStar Ventures and Novozymes (Danish enzymes manufacturer). The project aimed to introduce clean cook stoves that use ethanol gel. It also aimed to produce the gel through increasing cassava crop yields, which would be delivered to a local ethanol brewing facility. Basically it would set up an entirely new bio-energy economy. Ethanol is cleaner burning than charcoal, and more convenient. Company filed for voluntary liquidation in 2014. The ethanol-producing side of the business closed down. The stove-selling part of the business was sold off, and now operates as Ndzilo. It imports ethanol from South Africa at a slightly higher cost.	1. Sold more than 33 000 stoves (5% of Maputo population) and reached sales of more than 3 000 stoves a month.	1. Cassava crops never produced enough surplus. 2. Poor transport infrastructure limited the ability of the crops to reach the processing plant. 3. The stove cost is prohibitive: $50 as opposed to $10 for a double-burner charcoal stove 4. Stove design/technical acceptability: It was redesigned based on user feedback (e.g. double burner introduced). Still, most charcoal stoves in Mozambique are on 'legs'.	1. Fuel cost: $25 a month, which is comparable to charcoal spend. 2. Health impact: cleaner than burning charcoal. 3. Local farmers are empowered to increase crop yields. 4. Local people are employed at the ethanol factory. 5. Local sales agents are used for stove sales and door-to-door marketing.	1. Tighter regulation of the charcoal-production industry, and enforcement of charcoal stove standards is necessary. 2. Subsidies for the fuel and/or stove costs, especially if this presents the opportunity of opening up an entirely new agricultural economic opportunity.

	Case study name and summary	Performance	Sustainability	Socioeconomic	Policy
14.	**Toyola** Founded in 2003 in Accra, Ghana; the largest per capita consumer of charcoal in West Africa. Produce and sell efficient charcoal-burning stoves: 40% more efficient than traditional charcoal stoves. The stoves are produced from locally available scrap materials, and fired clay liners. Self-employed artisans produce stove bodies and liners. Encourage artisans to specialise in one of the 26 stove parts. Toyola finishes the assembly. Stoves are robust: 2.5% failure rate in Year 1, 15% in Year 3. Some 60% direct sales from Toyola, using a mobile delivery system and retailers. Agents also sell stoves on 10% commission, and are provided with stove credit, which can be passed on to consumers.	1. Sold more than 300 000 stoves between 2007 and 2013, more than 90% of which are still in use. Reached a sales rate of 100 000 stoves a year. 2. Aiming to sell three million stoves by 2020.	1. Some 25% of its funding is carbon-based (Gold Standard project). There are serious questions about financial sustainability in light of carbon price reductions. 2. Investment capital is needed for small entrepreneurs.	1. Stove costs between $6,60 and $33, depending on size. Cost is recovered through charcoal savings in Year 1. 2. There are health impacts through reduced indoor air pollution. 3. Employment: more than 200 local artisans and more than 300 sales agents.	1. Quality assurance and standardisation systems are put in place to leverage local artisanal production, while maintaining quality standards. 2. Work with local systems/ capacity, e.g. artisans, instead of importing technology. 3. Good records allow for access to additional funding (e.g. carbon funding).

	Case study name and summary	Performance	Sustainability	Socioeconomic	Policy
15.	**Tsumkwe Energy Project - Solar Hybrid** Namibia has only 13% of households with access to electricity. In response, the Desert Research Foundation of Namibia (DRFN) initiated the Tsumkwe Energy Project (TEP). Tsumkwe is a settlement 304 km from the nearest city. The project aimed to improve the electricity access of the 3 800 people of Tsumkwe, most of whom are San (Ashton et al., 2012). It provides 918 polycrystalline solar cells, a 766 kWh battery storage field and three diesel generators with a combined capacity of 630 kVA (Asthon et al. 2012). The project was coordinated by the DRFN and funded by the EU (75%), NamPower (14%) and Otjozondjupa Council (11%) for a total amount of US$3.5 million.	1. The improved access to electricity greatly enhanced the lives of Tsumkwe residents as streetlights, water pumps and clinics were upgraded and developed. 2. To prevent excessive load on the system, a range of energy-efficiency measures were implemented: (electric stoves for LPG, solar water heaters, CFLs, etc.). 3. The project resulted in more people using electricity and the result was growth in the load on the mini-grid. 4. Energy management is a constant challenge and requires complete buy in from people. 5. The maximum demand is 80% of the maximum capacity allowed to avoid degradation of batteries and outages. 6. There is no long-term strategy in place that addresses increased demand due to increased population.	1. Electricity in Tsumkwe previously cost N$6,00 per kWh. The amount was subsidised by the Otjozondjupa Regional Council of Namibia. Residents paid a tariff of only N$1,00 per kWh, while institutions paid N$1,90. 2. It now costs N$3,50 per kWh due to a reduced subsidy. 3. The project employs a small local team: two technicians, PV cleaners and two people to look after the generators. 4. Lower than the optimal number of households are connected – poor stakeholder engagement. 5. Reliance on foreign funding and the lack of involvement of NamPower suggest a lack of local support for the project. 6. The project aims to establish independent power producers. 7. The battery storage for the system is under-capacitated.	So far there is no evidence of the hybrid system having contributed to increased income to businesses or individual households in the area. The greatest benefit is the expanded hours of public services: - 24-hour water supply. - More accessible library and computer services through the extended hours of the Community Learning and Development Centre. - The improved ability of the clinic to deal with night-time emergencies. - The installation of streetlights along main roads. - Increased access to banking services through NamPost. - Increased broadcasting time and decreased broadcasting cost of the Tsumkwe Namibia Broadcasting Corporation.	1. Limited capacity of the local Department of Works to operate and maintain the solar-diesel hybrid system and ensure smooth operation in the future. 2. The TEP is largely a pilot project run by the DRFN, which does not wish to continue providing management and maintenance. 3. NamPower sees its support of the TEP as a social responsibility and is therefore not heavily involved. 4. It is suggested that a lack of local support for the project detracts from long-term sustainability. 5. Currently no policy for regulating tariffs in rural communities where the residents cannot pay high cost-reflective tariffs.

	Case study name and summary	Performance	Sustainability	Socioeconomic	Policy
16.	**Wind for Prosperity** Aims to bring affordable and reliable electricity to at least one million people living in rural areas (www.windforprosperity.com). Project by Vestas and local partners with on-the-ground knowledge, requiring a different approach to mature wind markets. Aims to install wind hybrid mini-grids and provide power at 30% less than diesel generators. The models are easy to transport, simple to erect, reliable and simple to maintain, and will be integrated into state-of-the-art wind-diesel power generation systems to connect to isolated mini-grids. The project is registered under SE4All. In Kenya, it will centre on up to 13 Kenyan communities, which are home to more than 200 000 people.	1. Too early to assess performance.	1. Too early to assess performance. 2. Public-private partnerships, in part driven by global turbine manufacturers seeking new markets and at the same time addressing energy poverty in developing countries. 3. Kenyan pilot projects are being jointly developed by Vestas, the pan-African renewable energy power project investor Frontier Investment Management (www.frontier.dk), and a local development partner. It is working closely with the Kenyan Ministry of Energy, Kenya Power and Light Company, and various government agencies to prepare the first installations. 4. The private-sector focus, with support from the public sector, done at scale, appears to be an ingredient for success.	1. The model for Wind for Prosperity is to attract private investors to own the generation facilities and manage the operations. 2. Typically, this would manifest in a private company owning the wind turbines and selling the output to a local utility or governmental energy agency, which would in turn distribute it to the end user.	1. The project is aligned with Kenya Vision 2030 – the country's development programme, which covers the period 2008 to 2030. Energy is recognised as a crucial ingredient to achieve Vision 2030 2. Wind for Prosperity is part of SE4All.

	Case study name and summary	Performance	Sustainability	Socioeconomic	Policy
17.	**The Wind Factory Madagascar** Madagascar has one of the lowest energy consumption levels in the world, at about 0.2 tonnes oil equivalent per person. Access to electricity is low at 20% of the total population and only 5% of the rural population. The Wind Factory Madagascar (TWFM) focuses on the following core activities: - Installation of medium-sized (80 to 250 kW) grid-connected hybrid wind turbines in partnership with JIRAMA (the state-owned electric utility and water services company in Madagascar) in cities and towns. - Supply of energy (hybrid wind-energy systems) to clients, such as other IPPs, the private sector, donor organisations, NGOs, communities and the government. - Service and maintenance activities for clients.	1. The Ilakaka project resulted in over 400 grid connections, providing electricity to about 2 500 people and over 200 businesses. 2. Reduced diesel by 40 000 ℓ per annum – decreased carbon emissions equivalent to over 100 Mt CO_2 annually. 3. The Malagasy locals were trained in the Netherlands for a month in order to achieve proficiency in maintaining and installing wind turbines. 4. The apparent success of this project is evident in Rolland and Auzane (2012), who believe that this project has given local government and private business confidence that "wind energy is not exclusively for developed countries and main grids". 5. Prices comprise between US$0,15 and US$0,35 per kWh. 6. The village of Ilakaka had been living without electricity from the end of 2012 until at least the end of February 2013.	1. Small and medium wind turbines (SMWTs) require a certain degree of maintenance. Experience shows that good performance needs regular maintenance. 2. A significant challenge for the long-term operation of small and medium wind turbines is their repair and the availability of spare parts. Faults need to be identified correctly, and require qualified/trained personnel to fix them. The right spare parts must also be ordered, shipped and paid for. To help with these issues, more and more installations in rural areas are equipped with remote control systems to monitor the performance and possible failure at an early stage.	1. Knowledge transfer: Six service engineers and two managers will receive training in service. 2. Employment: During the course of the project, TWFM will create direct jobs for 26 people. 3. Supply chain: Because the masts for wind turbines, frames and foundations will be made locally, the project will also create indirect jobs for the supply of goods. 4. The impact on women is positive; better health conditions within households, less time spent collecting wood. 5. Other: Electrification has a positive influence on the lives of poor people (access to communication, light in schools and a reduction in health problems related to air pollutants). Wind energy does not cause conflicts over natural resources. Medical insurance will be provided and information about HIV/AIDS will be made available.	

	Case study name and summary	Performance	Sustainability	Socioeconomic	Policy
18.	**Wind Energy Solutions - Indonesia** Wind Energy Solutions is a Dutch-based manufacturer of small and mid-sized wind turbines (50 to 250 kW). In Indonesia, the project consists of a hybrid power system: diesel generators, a solar power station and a wind power station. Power was originally supplied by diesel generator sets. Due to the remote location, diesel had to be imported by boat, which added to the cost. This project introduced alternative energy solutions to save on the diesel costs, and due to the favourable wind regime on the islands, wind energy was seen as particularly suitable. The electricity on the island is mainly used by local households and small industries.	1. Five 80 kW turbines were installed, providing a total of 400 kW of wind energy. 2. The project implementation took longer than expected: approximately a year, mainly due to a lack of support from the local authorities. 3. The project's saving in diesel is calculated at €250 000 per year.	1. Five turbines were purchased by PLN (the national utility), and cost €800 000. 2. Electricity generation costs are around €0.19/kWh.	1. No details available	1. No details available

Appendix B: Open-ended interview guide

- Opportunity environment
  - What are the key requirements for a successful off-grid programme?
  - What has changed over the past decade or so that has given rise to greater signs of success?
  - What role does government policy play?
  - What is the role of the private sector?
  - What is the role of technology, innovation, etc?
  - What is the importance of planning?

- Issues relating to the technology maturation process
  - How do technologies evolve/mature?
  - What programmes are in place to assist the integration of technologies?
  - How are projects evaluated?
  - Addressing the sustainability criteria
  - Don't want to pay for the same outcome twice – how to advance specific technologies.

- Issues around access to finance
  - Includes both consumer/end-user finance, as well as operating/asset finance

- Issues relating to socioeconomic impact

- Sales and business methodologies
  - Fee-for-service
  - Capital and operational subsidies
  - Technical standards
  - Aftersales services

- South Africa
  - Awareness of the South African off-grid environment
  - Suggestions to improve outcomes

Appendix C: Summary interview transcripts

Wim Jonker Klunne

- Wim recently joined EEP after many years at the CSIR, where he was a senior researcher on renewable energy. He has had to hit the ground running or, as he puts it, 'learning on the job' with his new role as EEP Programme Director.
- Finland is the managing country for EEP, although the UK's DFID is also a contributor and plays an important role in the programme.
- The first phase of EEP (which ended in 2013) was not very well monitored (the monitoring and evaluation focus was inadequate, so there was too little learning and positive feedback). It did not have appropriate management mechanisms in place. At times, it was not even able to recover unspent funds from project recipients.
- Donors are part of the decision-making process in terms of granting funds, and have a strong preference for sustainable business models. He would like to see the project's business being increasingly self-sustaining after the grant has been invested. If this process is not articulated in the proposal, it won't be approved. This is a lesson for South Africa.
- The DFID is very clear – as much of 60% of the grant/project portfolio might fail – and it's important that the programme learns from that and knows why some succeed and others do not. Mechanisms/tools are needed to ensure increased learning and the reintegration of lessons in the project management process.
- Examples in Tanzania indicate that some mini-grid projects are successful, while others are not. A financial model is crucial. One must develop a financial model. Those that could charge the necessary tariffs (read revenue) as opposed to those that could not was very often the difference between success and failure.
- It is important that the service is something people really want to have. They are deprived if the service does not work. The benefit of being connected to one's service impacts on the willingness to pay and correctly utilise the service.
- The private sector is important: entrepreneurial and efficient – but joint public-private-sector involvement is desirable. For example, the hydro-plant in Lesotho was donor funded and totally paid for by Sweden. It was 60 km from the nearest electricity grid point. It provides utility-type power to 160 customers, but the plant has a problem. The installed capacity is lower than the original specification (a time issue). This can be solved quite easily, but one cannot operate diesel and hydro at the same time. The diesel back-up was always there (for the dry season). Tariffs are fixed at R1,30, but diesel costs R4/kWh, so it is running at a loss when diesel is on. The hydro problem has still not been solved. Because it's publicly run, the results/numbers are publicly available, but there is no urgency. It tried to outsource this a few years ago. It was managed by a South African company, but they moved on (forced to keep staff, etc.).
- The point needs to be made: at the political level, it is unfashionable to talk of higher costs of rural service delivery, but this does need to be factored in. Subsidies need to be involved and a combination of private-sector/public sector finance will in all likelihood be required. The service needs to become more efficient over time.
- Implementation modality: in the case of eTolls, for example, the concept of payment is acceptable, but the method is the issue. The model needs to get buy-in from the user communities. It should be compatible with incomes and value of service.
- Affordability: Who will pay? Local people often cannot pay. Appropriate levels of research are required to ensure sufficient levels of adoption through alignment with willingness-to-pay.
- Getting the long-term viability sorted out is a key challenge. There are different levels of expectations associated with a technology that progresses from 'concept/pilot' through to widespread roll out. This needs to be better understood.
- There should be a logical choice/appropriate technology. But what defines logical choice? There should be an overarching framework (like a master plan).

- EEP is also developing ToR for an analysis of its own portfolio of work – a tool is needed to understand how to evaluate progress with particular technologies and objectives.

Dirk Muench

- Dirk remains deeply committed to the Distributed Energy Service Company (DESCO). He and Pepukaye Bardouille of the IFC developed in a joint paper[1]. This concept suggests that a new breed of distributed energy service companies can connect 500 million people within a decade.

- Growth rates on display by off-grid companies, such as Bboxx, M-Kopa, and OGE are at a different scale to anything before. M-Kopa is growing at 125 000 systems a year, while OGE is reaching 35 000 to 40 000.

- Persistent Energy Capital invested in OGE at an early stage. They thought: "This is it!" The company's growth seems to prove this. Two years ago, projected growth rates by these companies were considered foolish, but now it is happening or even being exceeded.

- What changed? Why not in South Africa 10 years ago (which is when the off-grid concession programme started)? What enabled this growth? Why is this model so powerful?

- Start by looking at the economics. It is financially attractive. One can extract enough revenue from customers to attract a margin. The reason is that one can have customers pay over time. It's all about instalment sale.

- The financing aspect to this model is so critical. This is why instalment sale works, as it exceeds the willingness and ability of customers to pay. One can never scale without these terms.

- They reviewed over 50 retail/cash business in Africa. The margins are too small to sustain business.

- These new companies are offering financing paths. They are offering returns in a very important space (off-grid).

- Why didn't this happen 10 years ago? It was attempted (like in South Africa), but the challenge was the willingness of customers to pay. The ability to collect payments wasn't there.
  - Enter mobile payments.
  - Need to do two things:
    Make sure the customers pays (lower non-payment by allowing a level of flexibility in payment and ensuring that the service aligns with needs, etc.).
    Do so cheaply (mobile money – referring to transaction costs).

- Persistent transaction costs are really low. This makes this economic model attractive. This is a large consumer market. It is not necessarily bottom-of-the-pyramid, but it is already there – it works at the bottom of pyramid. Mkopa is getting there now. This is really exciting. There are no real hurdles to scale. It is attractive to everyone (customers, business, etc.).

- Look at these companies. They basically indicate the same thing: a financing plan and mobile.

- Also look at Mobisol in Rwanda. It has a range of systems. Do not get stuck on small systems issues. Rather refer to services. Don't talk about kWh. This is doing the system a disservice. It will never grow/scale. Consumers are settling for less energy, but not for less lifestyle – they don't care about kWh, but rather for services. What can you power and what can you pay? (efficiency issues).

- The focus has moved to finance – but not necessarily cheaper finance, simply the availability of finance. In a prepayment context, these companies pre-finance all the costs, so the obstacle to growth is the ability to access capital to finance assets (hardware).

- The real thing is financial intermediaries and investors, who need to be managed well. They need a good knowledge of the market, to distribute capital and to work with that company going forward. Financial intermediaries to work with solar companies – business management – business development services, mentoring, etc.

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1 Bardouille, P. & Muench, D. 2014. *How a new breed of distributed energy services companies can reach 500 mm energy-poor customers within a decade: a commercial solution to the energy access challenge.*

Simon Bransfield-Garth

- Azuri Technologies was one of the early pay-as-you-go companies/approaches in the region.
- The size of its system ranges from 2 W to 20 Wp.
- The guiding business principle: they are better off with Azuri than they were before. This is how they design their programmes in terms of both technology (ability to deliver services) and cost (price point is better than the previous costs of kerosene and mobile phone charging).
- A smaller system costs about $1,70 a week. Based on this, households should be better off (it is roughly half of what people spend on the non-electrical equivalent for lighting and paying to charge their mobile phones).
- Rent-to-buy model: the customer owns equipment in about 18 months, but one can promote upgrades as well, which ensures service growth and the passing on of new technologies. It also ensures a longer-term relationship with the customer – more a utility/service relationship than an outright sale.
- We focused our business in the top left-hand quadrant – relatively low power, high impact – knowledge economy, lights, phones, laptops.
- "They sell services not energy." This is a constant refrain amongst these companies. It is not the size of the system, but the services it supports. Obviously, this needs to be accompanied by energy efficiency and new technology innovations (such as LED lights).
- Azuri currently operates in 10 countries, including Burundi, Kenya, Rwanda, South Sudan, Sudan, Tanzania, Uganda and Zambia. It has recently entered the market in West Africa as well – Ghana being the first country in that region.
- Limiting factors include distribution access and debt finance (not market). This was mentioned by Dirk Muench as well. It is the energy service companies that require access to capital and not the consumers on the micro level, as there are no upfront costs for customers, but systems cost money due to the companies having to pre-finance them.
- It is not possible to build business on equity. One needs a debt vehicle to fund working capital. Debt used to pay for working capital. Then that special purpose vehicle had privileged access to revenue from customers. That is the way Azuri has built its model.
- Looking more broadly at other finance facilities, Bloomberg provides debt finance for the industry as a whole. This is likely to be a massive fund (in excess of $100 million). The success of companies like Azuri and OGE is clearly making waves and investors are getting very interested; and the funding appears to be following.

Zubair Sadeque

This conversation relates to the phenomenal achievement of the IDCOL Programme in Bangladesh.

- Size of systems: smaller systems: 20 to 30 Wp can operate smaller television sets.
- Concessional financing: the World Bank's international technical advisor credits funds to the implementing agency. A loan to government was given to the Rural Electrification Agency. This has been crucial for driving/upscaling the programme.
- Bank policy (World Bank) would not allow the provision of financing at a rate other than the commercial rate. Although IDCOL receives the funds at a concessionary rate (around 3%), it is still commercial as opposed to grant finance.
- Outputs-based assessment: independent verification. How does such a large programme manage quality, honesty, etc.? It is outputs-based: the money is only paid after the installation has been done (much like the concession programme in South Africa).
  - IDCOL has its own inspectors
  - No independent auditors
  - IDCOL regional supervisors
  - Several layers within IDCOL
  - Independent technical audit – done by an outside auditor
- Standardisation – this is crucial for rolling out quality products and for the long-term sustainability of the systems and the overall programme. Key features include the following:
  - Committee: system components are crucial – includes battery standards, wiring, modules, lights, etc.
  - Seven specific systems have been approved (different sizes – important for choice and appealing to the broader market – these sizes

were determined over time as technology/ the programme matured)
The battery capacity has to match the panel size in each case – well-integrated systems.
– Keep the standards strict enough – with these volumes, it is unlikely to put too much pressure on price because the scale of the requirement is so vast.
– List of preferred vendors: another key feature of the programme is the need to ensure that agents are capable and do not undermine the sustainability of the programme.
– Continuous range is not possible – there must be a fixed number of products and not simply 'customised' systems that are harder to regulate in terms of components, costs (payment plans), etc.
– IDCOL's people are university experts. They are all highly trained and capable people, which supports the sustainability of the programme.

- Maintenance is another crucial part of the programme, particularly in a payment plan environment. If the system stops working, customers will stop paying. Key features include the following:
  - Maintenance contract: NGO offers options to customers.
  - The systems are running properly, even after three years.
  - There are adequate channels for returning batteries.
  - The system standards were so well laid out
  - The battery is actually slightly larger than what was required. Technical specifications are crucial.

- Other donors
  - Can only be done once the system is working well.
  - All donors were putting funding into the same programme.
  - Buy-in would be hard initially, but success breeds success/further interest.

- Service territories
  - Operationally: will not have interest, capacity
  - Tried this in Bangladesh – fee for service
  - Market model
  - Risk: grid encroachment?
  - Buy-back guarantee
  - Service territories need to announce their plans
  - But then the household received a double subsidy – master plan/planning is crucial so that there is less churn (SHS removals)

- Solar lanterns
  - IFC is doing lighting in Bangladesh
  - Purely market-based
  - Building capacity for companies
  - No financing involved
  - Trying to reach the bottom of the pyramid
  - Doubts about bulk purchase
  - Can't subsidise the lantern – how do you count this?
  - Number of lanterns sold – indicator of market growth
  - Let the lantern business be completely left to the market

Appendix D: Key issues emanating from the literature review

Title	Key issues
Aitken, R., Bank, D., Purcell., C. & Clarke., A. 2009. NuRa in depth case study. Report for the Renewable Energy and Energy Efficiency Partnership (REEEP).	• Level of service integration has benefits • Part of the challenge of rural utilities is that they need to be far more dynamic and flexible than large-scale, grid-based ones. • More integrated utilities present greater opportunities for mixed customer markets, not having to rely exclusively on impoverished rural households with their concomitant income constraints and uncertainties. • In NuRa's case, further integration is made very possible by virtue of the fact that the distribution networks, contacts, learning experiences and human resources are almost all in place already.
Bardouille, P. & Muench, D. 2014. How a new breed of distributed energy service companies can reach 500 m energy-poor customers within a decade.	• Rather than supporting a dogmatic view of specific systems as panacea, take a step back and apply a technology-agnostic, market-oriented lens to the issue. • People do not want kilowatt hours, they want services. • Donors and development finance institutions need to show a higher tolerance to risk. • The proliferation of mobile phone infrastructure and businesses at the base of the pyramid opened a commercial path for many.
Bellanca, R. & Garside, B. 2013. An approach to designing energy delivery models that work for people that live in poverty. CAFOD/IED.	• It outlines a participatory framework or approach for designing energy service delivery models for people living in poverty, building on previous research. • This also requires a 'people-centred approach' that begins by building a detailed understanding of the end users' needs and wants, and the specific context for intervention. • Test this approach through discussion with partners on the ground, with the aim of developing it into a methodology for project implementation in different local contexts. • The approach does not aim to solve key, structural questions, such as the affordability of energy services per se, but rather tries to understand and build the financial sustainability of the specific energy delivery model.
Clark, A. 2005. Innovations in South Africa's Off-grid Concession Programme. Human Sciences Research Council.	• Private-sector concessionaires have been given the space to innovate, and technologies and delivery models have not been strictly specified. • The public sector has produced guidelines on the anticipated end state. • Innovation is fostered by a supportive policy, planning, and political environment. • Innovation is best enhanced in an entrepreneurial environment, and requires champions who consistently work at making improvements.

Title	Key issues
Department of Energy. 2012. Non-Grid Electrification Policy Guidelines. Pretoria: Department of Energy.	• Universal household access to electricity is one of the cornerstones of the White Paper on Energy Policy. • The Non-Grid Electrification Programme is designed to temporarily give deep rural communities access to limited electricity until such time as grid connections are possible. • The lowest capacity grid supply cannot be supplied within the capital expenditure limit. • To fast-track service delivery and meet the universal access target, the Department is now looking to roll out the Non-Grid Electrification Programme to other areas that fall outside the concession areas.
Pachauri, S., Scott, A., Scott, L. and Shepherd, A. 2013. Energy policy guide: energy for all. Chronic Poverty Advisory Network.	• It is intended for policy and programme designers and implementers in energy agencies, as well as policy makers in ministries of finance and planning, energy, rural development and health, alongside those in local government. • Provides an overview of the current energy poverty situation in developing countries and presents a new analysis of the relationship between access to energy and poverty dynamics (the movement of people into and out of poverty over time and being trapped in poverty, or chronic poverty). • Presents key questions for policy makers in meeting the challenge of delivering energy services to chronically poor people. • Categorisation of countries according to the priorities and challenges they face, together with conclusions and recommendations for different categories of countries.
Peters, J., Sievert, M., Lenz., L. & Muyehirwe, A. 2014. Impact evaluation of Netherlands-supported programmes in the area of energy and development cooperation in Rwanda: the provision of grid electricity to households. RWI/ISS.	• This report presented the results of an impact evaluation of Rwanda's Electricity Access Roll-Out Programme (EARP) that is financed – among other donors – by the Embassy of the Kingdom of the Netherlands as part of its Promoting Renewable Energy Programme. • Micro-enterprises seem to face other (or additional) bottlenecks than (only) a lack of access to electricity. • Found that a considerable share of the target population that – in principle – has access to the grid, now does not connect (here: 40%), virtually all of them for cost reasons. • The EARP allows for Tier 4 access in terms of electricity supply. However, large parts of the target group reveal demand patterns that only qualify for Tier 1 or Tier 2 access.

Title	Key issues
Prasad, G. 2007. Electricity from solar home systems in South Africa. Create Acceptance Case Study. Energy Research Centre, University of Cape Town.	• Although the SHS technology is easy to use, the introduction of PV technology in remote rural areas has often been compared to providing space age technology to the least developed populations. • The service provider does not understand the needs and conditions of the customers, and the customers do not understand the technology and the often complicated agreements that go with it. • The project did not facilitate income generation. Productive end uses for PV systems are known in other parts of South Africa. The addition would have enhanced social acceptance and affordability. • The service providers showed that their business model to provide PV electricity to the rural poor was adaptable to the local conditions.
Van der Laan, R. 2013. Socio-economic impact assessment of rural electrification. Foundation Rural Energy Services	• Numerous studies indicate that electrification in rural areas greatly improves quality of life and reduces poverty (e.g., Human Development Research Centre, 2002; Energy Sector Management Assistance Programme, 2003; IEG/World Bank, 2008; and Organisation for Economic Cooperation and Development/International Energy Agency, 2010). • Electricity in rural communities is most commonly used for lighting and television. This leads to several social and economic benefits, including improvements in education, health, security and access to means of communication. • Review showed that while electrification is strongly beneficial to rural communities, the (magnitude of) specific benefits depends on the local context. • An important contributor to poverty reduction is the increase in income as a result of jobs created by the local electricity supply companies.
Wlokas, H. 2011. A review of the solar home system concession programme in South Africa, Energy Research Centre, University of Cape Town.	• The concession companies are dependent on the allocation of implementation areas by the DoE. With increasing electrification, existing customers are lost and the DoE is slow in identifying new areas and convincing municipalities to take part in the programme. • It has proven not to be possible to run a financially viable concession company by providing maintenance services alone. • The non-payment of the municipalities and their arguing around indigent registers are difficult as well. • A lack of communication and honesty between Eskom, the municipalities, the DoE and the SHS companies create serious barriers to accessing reliable information on the extension of the national electricity grid.

Title	Key issues
International Energy Agency (IEA) 2014. World Energy Outlook 2014 – Electricity Access Database. International Energy Agency (IEA) 2010. Energy poverty: how to make modern energy access universal. OECD/IEA publication.	• Sub-Saharan Africa is rich in energy resources, but very poor in energy supply. • A severe shortage of essential electricity infrastructure is undermining efforts to achieve more rapid social and economic development. • Bioenergy is at the heart of the energy mix[1]. • In our main scenario, the sub-Saharan economy quadruples in size and energy demand grows by 80%, but energy could do much more to act as an engine of inclusive economic and social growth. • A modernising and more integrated energy system allows for more efficient use of resources and brings energy to a greater share of the poorest parts of sub-Saharan Africa.
Tenenbaum, B. Greacen, C. Siyambalapitiya, T. and Knuckles, J. 2014. From the bottom up: how small power producers and mini-grids can deliver electrification and renewable energy in Africa. *Directions in Development*. Washington, DC: World Bank. doi: 10.1596/978-1-4648-0093-1.	• Small power producers (SPP) are independently operated electricity providers that sell electricity to retail customers on a mini-grid or to the national utility on the main grid or on an isolated mini-grid, or to both. • When one has expertise or experience in a particular area, whether it is engineering, economics, marketing, law, regulation or another field, there is a natural tendency to define key problems and solutions in terms of one's expertise. • It is unrealistic to expect that there will ever be enough donor or government funding to support a large-scale ramping up of small power producers' projects throughout Africa. • We noted that, in addition to financial capital (the 'seeds'), successful SPP projects also require human capital (the 'fertilizer'). • As with any new business, access to market data will be a key requirement for success in SPP projects.
Matlawe, S. and Setlhoho, G. 2013. New Household Electrification Strategy Presented at the IEP Stakeholder Consultation Workshop: Overview of Universal Energy Access Strategy.	• Households without electricity: ~3.2 million (informal 1.2 million and formal 2 million). • Escalating electrification costs and limited funding, as well as the high growth rate of houses (formal and informal), resulted in a serious threat to reach universal access in the country. • Despite its successes to date, the electrification programme will fall short in meeting its target of electrifying 92% of formal households by 2014, as defined as backlogs in 2001/02. • It is expected to deploy around 300 000 SHSs and reach universal access for formal households in 2025.

1 The IEA believes that bioenergy will play a very important role in future energy scenarios – bioenergy referring to biomass-to-energy processes (including wood, residues, energy crops, etc.).

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