“Assessing the Sustainable Infrastructure of a Low Carbon Community: Lynedoch EcoVillage Case Study”

by

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Declaration

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Abstract

Urban areas are responsible for 70% of global CO_2 emissions and the rapid growth in urbanisation presents a significant risk to cities. It is predicted that by 2030 more than 70% of the South African population will be living in cities. The decarbonisation of urban systems, especially building and energy infrastructures are therefore strategically important in mitigating climate change. Although reaching the goals of sustainability is complex and with few straightforward answers, experimentation is deemed necessary, and the biggest challenge of our time is for our carbon-based economy to transition into a circular economy ultimately. Some intentional communities globally have been experimenting with re-imagining socio-technical aspects of this nature. Four of these communities have been examined in this study - having not just adopted specific facets of sustainability but incorporated a whole sustainability system within different contexts. The similarities and differences of three have been compared with the fourth, the main case study. Lynedoch EcoVillage is an intentional community in the Western Cape province of South Africa that has applied alternative building practice. Recently twenty-seven households also became part of a micro-grid pilot project by Eskom Research, Testing and Development Laboratory. This micro-grid is an embedded photovoltaic (PV) solar system, inclusive of smart meters, with the aim of producing energy locally. This study assessed the current sustainable infrastructure in Lynedoch EcoVillage and interrogated the low carbon neighbourhood's sustainability claims, inclusive of the influence the human factor has had on implementing these experiments. This was accomplished by analysing four neighbourhood sustainability assessment (NSA) tools and comparing these with the ecological design framework of Bill Reed. The aim was to determine the best tool set for measuring restorative sustainability in the light of embodied energy, design (energy efficiency) and flow (energy use). Although this thesis highlights the limitations of NSA tools and features the valued experimental sustainable performance of these intentional communities outside of conventional practice, possible context-specific uniquely-developed measuring tools could reach into these gaps and measure sustainability more accurately. A further comparison was done between the sustainable infrastructure in Lynedoch EcoVillage and conventional infrastructure within middle class neighbourhoods and how experimentation with materials, building design principles and energy systems could decrease embodied energy, advance energy efficiency and lead to less overall energy use. Through indicative data collection of embodied energy, energy efficiency and energy use, the alternative building materials, sustainable building design principles and specific socio-technical aspects used in Lynedoch EcoVillage, has shown to outperform the energy efficiency of the same micro-grid system in a conventional building application by 60-70%.

Opsomming

70% Van globale CO_2-emissies word toegeskryf aan stedelike groei, en die vinnige toename in verstedeliking bied ‘n groot risiko. Daar word voorspel dat teen 2030 meer as 70% van die Suid-Afrikaanse bevolking in stede sal woon. Enige middels om koolstof in stedelike stelsels te minimaliseer, veral in die bou- en energie-infrastruktuur, is dus strategies belangrik om klimaatsverandering te bestry. Alhoewel die bereiking van die doelwitte vir volhoubaarheid kompleks is, met min eenvoudige antwoorde, word eksperimentering nodig geag. Die grootste uitdaging wat ons in die gesig staar, is om ons koolstofgebaseerde-ekonomie oor te skakel na 'n sirkulêre-ekonomie. Sommige doelbewuste gemeenskappe, in verskillende geografiese gebiede, eksperimenteer tans met die herontwerp van sosio-tegniese aspekte van hierdie aard. Vier van hierdie gemeenskappe word in hierdie studie ondersoek – hulle het nie net spesifieke fasette van volhoubaarheid toegepas nie, maar probeer ook 'n hele volhoubaarheidstelsel binne verskillende kontekste toepas. Die ooreenkomste en verskille van drie word vergelyk met die vierde, die kern-studie. Lynedoch EcoVillage is 'n doelbewuste gemeenskap in die Wes-Kaap, Suid-Afrika, wat alternatiewe boupraktyk toegepas het. Onlangs het sewe-en-twintig huishoudings ook deelgeneem aan 'n mikro-krag netwerk projek van Eskom se Navorsings-, Toets- en Ontwikkelingslaboratorium. Hierdie mikro-krag netwerk is 'n ingeboude fotovoltaïese (PV) sonkragstelsel, insluitend ‘smart’-meters, om plaaslike energie te produseer. Die studie het die huidige volhoubare infrastruktuur in Lynedoch EcoVillage, asook hul lae-koolstof-bewerings ondersoek, insluitend die invloed wat die menslike faktor op die implementering van so ’n eksperiment kon het. Dit is onderneem deur die ontleding van vier omgewingsvolhoubaarheidsevaluerings (NSA) en dié dan te vergelyk met die ekologiese ontwerpraamwerk van Bill Reed. Die doel was om die beste instrumentestel vir herstellende volhoubaarheid te bepaal in terme van ingeslote energie, ontwerp (energie-effektiwiteit) en vloei (energieverbruik). Hierdie proefskrif beklemtoon die beperkings van volhoubaarheidsevaluering-instrumente, terwyl dit die waardevolle eksperimentele volhoubare prestasies van doelbewuste gemeenskappe, buite die konvensionele praktyk erken. Moontlike konteks-spesifieke en uniek-ontwikkelde evaluering-instrumente kan in hierdie beperkings aanvul om volhoubaarheid meer akkuraat meet. 'n Verdere vergelyking is getref tussen die volhoubare infrastruktuur in Lynedoch EcoVillage en ’n konvensionele infrastruktuur van ‘n middelklasgemeenskap - en hoe eksperimentering met boumateriale, bouontwerpbeginsels, en energiestelsels, ingeslote energie kon verminder, energie-doeltreffendheid kon verhoog, en algemene energieverbruik kon verminder. Deur middel van indikatiewe data-insameling van ingeslote energie, energie-doeltreffendheid en energieverbruik, is daar bevind dat die alternatiewe boumateriale, volhoubare bouontwerpbeginsels en sosio-tegniese aspekte wat in Lynedoch EcoVillage toegepas is, die energie-doeltreffendheid van dieselfde mikro-krag netwerk in ‘n konvensionele boutoepassing met 60-70% oorskrei het.

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Table of Contents

List of Figures

List of Tables

List of Photos

List of Acronyms and Abbreviations

A	Ampere
A/h	Ampere per hour
AMPS	All Media and Product Survey
AC	Alternating Current
ADMD	After Diversity Maximum Demand
BRE	Building Research Establishment
BREAAM	Building Research Establishment Environmental Assessment Method
CASBEE	Comprehensive Assessment System for Built Environment Efficiency
CAT	Climate Action Tracker
CDIAC	Carbon Dioxide Information Analysis Centre
CO_2	Carbon Dioxide
C40 cities	Climate Leadership Group (C40)
DB	Distribution Board
DC	Direct Current
DEA	Department of Energy Affairs
EDGE	Excellence in Design for Greater Efficiencies
EIA	Energy Information Administration
ERC	Energy Research Centre
ESKOM	Electricity Supply Commission
GEN	Global Ecovillage Network
GBCA	Green Building Council of Australia
GBCSA	Green Building Council of South Africa
GHG	Green House Gas
HOA	Home Owner's Association
IPPC	Intergovernmental Panel on Climate Change
IP65	International Protection Marking 65
IRP	Integrated Resource Electricity Plan
kW	Kilowatt
kWh	Kilowatt Hour
kWp	Kilowatt Peak
kVa	Kilo-volt-ampere
LCR	Local Context Report
LEED	Leadership in Energy and Environmental Design
LEED-ND	Leadership in Energy and Environmental Design-Neighbourhood Development
Low-E glass	Low emissivity glass
LSF	Light Steel Frame
LSM	Living Standard Measurement
MJ/m^2	Mega Joules per Square Meter
NBR	National Building Regulations
NDC	Nationally Determined Contribution

NDRC	National Development and Reform Commission
NERSA	National Energy Regulator of South Africa
NHBRC	National Home Builders Registration Council
NRS	National Readership Survey
NSA	Neighbourhood Sustainability Assessment
PoPI	Protection of Personal Information
PPA	Power Purchased Agreements
PV	Photovoltaic
RCA	Recycled Crushed Aggregate
RFP	Request for Proposals
R-values	Resistance Value
SA	Stand-Alone
SANS 10400	South African National Standard 10400
SABS	South African Bureau for Standards
SD	Sustainable Development
SDMD	Stand Density Management Diagram
SI	Sustainability Institute
SIDE	Smart Integrated Decentralised Energy
SPU	Small Power User
u/d	Unknown Date
U-values	Heat Transmission Values
UV	Ultra Violet
USA	United States of America
V	Voltage
W	Wattage
ZAR	Zuid African Rand

Definition of Terms

Circular Economy

Circular economy is a regenerative system where products and services are traded in closed loops or “cycles” (source: Kenniskaarten het Groenebrein website).

C40 Cities

The C40 Cities Climate Leadership Group (C40) connects 90 of the world’s greatest cities, representing more than 650 million people and one quarter of the global economy (source: C40.org).

Double glazing

Double glazed windows utilize two separate pieces of glass, separated by a vacuum. The vacuum layer acts as an isolative barrier. The glass used can be laminated or UV tinted, but is otherwise similar to the glass used in single glazed windows. When double glazing is retrofitted to an existing window installation, the thermal efficiency can be improved by up to 80%. Factory made double glazed windows can be up to 100% more efficient than a single glazed equivalent (source: Next Generation Glass website).

Embodied energy

The sum of all the energy required to produce any goods or services, as if that energy was incorporated or 'embodied' in the product itself (source: EDGE Buildings application).

Energy trading

The simplest term is the bulk moving or selling of energy from where it is generated to where it is needed. This could include peer-to-peer energy trading, which is the moving or selling of energy from individual energy producers to individual energy users (source: Energypedia website).

Fenestration

The arrangement or positioning of windows in a building (source: Oxford Dictionaries).

Happiness Index

The Happiness Index is a report on the state of global happiness, published by the United Nations Sustainable Development Solutions Network. It indicates happiness through different criteria. There are four chief criteria, forming the four pillars of the index and include thirty-three indicators divided into nine areas. These areas include, Psychological Wellbeing; Mental and Spiritual Health; Time-balance; Social and Community Vitality; Cultural Vitality; Education; Standard of Life; Good Governance; Ecological Vitality (source: UNSDSN website).

Insulation

Insulation is also known as thermal insulation, this is the reduction of heat transfer (the transfer of thermal energy between objects of differing temperatures) between objects in thermal contact or in range of radiative influences (source: Energypedia website).

IP65

An IP65 enclosure is an International Protection rating that indicates the enclosure to be "dust tight" and protected against water projected from a nozzle (source: Enclosure Company website).

Low emissivity glass (Low-E glass)

Low-E glass has a microscopically thin, transparent coating—it is much thinner than a human hair—that reflects long-wave infrared energy (or heat). Some low-e's also reflect significant amounts of short-wave solar infrared energy. When the interior heat energy tries to escape to the colder outside during the winter, the low-e coating reflects the heat back to the inside, reducing the radiant heat loss through the glass. The reverse happens during the summer (source: Vitro Architectural Glass website).

Micro-grid

A micro-grid is a small-scale power grid that can operate independently or collaboratively with other small power grids. The practice of using micro-grids is known as distributed, dispersed, decentralized, district or embedded energy production (source: Energypedia website).

NERSA

The National Energy Regulator of South Africa (NERSA) is a regulatory authority established as a juristic person in terms of Section 3 of the National Energy Regulator Act, 2004 (Act No. 40 of 2004). NERSA's mandate is to regulate the electricity, piped-gas and petroleum pipelines industries in terms of the Electricity Regulation Act, 2006 (Act No. 4 of 2006), Gas Act, 2001 (Act No. 48 of 2001) and Petroleum Pipelines Act, 2003 (Act No. 60 of 2003).

Newtonian Worldview

This world view has a more traditional scientific baseline. It is mostly based on reductionism, determinism, materialism. Although this is intuitive and simple, it ignores human agency, value and creativity (source: Principia Cybernetica website).

NSA

The neighbourhood sustainability assessment tools have been developed to assess the sustainability from buildings to neighbourhoods on urban scales (source: Sharifi & Murayama, 2014).

Orientation

Orientation is also known as building orientation, this refers to the way a building is situated on a site and the positioning of windows, rooflines and other features (source: NJ Green Building Manual).

R-values

A measure of resistance to the flow of heat through a given thickness of a material (such as insulation) with higher numbers indicating better insulating properties (source: Merriam Webster Dictionary).

SANS 10400

SANS 10400-XA and the SANS 204 Regulations are an attempt made by government to regulate energy use and encourage energy efficiency in building (source: SABS website).

Shading

Shading and sun control in buildings are an integral part of the fenestration system design that improves comfort and save energy by reducing summer temperatures (source: Your Home website).

Single glazing

A single glazed window is constructed using a single pane of glass. This means that the only thing separating your home from the outside environment, is that pane of glass. Typical window glass ranges from 3mm to 10mm, which doesn't provide adequate insulation. A single glazed window can be up to 20 times less efficient than an insulated wall when it comes to energy loss or storage (source: Next Generation Glass website).

Solar Heating

Solar heating or solar water heating is the conversion of sunlight into heat for water heating using a solar thermal collector (source: Solar Server website).

Sustainable infrastructure

In this study this includes: build infrastructure, energy infrastructure and user habits/socio-technical aspects.

Thermal Mass

In building design, thermal mass is a property of the mass of a building which enables it to store heat, providing "inertia" against temperature fluctuations (source: Energypedia website).

Universal Energy Terms

A	Ampere	unit of electric current equal to a flow of one coulomb per second
A/h	Ampere per Hour	amount of energy charge in a battery that will allow one ampere of current to flow for one hour
kW	Kilowatt	unit of power equal to one thousand watts
kWh	Kilowatt per Hour	unit of energy used
kWp	Kilowatt Peak	the total installed capacity of the village
kVa	Kilo-Voltage-Ampere	unit of apparent power, which is electrical power unit
MW	Megawatt	unit of power equal to one million watts
V	Voltage	an electromotive force or potential difference expressed in volts
W	Wattage	unit of power

U-values

A measure of the heat transmission through a building part (such as a wall or window) or a given thickness of a material (such as insulation) with lower numbers indicating better insulating properties (source: Merriam Webster Dictionary).

Whole System Design

The earth surrounding us is one large system nested within another. An understanding of systems connection to the things that define it and how it 'thinks' is the framework for whole system design. This framework is the foundation of holistic action (source: Rethink Sustain website).

CHAPTER 1: INTRODUCTION

1.1 Background to this Study

Climate change is no new concept globally and different attempts are being made to deal with it, with sustainable development as the core goal in this transition (Parker & Baigorrotegui, 2018). As the scale of human impact increases (also the scale of human-made infrastructure), the importance of being embedded into the natural system becomes of the essence (Anderies, 2014). Sustainable development of urban communities and energy transitions have evolved into a universal political issue, drawing attention from developers, municipalities and academia, especially in the field of urban and environmental studies (Zuniga-Teran et al., 2016). This has resulted in a greater focus on experimentation of socio-technical systems in the urban setting (Swilling & Hajer, 2017).

Urban areas are responsible for 70% of global carbon dioxide (CO_2) emissions and the rapid growth in urbanisation brings a significant risk to cities (Ameen, Mourshed & Li, 2015). Urban design and development are mostly seen as the means to shape the future of the city and they establish the level of resilience to change, from climate or other factors (Yuan, Zhou & Zhou, 2011). Both building and energy infrastructure could be seen as transitioning from fossil fuel-based products and system to a more low carbon and clean energy-based one (Zuniga-Teran et al., 2016). Transitions of this kind could be highly dynamic, complex and could involve several dimensional processes, in which a primary socio-technical system could change into something quite different (Wu, Zuidema & Gugerell, 2018).

1.1.1 My Background as Architectural Professional and Sustainability Student

As an architectural professional, I have always been intrigued by co-construction linked to good building practice, decentralised, integrated, clean energy generation and its use in eco-villages and intentional communities. My curiosity was embedded in an on-going question: Could this form of socially, environmentally and ecologically sustainable living be a scalable model for urban settlements? Wanting to observe the way some eco villages function in various countries, I volunteered and lived in two eco-villages and volunteered in one (Torri Superiore in Italy - 2015, Lotan in South Israel - 2015, and Vereniging Aardehuizen in Olst Netherlands - 2018). These three eco-villages each have their own unique models and drivers that made them 'successful' and functional as intentional communities. Alex Cicelsky, one of the directors at Lotan's Centre for Creative Ecology used to say "an eco-village is not only a solar panel". Since then, evaluating the claims made by intentional communities has become my added interest, such as claims to having a

lower carbon footprint.

1.1.2 Low Carbon (Intentional) Communities

Low carbon communities mostly exist within urban areas and are also seen as eco-neighbourhoods or eco-villages. They are essentially citizen-organised residential communities intended to be socially, economically and ecologically sustainable (Hall, 2015). These communities exist to intentionally reinvent life in the city, combining environmental awareness, traditional wisdom and positive new innovation whilst focussing on participatory processes (Daly, 2017). Some new innovation of sustainability elements such as social justice, social-inclusion, co-creation, good building practise and decentralised clean energy generation rings true to the structure of these communities (Ragheb, El-Shimy & Ragheb, 2016).

Intentional communities are mostly experimental focused and have almost a half-century of empirical experimentation based evidence to offer, and according to Hall (2015) this could be utilised to benefit wider society. Many experimental examples could also illustrate the connection between embodied energy, energy efficiency, energy use and socio-technical relations in these communities (Adalilar, Alkibay & Eser, 2015; Hall, 2015; Barton 2007). The last couple of years there has been an additional experimental trend, it included the integration of micro-grids and District Energy networks (micro-grid and District Energy networks will be explained more in 1.1.8), in some of these intentional communities. Cloughjordan in Tipperary, Ireland; Earthavan EcoVillage in Black Mountain, USA; Lynedoch EcoVillage in Lynedoch, South Africa; Lotan EcoVillage in Lotan, South Israel; Narara EcoVillage in Narara, Australia; Vereniging Aardehuizen in Olst, The Netherlands; and Witchcliff EcoVillage in Witchcliff, Australia are some of these communities. This trend extends beyond the application of existing intentional communities only, the future prospects of integrated micro-grid systems are also included in the planning of some new intentional community developments, globally. One of these are ReGen Villages, with their pilot community soon to be in Almere, The Netherlands. They are technological-integrated and regenerative housing and community developments, with extensive micro-grid and District Energy network designs included in their plans. They consider the micro-grid as just a small aspect of the incorporated doorstep agency for integrated neighbourhood solutions (source: ReGen Villages website).

One of the largest intentional community networks in the world is the Global Ecovillage Network. Two eco-villages that I lived in and some mentioned above are part of the Global Ecovillage Network. They describe sustainability in four primary dimensions of human experience and a holistic map for sustainable design and development, embracing worldview, social, ecological and economic aspects (see Figure 1.1). This way of life is focused on whole systems design, the foundation for holistic

action. The main aim of the sustainability wheel is to give a guideline or act as a roadmap to be resilient and adaptable to unique local needs and circumstances. Although the consideration of embodied energy, energy efficiency, energy use and socio-technical is the focus of this study, their relation in these communities are only some part of the big picture towards sustainability.

Figure 1.1. Four Dimensions of the GEN Sustainability Wheel (Sources: GEN website)

Beyond the holistic approach of intentional communities to accomplish sustainability, the sustainable infrastructure contributes and supports the daily functionality of these communities, and refers to designing, building and operating various structural elements. These elements could include mobility, energy, buildings, green corridors and water resources.

1.1.3 Sustainable Infrastructure

Sustainable infrastructure in this research will include ecological design and environmental impact, in the form of building infrastructure; energy supply through an embedded renewable energy system; and the human interaction with the sustainable infrastructure. Furthermore, the ecological design regulations include various working examples of liveable ecologically designed urban systems. The

specific regulations include the following integrated ecological designs and renewable energy system approaches:

- Low hanging fruit - such as energy-saving lighting, gas-fired stoves and solar water-heating systems
- Building design principles - inclusive of orientation, fenestration, thermal mass, insulation and roof overhangs of buildings
- Energy usage measurements - inclusive of the envelope (building materials), passive heating and cooling and an embedded renewable energy system

In light of considering the specific regulations pertaining to the elements of the integrated ecological designs and renewable energy systems, it is crucial to understand that the lowest hanging fruit would be human behaviour, that is, human co-operation or human co-creation. Therefore, these components are inevitably part of the infrastructure and without considering these, the most advanced and carefully designed systems could be rendered unsuccessful. To achieve any form of sustainability, a sustainable component must include human behaviour and co-operation (Gou & Xie, 2017), considering the role the human factor plays in understanding and enhancing well-intended socio-technical systems, but also in the co-creation of such a system.

1.1.4 Building Infrastructure

The buildings in South African cities produce more than 36% of the total greenhouse gas (GHG) emissions - to power, heat/cool and operate them. Of these building energy demand systems, heating and cooling accounts for over 40% (Cartwright, 2018). It is predicted that by 2030 more than 70% of the South African population will be living in cities (Cartwright, 2018). To date, the Green Building Council of South Africa has certified more than 300 buildings (Cartwright, 2018). Four of South Africa's C40 cities (Cape Town, eThekwini, Johannesburg and Tshwane), as part of the C40 South African Building Programme, have committed to work on zero-carbon building standard practice (Cartwright, 2018).

The Lynedoch EcoVillage is not officially part of any global eco-village network and has not been officially certified by any Neighbourhood Sustainability Assessment (NSA) certification process as a sustainable neighbourhood or community yet. Still, this village claims to be low-carbon in their ecological designing processes. Currently, the village consists of 34 houses, which have experimented with eight different alternative building materials and other low carbon applications.

1.1.5 Energy Transition

According to the Intergovernmental Panel on Climate Change (IPPC), 65% of the total global GHG emissions came from CO_2 gas in 2014 (EPA, 2014). In 2008 data from the Carbon Dioxide Information Analysis Centre (CDIAC) showed that South Africa was the 13th largest contributor to fossil-fuel CO_2 emissions in the world and the highest in Africa (CDIAC, 2008). Since 1950, the fossil-fuel CO_2 emissions in South Africa have increased seven-fold, with 80-90% of the emissions coming from burning coal in 2010 (DEA, 2010). In response, South Africa is one of the few countries that has put forward emission reduction targets in the Nationally Determined Contribution (NDC). South Africa's key policies to reduce emissions is contained in the Integrated Resource Electricity Plan (IRP) 2010–2030, which sets a renewable capacity target of total 17,8 GW for 2030, that is 21% of energy generation from renewable energy and 48% from coal (CAT, 2018). Although this has the appearance of progress, the Climate Action Tracker (CAT) Consortium, tracking climate action since 2009, rates this target hard to reach by 2030 (CAT, 2018).

The Electricity Supply Commission (Eskom) is South Africa's well-known unbundled monopoly utility service provider, vertically and horizontally integrated in all core services – generation, transmission and distribution. They generate 93% of the current load from coal firing power stations (NPC, 2018; CAT, 2018). Regardless of this, Eskom has for the past few years been hampering the deployment of more renewables by stalling on signing Power Purchase Agreements (PPAs) with renewable energy companies. As the Climate Action Tracker (CAT) Consortium states on their webpage (2018), Eskom has been threatening the financial future of renewable energy companies, together with the renewable energy capacity goal, and lowering South Africa's renewable energy investment attractiveness. This changed substantially on 4 April 2018, when the minister of Energy, Minister Jeff Radebe, signed the next 27 PPAs (Photo 1.1) and tweeted:

"We have reached this milestone following a long period of uncertainty, not only for the renewable energy industry, but also private sector investment confidence" (@radebe_jeff 2018).

Photo 1.1. Signing of PPAs by MinisterJeff Radebe (source: @radebe_jeff).

Even with the Independent Power Agreements and carbon tax currently under the magnifying glass, the national energy mix is still shy of a greater input from renewable energy generation. Therefore, one of the biggest climate change challenges faced today concerns energy (Dixit, 2017). Humankind

is generating and using vast amounts of energy, mostly from fossil fuels. By burning these, large amounts of CO_2 are released into the atmosphere.

Regardless of the energy transition from fossil fuel to clean energy generation that has been moving slowly in South Africa, Eskom as an Energy Utility has a rather large interest in researching the possibilities for renewable energy systems in the residential space. As was indicated at the meeting with Eskom at a Lynedoch EcoVillage HOA meeting, they currently regard distributed renewable energy sources in the residential market as disruptive energy, in two ways (see Addendum A). Firstly, renewable energy sources are uncontrolled energy production; when alternative generation sources feed into the distribution lines, it is difficult for the utility to track stable supply and demand. Secondly, distributed renewable energy could be unsafe if not handled properly. The National Energy Regulator of South Africa (NERSA) has not yet allowed net metering for most, especially residential clients.

1.1.6 Partnering with Eskom

A few years ago the Eskom's Research, Testing and Development Laboratory initiated interest in partnering with Lynedoch EcoVillage, to install a micro-grid renewable energy system, which could contribute towards overcoming some of the challenges of renewable energy transitions (see Addendum B & Addendum C). Besides the reasons around distributed renewable energy sources that were mentioned above, the LSM mix became the main drawcard to use this specific village (Lynedoch EcoVillage) for studying the possibilities for energy trading on a residential level.

Since my first interaction with the Eskom team at a Lynedoch EcoVillage HOA meeting on 16 November 2017, my view of this company has shifted from being very sceptical to being less sceptical and slightly more supportive. In all fairness, my connection has solely been with various teams and individuals from their Research, Testing and Development Laboratory in Johannesburg, and their commitment to research and development has been inspiring.

1.1.7 The Micro-grid

A micro-grid is a small-scale electricity generation network (between 10kW and 10MW) and supply a smaller amount of consumers through a distribution grid that can function in isolation from the national grid. These micro-grids could also be grid-tied, which means that the micro-grid is a semi-autonomous energy generating network that could feed excess capacity back into the main grid. Within the micro-grid network, peer-to-peer energy trading is also possible. Energy trading is a new way of operating within a power system, where people generate their own power and sell the excess energy from peer-to-peer.

In Lynedoch EcoVillage the micro-grid network comes in the form of an embedded renewable energy system: this village has recently become an experimental site for an Eskom pilot project (see Photo 1.2). The twenty-seven resident households were included in an array of the embedded photovoltaic (PV) solar system, inclusive of smart meters, with the general aim of better energy efficiency and possible energy trading. This grid-tied micro-grid system was installed in 2016 by the Eskom's Research, Testing and Development Laboratory, the first of its kind in South Africa. The Eskom budget for installation was Zuid African Rand (ZAR) 4million (Eskom Correspondent 3, 2018).

Photo 1.2. Lynedoch EcoVillage view on some micro-grid panels (source: Sharné Bloem).

In theory the total installed capacity of the micro-grid is 51,8 kW peak. As not all roofs face north, the peak of individual systems is reached at different times of the day. Although the micro-grid is still grid-tied, the installed capacity of power that was supplied to the village by the Eskom grid - prior to the PV installation - was 103kVa, inclusive of the SI and Spark School (Eskom Correspondent 1, 2018).

Although this might sound fairly straightforward, the installed capacity for a small power user (SPU) is difficult to determine, because SPUs don't have to declare a maximum demand. Eskom (2018) confirms this statement in an email:

> The transformer which steps down from 11kV to 400V (the village takes supply at 400V) is rated at 100kVA, so you could say that's the installed capacity. The breaker supplying the village is rated for 150A [150A x 400V/sqrt(3) x 3 phases = 103kVA] – that means the breaker will trip if more than 103kVA is drawn, so that the transformer and other equipment is protected. So this ties in with the transformer size.
>
> Eskom Correspondent 1, 2018 (see Addendum D)

According to the Eskom Distribution Department, the grid configuration will stay as is for now. However, there will be a change in tariff. The grid-tied solar tariff for the pilot project will be ZAR1.27/kWh, compare to ZAR2/kWh for the former grid-only connection.

Eskom used the table below to make their assumptions on the LSM mix of the Lynedoch EcoVillage. Although the LSM estimation tool (see Table 1.1) is very useful for Eskom's domestic load planning, it becomes more useful as the number of homes increases. In column 7 and 13 the table refers to the term ADMD - 'After Diversity Maximum Demand'. This table assumes that at least 100 homes are being estimated as a block. That means that there will definitely be homes with higher peak demands, but if you were to take a homogenous neighbourhood of 100 homes all of a similar income level, their diversified maximum demand in the year would be the value in column 13 multiplied by 100. In the case of Lynedoch EcoVillage, with only 27 houses taking part in this pilot project with a mixed LSM, these assumptions become a guideline. (Please also note that the income range on this table might be outdated).

Table 1.1. Classification of domestic consumers (source: NRS 034-1: 2007).

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Current Type			Load Parameters – 7 years[CDEF]						Load Parameters – 15 years[CDEF]					
Consumer Class	AMPS* & LSM* Class	Income Range [B] (gross R/mo)	a	b	c	ADMD kVA	A	A	a	b	c	ADMD kVA	A	A
Rural Settlement	LSM 1	0 to 600	0.3	2.98	20	0.42	1.83	2.78	0.35	2.88	20	0.50	2.17	3.03
Rural village	LSM 1 and 2	400 to 900	0.43	2.52	20	0.67	2.91	3.55	0.48	2.13	20	0.84	3.65	4.07
Informal Settlement	LSM 3 and 4	900 to 1500	0.77	9.88	60	1.00	4.35	4.56	0.91	8.80	60	1.30	5.58	5.36
Township area	LSM 5 and 6	1500 to 3000	1.05	7.81	60	1.64	7.13	6.18	1.22	5.86	60	2.37	10.30	7.96
Urban Residential 1	LSM 7	3000 to 5500	1.23	5.56	60	2.50	10.87	8.28	1,25	3.55	60	3.59	15.61	10.93
Urban Residential 2	LSM 7 and 8	5500 to 8500	1.45	6.07	80	3.54	15.39	10.81	1.42	4.10	80	4.72	20.52	13.68
Urban Townhouse Complex	LSM 8	8500 to 12000	1.45	5.75	80	3.70	16.09	11.20	1.42	4.13	80	4.70	20.43	13.68
Urban Multi Storey	LSM 8 (high end)	12000 to 24000	1.43	4.41	80	4.50	19.57	13.15	1.37	3.39	80	5.30	23.04	15.09

[A] Living standard measure (LSM) as quoted in the All Media and Product Survey (AMPS) conducted annually by the South African Advertising Research Foundation.

[B] Average household income range shown for comparative purposes are in 2005 ZAR. Any income data collected at a later data should be deflated by the CPI to allow a direct comparison.

[C] If the target community matches the description, but the chosen value of c is different, new a and b values can be calculated for the chosen value of c, using the formula given in B.4.3.

[D] Parameters have been normalized to the climate in the interior of South Africa where the winters are generally cold and with low rainfall. In regions where the winter is cold and wet (e.g. Cape Peninsula), the ADMD is about 12% higher than that given. In climates similar to that of the Durban coastal region, the SDMD is about 12% lower than that given

[E] Except as indicated in f below, the parameters have been derived from carefully monitored case studies around the country, and reflect best knowledge at the time of publication of actual consumer over time. The actual load parameters used depends upon the strategy of the planner with regard to phasing of capital expenditure.

[F] Parameters for this consumer class have been extrapolated from exciting data, since no simple load data have yet been collected from such consumers. Load significantly higher than the ADMD shown in LSM 8 (high end) can be expected in the case of specific high-consumption developments. In such cases, estimated load data should be obtained from the relevant local authority or licenses.

Therefore if you take the installed capacity of 51,8kW peak divided by 27 households, the rooftop PV system's capacity per household is 1,92kW in theory. According to NRS Table 1.1, the average demand/load for a level 7 LSM household is 2,5kVa within the first 7 years. Assuming the power factor is 1, then 1kVa is 1kW and because this is a wet winter area (see footnote in Table 1.1), 2,5kVa = 2,5kW x 12% = 3kW. Assuming that after 15 years the household would have collected more appliances, the load will be 3,5kW x 12% = 4,2kW.

One critique against using this consumer table (Table 1.1), is that Eskom assumes that the income bracket of a household represents their LSM level. In a standard setting where one family lives in a home this could be more accurate, but when there is more than one family per household, more appliances are used, which pushes their LSM level into another bracket. What the table also does not represent accurately, is that some high income households are more environmentally aware and therefore have and/or uses less appliances, which in reality places them in a lower LSM than their income bracket indicates.

In summary, Lynedoch EcoVillage is an intentional community, a liveable urbanism pioneer while experimenting with socio-technical transitions. This low carbon village is constantly reassessing how to minimise its impact on the environment. This micro-grid experiment presents a good moment to assess some of the sustainability claims that have been made, and whether there is a lower impact on the environment.

1.2 Rationale of Research

1.2.1 Lack of evidence of sustainability

The rapid increase in the global population is putting more pressure on natural resources and adding to the continuous rise of CO_2 emission levels, leading to a move towards decarbonisation as the centre of many climate change debates (Cassen et al., 2018; Chong, 2018; Delina & Janetos, 2018). Therefore, various intentional communities around the world - such as eco-villages - have specific goals of living in an environmentally sustainable way and are taking conscious steps towards these goals to combat the unsustainability of global socio-technical systems. In both the academic and grey literature, claims are being made that intentional communities are making a significant impact towards sustainability goals and economic savings. Evidence and actual measures of progress in supporting these claims are relatively scarce, especially in South Africa.

1.2.2 Lynedoch EcoVillage - a unique case study

Lynedoch EcoVillage is unique in that it is not only socially and economically diverse but it is also a good representation of an intentional community claiming to be a low carbon community through their integration of various ecological building design principles, regulations of their sustainable infrastructure. These claims have never been evaluated; therefore no real evidence is available of what the actual outcomes are and whether these systems are really resulting in reaching more sustainability. In addition, the recent participation in the Eskom pilot project also extends the uniqueness of the energy mix of the energy infrastructure in this village.

1.3 Problem Statement

Certain sustainability claims have been made by Lynedoch EcoVillage. These claims have never been evaluated, therefore there is no real evidence of the sustainability of these building practises and of the renewable energy system.

1.4 Research Questions, Objectives, Importance, Limitations

The following *QUESTIONS* are the focus of this research:

- What is the state of the current sustainable infrastructure in Lynedoch EcoVillage?
- Does the sustainable infrastructure contribute towards neighbourhood sustainability?
- Does the sustainable infrastructure configuration minimise the carbon footprint of the inhabitants?
- If the micro-grid system was well-intended, what role does the human factor play in obstructing or enhancing the implementation?

The *OBJECTIVES* would be to establish -

- what the current sustainable infrastructure entails
- to establish a user-friendly metric for the measurement of sustainability
- to assess this low carbon community in specific sustainability aspects, such as an incoming micro-grid system, embodied energy, building design principles and use
- to ascertain whether the findings match the claims
- if the sustainable infrastructure contribute towards neighbourhood sustainability as claimed
- to evaluate the influence this has on the community on a social level, and to question whether this could be transferable (see Figure 1.2).

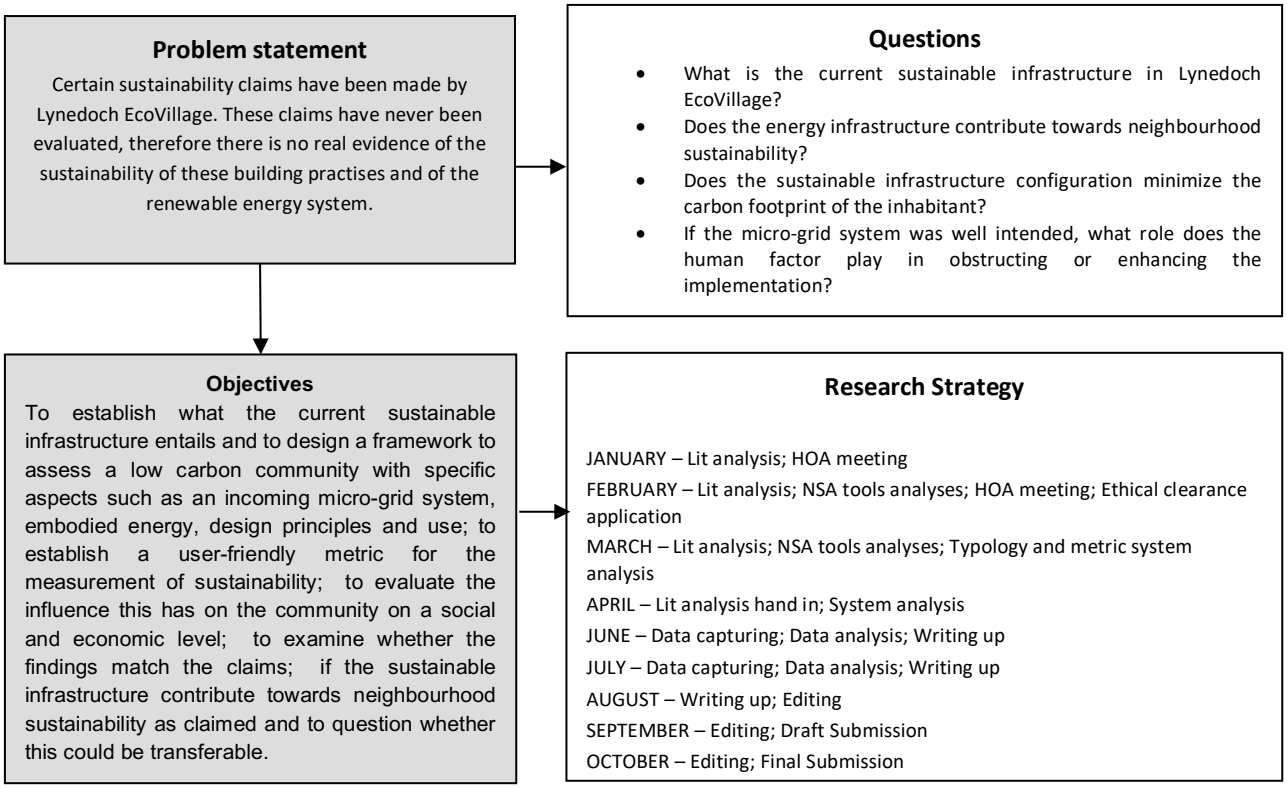


Figure 1.2. Research problem statement, objectives and strategy.

The *IMPORTANCE* of this research is to add value to Lynedoch EcoVillage first and foremost; thereafter to any developer, organisation or community aiming to contribute to sustainability through good building practice, decentralising energy generation or intentional community living. I believe that contextual circumstances will become an important consideration to take into account, for any aspiring intentional communities.

The *ETHICAL IMPLICATIONS* of this research has been carefully considered, especially in gathering qualitative data through conducting interviews and disclosing specific technical information connected to specific households. **Clustering** the typologies of the buildings will serve as a confidentiality measure, and by means of a metric system, each house will be described - for example, house 1 = system 1, plus building material 4, plus design regulations 3.

The *LIMITATIONS* of this research could be that this eco-village has a very specific social fabric and LSM mix - therefore a very unique case. However, lessons in context could be extracted from the findings for application in different settings.

Another limitation is that no set of NSA indicators could be found that are fully representative of the Global South and of an eco-village in the Global South.

1.5 Delimitations of the Study

This research will be conducted in Lynedoch EcoVillage. The scope of the study will be limited to assessing the sustainable infrastructure; building practices and energy systems. Building practices analysis in the village will be limited to embodied energy of the building envelope, specific building design principles and the energy efficiency of specific buildings, leading to a specific energy usage. The recent addition of the micro-grid energy system: the embedded solar PV pilot project installed by Eskom, will be covered by describing the micro-grid system and its integration into the village.

1.6 Chapter Outline

The chapter outline of the research thesis is as follows: The literature analysis in Chapter 2 covers the impact that experimentation and socio-technical systems have on the environment and sustainability transitions; and the role this can play in promoting neighbourhood sustainability and renewable energy systems towards energy democracy. The research methodology and all methods are covered in Chapter 3, inclusive of a review of NSA indicator tool sets. In the first section of Chapter 4 I have covered my own experiences in three eco-villages that I have lived in in 2015, providing some comparable profiles with Lynedoch Eco-Village. Thereafter I have included the data, analysis and research results of the Lynedoch Eco-Village case study. Chapter 5 contains the conclusion to the study, some contributions to practise, and recommendations.

CHAPTER 2: THE THEORY BEHIND AND BEYOND: LITERATURE ANALYSIS

2.1 Introduction

Various sectors are contributing to anthropogenic climate change, with the building sector being the largest energy-consuming sector (EIA, 2016). Buildings account for approximately 40% of the global energy consumption and contribute over 40% of the total world CO_2 emissions (Grey et al., 2017). Urbanisation and population growth, among others, are significant contributors. Africa's urban population is expected to triple between 2010 and 2050, reaching 1.2 billion people (UN, 2018). Soon the African continent will overtake Eastern Asia as the region with the largest urban population in the world (Gomez-echeverri & Gomez-echeverri, 2018). According to the latest UN population report (UN, 2018), the majority of Africa's urban population lives in smaller cities and are likely to experience significant expansion in the coming decades. The scale of development required to accommodate this growth is monumental, and for the most part is contributing to the even greater challenge of community transition (Jomehzadeh et al., 2017). This shift is moving faster than development can keep up, emphasizing the need for reinventing neighbourhoods.

Many discussions around reinventing neighbourhoods and urban settlements focus on physical or technical systems and not on neighbourhoods and urban settlements as entire ecosystems (Hall, 2015). These discussions are not complete without considering sustainable development (SD) within urban sustainability experimentation. On the one hand, Evans, Karvonen and Raven (2016), state that real-life experiments could produce more useful knowledge and are highly visible interventions. On the other hand, Hugh Barton states in his book *Sustainable Communities* (2000), that humanity is about human habitat, with human needs as the focus. Therefore, the experimental ecosystem approach is potentially most compatible with the anthropocentric Brundtland Commission's definition of SD:

> Sustainable development is the kind of development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It is about maintaining and embracing the quality of human life – social, economic and environmental – while living within the carrying capacity of supporting ecosystems and the resources base.
>
> United Nations 1998.

Although reaching the goals of sustainability is complex and with no straightforward answers, experimentation is deemed necessary, and the biggest challenge of our time is for our carbon-based economy to transition into a circular economy.

This literature analysis will explore:

- Neighbourhoods of the future
- The role of experimentation -
    - reaching neighbourhood sustainability through Intentional communities
    - building infrastructure through energy efficiency
    - energy transition through Smart Integrated Decentralised Energy (SIDE) systems
    - socio-technical imaginaries
- The concept behind finding a NSA tool -
    - tinkering towards sustainability
    - from minimizing damage to regenerative design

2.2 Neighbourhoods of the future

Human settlement and communities are as old as humanity itself. As the population expanded throughout the ages, so did the size and complexity of human settlements. The largest human settlement is manifested as a city, consisting of neighbourhoods, communities and urban spaces. For some, the phrase *neighbourhood in a city* means: crime, congestion, crowds and poverty. To others, it means: economic opportunity, innovation, community and cultural vitality. Regardless of the point of view or personal experience, the turn of the twenty-first century marks the tipping point for cities to be the greatest challenge humans have faced in terms of social activities and global climate change (Cugurullo, 2018). Currently, half of the world's population live within cities; and by 2050 more than 70% of the world population could reside in cities (Dübner, Esper & Stroh, 2018). With this reality in mind, what the phrase 'neighbourhood in a city' could come to mean, is 'urban sustainability', an 'ecological place', or an 'urban living laboratory', interchangeably.

Urban sustainability - because the challenges are not the *lack* of design in cities, but rather other aspects of design. Bulkeley et al. (2014) indicates that urban design has been based on the wrong paradigm (the industrial paradigm), failed principles (the core modernist principles of specialization, standardization, and mass production) and flawed implementation strategies. This design philosophy has had devastating effects on the character and sustainability of communities, neighbourhoods and cities (Cugurullo, 2018). However, Jaime Lenner, former mayor of Curitiba, Brazil reckons the city is not the problem, the city is the solution (Lenner, 2008), thereby implying that the *future neighbourhood in a city* should adopt a change of perspective, and suitable solutions could be found through trial and error to develop smart and sustainable neighbourhoods within cities (Dübner et al., 2018).

Ecological place - because the concepts of ecological cities have become more popular in the last decade and a half (Lin, 2018). According to Lin (2018) the term signifies an ecologically healthy city; one that permits residents to live a high-quality life with low impact on the environment; and focusses on both sustainability and a broad acceptance across cultures. Others believe that ecological cities are built on the principles of eliminating carbon waste, to produce all energy from renewable energy sources (Zuniga-Teran et al., 2016) and to include the natural environment into neighbourhoods of the city (Kuchenbuch, 2016). Kuchenbuch (2016) and Reith and Orova (2015) confirm again that neighbourhoods are after all building blocks of cities and need reinvention. They also propose that guiding principles and cooperation between parts should be seen as necessary to improve neighbourhood sustainability; inclusive of the consideration of the buildings, public spaces and infrastructure (Reith & Orova, 2015). However, many authors emphasize the inclusion of the direct social, economic and environmental interaction that is deemed vital while considering sustainability. (e.g. Anderies, 2014; Chen et al., 2015; Gollwitzer, et al., 2018; Huseynov, 2011). All these principles are important in the quest to creating ecological neighbourhoods inside and outside the city.

Urban living laboratories serve as 'truth spots' in sustainable urban development (Evans & Karvonen, 2010). Many attempts have been made to re-imagine neighbourhoods; and creating them in different contexts remains challenging. The 'truth' that these urban laboratories carry refers to them holding promise for improved urban futures, but not providing a blueprint to follow and implement everywhere. It's more like a receptacle with viral properties; the ability to spread and permeates life in different ways and contexts (Evans & Karvonen, 2010). Spreading these 'good ideas' could lead to the re-making of society in agreement with novel forms of knowledge and re-shaping of social aspects and infrastructure systems in the urban development context (Hodson, Evans & Schliwa, 2018). Therefore, these living labs for sustainability could emerge to facilitate transitions into environmental, economic and the social interventions. It is clear that the concept of ULLs could lead to some experimentation that could be used to find better solutions for these complex real life urban development challenges.

Before moving on to the role of experimentation in the urban developmental space, it is important to clarify the terms used in this study around neighbourhoods. The topic of this research examines a *low carbon community*, referring to a case study done in an *eco-village;* and in this section the term *neighbourhood* was also used. Later the term *green neighbourhood* will be used, and *neighbourhood sustainability* will be assessed in light of the case study done in the eco-village. The obvious question is, can an eco-village also be regarded as a neighbourhood? Academically, the term neighbourhood is contested with many descriptions but no one definition (Birkeland, 2007; Reith & Orova, 2015; Tam et al., 2018).

According to the Merriam Webster dictionary *neighbourhood* means:

- the area or region around or near some place or thing
- a district or locality, often with reference to its character or inhabitants
- a number of persons living near one another or in a particular locality.

Merriam Webster

In this definition, a neighbourhood could therefore refer to communities, intentional communities and eco-villages, and will therefore be used accordingly.

2.3 The role of experimentation

As the majority of the global population becomes more urbanised and prompts the need for alternative ways, the notion of 'experimentation' holds an innovative and creative key position within the study field of transformation towards more sustainable socio-technical systems (Dübner et al., 2018). Although natural science experiments are different from socio-technical experimentation, a **socio-technical experiment** can be conceptualized as "…an inclusive, practice-based and challenge-led initiative designed to promote system innovation through social learning under conditions of uncertainty and ambiguity" (Sengers, Wieczorek & Raven, 2016:10). Here, society itself becomes the laboratory with a variety of real world actors involved in messy experimental processes that could lead to reshaping and reforming social and material realities. Sengers et al. (2016) argue that experiments are like seeds of change, which could lead to profound functional societal shifts.

In the experimental city, urban sustainability experimentation becomes the focal point to re-shape infrastructure systems and social practices (Swilling & Hajer, 2017). Re-imagining other sustainable urban contexts is a popular topic currently, but the question lies with how to attain such change. According to some, the adjusting of infrastructure systems and social aspects in the urban development context could be an important way to cover the economic, social and environmental aspects (Hodson et al., 2018; Swilling & Hajer, 2017; Tam et al., 2018). Therefore, Hodson et al. (2018) argue that urban experiments of infrastructure interventions could be useful to learn more about what could work in practice leading to an urban transformation. These could include resource management and climate mitigation and adaptation, mobility, buildings and urban spaces. Following on that, McCormick et al. (2013) argue that sustainable urban transformation comes through "radical" change or "multi-dimensional" urban structures and the interaction between different elements. These elements include governance and planning, innovation and competitiveness and lifestyle and consumption (McCormick et al., 2013). Although, Sengers et al. (2018), and Wieczorek and Raven (2016) define experimentation as an inclusive, socially-led and practice-based initiative, which is designed to advance structural innovation by allowing social learning to take place within an

uncertain and ambiguous environment, they acknowledge that the overall picture painted by experimental sustainability transitions literature is mainly focused on bringing a source of hope. Conversely, it could be argued that if experimentation has a limited effect on conditions, the experiment could not be used for learning and/or influencing future conditions.

2.3.1 Intentional Communities and Experimentation

The present-day aspiration for intentional communities is partly rooted in the characteristics of the communal movement in the 1960s and 1970s (Hall, 2015), with further inspiration drawn from the alternative-communities of the 1980s (Gilman, 1991). It was only in the 1990s that Robert and Diane Gilman were instrumental in merging the ecological and communitarian themes (Gilman, 1991). This means that eco-villages have experimented with creating individual and community wellbeing for more than half century, with definite evidence that it could benefit society in general (Hall, 2015). According to Hong and Vicdan (2016), most intentional communities **seek to evolve** rather than to achieve a specific state of existence. The concept of eco-villages is rather heterogeneous, to the extent that no one model could apply to all villages (Daly, 2017). However, some sustainability elements and characteristics form the baseline, leading towards setting a trend and therefore separating intentional living communities from business as usual in urban areas (Daly, 2017).

A common trend in most intentional communities translates into specific goals of living in an environmentally sustainable way. Another trend is that these intentional communities seek to move towards the specific state of existence (Hong & Vicdan, 2016), namely a decentralisation neighbourhood (Zhang, Yung & Chan, 2018). Decentralisation and self-regulation contribute to the development of these villages, with a focus on the use of local resources and much lower emissions (Hall, 2015). Therefore, to quantify the real impact of an intentional community could be problematic but should be possible through assessing the ecological- and carbon-footprints and could also be measured against the benchmark of the conventional design of urban settlements. Although some claim that eco-villages are more an extension to eco-tourism (Adalilar, Alkibay & Eser, 2015), intentional communities inside and outside urban areas have been considering various sustainability elements, striving to incorporate human scale, diversity and healthy sustainable development (Daly, 2017).

Some of these principles within neighbourhoods are **human scale** and **diversity**. ‘Human scale’ responds to simple human desires and local initiatives, shifting society away from centralized and top-down social programs (Evans et al., 2016), It promotes the creation of walkable neighbourhoods, while supporting the individual entrepreneur and encouraging everyday face-to-face interaction (Cassen et al., 2018). The village square is a common human scale design element of traditional

villages, where villagers gather around, enjoy the sun, buy goods from the market and spontaneously interact (Kuchenbuch, 2016).

Diversity in nature is a key to **resilience** and could have profound implications for human settlements (Evans et al., 2016). In different forms, 'diversity' in neighbourhoods could stimulate inclusivity and integration, maximise the mix of activities, be energized by differences, and point to a return to mixed-use spaces (Evans et al., 2016).

According to McCormick et al. (2013), experimentation with an array of approaches and different solutions is the bottom-line to generate sufficient variety in problem-solving capacities, in both the Global North and Global South, an openness to learning is therefore the key component of resilience and adaptability (Anderies, 2014). Some basic principles are still universal, even from a Global North perspective; Hojčková, Sandén and Ahlborg (2018) agree that experimentation and deployment in specific niche areas plays a key role in developing novel systems, taking into consideration the internal momentum through economic gains and technical improvements, such as sustainability in architectural systems and the building industry.

2.3.2 Building Infrastructure through Energy Efficiency

Since the Earth summit United Nations Conference held in 1992, sustainable development in neighbourhoods but also buildings became a focal point to demonstrate more experimentation with sustainability principles and socio-technical imaginaries. These contemporary trends of environmental design not only became very popular, but also aimed to achieve more sensitivity towards the environment within the building industry (Masood, Al-Hady & Ali, 2017).

The building industry is one of the main contributors to GHG emissions and also a great consumer of energy, globally. This contribution to climate change has resulted in the sudden rise of one of the most important trends, known as '**green architecture**', which focuses on the relationship between buildings and nature (Masood et al., 2017).

Nykamp (2017) mentions a period in Norway when experimentation in architectural systems were only attempted by 'fringe actors' like self-builders and activists. This period was counterproductive because it alienated the mainstream industry actors, but during this period green building entered the policy agenda. "In 1997 a policy initiative called the 'Eco-build program' was established, aiming to increase awareness of eco-efficiency in the sector" (Nykamp, 2017: 87).

The concept of 'green architecture' is the theory, science and style of designed buildings with principles rooted in environmentally friendly construction, and striving towards less resource consumption (Ragheb et al., 2016). Green buildings aim to integrate techniques, materials, design and methods to reduce the building's negative impact on the environment and increase resource efficiency (Mahdavinejad et al., 2014). However, Lang (2013), states that in the global integration context, learning experiences are very important, especially considering humanity's perspective in the development of new concepts.

Some of these new concepts are also seen in neighbourhoods in Europe, with Germany as one of the leading countries in sustainability. Fastenrath & Braun (2016) state that the case study on Freiburg Germany is a rare opportunity to review a success story in the form of an experimental sustainable city that has gone through the **'sustainable transition pathways**' by analysing the interplay of vast changes through building practice and green architecture in the Global North. In the same way, green architecture or green urbanism is an experimental emerging field that concentrates on the intentional use of low impact local building materials, which enhances energy efficiency, is more environmentally friendly (Gupta, 2017; Huseynov, 2011), and forms part of the sustainable infrastructure and technology used in intentional communities.

At this point it is important to note that experimentation in green architecture is not only vernacular architecture but could support other features consider as green (Gupta, 2017). These features include design elements that enhance thermal comfort for users, improving the efficiency of energy in buildings, lowering the embodied energy through building material selections, decreasing the waste of energy in return for energy saving or consumption regulations, and combining renewable energy systems into the design (Hakiminejad, 2018). Although this is not necessarily the case in green building design, Sengers et al. (2016) warn that sustainability-oriented experiments could sometimes become isolated events, not contributing to the change they were meant to bring. However, in general, "experiments are often seen as the seeds of sustainable change that should be cherished and protected since they might flourish to transform incumbent socio-technical systems" (Sengers et al., 2016:9).

2.3.3 Energy Transition Through SIDE Systems

One of these seeds of sustainable change and another potential success story of experimentation comes in the form of SIDE systems. Swilling (forthcoming) refers to a report that was recently release by a Dutch company Metabolic that was funded by the Dutch Ministry of Economic Affairs and the Netherlands Enterprise Agency. This came after a pledge by the Dutch government under the Paris agreement to decrease CO_2 emission levels by 80-95 percent by 2050 in the Netherlands. This left the Dutch government with a daunting task that required rethinking energy systems in a radical way.

In recent years and in conjunction with the Dutch, the world's energy systems have been undergoing a large transition, inclusive of reaching key goals such as integrating low carbon, green and sustainable technologies towards sustainable development (Wang et al., 2018). District Energy and decentralised power generation have been a main feature in the energy transition process and the embrace of future smart micro-grids as a promising decentralised vehicle to achieve this (Ballo, 2015). One kind of District Energy is a micro-grid, a local generated electricity network. These micro-grids serve as island of reliability within the larger regional and national electricity grids, seamlessly providing power through grid disturbances. A **mini-grid or micro-grid** (used interchangeably) refers to local electricity generation and energy storage systems to supply electricity to local customers. A **smart grid** is the technology used to provide communication between the utility and the customer. Transitioning our carbon-based economy into a circular economy is truly the single largest challenge of our time. Energy plays a very important role in overcoming this difficulty.

The generation of power closer to the demand is one of the characteristics of decentralised power systems; these systems can exist as grid-connected, feeding surplus into the grid or stand-alone (SA) systems, exclusively meeting the needs of the local demand (Cloke, Mohr & Brown, 2017). On the one hand, Wang et al. (2018) state that tying into a micro-grid could have many benefits, one of it being a good solution in the case of main grid interruptions and could contribute to service reliability and security. On the other hand, according to the debate of localism versus centralism, one of the main concerns with localising energy transition is finding a way to mobilize support from and adoption by the local population (Parker & Baigorrotegui, 2018). It could be argued that as renewable energy grows in popularity, the local communities will become more eager to embrace possible economic and environmental benefits in the form of micro-grids.

Another consideration for decentralised power supply systems, is an energy trading framework, which could make power delivery possible with higher efficiency, sustainability and economic stability, safeguarding the consistency and security of the energy infrastructure, and further promoting resilient power supply (Khodayar, Manshadi & Vafamehr, 2016). Singh et al. (2017)

implies that mutual energy sharing can be seen as a 'complex social phenomenon' and that energy exchange could be connected to social relationships between the giver and receiver and that 'prosumers' in the distribution network could escalates the number of control variables beyond the capability of a single centralized controller (Khodayar et al., 2016). Through his theoretical work, Stephan Gudeman, an economic anthropologist, conceptualises co-existence and dialectically connected modes of energy exchange, that is; 'mutual energy sharing' and 'mutual energy trading' (Singh et al., 2017). Although this is a key aspect of SIDE, the focus of this research will not cover energy trading in depth - this will be a recommendation for future studies.

In a typical SIDE system, the decentralised energy philosophy not only presents re-imagining of energy systems alone, but also new models of ownership, urban planning and governance. The energy system includes the integration of heat and power systems to reach higher efficiencies, resilience and flexibility (De Graaf, 2018).

However, in the Dutch report the micro-grid is only the final result of several other decentralized technologies combined - such as, rooftop solar PV, electrical cars, heat pumps and battery storage. These technologies could easily be owned by local customers and cooperatives and are easily scalable to other contexts. Limitations for replication lies with context-specific regional factors, such as solar radiation and wind speed; and national policies on feed-in tariffs; legal regulations and electricity prices. The Dutch Government views this approach as pivotal in meeting their climate targets.

The Metabolic report illustrates that, when optimized properly, micro-grids could avoid big expenditures on infrastructure upgrades by the distribution of energy; balancing local supply and demand intelligently. The conclusion is that half of European households could be generating energy from renewable energy by 2050 (De Graaf, 2018).

Although this is an exciting future prospect, Metabolic is looking to co-design an advance form of SIDE, called 'Smarthoods' (see Figure 2.1). This self-sufficient neighbourhood of the future will have a circular connection from solar radiation, wind, biomass and rainwater to create energy, water and food. This kind of neighbourhoods decrease the ecological footprint by 40% (De Graaf, 2018). The main focus will be co-designing, high-tech, circular and decentralized systems.

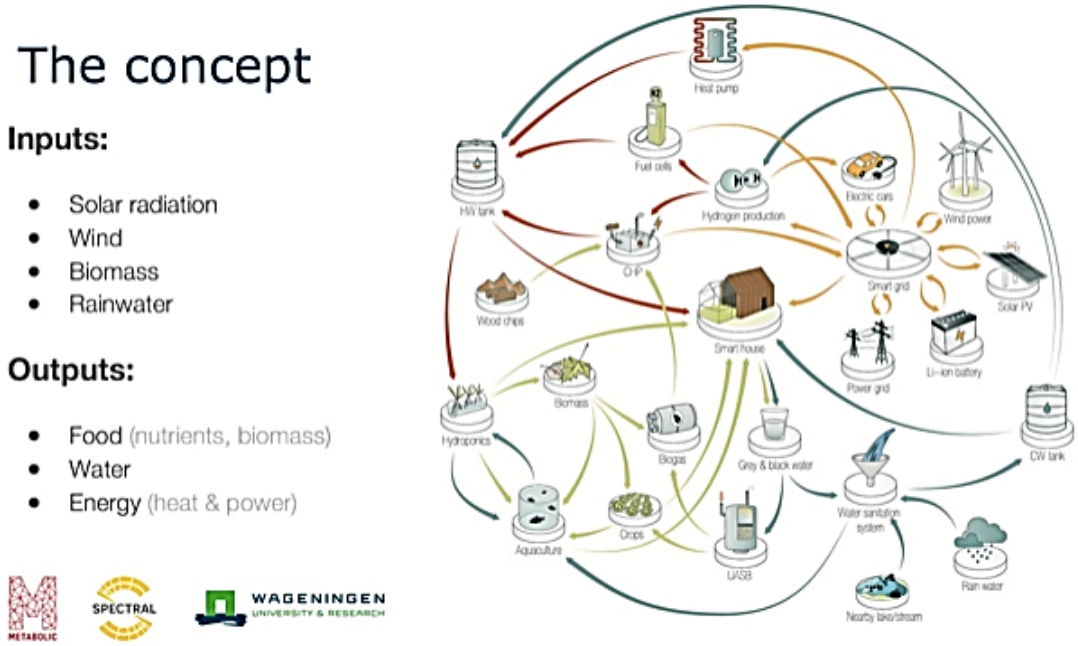


Figure 2.1. Concept of "Smarthoods" (Sources: Metabolic website)

2.3.4 Socio-Technical Imaginaries

Socio-technical systems design is a way is which technical, human, social and organisational factors are together incorporated into a design (Baxter & Sommerville, 2011). As efforts to decarbonise our global economy to reach climate targets are heading into different directions, sustainability transitions towards green building practice (Adil & Ko, 2016), decentralised renewable energy systems and clean technologies takes centre stage (Parker & Baigorrotegui, 2018). Sovacool (2009) indicated a decade ago that the main utility operators rejected renewable energy sources in the USA - because they were focussed on large utility scale, and this trend continues. Although renewables sources are costing less in most countries these days, the decarbonisation transition remains slow, multidimensional, complex and a long-term process (Parker & Baigorrotegui, 2018).

Despite all the challenges for renewable energy resources, the growth of Decentralized Energy Systems has been indicating a new way in urban energy planning and design of local energy systems (Adil & Ko, 2016). As affordability of renewable energy systems increases, decentralised energy generation and distribution systems increase, and demand a change in systems and paradigms in local energy infrastructure (Adil & Ko, 2016). The decentralizing transitions of urban energy systems call for an extensive evaluation of their socio-technical co-evolution (Hojčková et al., 2018); the **co-evolving of technologies and social responses** in creating more balanced physical urban forms, energy efficiency in buildings and local energy systems (Adil & Ko, 2016).

Socio-technical imaginaries are frequently researched for their contribution to visions of the future and scientists are continually trying to find answers for the present by studying the imagined emergent future (Sengers, Wieczorek and Raven 2016). Yet, Raimbault (2018) prompted engineers to be more inclusive in reconciling self-organization, chaos and emergence into their socio-technical designs. With all this in mind, it could be argued that interdisciplinary co-creation or co-evolving brings more favourable insights and results into the integration of sustainability transitional interventions (Adil & Ko, 2016).

According to Cloke, Mohr & Brown (2017), "… the emergence of the '**energy trilemma**' as a concept and framework for global action has captured the imagination of political elites the world over". This trilemma speaks of the characteristics of a new 'energy era' and addresses three main policy drivers: "energy security, climate change mitigation and energy access/equity to ensure long-term sustainability of global energy systems" (Cloke et al., 2017). In the Global South communities and neighbourhoods are more vulnerable to the effects of anthropogenic climate change but attract renewable energy technologies as a possible solution to all three drivers of the energy trilemma (Süsser, Döring & Ratter, 2017).

It could be argued that **energy equity** lies at the heart of socio-technical interventions in the Global South, and "… the socio-technical systems literature provides the theoretical base for exploration of electricity systems in transition and the level and type of interconnectedness to be a decisive characteristic in descriptions of different future renewable electricity systems" (Hojčková et al., 2018: 1). Renewable energy systems could affect entire neighbourhoods through the experience of a socio-technical intervention, as is also true of building technology interventions.

In the last decade, building green communities or buildings have been considered strategically important to the construction sector in the light of sustainability and mitigating climate change. 'Building Green' could include many factors, actors, elements and functions (Balaban & Puppim de Oliveira, 2017). According to Nykamp (2017), socio-technical application, as a complex innovation, could be indicative of energy transition nested inside a diverse social mixture and could co-evolve over time towards a positive interplay between innovation, energy trading, economic independence and the environment. However, Hargraves, Wilson and Hauxwell-Baldwin (2017) indicate that the installation of smart home technologies that are both **technically and socially disruptive**, would require familiarization and adaptation in learning to best use these systems, leading to possible domestic comfort, convenience and security while reducing energy.

Whilst considering more detailed building technology interventions, Sugiyama et al. (2014) argue that energy efficiency in buildings is one of the main drivers for mitigating climate change, especially

in a shorter or medium range time period. Berry and Marker (2015) remind us that the overall challenges, such as global climate change and energy security have contributed to the urgency for taking action and to improve energy efficiency in buildings. There is an array of design principles that could be considered to establish a user-friendly metric for the measurement of energy efficiency in these buildings (Muringathuparambil et al., 2017). Considering good green building practice is an important step towards building an environment free of negative impact, by conserving and reducing usage of natural non-renewable resources, and also considering the integration of renewable energy systems into the building design.

2.4 Analysing Neighbourhood Assessment Tools

Finding a user-friendly metrics to measure the level of success in these experimental projects connected to green architecture is challenging. Therefore, it would be beneficial to interrogate the Leadership in Energy and Environmental Design (LEED) rating system as a possible methodology for assessing the energy efficiency of these buildings. In addition to the LEEDs rating, Muringathuparambil et al. (2017) have used a building typology rating system to establish the ratings for local buildings in Cape Town which could be useful as a framework for the Lynedoch assessments. Conventional architecture in general is harmful to the environment; while measuring sustainable claims could provide indicators of the effects the mediating measures have on the environment. These methods and principles could bring real change that helps preserve energy, use energy as efficiently as possible, be compatible with climatic conditions, reduce GHG emissions, and meet the needs of the users (Mohammadabadi & Ghoreshi, 2011). According to Sharifi and Murayama (2013) most tools fall radically short in covering social, economic, and institutional levels of sustainability (Komeily & Srinivasan, 2015) and integrating these in a balanced, equitable manner.

2.4.1 Tinkering Towards Sustainability

The green building movement has existed since 1995 and for the most part, has not been focused on, or taken into account, the degree of ‘wholeness’ that comes from being connected to the natural environment. The problem has been increasingly recognized, with some efforts to address it. This is mostly noticeable through integrated design or making choices that would minimize the damage. These efforts have led to the development of specific **green building assessment tools**, BREEAM being the first.

Even though neighbourhoods are made up of buildings, they need different sustainability assessment indicators. It is only since 2014 that we have seen an increase in an awareness of the need for NSA indicators (Hall, 2015; Daly, 2017). This situation looks very similar in South Africa.

The sustainability measuring tools used by the Green Building Council of South Africa (GBCSA) for buildings is mainly based on 'green design', which in essence is only about minimizing damage. Interrelated wholeness has essentially been dismissed. And yet Reed (2007) identifies a reconnection between 'place' and interrelated wholeness, as the shift that would foster the much-needed change from sustainable design to restorative and regenerative design.

A critique of the GBCSA's epistemological stance of only minimizing damage becomes the aim of the conceptual framework. This will be accomplished by assessing the ecological design spectrum, inclusive of conventional design and regenerative design frameworks. Furthermore, a comparative evaluation will be conducted between different sustainability neighbourhood assessment tools as a vehicle of change and the role this plays in socio-technical imaginaries in the design and building of sustainable intentional communities.

In 1960, about 60 years after the Garden City movement, the 'ecological design movement' originated when alternative ways of living outside of the conventional industrialisation movement were formed (Daly, 2017). These grassroots experimental ways of living became a focal point to this generation and the way they relate to the most familiar structure and habitat - the house (Birkeland, 2007). Some described the challenge of the parallel journeys between sustainable development and ecological design thinking, in various disciplines and schools of thought, as an ecological design craft inside a real culture of sustainability (Cole, 2012). Others saw ecological design as an interactive, imaginative process for co-creating things never created before, such as sustainability (Birkeland, 2007). Temper et al. (2018:1) stated that "… transformation to sustainability calls for radical and systemic societal shifts".

Against the backdrop of the designed mess that our neighbourhoods, cities, and ecosystems have become, a regaining of skills to interweave human and natural design becomes essential (Daly, 2017). Unfortunately, our understanding of ecology could be more grounded in a better practice of ecological design, vision and coherent philosophy. Even though Gilman (1991), Birkeland (2007), Reed (2007), Cole (2012) have been instrumental thinkers in the ecological design field, the concept is not a new one - it is rooted in traditional values and ancient insights but through our detachment from nature, we have lost touch with these forms of knowledge. A return to these ancient ways is attempted through a sustainable development approach, hopefully to rekindle a symbiosis with nature and the intimate knowledge about natural processes and patterns that follows from these ways.

Lately attempts to further ecological design have been rooted in resource minimization, multi-function

spaces, durability and densification (Birkeland, 2012). This has only made conventional design more energy efficient, but still not sustainable. Birkeland (2007) argues that sustainability should be both "'path *and* a journey ', which eliminates the 'either-or 'thinking. A Path appeals to those with a human-centric and anthropogenic orientation; we cannot dictate how future communities should live. Yet, a path is not good enough for those with an ecological perspective; things they want to protect will soon be gone. Birkeland (2007:20) states that "to achieve sustainability, then, we need new, multiple pathways and destinations: different ideas about where to go and how to get there", and a possible change of direction in our intellectual and institutional frameworks.

> Many authors have suggested that ecologically sustainable development (ESD), is an oxymoron. It is the contention here, however, that an ethically and ecologically-positive urban environment is possible, but only with a new positive paradigm of design. However, the term 'sustainable development', as commonly used, is indeed a misnomer. It implies that it already exists, and that we only need to build more of it. This popular notion of ESD ignores the global context: development has already exceeded the earth's 'ecological carrying capacity' (ability to maintain biodiversity); up to one-third of the earth's species have been exterminated during a human lifespan; and one-third of the human population is without adequate means of survival or health.
>
> Birkeland 2012:163.

Reed (2007) adding to this quote, feels that the concept of sustainability should move us into a "…thoughtful relationship with our life support systems". It could be argued that the term 'green design' has been used in the last few decades to loosely represent the emphasis on environmental performance of buildings or neighbourhoods, compared to conventional design. According to many this is not accurate and should be considered in the light of a **sustainability spectrum** (Birkeland 2007; Reed 2007; Cole 2012). In this case, humanity might be lower on this sustainability path than hoped.

2.4.2 From Minimizing Damage to Regenerative Design

The quantification of the trajectory of ecological design is based on the regenerative design framework by Reed and helps us to understand sustainability in a different way (See Figure 2.2). This indicates the move from 'c**onventional design**' to '**green design**'; the move from business as usual or unsustainable practice, to a small tweaking of our behaviour in the form of minimizing damage, but still having a negative impact. Higher on the scale is '**sustainable design**'; this is 100% less bad but doesn't substantially give back and restore the damage done to the planet. Moving beyond sustainable design to '**restorative design**'; means reforesting and creating new eco-systems, but still within the mind-set of 'man-over-nature'.

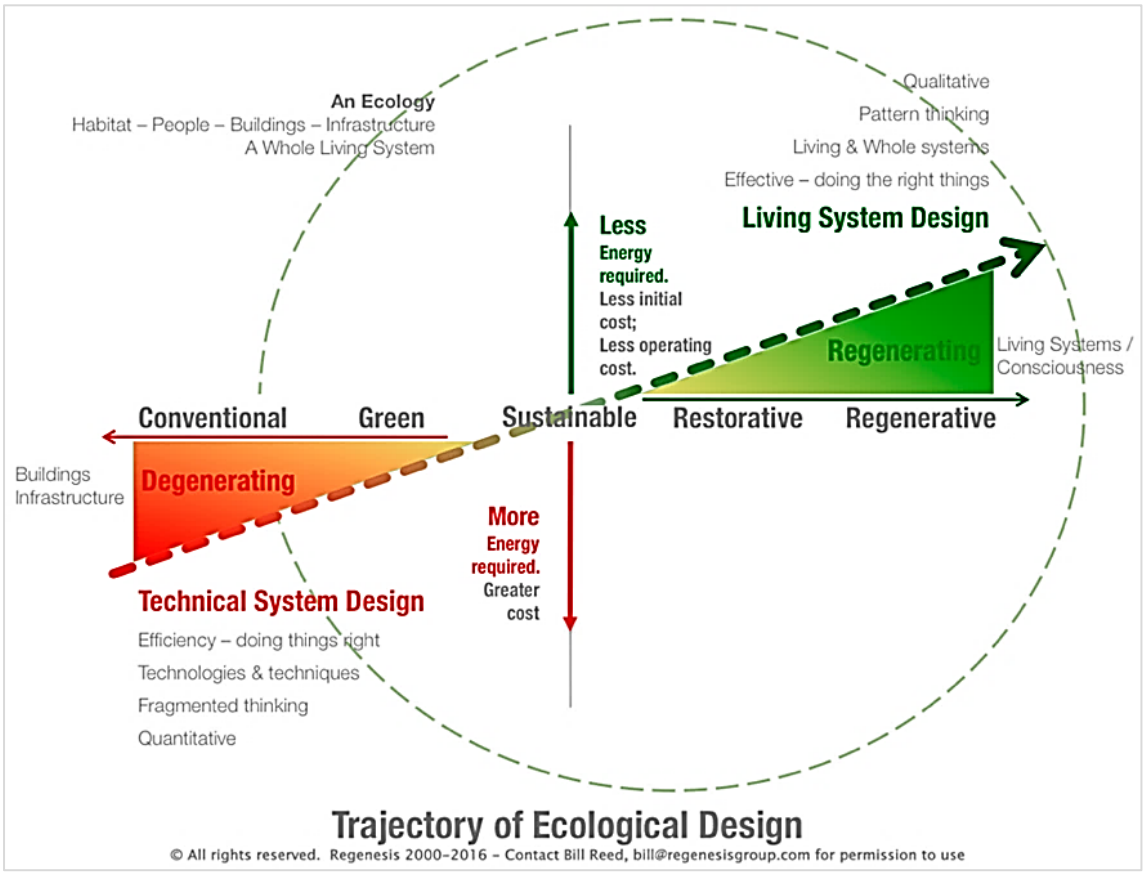


Figure 2.2. Trajectory of Ecological Design according to Bill Reed (Source Reed 2007).

The next step, is called **'reconciliatory design** '; where the relationship between humans and nature is reconciled - including the aspect of culture in nature and the fact that humans are an integral part of nature. Beyond reconciliatory design lies '**regenerative design**', which creates cultures that are able to work creatively with disruption, rather than to avoid them. This implies the ability to be resilient towards change - since change is the only constant on this planet - and be able to hand over a richer, more regenerative, more resilient system to the next generation, than what was received from the previous generation (See Figure 2.3).

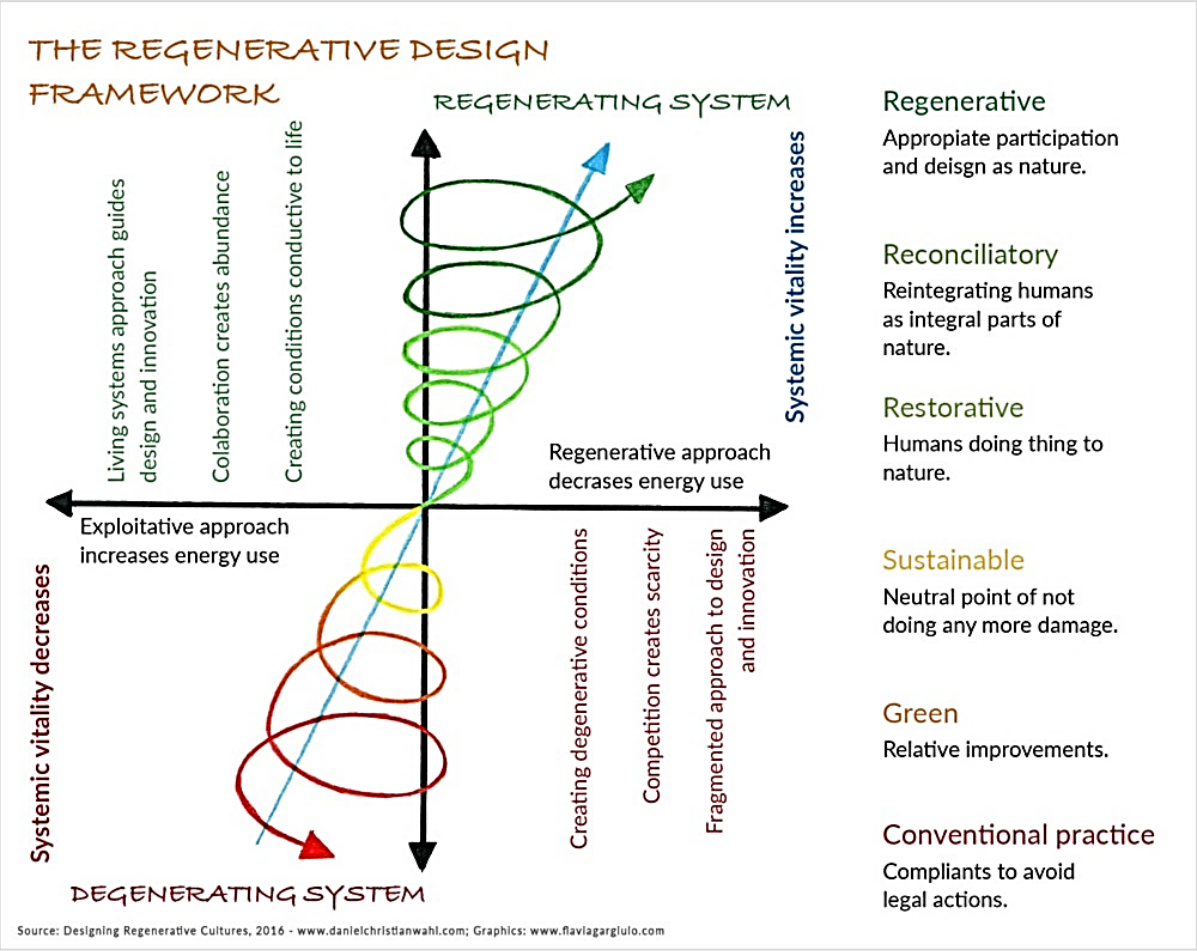


Figure 2.3. Regenerative Design Framework (Source: Redesigning Regenerative Cultures 2016 - Daniel Wahl).

"Note that these levels of the sustainability trajectory are not exclusive of one another, they are a progression, and each is nested in the more whole level" (Reed, 2007:677). The regenerative design framework is a process that interacts with the living and whole system that we are part of and encourages participation (Gou & Xie, 2017), by engaging all the key stakeholders in the design process and building capacity to engage to healthy relationships through co-evolution (Birkeland, 2012). Such processes tap into the consciousness and spirit of the people engaged in a place (Reed, 2007).

"The design process draws from and supports continuous learning through feedback, reflection and dialogue" (Reed, 2007:677), connecting the integral parts of the system and processes of life in a place. This engagement is the best way to establish healing back to place; the interactions between humans, earth systems and the consciousness that connects them.

"Regeneration is a deep search for the nature of relationship between human and earth systems" (Reed, 2007:667) - moving the discourse from "doing things *to* nature" to one of "participation as

partners *with* and *as* nature" (Nykamp 2017). In addition, Gou and Xie (2017:600) argue that green buildings should include both the triple bottom line - social, economic and environmental (Gou & Xie 2017) - as well as regenerative design, therefore taking a more "… holistic approach to sustainability, and rais(ing) the benchmark". Cloutier et al. (2018:139) state that "… ecological indicators typically include aspects of environmental quality, health or human interaction with nature", and argue that the holistic ways of ecological design should include human happiness in the form of both pleasure and meaning. However, Reed (2007:604) argues that regeneration is not "… simply about making a landscape and local habitat more productive", but that effectivity comes from engaging the "… entirety of what makes a place healthy". This implies that a building, or a community or one's home could become the entry point into the living and whole system (Reed, 2007).

Many believe that in order to make a shift towards a regenerative worldview, this requires moving away from a fear-based approach fixated on uncertainty and resource scarcity towards a positive model (Cole, 2012; Reed, 2007), which would align humanity within a larger community of life. This understanding or consciousness of essential and workable interrelationships forms the beginning of a whole-system healing process and living-system design. Buckminster Fuller was a dynamic engineer ahead of his time and said in the 1960s that life on this planet is interdependent and that we are not at the mercy of mother nature, but as humans we occupy a place somewhere between steward and pilot (Evans, Karvonen & Raven, 2016).

2.5 Conclusion

Thus, the building sector is the largest energy-consuming sector, contributing to anthropogenic climate change. Decarbonisation is therefore an important reality for the ever-expanding urban systems, and green communities and buildings are strategically important for the construction sector in the light of energy efficiency and mitigating climate change. Green buildings aim to integrate elements to reduce the building's negative impact on the environment and increase resource efficiency, inclusive of renewable energy systems. As a result, green architecture or green urbanism is also an experimental emerging field and enhancing energy efficiency is more environmentally friendly and could also account for a contribution to decentralised energy systems, such as SIDE energy systems. These are very sustainable, a resilient subset of micro-grids, and advancing the flexibility of the energy system from the bottom up through a decentralised design philosophy. Experimentation in socio-technical systems, the intersection where technical systems and complex social systems can co-evolve to create a lasting sustainability transition, becomes key. Finding a user-friendly metric to measure the level of energy efficiency in these experimental projects could be a challenge, but various methodologies are available and could be developed into useful rating systems.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 Research Strategy

This research strategy became the step-by-step guide to systematic direction and execution; it added clear definition, enabled me to stay focused and reach deadlines, and saved time.

The focus of the first two months was to establish the various theoretical frameworks as a solid basis on which to build the research. As I wished to explore the connection between sustainable infrastructures within neighbourhoods, this naturally led me to the junction where socio-technical and experimental frameworks meet.

The next two months were spent critically assessing four of the most popular NSA indicator toolsets. This conceptual framework was analysed using Reed's regenerative design model as the baseline for such a comparative study (Reed, 2007). These tool sets are dense, with each having their own weights and scoring for different indices which they find important to measure sustainability. It was challenging to simplify the use of these tool sets, create a comparative study between them, and evaluate them in the light of the Reed's regenerative design model. This led me to explore the value some indices would add or not add in my quest to develop the best criteria by which to assess sustainability in Lynedoch EcoVillage.

The following months were spent gathering and analysing the data, to produce findings. Then conclusions were drawn using a specific sustainability assessment tool, but also allowing the uniqueness of this village to influence the way this toolset evolved.

3.2 Research Methodology

In my *conceptual framework*, I analysed a few neighbourhood assessment tools measuring embodied energy, design and use, from both the Global North and Global South. The boundaries of this study remained focussed on assessing the sustainable claims and the socio-technical relationships in this village, including also environmental awareness.

To conduct research in a systematic way I used a case study research methodology, by using a mixed research methodology, both quantitative and qualitative research methods were used to provide more comprehensive data by including an array of narratives, images, statistics and numbers. This added nuances and texture that would normally be missed, and provided stronger

evidence for a conclusion. This combination also overcame weaknesses in the different methods. I could therefore present a more complete picture of the Lynedoch EcoVillage and the problem I was examining.

The case study methodology also helped me to conduct an empirical in-depth enquiry into Lynedoch EcoVillage. It gave me the freedom to ask “why”, “what”, “from where”, “how” and “when” this eco-village had made use of specific building practices and the new micro-grid system by exploring complex issues both qualitatively and quantitatively. This methodology also helped me to explain the real-life interventions that are too complex for some other strategies, and through assessing the logic, I could link questions and propositions to interpretations of the outcome. I could also examine two aspects, one being the micro-grid and the other being the building practice.

3.2.1 Quantitative Research Method

By using this method, two distinct aspects were assessed. The first was the energy infrastructure in the form of assessing the process of getting the Eskom pilot project going. This *micro-grid system* had recently been installed in the Lynedoch EcoVillage and some interim empirical research had been conducted by Eskom. I started by meeting with representatives from the Eskom Research, Testing and Development Laboratory in Roshenville, Johannesburg, which increased my understanding of the reasons for this pilot project. This enabled me to describe the technical components of this micro-grid system and design a small informative diagram (see Addendum E).

In the following stage of the research the village issued me with a letter of consent, granting consent to access and assess the ready-made data (secondary data) from Eskom. The primary data of this project was gathered and analysed in the light of *energy use, carbon emission savings, but also the potential for energy trading in the future*. The consulting engineer that installed the micro-grid also shared empirical data with me from a conventional neighbourhood, making the comparison very interesting.

The second aspect relates to the building infrastructure - assessing the building envelope and design principles towards *energy efficiency*. Some empirical data had been gathered by the HOA in Lynedoch EcoVillage regarding the sustainability of various building materials. Unfortunately this was not complete and more information had to be gathered. I gathered and grouped the outstanding data through my own observation and informal conversations with key people involved in the developmental stage and in the village for the last eighteen years.

One of the co-founders answered questions relating to the construction phase of this village (Addendum F). Other interesting and informative people were Malcolm Worby, the architect involved in designing and constructing some of the adobe houses in the village; Gita Goven from ART Designs who played an instrumental role in the developmental stages of the development; and some members of the HOA of the village. This information gave me enough to describe, analyse and model different building categories and typologies.

The first objective was to include all 35 houses in the eco-village and group them into various typologies (thus not only the 27 houses which were part of the micro-grid pilot project). After compiling a list of all building materials used in the building envelope, the Green Building Council South Africa (GBCSA) gave me access to an embodied energy application, which made it possible to compare the different materials with a conventional brick and mortar building and to indicate the differences in percentage. I also used proxy data from suppliers of the specific materials to add values to indicate the R-values, and then to determine what the thermal resistance was of each material. Continuing this investigation, I met with technical staff of the GBCSA and selected five building design principles as comparative criteria, to add to the indicated typologies. These design principles were orientation, fenestration, insulation, shading and solar heating. The information on solar heating was also gathered through meetings with former subcontractors and information from the HOA of the village.

With regards to the NSA tool sets, I had several meetings with the GBCSA. In one meeting we discussed the latest addition to the GBCSA tool sets, namely the Green Star Sustainable Precincts NSA assessment indicator set. Furthermore, in email correspondence with Building Research Establishment Environmental Assessment Method (BREAAM) and LEED, I enquired about specific applications of their NSA tool sets. This, in addition to analysing and assessing the technical manuals, gave me the information that I was hoping for, stimulating curiosity in what the appropriate technical assessment tool could look like for an eco-village like Lynedoch EcoVillage. Although this process now seems seamless, analysing the weights and scoring of these NSA tool sets was time-consuming and challenging, especially when comparing them to the regenerative design model of Reed (Reed, 2008).

3.2.2 Qualitative Research Method

Attending the HOA meetings became a source of valuable information, especially regarding the process and motivation of installing the micro-grid in the village (see Addendum B). Although the Research, Testing and Development division of Eskom had good intentions, the suspicion around

Eskom, shared by a large portion of the public[1], was always a background factor. However, my experience with the Eskom group was very positive most of the time. My participation in the HOA meetings was low-key and served only as a source of data collection. These meetings sparked questions which I later addressed with specific individuals in the village through informal, confidential and anonymous interviews - which will be reflected in Chapter 4 -as well as my own experiences with Eskom later on. In one of the first meetings I attended, Eskom came to inform the village of the micro-grid and handed out a booklet with Frequently Asked Questions (see Addendum G). This booklet was accompanied by another more technical hand-out, for technical support in the village, followed up by technical training by the consulting engineer and maintenance subcontractor (see Addendum H). This informative meeting happened in November 2017, just shortly after installation of the pilot project was completed in October 2017.

During the time I was involving members of the village in some surveys, I would also converse on lifestyle habits and electricity usage habits; in some cases I could suggest different habits that would lead to saving electricity and money. While my playing a small active participatory role in the village was educational to the village, it also provided me with a more accurate picture of the community of the village, and how they related to this pilot project.

Initially within the qualitative research method, I used an *exploratory method* to explore the research questions and possible research designs to describe the building practices and embedded PV micro-grid system in the best way possible. This understanding led me to more thorough methods to conduct the research.

The *experimental method* followed the exploratory method within the mixed methods methodology space, - inclusive of qualitative and quantitative methods - which allowed me to assess the socio-technical relationship in this case study. There are many situations in which the social, technical, and institutional relationships interlink, and this method highlighted the human factor within these technically designed systems. More on this in Chapter 4.

In this study the *immersive research method* allowed the fullest use of the mentioned methods and methodology, bringing about a greater pool of information from which to draw conclusions:

- I fully embraced the connection with Eskom - the technical team working on the micro-grid, spending time with the Eskom researchers, collecting stories and data from Eskom;

[1] Eskom is the local electricity utility in South Africa. The country experienced load shedding from 2008 till 2010 and again in 2018. There have been allegations of corruption, involvement in controversial practices, and it has also been in the public arena that Eskom is experiencing a serious financial crisis. The mismanagement of the monopoly has decreased the public's faith and trust in the company.

- I became part of the community, attending the HOA meetings, social meetings and gatherings, understanding the village users and other relationships;
- I often just walked around and had friendly conversations, which led to the sharing of interesting facts around village life - how this connects to the people's identity and pride, and more specifically the socio-technical engagements - which brought other interesting irrationalities to my attention - for example, the discrepancies in the way the back-up battery systems have been stored; and the challenge of finding a suitable tariff for this pilot project;
- I had informal interviews with most households in the village; 20 households that are part of the micro-grid pilot project and 5 households that are not; the interviewees completed a survey of 16 multiple choice questions, the LSM questionnaire and an appliances list;
- I also became more aware and familiar with the different systems, collecting information and stories of the building materials and design principles used.

By using the above methodologies and methods, my data collection and analysis has provided a stronger base from which to address the research question, in line with the existing literature.

Some *additional comments* on this study and reflecting on my positionality to sustainability, I would like to highlight a few personal reflections: Firstly, I appreciated the level of inclusivity that I witnessed at the Lynedoch EcoVillage HOA meetings; with a diverse 'audience' it is easy to lose some people in the detail, especially when the topic gets rather technical, as in the case of the micro-grid installation and negotiations. In my experience this was handled with care and inclusivity. Secondly, the ideas Eskom brought to the table at our first discussion, regarding the creation of a smart community at Lynedoch EcoVillage, could result in something very close to the Dutch 'Smarthoods' concept and could be an exciting trajectory for neighbourhoods of the future, even in South Africa.

3.3 Research Instrument

The *data collection tools* used were research journaling, informal interviews, an online survey on Survey Monkey, observations, NSA indicator sets, and Eskom empirical data. The quantitative data was collected and analysed first, and then some qualitative strategies were applied to find answers regarding certain trends that were identified through the numerical data.

My *research journaling* was a significant way of structuring my own observations and experiences while immersing myself in this village. It was also interesting how this instrument helped me to track my experiences with a stakeholder like Eskom, who tends to wear a different hat in every different department.

The *informal interviews* and *online surveys* I conducted in this study are divided into four sections:

- The first section focussed on the micro-grid and the overall experience of the villagers;
- The second section covered the building materials and building design principles, although most of these questions were answered through my own observation;
- The third section on user habits was more challenging to measure qualitatively, although I did ask some questions which I then compared to a control group of 20 people who live in non-intentional middle class neighbourhoods;
- The fourth section was the use of appliances; this was gathered by querying the appliance use of each household, and was useful to compare to the empirical data from Eskom.

In these interviews, surveys, questionnaires and written notes were mostly used. At times more than one interviewee took part in an informal interview. A structured list of questions was available to work from, which enabled me to collect more data in a shorter timeframe and then probe other questions in a more natural way without being too formal and overly structured. From my experience with the interviewees, they appreciated the structured surveys and standardized LSM calculator questionnaires - though these mostly turned into more spontaneous and also meaningful conversations, where some shared their experiences with Eskom more freely. It also gave me the chance to make some descriptive and inferential, albeit surface, observations, through observing the attendees' behaviour and body language.

In some situations, *observations* were a good way to collect some of the data, being less invasive - particularly with regard to the building infrastructure information. Attending the HOA meetings were more useful to gather the micro-grid information.

3.4 A Review of Indicators Tool Sets

Neighbourhoods are seen as building blocks in cities, with green neighbourhoods the first effort to link urban sustainability principles and micro-level community planning together (Tam et al., 2018). Therefore, sustainable community development needs a framework to measure these objectives and strategies against (Tam et al., 2018). This requirement has evolved into the using of NSA tools. These third party rating tools evaluate neighbourhoods against very specific criteria, mainly to determine the stance of such a neighbourhood on its way towards sustainability (Tam et al., 2018). These tools are generally represented by a set of indicators, divided into categories, and used as targets to reach points under specific categories. A sustainability rating is then given to a neighbourhood according to these points. Compiling such a rating tool is a complex process and

takes time and the best way to adopt a tool into a new context takes a proper Local Context Report (LCR).

All NSA tools can be divided into two main categories (Sharifi & Murayama, 2013). The first category is an extension to the original building assessment tools for single buildings, and altered and scaled to measure neighbourhood sustainability. The second category refers to sustainability initiatives to measure their sustainability performance, and is connected to neighbourhood-scale plans (Sharifi & Murayama, 2013).

All the popular NSA tool sets analysed in this section are tools from the first category. The intent of this section is to review four NSA tool sets, conduct a comparative study by using Sharifi and Murayama's (2013) eleven main themes, and then to analyse their position in relation to the "Trajectory of Ecological Design" according to Bill Reed. Many have done some comparative analysis around the NSA tools, but Sharifi and Murayama (2013) have done a critical review of seven NSA tools sets. This critical review covered three of the four NSA tool sets and became the base of the NSA analysis in this thesis. As for the local tool set in South Africa, other sources were used and applied to the eleven themes of Sharifi and Murayama (2013). A few articles, such as Tam et al. (2018), Komeily and Srinivasan (2015) and each NSA tool set, were also used to adapt the radar diagrams in the following sections into the eleven main themes used by Sharifi and Murayama's (2013).

3.4.1 BREEAM Communities

In 1988, the Building Research Establishment (BRE) in the UK developed the first green building rating system, called BREEAM. Initially such a rating was applied only in the UK, but since then other rating systems have been developed in other areas of the world. Since 1988, a neighbourhoods rating system evolved from the UK building tool set and the first BREEAM Communities version was released in 2008, and updated in 2012. There are 40 indices, and to date 85 official certified projects have been logged as part of the BREEAM Communities system.

> It was developed to help planners and developers take account of the full range of issues that must be considered from the earliest stages of the development process, and to measure and independently certify the sustainability of project proposals at the planning stage of the development process
>
> Sharifi & Murayama, 2013

The aim of the BREEAM Communities tool is to offer design support and assessment across life cycle stages of all development, master planning of large scale development, including social and

economic benefits while mitigating the environmental impact of the built environment. BREEAM claims to provide a well-rounded international framework of core standards and core science as a leader in sustainable development (BREEAM, 2012).

According to Sharifi and Murayama (2013:76) the main characteristics of BREEAM Communities is focused on the following: "Climate and energy; resources; place shaping; transport; community; ecology and biodiversity; business; and buildings".

To simplify the use of this tool set and facilitate a comparative study between all four tool sets, the BREEAM Communities' 40 indicators were grouped against eleven different categories and scored as a percentage out of 100 (see Table 3.1).

Table 3.1. BREEAM Communities (Source: Tam et al., 2018; Komeily & Srinivasan, 2015; Sharifi & Muraya, 2013; BREEAM, 2012).

Category	Criteria	%
Location and Site		4%
Transportation	Connectivity to Public Transportation; Connectivity to Bike Lane; Pedestrian-Friendliness; Private Car; Parking; etc.	11%
Green Infrastructure & Design Principles	Design Principles; Mixed Use; Compact Development; Green Infrastructures; Heat Island	14%
Innovation		0%
Water		4%
Energy		4%
Materials & Resources Conservation	Materials; Resource Conservation; Waste Management	8%
Biodiversity	Biodiversity; Nature; Microclimates	15%
Quality of Life	Safety; Well-being; Quality of Life; Sound Emission; Affordable Housing; Inclusive Communities; Social Networks and Infrastructure; Heritage	16%
Socio-Economic	Local Economy; Employment and Local Jobs; Business; Investments	15%
Institutional		9%

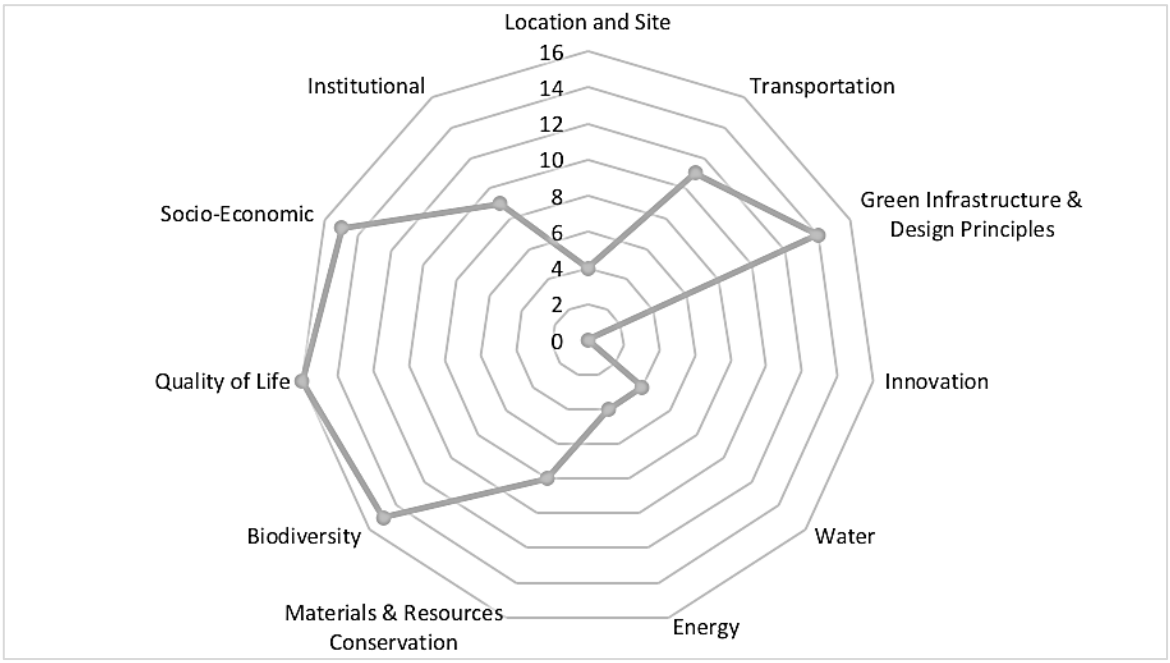


Figure 3.1. BREEAM Communities Criteria Results.
(Source: Tam et al., 2018; Komeily & Srinivasan, 2015; Sharifi & Muraya, 2013; BREEAM, 2012).

From Figure 3.1 it is clear to see that the BREEAM Communities criteria focus mostly on the categories of Biodiversity, Quality of life, Socio Economic, Green Infrastructure and Building Design Principles. Innovation, Location and Site, Water and Energy are the lowest scoring categories. For the purpose of the study boundaries, only Materials and Energy will be focused on. According to Yoon and Park (2015) BREEAM Communities have three indicators related to the category 'Materials'. The Energy strategy is covered by three indicators (BREEAM 2012).

3.4.2 LEED-ND

Another green building certification program, Leadership in Energy and Environmental Design (LEED), was developed in the USA in 1993 and in 2009 LEED-ND, the Neighbourhood Development certification process of LEED, was developed. The latest version of this tool was released in 2016, with 56 indices. This tool has been indicated as the most popular; the assessment period takes 40-100 days, and 184 project certifications have been logged up to date (Tam et al., 2018).

> Unlike other LEED rating systems, which focus primarily on green building practices and offer only a few credits for site selection and design, LEED-ND places emphasis on the site selection, design, and construction elements that bring buildings and infrastructure together into a neighbourhood and relate the neighbourhood to its landscape as well as its local and regional context.
>
> Sharifi & Murayama, 2013:75

The aim of LEED-ND is to encourage best practice through Smart Growth and New Urbanism by:

- promoting environmentally friendly habits
- developing walkable neighbourhoods that reduce private car use
- encouraging developments that have jobs and services easily accessible by pedestrians or public transport
- promoting green building practice, especially energy efficiency and water use
- protecting and conserving smart location choices (LEED, 2013).

The main characteristics of LEED-ND are, according to Sharifi and Murayama (2013:76): "Smart Location and Linkages; Neighbourhood Pattern and Design; Green Infrastructure and Buildings; Innovation and Design; and Regional Priority Credit". To facilitate a comparative study, LEED-ND's 56 indicators were grouped against the same eleven different categories as BREEAM (also grouped), and scored as a percentage out of 100 (see Table 3.2).

Table 3.2. LEED-ND (Source: Tam et al., 2018; Komeily & Srinivasan, 2015; Sharifi & Muraya, 2013; LEED, 2013).

Category	Criteria	%
Location and Site		18%
Transportation	Connectivity to Public Transportation; Connectivity to Bike Lane; Pedestrian-Friendliness; Private Car; Parking; etc.	6%
Green Infrastructure & Design Principles	Design Principles; Mixed Use; Compact Development; Green Infrastructures; Heat Island	34%
Innovation		5%
Water		3%
Energy		5%
Materials & Resources Conservation	Materials; Resource Conservation; Waste Management	2%
Biodiversity	Biodiversity; Nature; Microclimates	5%
Quality of Life	Safety; Well-being; Quality of Life; Sound Emission; Affordable Housing; Inclusive Communities; Social Networks and Infrastructure; Heritage	17%
Socio-Economic	Local Economy; Employment and Local Jobs; Business; Investments	5%
Institutional		0%

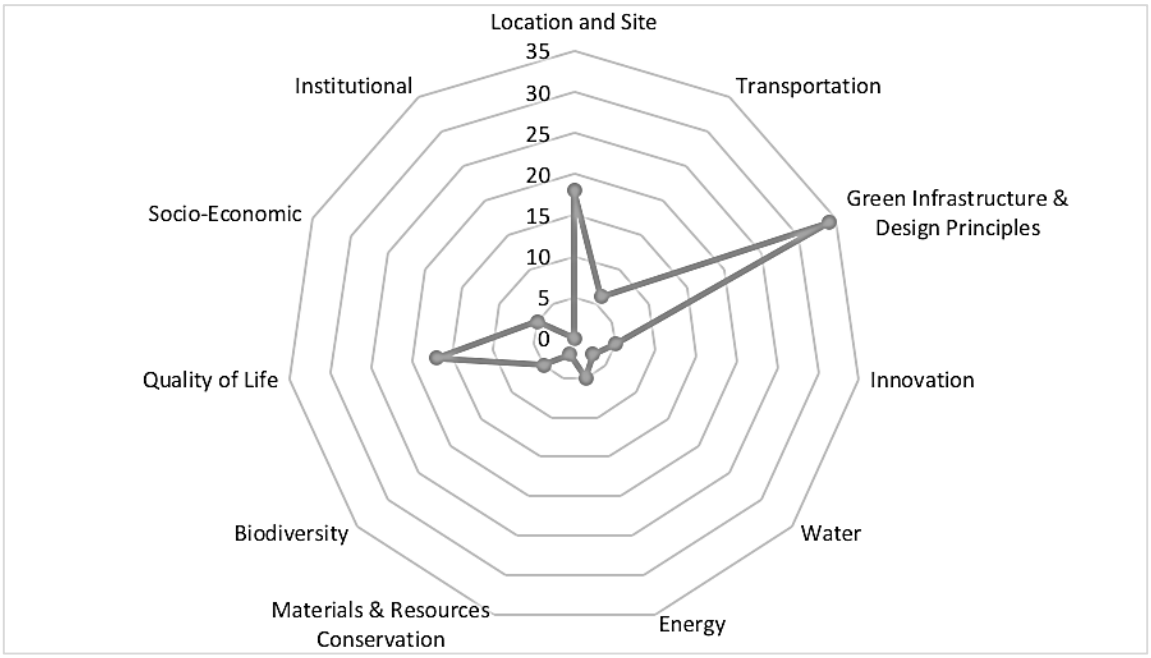


Figure 3.2. LEED-ND Criteria Results
(Source: Tam et al., 2018; Komeily & Srinivasan, 2015; Sharifi & Muraya, 2013; LEED-ND, 2013).

From Figure 3.2 it is clear that LEED-ND criteria focuses mostly on Green Infrastructure, less on Location, Site and Quality of life, while Institutional, Materials, Innovation, Water and Energy are the lowest scoring categories. Again, for the purpose of the study boundaries, only aspects of Materials and Energy will be considered. According to Yoon and Park (2015) LEED-ND has one indicator relating to the category 'Materials' while the Energy strategy is reflected in five indicators (LEED-ND, 2013).

3.4.3 CASBEE-UD

The Comprehensive Assessment System for Built Environment Efficiency (CASBEE) is the building rating system counterpart in Japan. In 2006 the first version of CASBEE-UD was released, updated in 2014, with 30 indices. (UD refers to Urban Development). The evaluation takes 6-12 months and only 4 projects have been officially certified to date (Tam et al., 2018). The interiors of the buildings are excluded from assessment; however, the CASBEE system includes 'CASBEE for an Urban Area + Buildings', which enables the use of CASBEE-UD linked to building scale assessment (Sharifi & Murayama, 2013).

The main characteristics of CASBEE-UN according to Sharifi and Murayama (2013:76) are:

- natural environmental quality in urban development
- service function for the designated area
- contribution to the local community (history, culture, scenery, and revitalization)

- environmental impact on microclimates, façade, and landscape
- social infrastructure
- management of the local environment.

To facilitate a comparative study, CASBEE-UD's 30 indicators were also grouped against the eleven different categories (also grouped and scored as a percentage out of 100 (see Table 3.3).

Table 3.3 CASBEE-UD (Source: Tam et al., 2018; Komeily & Srinivasan, 2015; Sharifi & Muraya, 2013; CASBEE-UD, 2014).

Category	Criteria	%
Location and Site		0%
Transportation	Connectivity to Public Transportation; Connectivity to Bike Lane; Pedestrian-Friendliness; Private Car; Parking; etc.	7%
Green Infrastructure & Design Principles	Design Principles; Mixed Use; Compact Development; Green Infrastructures; Heat Island	30%
Innovation		0%
Water		4%
Energy		11%
Materials & Resources Conservation	Materials; Resource Conservation; Waste Management	6%
Biodiversity	Biodiversity; Nature; Microclimates	21%
Quality of Life	Safety; Well-being; Quality of Life; Sound Emission; Affordable Housing; Inclusive Communities; Social Networks and Infrastructure; Heritage	19%
Socio-Economic	Local Economy; Employment and Local Jobs; Business; Investments	1%
Institutional		1%

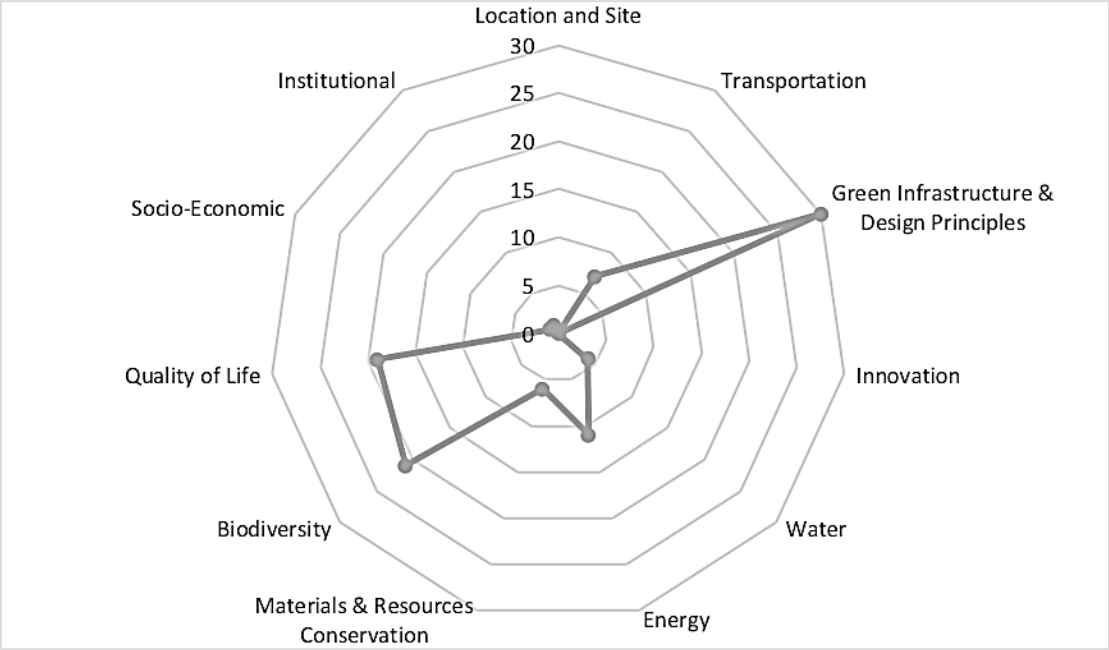


Figure 3.3. CASBEE-UD Criteria Results
(Source: Tam et al., 2018; Komeily & Srinivasan, 2015; Sharifi & Muraya, 2013; CASBEE-UD, 2014).

From Figure 3.3 it is clear that CASBEE-UD criteria focus mostly on Green Infrastructure, Energy and Biodiversity, Innovation, Location and Site, while Institutional and Socio-Economic are the lowest scoring categories. According to Yoon and Park (2015), CASBEE-UD have seven indicators related to the category 'Materials' while the Energy strategy covers four indicators (CASBEE-UN 2014).

For BREAAM Communities, LEED-ND and CASBEE-UD the subcategory of 'Materials' includes low-impact materials, certified reference materials, reused and recycled materials, and local materials. Energy strategy is mostly related to GHG emissions, energy efficiency and low carbon technologies.

3.4.4 Green Star Sustainable Precincts

In 2007 the Green Building Council South Africa (GBCSA) adopted its Green Star rating system from the Green Star rating system developed by the Green Building Council Australia (GBCA). GBCSA altered the rating system to be more context-specific to South African conditions. There is thus a close working relationship between the two countries.

In 2012 the latest version of the Green Star Communities neighbourhood tool was released by the GBCA and from the beginning of 2018 the GBCSA adopted and changed this tool to accredit a pilot project in Cape Town. The tool takes 6-12 months to certify a neighbourhood and to date, 12 projects have officially been registered through the GBCA (Tam et al., 2018).

The Green Star Communities tool set from Australia is called the Green Star Sustainable Precincts in South Africa and is still assessing projects against the same five distinct categories. According to Tyrel Momberg, the Technical Manager at the GBCSA, these categories are Governance; Liveability; Economic Prosperity; Environment; and Innovation (Momberg, 2018). Governance covers the early stages of the new project, while Liveability, Economic Prosperity and Innovation fall under the second phase, the planning section (Momberg, 2018). The Environment category, inclusive of the water systems and energy systems are part of the construction phase (Momberg, 2018).

As mentioned before, developing a rating tool takes time and effort. The adoption from the Green Communities to the Green Star Sustainable Precincts was adopted by the GBCSA to be more context-specific. The first two sections of the LCR are included in Addendum J; Executive Summary and Introduction. To facilitate a comparative study with the list of credits (see Addendum K), the Green Star Sustainable Precincts 32 indicators were grouped against eleven different categories and scored as a percentage out of 100 (see Table 3.4).

Table 3.4 Green Star Communities (Source: Tam et al., 2018; Komeily & Srinivasan, 2015; Sharifi & Muraya, 2013; GBCA, 2016).

Category	Criteria	%
Location and Site		2%
Transportation	Connectivity to Public Transportation; Connectivity to Bike Lane; Pedestrian-Friendliness; Private Car; Parking; etc.	7%
Green Infrastructure & Design Principles	Design Principles; Mixed Use; Compact Development; Green Infrastructures; Heat Island	22%
Innovation		9%
Water		6%
Energy		5%
Materials & Resources Conservation	Materials; Resource Conservation; Waste Management	10%
Biodiversity	Biodiversity; Nature; Microclimates	2%
Quality of Life	Safety; Well-being; Quality of Life; Sound Emission; Affordable Housing; Inclusive Communities; Social Networks and Infrastructure; Heritage	17%
Socio-Economic	Local Economy; Employment and Local Jobs; Business; Investments	15%
Institutional		5%

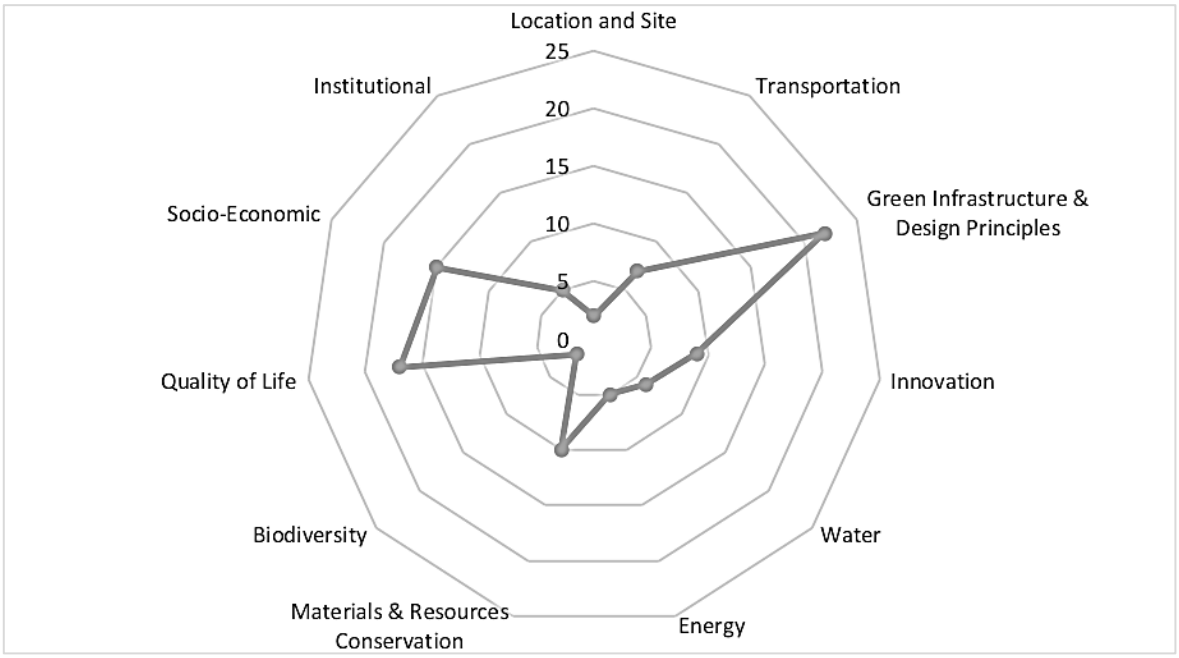


Figure 3.4. Green Star Communities
(Source: Tam et al., 2018; Komeily & Srinivasan, 2015; Sharifi & Muraya, 2013; GBCA, 2016).

From Figure 3.4 it is clear to see that the Green Star Communities categories focus mostly on Green Infrastructure, Materials, Socio Economic, and Quality of life. Location and Site, Institutional, and Energy are the lowest scoring categories. According to GBCSA three indicators related directly to the category 'Materials'. Only one indicator related to the 'Energy' category, 'Peak Electricity Demand Reduction', with one other indicator relating to GHG strategy (GBCA, 2016).

3.5 Analysing and Critiquing the Tools

Some basic information on NSA tools, relevant to this section, has been articulated in Table 3.5, and a general review will follow.

Table 3.5. A paraphrased NSA Basic Information Table. (Source: Tam et al., 2018; Komeily & Srinivasan, 2015; Pourmatin, 2018).

NSA	Since	Main Aim	Assessment Period	Certified Projects
BREEAM Communities	2008	BREEAM Communities: aims to ensure that its standards provide social and economic benefits whilst mitigating the impacts of the built environment. In doing so, BREEAM Communities enables developments to be recognised according to their sustainability benefits and stimulates demand for sustainable developments	-	85 (Only 45 in the UK)
LEED-ND	2009	LEED (ND) for Neighbourhood Development: (LEED (ND) was designed to inspire and help create better, more sustainable, well-connected neighbourhoods. It looks beyond the scale of buildings to consider entire communities	40-100 Days	184
CASBEE - UD	2006	CASBEE-UD: is aimed at Comprehensive assessment of environmental performance of a construction project planned and conducted under the unified intention of development for a relatively large group of land sections such as a whole block or a district consisting of blocks	6-12 Months	4
GREEN STAR Communities GBCSA GBCA	 2017 2010	The Green Star Communities/ Sustainable Precincts: evaluates the sustainability attributes of the planning, design, and construction of large scale development projects, at a precinct, neighbourhood, and/or community scale	6-12 Months 6-12 Months	1 u/c 12

3.5.1 Critique

In light of Table 3.5, Boyle, Michell and Viruly (2018) generally critique NSA tools and question the epistemological stance they promote. Subsequently, the critique lies more specifically in the limitations and how that could impact urban regeneration (Boyle el al., 2018). Urban regeneration is the basis of global sustainability and is deeply rooted in the existing urban form. Boyle et al. (2018) argue that most megacities and smaller cities are already built, so it is important to keep urban regeneration in mind when any urban development aims to consider sustainability in their redevelopment frameworks. This argument could indicate the 'need' for NSA tool sets (Tam et al., 2018), but at the same time, others find the tool sets rather limiting (Boyle et al., 2018). It could be

argued that these tool sets are a good start towards finding effective criteria to consider sustainability in neighbourhoods; a good start but not the end goal.

Cappai, Forgues and Glaus (2018) state that all four NSA tools aim to be inclusive of sustainability but hold challenges and weaknesses, with ambiguities and gaps in weighting and scoring. The comparisons made for this study, revealed the NSA indicator tool sets to be rather **complicated and technical and not user-friendly,** and as pointed out by Tam et al. (2018) and Cole (2012), these indicator tool sets become a barrier in themselves. They gather vast amounts of data which are time-intensive to process.

A barrier and critique of these tool sets are their **lack in guiding the community through co-creation, implementation, and operations of projects** (Plaut et al., 2012). Instead of building social and natural capital, they reduce it, thereby creating an emphasis on managing nature rather than fostering a co-creative and co-evolutionary process between human and natural systems; thus being expert-driven and outcome-based (Boyle et al., 2018). This illustrates the lack in collaboration and empowerment, and the need for institutional development and process leaderships, while reaching social, environmental and economic inclusivity through the application of these NSA tools.

Cities are the heart of human movement and activity, and therefore could play a vital role in reaching global sustainability. Some studies have shown that NSA tools are fundamentally more focused on meeting environmental criteria, which leaves the **social and economic aspects of sustainability vastly under-represented** (Boyle et al., 2018; Tam et al., 2018). This adds another critical barrier, and highlights the importance of social structures and economic processes in urban regeneration. Therefore, the transformation of poorly-performing neighbourhoods in these aspects of sustainability becomes vital for the future. Furthermore, Zang, Yung and Chan (2018) argue that urban regeneration is more complex than what the NSA tools allow, and that a wider consideration of the urban fabric should be included. Boyle et al. (2018) tate that NSA tools do not tell the entire social story and lack in accommodating the complex interactions of social networks at this scale and by oversimplifying these processes, NSA tool sets remain comfortably within their linear and conventional understanding of their view on urban sustainability.

In seeking answers, I consulted the GBCSA in Cape Town and emailed questions to BREEAM and LEEDs. These interactions highlighted more deviancies in the rating tools - the following one being very prominent. The GBCSA Green Star Sustainable Precincts tool **can only measure a *newly-established* neighbourhood design**; thus the redevelopment of communities could not be certified by using this tool (GBCSA, 2018). this makes it impossible to ever get Lynedoch EcoVillage certified through the GBCSA Green Star Sustainable Precincts tool set. From the other two tool sets the

answers were similar; BREEAM Communities and LEED-ND can be used for *new or transformed neighbourhoods*, but cannot measure an already established and operating community or neighbourhood (LEED, 2013; BREEAM, 2012).. In other words, while the *measurement* of a neighbourhood could point to aspects of sustainability that **need** *transformation*, that measurement is not always available. All four NSA tool sets only focus on a limited measurement of sustainability, with a reductive and fragmented approach[2], which only encourages relative improvement by minimising the damage done by conventional practice.

The last barrier to mention includes the NSA tool sets that are more generic in their formulations (Cole, 2012). Some challenges are regarded as too subjective, so a **"one size fits all" method** is applied (Boyle et al., 2018), which lacks the ability to be customized and to adapt to new settings. This also puts pressure on the tension between standardization and localization in the planning field, and fails to point out the diversity in opinions and beliefs of urban sustainability processes (Boyle et al., 2018; Tam et al., 2018). Sharifi and Murayama (2013) agree that it is necessity to adjust the benchmarking and weightings of these tool sets to the new location that is being measured. It is likely that if all four tool sets were used to measure the sustainability performance ratings of Lynedoch EcoVillage, the results would be different every time, as the weights and scorings are different to every tool set. It becomes apparent that context should be regarded as one of the most influential elements of these tool sets.

In light of the pervious barrier, this point was confirmed by the GBCSA. They adapted the Green Star Communities beginning 2018, and spent about four months to go through the local context process, with 30 different professionals and industry players and a paid consultant to compile a LCR. In reality **the indicators did not change much**, there were some small changes on terminology, minor changes to credits, some South African reference documents included, amounts converted from Australian dollar to ZAR, etc. As the GBCA had developed an NSA tool set for an universal context, and not for Australia only, few changes needed to be made. The Report has been included into the Addenda (the items in red have changed) (see Addendum J).

[2] If an existing neighbourhood wants to extend, they can be assessed by the NSA tool sets; or they can consider each building separately and assess only the buildings in relation to the services and high level strategy of the neighbourhood.

3.5.2 Where do they fall on the Ecological Design Framework?

After analysing these tool sets, it was clear that it is not possible to find **the** perfect tool within these four NSA tool sets to measure the sustainability performance of Lynedoch EcoVillage. Firstly, these tools could be effective in measuring the high level strategy for sustainable targets and objectives in urban planning, but less so for the more involved measurement of sustainability performance of detailed systems within a green neighbourhood. Secondly, when measured against Reed's Ecological Design framework, it becomes apparent that they only touch on minimizing the damage caused, and have only just embarked on the journey to sustainability (Reed, 2007) (see Figure 3.5).

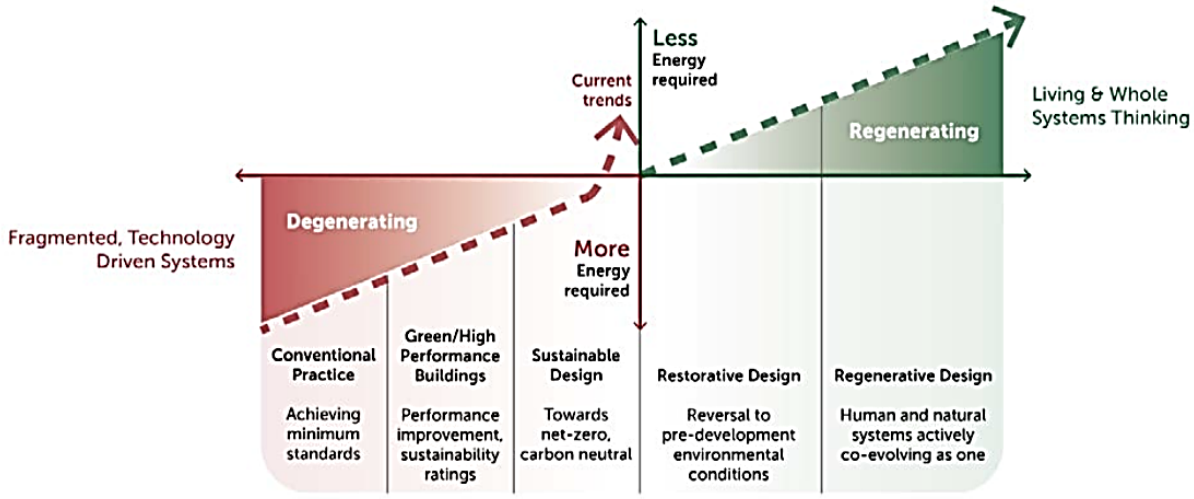


Figure 3.5. The Range of Sustainability according to Bill Reed (Source: Reed, 2007).

The four NSA tool sets that have been assessed fall under the second column from the left – "Green/High Performance Buildings" (see Figure 3.5). They are all about minimizing damage from conventional practice, bringing performance improvement and giving sustainability ratings.

Regardless of the critique, our own indicator tool set guardian in South Africa, the GBCSA, in April 2018 joined the C40 South Africa's Building Programme initiative, in collaboration with four major cities in South Africa; eThekwini, Johannesburg, Cape Town and Tshwane. Tim Pryce leads the C40 initiative, a network of world class cities aiming to cut climate change emissions and to scale up low-carbon buildings to achieve net zero carbon by 2050. Tim Pryce's ambitious target for these four cities in South Africa, is to align policies, building codes and planning requirements - to reach, high efficiency, almost fully running on renewable energy for new buildings, by 2020.

This collaboration puts the GBCSA on a trajectory to soon reach the third column from the left – *Sustainable Design*. Another exciting step in the 'right' direction is their annual conference - this year

called “The Race to Zero” - aimed to bring more carbon neutral awareness to the building industry in South Africa (Braune, 2018).

The involvement of the GBCSA in all these net zero carbon initiatives is extremely valuable. However, the Green Star Sustainability Precinct tool set is not measuring net zero carbon yet. Even if the measurements in all the different categories are considered, indicators such as the ’Green Infrastructure and Design Principles’, for example (rated among the top four indicators in all four NSA tool sets), scored between 14% and 34%.

The reality is that the most technical categories are only covering the general high level strategies of a neighbourhood (Braune, 2018). Therefore, since the GBCSA has marginally included some local context in their Green Star Sustainability Precinct indicator tool set, the best way to use their tools would be to **include the Green Star building assessment tools**. In this way the sustainability performance for energy and building infrastructure could be measured and considered on a more detailed level and at a separate individual systems level. This holistic approach to measuring sustainability could include specific benchmarks for the building assessments and the services between the neighbourhood and district scale renewable energy systems. However, all these systems need their own benchmarking.

Embodied energy of any material or entire neighbourhoods could have their own benchmarking, and can be measured by Life Cycle Analysis or more generally, through the EDGE Buildings application used by the GBCSA as one of two residential assessment tools. Energy efficiency could be measured through different technical tools, such as simulation tools, comparative analysis, R-values and U-values of materials. In this study EDGE Buildings application will also be used for Energy Efficiency.

These NSA tools have done so much preparatory work in identifying different criteria and could experiment more towards better sustainability. A kind of a “plug-in” tool selection could be a solution. The same as what you get in computing, a “plug-in” is a software component that adds a specific feature to an exciting computer. Development of these “plug-in” tools could advance NSA tools sets to a uniquely-developed measuring tool, these could be complimentary to sustainability in general. By using these “plug-in” tools the user is not just stepping away from the conventional ways, but a uniquely-developed measuring tool such as a Happiness Index ‘for neighbourhoods’ could be developed. From a technical and environmental perspective this would be a stepping stone in the right direction. NSA tool sets should contribute to establishing a user-friendly metric to measure sustainability, even for an eco-village.

Measuring neighbourhoods on a technical level could confirm the sustainability of these neighbourhoods to a certain degree. But argues Boyle et al. (2018), by not considering context, and only using technically-based tools, the deeper issues of sustainability are being ignored. Tam et al. (2018) confirm that social fabric, socio-economical or socio-technical aspects should be included into these measurements. It is interesting that all four NSA tool sets score between 16 to 19% in the category of 'Quality of Life', rated among the top four indicators in all tool sets.

The 'Quality of Life' criteria in most tool sets include some social aspects, but their weightings are very low (Tam et al., 2018). They include some small level of the following aims; safety, well-being, quality of life, sound emission, affordable housing, inclusive communities, social networks, heritage (Tam et al., 2018). These are bold phrases, but the question to ask is: what does this mean in a particular context?

The Quality of Life criteria are mostly on a high strategy level (Boyle et al., 2018), not really inclusive of all different aspects of quality of life. Perhaps the intention of these tools were never to be so deeply involved and comprehensive, but it excludes too many important sustainability aspects. Most of these aspects could be found within the Happiness Index. This is a tool set used by the UN to measure human happiness, it measures well-being in the form of privacy, education, income, healthy life expectancy, social support, freedom, trust and generosity, to name but a few. These values could form the baseline for a sustainable neighbourhood, but there are many more social aspects that could be included.

Without considering social aspects, technical measurement and efficiency does not truly represent sustainability (Boyle et al., 2018).

3.6 Conclusion

In conclusion, the four NSA tool sets use anything from 30 to 56 indices to measure sustainability. While they have had a positive impact on the sustainability of the built environment and have mainstreamed green innovation in neighbourhood development, recent studies have highlighted various shortcomings of NSA tools. The result of this analysis indicates that most of these tools are not performing well regarding the coverage of social, economic, and institutional aspects of sustainability. There are ambiguities and shortcomings in the weighting, scoring, and rating; in most cases, there is no mechanism for local adaptability and participation; and, only those tools which are embedded within the broader planning framework are doing well with regard to applicability. Therefore, conducting the study on the NSA tool sets have been very useful in realising the gaps that exist in these tool sets and for application purposes of this study, some of the technical indicators

of both EDGE Buildings application (for residential assessment) and Green Star Sustainable Precincts might be suitable to measure the sustainability performance of the sustainable infrastructure of Lynedoch EcoVillage, although, the socio-technical indicators are not currently weighted appropriately to measure that side of the Lynedoch EcoVillage.

Instead, focussing on co-creation might be more applicable, considering the context inside the village, and focussed on its strengths and weaknesses, while operating in the uncertainty of the complexities of these dynamic socio-technical aspects.

Thus, **the tool set that will be used in Lynedoch EcoVillage is EDGE Building applications.** More specifically, only some of the high level technical indicators of EDGE Buildings application (for residential assessment) will be used to measure embodied energy and energy efficiency of Lynedoch EcoVillage. Energy use will be measure by indicative data capturing from the smart meters currently connected to a Conext application portal. As was indicated in this study, the socio-technical indicators are not well represented and therefore the qualitative data will be captured by considering the co-creation by focussing on the context-specific strengths and weaknesses in Lynedoch EcoVillage and the enhancing or obstructing of the human factor in the micro-grid installation.

CHAPTER 4: CASE STUDY AND OTHER ECO-VILLAGES

4.1 Experiences in Other Eco-Villages

In the previous section the challenges of moving from a mechanistic Newtonian worldview towards sustainability became apparent. However, there is the temptation to focus only on specific facets of sustainability in isolation which presents a challenge to a regenerative integrated design profile.

In the next section the profiles of two very different eco-villages are examined, in which I lived in during 2015 and one where I volunteered in 2018. Although not complying to all the criteria of the GEN sustainability wheel, each in their own way are living an experimental sustainable existence. This refers to the argument by Swilling and Hajer (2017) that experimentation should be context-specific and not merely a cut-and-paste exercise.

For the purposes of this study, highlight aspects are highlighted that are comparable (similar or different) to aspects of the Lynedoch EcoVillage.

4.1.1. Kibbutz Lotan

Photo 4.1. Bustan Eco-Campus, Israel (Source: www.kibbutzlotan.com)

On-site educational centre: In 2015, I lived in the Bustan Eco-Campus for a few months (see Photo 4.1), as part of the Green Apprenticeship course hosted by the Centre for Creative Ecology. The Bustan is an immersive learning micro community adjacent to a Jewish intentional community. The Kibbutz was established in 1983 in the Arava, in Southern Israel. The Centre for Creative Ecology (see Photo 4.2) was established later in 1997, and the program focuses on environmental education

for Tikkun Olam; repairing the world 'with our hands, minds and heart'. The aim of the Bustan is to experiment with a prototype model for sustainable development and offer residents an immersive learning experience, daily (see Photo 4.3 & 4.4).

Building technology: The Bustan consists of ten domes, built from geodesic dome frames, straw bales and plastered with earth (see Photos 4.5 & 4.6). Together the straw bale and earth plaster creates a super insulation, with thick thermal mass for indoor climate stability. In the winter, the sun penetrates the walls and floors through the south facing windows, storing the heat till night time and then releasing the heat into the domes. In summer the closed window shutters keep the penetrating sun out and at night time opening these up cools the domes down. According to studies done in the village, the energy efficiency of these passively designed domes out-performs that of the conventional buildings in the area, and is using much less energy in the form of electricity to cool the buildings off.

Energy generation: Located in the Arava desert, one of the most arid deserts on the planet, this area receives hardly any precipitation annually. These conditions contribute to their energy mix, generating heat and power from the sun. All hot water comes from the solar heating system. The kitchen uses different sources for cooking and baking solutions; two passive solar ovens (see Photo 4.7); a J rocket and L rocket stove (see Photo 4.8); an outdoor pizza oven; and a parabolic sun stove. Cooking gas is mostly methane, produced by the waste-to-energy biogas digester, using food scraps as fuel.

The Bustan has a 16,485kWp capacity with 58 PV solar panels array, with an annual production of approximately 28 025 kWh (1,700 kWh/kWp) and generating between 1 200kWh to 2 500kWh from 1 January 2018 until 31 July 2018 (see Figure 4.2 and 4.3). Each panel has a capacity of 280 Watts and the array of 100m^2 solar panels doubles up as a shading structure for the community recycling centre. The panels are at 5 degree angle, although most panels in Israel are installed at 30 degree angles. The Lotan project was commissioned on 29 November 2012 and saves the planet from circa 19,6 tons of CO_2 annually (Cicelsky 2018).

The Bustan also employs some human powered appliances, which contribute to the awareness of using less energy and also the low carbon baseline of the neighbourhood. The only washing machine inside the Bustan is a Bike Washing Machine (see Photo 4.9) and a Human-Powered Bike Blender makes the best smoothies in minutes (see Photo 4.10).

Socio-technical interaction: The success of the sustainability systems in the Bustan is directly linked to the user habits. Residents and users service and maintain all systems daily. Some systems

have more buffer-capacity for mistakes, but others, like the composting toilets, have to be used in the right way or it would start smelling. Closing the shutters in summer is also crucial to prevent direct sunray penetration and overheating.

Social composition: Kibbutz Lotan was one of the last kibbutzim to be established on the traditional kibbutz model, which is an experiment in communal living, mostly a rural community, dedicated to mutual aid and social justice. This socioeconomic system is based on joint ownership, equality and cooperation of production. Having the Bustan Eco-Campus adjacent to Kibbutz Lotan (see Photo 4.11), has enlarged their approach to a concern for adaptation and environmental-awareness.

Kibbutz Lotan represents different ages and genders, with one cultural common denominator: They are all Jewish, following reformed Judaism. There are two rabbi's on site – a single lady and a married man. The Bustan accommodates students from different ages, countries and backgrounds 'forced' into living a shared, hands-on learning experience (see Photo 4.12 & 4.13), with the only golden thread their connection to Sustainable Development. The social interaction within the Bustan, and connecting to the Kibbutz Lotan community, was, in my experience, very rich but sometimes very socially uncomfortable.

Mobility: Public transport is encouraged, with a regular local bus service running past all Arava kibbutzim all the way to Eilat, and a regular national bus service stopping right by the Kibbutz Lotan junction that runs to all major cities in Israel. If that does not cover one's needs, there are three cars available for use, to be booked for particular times. Often people write where they are going to support ride-sharing. Payment is per kilometre – 1,4NIS/km (2018 prices). The charge covers insurance and petrol.

Overview: these experiments could lead to valuable efforts to decarbonise our global economy to reach climate targets and head in a different direction (Baxter & Sommerville, 2011). The way the Bustan is co-evolving in their socio-technical system designs, displays the **strong relationship between technical, human, social and organisational factors** (Hojčkova et al., 2018), and much can be learnt from this. Although the eco-village is not in an urban setting, the socio-technical imaginaries could contribute to the vision of future neighbourhoods and are rich in finding sustainability answers in an imagined emergent future (Sengers et al., 2016).

Center for Creative Ecology – Kibbutz Lotan
مركز الأبداع البيئي - كيبوتس لوتان
המרכז לאקולוגיה יצירתית – קיבוץ לוטן

Photo 4.2. Center for Creative Ecology Logo (Source: www.kibbutzlotan.com)

Photo 4.3. The author's Dome
Photo 4.4. The author, Sharné Bloem (Source: Sharné Bloem)

Photo 4.5. & 4.6. Domes under construction (Source: www.kibbutzlotan.com)

Photo 4.7.Cooking black beans in the passive solar oven. Photo 4.8. Frying mushrooms on the J-Rocket stoves (Source: Sharné Bloem)


Photo 4.9. Doing laundry on the bike washing machine. Photo 4.10. Making a lovely smoothie on the human-powered bike blender. (Source: Sharné Bloem)

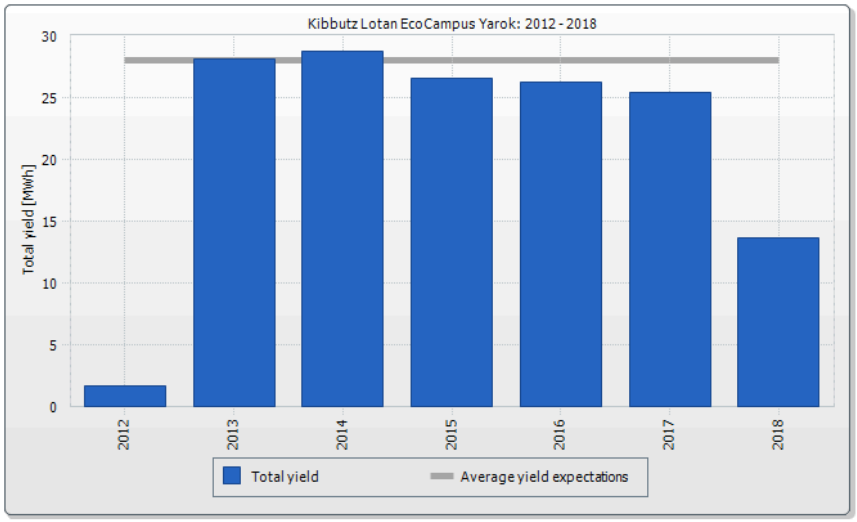


Figure 4.2. Bustan lifetime yield for the solar PV system (Source: www.sunnyportal.com)

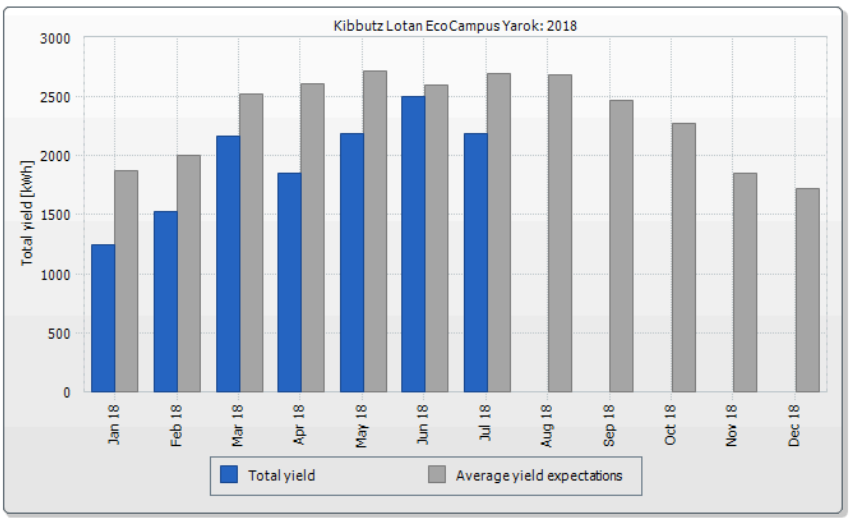


Figure 4.3. Bustan annual yield for the solar PV system: January to July 2018 (Source: www.sunnyportal.com)

Photo 4.11. Satellite image of Lotan (Source: Kibbutz Lotan)

Photo 4.12. Feeding the biogas digester food-scraps daily &
Photo 4.13. Leachate draining of the composting toilets (Source: Sharné Bloem)

4.1.2. Ecovillaggio Torri Superiore

Photo 4.14. Ecovillaggio Torri Superiore, Italy (Sources Google images)

The second eco-village I lived and volunteered in for almost four weeks was a small village in the Italian countryside. Ecovillaggio Torri Superiore was founded in 1989 (see Photo 4.14). This restored and re-inhabited medieval village is situated about 30 minutes' drive from the coastal town on the Italian Rivera, Ventimiglia. The village started as a small group of like-minded people and has grown to be almost 30 members currently. Even though the members are from all over the globe, they pride themselves in one common goal; to rebuild, educate and live responsibly through the following of specific guiding principles - sustainability, cooperation and solidarity (see Photos 4.15 & 4.16).

Social interaction: Aside from the common goals in the village, they do not make any declarations around religion, politics or ideological viewpoints. Every family lives in their own private home, with their own bedrooms, living spaces, kitchens and bathrooms. Yet, they eat most meals together in the dining area of the guesthouse. All day-to-day activities are the responsibilities of the residents, with the help of the volunteers. The community members meet once a week and make any decisions by consensus.

Consensus decision-making is a social safety measure, to prevent any tension between majority and minority that could erode the mutual trust in the group. The community uses this facilitation technique to overcome any potential threat to the positive climate in the community. This process starts with *debate*; allowing a proposal to be presented and discussed in the community. In order to reach consensus, members could then take three positions towards the proposal; firstly, giving *consensus* – one approves and will be involved in the action directly; secondly, *standing aside* – one approves but will not participate; thirdly, *blocking* – not agreeing with taking the proposal forward. The last position must be explained and one block can be enough to stop any proposal. The community has used this method successfully for many years. Even in the selection of new residents, one block is valid.

Another social safety measure is their annual *sabbatical month*. Once a year the community closes shop, to spend quality time with their families and other residents. This time allows them to just 'be', without any major events or responsibilities. This usually happens each January.

Social composition: This break in routine help the community to rejuvenate before allowing so many strangers into their space in the form of hundreds of volunteers or regular visitors to the guesthouse per year. Their level of acceptance, inclusion and treatment of people is remarkable. Equality and inclusivity are big themes. Something has to be said about the way they have incorporated Italian hospitality and their ultimate celebration of life at every meal. Even though they are deeply rooted into the rural Italian way of life, their social fabric is not purely homogenous - they represent different cultures, ages and genders.

Energy generation: The village has an advance renewable energy heating system (see Photo 4.17). All hot water is produced by solar collectors by day and a wood fire water boiler or a 'donkey', as they refer to it, in the winter by night, which allows them to have a low-temperature heating system throughout most of the village.

Building technology: During restoration of the village, they used local stone, natural lime and natural insulation (such as cork and coconut fibre panels) and inlayed the heating system into some of the walls and under some floors, allowing for a better indoor climate. The paint used is only eco-friendly and all doors and windows are made from sustainable wood.

It must be said that this technical system has no direct link to user habits. With average 'normal' consumption the energy system is regulated and maintained by two responsible people, with added attention in the winter, when the indoor climate is taken in consideration and the 'donkey' needs pellets to burn and create hot water.

Mobility: There are only 5 cars owned by the village, car sharing and the use of public transport is encouraged. They also use two mules to work in the gardens and around the village (see Photo 4.18).

Overview: Torri Superiore eco-village is situated on the fringes of the main village Torri and is an immersive learning experience around sustainability experimentation in an urban space.

Photo 4.15. The author (centre) with her hosting family.
Photo 4.16. The author (right) with a new friend (Source: Sharné Bloem)

Photo 4.17. Heating system (Sources: Torri website). *Photo 4.18. Local Transport System (Source: Torri website)*

4.1.3. Vereniging Aardehuizen

Photo 4.19. Vereniging Aardehuizen, The Netherlands (Source Twitter)

The third eco-village is Vereniging Aardehuizen (see Photo 4.19), a small pedestrian-only neighbourhood situated on the edge of the village Olst, in the eastern part of the Netherlands and established in 2011. After a collective construction effort by the entire neighbourhood themselves, the 23 houses were completed in 2015 -12 Earthships and 11 straw bale houses. I volunteered here for a few days while on a student exchange in the Netherlands.

Building technology: The concept of the Earthships in Aardehuizen was adapted from Michael Reynolds' idea of an Earthship. The aim of the original concept was to construct a house from recycled materials such as old tyres; locally sourced materials such as the soil from the land; and low impact materials such as hemp insulation for the domes. Building design principles such as orientation, overhangs and the use of thermal mass plays an important role and apart from the building design principles and materials used, the aim is also to be self-sufficient in energy generation, water systems, recycling and food systems. Therefore, these were indeed elements that Aardehuizen took into consideration during their planning, design and construction period.

Twelve of the 23 houses used earth-filled tyres as their back wall and timber poles as the structure in the front, with big south-facing glass façades to allow maximum sun into the house in the winter (see Photo 4.20). Some of the houses also have a geodesic dome extension on the roof; the timber structure of these domes was constructed in a kite shape to accommodate a flat surface for windows (see Photo 4.21). The other eleven houses were constructed from straw bales with a timber structure. All houses used lime, clay (from the site) and straw to plaster the buildings inside with a special water resistant layer on the outside. Most houses also used the floor space as thermal mass, accomplishing passive heating generation by night time. Most houses also made use of many recycled items, such as the pallets used to store materials as cladding (see Photo 4.22 & Photo 4.23), and recycled tiles, flooring, lighting, doors and windows.

Energy generation: As mentioned above, the houses use passive heating and cooling systems to contribute to an optimal indoor climate. To compliment and complete these passive systems, all houses have solar PV panels to generate energy, a solar heating system and different forms of wood fire water boilers.

The *solar PV system*, installed on the roofs, are all individually owned and used, and accounts for about 80% of annual energy use in most houses. Although most systems generate surplus energy daily, they do not own any battery backup systems yet, but the surplus gets 'stored' in the grid for night time use. Most households only spend about 50-100 euro's a year for electricity, which mostly accounts for the taxes. The aim of the village is to invest in battery backup, to be fully self-sustainable in the future, and to consider peer-to-peer trading.

With cold long winters in the Netherlands, a *heating system* becomes an important part of reaching better energy efficiency. All houses have two feeders; the first is the solar heating system, with solar collectors on the roofs heating the water and storing this in a well-insulated hot water tank. This system plays an important role in the summer, but could also contribute in the winter. The second is either a rocket mass heating system, or closed combustion fireplaces, heating the houses but also connected to hot water tanks. These hot water tanks are then connected to underfloor heating and the hot water supply. The rocket mass heating system is installed within thermal mass that reaches up to 1000 degrees Celsius. The heat is stored in the thermal mass (clay and lime) and is radiated into the house (see Photo 4.24 & Photo 4.25). In an open or closed combustion fireplace more than half of the heat travels through the flue normally, but the mass heating systems in this neighbourhood are so effective, that the temperature is only 60 degrees Celsius by the time it reaches the flue. From 1000 degrees Celsius in the heart of the system - to 60 degrees Celsius at the 'end'. The closed combustion fireplaces take about two cubic meters of wood a year and the rocket mass heating system about four cubic meters of wood a year. The only disadvantage of this rocket mass heating system is that it takes four hours to warm the house.

Water systems: The neighbourhood is 100% off the grid with their water system. This includes water supply, treatment and sanitation. Water supply comes from a circa 40m deep borehole to draw earth water from. Waste water is treated through a grey water filtration system. They have three tanks underground with oxygen pumped though it and a reed bed with bacteria, algae and fungi digesting the sewerage before this is pumped into a pond where soil filtration could be the last step before the water recharges the aquifers. The neighbourhood has no sewer connections and only uses composting toilets to compost the waste, over a two year period before using it as fertiliser.

Social composition: The houses are individually owned and the neighbourhood is collectively owned. Twenty owners live in the neighbourhood and three have tenants. The overall feeling in the neighbourhood has been of solidarity and kindness. They have a formal dinner and community garden participation once a month, which allows for an open channel to discuss things around the neighbourhood. The community feels strongly about creating sustainability awareness and therefore have organised tours once a month. My observation was that privacy could be a challenge, as this ground breaking innovative neighbourhood project draws a lot of public attention. Although this is private land and is indicated accordingly, the public are curious and visit when they want to.

Mobility: The neighbourhood owns two electric cars, and are aiming to use only electric cars in the near future. They promote cycling, which is easy in the Netherlands and public transport, which is also easy, seeing that they are only 10 minutes' walk from the train station Olst.

Overview: The above urban project results in an 80% energy self-sufficiency, and the aim is to become a 100% off the grid in the near future, using battery back-up and possibly peer-to-peer energy exchange. Already there is a 100% water self-sufficiency, and many other exciting contributions to a grand experiment for the neighbourhoods of the future, from which many lessons could be learned. In addition, the current energy data from Aardehuizen was recently used in a report by the Dutch government to lead to a pilot for the SIDE system and through this decentralised design philosophy to reach energy climate goals for 2050.

Summary: Regardless of their different approaches in experimenting towards sustainability, all three eco-villages are very conscious of their carbon contribution and also have **community ownership of their energy infrastructures**, which adds in some way to their economic independence as a community. Yet again, these three experiences, Lotan, Torri Superiore and Aardehuizen, are good examples of the **complexity around rating any neighbourhood to be at a certain level of sustainability**, especially if popular NSA tool sets are used and socio-technical, socio-economical and socio-institutional aspects are included. Sustainability is a journey and not a place or location, therefore the comparison highlights the journey towards sustainable existence that is ongoing and evolving. A conclusion on the comparison between the similarities and differences with Lynedoch EcoVillage will be included in the end of this chapter.

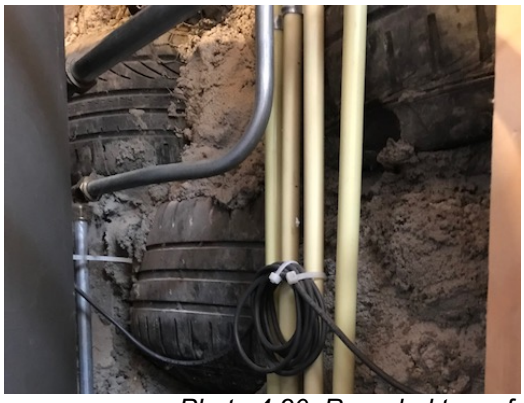



Photo 4.20. Recycled tyres for the back wall of the Earthship &
Photo 4.21. Kite shape structure of the domes (Source: Sharné Bloem)


Photo 4.22. Recycled pallets timber as a ceiling &
Photo 4.23. Recycled scaffolding timber as wall cladding (Source: Sharné Bloem)


Photo 4.24. Rocket mass heating system &
Photo 4.25. Feeding and burning chambers (Source: Sharné Bloem)

4.2 Sustainable Infrastructure in Lynedoch EcoVillage

4.2.1 Setting the Scene: Stellenbosch, Western Cape Province, South Africa, 1998

In 1998 a law was about to be passed that would give workers who were living on farms, the right to stay on the farms. Farmers in the valley reacted by demolishing farm worker houses. At the same time the local primary school was about to be evicted from the farm where it was based. What the land restitution legislation was therefore hoping to achieve, resulted in the exact opposite effect.

At the same Mark Swilling and Eve Annecke were involved in projects at Spier Wine Farm, and the crisis triggered activists to approach them. Another parallel coincidence at that time was that the Drie Geuwels Hotel in the valley became very run down, with various illegal practises, and went bankrupt. Mark and Eve's original intention was to find a space for the school, but then realised that the Hotel premises were big enough to accommodate the school as well as farm worker housing. It became clear that the school and the farm worker housing would not generate enough to cover the development cost and they shifted towards a mixed income solution, inclusive of middle income housing. The loans driving the development were ZAR1million from Boland Bank, ZAR3million from Spier Wine Farm, and another ZAR3million from the Development Bank. The school later changed to a Spark school.

Gita Goven and Alastair Rendall, two architects from Cape Town, were in the process of setting up an architectural practise, ARG Design, which would implement green solutions. They set up shop in the former Drie Geuwels Hotel and became the architects for the development, treating the village as a pilot project for architectural green solutions. The former shed building was renovated first for the school and was funded by Amy Biehl Foundation and Spier Wine Farm, becoming the first attempt at sustainable architectural design: wind chimneys and alternative adobe brick material. This design won an Architectural Association Award a few years later, subject to providing technical information on the energy efficiency claims.

ARG Design also compiled an urban design for the whole site. The site included the new Spark school, 150 residential units and the Sustainability Institute (SI). In order to achieve rezoning of the land, a complete development concept had to be submitted. In this document the first fully-fletched alternative approach in terms of building design principles and materials were articulated. Objections from the neighbours made municipal approval a rather tedious journey and provincial approval was obtained in the end. The approval was subject to the establishment of a Home Owners Association (HOA), who would have service delivery responsibilities, and also be instrumental in the approval of building plans. About 12km from Stellenbosch, in the heart of the rural Boland in the Western Cape

Province, South Africa (see Figure 4.4), Lynedoch EcoVillage was established in 2000 (see Photo 4.26), the SI shortly thereafter, and the school next door in 2001.

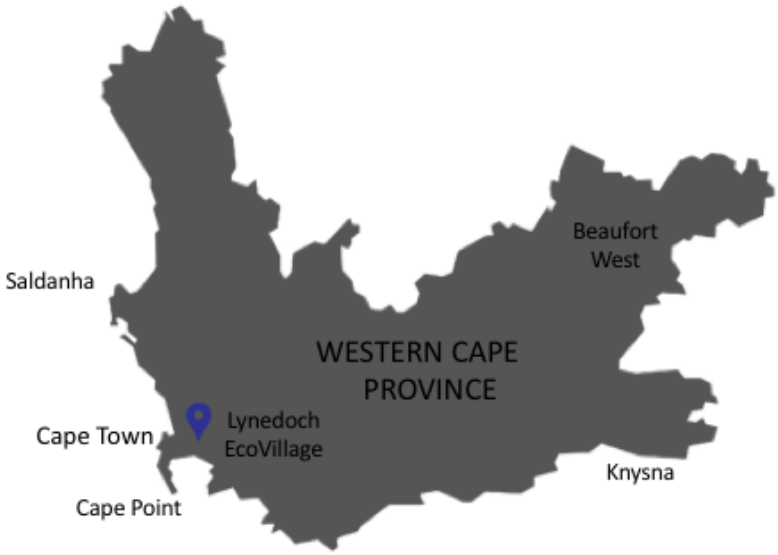


Figure 4.4. Locality Map of Lynedoch EcoVillage (source: Sharné Bloem).

Photo 4.26. Lynedoch EcoVillage (source: google maps).

This ecological, intentional community is known for being culturally and socio-economically mixed, having a diverse living standard measurement (LSM) and being environmentally aware (source: Lynedoch EcoVillage website). In addition to these three pillars, the village has very specific building regulations (see Addendum L); the regulations do not dictate the aesthetics but rather provide a very specific standard of decarbonisation for the sustainable infrastructure.

A combination of factors brought about the establishment of Lynedoch EcoVillage. During the establishment, the process of formulating the Constitution of the HOA took many hours, and only architectural principles were included in the original document. As a consequence, the new residents had freedom in financing, material freedom and form freedom. The core group involved in this process were also the first people to get subsidies to build houses in the village. Lower income

housing was built first, to avoid middle income housing dictating the look and feel. Most of the first houses were built from adobe bricks and thereafter more materials were experimented with.

Lynedoch EcoVillage is a very unique village, and could also be a good representation of an intentional community claiming to be sustainable and low carbon users. The research goal is to assess these claims.

The results of the study survey, and how the evidence was interrogated and the data analysed, will be explained in the next section.

4.2.2. Building Infrastructure

This section will reflect the embodied energy and energy efficiency of the building infrastructure of Lynedoch EcoVillage, in relation to the Green Star Building Assessment benchmarking, and compared to conventional practice (i.e. a brick-and-mortar house).

Embodied energy

One definition of embodied energy reads:

> The quantity of energy required by all of the activities associated with a production process, including the relative proportions consumed in all activities upstream to the acquisition of natural resources and the share of energy used in making equipment and in other supporting functions, i.e. direct energy plus indirect energy.
>
> Treloar, 1994.

In addition, some others describe embodied energy as the energy consumed by all processes related to production of a product and embodied energy could be seen as the “front-end” component of the life cycle impact of a home (Yourhome, 2018). Life cycle indicates a materials life span, from the raw material to the end of the materials life or use.

Generally, embodied energy can be the equivalent of many years of operational energy, and the reduction of embodied energy of a building could be regarded important for the conservation of energy (Balouktsi & Lützkendorf, 2016), because conservation is about taking action and not self-deprivation. Until recently this has put embodied energy in the shadow of operational energy, but the global trend is moving towards tighter regulations for operational energy consumption. This shift is increasing the importance of embodied

energy and associated carbon emissions, currently embodied energy is responsible for 40% of the total energy consumption (Balouktsi & Lützkendorf, 2016). In addition, Balouski and Lüzkendorf (2016) explain how the ambition of net-zero-energy building regulations in places like Europe will soon have the carbon footprint of a house consisting of 100% embodied energy.

Although operational energy still plays a role in the sustainability of a building, for the purpose of the study only the embodied energy of the building envelope of most houses in the village are considered, while the next sections will deal with the renewable energy system and the solar heating system.

To calculate embodied energy of a building is not an easy task, a building is a complex combination of many processed materials and involves many sources of data. Even maintenance and renovations of buildings adds to the total embodied energy. It is important to draw specific boundaries in this assessment process. Whether to include, energy used for transportation of materials and workers; upstream energy input in manufacturing these materials; which part of the building to assess, only the building shell or all materials; urban infrastructure. Gross energy requirement is the true embodied energy measurement and include all the above boundaries, but is very impractical to use for measuring in practice. A less comprehensive measuring tool is process energy requirement, this is measuring the energy directly related to the manufacturing of the material. This is easier to use, and most values quoted for embodied energy are reached through using process energy requirement. According to GBCSA, some applications in the building industry have their boundaries pre-set to represent a specific material within a specific location inclusive of transportation (Braune, 2018). This could either be transportation of raw material to manufacturing or transportation from national distribution points to site.

In this section an **application recommended by the GBCSA** to calculate and compare embodied energy of different building material applications was used. This tool is called Excellence in Design for Greater Efficiencies or EDGE Buildings application. The same baseline information for all materials were used, that is for a two bedroom, one bathroom, four-occupant, 80m^2 house in Cape Town, South Africa; and the different materials were adjusted to see the amount of embodied energy that are used in each. This was compared to a conventional brick-and-mortar house with the same criteria.

The **embodied energy proxies** are measured in mega joules per square meter (MJ/m^2) as follows (see Figure 4.5). As per the definition section, it is important to note that calculating embodied energy is a very detailed and complex calculations with very specific boundaries, and for the sake of comparing building materials, we are using the EDGE Buildings application proxies. In addition, this study does not focus solely on comprehensive embodied energy calculations in the Lynedoch EcoVillage. The focus is to isolate certain primary building materials to highlight the difference between conventional brick and mortar and alternative primary building materials.

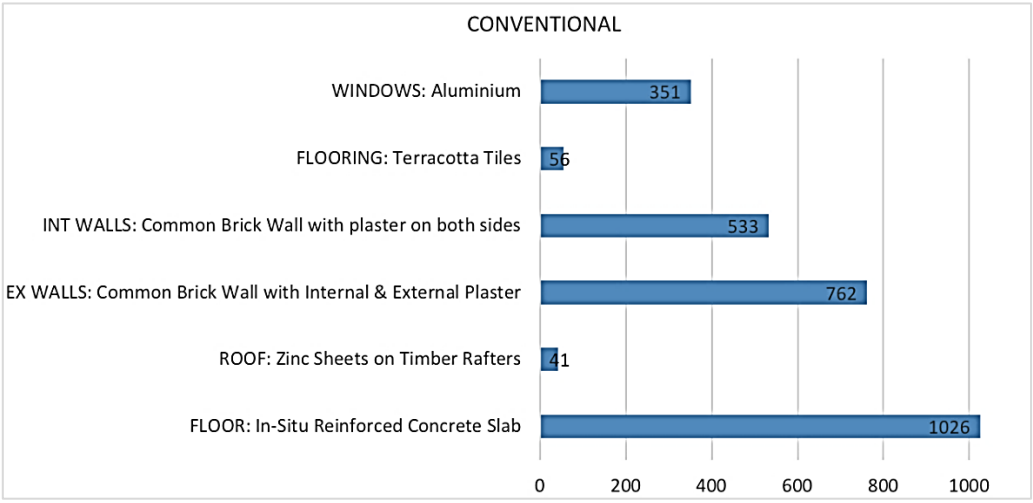


Figure 4.5. Embodied Energy Proxies of a Conventional House (Source: EDGE Buildings application).

The material selection is a good representation of many brick and mortar middle class houses in South Africa. Assuming a **conventional house** according to the material selection above uses 2 769 MJ/m^2 of embodied energy, we can now compare this with what was built in Lynedoch EcoVillage and compare the embodied energy.

The **background of Lynedoch EcoVillage primary building materials**. In this study primary building materials indicates the main material the walls are constructed with. In this village the houses have a $70m_2$ footprint and have insulation in the ceiling, concrete ground floors and timber upstairs floors (Swilling 2018). Thirty two houses have made use of ecological building materials. These materials mostly include locally sourced adobe bricks, recycled bricks, sandbags, timber, light steel frame and magnesium board cladding; soil-cement blocks were sourced from Gauteng. If materials are locally sourced, the raw materials are from a local source and contributes less to the embodied energy used. Making use of embodied energy proxies in the EDGE Buildings application, a comparison between materials used in the village and a standard brick-and-mortar house was done. Seeing that most houses in the village made use of standard concrete floor slabs, a timber roofing systems and sink roof sheeting with insulation, some materials will be a repeat in the analysis. Also, the project details were the same for all models of different materials used in the EDGE Building application. The different materials are reviewed below, each time the material background; the

background of the material selection in this specific village; and the embodied energy used, as was measured by EDGE building application, were included.

ADOBE BRICK: The first material to consider is the adobe brick. These bricks are made from a mixture of clay, sand, straw and water which is placed in a form and dried in the sun (Swilling, 2018). Adobe has a very high thermal mass, the warmth of the day could be absorbed by the adobe bricks and stored within the walls until night time when temperatures dropping, when heat will track the way of least resistance and warm the house (Worby, 2018). If the windows are kept closed, the materials properties could contribute to passive heating and cooling in the house (Worby, 2018). The material also has a high fireproof rate and excellent sound insulation. The product is natural and can easily be recycled and has a low carbon footprint and embodied energy.

In Lynedoch EcoVillage, **thirteen houses are built from adobe bricks**, with one of the twelve with a timber extension. The embodied energy proxies for using adobe brick only is as follows (see Figure 4.6).

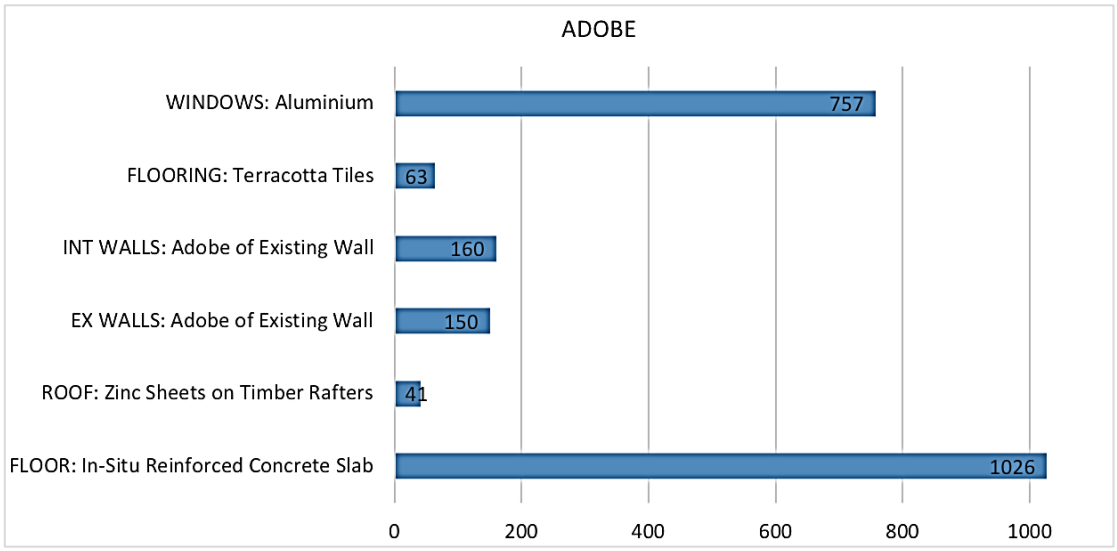


Figure 4.6. Embodied Energy Proxies of an Adobe Brick House (Source: EDGE Buildings application).

The material selection is a good representation of the adobe application in the village. The clay was sourced was **locally sources**, from Spier Wine Farm, across the road, and the unemployed youth of the Lynedoch valley was offered an opportunity to join in making these bricks on site with a brick-maker. The bricks then dried in the sun. Minimum embodied energy was used by this specific application. Assuming an adobe house, according to the material selection above, uses 2 197 MJ/m^2 of embodied energy, this application provides a **saving of 21% on embodied energy**.

RECYCLED BRICK: The next material to consider is recycled bricks. Embodied energy could be reduced if the raw materials are sourced close to the manufacturing plant and should contain as much recycled material as possible. Such is the case in Lynedoch EcoVillage, as most materials

used in the building envelope were sourced in the area. Some houses were built from recycled bricks, sourced from Cape Brick in Salt River, a good example of using recycled materials from a local company.

In conjunction with Ross Demolition, Cape Brick uses construction and demolition waste such as recycled crushed aggregate (RCA) from mainly reinforced concrete to manufacture the concrete plaster bricks. This product consists of 96.5% recycled materials.

Some **interesting facts about this product**: the approximate GHG intensity of a 14 mpa concrete brick made from recycled aggregate is 0,13kg CO_2/brick. This is 0,02kg/CO_2 lower than an estimated 0,15kgCO_2 for bricks made with virgin materials. These figures do not include benefits from reduced transportation intensity. Cape Brick has analysed the embodied energy of its products and made a comparison to concrete bricks made from virgin stone aggregate and sand. The results from the analysis are as follows: 1,43MJ/ 14mpa Cape Brick concrete brick: 2,72MJ/14mpa standard concrete brick. The results are based on embodied energy figures of 0,66MJ/kg and 0,819Mj/kg for recycled aggregates and virgin crushed stone aggregate respectively. The figures are calculated to include transport energy which is largely responsible for the difference in embodied energy.

In Lynedoch EcoVillage, **six houses are built from recycled bricks**, and embodied energy proxies are as follows (see Figure 4.7).

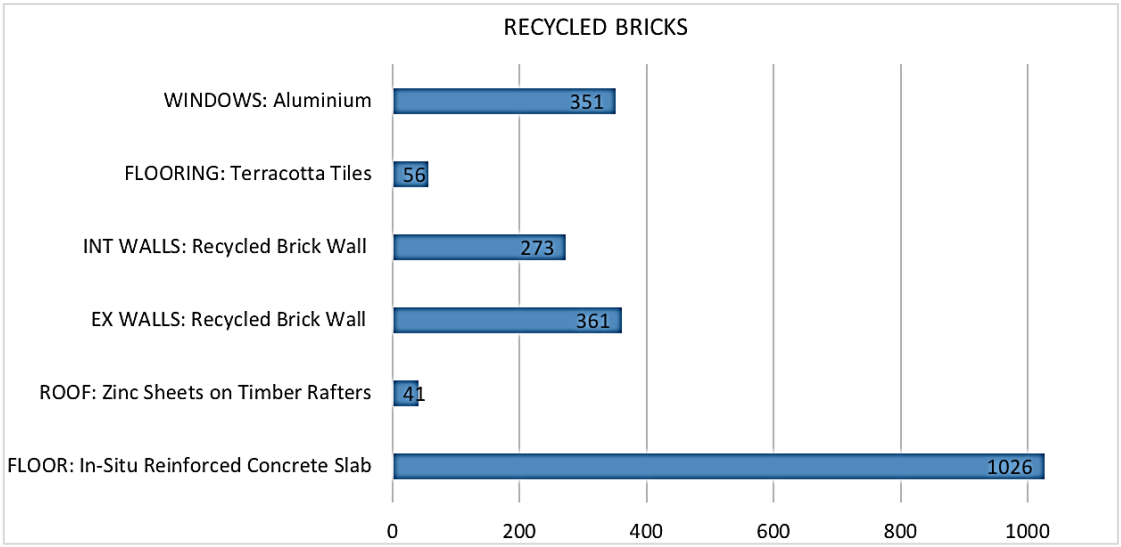


Figure 4.7. Embodied Energy Proxies of a Recycled Brick House (Source: EDGE Buildings application).

This material selection is a good representation of the recycled bricks application in the village. This brick was **locally sourced** from Cape Brick in nearby Blackheath and made from recycled material - therefore lower embodied energy was used by this specific application. Assuming a recycled brick

house, according to the material selection above, uses 2 108 MJ/m^2 of embodied energy, with this application **a saving of 24% on embodied energy** is achieved

RECLAIMED BRICK: The next material is reclaimed bricks. **Eight houses are built of reclaimed bricks** in the village, some bricks coming from the Stellenbosch Landfill and some from the Philippi woman's project (Swilling 2018). One of the houses used recycled timber windows and doors and therefore will have an even lower embodied energy. For the rest, the embodied energy proxies are as follows (see Figure 4.8).

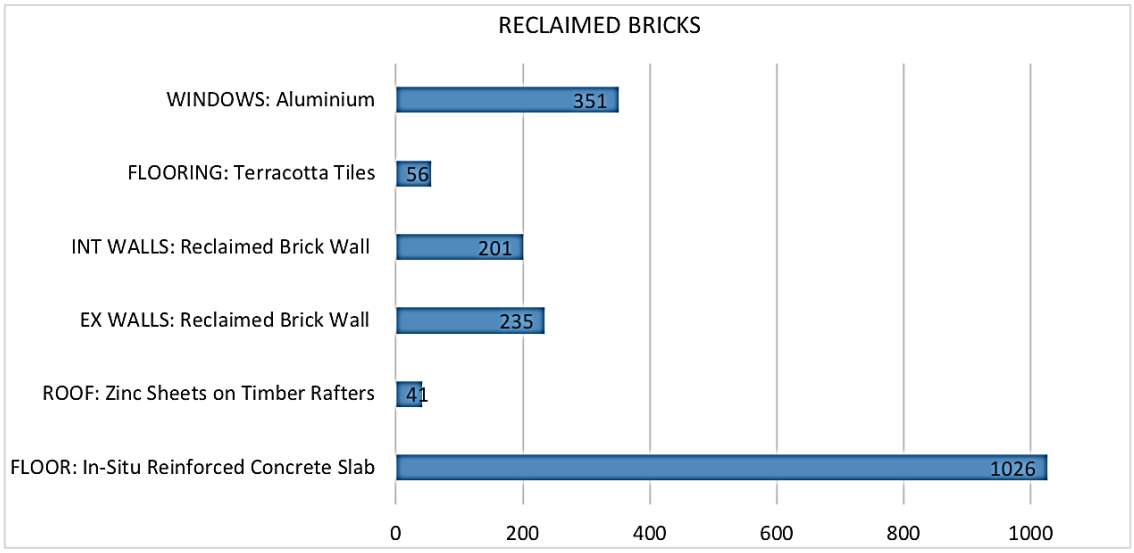


Figure 4.8. Embodied Energy Proxies of a Reclaimed Brick House (Source: EDGE Buildings application).

This material selection is a good representation of the reclaimed bricks application in the village. As mentioned above, these bricks were **locally sourced** from Stellenbosch landfill and Philippi women's project and only the transport accounted for the embodied energy; therefore lower embodied energy was used by this specific application. Assuming a reclaimed brick house, according to the material selection above, uses 1 910 MJ/m^2 of embodied energy, and some concrete is still used for the mortar, according to this application there is **a saving of 32% on embodied energy**.

SANDBAGS: The next material is sandbags. Some interesting facts about this product: this application carries a relatively low carbon footprint, as the bags could be reused and recycled. Minimal water is needed in the construction phase. It is a very strong structure and has really good sound insulation.

Two houses are built from sandbags; the one has also been cladded with magnesium board. Excluding the cladding, the embodied energy proxies are as follow (see Figure 4.9).

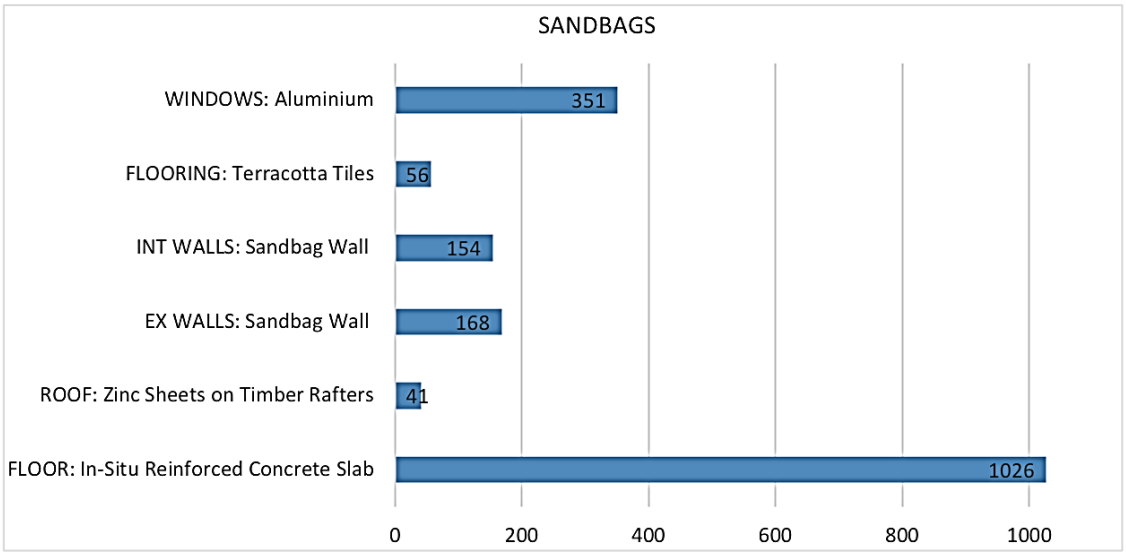


Figure 4.9. Embodied Energy Proxies of a Sandbag House (Source: EDGE Buildings application).

This material selection is a good representation of the sandbag application in the village. The soil used in sandbags could be normal soil, excluding topsoil and soil with more than 10% sodium chloride in it (eg. beach sand), and only the empty bags need to be transported. This material was **locally sourced**, from site. Thereby lower embodied energy was used by this specific application. Assuming a sandbag house, according to the material selection above, uses 1 796 MJ/m^2 of embodied energy, and some concrete is still used for the mortar, according to this application there is **a saving of 36% on embodied energy**.

STABILIZED SOIL-CEMENT BLOCK: The next material is a stabilized soil-cement block. These interlocking building blocks were sources from Hydraform in Johannesburg, and are made from a mixture of soil and clay plus 5 –7 % cement. The soil in the Western Cape is too sandy while in Gauteng the soil is perfect for stabilized soil-cement block. A special stabilized soil-cement block making machine is used to make these blocks. Using these blocks eliminates around 70% of mortar use.

Up to now only **one house has been built from stabilized soil-cement block**. The embodied energy proxies are as follow (see Figure 4.10).

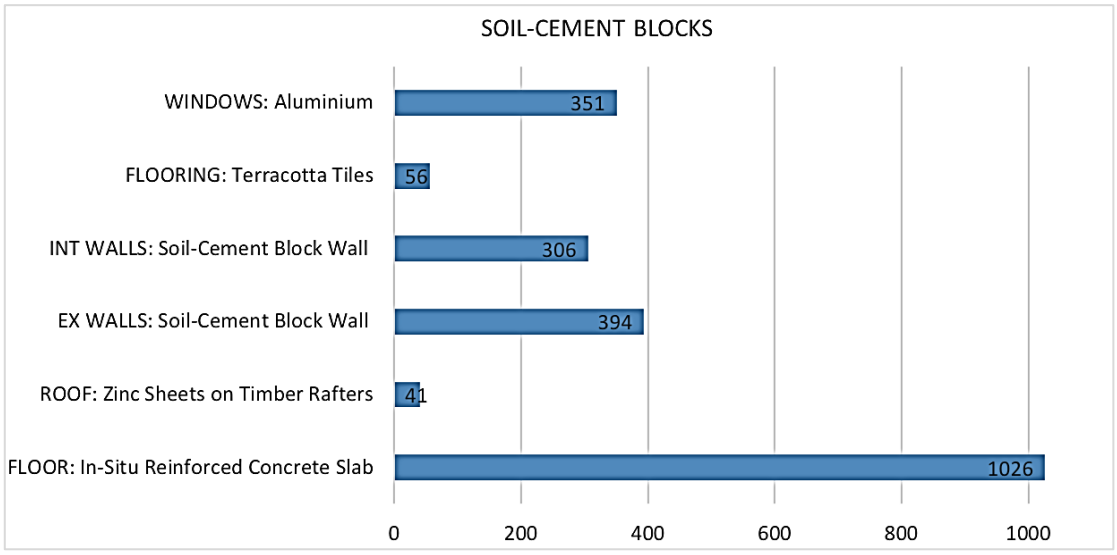


Figure 4.10. Embodied Energy Proxies of a Stabilized Soil-Cement Block House (Source: EDGE Buildings application).

This material selection is a good representation of the stabilized soil-cement block application in the village. The blocks needed to be **transported from Johannesburg**, contributing to the transport embodied energy. Assuming a stabilized soil-cement block house, according to the material selection above, uses 2 174 MJ/m^2 of embodied energy, and 70% less concrete is used for the mortar, while the transport contribution is higher, according to this application there is still a **saving of 22% on embodied energy**.

TIMBER: The next material is timber**.** There are **two timber houses with timber windows**. The one is an extension to an adobe house and the other one is treated with boron. The embodied energy proxies are as follow (see Figure 4.11).

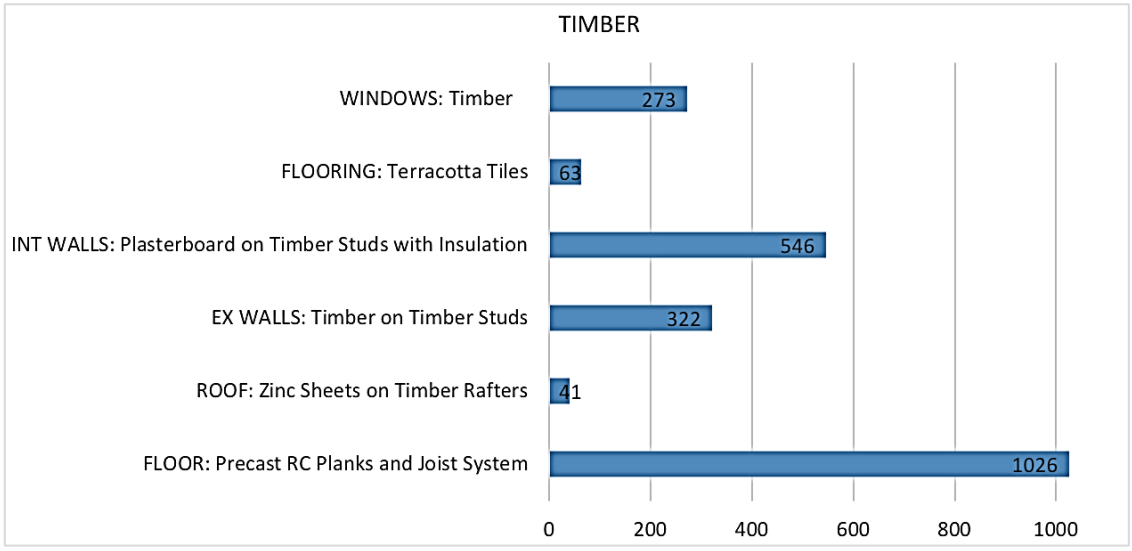


Figure 4.11. Embodied Energy Proxies of a Timber House (Source: EDGE Buildings application).

This material selection is a good representation of the timber application in the village. An obvious change is the windows from aluminium to timber brings the embodied energy use down, especially if these are all **locally sourced**. The distribution was local, but sustainable timber sources are not always locally available. Assuming a stabilized timber house, according to the material selection above, uses 2 230 MJ/m^2 of embodied energy, according to this application there is still a **saving of 19% on embodied energy**.

LIGHT STEEL FRAME: The next house is built from Light Steel Frame (LSF). This construction is an alternative building system, recently introduced in South Africa and was used to build one home in the village, with magnesium board cladding.

Some **interesting facts about this product**: LSF construction offers a wide range of benefits over traditional brick-and-mortar buildings; it is greener, more efficient, quicker to erect and more durable. Compared to traditional methods, LSF construction delivers structures of a higher quality and with less wastage and is more cost-effective than brick-and-mortar (Paul, Radavelli & De Silva, 2015). It is constructed to exact building specifications and the material is fully customisable to the requirements and the architectural style. Furthermore, steel is 100% recyclable and currently the most recycled product in the world (De Angelis & Serra, 2014). It reduces carbon footprint by up to 80% and allows for future-orientated construction practices (Paul, Radavelli & De Silva, 2015). A typical house framed in steel requires the equivalent of about six scrapped automobiles, while a similar house framed in wood requires lumber from 40 to 50 trees (De Angelis & Serra, 2014).

The embodied energy proxies are as follow (see Figure 4.12).

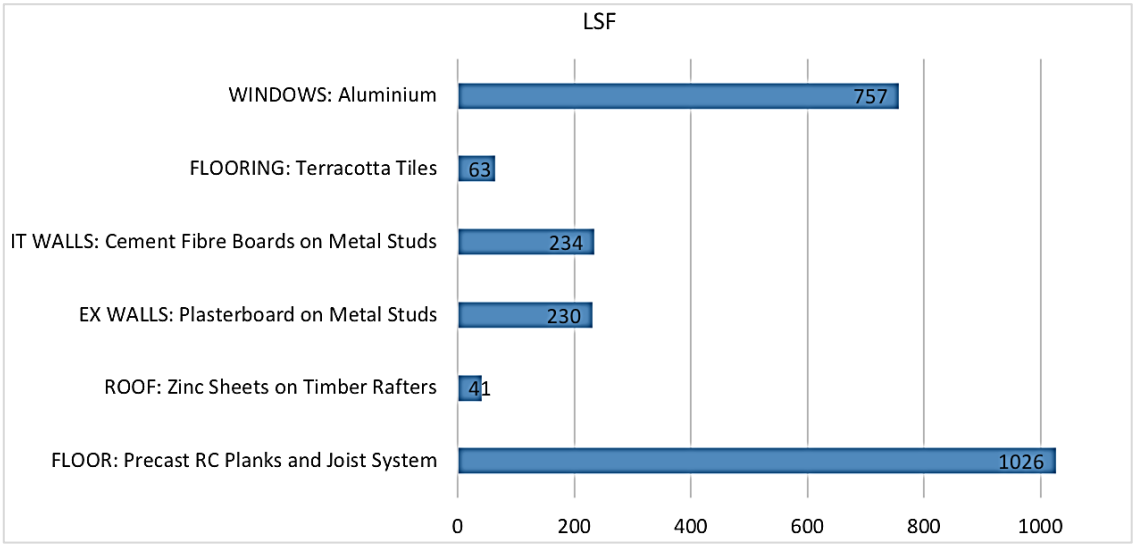


Figure 4.12. Embodied Energy Proxies of a Light Steel Frame House (Source: EDGE Buildings application).

The distribution of this product is local, the material are **semi locally source** from within South Africa. Assuming a LSF house, according to the material selection above, uses 2 351 MJ/m^2 of embodied energy, there is still a **saving of 16% on embodied energy**.

In summary, Lynedoch EcoVillage could have an embodied energy saving between 16% and 36% - building material specific -compared to the conventional double skin brick-and-mortar application.

Energy Efficiency

A definition for energy efficiency in buildings reads as follow:

> The energy performance of a building shall be determined on the basis of the calculated or actual annual energy that is consumed in order to meet the different needs (energy needed to avoid overheating) to maintain the envisaged temperature conditions of the building, and domestic hot water needs.
>
> Energy Performance of Building Directive of the European Union (EPBD 2010)

Energy efficiency does not mean energy conservation (using less energy). It implies using less energy, while granting the same extent of benefits. Lately, various building regulations in different countries have been compelling building owners, when retrofitting their buildings, to increase energy efficiency in buildings (Li et al., 2013).

Energy efficiency in buildings has many facets, and regulation is therefore needed to achieve these criteria. Beyond the borders of South Africa there is an array of international regulations, confirmed by sustainability and energy certificates. Yet, in South Africa, energy efficiency in buildings had a voluntary standard until September 2011 (Barker, 2012). Since then, the Department of Minerals and Energy (DME) developed an energy saving strategy (Barker, 2012), in conjunction with the National Building Regulations (NBR), and the new SANS 10400 X: Energy Usage in Buildings, and SANS 204. It could be argued that these regulations are playing a vital role in empowering and highlighting the urgency to improve energy efficiency in buildings.

Buildings provide protection from the elements, shelter and comfort. Regardless of the weather or South African building practice, the indoor temperature during the day and evening should ideally be in a range between 19 and 25°C, provided the humidity is within the range 25-60%, which is comfortable for the large majority of people. A comfortable indoor climate can be achieved through building design that is appropriate for the local climate. Specific design principles can optimise the energy efficiency inside the building. In South Africa the energy usage and energy efficiency in

buildings are regulated under the SANS 10400, SANS 10400 XA, SANS 204 and SABS standards. By only regulating thermal ceiling insulation and high performance window systems in all new residential and commercial buildings, these compliance routes aim to reach an electricity saving of 3 500MW by 2020 (SANS 204). For the purposes of this research, an energy efficiency study will be made by comparing the following building design principles in Lynedoch EcoVillage buildings to conventional buildings: **fenestration design (and orientation), shading, insulation, thermal resistance and solar heating**.

FENESTRATION: Fenestration design could be divided into the sub-sections of window-to-floor ratio; window orientation; and width-to-depth ratio. In this study only the first two will be covered. Optimal design of these sections could decrease energy consumption in buildings, and energy savings in different climate zones (Horváth, Kassai-Szoo & Csoknyai, 2016).

In addition to the actual fenestration design, the window glass product also plays a role; it could be single glazed, double glazed, low emissivity glass (low-E glass) etc. Glass is a high conductor of heat and cold and by staying to the minimum NBR requirements, the better your natural materials can perform on energy efficiency (Fenster website, u/d). Lynedoch EcoVillage most houses have used single glaze, with only a few houses having some windows in double glaze.

According to the National Building Regulations (NBR) and SANS 10400 building code, window-opening for natural light should be a minimum of 10% of floor area and window-opening for fresh air should be 5% of floor area (SANS 10400). Natural light through windows reduces the need for artificial lighting, and ventilation not only provides fresh air but is also critical for providing a cool breeze in the summer.

In light of the *window-to-floor ratio*, most house typologies in Lynedoch EcoVillage have smaller window openings, 58% of the typologies have a window-to-floor ratio of 10-20%. Another 36% have a 20-30% window-to-floor ratio and only 6% have 30-50% window-to-floor ratios (see Figure 4.13).

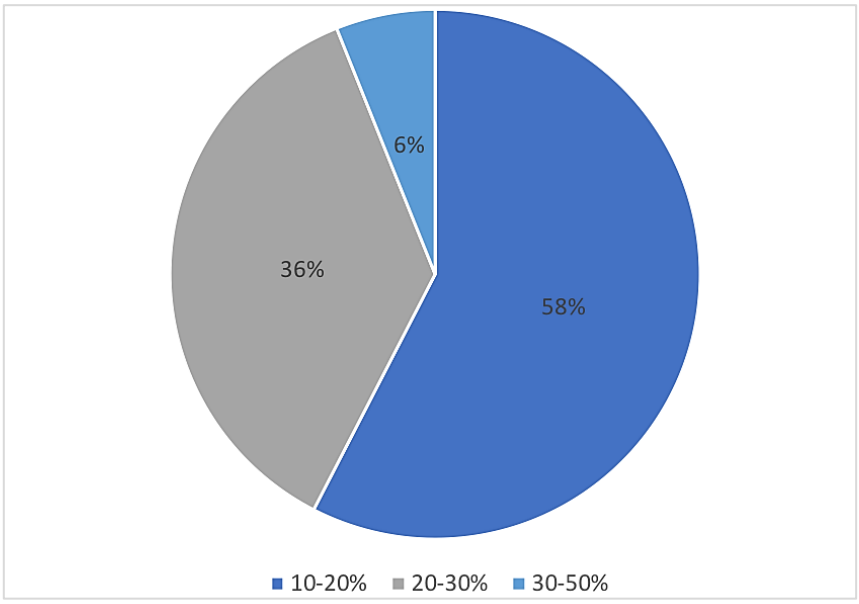


Figure 4.13. Fenestration in Lynedoch EcoVillage (Source: Sharné Bloem)

In summary, houses with up to 30% window-to-floor ratio -which comprises 94% of Lynedoch EcoVillage houses - are saving on energy efficiency.

ORIENTATION: In general, the optimal orientation in the southern hemisphere for best heat-gain through window openings is north-facing (Horváth et al., 2016). As shown in Figure 4.14, the angle along the horizon indicates the solar azimuth, for the summer and winter sun paths. According to thermal analysis, the relationship between the winter and summer sun paths, and the orientation of the building, determines the room temperature; the north-facing rooms will be warmer; south-facing rooms will be colder; direct sun can heat up west-facing rooms to get extremely hot in the summer, especially those without window treatments (Kirankumar, Saboor & Babu, 2016).

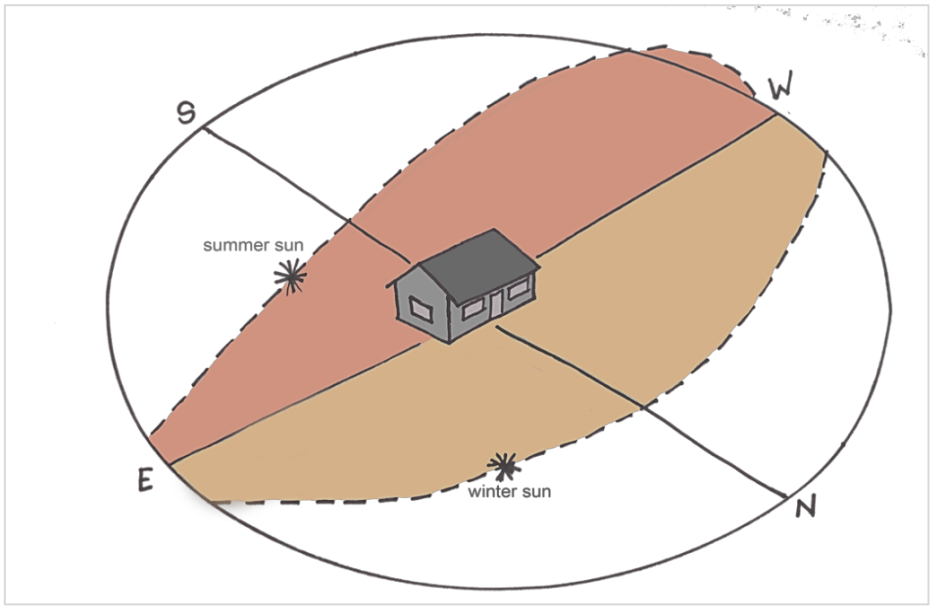
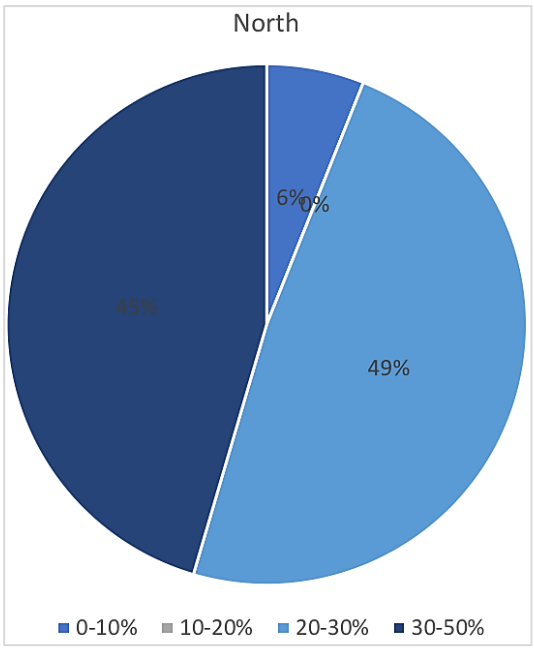


Figure 4.14. Orientation through optimizing heat control between winter and summer sun paths. (Source: Sharné Bloem)

In Lynedoch EcoVillage most houses face North, North East or North West. The study revealed that 49% of houses in Lynedoch EcoVillage have 20-30% of windows facing North; 45% have 30-50% of windows facing North; and only 6% of houses have 0-10% windows facing North. That means that only one or two houses do not have a north-facing orientation and therefore no or barely any windows facing North (see figure 4.15). With regard to east-facing windows: 70% of houses have 20-30% windows facing East; 15% have 10-20% facing East; 12% of houses have 30-50% of windows facing East; and only 3% have 0-10% windows facing East (see Figure 4.16).



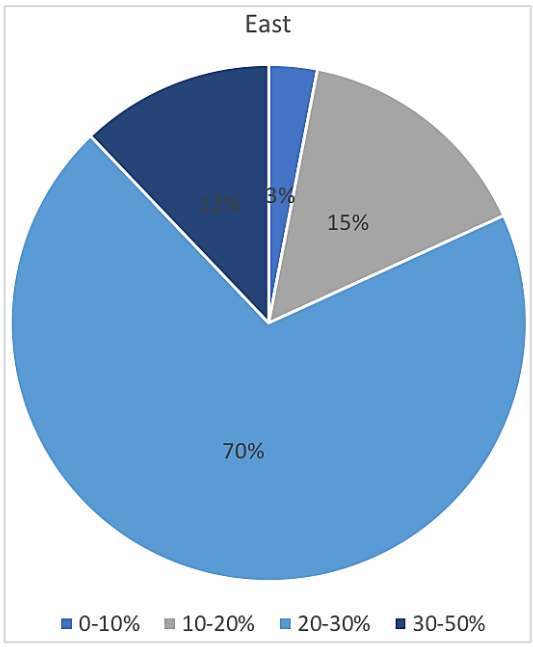
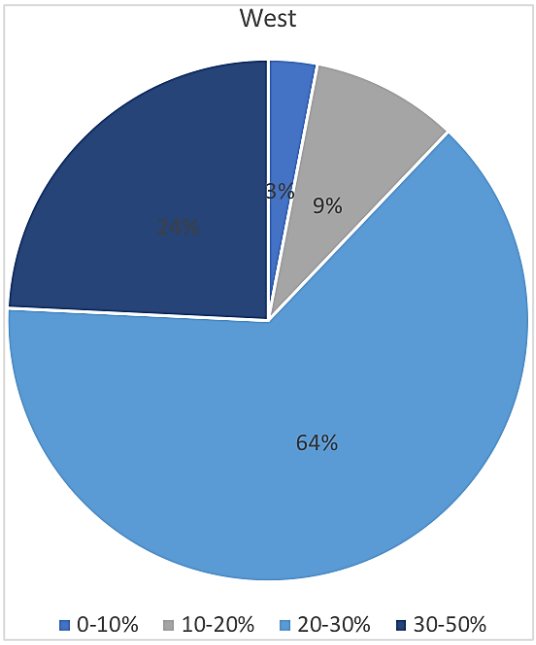


Figure 4.15. North Facing houses. Figure 4.16. East-facing houses. (Source: Sharné Bloem)

West-facing windows have more solar gains in the afternoon. In Lynedoch EcoVillage, 64% of houses have 20-30% of windows facing West; 24% have 30-50% of windows facing West; 9% of houses have 10-20% windows facing West; and only 3% have 0-10% of windows facing West (see Figure 4.17). Those with south-facing windows are not many: 64% of houses have 0-10% of windows facing South; 21% have 10-20% of windows facing South; and 15% of houses have 20-30% of windows facing South (see Figure 4.18).



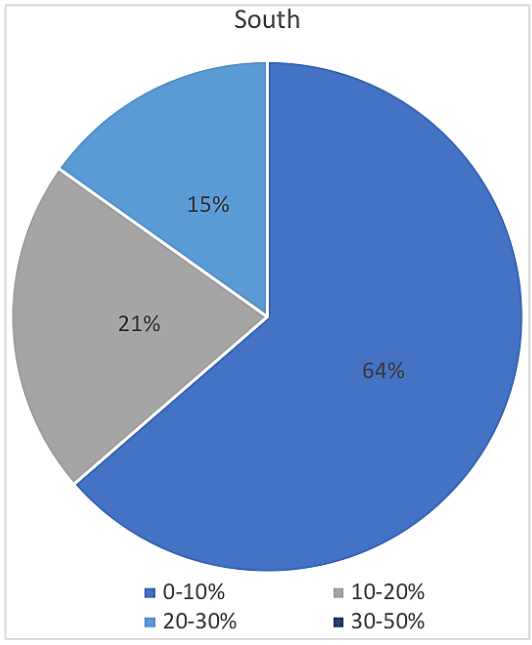


Figure 4.17. West-facing houses. Figure 4.18.South-facing houses. (Source: Sharné Bloem)

Building efficiently and building sustainably go hand in hand and orientation plays a very important role in reaching this efficiency through optimizing the heating and cooling of buildings by choosing the orientation with low energy consumption (Ruiz & Bandera, 2014). No building energy efficiency modelling has been done in this study, but proxies have been used to make assumptions. In a recent study conducted in Spain, three case studies were modelled and simulated, one with 10%, 20% and 30% window openings on the North side. The findings indicate that, statistically, the average energy efficiency for 10% openings is 2,57kWh/m2/year; for 20% openings it is 3,58 kWh/m2/year; and for 30% openings it is 4,71 kWh/m2/year (Ruiz & Bandera, 2014).

In summary, assuming that up to 30%-50% of all windows face North, this will increase the energy efficiency (see Figure 4.19).

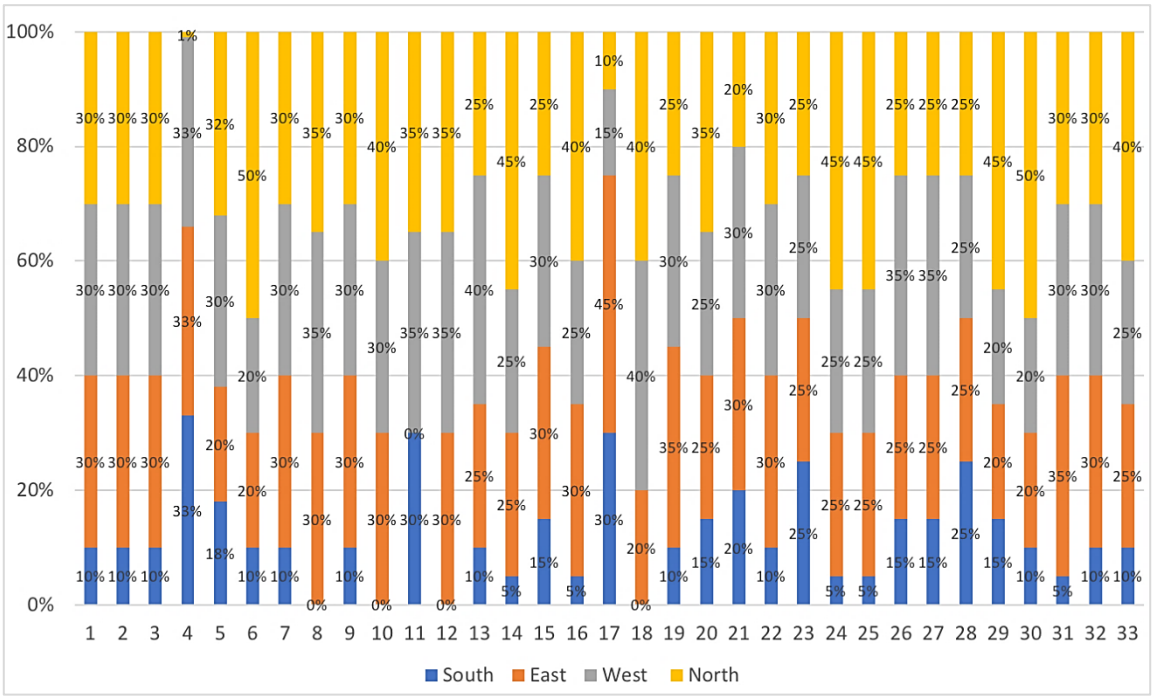


Figure 4.19. Summary of all four window facing sides of Lynedoch EcoVillage houses. (Source: Sharné Bloem)

SHADING: Most housing typologies are north-facing in the Lynedoch EcoVillage. In the summer, north-facing windows will be most optimal with overhangs or other shading devices (Iqbal, Himmler & Gheewala, 2017). This controls and regulates the higher, hot summer sun and allows the lower winter sun into the rooms (Iqbal et al., 2018). Vertical protection, such as shutters, are needed for east- and west-facing windows; rooms with west-facing windows could get extremely hot, especially in hot climates (Kirankumar et al., 2016). Regulating winter and summer sun could also utilise thermal mass for passive solar building design, by distributing solar energy in the form of heat in the winter and rejecting solar heat in the summer (see Figure 4.20 & 4.21).

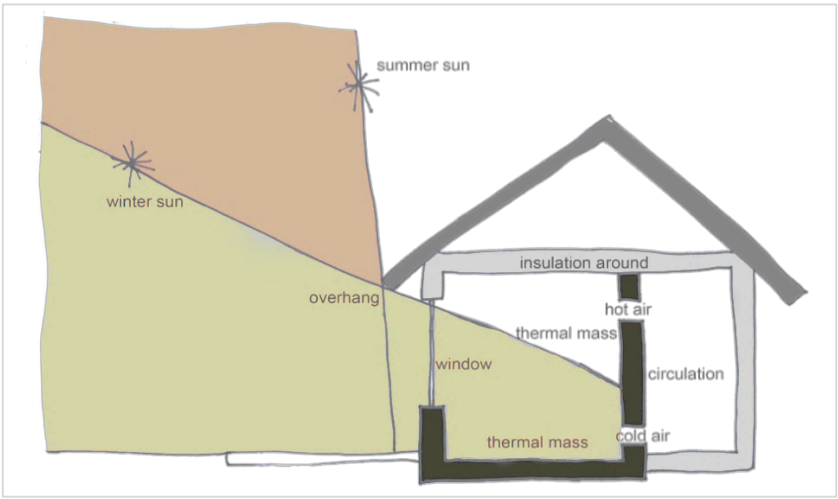


Figure 4.20. Winter and summer sun path in relation to an overhang on the north façade. (Source: Sharné Bloem)

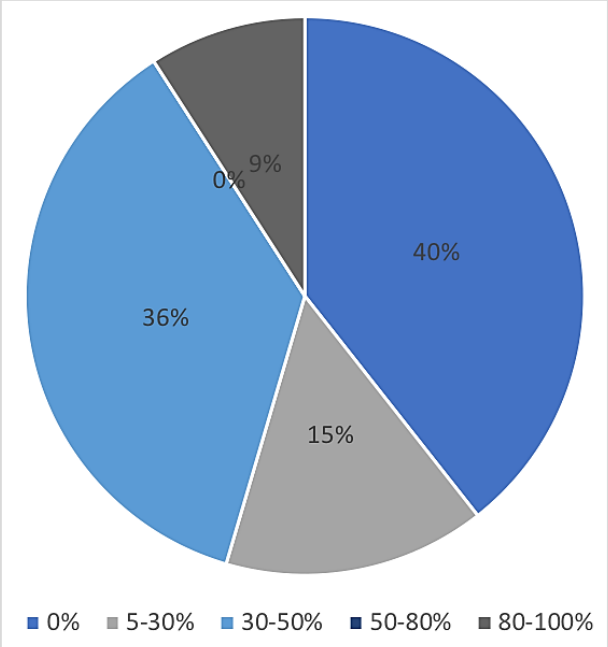


Figure 4.21. Overhang on the North façade of Lynedoch EcoVillage. (Source: Sharné Bloem)

In Lynedoch EcoVillage, there are only 9% of houses with 80-100% north-facing overhangs and almost full protection against the summer sun; another 36% have 30-50% overhangs on the North side; with 15% that have 5-30% north-facing overhangs; while 40% of the houses have full exposure to the summer sun with a 0% north-facing overhang.

INSULATION: Proper insulation is a great contributor to better energy efficiency in buildings. Different applications of insulation could be done within a building with efficient roof insulation as the most popular application in South Africa. In this sunny climate the roof takes much exposure to sunlight and proper roof insulation can increase the overall energy efficiency of the building but also decrease the temperature by 10 degrees Celsius in the summer and 5 degrees Celsius in the winter. In Lynedoch EcoVillage, all houses have insulation in their ceilings.

To add to the previous section, **the Thermal Resistance** (R-value) of all the materials used in the building envelope of the houses in the village are depicted in Table 4.1. As was mentioned in the adobe brick section, heat will always follow the path of least resistance, which translates in heat flowing from warm to cold areas. If the thermal resistance of a material is very low, the hot air from inside the house will escape to the outside much easier on a cold winters' day. The same in the summer; heat will flow much easier into the house, heating the house up, losing the optimal indoor climate. If the materials, such as roof insulation have a higher R-value the heat will not pass through so easily and retain the indoor climate more naturally, increasing energy efficiency.

Table 4.1. Energy Efficiency Proxies of Thermal Resistance (R-value*) (Source: Ching 2013; Ciravoglu 2005; NBR South Africa; Shukla, Tiwari & Sodha 2009;).

Description	Energy Efficiency	Description	Energy Efficiency
1a) Double Skin Brick-and-Mortar	R-0.26	7) Adobe Bricks (300mm)	R-7
1b) Double Skin Brick-and-Mortar (with cavity wall)	R-0.5	8) Compressed-Soil Bricks (compressed earth blocks)	R-2.61to 3.51
1c) Double Skin Brick-and-Mortar (with cavity wall insulation)	R1.5	9) Container House (with wall insulation panels)	R-8 to R-12
2a) Aluminium frame with Single Glazing Conductance Solar Heat Gain - ($0.6m^2$ to $2.1m^2$)	R-0.5 to 2.0 C-2 to C-17 C-12 to C-4.3	10) Light Steel Frame (inclusive of cladding, internal board and 120mm insulation)	R-2 to R-3.76
2b) Timber frame with Single Glazing	R-0.71to 1.5	11) Sandbags	R-2
3) Ceiling Board	R-0.05	12) Timber Cladding	R-0.47
4) Sisolation & 120mm Isolation	R-3.35	13) Magnesium board	R-0.5
5) Roof Sheeting	R-0.3	14) Recycled Bricks	See 1a to 1c
6) Reinforced Concrete Slab	R-0.1	15) Reclaimed Bricks	See 1a to 1c

Referring to Table 4.1, numbers 2 to 6 are the standard materials, used by most houses in Lynedoch EcoVillage, and their R-values according to South African or Australian building material proxies. Numbers 1a to 1c refers to the R-values of different variations of conventional brick and mortar house in South Africa. In Lynedoch EcoVillage the recycled (13) and reclaimed (14) brick houses will fall under 1b, double skin brick and mortar with cavity walls. Cavity walls have two purposes, preventing moisture penetrating from outside to inside and adding to better insulation, as is clear when one compares the R-value of a double skin brick and mortar house of R-0,26, to a double skin brick and mortar house with cavity of R-0,5.

Numbers 7 to 13 are the other materials used in the Lynedoch EcoVillage. Number 7 refers to adobe bricks, which have not only a good thermal mass, but also a high R-value, at R-7. Number 8 refers to compressed-soil bricks, which could vary in R-value, depending on the soil that has been used, which could result in a different thermal performance between R-2,61 and R3,51. Counter-intuitively, number 9, the container house, could have a very high R-value at R-8 to R-12, depending on the insulation used. A container without insulation will have a R-value lower than a brick and mortar house, but if wall insulation panels were used (wall panels similar to cooler rooms) the R-value would be high, as is the case in the Lynedoch EcoVillage container home.

Included in number 10, the light steel frame construction, is the cladding, inside board and 120mm insulation. This building technology could reach good R-value ratings depending firstly, on what the thickness of the insulation is, and secondly, whether the spacers between the inside and the outside are blocking heat conductivity traveling through the steel frame through the outside walls of the building (Harris 2018). Sandbags, at number 11, are not the best insulator, although still doing better than brick and mortar, but the real merit of sandbags are their high thermal mass qualities. Timber cladding and magnesium boards, at numbers 12 and 13, are also not good thermal conductors. Both are normally installed as part of a well-insulated building technology and could therefore be more energy efficient than brick and mortar.

In summary, all building materials used in Lynedoch EcoVillage have a better thermal performance than a standard double skin brick and mortar wall of R-0,26. However, most middle class conventional houses built in the Western Cape also make use of cavity walls. A cavity double skin brick and mortar wall has a R-value of R-0,5. If this is compared with adobe with a R-value of R-7, and the well-insulated container building with R-12, then the adobe application outperformed the cavity wall by 14 times and the well-insulated container building outperforms the cavity wall by 24 times.

As a follow-up to these findings, further studies could be conducted on the U-value (heat transmission), of these materials. U-value and R-value both measures the thermal performance of a material, but unlike R-value that only considers the resistance to heat transfer, U-value considers the transfer of energy through conduction and radiation.

SOLAR THERMAL HEATING: Solar thermal heating is the most commonly used on-site renewable energy technology, mostly used in the residential sector and adopted to increase energy efficiency and decrease the overall household energy consumption (Marszal, Heiselberg, Lund Jensen & Nørgaard, 2012). Recent studies have shown that as the development of the technology improves, greater energy savings and CO_2 emission reductions are achieved (Lie, Yang & Lam, 2013). Other studies also show that the hot water coming from the solar thermal array on the roof will even suffice on a cloudy day, while in the winter a dual system could be connected as a hot water top-up (Day, Jones & Turton, 2013).

Lynedoch EcoVillage replaced all their conventional geyser systems with solar thermal in 2014. These systems were installed with a pressure-relieve valve to regulate high temperature boiling water inside the system in summer. Although at the present the solar heating gets *monitored* through the new micro-grid system, it is *not connected* to the solar PV system; the two systems work independently. The controller switch on the geyser's solar heating system is set to switch off when

the geyser reaches 50 degrees, and when the grid connection has some challenge. The contactor prevents the solar heating from using any energy from the solar PV.

If the user wants to top-up the temperature of the hot water from the solar heating system in the winter, grid power could be used. Assuming an average domestic geyser uses 2kW x 4 hours a day for 120days = 960kWh for the winter time, the extra grid consumption will be about 240kWh per month per geyser.

As can be illustrated from the Lynedoch EcoVillage building typologies (see Addendum M), building design plays a role in the energy efficiency of a building, encourages decentralised energy, low or zero carbon energy sources, and energy-efficient design measures.

4.2.3 Micro-grid System

This section will reflect on the new micro-grid system and the energy use of some households of the Eskom pilot project.

THE SYSTEM: As mentioned before, 27 households became part of the micro-grid[3] pilot project in 2016. Every solar home system has the same solar PV system configuration installed, which include an array of six Trina solar PV panels at 320Watts (lifespan of 20-30 years) (see Addendum G). The panels are mostly facing north to north-west and at an angle of 20-25 degrees on the roof structures. Direct Current (DC) from the panels and Alternating Current (AC) from the Eskom grid feeds into an 8kW Schneider Electric Conext XW+ Inverter (see Photo 4.28), which then connects to a Schneider Electric Conext ComBox Communications box (see Photo 4.27) and sends the information from the Inverter through a wireless signal to a central point in the village.

The inverter firstly draws energy from the solar PV, then from the grid and then from the batteries. The surplus energy gets regulated by a Schneider Electric Conext MPPT 60 150 Charge Controller (see Photo 4.29) and stored in four 160A/h Maze VRLA AGM deep-cycle valve-regulated lead-acid batteries (see Photo 4.30). All of this is installed inside a water- and weatherproof steel IP65 box (see Photo 4.31). The DC cabling is protected inside a special fire resistant conduit (see Photo 4.32). The Sabre Contour ED Cyber E Smart Meter from T-systems sits inside the house and measures the amount of units used and the amount of units available in the micro-grid.

[3] Micro-grid and mini-grid in the industry refers to a small scale decentralised grid system and are sometimes used interchangeably.

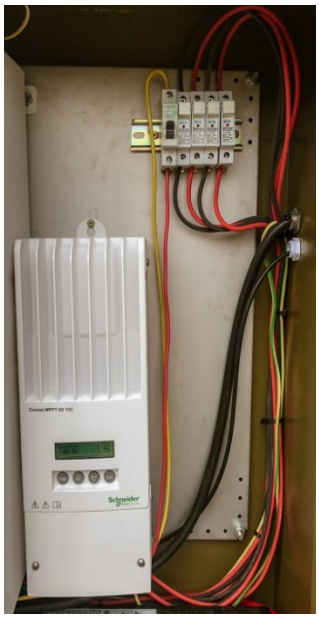


Photo 4.28. Communication Box (Source: Sharné Bloem); Photo 4.27. Inverter (Source: Sharné Bloem) & Photo 4.29. Charger controller (Source: Sharné Bloem).

Photo 4.30. Batteries (Source: Sharné Bloem).

Photo 4.31. IP65 Box (Source: Sharné Bloem) & Photo 4.32. DC Conduits (Source: Sharné Bloem).

Maintenance and cleaning the panels are an important part of achieving the best efficiency levels for any system (Van der Westhuizen, 2018). To clean the bird droppings and dust, these panels get washed every 3 months with a standard squishy and a bucket of tap water (Van der Westhuizen, 2018). The system also receives preventative maintenance every three months (see Photo 4.33). The most important aspect of such a 'visit' is to see if the batteries are in step (they should all have the same voltage), whether all terminals are correct, and whether the inverter is in working order (Van der Westhuizen, 2018). If this is all according to specification, the system is working properly. It takes two to three days to do the maintenance (Van der Westhuizen, 2018).

Photo 4.33. PV panels being cleaned (Source: Sharné Bloem).

Energy Use

A definition for energy use reads as follow:

> Energy use or energy consumption is the calculated amount of energy used. Any process or system can be evaluated or measured. Energy consumption could refer to the use of electric energy.
>
> Merriam Webster Dictionary

Electric energy use or consumption is the form of energy consumption that uses electric energy. It is typically measured per year, in this study it will only be measured over nine months.

LOSSES: A detailed table of the indicative energy use in Lynedoch EcoVillage can be found in Addendum N. If one looks closely at this table one sees that the numbers do not add up; losses are not included. Energy systems have **different losses**, assuming the following could account for the losses in each individual solar home system:

- each solar home system has an internal usage of about 70watts/hour, which translates to about 50kWh for standby power
- the lower the load, the higher the losses
- the lower the kWh readings are, the more inaccurate they will be
- energy flow from the grid to load has a circa 4% loss
- flow form the grid, bypassed thought the inverter towards the load, has a circa 4% loss
- from the battery to the load there is a circa 4% loss
- the battery efficiencies are circa 70% at 20 degree Celsius, and these boxes measure 28-30 degree Celsius, therefore they should reach circa 65% efficiencies
- losses occur between the PV panels and the MPPT (charge controller), although these losses are small.

As losses are not formally accounted for in this micro-grid system configuration, installing billing meters and battery monitors will result in more accurate measuring of total energy movement.

AN EXAMPLE: Figure 4.22 is an example of one of the solar home system (unit 12) and how this system operates within the micro-grid system. These readings were taken from 1 October 2017 until 1 July 2018. Number 1 on Figure 4.21 indicates the solar PV panel's capacity that feeds 981,9kWh of solar power into number 2, the charge controller, and this feeds into number 3, the inverter. The grid feeds into the system at number 4, with 497,8kWh, into the batteries. At number 6 there is a 1 174kWh input and at number 7 a 984kWh output from the batteries. The overall picture of this system

is that the energy coming into the system is much higher than the load - number 5 indicates a very low load. These inverters have a control function through an axillary setting, and by connecting a contender to the axillary setting any surplus energy could be released by overriding the system, eg. switching on the geyser or other appliances. This is a very good indicator that there is surplus energy in the system that could be used for energy trading in the near future.

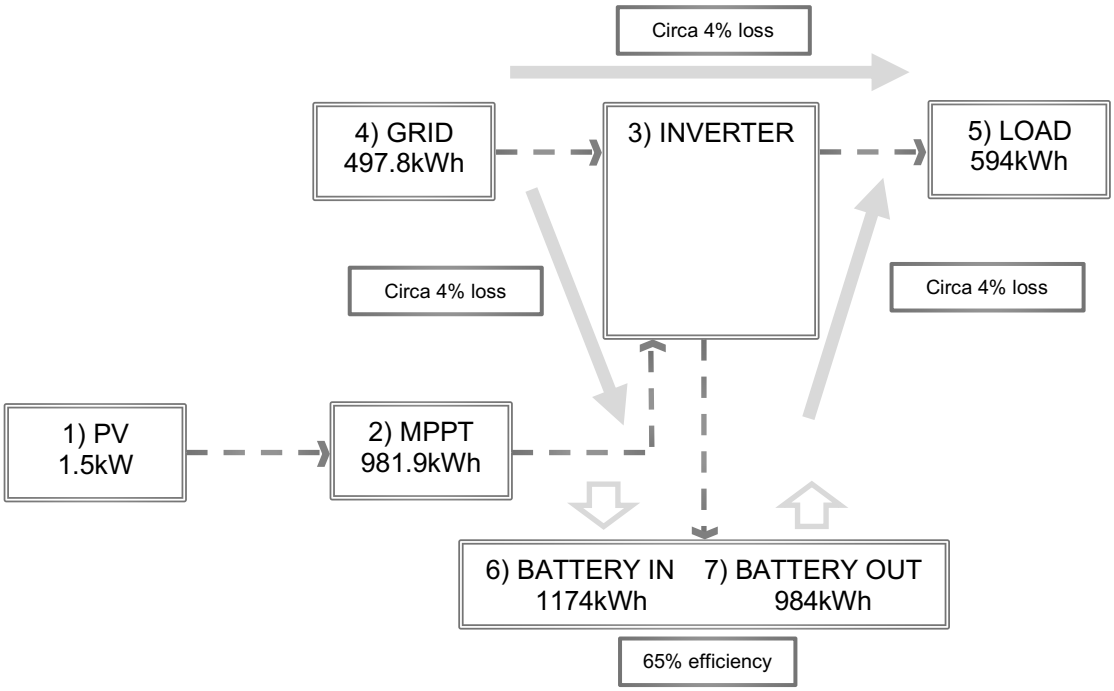


Figure 4.22. Energy Use of unit 12 (Source: Sharné Bloem)

THE RESULTS: This system was compared to other systems of the same size units in conventional neighbourhoods by the consulting engineering firm, Energyneering. They also designed the Lynedoch EcoVillage micro-grid. Comparing similar uses of energy, in the form of cooking, laundry, heating etc., the results were 60%-70% more energy efficient in Lynedoch EcoVillage (Anderson, 2018).

South Africa is known to be using some of the dirtiest coal in the world. By switching to a renewable energy source for energy generation a CO_2 saving on the environment is achieved. Data has been collected on the Lynedoch EcoVillage micro-grid system since the installation in October 2017. Of the 27 solar home systems which are part of the micro-grid in Lynedoch EcoVillage, about five have had and still experience communication challenges with the wireless central data capturing. Fortunately the other 22 systems could be analysed. Therefore, the calculation stretches from 1 October 2017 until 1 July 2018.

Assuming that the total amount of energy that has been used from the solar PV system, from 1 October 2017 until 1 July 2018, is 18,8MWh (see Appendix J) and that coal emits 1 001g CO_2 /kWh. (If you multiply 18 879,2kWh by 1 001g, this equals 18 898 079,2grams).

It could then be deduced that the total amount of CO_2 that has been prevented from being spewed into the environment is **188,9 tonnes of CO_2 over a period of 9 months**. To bring this closer to home and to put this into perspective, let us assume an average new car emits 120,1g/km of CO_2 ; an average person living in Lynedoch EcoVillage drives their new car into Cape Town daily to work over a 9 months period; and an average work month has 21 days. From Lynedoch EcoVillage to Black River Park in Observatory is 36km one-way. At 72km/day for 189days over 9months, this one person will travel 13 608km and will emit 16,08tonnes of CO_2. Thus, it could be assumed that 188,9 tonnes of CO_2 is equal to around 12 people driving to and from Cape Town for work over 9 months.

4.2.4. Socio-Technical Aspects

As previously mentioned in Chapter 1 of this study, sustainability is not just about sustainable technical systems. Social elements are equally as important. Since its establishment in 2000, Lynedoch EcoVillage has been experimenting with different sustainability elements towards individual and community wellbeing. Some of these principles were inclusivity, diversity, human scale, mobility and healthy sustainable development (Daly, 2017). On the **first part of this section** the focus will be on reflecting on some socially important aspects such as **socio-economic diversity; LSM mix; human-scale and knowing your community; mobility; and user sustainability.** Sustainable technical systems and social interaction can also not exist in silo's. The interaction between humans and these systems are easily overlooked, but as mentioned in Chapter 1, serves as a low hanging fruit. Therefore, socio-technical aspects will be the **second part of this section**. Some specific points will be reflected on in the next section, such as **building materials; the recently-introduced Eskom pilot project; some of the integration process into the village; and a systemic account of this installation**. This section will also include the obstructing and enhancing that

Social Aspects

A definition for social aspects read as follow:

> Social aspects are the commonalities among people within a specific culture or subculture.
>
> Merriam Webster Dictionary

Communities are built through social dimensions. These dimensions could include daily patterns, norms, behaviours, relationships, cultural background, common ground and activities.

SOCIO-ECONOMIC DIVERSITY: This ecological intentional community is known to be culturally and socio-economically mixed (see Figure 4.22, Figure 4.23 & Figure 4.24) and having a diverse LSM (see Figure 4.25). According to Evans et al. (2016), diversity is key to resilience and could have great implications and in different forms could encourage inclusivity and integration. Currently in this village 52% of the population are from 'European Descent'; 37% from 'Mixed Descent'; and 11% from 'African Descent'. The language mix consists of 56% of the village speaking Afrikaans at home; 33% English; and 11% Xhosa. Not the entire village took part in the following question, but out of 11 households that answered, the income earned for less than ZAR4 000 a month was 9%; 46% earned between ZAR4 001 and ZAR16 320; 9% earned between ZAR16 321 and ZAR25 487; 9% earned between ZAR25 488 and ZAR35 275; 27% earned more than ZAR35 275 monthly. This indicates a rather mixed group of people on a cultural, social and income level.

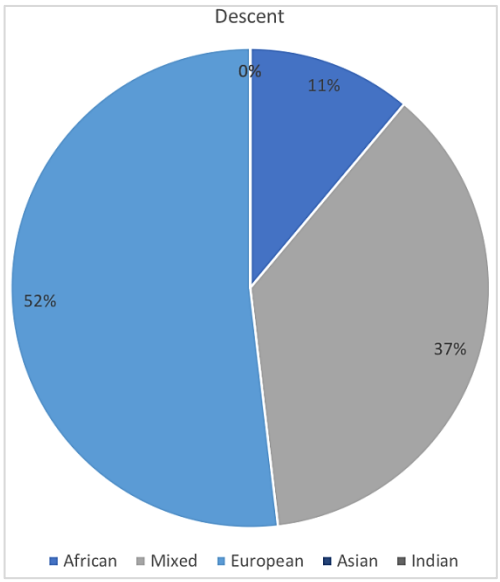


Figure 4.23. Descent mix.

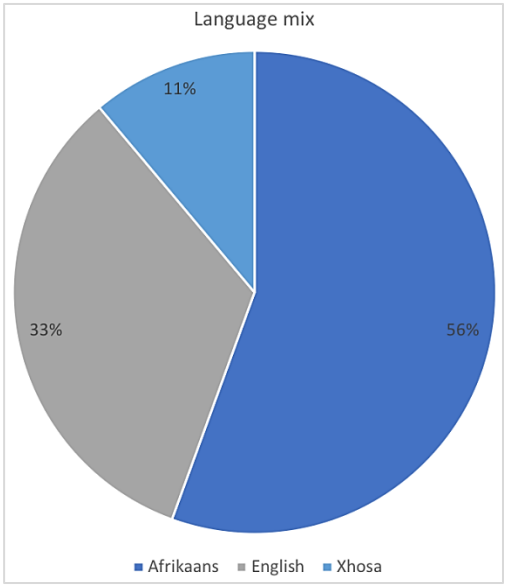


Figure 4.24. Language mix.

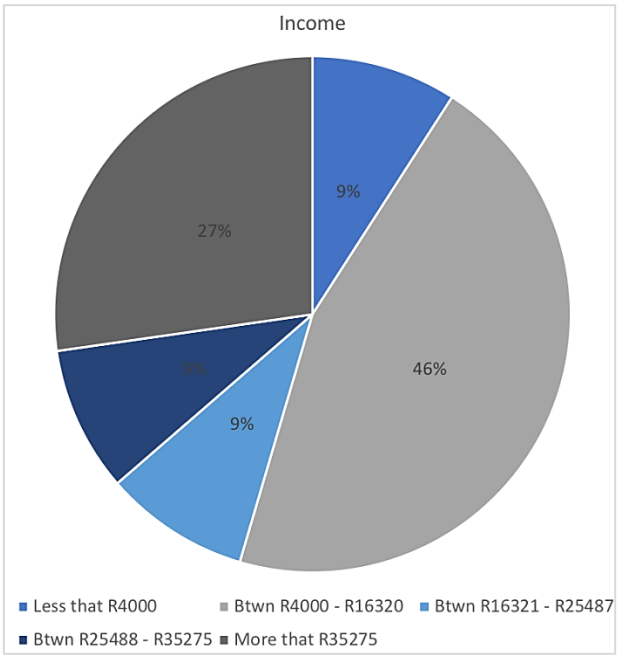


Figure 4.25. Income of Lynedoch EcoVillage.

LSM MIXED: The LSM of the 25 households that took part in this screening is still very diverse. It ranges from 6 to 9 points on the LSM graph. This test was done through the Eighty-20 website calculator for South Africa (see Figure 4.26). Despite the rather diverse outcome, the HOA has been concerned about the diversity in the village, and of the slight tendency towards gentrification – i.e. becoming a more middle-class village. The HOA anticipated this and has been reaching out to clients in different residential markets, to prevent a compromise in the diversity of the village.

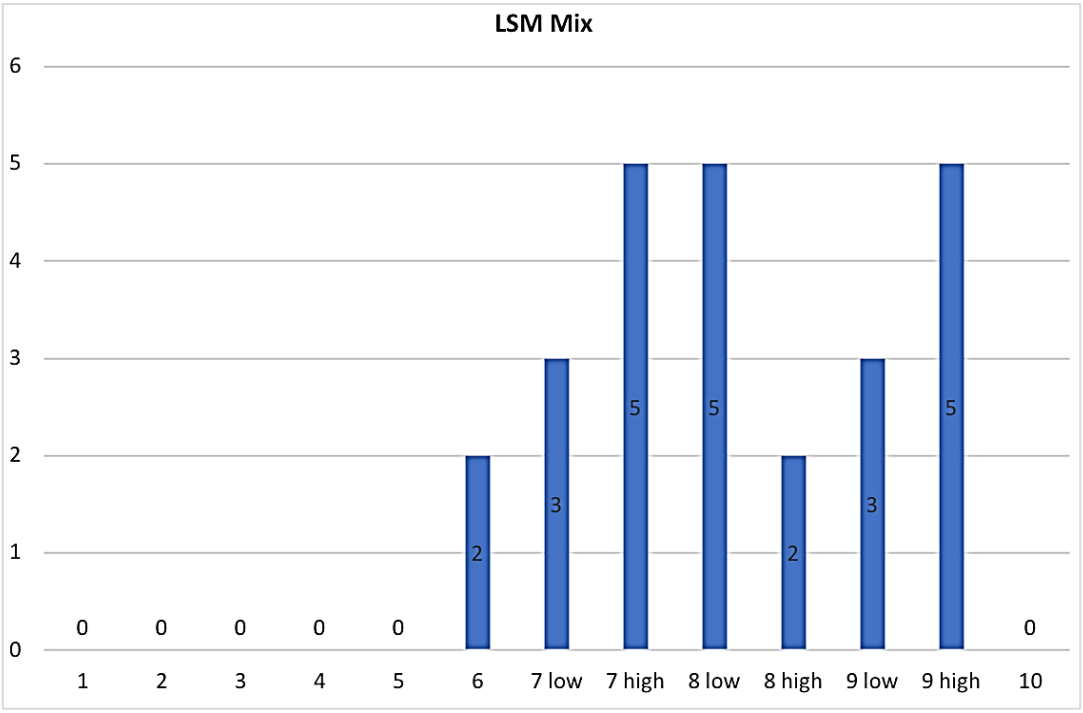


Figure 4.26. LSM of Lynedoch EcoVillage.

To get some further indication of this, a question was included in the survey on Length of Stay in the village. Out of 27 households, 56% of them have lived in the village for less than 7 years; 26% between 7-15 years; and 19% have lived here since its establishment. This means that the change of ownership has been quite significant in the last 7 years. However, with a new residents' welcoming program and in a community of just over thirty households, it is easier to get to know people in the village. (I witnessed a new couple being introduced and welcomed to the village while attending a HOA meeting).

HUMAN SCALE AND KNOWING YOUR COMMUNITY: Lynedoch EcoVillage is mostly pedestrian-friendly, and the human scale design makes it easier for people to have everyday face-to-face interaction. People know each other and do various social or educational events together. There are also the monthly HOA meetings that are very informative and inclusive. Evans et al.(2016), refer to 'human scale' as the response to simple human desires and local initiatives, moving society towards decentralized social programs, and creating neighbourhoods that are walkable and encouraging everyday face-to-face interaction (Cassen et al., 2018).

If we compare this to a middle-class neighbourhood the findings look very different. In the South African middle-class context, walking around in your neighbourhood is not always a form of bumping into your neighbours. A Control Group of 20 random people living in middle-class South African suburbs were asked if they do walk in their neighbourhoods. All answered affirmatively. They were next asked whether they walk in their neighbourhood, for 1) fresh air; 2) exercise; and 3) to bump into their neighbour? Thirty-seven percent said to get fresh air, 63% for exercise, and 0% to bump into their neighbour. The next question was, when they walk in the neighbourhood, how many times do they bump into their neighbours or acquaintances? The answers varied from 16% 'never'; 32% 'rarely'; 47% 'sometimes'; 0% 'mostly'; and 5% said 'always'. Most of the control group live in neighbourhoods without a 'village square' or a place of coming together to just sit in the sun.

Most traditional villages have a village square, where residents in the village gather around, enjoying the sun, and having spontaneously interaction (Kuchenbuch, 2016). In the Lynedoch EcoVillage case, I have seen some residents coming together in the sun, having spontaneous face-to-face interaction. With regards to a 'village square', the little dam at the top end of the neighbourhood could serve as such a gathering place - a lovely, natural space with a stunning view, for people to be social together. Apart from formal events, I never saw anyone using this area socially.

MOBILITY: Although every household in the village has a car, and sometimes more than one, they do encourage public transport, motorcycle use and ride sharing as far as possible. In a country where public transport is sometimes a safety and accessibility challenge, they do have an advantage of being right next to the Lynedoch train station (see Photo 4.34). This station sits on a main line running from Stellenbosch to Cape Town. Another recent mobility initiative that was co-launched by the Sustainability Institute, is a mobility application called uGoMyWay. This is a ride sharing application with the possibility of asking a small fee for the ride share.

One of the future plans of Eskom is to experiment with the home solar PV system and e-cars. This will be another interesting part of the pilot project because e cars could be used as a storage device but will also need alternative energy from the micro-grid (De Graaf, 2018).

Photo 4.34. Lynedoch train station (Source: Sharné Bloem).

USER SUSTAINABILITY: Another attribute of the village is that they generally live sustainable lives. A few questions were asked about sustainable user habits.

First question: **Do you switch off the lights in rooms that are not in use** (see Figure 4.27). From the five multiple choice options, Fifteen Lynedoch EcoVillage residents answered the following; 21% ‘every time’ and 79% ‘almost every time’; and 0% for the other three options, ‘sometimes’, ‘almost never’, ‘never’. Twenty random people living in middle-class suburban neighbourhoods answered, 43% ‘every time’; 36% ‘almost every time’; and 21% ‘sometimes’.

Figure 4.27. Do you switch off your lights in rooms where they are not used?

Second question: **Do you turn off the tap when brushing your teeth** (see Figure 4.28). (With the current drought in Cape Town this question was probably answered in a more water-wise way). The Lynedoch EcoVillage residents answered, 70% 'every time'; 20% 'almost always'; and 10% 'sometimes'. The control group answered, 64% 'every time'; 36% 'almost always'; and 0% for 'sometimes, 'almost never' and 'never'.

Figure 4.28. Do you turn off the tap when brushing your teeth?

Third question: **Do you separate your organic waste and recycle your trash** (see Figure 4.29). The Lynedoch EcoVillage residents answered, 55% 'every time'; 36% 'almost always'; and 9% 'almost never'; with 0% for 'sometimes' and 'never'. The control group answered, 43% 'every time'; 29% 'almost always'; 7% 'sometimes'; 14% 'almost never' and 7% answered 'never'.

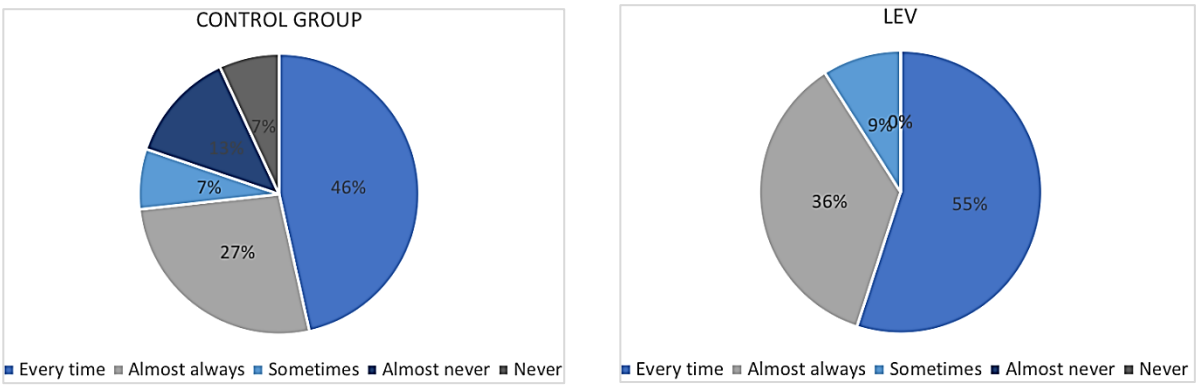


Figure 4.29. Do you separate your organic waste and recycle your trash?

Fourth question: **Do you buy your food based on how sustainable they are (eg. local, organic, free range, GMO-free)** (see Figure 4.30). The Lynedoch EcoVillage residents answered, 36% 'almost always'; 55% 'sometimes'; 9% 'almost never'; and 0% said 'every time' and 'never'. The control group answered, 7% 'every time'; 29% 'almost always'; 43% 'sometimes'; 14% 'almost never'; and 7% 'never'.

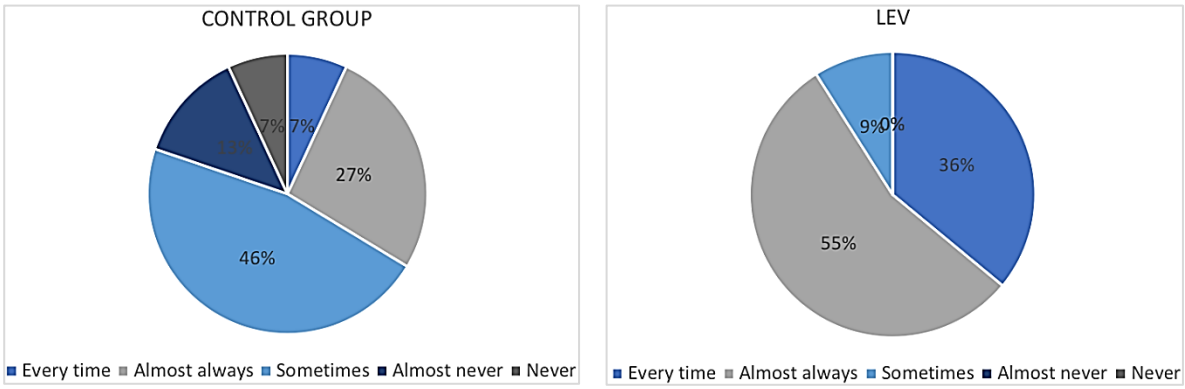


Figure 4.30. Do you buy your food based on how sustainable they are (eg. local, organic, free-range and GMO-free)?

Fifth question: **Do you believe you are more sustainable than your neighbour?** The Lynedoch EcoVillage residents answered: 9% 'agreed strongly'; 9% 'agreed'; 73% were 'neutral'; 9% 'disagreed' and 0% 'strongly disagreed'. The control group answered, 29% 'agreed strongly'; 14% 'agreed'; 43% were 'neutral'; 14% 'disagreed' and 0% 'strongly disagreed'.

Sixth question: (only asked to Lynedoch EcoVillage residents): **Do you believe that you are living a more sustainable life than people living outside this village, in South Africa?** The village residents answered, 45% 'strongly agreed'; 36% 'agreed'; 9% were 'neutral'; 9% 'disagreed' and 0% 'strongly disagreed'.

Although the control group did score higher than expected, the village is still more sustainable in their habits.

Socio-Technical Aspects

A definition for socio-technical aspects read as follow:

> Socio-technical aspects refers to the interaction between society's complex infrastructure and human behaviour.
>
> Merriam Webster Dictionary

As mentioned in Chapter 2, although natural science experiments are different from socio-technical experimentation, a socio-technical experiment can be conceptualized as "…an inclusive, practice-based and challenge-led initiative designed to promote system innovation through social learning under conditions of uncertainty and ambiguity" (Sengers, Wieczorek & Raven, 2016:10).

BUILDING MATERIALS: During the establishment of the village, a few aspects played a role in the selection of the building materials. *Adobe* was selected because of a supply of local clay. The first few adobe houses had a few structural challenges because of the human factor *obstructing* the implementation of ring beams and making the bricks about 300mm by 300mm (see Addendum F). Square bricks are not a structurally sane choice and the bricks were changed to be rectangular. The lack of a ring beam also resulted in a structural compromise and shortly after was strengthened by cross bracing of the walls in the form of steel rods and L-brackets in the corners. The use of *recycled and reclaimed bricks* was used by people needing bonds to fund the building of their houses - in South Africa the banks use the National Home Builders Regulation Council (NHBRC) as a regulatory board to give a five-year structural approval on newly build houses, almost like a surety to the banks. The NHBRC has very specific rules about building materials and hardly any alternative material to brick and mortar is approved. This led to the use of recycled and reclaimed bricks in the village. The specific rules by the NHBRC is another example of the human factor *obstructing* the use of the technical systems or building materials. Previous users of alternative materials have used substandard techniques, leading to a resistance to these kinds of experimental materials.

ESKOM PILOT PROJECT: Eskom was looking for a neighbourhood to conduct experimental research on home solar PV systems within a micro-grid setting. The Lynedoch EcoVillage was a perfect fit for their criteria; to find a socio-economic diverse, LSM diverse, green thinking and open to experimentation neighbourhood. The entire village was approached by Eskom in 2016 to sign up

for the pilot project – but only 27 households signed up, and a good example of the human factor *enhancing* the technical system.

The signing-up launched **the kick off** of this pilot project. Eskom claimed that the project was co-designed, and that a bottom up approach was used by consulting the HOA, the founders, the CFO of the Sustainability Institute, and in future participation via the on-line portal. However, the process seemed more to have characteristics of consultation than of participation. A few months into the process, a few other households wanted to join, and have not been able to, as no new households could be added to the pilot at this point.

Eskom considered all parts to be part of the research process. For example, firstly, they expected people to not want to take part; secondly, after the project had started, and people could see the benefits of the project, then more people would want to join, but could not. Thirdly, the pilot would also have a follow-on phase for Eskom to try and figure out how to incentivise people not taking part to want to take part in such a project.

THE INTEGRATION PROCESS: **The process** of getting these possibilities up and running started before the installation of the system happened in October 2017. The initial installation months had many power failures and some houses had many technical glitches, the subcontractors made some mistakes and therefore causing the human factor to be *obstructing* of the implementation process. In a few months that the meters were faulty and did not read the solar reading, to Eskom's detriment, everyone gained free electricity in that time - it was also risky for the transformers with power running back into the grid. Regardless of some technical glitches, in the beginning few months the participants appeared to be excited and happy to be part of this pilot project. Many of the first households were excited about the possibilities of peer-to-peer energy trading and what opportunities that could bring. Eskom indicated in the discussions that up to 40% could be paid to the 'selling' peer. These possibilities had potential for both *enhancing and obstructing* possibilities for the human factor involved.

Eskom's has experienced some challenges, such as working with external contractors and not Eskom employees. The residents felt that the installation of the expensive micro-grid system could draw more attention to the village and could increase petty theft or people snooping around. In terms of finding the best security system for armed responses took much time, as it seemed that most security companies only wanted to exploit the situation because Eskom was involved. The residents' 'buy-in' had challenges from the start and continues to be challenging. Many technical questions emerged and Eskom perceived these questions to be stalling the process. Most of these examples above are the human factor *obstructing* the implementations process.

Eskom needed NERSA to register this site as a demonstration pilot and approve the tariffs for the project. This presented further delays and challenges to Eskom - the NERSA process dragged on in a very long engagement, mostly because this pilot had no reference point to previous other projects.

THE SYSTEMIC ACCOUNT OF THIS INSTALLATION: Lynedoch EcoVillage's experience with the Eskom contractors was not always positive: installation was sometimes a huge inconvenience. Some households experienced their house wiring being tampered with. This cost them a lot of time and money to restore – one user spent about ZAR10 000 to rectify the wiring.

Many questions and suspicions erupted in the last few months (since June 2018 until September 2018).

- Firstly, some villagers felt that Eskom was using their roof space and that there should be some benefit for the village in this; however, they only felt exposure in terms of security.
- Secondly, security remained a challenge. Very high quotes were received from security service providers - between ZAR1,2million and ZAR2milllion. The interim solution before a security contactor could be appointed was to provide remote access with alarm detection that connected to the villagers' mobile phones. A second call for potential security contractors to tender was sent out after about six months and still the village needed to understand what would happen after the two years, with Eskom replying that the project would be handed to Eskom Distribution to manage locally.
- Thirdly, research privacy was a pressing question. What personal information would be stored and how? Eskom confirmed that they are 100% Protection of Personal Information (PoPI) Act compliant and no information would be used without consent. They also added that the data that would be used would be for optimisation of the best balance between load and supply.
- Fourthly, the timeframe of the project was another question, with uncertainly of what would happen after the two years contractual period. Who would be liable for what, would the trading continue, would there be any benefit for the village? Eskom answered that after the two years the assets would be handed to Eskom Distribution. They would take care of the system and hopefully, during the two years, all glitches in the system would be ironed out. There were no clear answers on the trading, although this was one of the main reasons for the pilot. True to an experiment, time will tell.
- Fifthly, what about the tariffs? Regardless of the system being installed in October 2017, they were still paying ZAR2/kWh. Although there had been promises that Eskom might change their tariff to ZAR1,27, the middleman CyberVentIT still benefited from their position. Eskom answered with the following proposal. To convert the village to Home Power Four customers,

and then pay ZAR1,27, they needed to upgrade to be Eskom Direct customers. This switch would cost each user ZAR9 000 in installation costs and connection fees. As an incentive, Eskom RTB would pay this fee, with the provision that the user remained as an active participant. If the users cancelled their involvement, then they would be liable for the fee of ZAR9 000.

Although these questions were answered by Eskom as best they could, in the next week one of the users cancelled their participation in the micro-grid.

This left the system with 26 other unsettled participants. The household that left felt that Eskom did not want to answer their difficult questions sufficiently and had a serious issue with their privacy being jeopardized. With the installation and three-monthly maintenance cycle they already felt their privacy was compromised.

In the midst of the uncertainty, and as some of the excitement faded around the project, a *few questions* related to the experience with Eskom were asked to 20 people in the micro-grid (see Addendum P).

Question 1: **What do you think about Eskom's contribution in the village so far?**
35% said 'good'; 25% said 'average'; 5% were 'pleasantly surprised'; 5% felt this was all 'empty promises'; 5% said 'awful'; and 25% said 'other'. 'Other' answered the following: 'Not sure why we have to pay for solar if we could install it ourselves'; 'see where this goes'; 'leaking roof since the installation'; 'awesome idea/technology but delivering on promises still needs to happen'; buying directly from Eskom could be a better thing'.

Question 2: **Any monthly savings since the micro-grid was installed?**
35% said 'yes'; 50% said 'no'; and 15% said 'other. They specified that, 'we only moved into the house now'; 'same'; 'depends on how you use it'.

Question 3: **Did the micro-grid change your life in any way?**
55% said 'yes'; 30% said 'no'; and 50% said 'other'. The specified answers were, 10% 'saving money'; and 40% said 'it is good to have backup electricity when the grid is off'.

Question 4: **What is the general feeling you have knowing that you are part of a pilot project for Eskom?**
35% were 'excited'; 25% were 'neutral'; 15% said they are 'waiting for the catch'; 0% said they do 'not completely trust Eskom'; and 25% said 'other'. The answers under 'other' came

> as, 'The beginning was very exciting, where is my gain now'; 'mixed feelings – happy to be in the program, but Eskom has a face of rejecting renewable energy'; 'when the grid is down there is still power'; 'not sure about the system yet'; and 'we withdrew from the project since we are not happy with the agreement that is not in line with the initial concept. We are also unhappy about the fact that we do not have any access to data being accumulated'.

Trust in Eskom just faded as the days passed.

Battery backup is an expensive part of a PV system. As part of the micro-grid, these IP65 Eskom steel boxes were used for its 100% weatherproof abilities and installed next to the 27 houses that took part in this pilot. Some of these boxes were installed on the sunny side of the houses. These were criticised on a ventilation level. The initial critique was that the boxes would get extremely hot (which was the case), and then compromise the life expectancy of the batteries. The efficiency of the batteries in optimal conditions of 20-25 degrees Celsius is 70%. The maintenance team have heat monitors inside the boxes, which only measured temperatures *above* 30 degrees Celsius in a few boxes. These boxes were then insulated with polystyrene, which brought the temperatures down to 28-30 degrees Celsius inside these 'sun-facing' boxes. The efficiency is now reckoned to be 65% (Anderson, 2018).

In summary, the signing of the contract took almost a year, and by the time of the study and surveys, the excitement had faded radically. More technical questions came from the village and the reputation of Eskom came to haunt the once very-excited people. The village also felt that the expensive system was drawing attention and could lead to an increase in crime; and the uncertainty on general security created some unhappiness.

SOME ADDED REFLECTIONS: In the last HOA meeting Eskom attended, they answered more questions regarding the two year contract period and provided more detailed information around the research that would be done through this pilot project. Most of the home owners involved in this project attended, so that they could clarify their last pressing questions before the contract would be signed by the parties involved. Although this meeting seemed to go well (all questions being answered), and the village residents appeared content and ready to sign the two-year contract, nevertheless, during the next week one of the households cancelled their participation in this pilot project.

In answer to a question I posed to Eskom employees, they answered that this project was a 'bottom-up approach'. However, it could more accurate be described as a top-down, consultative process, and could not be construed as a co-design exercise.

While many technical systems are designed with users in mind, two things could be a hindrance in reaching the desired results of a system; systems get designed without co-designing opportunities for the user; and users don't necessarily adhere to those designs (Adil & Ko, 2016). In this pilot project, such discrepancies became obvious early on in the installation. Eskom made an independent decision around the size of the system. And the installation was not without hick-ups: two households had wiring discrepancies post-installation - one user had to spend almost ZAR10 000 to rectify the error. Other systems were installed with a weak signal to the mother-receiver of the system. In other instances, users used the system in different ways than was intended, causing data collection challenges. In the defence of some users, the technical booklet that was distributed by Eskom contained an error, causing some serious technical issues.

A general comment: The assumption is that higher income equates to more appliances equates to higher consumption. However, when comparing Table 1.1 - (the tool Eskom used to measure the LSM) and the LSM calculator used in the study (see Addendum Q), there is quite a discrepancy. One could deduce that LSM might not be the best metric to understand different energy profiles. Even income might not be the best metric.

4.2.5. The Comparison

A conclusion on comparing the similarities and differences of the three eco-villages to Lynedoch EcoVillage: One of the biggest challenges of our time is for our carbon-based economy to transition into a circular economy. These four intentional communities have been experimenting with re-imagining socio-technical aspects of this nature by having not just adopted specific facets of sustainability but incorporated a whole sustainability system within different contexts. In comparison to Lynedoch EcoVillage, a few things could be highlighted. All four villages made use of solar PV systems, generating energy locally. The building materials and building design principles are very similar between all four villages. Three of the four villages used locally sourced adobe that could bring a decrease in embodied energy. In comparing the energy efficiency indicators of each village, at least a few similarities were found. Smaller windows were used in three of the four villages. Some shading were applied on the predominant summer sun path side of the buildings. The use of insulation was priority in all four villages. Although all four villages have a unique context-specific intervention for the hot water and heating systems, they all made use of passive solar heating systems in some way or the other to decrease overall energy use. Lynedoch EcoVillage stands out as being socially mixed and LSM diverse, unlike the other more homogenous eco-villages, this could lead to peer-to-peer energy trading for those taking part in the micro-grid pilot project.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 Preamble

This thesis documents a lengthy time frame of immersive research, reflections and analysis, as I journeyed and investigated the sustainable claims made by the Lynedoch Eco-Village, as well as their initial process of experimentation with different building materials, building design principles, the pilot project for Eskom and the effect this could have, or has had, on socio-technical aspects.

Chapter 1 defines my interest in the topic, my motivation for conducting this study, and the background of the eco-village.

The defined ***Research Questions*** ask: What is the state of the current sustainable infrastructure in Lynedoch EcoVillage? Does the sustainable infrastructure contribute towards neighbourhood sustainability? Does the sustainable infrastructure configuration minimise the carbon footprint of the inhabitants? If the science was well-intended, what role does the human factor play in obstructing or enhancing the implementation?

The defined ***Objectives*** seek to establish: what the current sustainable infrastructure entails; to establish a user-friendly metric for the measurement of sustainability; to assess this low carbon community in specific sustainability aspects, such as an incoming micro-grid system, embodied energy, building design principles and use; to ascertain whether the findings match the claims; to evaluate the influence this has on the community on a social level; and to question whether this could be transferable.

The literature analysis in *Chapter 2* addresses the research questions by covering the position the research took in the light of an overarching transitional perspective through the theoretical framework of experimentation and socio-technical imaginary. Also covered in *Chapter 2* is the position of sustainable neighbourhoods in relation to the NSA tools. These are interrogated and analysed against the ecological design criteria of Reed.

In *Chapter 3* a mixed research methodology is used to address the research questions but also to refine those questions, ultimately leading to answers. This case study methodology in conjunction with a mixed research methodology added insights and understanding of the process of experimentation in an intentional neighbourhood setting.

Chapter 4 describes and analyses the case study, whilst considering the experimentation and socio-technical frameworks, and illuminating different processes of systemic learning though assessing the case study. The data that fed into this process focusses on *embodied energy, energy efficiency*, *energy use* in the village and *socio-technical aspects* of the implimentation.

The research journey includes many aspects of the sustainability infrastructure in Lynedoch EcoVillage. These aspects are divided in different sections to answer the research questions and research objectives. The conclusion of the findings covers the *NSA tool sets*, the *building infrastructure*, *energy infrastructure* and *socio-technical aspects*.

5.2 Findings

5.2.1 What is the state of the current sustainable infrastructure in Lynedoch EcoVillage? Does it contribute towards neighbourhood sustainability? Does it minimise the carbon footprint of the inhabitants?

Establishing a user-friendly metric for the measurement of sustainability

To assess the ***NSA tool sets*** a study was conducted of the role of these tool sets in attaining neighbourhood sustainability. The study compared them to Reed's ecological design framework, looking at them particularly through the lens of embodied energy, energy efficiency, energy use and socio-technical aspects. An analysis of four of the most popular tool sets, revealed not one perfect tool to measure the sustainability performance of Lynedoch EcoVillage. Therefore, conducting the study on these tool sets has been very useful in highlighting the gaps that exist in them.

Therefore, for the purposes of this study, **some of the technical indicators of local assessment tools, such as the Green Star Buildings Assessment, EDGE Buildings application, and Green Star Sustainable Precincts might be suitable to measure the sustainability performance of Lynedoch EcoVillage's sustainable infrastructure.** However, the socio-technical indicators are not currently weighted appropriately to measure the socio-technical aspects of Lynedoch EcoVillage. Focussing on co-creation, the context inside the village, and its strengths and weaknesses - while operating in the uncertain complexities of these dynamic socio-technical aspects - might be more applicable.

To assess the ***Building Infrastructure*** a study was conducted on e*mbodied energy* and *energy efficiency* by considering: the building materials used, and a number of building design principles, such as *fenestration design, shading, insulation, thermal resistance* and *solar heating*.

The *embodied energy* was calculated by using the EDGE Buildings application from the GBCSA Residential assessment tools. The benchmark was a brick and mortar (with plaster both sides), conventional middle-class house. The same project details were used throughout this comparative analysis, only the materials for the walls changed.

The saving in embodied energy between the conventional material and the alternative materials used in Lynedoch EcoVillage was 16%-36% (see Figure 5.1).

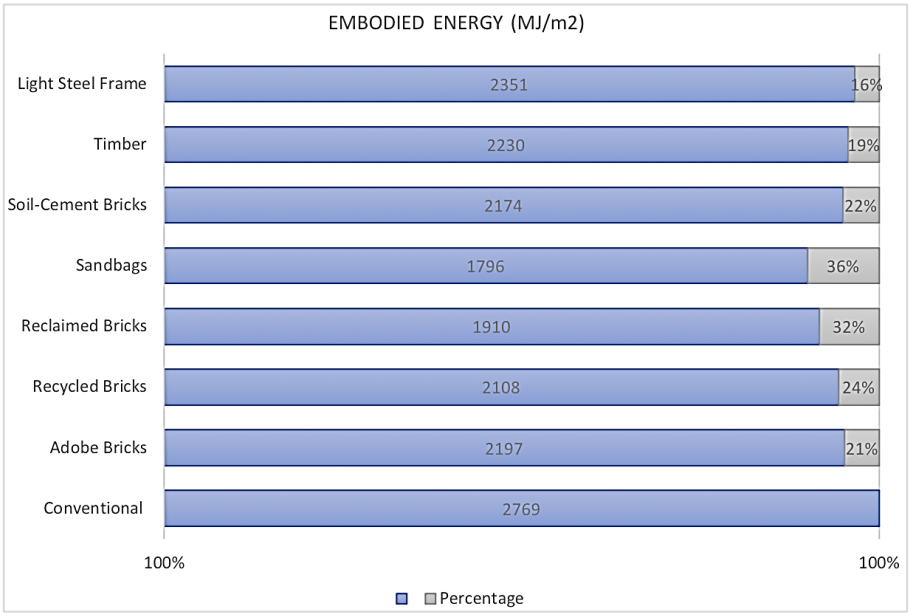


Figure 5.1. Embodied Energy (MJ/m^2) – Comparative study of building material (source: Sharné Bloem)

The *energy efficiency through fenestration design* was calculated by an indicative study of window-to-floor ratio and window orientation of each house, and then using literature to indicate some general findings. Lynedoch EcoVillage has mostly smaller window openings - the benchmark for window-to-floor ratio was the South African NBR, minimum 10% of natural light and 5% window openings for fresh air (although the later was not calculated). The benchmark for window orientation was north facing windows.

Up to 94% of houses in Lynedoch EcoVillage have a window-to-floor ratio of below 30% and about 45% of houses in Lynedoch EcoVillage have 30-50% of all windows facing north (see Figure 5.2).

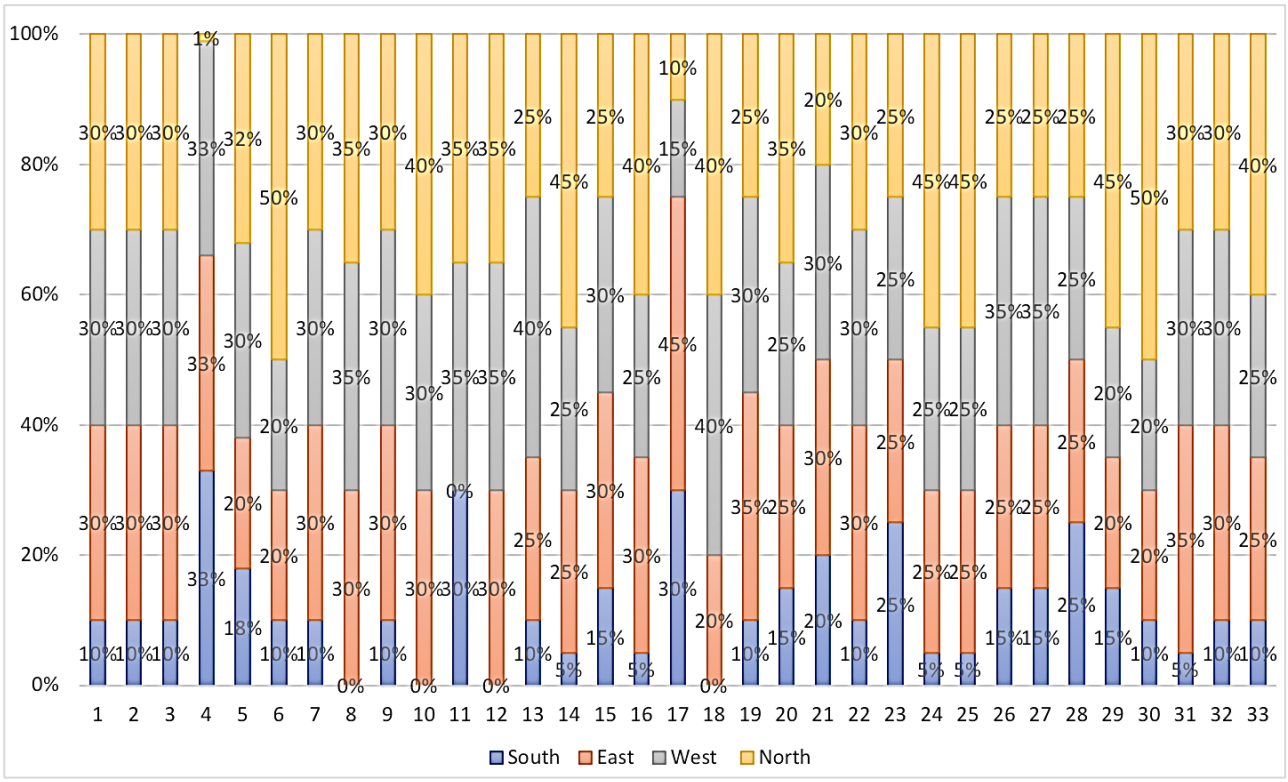


Figure 5.2. Summary of all four window facing sides of Lynedoch EcoVillage houses (source: Sharné Bloem)

The *energy efficiency through overhangs* was calculated by an indicative study of how north facing windows have overhangs or shading. Most houses are oriented towards the north or a slight variation from north. The benchmark for overhangs was having north facing windows shaded for direct sunlight in the summer, and allowing sunlight into the house in the winter.

Up to 40% of houses in Lynedoch EcoVillage with north facing windows are almost fully exposed to direct sunlight in the summer and 36% of houses in Lynedoch EcoVillage with north facing windows have some sort of overhang or tree protection (30%-50% covering) against direct sunlight in the summer (see Figure 5.3).

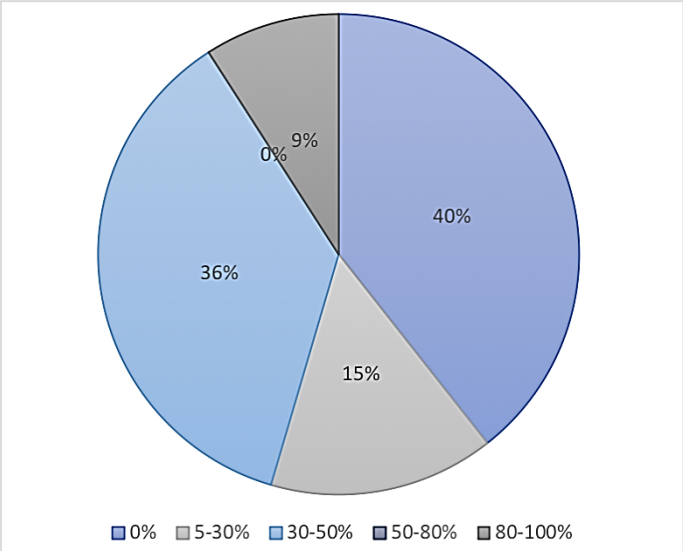


Figure 5.3. North-facing overhang for north facing windows of Lynedoch EcoVillage houses (Source: Sharné Bloem)

The *energy efficiency through insulation* was not calculated, but according to Swilling (2018) all houses have 100% insulation in the ceiling space. The benchmark for insulation was insulation in the ceilings.

100% of houses in Lynedoch EcoVillage have insulation in their ceiling space.

The *energy efficiency through thermal resistance* was calculated by an indicative study of the materials used in the building envelope. The benchmark for thermal resistance was obtained by comparing the R-value of materials used in Lynedoch EcoVillage to a conventional middle class house in South Africa with double skin brick and mortar at R-0.26, and a conventional middle class in the Western Cape with double skin brick and mortar cavity walls at R-0.5.

Adobe at R-7, outperforms the double skin brick and mortar wall with cavity by 14 times and a well-insulated container building at R-12, outperforms the double skin brick and mortar wall with cavity by 24 times (see Figure 5.4).

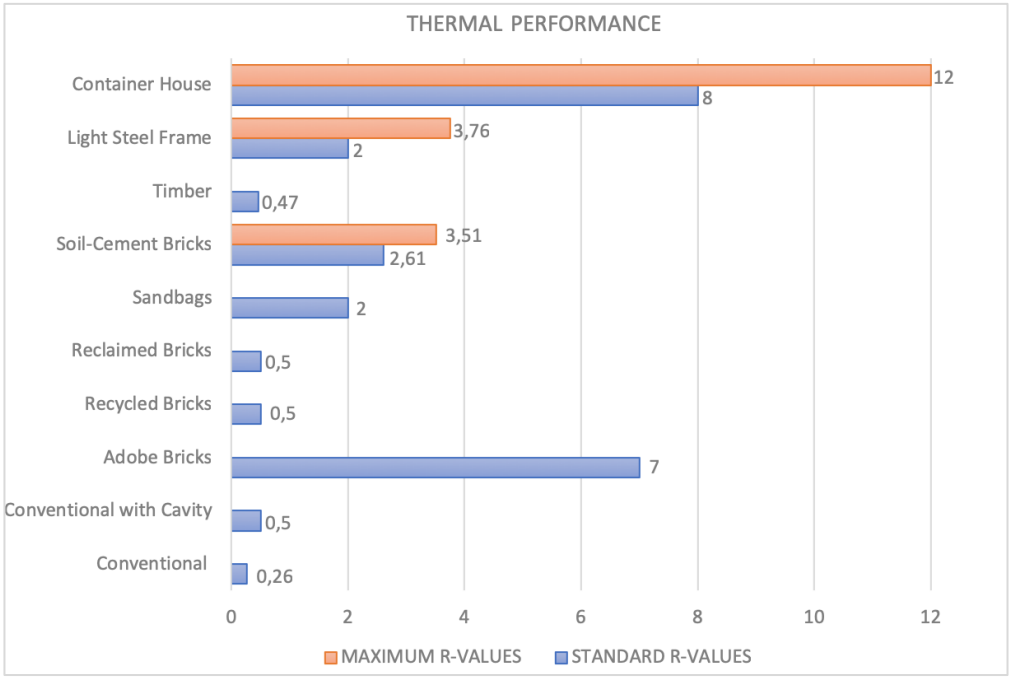


Figure 5.4. Thermal performance of wall material of Lynedoch EcoVillage houses (source: Sharné Bloem)

The *energy efficiency through solar thermal heating* was not calculated but according to (Swiegers 2018) all houses have solar heating panels on their roofs. The benchmark for solar thermal heating was actually having solar heating panels on their roofs.

100% of houses in Lynedoch EcoVillage make use of solar thermal heating on their roofs for heating water.

To summarize this previous section, part of this study compared some building design principles (fenestration design, shading, insulation, thermal resistance and solar heating) in Lynedoch EcoVillage buildings to the energy efficiency of conventional buildings. To conclude this comparison, the EDGE Buildings Application tool was used to indicate the difference between the building design principles used in Lynedoch EcoVillage and a conventional middle class residential building in the Western Cape and was measured in energy (kWh/m^2/year).

While referring to some factors in the analysis, the energy efficiency measured by the EDGE Building Application tool indicates that Lynedoch EcoVillage saves around 65% compared to a conventional building (see Figure 5.5).

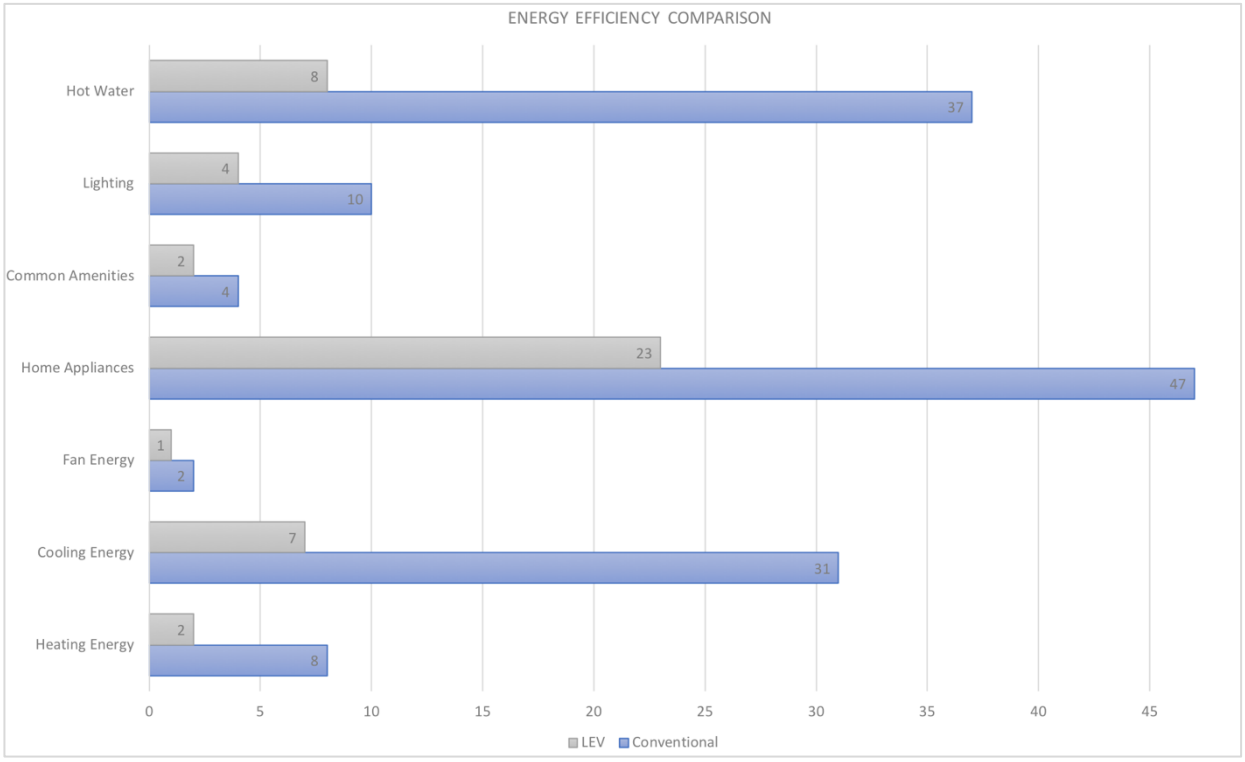


Figure 5.5. Energy Efficiency Comparison (source: Sharné Bloem)

The ***Energy Infrastructure*** was assessed by conducting an indicative study of the new micro-grid pilot project by Eskom and the energy use in the village.

The *energy use* of the 22 houses in the micro-grid is illustrated in Figure 5.6. The indicative empirical data was collected from 1 October 2017 to 1 July 2018. ***The grid input was 20 053kWh and the solar input was 18 879kWh.*** Both these feed into the inverter that is regulated by the charge controller and feeds into the load or the batteries. ***The batteries input was 28 085kWh and 19 499kWh output. The total load for these 22 houses was 23 598kWh over 9 months.*** The discrepancy between all the input and output calculations are due to losses in the system.

The Lynedoch EcoVillage system was compared to a system of the same size units in a conventional neighbourhood, indicating that Lynedoch EcoVillage was 60-70% more energy efficient.

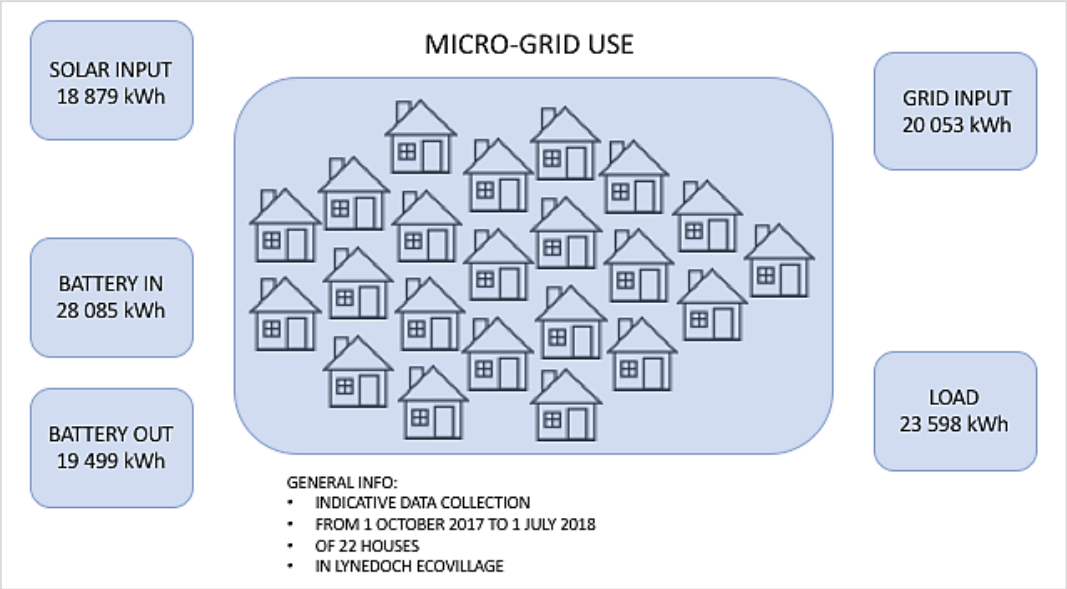


Figure 5.6. Energy use in Lynedoch EcoVillage micro-grid (source: Sharné Bloem)

The sustainable infrastructure configuration of the micro-grid *minimized the carbon footprint* of the Lynedoch EcoVillage inhabitants by 188 tonnes of CO_2 for the period 1 October 2017 until 1 July 2018.

The CO_2 saved is equal to 12 people driving from Lynedoch EcoVillage to and from Cape Town for work over a 9 month period.

5.2.2 If the micro-grid system was well-intended, what role does the human factor play in obstructing or enhancing the implementation?

To assess the ***Socio-technical aspects*** a study was conducted of the role the human factor played in the building and energy infrastructure in the village. The village claims to be socio-economically diverse, LSM mixed, human scale, knowing its community, considering sustainable mobility, and employing sustainable user practises. The human factor played a role in establishing the building and energy infrastructures, some in obstructing and others in enhancing the implementation.

The *socio-economic diversity claims* were calculated by compiling a survey asking specific questions around origins of descent, home language and income.

The findings were indicative of a diverse socio-economic group.

The *LSM mixed claims* were calculated by allowing the residents to fill in a LSM calculator online for South Africa.

The findings covered 7 LSM groups and are indicative of a mixed LSM group (see Figure 5.7).

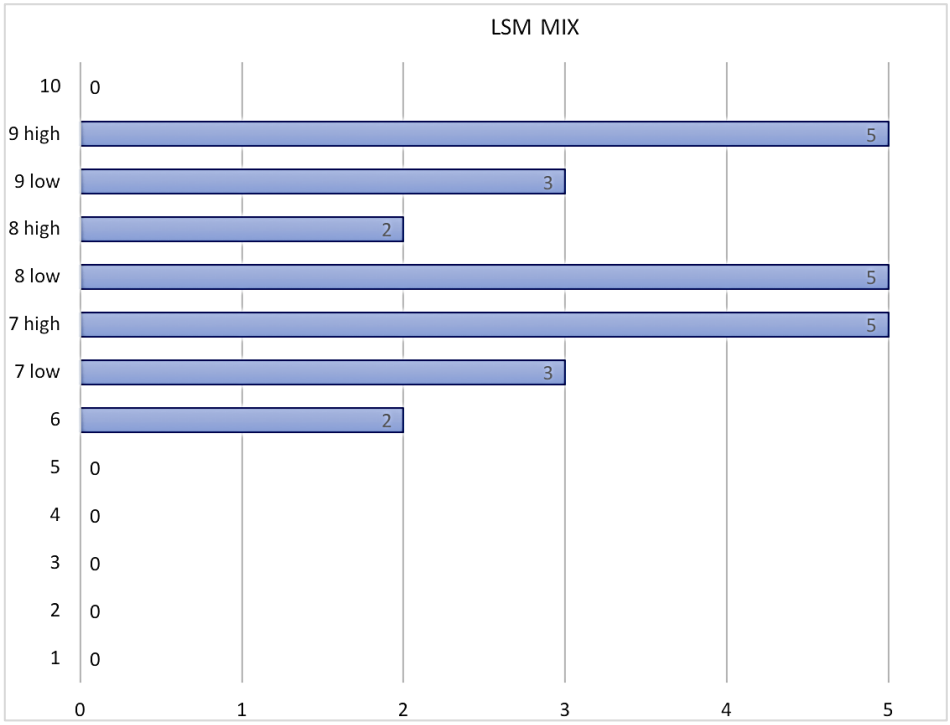


Figure 5.7. LSM mix of Lynedoch EcoVillage (source: Sharné Bloem)

The *human scale and knowing your community claims* were assessed by observation. In light of some key elements of new urbanism, such as human scale, the village probably needs a space where people could gather informally and spontaneously. Like a village square, as was mentioned in Chapter 4, the dam at the top end of the village lends itself to such a concept but does not seem to draw the villagers.

However, much effort goes into inclusivity and human scale in this village.

Mobility was calculated by observation. As part of the Eskom pilot project, the use of electric cars has been mentioned before as a future possibility.

Although villagers use public transport, ride sharing and motorcycles, most residents have a car.

The *user sustainability* was calculated through a survey and compared to a control group of random middle-income urbanites. .

Although the control group did score higher than expected, the village is still more sustainable in its habits.

The establishing of the village and especially considerations of the *building infrastructure,* was accompanied by many interesting aspects of the human factor playing a role, in both enhancing and obstructing the sustainability trajectory.

Although sustainability always remained the goal, both 'obstructing' and 'enhancing' occurred as the human factor experienced learning through experimentation.

The *Eskom pilot project* presented many learning opportunities and still does. There were many interesting aspects of the human factor playing a role in both enhancing and obstructing the implementation. An example of enhancing, most community members are living intentional lives and the way they relate to the micro-grid system is very positive. An example of obstructing, it will be interesting to understand the total influence of Eskom as a bureaucracy. This experience gave the impression that the Eskom staff might have 'the vision', but they might be hampered by the bureaucracy of a governmental body, which was in any case, ploughing through the aftermath of 'state capture'.

Both obstructing and enhancing occurred, as 'the human factor' not only included the villagers, but also Eskom, the service provider, as well as outside contractors.

A comparison between Lynedoch EcoVillage and the other three intentional communities that were examined, illustrates one glaring difference: the ownership of the energy infrastructure. The Lynedoch EcoVillage energy infrastructure is owned by Eskom, that is, state owned. The energy infrastructure of the other three villages is community-owned.

It would seem that the community-owned infrastructure has provided more freedom to co-design - from the bottom up - a sustainable neighbourhood, inclusive of social, economic

and environmental aspects. However, further studies could examine the socio-economic and sustainability outcomes of a community-owned vs a state-owned energy infrastructure.

Regardless of their different approaches in experimenting towards sustainability, the three eco-villages - Lotan, Torri Superiore and Aardehuizen - are very conscious of their carbon contribution and also have **community ownership of their energy infrastructures**, which adds in some way to their economic independence as a community. These three eco-villages are good examples of the **complexity around rating any neighbourhood to be at a certain level of sustainability**, especially if popular NSA tool sets are used and socio-technical, socio-economical and socio-institutional aspects are included.

However, what can be stated unequivocally is the value that can be derived from all four eco-villages in terms of Experimentation.

5.2.3 Could the lessons learnt from this intentional community be transferable?

Different theoretical terms represent the possibility of an ideal sustainable solution and experimentation could lead us closer to this ideal reality. In light of intentional communities, a part of this study made an indicative comparison between the similarities and differences of three eco-villages and Lynedoch EcoVillage. Although these villages are experimental sites, they could be seen as a source of wealth in the form of valuable knowledge gained in the pathway to sustainability. While the sustainable infrastructure of Lynedoch EcoVillage was assessed in light of claiming to be a low carbon community and was found to have lower embodied energy, better energy efficiency performance and in turn led to lower energy use in comparison to conventional middle class buildings in the Western Cape, South Africa. Some similarities between the four eco-villages in light of embodied energy, design, energy use and the socio-technical aspects were found and could be useful in reaching better energy performance in buildings.

Lynedoch EcoVillage and the other three eco-villages had all their own context-specific applications of locally sourced alternative building materials, three out of the four made use of locally sourced adobe building materials and therefore translates into lower embodied energy results in that specific area. Although this translates into lower embodied energy, not all new buildings could be built from adobe, but locally sourced materials do make a difference in the total embodied energy used.

The energy efficiency indicators of each village have a few similarities. Smaller windows were used in three of the four villages. Some shading were applied on the predominant summer sun path side of the buildings. The use of insulation was priority in all four villages. Although all four villages have a unique context-specific intervention for their hot water and heating systems, they all made use of passive solar heating systems in some way or the other to decrease overall energy use. These specific building design principles could be followed for better energy use results.

Thus, it could be argued that the experimental nature of these eco-villages lean more towards co-designing of socio-technical systems and therefore have potential to contribute to the neighbourhood of the future.

The trajectory of SIDE decentralised energy systems offer many possibilities in shaping the energy landscape of the future and the experiment with Lynedoch EcoVillage micro-grid could lead to similar possibilities, especially when peer-to-peer energy trading is considered. This has great potential to shape into a scalable model that could be rolled out in South Africa. However, national policy and other factors, such as legal regulations and NERSA, will present limitations. Natural potential, such as solar radiation, will also play a role in the scalability and replicability of such a model, not to mention the capital outlay. This study does seem to confirm that decentralisation of energy systems are the way forward for energy transition and the renewable energy future. It would be exciting to see where the “Smarthoods” can take us and how this concept could be imagined to revolutionise neighbourhoods of the future.

IN CONCLUSION: Firstly, this thesis sits in a unique position for a number of reasons. Never has a study been done in South Africa to identify a NSA tool set to measure a local sustainable neighbourhood. In doing so, this thesis highlighted the limitations and inadequacy of the existing NSA tools; and went on to feature the valued experimental sustainable performance of a few intentional communities outside of conventional practice. By considering the feedback from local professionals and GBCSA, possible context-specific uniquely-developed measuring tools could be developed.

Secondly, through the collection of indicative data of embodied energy, energy efficiency and energy use, the alternative building materials, sustainable building design principles and specific socio-technical aspects used in Lynedoch EcoVillage, have been shown to outperform the energy efficiency of the same micro-grid system in a conventional building application by 60-70%.

Thirdly, this thesis found that, in aspiring towards sustainability, it is crucial to apply experimentation which could lead to better socio-technical relationships and outcomes. Socio-technical imaginaries were regarded as a relevant form of learning, while at the same time uncovering appealing environments with diverse stakeholders, who could appreciate aspects and reasons beyond the conventional.

Therefore, this study has proved immensely useful in uncovering details in intentional sustainability practices – particularly with regard to building practices and energy provision. The indicative quantitative analyses was a good indication of the performance of different building and energy practises, in comparison to 'business as usual'. An added bonus gained was the depth of socio-technical understanding that well-designed technical systems do have to consider the human factor as an imperative.

5.3 Recommendations

In this thesis many angles were explored to find an accurate and sound way to measure sustainability. This proved challenging; therefore, some recommendations could be made which could lead to further investigation. The NSA tool sets, while proving to be more effective in measuring high level strategy for sustainable targets - have become a barrier in themselves. However, it could be argued that they provide a good baseline; and a possible study could be done to develop "plug-in" tools to supplement the existing NSA tool sets. These uniquely-developed measuring tools could expand the current NSA tool sets to become more context-specific in measuring sustainability in interested neighbourhoods.

Beyond the tools to measure sustainability, the following recommendations are related to the recent addition to Lynedoch EcoVillage of the micro-grid pilot project from Eskom.

Firstly, during the implementation phase of the micro-grid Eskom stated that this was a co-design project on their part. As stated before, the process seemed to have characteristics more of consultation than of participation. This was reflected in the thesis, but an additional interesting study could be to analyse the social dynamics during the two year pilot project between Eskom and the HOA.

Secondly, another interesting study that could emerge from this thesis, is the discord between policy and Eskom (as the state) in the context of how it relates to residential renewable energy. Currently,

residential renewable energy has no guiding policies. With current shifts in Eskom, could policies be developed to encourage decentralised residential systems and possibly bring a brighter future?

Thirdly, Lynedoch EcoVillage and the other three intentional communities that were examined, illustrates one glaring difference: the ownership of the energy infrastructure. The Lynedoch EcoVillage energy infrastructure is owned by Eskom; that is, state owned. The energy infrastructure of the other three villages is community-owned. Further studies could examine the socio-economic and sustainability outcomes of a community-owned vs state-owned energy infrastructure.

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Addenda

Addendum A: HOA Meetings with Eskom

Addendum B: Public Tender Document

Addendum C: Smart Integration of Residential Micro-grids PR

Addendum D: Email Correspondence with Eskom

Addendum E: Description of Lynedoch EcoVillage Mini-Grid

Addendum F: Interview with Co-Founder of Lynedoch EcoVillage

Addendum G: Eskom Rooftop PV Frequently Asked Questions

Addendum H: Eskom Rooftop PV Safe Operation Guide Rev 0.1

Addendum J: Local Context Report

Addendum K: Green Star Sustainable Precinct

Addendum L: Lynedoch EcoVillage Basic Design Principles

Addendum M: Description of House Typology

Addendum N: Energy Use by Lynedoch EcoVillage

Addendum P: Interview Questions for Lynedoch EcoVillage

Addendum Q: LSM Calculator

Addendum A: HOA Meetings with Eskom

HOA Meeting 1:

Date: 16 November 2017

Eskom said: It has been a couple of months. There's been some hiccups on the way. This is one of the first projects for Eskom in this domain. So as you know, when you think Eskom you think traditional grid, traditional energy. And we've been in the country, I know we're in the news for good and bad, but it's not all bad. There's still a lot of Eskom, especially at the ground root level where we're still looking for the best for the country, trying to keep the plants going, trying to keep the costs down.

So from that side, if you look at renewable energy, distributed generation, PV renewable, PV systems, wind generation, all these distrusted energy sources is seen as disruptive energy sources from a utility point of view. Disruptive in two ways. The first way is that it's uncontrolled energy production. So as a utility that's looking at the needs of the country it's very hard to be able to work out what your supply and demand needs to be in terms of what you need to have really on the grid if you have other generation sources in the network. So you've got other people's in your pocket basically. It's as simple as that. And it's not a nice situation.

The second aspect of distrusted generation is that it becomes quite unsafe if it's not handled properly. So I'll give you an example. NERSA has not allowed people to put energy back into the network, except for our IPPs. So in terms of large power producers, independent power producers, [all that happened? 0:05:56]. So when you're in the residential sector, this is parts that have always been, NERSA has been very reluctant to approve this and for a very good reason, the safety constraints of it. So for argument's sake, if you have a ring feed that's a municipality or Eskom feed area and let's say something goes wrong with the transformer, if a staff goes on there, isolates his side – because traditional norms is there's the other generation source – and while the person is working on this line for some reason somebody within the network is generating energy, you're gonna kill that employee.

So these are the safety aspects that we are battling to deal with. And NERSA understands this, that this is the reason why there is so much of reluctance to say if it's going to be done, it needs to be done responsibly. So you can't stop this from happening. You can get testing [inaudible 0:06:51], they're a private company. We've employed them on this contract. But that's their job, they do distributed energy systems. So you're looking at commercial sectors, you're looking at residential and it's happening.

So Eskom's in a catch 22 now. Do we go with the flow and let this continue happening or do we step in and try to own it and make it our own? To find a collaboration between the consumer and the utility to come with some sort of agreement where the safety aspects are maintained on the network as well as the benefit of having renewable energy. And I think that's what this project's about.

So you guys can be proud that it's the first in the country. This has never been done. So you guys are almost like the pioneers of this new technology. And when we started the project, that was very, very clear. I understood the village, you guys are sustainable. I've seen it. I've seen you guys' houses. I've seen grey water recycling. You guys do fantastic. So when it comes to energy efficiency and trying to do the best for the environment, I think you guys are way ahead of the rest of the [inaudible 0:08:09]. So it was a perfect opportunity to take the strengths that you already have and make it stronger. And that was the intention of doing this project.

And on that note, it was a very expensive installation. I'm sure you guys are aware of this. We didn't skimp. It was the best inverters you can get, best panels you can get, best quality batteries you can get. So the last thing I wanted was any technical aspect of this project to fail because of some inferior quality product.

So I've prepared some frequently asked questions which I have told you all about. And I've prepared a bit of questions and answers. So I don't know if I should read it and just give you the answer first. I think I covered most of it. And then if there's any additional questions coming from your side, I'm more than welcome to answer that, to explain it to you.

HOA asked: Just in terms of the first introductory part, was that clear enough or is there anything about that the people want to know a little bit more about before we get to the technical questions?

Eskom said: Lynedoch is a very unique community. Now, if you look at the energy usage in the village, it ranges from very low to very high. So this is a fantastic curve. And if you look at the dynamics within the village and if you had to represent that, in my opinion, to the rest of South Africa, the dynamics are there as well.

So one of the most unique aspects that we are trying to do on this project is that we took the total energy, area of the energy underneath the curve for the entire village, so you had guys that's using very little and guys using a lot, and we have this fantastic triangle with a massive area underneath it, and what I did is I levelized it and I put a flat 2 kW PV system across everybody's home. 1.7, around there. So it works out by design because we worked out what was the energy underneath the curve.

So I don't want to get too technical, but what it boils down to is that the system is designed that if there's additional energy on the lower users, that energy can now be

traded across to the higher users. And what that results in is a perfect curve for Eskom because your supply and demand is balanced. So unlike you've seen the load shedding and the morning peak and afternoon peak and switch off your geysers and all of that, but this system proves that if you do it the way that we've designed it, you can actually have a perfectly level supply-demand curve. So a lot of people think this is a myth, that it cannot exist. So part of this is actually proving that it can actually happen.

The system is unique in another way that where traditional PV systems did have PV inverters, we've added battery storage to the system. So in terms of a customer ... And I know you guys are probably asking, so what's in it for Eskom, what's in for the consumer? So I can give you both sides of the coin.

So *from the consumer* you're getting ... Imagine your previous connection. So you have a conventional Eskom connection, you have prepaid tokens at a fixed rate. So maybe you'll have inclining block tariffs in terms of what you buy, in terms of kilowatts and hours, you know, blocks, and then the price increases accordingly within the prime block tariff. But it's basically one tariff structure. Now, that's conventional for the rest of the country as well. Nothing has changed. So by us installing this system in there and the way the system is configured at present, it changes the dynamics in terms of the costing models that now can be applied to you and it's to your benefit.

So for starters, the system ... Okay, this will be complicated, but you've got different types of energy. You get solar inverted energy. So basically your PV panels take the energy through the inverter and rectifies it. That's actually very, very cheap energy. So that's one tariff. It's cheaper than you traditional grid. The second type that you have is stored battery energy. Now, the way the system has been configured ... Remember, batteries are expensive and the moment you take clean solar energy and convert that energy into a storage it becomes a very expensive commodity. And it's more expensive than gird by design because it's battery technologies, the losses through the inverter in getting this energy in here. So that's the other end of the scale. And then in the middle obviously you have the standard tariff.

So with the system ... And we are about to install another set of metres. So we're gonna try to either migrate your conlog metre, the one with the keypad that's in your guys' houses. So we had another company that came in at the beginning of the project and put the wafers in. So what the wafer did, it took a, forgive the French, but it's a dumb metre and converted it into an intelligent metre. So there was telemetry on the meter. So you could see a consumption pattern.

And in the grey boxes on the outside there's another metre that was installed at the beginning of the project, which is a Landis+Gyr little grey metre. That's a smart metre.

That's a fully-fledged smart metre which is a national regulatory standard that goes out to almost every household. So that's installed.

So we have two options. At the moment you guys are buying tokens through a third party. Am I right?

Speaker 3: Yes.

Eskom said: What's the company called?

Speaker 3: CyberVendIT.

Eskom said: CyberVendIT. So I have two options. I can either move those accounts directly to Eskom where you buy tokens directly from Eskom using the same platform. Or, and that's what I need to figure out, if the metres belong to [you all? 0:16:03], those metres that we installed, then that's fine. But if the company CyberVendIT are saying they're going to take the metres away, I'm not sure what the situation is.

Speaker 4: I don't know what happened in the beginning, I wasn't here, when the metres were installed. Was Ian at the time doing that? So I can find that out. But when you say that you're gonna change the metre, if we go to the Eskom system and we cut out CyberVendIT, which is what we would prefer, because that would drop our rate ...

Eskom said: 100%.

Speaker 4: Will that mean that your metre will come on board anyway, you'll change the metre to your metres?

Eskom said: No, I can use that existing metre and just connect it on the backend of the Eskom system.

Speaker 4: So I must find out whether those metres belong to somebody.

Eskom said: It's not the end of the world. Worst case I will give CyberVendIT 30 prepaid conlog metres from my store and we own these metres.

Speaker 4: So either way you guys can do it?

Eskom said: We can do it. And that already is gonna reduce you guys' rates for starters.

Speaker 4: That's good news.

Eskom said: There are some good news coming out of this.

So that's the first one. The second one is, because this has never been done before, the tariff structures that's associated with renewable generation is something that hasn't been rubberstamped and formulated for the country. So part of this research is trying to working out what that optimal costing is that we can now charge for solar energy. Because at the end of the day you've got a capital cost that has now been put into the system. If you amortise the value of the capital cost over 25 years for the lifespan of this plant, with the operation and the maintenance and everything else, at the end of the day you need to at least break even.

So Eskom's business model does not want to victimise and to make the most out of it. The [inaudible 0:17:58] here with Eskom's side is that even if you break even during this period, it's still better than trying to lose the market to a third party that will be here for today and maybe the next three, four years, but they will not have the reputation of Eskom to be there for 95 years. So by us embracing this technology and making it part of our operation and maintenance, we make sure that our distribution offices in Eskom now maintains the plant. So there's no maintenance whatsoever. All of that has been taken care of [inaudible 0:18:30].

So in terms of the tariff that we will be experimenting with and charging you, I can guarantee you now it's gonna be lower, it's not gonna be higher. But how much lower will depend on ... For argument's sake, we are now utilising your roof space for this [inaudible 0:18:47]. So if you think about it it's a rooftop rental. But instead of me giving you a physical rand amount every month for renting your roof, it's fed into the tariff that I now charge you, which is at a lower rate, to recuperate those costs. As simple as that. So you do get the benefit of that.

Speaker 4: Are you saying that ... So if we convert the existing metres to Eskom for a start, then we go to a standard Eskom rate and from there we'll get a lower tariff?

Eskom said: Yes. But it'll be a lower overall tariff. But let me explain. When you guys are using grid energy, in other words it's not coming from the PV and you're using, on very bad days, and if you're using it straight from the gird, you will be charged at an Eskom rate.

Speaker 4: Yes, I understand.

Eskom said: But if there's ample sun during the day and my battery's got to get up to full charge, then all that additional energy, we can provision hours during peak, during the day where that energy is at a lower rate. Do you understand? So it will be a hell of a lot cheaper. So I have to work out the numbers, but in my head it's about 65 cents [kilowatt hour? 0:19:57]. That's my number that I worked out. Which is very, very attractive. We still have to do the maths and stuff, but I'm normally pretty good when I work out these things. It's around there.

Speaker 4: In that kind of region.

Eskom said: And then I'm not saying it's for everybody, but as a green village, as a sustainable village, then I'm not saying ... Some of us are hypocrites. So I am one. We'll say green, green, green, but I'm driving a VH that have consumption of three Ks per litre. You know what I mean? So we've all got our evil sides.

Speaker 4: Fancy [inaudible 0:20:32].

Eskom said: No, I left that in Durban.

So I'm saying the stored battery energy. Now, if you are truly a green person, and I'm not forcing this onto you, but I'm saying if you're gonna walk the talk and if you're

saying I'm prepared to pay premium for green stored energy at night knowing that I have no impact on the environment, that energy is gonna be more expensive. So you either pay more and use green energy or you use the Eskom grid energy at normal cost. But it's up to you guys.

And it's a difficult one because a lot of people will say, yes, I'm green and I'm sustainable and I drive Priuses and everything else, but when it comes to the money and how you use your energy. So for those who want to really be true, and I believe that the stored PV energy is gonna be fantastic at night, but it's not gonna cost you the Eskom rate, it's gonna be a little bit more expensive.

Speaker 4: But the direction you guys are heading now, you're not exactly catching for the niche upper market, you're trying to get into South Africa. So people aren't necessarily thinking as green as a village or as green as someone that's intended to be green. This is people that think, well, how can I benefit from Eskom putting solar on my roof, but this is now sun energy. The average South African will think how can I benefit, not necessarily how am I contributing.

Eskom said: Yes. But I think that's gonna change as the country matures as well. The more you start getting remunerated for carbon trading and your effect on impact, you're gonna start being issued carbon credits for what you offset in terms of carbon. Now, that becomes a very, very important commodity because in certain companies they can be as efficient as they can be, but they still have a carbon footprint and those guys are prepared to buy these carbon credits to condone their actions, if you know what I mean. So that becomes a very expensive commodity [going forward? 0:22:49].

So the part of the system is that if you're producing green energy and if you want to now say I'm using this, you will be issued with a credit, a carbon credit, which in my opinion just like how Bitcoin has now got this crazy, that's gonna happen as well. But it's still very, very early days. The idea of this project is to have all the peripherals and all the mechanism in place so that we can try all these dynamics.

And I promise you guys, this is just the first part of this. Ultimately, and I spoke to [Graham? 0:23:22] about this, that I want this to become a green community complete. So it must be a smart community where you can even look at your amount of gas that you guys are using for cooking in terms of the energy [you got there? 0:23:38], how much of carbon you've emitted for the year, look at your water, how's your water recycling habits, how many detergents and cleaning agents you use. The total mix.

And if you couple that there with the telecommunication capabilities within here, so we've got networks already. So the next thing is how does Eskom now do ...? If you're

gonna do telemetry, with very little effort I could give internet connection as well, all value added services that come on top of this platform.

So these are all the iterations that will happen within the project. I'll give you another example. Eskom right now has got approval for the e-mobility strategy, which is electric cars. This is the perfect community. So just out of the blue, if I ever come to one of you all and tell you you're driving a car and your monthly instalment is, I don't know, a couple grand a month. If I had to offer you a lease agreement on a Nissan Leaf that's owned by the utility and you lease the car from us and I'm giving you preferential charging using the PV infrastructure to charge the cars up for free, that's very attractive.

Speaker 3: So those are possibilities for the future?

Eskom said: Exactly.

Speaker 3: But can we just take in terms of ... I think there's a lot of other people who might be sitting with questions. In some sense I'm keen to hear what the questions are that people have and they might be on your list or they might not be and people perhaps who haven't had a chance to ask. And we're just zooming in on the solar for the moment to make sure that ...

This is something new for us. We're not quite sure how it's going to work. You've addressed to some degree that question around the cost, the tariffs. But people might still not be clear about the [inaudible 0:25:19]. So shall we just open the floor a bit and see if there are other questions that we have an opportunity to ask now straight, we don't have to go through somebody else?

Speaker 5: I've got [inaudible 0:25:38].

Speaker 3: [Inaudible 0:25:39] has a question, [Martin? 0:25:40] has a question.

Speaker 6: Is there any chance of getting the system rolled out to people who didn't sign up because they were perhaps not in the village yet? Is there any plans to roll it out to more houses?

Eskom said: That's one of the things that we wanna try and test. Because you must understand, there's a lot of people that have went off gird already. In other words ... Not off grid, have got renewable systems in the rest of the country. So one of the case studies is how does Eskom now approach somebody that is not part of this thing and now entice them to do it, firstly. The second one is what if somebody already has a system installed that's not a part of our ... How do I now bring that system on board?

I'll give an example. Faan wants to do some PV in his fantastic new house. But I'm not funding it, he's doing it on his own. Which is a very interesting model as well. Because if you're willing to put up the capital cost, which is quite a lot of capital cost, I'm not gonna expect anything less than the standards that I have in place for the rest

of the system. So the guidelines and standards for if somebody wants to put their own system, they have to meet those standards. And then the funding model becomes slightly different now. So the first, he now had a capital [inaudible 0:27:03] that he's put in the system. The tariff structure will be different because obviously I'm not paying back that asset. But I still need to do operation and maintenance on his system. So this model's changed.

So I'm saying there's many different iterations of this model and [inaudible 0:27:20].

Speaker 6: Yes, but are there concretely any plans currently to consider rolling it out to other people in the village that don't have it yet?

Eskom said: Can I be honest with you?

Speaker 6: Of course.

Eskom said: This project took three years to plan from inception. We're a public company, PFMA, Public Funds Monetary Act. There were a hell of a lot of committees, approvals, budget approval that had to happen for this project to happen.

Speaker 6: Lots of red tape, so probably not. Okay

Eskom said: So the thing is I can't just add extra systems on, because I don't have the budget. I'm being honest with you. But it doesn't mean it won't happen. The whole idea is ... Ultimately I would love for the entire village to be on it. So I will keep you guys in the loop and there will be a next stage and then I'm sure that that will ...

Speaker 6: Thank you.

Speaker 7: And I think you said that if we want to use the battery system over night it will be more expensive. But how does it practically work? I mean, there's no switches that I can say I wanna use the battery now instead of the Eskom grid.

Eskom said: The inverters can be configured in different patterns. So when there's no sun at night, the inverters can be configured to say only take energy from the grid and if the grid supply is interrupted it will use the batteries as a UPS, a backup, until it gets to a 50% [depth? 0:28:51] of discharge to safeguard itself. That's one configuration. I can have it configured the other way. In the night by default it must use the batteries first.

And now, all those configurabilities and that, remember, it comes down to you as a consumer and what you want. So that flexibility in the system, ultimately you should be able to have the control of that system to decide what you want. But obviously there are repercussions that comes or the tariffs that comes with it. You understand?

Speaker 7: Yes.

Eskom said: So I hope that answers your question.

Speaker 3: So can I just, to clarify. So we will have a choice in terms of what we want to use at night. If we choose to use the batteries that will push up the tariffs?

Eskom said: Yes.

Speaker 3: If we say that we go on the Eskom grid at night, then obviously that will be a lower rate. And because you then have solar energy during the day, your overall cost will be definitely lower?

Eskom said: Yes.

Speaker 3: But if you choose the batteries at night, then it becomes less clear what you are going to pay?

Speaker 8: I think we must just make it clear that right at the begging we want to try this different options. So it's not right from the beginning that you will have the choice cause we want to experiment a little bit with the different options before we give the choice over to the community.

Eskom said: I'll give an example. Even though the metring standard is where it is right now, do you have a choice to be a pre-paid or post-paid customer? No. But [at best of the will? 0:30:19], you can change on the fly overnight, on the minute. I can be pre-paid up to this point and then there will be one application, I'm post-paid. Just like that.

And ultimately I believe that the consumer should have that ability. He should have the choice. The system by all means has the capability to do that. It's just that it's not the point of just the system changing over, the billing system needs to be complimented with that change and that's where the ...

Speaker 8: We bring the two together, the billing system and the [inaudible 0:30:54].

Eskom said: And part of the journey for Eskom is that the traditional way of billing that we normally do it ... So let me explain. We've got something called [CCM? 0:31:02], the customer [inaudible 0:31:03], which is this massive system that sits as Eskom. Then you've got OVS, which is a vending system where you guys buy the tokens, et cetera from. Even though you're buying from a reseller, he vendors it from Eskom. Now, those two systems talk at the macro level. Now, the systems are so rigid that they never considered all the things [inaudible 0:31:24].

So instead of me going and putting a completely different vending system to prove the concept of the project, which ultimately will work, but when it comes to Eskom saying, fine, how do we now implement it to the business, the transition is gonna be so big it's never gonna happen. So what I'm trying to do is use the tools that I have in Eskom already and with a very logical approach, migrate the system into what it needs to be. So that's [inaudible 0:31:51].

Speaker 9: If I may, you explained it very well, but may we just take it step by step. If you have the option of having PV, sun energy, as the lowest cost, second lowest tier is normal Eskom power coming from the gird, most expensive is your battery. Then what we do is, the current situation is we've programmed the system to take them in that order, the inverter, because that's the most beneficial to you.

So we're not gonna use the battery every night. Because why? Why do you want to pay more for the stored energy? The battery is there. If the Eskom falls away and there's a power failure or there's an outage, you will have a backup battery system and then you'll pay a [inaudible 0:32:37] rate. But it doesn't make sense to say I want the choice to use the battery every night.

Eskom said: No, but [Allen? 0:32:44], from a green point of view, sustainable point of view, you know it's cleaner energy that's coming from the battery at night than the grid. It should be a choice of the consumer to say I wanna walk this walk.

Speaker 9: I understand it. I'm just saying that's the way we've programmed all of this from a cost point of view.

Speaker 3: We don't want to get too technical around that. But is there any questions around this in terms of how the system is actually going to work? Because I think that's what people have been saying. We're not quite sure how ... It's installed, it's got all these different ... There's cabling between houses and clusters and there's all kinds of complicated stuff going on, I understand. Just explain how this thing will work.

Eskom said: Even though it looks very complicated, it was by design so that we took all the complication. I promise you. As Alex explained, those three ways is now the most optimal way where you will save. So that has been done on your behalf.

Speaker 3: So it's pre-programmed?

Eskom said: Right. At the next stage of the project ... Remember, there'll be different phases where we're doing testing.

Speaker 3: So the first stage is from when till when?

Eskom said: I'll give you the [inaudible 0:33:54]. But our financial year ... This project and according to our [SAP? 0:34:00] and our PCMs within Eskom, it completes on the 31st of March with this phase.

Speaker 3: First phase?

Eskom said: Yes. So from 1st of April, which is our new financial year, the research actually starts. So [inaudible 0:34:14] being ready by now. So I'm quite happy about that. That's the first thing.

The next part ... So we're testing in the first phase. The whole idea about the design, as I explained with the curve and the area under the curve and why we levelized to a 1.7 is that we really want to incentivise the energy trading aspect, which is the next part. So right now as it's configured, the Landis+Gyr smart metre, the last metre that was installed, not the one in your house, will not allow energy to go back into the grid. So basically as it stands right now, no energy will move between you and your neighbour because that's another thing we need to sort out in terms of the tariff. And

then if that happens, when that happens, then you are gonna be reimbursed for energy that you are not using and that you have moved over.

Speaker 3: That's the next phase?

Eskom said: That's the next phase. And remember, it has to be very stringent in terms of the testing regimes that we want to do because we're not gonna have another opportunity to mess you guys around. So we wanna try to be as thorough, make sure we get all the findings, whatever we need to do before we move into the next phase.

Speaker 3: Anybody else who's sitting with a question?

Speaker 7: Just maybe a short question about the six panels can basically recharge a battery during the day even it has been used the whole night and you could use it the next night again?

Eskom said: If there's sun.

Speaker 7: If there's enough sun.

Eskom said: Yes. That was according to the energy profile that we built it. Because at the end of the day you must understand that it's pointless having an overdesigned system which is not gonna be giving you all the energy outflow. Then it's capital costs that are never gonna be recovered in the period. So you try to keep it as optimal as possible.

Speaker 9: Maybe I can just on a simple note explain. Your question was how does the system work. So Eskom is the power supplier. Whether it comes from a coal station in Mpumalanga or whether it's coming from the roof, they are the power supplier. So there comes the power and the inverter sits there and it makes the selection, programmed to first take Eskom power from the roof. If that's not available, if there's not sufficient, if you're putting on a big load, you're mowing your lawn and you've got the toaster on and the kettle and everything, then it will draw whatever the short is from the Eskom grid. And then the batteries sit there as the backup. If Eskom falls away then that's [enough? 0:37:01].

So that whole system all comes from Eskom and it's then metred on the load side because we need to metre to understand how much does they use and how much does he use to see when we start trading. So that's the simple way. There's a supply which goes to an inverter, it's got different sources and then the load is metred to the use. So the less you use, the more you save.

Eskom said: You'll notice that that new DV box was added to your house with that switchover between Eskom and PV. So that was to safeguard the consumer and Eskom in two ways. If Eskom needed to do any maintenance on the PV system we will merely move you back to a continuous Eskom supply and we can safely work on that system. If for some reason that system is unavailable, then you merely move it back up to Eskom

only and then life continues as normal. So we've safeguarded so there's no inconvenience factor for the residents in any way.

Secondly you guys must have noticed that most traditional inverter and battery installations will be done in a little battery room in the house or something like that. So we went out of our way and commissioned and designed these very special cabinets that are green, through people's choices, which looks beautiful by the way, and it's there so that there's no interruption. So if there's a problem with the system we operate on that thing and we don't affect anybody's ... So we tried to be as sensitive as possible, not to be intrusive.

Speaker 3: Thank you, we appreciate that. Anybody else with a critical question? [Inaudible 0:38:40].

Speaker 4: No, I don't actually. This is something that was mentioned before, was the intelligent use of the system from a consumer point of view. So what we have at our disposal in terms of choice, it was mentioned that there's possibility for a pad or something that could sit and we could monitor the use of solar versus Eskom. Is that still on the cards?

Eskom said: Yes, it's still on the cards. It's actually available right now. [Inaudible 0:39:14]. So all the systems are actually online and available right now where you can see all of that information, for an individual household. So that information is there. Now, I'm not being biased, but it's a Schneider system. So I need to Eskomize it a bit. So my guys are busy with it right now. We're gonna make it ... And this is, you see, because Schneider didn't come and ask, okay, it's Connex is it?

Speaker 4: Yes, Connex.

Eskom said: There was very little consumer engagement to say what actually do you wanna see on the screen and what's useful to you? That never happened. So I don't wanna force an app down you guys' throat and say this is what you have.

So I'm gonna try to be very nice about this as well. There's gonna be interactions with the community. Tell me what you want and what's useful to you and then we're gonna come and design a personal app with Lynedoch on the corner and everything else that you need. It will be like your own personal little portal where you'll have access to and privileges to information.

And then there'll be authentication here as well. So you need to tell me whether you are comfortable with everybody seeing your information or whether you want a personal portal where you only see what you do. So those are the kinds of things that we just wanna ...

Speaker 4: Will it give us choice in terms of usage?

Eskom said: In terms of you using what?

Speaker 4: So will we be able to make intelligent decisions on when we wanna use what in terms of between PV and Eskom main feed?

Eskom said: I don't want to undermine intelligent decision, but if it's gonna be based on cost and based on the most efficient energy at the time, the system is configured for that already. So you're getting the maximum benefit.

Speaker 4: I'm looking at it from a point of view if I had to install a system myself, a solar system on my roof and I would then make a decision on when I would do my washing, because I know that my panels will be taking care of my washing in the daytime, so I would be doing the lighter things at night and that's intelligent use of energy.

So with Eskom providing the system, as you guys are, my question is how much say flexibility have we got in terms of usage of that? With those little panels. Is that on the cards or ...?

Eskom said: It's difficult to get that level of flexibility on the system. I'm being honest with you at the moment. So the way that it's configured, it can be configured on the fly, but it's a little bit more complicated. Because now the portal is giving you one directional flow. So it's telling you the status of things and reporting them. For you to have physical interactions to talk back to the system becomes a very complicated thing. I'll be honest, it's complicated.

Speaker 9: And lead to problems, user problems when you're switching all the time. Just remember, the profile, the daily profile follows a pattern providing there's sunlight. So from 10:00 to 14:00, 15:00, in the Cape even a bit later, there's a lot of energy sitting there. I've seen some houses, they were sitting for today at about 6 kW for the day that was produced from the roof. So logically, if you can make sure that you're washing and you're tumble drying, if you use a tumble dryer, is done between 10:00 and 14:00 in the afternoon, you'll always be safe. So anything major, any major appliance that you wanna run. The fridge runs all day, that's fine.

Speaker 4: But when you say safe it's not necessarily, you're not implying a better cost because the same tariff is running through the metre. So you'll still be paying for that tariff, right?

Eskom said: No, but I'm saying, the whole idea here is that the sun energy will be at a lower tariff.

Speaker 4: Will it be at the lower tariff?

Eskom said: Yes.

Speaker 4: [Inaudible 0:43:12].

Speaker 8: Not from today, but as soon as we [inaudible 0:43:18].

Eskom said: As soon as we have the second metre installed I can do that. You understand?

Speaker 4: Okay. So that's dependant on that metre.

Speaker 3: Can we have just in terms of timeline, I'm trying to picture ... So there's quite a lot of possibilities into the future.

Eskom said: Yes. Can I be honest? From the beginning there was a roughly two-year test procedure. I said at least two years. Because we're all, we're planning.

Speaker 3: So we're getting to the end of the installation phase?

Eskom said: Yes.

Speaker 3: Then once the installation phase is finished we move into the testing phase which we're saying, okay, we talk about two years. And during those two years there will be different stages?

Eskom said: Different iterations, yes.

Speaker 3: Where during the initial stage you'll figure out how to actually do the tariff structure.

Eskom said: Yes.

Speaker 3: So from our point of view we just need to be patient and in the meantime basically things are going as normal in terms of how we do our electricity with the only certainly, as soon as we can switch to cutting out the middle person, that will already bring a reduction?

Eskom said: Yes, that's it.

Speaker 3: That's just a matter of technical, we just need to get those metres ...?

Eskom said: Yes, onto the Eskom system.

Speaker 3: And we don't know when that will happen?

Eskom said: That will happen soon.

Speaker 3: Soon, okay. So relatively soon we will see a benefit ...

Eskom said: Already.

Speaker 3: ... because of the cutting out of the middle company. Then the third reduction will come from the next stage ...

Eskom said: When the tariffs on the actual ...

Speaker 3: When we're clear how it's actually working. And then at the next stage we will know more or less what are the possibilities to start trading, which will then be a further benefit.

Eskom said: 100%.

Speaker 3: So those are three possible ways.

Eskom said: And I think there's gonna be ...

Speaker 3: In terms of rand and cents we will benefit from it?

Eskom said: 100%.

Speaker 3: And the other benefit is that even if there is an Eskom outage we now have a backup system.

Eskom said: We have, yes.

Speaker 3: So that's already a big benefit we've got, okay.

Eskom said: So you've got uninterrupted supply, you've got resiliency, and it's green energy.

Speaker 3: And then just the obvious, it was raised I think, in terms of maintenance also, that's not something we need to worry about at all?

Eskom said: No.

Speaker 3: And if there is an issue in a particular house, how do we ...?

Eskom said: We have a booklet that's being created now. I'll circulate it.

Speaker 3: That explains it?

Eskom said: That explains everything in that space. So it's very comprehensive. We will be the first point of call and then we'll issue instruction to Eskom distribution to come out and rectify the situation. So there's very simplistic guidelines to say what happens. There's a fault in the system, switch it over to Eskom. You are uninterrupted. So you will continue as normal and then the system will have turnaround times [inaudible 0:45:43].

In terms of what [Joel? 0:45:47] was saying, when we start to test it, I'm also gonna install ACDs, appliance control units. So ACDs are intelligent timers that you have controllability over, that you can now configure when your dishwasher comes on so that you maximise that sun curve during the say to get the most out of your unit. So that's a second component.

Speaker 3: Excellent.

Speaker 8: So this booklet we've set up in such a way that if there's problem with your system that you can actually go through. Best is to read it just once through so you're familiarised with what's going on in there. And then there's a section, specifically what is a healthy situation, what your switches must be set to, and then thereafter most of the stuff is in red basically, if you've got that problem, what to do. It's sort of a step by step thing. Try this, try this, do this, do this and it will tell you what's actually happening because of that kind of thing.

So you can go through each point and see what's the problem. One of those points should cover that problem that you have and that will help you to switch over to Eskom power if the system is really a problem or that kind of thing. So we just go through the book and I've tried to make it as simple as possible so that everybody can use it.

Speaker 4: But for those who are not really manual oriented and is not gonna understand it, there's always the backup with Faan then

Speaker 9: For the next two years I'll do the physical maintenance on the system. But it's the calls that need to be logged through to Eskom. Because what happens is, because a system has been installed, one assumes that a normal electrical fault, it's the system and it's not. The system is just, there's two feeds into the house. But if you have an

electrical fault it can just still be a fault in the hairdryer that's tripping the breaker. It's not the system tripping.

Speaker 4: Yes, not necessarily.

Speaker 9: Yes, that's why they've got the booklet and then you'll have a local person in your upstream to do that first line of, just come and have a look and make sure, after you've gone through that process, for those that don't grasp it ...

Speaker 4: I tell you now there's gonna be someone that ... Especially people that's not really ... You know, and they go, what? And they just wanna make a quick call to someone and say, listen, can you just come and see what's wrong here? And someone like Faan can go and say, okay, it's not the system, it's your stove, you're gonna have to get an electrician for your stove. At least the person didn't have to now go in the dark try and find an answer in the book.

Eskom said: But I think very simplistic, Karel, maybe you can correct me, but if there's a problem and if you move it back onto the Eskom and the problem still exists, then it's not the system. It's as simple as that.

Speaker 4: That's the basic stuff we need to know and everybody needs to be ...

Speaker 8: I've basically said every time when you must call Eskom or when you must call your electrician, say Faan, to come and check it out for you and then he will see, okay, that's definitely a system problem and then he will call, perhaps just call us to report it to us so we can know what's going on.

Eskom said: So no shortcuts were taken in terms of the protection of how your DV was originally configured. So in terms of the earth leakages and the over voltage, all of that that was by design in terms of certificates of compliance, none of that was jeopardised in any way. You understand? So the system is not any more dangerous than it was previously.

Speaker: [Inaudible 0:49:49].

Speaker 9: Then just a question from my side. Let's say people in the houses now want to add some more circuits in their house, get an electrician and he comes and installs five more plugs on the breaker. Do they have to notify Eskom that they're working on the DV or is that just after the fact?

Eskom said: If you guys noticed now, the only aspect in terms of a large load that we were worried about was the geyser and that has now been sorted out. So I would say if there's gonna be additional lights and stuff, as long as it's on that side it's fine. But don't go install another geyser because then you're gonna have a problem. You understand? And it's a problem that we'll see very quickly because we'll see how the system is behaving.

The beauty of the system is it's being monitored. So I can see ... And remember, it's also for pre-emptive maintenance. So if I can see that the batteries in terms of its discharge cycle is now being dramatically reduced, reduced, reduced, I can pre-empt it and say this battery is gonna fail and I will arrange booking ... Not booking. I will say arrange with Eskom distribution, please replace that battery before it gets to the point where it's not useable anymore.

So all these things will help you now because there's bidirectional communications at all times on the system, which is fantastic.

Speaker 10: And I think part of it is that we will know as it goes along what might be some of the things that we haven't anticipated and the beauty of at least a two-year testing period is that that is part of the growing pains that you would expect. And it's in your interest that it works well, it's in our interest that it works well. And I think that it could even be a win-win in the real sense.

Eskom said: No, it will be. I can almost guarantee you.

Speaker 9: But you will just have to then internally in the village arrange for who logs the call with Eskom, how's that gonna work. Because let's say something happens at your place tonight, what do you do? Who are you gonna call? So I think there must be single point of the home owners and a mail or a SMS or ...

Speaker 4: Why are you looking at me?

Speaker 9: No, [inaudible 0:52:20].

Eskom said: We can do this two ways. I'm just thinking out loud now. Remember, Eskom has got professional call centres that are on call for things like this, but that's for traditional Eskom [call outs? 0:52:33]. So I could try to set up a group within the call centres that now looks after this kind of thing, that if you phone them they log the call and then they contact Alex. That could happen. Because the last thing [inaudible 0:52:50] on holiday or something. It's very [inaudible 0:52:55]. So you need a professional call centre thing. So let me try doing that first. If I'm losing and it is taking time, maybe there's an interim solution we can ...

Speaker 3: Between Fanie, and Fanie is often the hands-on person people go to. Is there anything you wanted to add, Faan?

Speaker 11: No, I'm happy and relaxed with the system. But I would like if they ask me just to have a look first before we ... Sometimes it's just a stupid thing.

Speaker 3: Because I know that has happened already. People have just asked you to come and have a quick look and you were able to just give very quick, clear advice. And then obviously if there is some kind of a technical process ...

Speaker 11: It will save a lot of time.

Speaker 3: ... then it's easy [inaudible 0:53:41]. We actually have better systems in place now in our village than we used to have. So I'm quite confident we'll figure out a practical way to do it.

Speaker 7: How does it work in terms of the ... The metres that we have in the house, it obviously at this stage just tracks the direct Eskom stuff, it does not take into account the solar that comes through or how does it work?

Eskom said: It's taking a combination of your PV, the Eskom solar and Eskom grid. So we're getting a total sum. Let me make the maths easy. If you're consuming 100 kW a month and let's say the split is ... You've got your 100 over here and then you've got another metre in the front. By subtracting the two I can work out what the renewable is gonna be. So there's two metres that are involved. So I take that information and I'll populate it onto this portal and then you'll be able to see what the split between the two is.

Speaker 7: Yes, because what I read in there is the combination of the two?

Speaker 1: It's the total, yes.

Speaker 8: Yes, it's the total usage.

Eskom said: So the app will actually now differentiate and tell you what the difference between the different types of energy is.

Speaker 3: And what you can aim towards is maximising the solar obviously and there's ways that you can do that.

Speaker 7: So what are we paying for solar at the moment?

Eskom said: At the moment you are paying the same rate.

Speaker 4: CyberVendIT rate.

Eskom said: Yes, basically.

Speaker 7: Is it the CyberVendIT rate?

Speaker 4: We pay CyberVendIT rates at the moment until Eskom replaces the metre and we can [inaudible 0:55:22].

Eskom said: And here's the thing, I need to sort out the CyberVendIT guys very quickly because this is something that needs to really change immediately. So I'm flying back tomorrow. When we go back, next week the first thing is try and find out how do we migrate ...

Speaker 4: I'll get back to you from CyberVendIT's side?

Eskom said: All right. So the feeling here ... We have a list of the metres, don't we Joel?

Speaker 12: Yes, there was a full list of the metres and accounts and stuff and we need to find out what we can bill.

Speaker 3: And we will be kept informed in terms of how that new system will work and ... And you'll keep us informed when you get to the point where we actually will be able to

benefit from the solar being at a different rate so that the more that you use, the more you will save.

Eskom said: Yes.

Speaker 3: And then later on you can start trading as well. Okay, is there anybody that ...

Eskom said: Maybe I just wanna clarify on the next phase, on the trading. By default the system is designed ... When we're saying trading, you're doing voluntary trading. Because if you have additional energy, by default that energy will go to wherever the source is. So it's not like today I feel like trading, tomorrow I don't. So you'll always get the benefit of that. That's the advantage.

Speaker 3: If you use that.

Eskom said: Yes. You must understand the Eskom benefit of this. It's now creating a parallel revenue stream of traded energy. So these are the other aspects of it. So there's a lot of ... The maths gets complicated and the financial modelling and everything. So I don't wanna get you all crazy about that. But there's a lot of work that needs to be done in that space to know the option and what needs to be ...

Speaker 4: So I wouldn't where my energy comes from?

Eskom said: You will know where your energy comes from.

Speaker 4: What if it's negative? Someone is very negative when I'm getting the energy and now I've got to buy that now?

Speaker 3: Is there any other questions? The one thing that has come up I think at some discussion is that this is obviously an important project for Eskom and there will be some PR activity around this eventually and some media coverage. And we as a village just need to be aware of that and we'll need to obviously work sensitively with that so that we don't get the whole world interested in this project coming and knocking on people's doors, telling you about how the system is working.

Eskom said: So respectfully I must tell you guys, this is [core? 0:57:42] work right now. There hasn't been any official statements. Yes, executives are aware. [Thava Govender? 0:57:51] visited site. He's the head of transmission for Eskom. So that's as high as you go before you go to the chief executive officer, who's acting by the way. And this is his baby and he's well aware of it.

Now, the person who's responsible for IPP, [inaudible 0:58:08], was also on site. [Inaudible 0:58:11]. The guy who's in charge of grid planning and all these new networks was also on the site. So all the core people that are fully aware of the project. I haven't engineering news. I haven't done press releases. I've got other projects that I'm doing everywhere and trust me, this publicity is not a nice thing to have because it just becomes painful.

Speaker 4: Especially Eskom.

Eskom said: No, it's good publicity for [inaudible 0:58:36]. And it's difficult. And the last thing I want to do is take good and get politics involved, because that can happen very quickly. Even Bridget Masango, you guys' shadow minister for social development, wanted to come. Please [Mick? 0:58:59], let me come. You see? We have to just manage it carefully. So there will be a launch, a proper launch, but just bear.

Speaker 3: And we will [inaudible 0:59:13].

Eskom said: You see, there's a grey area between energy trade. This here, what we're doing, nothing is wrong. But the moment you start trading energy between the neighbours, NERSA, it's like a grey area for NERSA. NERSA doesn't know how to apply this. Because you're not breaking any rules because you're not putting energy back into the network, you're actually trading after the transformer. It's a grey area. There's no rules that have been written in this place and this is why you need to be careful on how you ...

Speaker 7: That drone image, that drone imagery, where ...? Is that available somewhere or ...?

Eskom said: The drone imagery was stitched. So that's a 4K picture from the drone. So I stitched 21 4K pictures together on a GIS view. So if ever you guys are in Johannesburg on holiday or whatever it may be, let me know, I will give you guys a tour of our facilities in Rosherville, which is the research hub. We have the entire village, including my rural [inaudible 1:00:17] that are done in the country, that's available on GIS map.

So it's a geographical system that looks like Google Maps and you can zoom in, then you see a top view of the village and you can see all the homes segregated in terms of the erf numbers or the stand numbers and you click on it and you'll have all the consumption and the total for the village and all those analytics. So it's fantastic. So that's the future. That's ultimately where you wanna go.

Speaker 3: But you can't be looking and seeing what we are cooking in a barbeque in the backyard?

Eskom said: No.

Speaker 3: You're not a [inaudible 1:00:49] or an agent for the CIA?

Eskom said: No. It's static image, it doesn't change.

Speaker 3: Okay, good. Just in case people were wanting to [inaudible 1:00:57]. Okay, is there anybody else? But just anybody else who's not had a chance to ask something? Okay, we need to end off.

Speaker 4: The matter of the ... The last time I spoke to xx regarding the security company that will be fitting the security system, is there any progress on that, xx?

Eskom said: I can answer that for you.

Speaker 4: Okay.

Eskom said: It's actually terrible news. We went out on the [inaudible 1:01:30] proposal. I even asked, these guys showed up, you guys' security company, the guys who are preferred, ABC.

Speaker 4: Yes, and they're not on board as a tender?

Eskom said: They didn't even get on as a valid tender. Remember, we can't ...

Eskom said: We can't have unsolicited tenders. I can't choose accompany that gets it. So it's fair and equitable. So it goes out to open market, everybody came in with their tender options, and between you and me, these guys are snorting something. The guys came in at ZAR1,2million, ZAR1,3million. Guys, I'm not gonna be taken for a ride because we're Eskom. I promise you.

The guys came, you can ask these guys, they came in at over ZAR1,2million for a two-year contract to do security. What are these guys smoking? It's not gonna happen. So I don't know. So one of the ... We decided is that xx is gonna reissue a new tender and maybe cut down on the services. Because I know we had [inaudible 1:02:33] as a full house solution. And these guys are abusing us. There's no way we're gonna be paying ten times market value for something. That's just not right.

Speaker 4: So, and it must go through the tender system?

Eskom said: It has to. It's a public fund.

Speaker 4: Because if we get the companies ... ADT and ABC, they were the ones that really understood. They walked the ground with us, they knew what we wanted.

Eskom said: They didn't ...

Speaker 4: They never pitched, I know. But if we can get back into that road and get a realistic quote, even if it has to go through the tender process.

Eskom said: But then if they're not gonna buy a ticket, they won't win the [lotto? 1:03:11].

Speaker 3: But they can go through the new tender.

Speaker 4: They were just late with it. I don't know what the hell happened.

Speaker 3: Okay, so that's something we need to separate just make sure exactly ...

Speaker 4: Yes, that's sad news.

Speaker 1: Yes, it is. It is really sad. But then again, those boxes are bloody secure.

Speaker 4: So we can pick this up again?

Eskom said: So we're gonna try again but obviously I need to just re-roll it, see what comes in and then if it's a reasonable amount we will do it. But I mean, this was ridiculous. Honestly, it was ridiculous. And I'm not gonna be held to the mercy of somebody that says ...

Speaker 4: No, sure. Apparently they weren't prepared well either.

Speaker 13: No. The technical information was wanting.

Eskom said: They are saying compliant to all technical specs, full stop. But they don't give you the specs of what they're gonna be complying to. Unbelievable.

Eskom said: Yes, I agree. I think we need to move forward on this because there's been ... I remember our first conversations with Eve and Mark, that was a long time ago, where we got very excited. Mark, at that time he was ... It was Brad that introduced me to Mark and we were so excited on this concept of using renewable energy, especially for the sustainable village, and that gelled so well. So I'm trying to make that happen, but I think we've done the hard part. The easy part is this part, hopefully.

So I don't know where we're gonna start. There was a lot of questions that were raised. We had the first HOA meeting where I spoke and I thought that went pretty well, and then the e-mails started. So there was a lot of follow-on e-mails with questions from people. Which was fine, and I was prepared to answer them, and they went back and forth and back and forth. So I'm trying to answer everything. So if anybody has anything on their mind, ask me and I'll give you guys an answer on that. Kobus, was it a couple of points that ...?

Speaker 10: My questions were just about technicalities of the agreement basically. Some wording I think needs to change. It seems like an indefinite sort of agreement and the bounds are there to stay we can't really get rid of it if we ever wanted to.

Eskom: No, I understand.

Speaker 8: I know about XXX technical question in terms of the agreement. We mentioned that this thing started a long time ago and it was all excitement and then there we questions to and fro in e-mails, as if the e-mails and the questions somehow contributed to the delay.

You could go a little bit back. I think it must have been nearly a year ago or whenever it started and we had ... I was involved in discussions in detail about the security upgrade to the village, sponsored by Eskom. When this whole thing started it sounded like Christmas Father came to the village, he's gonna dish out presents. The security will be upgraded, this will be better, this will be better. It sounded fantastic.

A lot of that in terms of also the slow progress of the installations, but a lot of those things that were initially part of the offer or the idea to excite everybody, to get everybody on board, kind of disappeared and it's not even being discussed as options as far as I can see at the moment.

Speaker 10: It's still on the table.

Speaker 8: It's still on the table, okay.

Speaker 10: Yes, it's still on the table.

Speaker 8: Now, part of that on the table, part of that agreement that needs to be signed by everybody, and these things that are still on the table, they're obviously part of the same discussion.

Eskom said: I agree. So the idea today is to actually talk about all of those things and what we're trying to do. This being a research project and this being the first time something like this has been done in the country, it's very difficult to foresee every single possible situation. So we're also taking this idea at a time and we're trying to do the best we can to try to make this work.

The first original proposal, if you ask Faan, was a plastic cabinet that was holding everything up. The batteries and the inverters, whatever. That was from the contractor. So the original intention for the security was, how do we safeguard our asset? We were worried because there's a lot of assets sitting out there. And then with that problem came a solution, because when we saw that we're battling to actually find something to house this in, we then did a proper design of those green enclosures that you guys see today. Now, that's an Eskom distribution standard, it's IP65, it's got security, everything. So in terms of that system it's safe. It's very difficult to get into those cabinets. Plus there's alarm systems within the cabinet, alarm of intruder detection, et cetera, et cetera.

So then the questions of security within the village. And Eskom did go out on a request for proposal, RFP, and that happened quite some time back. And I think Joel, I think we spoke to you about it and the guys were taking Eskom to ransom. You got suppliers that came in with quotes that's ZAR1,2million to ZAR2million a year to secure this village. You understand? Remember, we have to follow process. So I went out on request for proposal, open market, ABC or whoever this ...

Speaker 6: There were quite a few. There was about five of them that came that day with tenders.

Eskom said: So we even considered the preferred security person that was doing the village at the time. What's it called?

Speaker 6: Yes, that was ... That's ABC.

Eskom said: Yes, it was ABC. Funny enough, they didn't even put in a proposal.

Speaker 8: And they were late.

Eskom said: So they were late. So even that attempt to try to get somebody that you guys preferred we've tried to entertain and nothing happened. So remember, I can't spend ZAR2million on security. I'm sure everybody will agree with me that that's a little bit crazy. So xx and her team went out on a new request for proposal and we brought the scope down a bit in terms of armed response. So if there is an alarm detection then we'll have an armed response that will come over. They are busy with that at the moment.

So in parallel to that I tasked xx and all and which they've got already is a set of cameras that you guys wanted. So you have remote access with alarm detection that will go to you guys' cellphones, whatever. So I've done that already. So that hopefully in the next couple of weeks, we should have it installed, et cetera.

Speaker 1: So that's going ...

Eskom said: That will go ahead. But again, this other one, the question of the security contractor is still in the tender process. So we haven't picked anybody yet and I don't know, the say the definition of madness is trying the same thing expecting a different result. And that's exactly what we've done, we've gone out again. So I have no idea what we're gonna come back as.

Speaker 8: Are you not doing it internally now?

Eskom said: We can't do that.

Speaker 8: Is it?

Eskom said: No, you can't. Unfortunately I can't.

Speaker 6: So [inaudible 0:20:25].

Eskom said: It has to.

Speaker 1: Can I just say in terms of ... So one of the issues is the security. So let's just say, so in terms of the decision is that there is investment within the next few weeks in terms of the ...

Eskom said: Yes. The cameras, yes.

Speaker 1: So that is going ahead?

Eskom said: That is going ahead.

Speaker 1: That's just taken from our point of view because at some point we were not sure about that. And that it's pending which company will be used for a possible armed response?

Eskom said: Yes.

Speaker 1: So I think in terms of if we can just say that's one of the issues that has to be clarified now. And that's huge progress and we're very grateful for that because it really does help us in our internal structure with security where we never had the finance to do it properly. So it really is coming together nicely and it will be a significant I think commitment to the undertaking that was given at the start. And there were delays along the way, some of it outside your control.

I think we can probably ... That's great. So is there anything else that people are really concerned about?

Speaker 7: Just on top of that [Ray? 0:21:19], that raises another concern for me, is this being a research project and installation of cameras and so forth, what about ... What exactly is being researched? What personal information do you gather and how do you store

that, how do you use that? I'm thinking of legislation, POPI compliance. [Inaudible 0:21:37]?

Eskom said: No, 100%. So Eskom is 100% POPI compliant. So in terms of protection of private information, none of that information will be disclosed. Exactly like how our billing information, our customer information is compliant to POPI, that'll be exactly the same. So no private information is gonna be given without consent to anybody.

Speaker 7: But what private information will you be harvesting or ...?

Eskom said: You're gonna have your billing number, for argument's sake, your metre number. We'll have privilege to look at your loading, what's happening in your house. Because we need to know ...

Speaker 7: So when you switch on your kettle you will know about it?

Eskom said: But we won't know about it, we'll be, we'll have ... It will be monitored. Not monitored. It will be logged. Because you're gonna need to have that information.

Speaker 1: See which electricity, what is the consumption per household.

Eskom said: Yes. Because remember, the whole idea is to get your system to be able to be optimised, to work out what's the best balance between loading and supply. So all that information will be available. And we're not gonna be disclosing that information without any consent. We will get consent from you all if we're gonna use it. And vice versa. So for people doing dissertations and whatever, you're gonna need to get consent to publish any information from Eskom before you guys do that. Because obviously it's sensitive information.

And then going back to your earlier point about the agreement that was done. Remember, we are engineers first, we are not lawyers. So when this thing was drafted we just thought this will be good enough. And then we knew it's gonna go back and forth and back and forth. So there were suggestions that were put forth and we've done the amendments to it and we've changed it. So at least two years, we've specified a time, et cetera, et cetera. So we've got a corrected version of it which we'll submit.

Speaker 1: So all the points, all the specific points that were raised in terms of wording, those concerns, you have actually looked at and addressed it as far as possible?

Eskom said: Yes. 100%. Another point that's an important one that came out from his e-mail, is what if your bill goes to R1 000 or whatever. It was you who asked you. We are not in control of how you'll use your energy. I wanna make that very clear. We are optimising the use. There's a big difference. It'll be less, it won't be more. So we're trying to find smarter ways of how do you take the energy you have and make the best of it.

And now let me just quickly try to explain the system. So the system, as you know, is a photovoltaic system, PV system, that has got a battery storage component and it's got connected to an Eskom national grid. So there's three components.

Now, as it stands we all know PV energy is very, very cheap. If you take inverted energy through an inverter and you use it it's very cheap. There's no network charges. There's no infrastructure. There's no transformers. All the infrastructure that's in our traditional grid, it's absent of that. So that's there. But then on its own it has its limitations. Hence while we've added the battery storage to show that there is more resilience during poor sunlight or no sunlight at night. So you have that additional benefit of having uninterrupted power.

Now, obviously it's only 450 amp-hour batteries in there, which is a lot of energy, but you can't go crazy with it. So the idea is that that energy that we have available is for uninterrupted power supply, but limited usage. So obviously you can't do crazy things with it. It's energy. You've got a finite amount of it in there and it's been designed for that way.

We've designed the system so that there's a 50% depth of discharge. That's a terminology for batteries to say only half of that energy of the battery will be taken away. The reason for that is that you've got longevity of the battery. So we want the system to last for many years. So the less you discharge from that battery, the longer it will last. So that's the intention of that.

And then in terms of information, how is this useful to you all? So we've developed an application, an app, which is available, which will give you full information on your system. It'll tell you what your daily consumption was, how much of that came from the national grid, how much of that was from the PV, how much of that was from the battery.

Now, this concept is something new to South Africa in terms of evolving from traditional state to a smarter state. So for those who don't know, I'm heading up the Smart Grid Centre of Excellence for Eskom. So we do all this interesting stuff. Electronic engineering as well.

So the idea is ... And I saw, it was fascinating in this village, especially with the grey water recycling and all this other fantastic initiatives you guys are doing. And smart doesn't need to mean it's electronic or electrical. It's a state. As simple as that. So a smarter way of doing things. So the evolution of this village in my head will be to incorporate all the smart things into one umbrella and to make it work for you.

So with very little effort, in the future, if you've got electrical energy [report? 0:27:11] in terms of energy, I could now also add in how much of water you guys use for the month, and how much of grey water you are recycling, and how much of detergents

you use, and what was the cost of that detergent, and do an entire energy nett balance. Now, these are the things that we can do together. You understand?

The fact that I have a battery storage facility and an inverter means that in the near future I could come and offer you guys lease agreements for electric cars, for argument's sake, where you guys could actually charge your electric cars using the infrastructure.

Speaker 1: Can I just ... There's a lot of possibilities. But I think the main priority for us is to make sure that there's nothing that holds back the mutually beneficial agreement. So I just want to make sure in my mind, did we go through the points that people have raised and then see if there's anything that's not clear and that if we can get out of the way then I think if there's ...

So can I just make sure that ... So we've looked at the security issue that James has raised. And the only thing that wasn't clear for me around that was happen after the two-year period. Then it becomes an HOA responsibility, that the infrastructure stays, or what is the picture around just beyond the two years?

Eskom said: Well, we need to look at the feasibility of the systems and whether there's going to be a, whether it's gonna work. And the whole idea during this two year's period is to make it work, to look at what we need to tweak, what we need to negotiate to make this something that ... Remember, this is gonna be the start of hopefully a national [inaudible 0:28:39]. So it's gonna have positive impacts on the country in terms of that. The system, and we said this from the very beginning, is the property of Eskom. So we are operating it, we're maintaining it and we ...

Speaker 1: Also beyond the two-year period?

Eskom said: Well, part of the research will be to see if our distribution partners within the region can start looking after that asset going forward. So after two years, when the research is finished, the intention is to hand over that asset to Eskom distribution and make it part of their distribution business. You understand?

Speaker 1: The same applies to the security infrastructure that you'll put in?

Eskom said: That will also be part of that.

Speaker 1: So it's part of package, as I understand it, and the intention is beyond the research period that it will still be an Eskom operation?

Eskom said: Yes. Remember ...

Speaker 1: But obviously we'll need to work out those details.

Eskom said: 100%.

Speaker 1: For the next two years that's the commitment.

Eskom said: That is the commitment.

Speaker 1: Around security.

Eskom said: Yes.

Speaker 1: In terms of the questions that ... There was a number of questions in terms of formulations in the contract and then questions about information. Have those been addressed?

Speaker 7: We'll have to see the new contract, cause he says they have now addressed it.

Speaker 1: But are there any other questions that you had apart from those?

Speaker 7: Cancelation clause. If we no longer want to take part in the research or in this project, how do we cancel?

Eskom said: So let's just ... By all means. The whole idea there ... Let me just put it back in perspective, which I don't think ... There was a request to migrate you guys over to Eskom direct customers. Have any of you looked at that process and what it entails?

Speaker 6: We asked if it was possible to somebody. I just remember it was an option and I understood it that we're waiting for Eskom and Eskom said, no, it's not possible. So there were ...

Speaker 1: Just quickly explain for people who are not with us. This was about trying to get a cheaper thing to cut out the middle people. Just give us quickly the background.

Eskom said: I don't know about that. So there's an Eskom transformer, 100 kVA transformer that's out in the yard. So that's an Eskom direct supply point. From my understanding the ... Not the community, the ...

Speaker 6: SI.

Eskom said: SI owns that transformer and pays for that services of that transformer. And then that energy is re-brokered via those ladies downstairs that issue the tokens. So you'll have an internal process where you'll buy energy from the institute.

Speaker 6: Through an agent.

Eskom said: Through an agent.

Speaker 8: Through CyberVendIT.

Eskom said: Through CyberVendIT. But CyberVendIT is just the mechanism.

Speaker 6: Who earns the income from it.

Eskom said: Partly, not completely. Because at the end of the day [SNI? 0:31:28] is purchasing that energy from Eskom.

Speaker 6: They're scoring 40% at the moment I think.

Eskom said: So that's what the present situation is. So to sweeten the deal, what I suggested was Eskom ... The cost to convert you guys to Eskom customers, if you had to physically go and do that application it's gonna be between R8 000 to R9 000 per connection.

Speaker 1: Eight to nine?

Eskom said: R9 000 per connection.

Speaker 1: Per connection.

Eskom said: Which now means that you need to do an application to Eskom and they will come and do the whole conversion for you. And I think it's also updating of the, looking at whether the cabling is up to standard, because now you have to get to that level. So it could be ... I'm not sure what it's gonna be.

So I am offering to pay for those connections and convert everybody to Eskom customers as our research.

Speaker 1: Individualised home owners?

Eskom said: Yes. So wherever those systems are installed, I will go and arrange with distribution to migrate you over to Eskom direct customers.

Speaker 9: Only for people who have the solar panels or for the entire village?

Eskom said: [Sigh]. You see, now you're making it difficult for me.

Speaker: [Inaudible 0:32:47].

Eskom said: Well, it's 27 out of 30. I think there's three people that don't have it.

Speaker: It's 35 houses.

Eskom said: Okay, there's a little bit more.

Speaker: [The house? 0:32:53] has moved to one that hasn't got.

Speaker 6: What benefit is it to become a direct Eskom customer?

Eskom said: So the whole idea, you don't have a middleman anymore. So you you're gonna be able to get ...

Speaker 1: It's just to cut out the middleman, the middle person percentage.

Eskom said: I'll give an example. I worked out what you guys are paying at the moment and it works out to about two bucks, just over R2,00 a kilowatt-hour. So if you guys had to move to home power four, which is an Eskom tariff, it will be around R1,27.

Speaker 1: That's significant, hey.

Eskom said: But here's the thing. So I actually worked it out quite nicely. So there was a very strong request to convert the residents to Eskom customers. The further benefit to the Eskom, to the customer, [RTB? 0:33:39] will convert the residents to Eskom customers, there's a cost implication of R8 000 to R9 000 per connection. Eskom RTB will cover the cost, provided the community actively participates in the research pilot and sign the participating agreement.

Speaker 1: It's an incentive.

Eskom said: It's an incentive. The customers will then benefit from the Eskom tariff, which is home power four, [R1,2733? 0:34:03] per kilowatt, opposed to over R2,00 which is currently being paid per kilowatt-hour.

The NERSA engagements which we are busy with at the moment are in play to facilitate feeding of energy and energy trading. So we're busy with NERSA on those

rules at the moment. You guys will also be able to participate in those programmes now that you will be Eskom customers. So there's a further incentive.

Speaker 6: That's great.

Eskom said: Should at any stage a customer wish to withdraw from the programme, the connection fee above will be for the customer's account. I think that's fair. You said I need to incentivise, I'm incentivising.

Speaker 8: That's great. So NERSA, are they gonna allow you then now to actually do a mini-grid on the Eskom [inaudible 0:34:53]?

Eskom said: People, I'm busy with that application right now. So I'm trying to register it as a demonstration pilot.

Speaker 1: So we're just moving on to another point. *Is almal nou duidelik oor wat Nick nou daar gesê het? Hy sê hulle's bereid om as 'n aanmoediging vir ons om deel te neem aan die navorsingsporjek, gaan hulle betaal vir die koste om elkeen van ons 'n* customer *te maak van Eskom sodat dit nie meer deur SI gaan en dan CyberVendIT en dan betaal ons vir daai middelagent nie. Die verskil in prys gaan basies wees van R2,00 min of meer per eenheid na R1,27?*

Eskom said: 23, yes.

Speaker 1: 23? R1,23. *So hulle's bereid om basies R8 000 tot R9 000 per familie te spandeer ...*

Eskom said: R1,27. Sorry, my correction.

Speaker 1: R1,27, that's all right. *So hulle's bereid om dit per familie te spandeer op hulle koste. En dan die voordeel vir elkeen van ons gaan wees dat ons dan daai bedrag minder gaan betaal vir ons elektrisiteit. Die enigste* catch *is as iemand op 'n stadium gaan besluit, nee, maar ek is nou moeg vir hierdie sisteem, ek wil onttrek, dan gaan daai koste vir die aansluiting, dit gaan dan jou koste wees*.

Speaker: *Vir daai persoon wat onttrek?*

Speaker 1: *Ja, net vir die persoon wat onttrek*.

Eskom said: Yes, just for that person.

Speaker 1: *Vir ons as HOA in terme van Janine se punt*, there's a separate question about what do we do about the people who are not on the system and we need to negotiate or it becomes our responsibility as a village to say how do we handle that to make sure that people are not disadvantaged.

Eskom said: I think with all fairness, whoever is part of the programme, I think I should only be obligated to them.

Speaker 1: That would be my sense also, but I think that feels like that is a very significant incentive that you're putting on the table with a clear commitment at least to a rate reduction, which was one of the sticking points. My understanding is that there's a potential for other clarity around what we pay when we use the sun energy. Because

you're not able to actually clarify that yet before we're actually part of the whole thing. So that's the catch 22.

Eskom said: There's a lot research involved in that part because ... I'm gonna bore you guys on tariffs and metering right now. But the present infrastructure in the country, even for the most latest smart metres, every instruction from a metre that switches to a particular tariff for that time of day, so whether it's a critical peak tariff or whether it's any of the accepted tariffs, it's a single instruction that goes to all the metres. Metres don't talk individually to the backing system.

So what we're trying to do over here is, part of the research is to see will you be able to differentiate and charge a different tariff for different types of energy? You understand? So that's what we're trying to achieve.

Speaker 6: Does it benefit you if we are direct Eskom customers or does it make no difference?

Eskom said: It does. It was an Eskom transformer. You understand? So it's just this CyberVendIT that was complicated, but you guys will get much less than ...

Speaker 1: Basically we're cutting out the middle person, the middle [commodity? 0:38:02] costs.

Eskom said: And the request did ...

Speaker 1: Actually that for us is a significant thing and we're not paying for the installation of that.

Eskom said: Yes.

Speaker 1: So is there anybody with questions around that one?

Speaker 6: I'm wondering why Eskom is charging SI X tariff if there's not a ... I don't know if it's beneficial for every individual house to be a direct Eskom customer. I'm worried that there could be other, *nie voordele nie, nadele*.

Eskom said: Disadvantage.

Speaker 6: Disadvantages. Because it sounds like we're a community, now we're all going direct. In the meantime we are Eskom customers. So can't we cut out the middle man somewhere else? We don't have the time for this now, it just feels like let's go direct to become Eskom customers, I've heard about it, we've had no background information, it sounds like it's gonna be beneficial. On the face, let's go for it. I have lots of other questions.

Eskom said: You see, the trouble is with CyberVendIT ... Who's dealing with that? Is that a contract? Obviously they're making money with that.

Speaker 8: Yes, they've got ... They're obviously facilitating in the back end. So they've got the software and we generate tokens through CyberVendIT. So there must that percentage that they're taking and you estimated 40% in terms of ... Because we're only paying for the Eskom part, there's 40% that's hanging which is what they're really getting. They shouldn't be getting it.

Speaker 1: So is there anything in terms of this but that we need to clarify. This is obviously a critical point that's been put on the table, which I've not heard so clearly expressed before. *Is daar vrae wat mense daaroor het?*

If I understand you correctly, if we go this route there might be complications in terms of village dynamics that we need to be aware of, but that's something for us then to manage. But in terms of what you're saying is that within the near future there will the possibility of individualised direct access so that when you pay for electricity it's all done individually, it's not going through all these tokens. We don't have to pay the three people. Because every month we're paying R1 500 to three people to manage the CyberVendIT on top of the CyberVendIT costs.

So all of that will go, that there will be these individualised with the cost being carried by Eskom. And there's no hidden clauses to that point, is there?

Eskom said: The only clause is allow us to do, have the systems installed and stay installed. If the systems ...

Speaker 1: But there's no, so if it's more than [nine? 0:40:34] that's something we pay for the rest of the installation costs?

Eskom said: Well, none that I'm aware of. I think it's a fixed connection fee and once it's paid it's paid.

Speaker 1: But can we say that our agreement, is that what we're agreeing to? We're not agreeing to whatever the installation costs are, but is that to what ... You will cover the installation costs? Is that ... Just to make sure there's no ...

Eskom said: Yes. And remember, the benefits, the second benefit that I'm talking about in terms of feeding tariff and energy trading, that can only be done if you're an Eskom direct customer [in that case? 0:41:05].

Speaker 1: So that opens up those possibilities that we're really interested in in terms of the dynamics in the village and the sharing of energy and so on. So is there anything we're missing around this critical point? Cause this has to be a sticking point for everybody.

Speaker 1: It's another point. So let's just on this point. Janine?

Speaker 9: So, I know that I'm repressing the minority without the panels. If you install the direct conversion thingy, does everybody have to do that?

Eskom said: What you mean everyone?

Speaker 1: So those who don't have panels, what happens to those? So for them to be able to ... Can they still ... Their cost will go through SI, through ... It's like we need to figure that one out and basically amongst ourselves.

Eskom said: Yes.

Speaker 9: Well, I just needed to ask that.

Eskom said: Because the additional work that I'm gonna be, and which is part of the research, will only work if you're an Eskom customer. You understand? And there's no energy coming from those customers that didn't opt in and didn't want the systems installed. So there's no additional PV energy, there's no storage energy, there's nothing.

Speaker 9: So they don't need to switch? So they can stay as is?

Speaker 6: So there's gonna be a handful of people staying with CyberVendIT.

Speaker 9: They don't have to spend R8 000 to R9 000 to convert?

Eskom said: No.

Speaker 1: So there's no pressure then on those. I think that will be a question whether if we want to figure it out for those who then want to be part of this and as an HOA we need to make decisions.

Eskom said: Part of the research, and I said this before as well, that part of the research was that in an ideal world you're not gonna have everybody that wanted to be part of something and this was proof of it. But then as soon as people see the benefits they want to be part of it and I've seen that as well. So not to say the boat has left, it's also research to see how do I incentivise and how do I get people who are not part of the system onto the system. So that's a follow-on of this research.

So I'll give an example. If you decide to decide, if Faan ... Where's Faan? Faan has built himself a container house and he wants to put renewable energy. So if Faan had to put renewable energy to the specifications that's complaint with the rest of the village, how do I get Faan onto the system? Obviously he's not tied capitally like how the rest of you all are, because I paid for the system, but he's invested in the system. He's got a longer return on investment because he's put the asset into it, he's paid for it himself.

So obviously the deal that I strike with Faan opposed to the rest of you will be slightly different. So this is part of the research.

Speaker 1: And it could be a deal with Janine and people who've come later ...

Eskom said: Exactly.

Speaker 1: ... for not their own, for various reasons. And then I think it becomes a village question of how do we make sure that people who want to be part of this [inaudible 0:43:53].

Eskom said: And there'll be many iterations of this and hence that research and there's no manual on this. I'm busy developing that.

Speaker 11: I just want to tell you, that there are some people that it's not that they didn't want to be part of it, they came later and they couldn't then ask. So they'd love to be part of it, but exactly what you want to research is what they still want to wait and find out. It's not that they didn't want to. So just to tell you.

Eskom said: Okay.

Speaker 8: Can I make one more?

Speaker 1: So this is just on this point?

Speaker 8: Yes. On the same point ...

Speaker 1: I just want to make sure, because this is a critical point. We just need to be clear on what ...

Speaker 8: What I'm saying is, I've started saying it already. We have lots of questions to technically challenge you, which is real and it's important because it's part of reality. Everybody, wherever you want to install, people are going to have these kind of questions. But it's important to say I feel quite honoured and proud to be able to be part of this system and I think everybody feels like that. So it's awesome. Thank you for Eskom for being involved in this village, doing this. I think that's maybe the end of it.

Speaker 1: So those technical questions, I think obviously there will be more. But I think there were a couple of key sticking points in terms of the mutually beneficial agreement and as I understand it this is our main priority, to make sure that there's no ...

Eskom said: I don't think you're gonna get more mutually beneficial than me giving you R8 000, R9 000 worth of stuff, guys.

Speaker 1: And I think that's why I'm saying this sounds like a significant additional commitment that wasn't so clearly put on the table, which gives some clarity around the key question around reduction in rates which I think for many people was the initial, one of the big incentives, that actually this will be for us also to reduce cost in terms of electricity. And now we realised that's a quite complicated story because it's got to go through NERSA, blah blah blah.

But in the meantime this seems like a very concrete way to benefit us in a significant way. And there might be complications down the line, but it sounds at least this is enough for us to be able to say that issue has been addressed. So the security issue has been addressed. Some of the legal issues has been addressed. The issue around the cost and the rates I think have now significantly been addressed. Is there anything around those issues that we need to [inaudible 0:46:05]?

Speaker 7: So different point?

Speaker 1: Different point.

Speaker 7: Can I make a different point?

Speaker 6: Listen, but I'm still on the same point though. There's one thing just wanna add.

Speaker 1: We'll come back to you. [Inaudible 0:46:12].

Speaker 6: Before we finish off. One little snag with this now, which is basically ... You said earlier that people will be able to opt out, you could put that clause in. However, once you've done that transformation of R8 000, R9 000 you're in. Now, say like half a year later

the system is just giving you endless problems, whatever the reason is and you wanna get out. So then you must pay for the installation cost. You must carry the initial installation cost of the transformation. Is that what you're saying? Okay.

Speaker 1: So I think we can think of complications, Jo, but I'm also saying ...

Speaker 6: I'm just saying.

Speaker 1: ... let's say in those six months, if problems arrive, we have to make commitments, that it's in the interest of all of us that this thing should work. So I know it's a possibility, but there's also a process commitment as I understand it.

Speaker 6: As far as I'm concerned the pros far outweigh the cons now. That's for sure. I'm just asking a question.

Eskom said: And then you guys are forgetting one very important fact, that when we rewired the DV box I've got a switch over switch. If my system fails in any way, it's one switch and you revert back to where you all were.

Speaker 5: You see.

Eskom said: So I don't understand where ... No, it's true. There's no issue.

Speaker 6: That hasn't been explained to me by anybody.

Eskom said: So we have a ...

Speaker 6: So training and education is not a question.

Eskom said: We did do a brochure. Did you get one?

Speaker 6: No.

Speaker 1: I think some of that ...

Speaker 8: The brochures were given out.

Speaker 1: The brochures were given out.

Eskom said: Okay, fine.

Speaker 6: The contract you want us to sign, where is that? When can we see that? Will it be distributed to everybody? Thank you very much. Will it be distributed as a final contract or has ...? I've seen that six months ago or four months ago and there were lots of questions. I haven't seen one since then.

Speaker 1: They've done the work on it but they haven't seen that one yet.

Speaker 6: So will it now be the final either sign or don't sign?

Eskom said: Hopefully it will be the final one.

Speaker 1: And within that there will be reference to this point around the direct customer. I think that's part of it or is that a separate point we need [inaudible 0:48:20]?

Eskom said: I will have to add it to it.

Speaker 1: I think it will be good to add it.

Eskom said: Yes, I will add it.

Speaker 1: For clarity around that.

Eskom said: At the [inaudible 0:48:27], the direct customer thing.

Speaker 1: Because that seems to be critical point in terms of [inaudible 0:48:31] costs and also commitment.

Eskom said: So just to explain basically what it is. The system has got a parallel contactor that now either disconnects the inverted battery PV system completely. So it's like it wasn't there and you would be back to where you were in terms of your original. So that was done for two reasons. One, if there is any maintenance to be done on the system from our side we could do it without affecting the customer. So that was thought about. And then if the system had to fail, you revert back to normal. So that ...

Speaker 1: If the Eskom system fails, then we can [inaudible 0:49:12].

Speaker 9: And then one small question. I'm sorry, Peter, just a small one.

Speaker 7: Don't worry. My question seems to have disappeared. I'm just waiting if it will come back.

Speaker 9: So the only thing I can hear, look, I've been covered, but after your two years you're going to hopefully give us to the local Eskom people. If they didn't want us for any reason, we could just switch our button like we used to be?

Eskom said: Back to where you were. Yes, 100%.

Speaker 9: We hope they do want us, but if they didn't we could switch our button.

Eskom said: And remember, this is powers much higher than me that makes that decision.

Speaker 9: Yes, I'm just saying, for us.

Speaker 12: On my board, I could hear sometimes noise on my board, DV, noise. But sometimes, not all times. But it's a little bit scary, to know what's ...

Eskom said: I understand. So Faan was telling ... I was only made aware of it today. Faan, when did I see you? Yes. So another thing, reporting is very important. If something is wrong, tell me immediately. The whole idea of me having contractors available, like Alex and [inaudible 0:50:26] and all these guys is to sort exactly these things out. You don't have to wait. Apparently there was some problem with two of the inverters as well that had to be reset.

Speaker 1: Yes, that's the complaint. I think it's the noise that we've had and the lady [inaudible 0:50:38].

Eskom said: So those three inverters. It was reported two or three weeks ago and I find out about it today. You guys don't have to wait so long. Just scream.

Speaker 1: What is there about the reporting system, because I did speak to a member of the team, your team, when they came to do the signing of the ... And he said he would take it up with you. So there's something in the reporting system we need to make sure.

Speaker 6: Yes. So I was just gonna say someone will report to me sometimes, or to Faan, and then I would either, someone reporting to me I'll pass it on to Faan or to [inaudible 0:51:09] and then at that point they should probably report to you.

Eskom said: So I don't even mind Bcc'ing everybody, or Cc'ing everybody. So xx is responsible on this side in terms of the project leader. So whether it comes, you give it to Alex and Alex gives it to her or whether you give it to Jo and Jo gives ... You guys can decide.

Speaker 9: Yes. You have to tell us [inaudible 0:51:29].

Speaker 1: So we'll just clarify the reporting system, but that has been a little bit of a hiccup.

Eskom said: Just carbon copy xx, it'll be sorted.

And then sorry, I just want to say something else. That relay was chattering. That's what we call it. And that was happening because there was a problem on the Eskom feed, not me, the region, this area, distribution, they had an undervoltage problem. There was some phasing balancing on the transformer and that was not 220 V on the really, it was 125 V or something, which will cause the relay to get confused.

So that was a maintenance thing from the region and I don't think it will repeat itself. What I'll do, nevertheless, is I will try to resolve the chatter on the really by doing some other electronics on it. So we will try to ... Obviously I don't want you guys having to live with some noisy little relay in the box.

Speaker 1: It was scary for people a few times. But, Peter, Peter had a few ... Can we just ...? Sorry, you've got another question?

Speaker 12: And the button moves up and down, the button.

Eskom said: Yes. It was opposite.

Speaker 12: Yes. But sometimes we don't know because sometimes our power does go off and then ... But the Eskom [inaudible 0:52:42], the power from Eskom's side, but the button ... Sometimes we don't know if the button was up or down because I wasn't there when the company do the placements, only my wife or my daughter. But sometimes they will get and [inaudible 0:52:58].

Eskom said: I will get that rectified both on the brochure as well as clear labelling on the actual relay. So, xx, right? And get that done.

There was another request from Faan, I'll have to look at it, but he wanted a light giving me the state when the Eskom power is off. So I'll look at that and try to figure that out.

Speaker 1: We'll figure that one out. So sorry, Peter, you've been waiting patiently.

Speaker 13: I just want to clarify the one point that a few people have raised about those who aren't on the system. So I think you've mentioned it has been an inclusive type of process where ... And I think as a village we want people to be part of it. But there are new

people who have come in. So is it possible then for people to negotiate particular agreements with you about how they come into the system?

Eskom said: I think most definitely. But public funded enterprises like Eskom, I went out on request for proposal for the contract for the additional one. I wasn't being nasty when people were late, that I couldn't accommodate them, it's just that I had a finite amount of money that was allocated for that. So out of that period it's huge processes to go to investment committees and and and to now get money unlocked to do this kind of things.

But then again, you get enthusiastic people like Faan that says I want to do it myself and I will speak to you and we'll see what I need to do. So I'm not saying we're now ... But it's not gonna involve me funding anything, but merely giving you guys useful information of what to get. By all means, I'll do that. You understand?

Speaker 1: That's straightforward.

Eskom said: So if you're prepared to ... You guys have a system from what I understand.

Speaker: Yes, we do.

Eskom said: So you guys have ...

Speaker: You're lucky you're in [inaudible 0:54:51].

Eskom said: So back to Faan again.

Speaker 1: But it's also Janine, they moved in just after the window was closed.

Speaker 11: I'm just saying we really want you to try. Please.

Speaker 6: And you know what's the saddest thing? I had a system.

Eskom said: Yes, I know.

Speaker 6: And now I no longer have one.

Speaker 1: So there's a couple of things. I think on this point ...

Eskom said: So that's the problem.

Speaker: Clarity for everybody else, not for myself.

Speaker 1: I'm saying that we need a bit of information about what would it involved for people to join the system.

Eskom said: 100%.

Speaker 1: Can we get as much as possible information from you?

Eskom said: Yes.

Speaker 1: And then we as the trustees and HOA, then we can also see what is actually involved and can we for the sake of inclusivity actually use some of our say environmental funds or whatever we have to make sure that this really becomes as far as possible an inclusive, very practical way to include everybody as far as possible. But for that we would need information.

Eskom said: 100%

Speaker 1: As much as possible from you. So I think from a decision-making point, to say we're requesting as much information as possible to what is needed for people to join the system. Is that good? And then we have information to work with. Whether it then goes through a complicated funding process within Eskom or whether we figure out something with you, that's a separate point. But at this point we don't ... And for the agreement we don't need to have clarity on that.

Eskom said: What I can tell you right now is that the latter option where you're trying to do it yourself is a very difficult ... It's costly. Because the systems are not cheap. Especially if you're gonna get to the specifications of the system that we've installed. We didn't spare anything. It was the best of the best in terms of longevity of the system.

But then again, you do get customers that want to do it themselves. So we have to give that guidance. Now, that guidance in the future will probably form part of national regulatory standards in the country, to say that if you want to be an SSEG, small-scale embedded generator, you need to comply to A, B and C. And that's part of the future process that's coming.

So I don't know if you guys are aware, but there was a national gazette that was just signed now my minister Radebe where any generator ... Now I'm also saving you all from this headache. So the new rules now is that any generator, immaterial whether you're connected to the gird, not connected to the grid, all under 1 MW, so that's a lot of energy, so everybody falls in that category, has to by law register it with NERSA. You need to report on it four times a year. So quarterly you need to report the status of your system to NERSA or the distributor.

There is a lengthy registration process to now ... And I oppose it completely because it's your system but you need to register it with NERSA and you have to pay NERSA per kilowatt-hour for your smart embedded generation system. So if I did do this and if you guys wanted to do this in the future, that's the process you guys would have had to go through. So I'm nullifying that process we're talking about.

Speaker 1: Can I just in terms of the mutually beneficial agreement, is there anything outstanding that we need to now just get clarity on? Because there's obviously going to be detail around education and using, other technical questions and now the joining. But in terms of the agreement, is there something that we've missed from all the discussions that we've had?

Speaker 8: No, I don't think so. Not from where I come from.

Speaker 1: So there's been significant clarification as far as the security thing is concerned and then there's been very significant clarification in terms of the rate and the cost that goes into that. That answers the questions around clear, at least clear benefits in addition to the other things that we've talked about before.

Is there any questions that people have around those, whether we could now ...? Ideally we will then get the contract and from your point of view that will be the final contract, but obviously then people would have to [inaudible 0:58:51] ideally then as soon as possible get to a point of signing. Unless there's some big unforeseen thing that jumps out at somebody that needs to be clarified. But hopefully we won't need that. So that, I think you're quite keen to get to the point of being able to start the procedure.

Eskom said: 100%.

Speaker 5: Can I just support from our side to be super disciplined so that as soon as we've got it we're very quick and we're not adding to it. Because I think we're messing things up a little bit now. I'm grateful we've asked the questions, but now I'm just saying as a resident, let's try and move with it fast.

Speaker 1: So that was just in terms of the urgent priority of getting that particular at least addressed as best as we can tonight. Are there anything else that people feel they want to just raise around this? I know you were starting to ... Earlier on when I interrupted you, I'm sorry, but just in terms of the bigger picture, just reminding us of the [inaudible 0:59:43].

Eskom said: Yes. I'm a little bit anxious, because I know this is an important step but there's no malicious intent from me. I don't know how nicely I can say this. Jo, there's ulterior motives. This is meant to be a collaboration which is gonna grow into something wonderful. That's what the intention here is. I know it's hard to believe it. My name is Nick, not Saint Nick. Maybe the other Nick. I don't know, you guys can decide. But the idea is to make this work. And it gets tedious and we are not good at writing contracts, et cetera, et cetera, as you can see, but the intent is there and it is good intentions. I just wanna make that quite clear to you guys.

And there's a lot to come and I started alluding to that. But you have no idea how much stuff goes on in my head that I need to bring to this place. Electric vehicles are coming. Eskom's doing a while e-mobility strategy now to roll out electric vehicle charging stations to incentivise the growth of electric cars. Why electric cars? Obviously it's electric, there's a new revenue stream for Eskom. What's in it for the customer? R30 worth of charge, you get 100 km. R30 worth of petrol you get what?

So these are the incentives. This is what I'm talking about. I'm not here to sell Nissans and BMWs to you guys. But if we in the future came to you and said you are leasing a vehicle or you've got a five-year rental agreement or you've bought a car on an [HP? 1:01:23] and it's gonna cost you this, and let's say I'm not gonna ask you to cancel your contract, but if the time arose where you had a choice of now driving or leasing

an electric car for this period, then these are the kind of things that I would like to [inaudible 1:01:36].

Speaker 1: Well, I hope you enjoyed being part of this conversation which has been going on for a while. It got ... And there was attention to detail, which we do appreciate. But I think in terms of the bigger process, it is exciting. I think in some sense you are paying the price of people's bad experiences with Eskom.

Speaker 9: Yes, sorry.

Eskom said: I know.

Speaker 1: And you also represent this huge company where trust levels are quite low. So it's difficult to see through all that fog ...

Eskom said: I know. I understand.

Speaker 1: ... of not knowing what are we actually letting ourselves in for. It's too good to be true almost the way it's being talked about and it now feels to me that on significant points we've made serious progress, and you again showed the concreteness of the intention. So thank you for that.

Speaker 3: Sorry, just a quick question. I'm not sure if I understood coming in at this idea. But so the security that you mentioned in the beginning, is that just to monitor the assets that you've brought on site or is it for the entire complex?

Eskom said: Well, it's gonna be cameras that's installed in the complex. So it will be for ... I don't know how you guys are gonna mange the intruder detection. So if this is gonna tell you somebody's walking there, you guys are gonna get bombarded with ... I don't know. I will give the system, you guys can decide what you wanna do with it. Because I actually think it's gonna be a headache.

Speaker 3: But you guys aren't managing it?

Speakers: [Inaudible 1:03:00].

Speaker 8: We need to talk about this.

Speaker 1: It's more than just around specific things.

Speaker 8: So we need to talk about this.

Eskom said: No, I agree.

Speaker 5: Not now.

Speaker 8: It's the first thing I'm hearing now.

Speaker 5: Yes, but not now.

Speaker 8: Not talk about it.

Eskom said: The thing is, we can talk about it in two minutes. If you had to have intruder detection at your home and if you installed your own little camera, 03:00 in the morning it's gonna detect something, it's gonna flash on your phone at home and you're gonna say, damn, there's somebody outside my yard. You're gonna respond that way. Is the

same gonna happen here? Yes. Plus you will get a back-up, hopefully, of an armed response guy coming over there.

But then with the amount of people in this village, it's not a controlled thing. It's not your property where you've got four people in the property at a time that should be there, all four in bed, and now you've got a fifth person outside that you worry about. How are you guys gonna manage this entire village?

Speaker 5: But we can't talk about it now.

Speaker 8: It's just a very important question about it because we haven't spoken about this at all. So the cameras that you guys are now putting in, is it not linked to the security company [inaudible 1:04:12]?

Eskom said: You can most definitely do that and link it to the security company. But how do you manage false detection? Now, you decide to walk and visit this man or take a walk in the night and you live in the village, you're not an intruder, the camera's gonna pick you up, it's gonna tell Chub or whoever that you are ...

Speaker 1: I think what we're thinking about, I think we'll have to figure it out.

Speakers: [Inaudible 1:04:31].

Speaker 1: I think there will be, for example, we could agree if it happens between certain hours of the night it's more likely to be somebody that shouldn't be ... But we'll figure it out.

Speaker 8: The cameras must also ... In the beginning, just to clarify this, it was never intended to show the interior of the village. It was meant to ... We would walk the periphery. So the guys would have put up cameras for outside so that if an intruder approached the village then the security company would pick that up. that was the idea.

Speaker 1: Especially so from outside.

Speaker 8: So now if being inside, it's a complete turnaround of placement.

Eskom said: Okay, if you want it outside I'll put it outside, it's fine.

Speaker 8: Okay, cool.

Speaker 1: Exactly. So I think we've had enough conversations and I think we'll agree together what will be the most effective way to make use of these additions to the security.

Speaker 8: Thank you for it though, Nick. Thank you very much.

Speaker: If it's installed before Christmas 2019 it would be fantastic.

Speaker 1: What's happening then?

Speakers: [Inaudible 1:05:22].

Speaker 1: This is a unique opportunity to have so many people here, because we don't often have as many people at, definitely not at a trustees meeting. But I just not to ... Sorry, Nick, do you have a few minutes?

Eskom said: Yes.

Speaker 1: And also, it's exciting I think what's happening in the village in terms of the improvement we've had with operations, with the [log team? 1:05:44]. There's much more of a sense of things are moving forward. There's improvements on the wetland system to increase the quality of our water coming into our grey water system. So there's serious investments in time and energy going into that.

In the meantime the new group of trustees have gathered last weekend with a number of people who've been in the village for a long time and we started to use the language of elders. And obviously there were people who could not be there and there's more people we want to include. But we gathered for a few hours at a place just outside in Kuils River, in Suzie's coffee shop, and literally just sat and talked with each other about what is it that we would like to do to improve our village, to grow our village.

And as it happened, the lady who hosted us started talking about food and the people she gets to come and help with the food. And then Veronica and Magda was there and people who were here from the start, and they stated talking about the way in which the village gardens used to operate and how good it was as a space. We could work together. And I know Ross, when I talk to him, and Eve when I mentioned it, and of course [inaudible 1:06:48] you would remember that one too.

So one of the concrete suggestions we've come up with is that we're going to look for a site in the village, we're exploring which site to use, but we would want to start a village vegetable garden where we'll do it in a create way so that we can do this together. But that's one of the very specific things we want to get going within the next few weeks if possible. And that I think will add to what we're doing together, but also the quality of food and so on that we will be able to use.

The other thing that came up was we had two younger people there who were elders, because they've been basically growing up in this village, and Francesca came up with the idea of sport. They want to organise sports activities. So we'll figure out when and how and whether it's a winters festival and a summer festival or where we do it on a morning, the places, what we need to invest as an HOA, to get equipment. But we have the facilities on site and some of the young people I think are gonna take the lead to help us to also have those kinds of activities.

Then another thing that came up that's something we've talked about before, was the need to capture, in creative ways to capture some of the life stories, the experiences of the people living in the village. And of course the story of the village itself. And there's new strands being added as we speak around the electricity of course. But so there's a number of people who are quite excited to say how can we actually capture these stories in a sensitive creative way that can communicate to a wider audience

but can also ... For example, we may have two new people joining us, to say this give you a sense or here is a little exhibition or here is a website or whatever.

We'll figure out the detail. But there are a couple of people who are quite keen to take the lead on that. So just to give you a sense that that's coming. And this year we really wanna make progress on that, even in small ways. Because there are rich, rich, rich stories and experiences that we live with and we're not even aware sometimes of the detail.

Then another thing that came up ... So these are just some of the thoughts that came up. There was something around doing an education project around how we great each other. It came up in terms of different languages, different ways of speaking to different people, whether they're older or younger. How do we actually encourage each other to great in a culturally sensitive way? There's going to be a notice board put up soon and some of that information will be on there, but also distributed amongst the families.

And then the last thing that I just want to mention is that this is something that of course Eve really needs to speak about more, [inaudible 1:09:20], but from the beginning as part of the vision for the village there was a, let's put it a spiritual component. Not a religious, churchy component, but there's deep, deep values, deep spirituality that we share.

Speaker 5: A place for our souls.

Speaker 1: A place for our souls, yes. So Soul, Soil, Society was the vision that drew me to this place and it came from Eve and Mark at that time and the Schumacher college. So we're just saying that's one of things we wanna put out there and say how can we create freedomful ways to also cultivate that part of who we are together without any preachiness and without any pressure.

So that's a handful ideas that came out of a few hours of eating together. Not facilitated really, it was just let's come together and talk and share from different experiences, different backgrounds. I'm personally very excited about what came up. Hopefully we'll get people who are not on the trustees to be very involved in these projects, as many people as possible, and over time and hold ourselves accountable to these ideas, in creative ways again.

So that's just to give you a little flavour of what happened at that gathering between some trustees and some of the elders in the village. Does that make sense?

Speaker 8: Yes.

Speaker 1: *Moet ek dit in Afrikaans ook herhaal?*

Speaker 12: I've just got something. I don't know if we missed out, but how effective is that solar system during winter time, winters?

Eskom said: It's quite effective, solar radiation in winter is still significantly high. So at the end of the day it's renewable energy.

Speaker 5: It works in winter.

Speaker 10: It does.

Speaker 1: Not as good as in the summer, but there's somewhat, yes.

Speaker 12: Sometimes there's no sun in, somewhere, but [inaudible 1:11:07].

Speaker 1: So there's some of those details we can also follow up on. Is that okay? Did I miss something that people who were there ...?

Speakers: No.

Speaker 1: Did I miss any inputs? So we hope now within the next week or two to gather people who raised those ideas, gather a few people who are interested. We'll advertise ... Advertise. We'll communicate it on the WhatsApp group, on the e-mail and just ask whoever wants to be involved to choose where you want to be involved in one of these projects and take it from there. Is that okay?

Speaker 5: Fabulous summary.

Speaker 8: That's good.

Speaker 1: *Baie dankie almal. Dit was bietjie langer as 'n uur gewees*.

SOURCE: Sharné Bloem

Addendum B: Public Tender Document

Eskom	Invitation to Tender	Unique Identifier	240-114238630
		Revision	Rev 1
		Revision Date	October 2019
		Group Technology and Commercial	
		Enquiry no	PTATEN 2332

ESKOM HOLDINGS SOC LTD

INVITATION TO TENDER/REQUEST FOR PROPOSAL

FOR THE DESIGN, SUPPLY; DELIVERY; INSTALLATION AND TESTING OF A ROOFTOP PV SYSTEM IN LYNEDOCH ECOVILLAGE AT STELLENBOSCH.

RFP number	**PTATEN 2332**
Issue date	**15 December 2016**
Closing date and time	**02 February2017 at 10h00**
Tender validity period	**12 weeks from the closing date and time**
Clarification meeting	**17 January 2017**
Tenders are to be delivered to the following address on the stipulated closing date and time:	**Tender Box Office situated At Menlyn 5 Level 1 Eskom Holdings SOC Limited Menlyn 01 Gobie Street Newlands Extension1 Pretoria 0125**

Invitation to Tender/Request for Proposal

Eskom Holdings SOC Ltd (hereinafter "Eskom") invites you to submit a *proposal* **for the design,supply; delivery; installation and testing of a rooftop PV system in Lynedoch Ecovillage at Stellenbosch.**

The enquiry documents are supplied to you on the following basis. Free of charge

Eskom has delegated the responsibility for this tender to the Eskom *Representative* whose name and contact details are set out in the Tender Data. A submission of a tender/proposal by you in response to this *RFP]* will be deemed as your acceptance of the Eskom Standard Conditions of Tender (to be accessed via www.eskom.co.za)

Queries relating to these RFP documents may be addressed to the Eskom *Representative.*

Yours faithfully

Mathetja

Mrs Damela Mathetja
Acting Procurement Manager
Group Commercial - Corporate Tactical Sourcing

SOURCE: Eskom public publishing

Addendum C: Smart Integration of Residential Micro-Grid PR

Eskom	**PROCUREMENT REQUEST (PR)** *[To be used in cases of SAP non-availability]*	Unique Identifier	240-76879530
		Revision	Rev. 1
		Revision Date	Sept 2018
		Group Technology and Commercial	

New Contract	X	Purchase Order		Enquiry process		Sole/Preferred Supplier		Direct Foreign Supplier	Yes / No
Request for Information		Request for Proposal		Contract Modification		Contract No.: Expiry date:			Interdivisional
Contract Modification		Contract No.: Expiry date:				Purchase request number:			

NOTE: If the request is IT related, the "Request needs to be communicated to the local IM Representative prior to the purchase request being created on SAP

Project Name: (please fill in applicable line, and delete other one)	Smart Integration of Residential MicroGrid	
The services/products are for	The Works makes provision for the supply, installation, testing, transportation and delivery of a rooftop photovoltaic (PV) system including inverter, battery backup, cabling, reticulation and certifications for a selected group of houses at the Lynedoch Eco Village in Stellenbosch.	
Cost Assignment (Cost Centre or Asset Number)	213186	C.RTD0050
OPEX OR CAPEX (Indicate whichever is applicable)	CAPEX	
Actual / Estimated Cost (Total)	R 4 000 000	
Period of service to be rendered	N/A	
Governance process followed (Attach Budget approved letter by relevant IC) NOTE: If it is not a capital project, "IC Approval" means Cost Centre Manager approval in terms of the DoA		

DOA Approver:	Name:	Barry Maccoll
	Designation:	General Manager - Research, Testing and Development
	Signature:	

240- 76879530 Procurement Request Rev. 1 Controlled disclosure TE – Group Technology and Commercial Effective September 2015

SOURCE: Eskom public publishing

Addendum D: Email Correspondence with Eskom

CORRESPONDENT 1:

Tue, May 29, 2018 at 1:19 PM

Sharné Bloem <xxx@sun.ac.za>
To: CORRESPONDENT 1

Hi,

It was lovely to meet you. My correspondence with ANOTHER ESKOM EMPOLYEE seems rather intermittent and I have some more questions that I was hoping you could maybe assist with.

- Would you perhaps know what the installed capacity that was supplied to the village by Eskom prior to the PV installation?
- Also, what the current grid supply is?
- ANOTHER EMPOLYEE once told me about a public document that included some technical information of this pilot project, would you perhaps know where I could find this?

Hope to hear from you soon again. Take care.

--
Kind Regards
Sharne

FROM: CORRESPONDENT 1 Tue, May 29, 2018 at 3:41 PM
To: Sharné Bloem <xxx@sun.ac.za>

Hi Sharne,

When you ask about “installed capacity” for a small power user (SPU), it’s difficult to say, because our SPUs don’t have to declare a maximum demand. The transformer which steps down from 11 kV to 400 V (the village takes supply at 400 V) is rated at 100 kVA, so you could say that’s the installed capacity. As far as I know, the breaker supplying the village is rated for 150 A (150A x 400V/sqrt(3) x 3 phases = 103 kVA) – that means the breaker will trip if more than 103 kVA is drawn, so that the transformer and other equipment is protected. So this ties in with the transformer size.

I don’t know what the current supply is. I don’t think they’ve changed the equipment at all, so I imagine it’s the same.

I’m not aware of a public document, unfortunately. I’m guessing this is a brochure which ANOTHER team has created. Perhaps ANOTHER EMPLOYEE can assist you with this?

Regards,

Sharné Bloem < xxx@sun.ac.za> Tue, May 29, 2018 at 4:07 PM
To: CORRESPONDENT 1

Hi again,

Thank you for that! Just to clarify:

"I don’t know what the current supply is. I don’t think they’ve changed the equipment at all, so I imagine it’s the same." Does this just mean that the village could use the grids full capacity if needs be, but in the meantime it uses (hopefully) less with the rooftop PV?

Say they did use less energy from the grid, how would that technically affect distribution?

Best,
Sharne

FROM: CORRESPONDENT 1 Tue, May 29, 2018 at 4:38 PM
To: Sharné Bloem < xxx@sun.ac.za>

HI Sharne,

Sorry for the delayed reply.

Unfortunately that's not a figure I can help you with. Perhaps there'd be an estimate somewhere on the internet if you googled a generic Tonnes of CO2 per MWh of coal generation. You'd then need to work out the MWh saved by the PV installation.

All the best.

CORRESPONDENT 2:

Sharné Bloem < xxx@sun.ac.za> Sat, Jun 23, 2018 at 11:19 AM
To: CORRESPONDENT 2

Hi,

Could you kindly help me with a few questions:

1. When did the pilot project started (planning phase included)?
2. Why was the Lynedoch EcoVillage selected as the pilot location?
3. Have you conducted an actual LSM profile of this village?
4. When will the pilot start?
5. When will the pilot finish?
6. Is the tariff charged fixed, or different for solar vs grid vs battery back up?
7. What has been your top three biggest challenges during the implementation period?
8. Can you kindly share the public tender document with me?
9. How was the capacity of the system determine?
10. Was the village residents consulted in co-creating this system?

I will leave it to 10 questions for now, and might have a couple of follow up questions related to your answers.

Thank you!
--
Kind Regards
Sharne

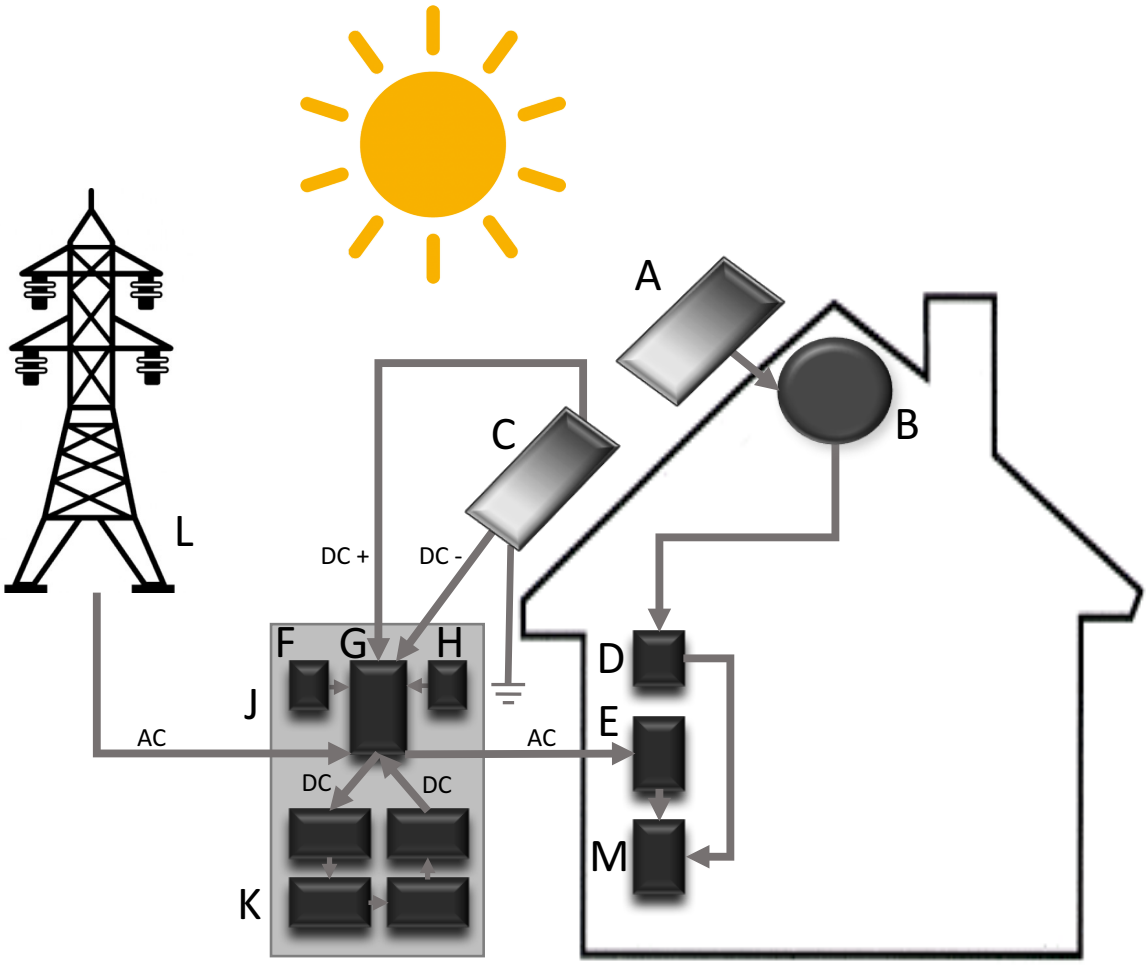
Sharné Bloem < xxx@sun.ac.za> Sat, Jun 23, 2018 at 11:19 AM
To: CORRESPONDENT 2

Hi,

Please see my answers below:

1. When did the pilot project started (planning phase included)? 2016
2. Why was the Lynedoch Eco-Village selected as the pilot location? DYNAMICS OF THE HOUSEHOLDS, ENERGY EFFICIENCY THAT IS PRESENT(SOLAR WATER GEYSERS ETC), GREEN THINKING THAT IS PART AND PARCEL OF THE VILLAGE
3. Have you conducted an actual LSM profile of this village? YES, BASED ON ENERGY USAGE, HISTORIC AND VIA METERING INFRASTRUCTURE.
4. When will the pilot start? ONCE THE LETTERS ARE SIGNED AND CONSENT IS FORMALISED
5. When will the pilot finish? A FEW YEARS AS PER THE LETTERS
6. Is the tariff charged fixed, or different for solar vs grid vs battery back up? FIXED AS PER NERSA PRICING STRUCTURES.
7. What has been your top three biggest challenges during the implementation period? CONTRACTORS, RESIDENCE BUY-IN, SECURITY CONTRACT
8. Can you kindly share the public tender document with me? I HAVE ALREADY EMAILED THIS TO YOU
9. How was the capacity of the system determine? VIA THE METERING DATA
10. Was the village residents consulted in co-creating this system? YES, VIA HOA AND FOUNDERS AND CFO OF INSTITUTE, AND IN FUTURE FOR THE USER INTERFACE VIA THE ON-LINE PORTAL

Addendum E: Description Lynedoch Mini-Grid



Legend:

A	–	Solar heating panel
B	–	Geyser
C	–	PV Array – 6 x Trina Panels – 320Watts
D	–	Geyser Switch
E	–	DB board
F	–	Communications box – Conext ComBox (Schneider Electric)
G	–	Inverter – 8kW – Conext XW+ (Schneider Electric)
H	–	Charge Controller – Conext MPPT 60 150 (Schneider Electric)
J	–	Eskom – Waterproof Steel Box - IP 65
K	–	Valve Regulated Lead-Acid batteries – Deep cycle - Maze VRLA AGM – 160A/h
L	–	Grid power - AC
M	–	Smart Meter – Contour – Cyber E Meter – Sabre ED - T-systems

Acronyms and signs:

AC	-	Alternating Current
DC	-	Direct Current
+	-	Positive Current
-	-	Negative Current

SOURCE: Sharné Bloem

Addendum F: Interview with Co-Founder of Village

Interviewer: **I think I'm trying to just get interesting stories from your experience of building an ecovillage and the choices you've made by putting certain regulations on building materials, seeing that I'm looking at the energy efficiency of these buildings and the way they translate or relate to energy use and to energy flow and all of these different embodied energy and all of this.**

Obviously the choices you've made in those initial phases of the ecovillage influenced the way these, well, the way it's run today or the way we perceive it today, or the performance, if that makes sense. Do you think that ...?

Interviewee: Are you going to record it, cause it's a lot?

Interviewer: **Okay. Yes.**

Interviewee: Is it recording?

Interviewer: **I'm recording it.**

Interviewee: I don't know where to start. So at a kind of broader social level, the original intention was to find a space for the school.

Interviewer: **Oh, okay. Yes?**

Interviewee: And as soon as we started thinking that this is an appropriate property for the school, then it widened out to say, well, it's big enough to also accommodate farmworker housing. Because at that stage housing was getting demolished on the farms in the surrounding area. And then as we proceeded further down that road it became clear that the farmworker housing and the school were not going to generate the kind of income to cover the development cost. So that's when there was a kind of shift towards a mixed income solution.

Interviewer: **Do you know why it got demolished?**

Interviewee: What?

Interviewer: **The farmworker houses?**

Interviewee: At that stage the farmers were demolishing the houses because a law as about to be passed that would give workers who were on the farm rights to stay there. So farmers in anticipation of this got people off the farms and demolished their structures. So in other words the land restitution legislation had the opposite effect.

So that was what caused the crisis and it's what triggered activists to come and approach us to assist them and that led to this combination of finding a place for the school and finding a space for farmworker housing, came together. But in trying to make that financially viable, we had to start broadening out to incorporate middle-class housing to generate the kind of income needed to cover the loan and for buying the land, the loan from Spier and then eventually another loan from the Development Bank.

So there were three loans that were driving it. ZAR3million from Boland Bank, ZAR1million from Spier and then another ZAR3million from the Development Bank. So in total it was about ZAR8million to do the development, buy the land and do the development.

So it was during that ... When we started, the first thing that we did was to start renovating this building.

Interviewer: Yes, this middle...

Interviewee: This space for the school. For the school. And some friends of mine, Gita Goven and Alistair Rendall, who were architects, were in the process of setting up an architectural practice that would implement sustainable green solutions. And what we decided is for them to come here and treat this as their pilot project.

And the overall ... I can't remember exactly how the financing of this building, but the Amy Biehl Foundation was involved in providing funding in some ways, and Spier.

Interviewer: AMD, sorry?

Interviewee: Amy Biehl. She was a young woman that was killed in the townships and her parents who were Americans set up this foundation to do poverty work. So somehow between the Amy Biehl Foundation and Spier the money was raised for renovating this building. I can't remember how much that was. I think it might have been ZAR2million. I'm not sure.

And Alistair Rendall and Gita Goven, who were a couple, then set up their practice here in the guest house, in the offices there. That was their office and their project was designing this building. And so they did all the designs for the renovation.

Interviewer: Are they still around?

Interviewee: Now they're a very, very big practice in Cape Town. Huge. They're like one of the top architectural practices who specialises in sustainability. So they did this building and in particular they were quite forceful in designing the wind chimneys and getting the alternative adobe brick kind of material, figuring out how to do that. And basically we did this building as the first attempt at green architectural design, sustainable architectural design.

It later on, a few years later got an architectural association award, but the award was subject to providing the quantifiable results, technical information of the actual energy efficiency of the building.

Interviewer: So was that measured technically?

Interviewee: Yes, but we didn't never do that. We never had the measurements. So that award was made in principle but never finalised because all the monitoring devices and stuff that you needed to put in to actually quantitatively test the claims made about the energy efficiency of the building were not put in place.

Interviewer: So did you still get the award though?

Interviewee: No, as I said, it was made in principle subject to providing the technical information. That technical information wasn't ... So it still sits there but it's not a proper award, it's subject to. We never met the conditions.

So while we were building this building it became clear that financially we're going to have to do more than just renovate this building for the school, we have to go into housing. When it became clear that it can't just be farmworker housing, again with ARG design, that's the name of their company, we compiled an urban design for the whole site and it included wall-to-wall housing among there, there, housing all the way up there, all the way around. I think it was a 100 plus apartments in front here. I think the total number was like a 150 residential units.

So that was what we were doing. And in order to submit the development plan to get the rezoning we had to submit a whole development concept like a normal development rights application for rezoning of the land. And inside of that document we developed the first fully-fledged if you like articulation of the alternative approach in terms of design and materials and so on. And after a whole long battle with the municipality because of objections from the neighbours, it had to be approved by the province.

The approval that we got was subject to the construction of a home owners' association who would have service delivery responsibilities, but also the responsibility for design, for the approval of building plans, which would then, the home owners' association would approve plans and it would go the municipality and get rubberstamped. So the home owners' association then had to be constituted and the constitution of the home owners' association contains all the detail. And that's actually what you should read very, very closely, the constitution of the home owners' association. That is the key and critical document to read. I think I have a hardcopy in my office at CST.

So there was a long consultative process to actually formulate the architectural guidelines which are part of the constitution of the home owners' association. And the core group that was involved in that process was the group of people who eventually qualified to get housing subsidies to build the first houses. So what's interesting about ... When you read the architectural guidelines, they don't specify a particular architectural form or style. The architectural guidelines specify a set of principles primarily and it's left up to every home owner to then interpret those principles with or without and architect, come up with a plan and submit that for approval to the home owners' association.

Now, what the consequences of that are is what we have now, which everybody interprets those guidelines differently. Partly out of their own aesthetic preferences, the space that they require and the kind of financing they need. So obviously if you need a bank loan you need to specify a set of materials that are acceptable to the bank. Or if you're building a new house it has to be registered and approved by the H ... Home building regulatory, H ... What's it?

Interviewer: The NHBRC.

Interviewee: NHBRC, yes. So that's basically how the framework emerged. But then there was a strategic decision that I felt very strongly about, which was to build the houses of the poorer people first. And that was because I wanted to make sure that the middle class didn't dictate to the poor what was best. So if you have the houses built of the poor first, then the middle class have to kind of fit in. They can't manipulate the power relationships which they're so good at doing.

Interviewer: Just one question. So this land, I know there was a hotel there before, but what was the zoning? Cause you said you had to rezone.

Interviewee: It was ...

Interviewer: Just commercial or?

Interviewee: It was like tourism or something. It was just a hotel

Interviewer: And you had to change it to residential or partly residential.

Interviewee: Yes. So it wasn't from agriculture to ... Which would have been much more difficult.

Interviewer: Yes, it's hard to get.

Interviewee: So it was ...

Interviewer: Tourism.

Interviewee: Tourism, I think. If there is such a zoning.

Interviewer: I don't know.

Interviewee: I think it's a commercial. Maybe it's just commercial.

Interviewer: Yes, I think it's commercial.

Interviewee: I can't remember exactly.

Interviewer: You've got business rights basically.

Interviewee: Yes. So when it came to the houses that qualified for a housing subsidy, at the time I felt very, very strongly about adobe. So I didn't know very much about ecological design then, so I just focussed on the obvious, which was materials. I thought from a sustainability point of view the materials is like the be all and end all. So make it out of clay and it will be 100%. What I know now is that over the life cycle design matters more than material. So you can have the best materials in the world, a bad design, and over the life cycle you're not looking great. And you can have poor materials from a sustainably point of view, like very engineered materials and a really great design

and you can have a better outcome. Obviously you need good materials and a good design.

So at the time I was just obsessed with materials and I kind of went through a whole long process with the people who qualified for housing subsidies to convince them about adobe. We went to Robertson and we saw the adobe houses. People were happy because they looked modern.

Interviewer: Just one question on the adobe. So your plan, was it to use local ...? Was there clay on site to have...?

Interviewee: There was, but not really enough.

Interviewer: Not really. So you couldn't really use something local? You had to order in from ...?

Interviewee: Well, in the end we used a lot of material from Spier. So a whole pile of adobe bricks were made at Spier with material from Spier.

Interviewer: And also, the other thing is, is it just adobe or did you mix it with straw bale and ...? Cause I know you had a brickmaker here and you made ...

Interviewee: Yes. No, we didn't have ... The first adobe bricks were square bricks.

Interviewer: Fired like normal red, those red bricks? Or not?

Interviewee: No, it was clay from here and across the road so it was yellowish. And it wasn't fired, it was ...

Interviewer: Sun-baked?

Interviewee: Just normal adobe made in a form, a wooden form, mixed with straw. And they were square and they were ...

Interviewer: Square, okay.

Interviewee: What's it? I think 30 by 30. Or was it 25?

Interviewer: Probably ... Well, could be either.

Interviewer: So the adobe, so you were very passionate about this and so coming back to your idea that you had for the lower income group to have their houses built first, did you then use adobe bricks for the houses? Cause I know there's one house at the back, the *grasdak ene* that used to be here, it was part of the hotel I think

Interviewee: No.

Interviewer: Not? Okay. A small little house there in the back.

Interviewee: Yes.

Interviewer: Oh, no, okay.

Interviewee: So actually that was the first adobe house.

Interviewer: Oh really?

Interviewee: Yes. So that was ... So actually what I've just said is not completely correct. So one of our students, his name is XXX, I think he was in our very first year of the degree and he was computer programmer at XXX and did the degree, he didn't do his thesis though, and he quit his job and he decided to buy a plot here and build an adobe brick house and he built that cottage for himself.

Interviewer: So the white one with the ...?

Interviewee: The gable. And he teamed up with a colourful character, I've forgotten his name, who created the impression that he was an expert in adobe brick construction.

Interviewer: Oh my goodness.

Interviewee: Which is how I met him, through this guy XXX. So he built this little cottage, which had all sorts of problems, because if you have exposed gables they need to be waterproofed and they weren't probably waterproofed. So they had some hassles there. But there was some lessons learnt in making that adobe brick house. I met this guy, I've forgotten his name ...

Interviewer: Did they also plaster it with adobe?

Interviewee: Yes. They plastered it with adobe.

Interviewer: A mix?

Interviewee: Yes, with clay and a lime mix and then they painted it in the traditional way, with lime mixed with fat. And we take animal fat and we put in the lime and it bubbles away and it create a paste.

Interviewer: It's supposed to create some form of waterproof ...?

Interviewee: Yes. So that's what happened. And then while they were doing that, this whole ... I put in a funding application to get housing subsidies, set up the whole kind of training programme with the construction SETA and the Swiss funders to provide funding for a training programme in adobe brick construction.

And then with this guy, instead of hiring an architect, which was a big mistake, this guy, he's like one of these people who's very charismatic and he's a great storyteller and he gives people like me, he makes me feel really good because I think he's like, I can hand over my problems to him and he can just sort them out.

Interviewer: Oh gosh.

Interviewee: But actually it all was an illusion.

Interviewer: Oh no.

Interviewee: So he, with the home owners, designed the houses.

Interviewer: So the first lot of lower income housing?

Interviewee: Yes. So he designed those houses with them. So he's not an architect. He's just a builder.

Interviewer: **But back in the day you didn't need to have, you didn't need to be registered to actually ...**

Interviewee: Yes, but still ...

Interviewer: **This only happened like ten years, about eight years ago.**

Interviewee: But he made big technical mistakes.

Interviewer: **Yes, of course.**

Interviewee: So he left out ring beams, for example. So he did all these designs. I found a way somehow, I can't remember how, to get them costed. We then went into the making of these ... He was convinced about square adobe bricks, which was also a fuck-up because your corners, there's no ...

Interviewer: **Yes, square is never good.**

Interviewee: So square on square means you've got square on square at the corners, which means ...

Interviewer: **It's never a good idea.**

Interviewee: Never a good idea. And they were too bulky and ... Anyway, but he always knew the answers and he had this business partner who was a structural engineer who also gave me a false sense of security.

Interviewer: **Oh gosh.**

Interviewee: And they went and they just built these houses. And over time they cost more than they were supposed to and I had to find other money and there were technical problems.

So luckily I had this kind of associate cum friend from the Netherlands who was a really expert sustainable design builder, adobe builder, and he just like, one of these superb super hero type of Dutch people who know everything. And he came to visits and he looked at these houses, said they haven't got ring beams and they're going to either implode or explode. And so there were a couple of the houses that were already built and we had to put steel collar, and you know like L beam and a steel ...

Interviewer: **Yes, L bracket.**

Interviewee: L bracket around all those houses and bolt them together.

Interviewer: **Yes, on the corners probably. And brace it.**

Interviewee: In the corners. We put rods all the way through. We had to brace the whole thing and then put a false thing around it that looks like a feature, to hide it, and that's how we saved those houses.

Interviewer: **That's so hectic.**

Interviewee: And then the rest of the houses that hadn't been built, we put steel reinforced concrete ring beams above the windows. So that's basically ... So those houses are not, from

an orientation point of view are not great. They're basically pretty badly designed adobe brick houses.

Interviewer: Yes, I do agree with the orientation.

Interviewee: Aesthetically they're not great. From an orientation point of view they're not great. From a window spec point of view they're not great. From an overhang point of view they're not great. So all we really got right was these were adobe brick houses and that's what this person knew, that's what I knew and we were very, very proud of ourselves with building adobe brick houses.

But actually from a ... And yes, it had all the nice insulation, solar hot water heaters, we built all the infrastructure already, we had electrical specs based on the assumption there wouldn't be electric geysers and electric stoves, which saved us ZAR2million.

Interviewer: Gas. So aesthetically the orientation was ...

Interviewee: Yes. You can do your own analysis of all of that.

Interviewer: Yes.

Interviewee: But yes, they were adobe, so that was cool. But the rest was I think a bit problematic. Also, the urban design that the so-called green architects did, only when we had it approved did we realise that the urban design wasn't appropriately aligned north-south. So we did an alternative design. So the design is oriented in accordance with the structure of the site. So the structure of the site is like that. Well, if you think of it like that, the structure of the site is like that and the plots are this way, or this way, but north is here.

So when we realised this, we tried to shift all the sites from this, from being like this to being like that and we created a really nice design together with this Dutch guy. Really beautiful urban design with a north orientation with curves rather than ... So even the urban design was problematic and then we put these badly designed adobe brick houses on top of that urban design without figuring out a way to compensate for the inappropriate orientation. I mean, those days you couldn't find anybody who knew the stuff.

Interviewer: Exactly, that's the thing.

Interviewee: So even the guys who were the leaders didn't know it. So, anyway ...

Interviewer: Yes, a lot has happened since 15 years ago.

Interviewee: Yes, absolutely. We'd never have done an urban design like this, never. And the design of the adobes would have been completely different. Anyway, so to cut a long story short, we completed all the houses that were qualified for housing subsidies, we got the housing subsidies, we got the subsidies for the labour team.

Interviewer: How many houses were in there, can you remember?

Interviewee: I think it's 11. So it's one, two, three, four, five, six, seven, eight, nine ... Yes, I think it's about 11. So we did that. Financially these builders that are contracted are financial idiots, reckless, badly ... They lost money and it cost me more money than I had available. So we had to box clever and do all sorts of deals on these buildings and guest house and da-da-da in order to complete the construction of the houses, which we did. In the end it was like a massive bust up with the builders and I've never spoken to them again.

Interviewer: Really? Were they local?

Interviewee: Yes, they're from around here. Two white guys. The builder, the white guy, and then the engineer was an Indian guy and they used black labour obviously.

So once we finished that, then a guy called Malcolm Worby, an architect who had spent 25 years doing adobe brick houses in Santa Fey in New Mexico moved to Cape Town and I made friends with him and he started to, and he's like really an expert. He's an architect and he knows building. So it's a very rare combination?

Interviewer: What's his surname?

Interviewee: Malcolm Worby. And he lives here, just around here in Somerset West, and he's got a beautiful website called Worby Design I think and he's a very nice guy, vey competent and he designed our house. And he said, get rid of the straw, do rectangular bricks, make them thinner and you have a better result, and that's exactly what happened. So my house is really the best form of adobe and it's also, from a design point of view it's very effectively done. The only thing I never built, completed was the overhang on the northside. But if you have the overhang on the northside, like with a vine, it would be absolutely perfect design.

So you get your full double volume solar penetration, you get your ventilation right, you're cool in summer, you're warm in winter. You have a double storey so it's not a loadbearing structure, so it's a post-and-beam structure. Steel reinforced ring beams at both levels above the windows at the bottom ground floor and then above the first-floor windows. And then on top of the ring beam at the top is normal fired brick insulated passive heating. So that is a really, really great design and fantastic materials.

Interviewer: What did you say the ventilation, what's the ...?

Interviewee: The ventilation, you need to ... So your interior design must have spaces for your southeaster to come in through one set of windows and out through the other set of windows.

Interviewer: Yes, cross ventilation.

Interviewee: Whereas if you don't have a double volume, if your house is completely compartmentalised, then you can have air coming in and stopping and not going

through the house. So you need the open spaces like we have in that house so that when the doors are open you get your full ventilation through

Interviewer: And in winter time, is it nice and warm in there?

Interviewee: Yes, in the winter time it's nice and warm because the southeaster is not blowing through. And you keep the windows closed and you have a fire burning, you warm up the adobe structure and it holds the heat effectively.

Interviewer: Interesting. So you feel that your house was then the best adobe?

Interviewee: Yes.

Interviewer: And then how did the sand bag house, how did all this, the recycled bricks or reclaimed bricks ...?

Interviewee: Well, the recycled, the reclaimed bricks houses emerged because there were people who needed loans from the banks and they wanted a sustainable material.

Interviewer: So the banks, NHBRC didn't approve the adobe bricks?

Interviewee: No. And my house was never approved by NHBRC. And that was before the NHBRC was really as effective as it is now.

Interviewer: But also, I think they refined their thing, that after five years in any case.

Interviewee: That's right.

Interviewer: So that happened because people needed bonds and the NHBRC ...?

Interviewee: Yes, sorry?

Interviewer: No, so I was saying, so basically they then experimented with other materials that was approved by the NHBRC?

Interviewee: Yes.

Interviewer: Timber and light steel frame?

Interviewee: Yes. So there were a couple of different products that emerged where people needed loans from banks. So the one was reclaimed brick, unplastered. The other was Cape brick, which is brick from Cape brick, which is crushed building materials with cement added. And some of those houses are also not plastered, just painted. A light steel frame house with fibre cement cladding and tongue and groove on the inside. And a wooden house which was basically normal pine exterior and tongue and groove interior. Those were all approved by the banks. In other words, there was NHBRC certification for those materials.

There was another adobe brick house that went up, also designed by Malcomb Worby on the left side of the site, next to the green house made from reclaimed brick. It was beautiful, with a wooden extension. Normal ... I mean, it was also rec- ...

Interviewer: Yes, I think it's in the corner there.

Interviewee: Yes, it's the corner. The rectangular adobe brick. Exactly the same material and design as mine, but much more curvy and [inaudible 1:41:32].

Interviewer: Yes, I saw that.

Interviewee: But same architect. So there's quite a few more houses being built using reclaimed brick up in the top left-hand corner.

Interviewer: Yes, I saw there's one new one. And then the new extension with the ship containers.

Interviewee: Oh yes, the ship containers.

Interviewer: What's your take?

Interviewee: No, I think those are interesting. I really like that. I wanted one of those. I wanted to buy a plot here and do one of those for myself actually.

Interviewer: No bamboo houses yet?

Interviewee: No bamboo houses, no straw bale. So there are two houses made with ...

Interviewer: Sand bags.

Interviewee: Sand bags. One of them is a proper sandbag house with chicken wire.

Interviewer: Faan's old one.

Interviewee: Yes, with chicken wire and clay and lime plaster. And then the other house was fibre cement cladding. So the sand bag houses obviously have these eco beam frames.

Interviewer: With the bracing?

Interviewee: Yes. And brick pillars and steel reinforced ring beams.

Interviewer: Is it light steel or is it I beams?

Interviewee: No, the sand bag house is eco beams, there's no light steel frame.

Interviewer: Yes, but I mean the ring ...

Interviewee: Steel.

Interviewer: Oh, so it's just a ...

Interviewee: Steel reinforced ring beams, yes. Those are the different building systems and building materials. I don't know whether any of the houses, I don't know, I haven't been to see any of those houses, the new houses being built on the top left-hand side. But from a design point of view, I think there are a couple of impressive structures, I must say. I was going to be a bit negative, but actually when I think of them, some of them are impressive.

Interviewer: So was the adobe bricks were those made on site?

Interviewee: Yes, they were actually. Yes.

Interviewer: And your house?

Interviewee: No, we got those from Spier.

Interviewer: From Spier?

Interviewee: Yes.

Interviewer: Do they have a brick ...?

Interviewee: They made a massive quantity of adobe bricks from some plan they had and then they scrapped the plan. So there were these adobe bricks just lying there that we, I think we got for free.

SOURCE: Sharné Bloem

Addendum G: Eskom Rooftop PV Frequently Asked Questions

Eskom has built Rooftop PV systems on some of the houses at the Stellenbosch Eco Village. These systems are 1.68kWh systems including battery storage in each home. This FAQ is set up to help the residents understand the system and Eskom's stance. Any other questions may be sent to singhnn@eskom.co.za.

ROOFTOP PV SYSTEM

1. *What are photovoltaic systems (PV)?*
   Solar photovoltaic (PV) panels are composed of solar cells that convert sunlight into direct current (DC) electricity. The DC electrical charge is then converted into alternating current (AC) electricity by a power inverter so that it can be used for our household electricity needs. Many cells are assembled to create a module (also called a panel), and many modules can be linked together to form a solar array.

2. *How long do solar panels last?*
   Solar panels have an expected lifespan of at least 25 years (there are panels installed in the 1070's that are still generating power), and they are typically warrantied for 25 years. They are generally made with tempered glass that is rated to withstand a direct vertical impact of a one-inch diameter hail stone traveling at 80km/h.

3. *Will the solar panels work during load shedding or power cuts on the Eskom grid?*
   The grid limiter will automatically shut itself off within a few milliseconds of a power outage, to avoid and prevent back feeding into the grid. If the blackout is during the day there will be power available because the solar panels will still supply power to the inverter.

4. *Will the solar panels damage my roof?*
   The rooftop PV system will have no negative impacts on the rooftops. The contractors used to install the panels will be fully certified and the roof will be covered from damage due to negligence on the part of the contractors or Eskom.

5. *What happens if I want to replace my roof?*
   Before installation all the houses roofs will be assessed to determine if the rood needs to be replaced within the lifespan of the PV system. Therefore any roof replacement done by the owners will need to be done at their own cost. If this is done within Eskom project lifespan, the replacement of the solar PV system will be at the owners cost and the owner will be liable for any damage done to the system. The owners will also be requested to install the panels within a limited period of time as the data gathered from the panels are crucial to research within Eskom.

6. *Who will maintain the system?*
   Eskom Research will be in control of the maintenance for the duration of the project; once the project has been completed further information will be communicated.

7. *What will happen to the system once the project is completed?*
   The system will be owned and maintained by Eskom distribution. This is to minimise the risk, financial, safety and technical with trying to maintain and upkeep the system on your own.

8. *Does my neighbour get the same system as I do?*
   All the systems are the same, 1,68kWh systems with battery backups.

9. *Why is my system the same size as the other systems if I use more energy?*

Eskom is attempting to test a system which includes the energy trading, if you use more energy than your neighbour, you neighbour may sell his energy to you at a rate that is lower than the Eskom tariffs. This promotes energy saving practises as there is the chance to make money out of the energy saved.

10. *Will someone need to get into my house to maintain/upgrade the system?*
    There may be a need for work to be completed in your home; however it will be communicated with you beforehand for an available time and the reason.

11. *What should I do if there is a problem with the system?*
    Eskom RT&D will appreciate it if the community informs RT&D of any damages or faulty systems by contacting your community representative (Jo Engelbrecht) or maintenance person (Faan Swiegers) or directly to Eskom RT&D (Nick Singh, Mpho Manoto or Carl van den Berg) at 011 629 5111.

12. *What happens if the system is stolen or broken?*
    There will be an investigation conducted to establish the root cause of the incident and corrective action will be taken.

13. *Who owns the Rooftop PV system?*
    The rooftop PV system is the property of Eskom Holdings Ltd. Research, Testing and Development Smart Grid Department. After the duration of the project the system will be transferred to Eskom Distribution and will be treated as an Eskom supply.

14. *What data will be collected?*
    All the consumption data as well as the energy trading statistics are a part of the research and will be collected. Popi act will ensure privacy and professionalism is maintained.

15. *What data will be shared?*
    No there will no data sharing, unless there is a mutual agreement between the community to view each other's data (Consumption, solar generation, import/export power). No personal information will be shared.

16. *What do I do in case the PV system trips my breaker/earth leakage (am I allowed to bypass)?*
    Please refer to section 4 of the "Safe Operation of PV system" booklet. The booklet has information regarding the bypassing of the system.

17. *Am I allowed to expand the system at my own cost?*
    This will not be allowed for the minimal 2 years duration of the project. However once the project has been completed the system will be transferred over to Eskom Distribution. Once this has occurred you may apply for a system expansion, this will come at a legislated cost to you and will be done by Eskom Distribution, not a third party company.

18. *What is the benefit of the solar system to the customer on this Eskom research project?*
    Accessibility to Renewable energy (clean energy); UPS (Uninterrupted Power Supply); Renewable energy at reduced tariff; Cut out the middle man who sells Eskom electricity at R2 per kW.

SOURCE: Eskom handout at HOA meeting

Addendum H: Eskom Rooftop PV Safe Operation Guide Rev 0.1

Safe Operation of the PV System:

For the safe operation of the Solar System, please familiarize yourself and your family with the following. This guide gives you first line of options to help yourself in the event of a power failure. If you or your family are unsure, please call your village electrician/maintenance person to assist you.

1. Safety First:

By complying to the following safety tips, electricity can be your friend and make life easy:

- Always treat electricity with respect as it can cause serious injury or even death
- Do not play with electricity
- Do not touch circuit breakers with wet hands
- Do not push an object of any type of material into a distribution board of circuit breaker/switch to hold it in a position
- If unsure, call your village electrician/ maintenance person to assist you.

2. Information:

Below is the typical layout of all residents' distribution boxes situated in their houses. There are three boxes:

- **Pre-Paid Meter** – For the metering of your electricity.
- House Distribution Board (DB) – All the circuit breakers are housed in the box. Each circuit breaker should be marked. There are three different circuit breakers:
  - The **Main Breaker** (MB1) connects the current to the power network. This breaker is normally white and green and doubled.
  - The **Earth Leakage** (EL1) is normally green, double and is wider than the standard breakers and has a white test button. The Earth Leakage protects the user against faulty equipment that can give a harmful shock and will trip under the faulty conditions.
  - **Individual Circuit Breakers** (CB1, CB2, …)

  These circuit breakers are for your protection and for the safe operation of any equipment. All of the circuit breakers have three positions.
  - Bottom position – Breaker if OFF
  - Top position – Breaker is ON
  - Middle position – Breaker is TRIPPED. To clear the tripped condition, the breaker must be switch to the OFF position and then it can be switched back to the ON position. If the circuit breaker trips immediately, there might be a serious problem.
- **Power Selector Switch Board** – This is a new switchboard that connects the Solar Power System with the house and selects the power source (SOLAR POWER or ESKOM POWER) for the house. There are three circuit breakers/ switches:
- **Inverter In Breaker** (SS1) protects the Grid from an overload by the Solar Inverter System. The circuit breaker has three positions:
  - Bottom position – Breaker OFF
  - Top position - Breaker ON
  - Middle position – Breaker TRIPPED. To clear the tripped condition, the breaker must be switch OFF (bottom position). If the circuit breaker trips immediately, there is a serious problem.
- **Power Selector Switch** (SS2) is a multi-pole breaker (4 switches interconnected) and selects the power source of the house. The selector switch has three positions:
  - Bottom position – ESKOM POWER is selected to supply the home
  - Top position – SOLAR POWER is selected to supply the home
  - Middle position – OFF, the two power sources are disconnected from the home, thus there will be no power to the house
- **Inverted Out breaker** (SS3) protects the Solar Inverter System from overloads by the customer electrical equipment. The circuit breaker has three positions:
  - Bottom position – Breaker is OFF
  - Top position – Breaker is ON
  - Middle position – Breaker TRIPPED. To clear the tripped condition, switch the breaker OFF (bottom position) and then back ON (top position). If the circuit breaker trip immediately, there is a serious problem.

3. Health Condition:

3.1 Solar Power

For the system to operate correctly in the NORMAL SOLAR POWER condition, the circuit breaker must be switched to follows:

- The Main Breaker (MB1) must be ON (top position)
- The Earth Leakage (EL1) must be ON (top position)
- Individual Circuit Breakers (CB1, CB2, …) must be switched ON (top position)
- Individual In Breaker (SS1) must be switched to SOLAR POWER (top position)
- Power Selector Switch (SS2) must be switched to SOLAR POWER (top position)
- Invertor Out breaker (SS3) must be ON (top position)

3.2 Eskom Power

For the system to operate correctly in the ESKOM POWER condition, the circuit breakers must be switched to follows:

- The Main Breaker (MB1) must be ON (top position)
- The Earth Leakage (EL1) must be ON (top position)
- Individual Circuit Breakers (CB1, CB2, …) must be switched ON (top position)
- Individual In Breaker (SS1) can be switched to ON or OFF (top or bottom position)
- Power Selector Switch (SS2) must be switched to ESKOM POWER (bottom position)
- Invertor Out breaker (SS3) must be ON or OFF (top or bottom position)

4. Fault Condition:

4.1 No power, power selector (SS2) is switched to Solar Power and Inverter In (SS1) is tripped.

- Reset the tripped Inverter In circuit breaker (SS1) by switching it OFF (bottom position) and switch it then ON (top position).
- Power restored, thus Solar Power in ON – There was something wrong/faulty with the Solar Power System. Please inform your village electrician/ maintenance person to report it to ESKOM and Trackos, you will do the necessary repair/maintenance.
- Still no power, thus Solar Power OFF – The Solar System might be faulty or the PV Power and the Battery Power might be exhausted. However, you can run on ESKOM Power.
- Switch the Power Selector Switch (SS2) to ESKOM POWER (bottom position).
- Power restored, thus Eskom Power is ON – There might be something wrong/faulty with the Solar Power System. You will run on Eskom Power in the meantime. Ask your village electrician/maintenance person to assist you and double check and confirm your findings. Your electrician/maintenance person will report it to ESKOM and Trackos, who will do the repair/maintenance.
- Still no power, ESKOM Power might be OFF – Proceed to section 4.4 for possible solutions.

4.2 No power, power selector (SS2) is switched to Solar Power and Inverter OUT (SS3) is tripped.

- Reset the tripped Invertoer Out circuit breaker (SS3) by switching it OFF (bottom position) and switch it ON (top position).
- Power restored, thus Solar Power is ON – There was an overload which caused the switch (SS3) to trip. If circuit breaker SS3 trips regularly, please inform your village electrician/ maintenance person to report to ESKOM and Trackos, who will do the necessary repair/maintenance.
- Still no power, thus Solar Power is OFF – The Solar System might be faulty or the PV Power and the Battery Power might be exhausted. You can run on ESKOM Power in the meantime.
- Switch the Power Selector Switch (SS2) to ESKOM Power (bottom position).
- Power restored, thus ESKOM Power is ON – There might be something wrong/faulty with the Solar Power System. You will run on ESKOM Power in the meantime. Ask your village electrician/ maintenance person to assist you and double check and confirm your findings. Your electrician/maintenance person to report to ESKOM and Trackos, who will do the repairs/maintenance.
- Still no power, ESKOM Power might be OFF – Proceed to section 4.4 for possible solution.

4.3 No power and power selector (SS2) is switched to Solar Power.

- Switch the Power Selector Switch (SS2) to ESKOM POWER (bottom position).
- Power restored, thus ESKOM Power is ON – There might be something wrong/faulty with the Solar Power System. You will run on ESKOM Power in the meantime. Ask your village

electrician/ maintenance person to assist you and double check and confirm your findings. Your electrician/ maintenance person will report it to ESKOM and Trackos, who will do the repair/maintenance.

- Still no power, thus ESKOM Power is OFF – Proceed to section 4.4 for possible solutions.

4.4 No power and power selector (SS2) is switched to ESKOM Power.

- Find out form the village electrician/maintenance person if the ESKOM Power is on.
- If the ESKOM Power is ON – Another Distribution Breaker, not shown on the above DB boards as it is situated in the Grid Distribution Box (Light Grey) which is common between multiple houses, might been tripped. Ask your electrician/ maintenance person to check it and assist you to get the power restored.
- If the ESKOM Power is OFF – Try to switch the Power Selector Switch (SS2) to Solar Power (top position).
- Power restored, thus Solar Power is ON – BE AWARE!! Limited power is available as the duration of the ESKOM Power failure is unknown, thus switch all non-essential equipment/appliances off to minimize power usage.
- Still no power, thus Solar Power and ESKOM Power is OFF – The PV Power and the Battery Power are exhausted and you had to wait for the ESKOM power to be restored or good sunshine before power will be available again. If in doubt, ask your village electrician/ maintenance person to assist you and double check and confirm your findings.

4.5 No power and Earth Leakage (EL1) is tripped.

- Try to reset the Earth Leakage Switch (EL2) by switching it OFF (bottom position) and switch it ON (top position).
- Power restored, thus Power is ON – BE AWARE!! Some appliances or fault caused the Earth Leakage Switch (EL2) to trip. If it happen again in a few minutes please try to pinpoint the appliances/equipment that cause the fault or ask your village electrician/ maintenance person to assist you. If EL1 stay tripping, thus faulty appliances/equipment – Switch
- All the circuit breaker (CB1.. CBn) OFF (bottom position). Switch each breaker back ON (top position). When a breaker switch cause the Earth Leakage (EL1) to trip, leave that breaker off and continue to switch breaker by breaker back ON (top position).
- Disconnect all appliances from the circuit breaker that caused the earth leakage (EL1) to trip. Reconnect and switch each appliance one by one on to find the faulty appliance. If in doubt, ask you village electrician/maintenance person to assist you and double check and confirm your finding.

4.6 No power on some appliances

- Check if your socket outlets (plugs) circuit breaker (marked PLUGS) is ON at the distribution board.
- If not, switching it OFF (bottom position) and switch it ON (top position).
- If the problem persists notify your village electrician/maintenance person to assist you.

4.7 No power and lights are not working

- Check if your lights circuit breaker (marked LIGHTS) is ON at the distribution board.
- If not, switching it OFF (bottom position) and switch it ON (top position).
- If the problem persist notify your village electrician/ maintenance person to assist.

SOURCE: Eskom handout at HOA meeting

Addendum J: Local Context Report

1 Executive summary

This report applies to the Australian Green Star Communities Tool v1.1. and considers the applicability of the tool in South Africa. Included in the report is an overview of the methodology to develop this LCR, a communities' perspective in South Africa and an in-depth credit-by-credit analysis. The credits have all been analysed to assess their applicability in South Africa. The brief was to make amendments to the credits so that the tool is applicable to the South African context. This did not include a complete tool development process to create the South African Sustainable Precincts Tool v1.

A summary of recommended credits requiring adaptations can be found below (all other credits are proposed to remain unchanged, but where projects do want to propose changes these must be applied for through the TC/CIR process on the GBCSA website):

GOV-01	**Green Star AP**
Minor changes made to this credit – the credit references the GBCA's (Green Building Council of Australia's) CPD Programme. The Green Building Council of South Africa (GBCSA) does not have a CPD Programme in place, therefore, this requirement has been replaced with the alternative for the Green Star South Africa Accredited Professionals to attend a Green Star Sustainable Precincts Workshop and pass the Green Star Exam instead of being part of the GBCA CPD Program. Documentation requirements also edited to align with the new requirement.	
GOV-02	**Design Review**
Minor changes and additional reference documents listed within the credit to make it more applicable to the South African market.	
GOV-03	**Engagement**
Minor changes made to the credit – the credit calls for the use of (International Association for Public Participation) IAP2 Australasia core values in carrying out the public participation, this was changed to IAP2 Southern Africa. Projects also have the option to align the Public Participation carried out during the Environmental Impact Assessment (EIA) process with GOV-03 requirements, ensuring that all the GOV-03 requirements are addressed.	
GOV-04	**Adaptation and Resilience**
Minor changes made – additional South African reference documents have been listed within the guidelines to assist in rendering the credit more applicable to the South African Market. As the credit is to be compiled by a suitably qualified individual, the onus will be on the said professional to use the correct Global Circulation Models (GCMs) endorsed by the IPCC (Intergovernmental Panel on Climate Change).	
GOV-05	**Corporate Responsibility**
Changes made to the credit to enable smaller and Public entities to target the credit. In addition to using the (Global Reporting Index) GRI Sustainability Guidelines for the second part of the credit, project may elect to use King IV, which is applicable to all types of entities.	
GOV-06	**Sustainability Awareness**
No changes, credit to remain as is. Requirements stipulated within the credit are straightforward and applicable to the South African market.	
GOV-07	**Community Participation and Governance**
No changes, credit to remain as is. It was determined that the credit is applicable in the South African Context.	

GOV-08	Environmental Management
Changes have been made to the credit to make it more applicable to the South African Market. The first part of the credit requires that appointed contractors with contract amounts over $5 million (AUD) to be ISO 14001 Certified. Research had to be conducted to convert the AUD amount to ZAR. In order to convert the AUD to ZAR, two alternatives were considered; Purchasing Power Parity and direct conversion. Direct conversion was used with the contract amount set at 50 million ZAR. The second part of the credit references the use of the Western Cape Environmental Management Plan Guidelines (instead of the New South Wales Guidelines) for the development of the Environment Management Plan.	
LIV-09	**Healthy and Active Living**
Under Guidance in the Submission Requirements the existing Table 9.0 summarising the AMCORD requirements have been replaced with a new 'Table 9.0 Characteristics of Street Types and Pedestrian Walkway Provision' and includes changes to terminology. The changes serve to provide localized guidance. No changes are proposed for credit 9.2 Recreational Facilities. It is suggested that the guidelines provided by the Australian Communities tool be followed until an equivalent local standard has become available. An additional reference has been added under Additional Information namely the City of Cape Town Urban Design Policy (2013), as further localised reference for credit 9.3 Healthy Places.	
LIV-10	**Community Development**
A definition of 'Community' has been added in order to focus the scope of the credit. A reference to the Governance Credit 03 has been added under 'Synergy with other Credits' with an explanation of the connection between these credits. The reference already exists in the Governance section, but questions raised by Pilot Project representatives made it clear that it will be useful to make this cross reference again under Liveability Credit 10.	
LIV-11	**Sustainable Buildings**
It is proposed that the credit be adapted to the local context by making up to 4 points available based on the percentage of dwellings in the project site that achieve a Green Star South African Multi Unit Residential rating or an EDGE rating for 11.2. The application of the Green Star RSA Multi Unit Residential Tool brings credit 11.2 in line with credit 11.1. The option for projects to apply the EDGE rating tool to dwelling units in the project makes this credit applicable to projects that have a variety of dwelling types on the project site. The new proposed criterion is also aligned with the way the credit is approached in New Zealand. The benchmark for Energy saving in the EDGE tool ensures an improvement over the SANS10400 standard that is equivalent to four points under the ENE 01 credit in Green Star. It would thus be required of projects that target the Green Star South African Multi Unit Residential rating to achieve a minimum of four points in the ENE 01 credit in order to align it with the EDGE tool requirement. 11.2NZ was written exclusively for projects in New Zealand, therefore it could be removed.	
LIV-12	**Culture, Heritage and Identity**
No changes were made to this credit	
LIV-13	**Walkable Access to Amenities**
No changes were made to this credit	
LIV-14	**Access to Fresh Food**
Although 14.2 might be challenging for projects to achieve, no changes were made to the criteria as this credit remains relevant. The Pilot process will allow the level of difficulty of this credit to be tested in practice.	

LIV-15	Safe Places
The only changes to this credit are that projects seeking to achieve certification through GBCSA can also make reference to the City of Cape Town, Design and Management Guidelines for a Safer City Best practice guidelines for the creation of sustainable, safe and lively neighbourhoods in Cape Town. This document addresses the following six key overlapping CPTED principles, which align to the requirements of 15.1.2. A further additional South African web based resource has been added that disseminates information on CPTED.	
ECON-16	**Community Investment**
In order to reflect the South African context, the investment amounts were converted to South Africa context using the average house prices as a reference point. The South African investment amounts identified are as follow: • For Residential Infrastructure Investment the minimum investment amount is R10 000; and • The minimum investment amount for infrastructure provided should be at least R80 per square meter for non-residential space.	
ECON-17	**Affordability**
Affordability is a complex issue in South Africa, especially as it relates to the provision of housing. Minimal changes to Section 17.1 Residential Affordability Strategies were required, to bring it in line with South African terminology. The essence of the credit is however acceptable and retained. The specific terminology changed that were made include: • 'lot sizes' were changed to 'erf sizes' • 'lots' changed to 'erven' • reference to the Australian National Construction Code (NCC) was changed to refer to the South African National Building Regulations and Building Standards Act (No. 103 of 1977) (as amended) In terms of 17.2 no further investigations were required for the non-residential and mixed-affordability strategies as set out in the Green Star Communities v1.1. Submission guidelines and were therefore retained as is. For 17.3 changes were necessary to bring the credit in line with South African legislation. References to the Australian National Construction Code (NCC) were replaced with reference to the South African National Building Regulations and Building Standards Act. No. 103 of 1977 (as amended).	
ECON-18	**Employment and Economic Resilience**
Only minor changes were proposed in order to bring specific references to economic/industry classifications and building regulations in line with South African legislation. For 18.1, 18.2A and 18.2C the following changes were made: • Reference the Australian and New Zealand Standard Industrial Classification (ANZSIC) was replaced with reference to the Standard Industrial Classification (SIC) used in South Africa; • Specific building classes as contained within the Australian National Construction Code (NCC) was compared and changed to refer to the equivalent building classes as set out in the South African National Building Regulations and Building Standards Act (No. 103 of 1977) (as amended).	

18.2B required some changes to the text to clarify credit requirements regarding the definition of *Major City*.

ECON-19	**Education and Skills Development**
This credit makes significant reference to 'Higher Education', which in the South African context refer to a very exclusive segment of the population. In order to ensure that this credit retains the original intent, revision is required. The following changes were recommended: • For 19.1.1 and 19.1.2 - To protect the integrity of the credit removing all references to the term 'higher' education; • For 19.2.2 and 19.2.4 removing the reference to Technical and Further Education (TAFE) institutions, and replacing it with reference to the following institutions: Technical Vocational Education and Training (TVET), Further Education and Training (FET) Colleges, and Community Education & Training Facilities • For 19.2.3 it was recommended that the reference to the Australian Skills Quality Authority be replaced with the more relevant South African Qualifications Authority • Additionally, 19.2.3 and 19.3.1 required definitions to be added to ensure clarity on credit requirements.	
ECON-20	**Return on Investment**
Credit to remain as is, with the option of pursuing a CIR for South Africa specific methodology or methodology not yet specified. Alternative methodologies are available to South African projects, and CIRs regarding methodologies not yet mentioned will be considered on a project specific basis.	
ECON-21	**Incentive Programmes**
This credit required minor adjustment to reflect South African appropriate investment amounts, and to refer to specific location examples more appropriate to the South African context. To calculate South Africa relevant investment amounts, the same approach used in Credit 16: Community Investment was used. The investment amounts were expressed in terms of average residential value and the ratio used to convert for South Africa by multiplying it with South African average house price. The proposed new investment amounts were R2 000 per residential dwelling and R16 per sqm of non- residential spaces. The specific pathway selected is dependent on whichever development type occupies a greater proportion of the project site.	
ECON-22	**Digital Infrastructure**
Investigations on the suggested connection speeds (25-50Mbps) revealed that this referred specifically to a new service rolled-out by an Australian service provider. Engagement with a South African industry expert indicated that although similar digital infrastructure is available in the market through VDSL which provides line speeds of 25-100Mbps, the slightly lower line speeds provided by ADSL2+ infrastructure (10-25Mbps) are more widely available. The appropriate line speed identified for consideration within the South African context is therefore 10- 50Mbps/5-20Mbps. Even with the lowered line speed, there is still some concern that the issue of service and infrastructure availability might lead to complications for projects. The Green Star Communities v.1.1 does provide for Alternative Compliance Methods to be considered on a project-by-project basis, which is deemed sufficient.	
ECON-23	**Peak Electricity Demand Reduction**

The requirements of the credit were regarded as clear and appropriate, and were retained as is.

The only proposed changed was the additional of the term 'heat pump' to support the use of the term 'solar air-conditioning' as the first mentioned term is better known in the South African context.	
ENV-24	**Integrated Water Cycle**
Storm water is a critical topic for the South African context. It is therefore important that project teams get encouraged to apply the requirements in the credit. From the research and stakeholder interviews it became clear that the credit was too onerous for South Africa and it was suggested to break up the credit into achievable parts. Therefore, whereas in Australia a project achieves 2 points for meeting all requirements, South African projects can get up to 2 points, depending on if they are targeting quantity and quality separately. From the stakeholder interviews, it was also a recommendation to address the smaller storms as they cause severe damage to the direct surroundings. Therefore, we included both the 1 and 5 year ARI to be addressed in the storm water quantity requirements.	
ENV-25	**Greenhouse Gas Emissions**
Performance Pathway: The major change in this credit is that we had to change to the Australian references to South African relevant references. The major reference in South Africa related to energy efficiency is the SANS 10400 Part XA, which has been the baseline for most of the Green Star South African tools. Prescriptive Pathway: There are also some additional initiatives that projects can target to achieve points. Maximum number of points remains 4 points. The new initiates are an option for energy efficiency for new buildings; energy metering; and monitoring.	
ENV-26	**Materials**
For South Africa, we changed the minimum requirement to a credit where projects can achieve 1 point for meeting the credit criteria. From research, experience and stakeholder interviews the conclusion was that these requirements are still tough to achieve in South Africa. We want to encourage the projects to target points for Materials and the minimum requirement was seen as a barrier to this. The point that was allocated to the minimum requirement was taken out of the points for the 26A.1 and 26B.1 pathways.	
ENV-27	**Sustainable Transport and Movement**
No changes were made to this credit	
ENV-28	**Sustainable Sites**
Minor changes were made to this credit; the Australian act was replaced with the NEMA act; and the definition of the Suitable Professional was changed accordingly.	
ENV-29	**Ecological Value**
Minor changes were made to this credit; mainly to change the definition of the Suitable Professional to a South African relevant profession.	
ENV-30	**Waste Management**
No changes were made to this credit	
ENV-31	**Heat Island Effect**
No changes were made to this credit	
ENV-32	**Light Pollution**
No changes were made to this credit	

2 Introduction

What is Green Star Sustainable Precincts? Green Star is an internationally recognised rating system that delivers independent verification of sustainable outcomes throughout the life cycle of the built environment. Green Star Sustainable Precincts is a holistic rating tool for communities and precincts.

As per the Australian Green Star Communities v1.1. Submission Guidelines:

Green Star – Communities is a rating tool that evaluates the sustainability attributes of the planning, design, and construction of large-scale development projects, at a precinct, neighbourhood, and/or community scale. The Green Star – Communities rating tool will assist governments, development project teams, contractors and other interested parties aiming to deliver large-scale sustainable developments around Australia to:

- Provide diverse, affordable, inclusive, well connected and healthy places to live, work and play;
- Protect, maintain and restore the natural environment by reducing the ecological footprint of developments;
- Receive recognition for demonstrated leadership and commitment to sustainability;
- Achieve real value for money through demonstrated whole-of-life cost savings; and
- Encourage opportunities for business diversity, efficiency, innovation, and economic development.

Green Star – Communities assesses projects against a holistic set of distinct social, environmental, and economic categories, and an innovation category. The categories are called:

- Governance;
- Liveability;
- Economic Prosperity;
- Environment; and
- Innovation.

The Green Star Sustainable Precincts Rating Tool is composed of the following documents
I. Green Star Australia – Communities Submission Guidelines and Submission Templates

II. Green Star Australia – Communities Scorecard; and
III. Green Star Australia – Communities Change in Ecological Value Calculator. IV. Green Star – Sustainable Precincts Local Context Report

2.1 Local Context Report – Green Star Sustainable Precincts for South Africa

The development of the Australian Communities Tool was been a complex process and took an extensive amount of time in Australia. The objective of the Local Context Report (LCR) was to assess where the tool needs to be changed to be applicable to the South African Context. The development of the LCR did not constitute the development of a South African Communities v1 tool, it will however be the point of departure for a future version 1 tool.

The GBCSA initiated the LCR process to be carried out as the demand for a Sustainable Precincts tool was growing in South Africa, which is evident by the number of PILOT projects involved in this process. USAID provided the budget for a Technical Consultant to be appointed to undertake the work. Solid Green was appointed to lead the development of the LCR; which is done in collaboration with Urban Reflection and TAP Properties. The Technical Advisory Panel (TAP)

consisted of 20 experts from the industry and thirteen PILOT projects were selected to provide input to the LCR development.

2.2 Stakeholders, Roles & Responsibilities

GBCSA

The GBCSA was the client on the project as they are the custodians of the LCR and guided the LCR development to ensure the Technical Consultant adheres to the GBCSA's vision.

Technical Consultant

The Technical Consultant is the appointed party, responsible for managing and leading the stakeholder participation and the developing of the LCR. The Technical Consultant was responsible for administrative tasks related to minutes and meetings, as well as ensuring that the pilot projects and expert's opinions are considered. They did interviews with industry experts where the expertise was missing on the Technical Advisory Panel (TAP) team. The consultant worked closely with the representatives of the PILOT projects and the TAP team to ensure the most inclusive results.

PILOT projects

Thirteen pilot projects were selected to participate in the LCR development. Pilot projects contributed to the LCR by participating in a technical advisory panel (TAP) and by providing their written feedback to the GBCSA and the Technical Consultant.

Technical Advisory Panel (TAP)

There were 15-20 people accepted for the Technical Advisory Panel (TAP); several of these individuals are also representatives of pilot projects, so there was an overlap of expert input and project input from the TAP. The TAP has a wealth of experience and knowledge, which the consultant captured into the development of the LCR.

2.3 Methodology

The Sustainable Precincts tool is different from the other Green Star tools as it does not follow the standard eight categories of Green Star. The Sustainable Precincts tool has four categories; namely Governance, Liveability, Economic Prosperity and Environment. In total, there are 32 credits in the four categories and 100 points are available for the projects.

The team looked at the eligibility criteria and the certification process and evaluated if all the requirements are appropriate for South Africa.

Each credit was reviewed in the following manner:

- **Aim of the Credit**
- Is the aim of the credit relevant to the South African Context?

- **Credit Criteria**
  - Are the credit criteria relevant to the South African Context?
  - Are the benchmarks set correctly for the South African Context?
  - Are there local equivalent standards/legislation that can be referenced?
  - What must be amended to make the credit criteria appropriate for implementation in South Africa.

- **Calculator (credit 29 Ecological Value)**
  - Is the Calculator for Ecological Value applicable to South Africa?
  - What changes to the benchmarks and calculator are required?

- **Total suite of credits**
  - Are there any major gaps in the issues that the credits address?
  - Are there South African specific planning items that must be included?

- **TAP Workshops**

  As part of the LCR development process, three TAP workshops were held.

  - TAP 1
  - TAP 2
  - TAP 3

  5 October 2016
  2 November 2016
  2 December 2016

The goal of the workshops was to get as much feedback and technical input from the different stakeholders and PILOT projects as possible. The workshops were structured as follows, first a general session followed by working group sessions. In the general session we discussed the tool name, eligibility criteria and recertification. During the latter part of the workshops, the TAP members were divided in 4 groups, a group for each category. In the working groups the TAP members were taken through the details of each of the credits for the TAP to comment on.

Solid Green appointed group leaders to each of the categories.

Governance Livability
Economic Prosperity Environment

PILOT feedback

Working Group Leader: Bakang Moeng (TAP properties) Working Group Leader: Zendre Compion (Solid Green) Working Group Leader: Adrie Fourie (Urban Reflection) Working Group Leader: Marloes Reinink (Solid Green)

The pilot projects were requested to provide feedback to the Technical Consultant. This was done in two parts; one deadline on the 19th of October and one deadline on the 16th of November. Each project had to complete two categories for each deadline. This information was summarised and included in the LCR Tracker sheet.

SOURCE: GBCSA Green Star Sustainable Precinct – Local Context Report.

Addendum K: Green Star Sustainable Precinct

List of Credits

	Location and Site	Transportation	Green Infrastructure	Innovation	Water	Energy	Materials & Resources	Biodiversity	Quality of life	Socio-Economic	Institutional
Governance: (28)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Green Star Accredited Professional			1								
Design Review			7								
Engagement			6								
Adaptation and Resilience			4								
Corporate Responsibility											3
Sustainability Awareness							2				
Community Participation & Governance											2
Environmental Management							1				
Liveability: (22)											
Healthy and Active Living									4		
Community Development										3	
Sustainable Buildings			4								
Culture, Heritage and Identity									3		
Walkable Access to Amenities		2									
Access to Fresh Food									2		
Safe Places									2		
Economic Prosperity: (21)											
Community Investment										3	
Affordability									3		
Employment and Economic Resilience										2	
Education and Skills Development										3	
Return on Investment										2	
Incentive Programs										2	
Digital Infrastructure									2		
Peak Electricity Demand Reduction						2					
Environment: (29)											
Integrated Water Cycle					6						
GHG Strategy		2				3					
Materials							5				
Sustainable Transport and Movement		3									
Sustainable Sites	2										
Ecological Value								2			
Waste Management							2				
Heat Island Effect			1								
Light Pollution									1		
Innovation: (10)				9							
TOTAL: (110)	2	7	22	9	6	5	10	2	17	15	5

SOURCE: GBCSA Green Star Sustainable Precinct Manual

Addendum L: Lynedoch Ecovillage Basic Design Guidelines

1. THE VISION

Lynedoch is located in a beautiful part of the Stellenbosch winelands and aims to be a pioneering settlement in ecologically sustainable development. Its growth will take place in naturally small steps to allow the social, economic and physical aspects to develop with the community.

1.1 CONCEPT OF THE DEVELOPMENT

It is more and more clear that human settlements throughout the world are weakening the long-term sustainability of the planet through the way they are built, operate, dispose of waste and are demolished. Lynedoch aims to be an example of a settlement that, through gradual development, meets the standards of environmental sustainability in 2020. The design and building of the houses will follow this vision and the designs should not, therefore, be in conflict with one another and thus harm the environment. They should look as if they are based on a similar creative idea rather than a collection of very different approaches. Although individual creativity will be encouraged with the building plans and detail design, a common architecture will be maintained through control of the main design elements, the use of natural materials, the choice of colours (a few earthy ones) and landscaping that is in harmony with the surrounds.

Although existing building technology will used in the Village, the vision will still be followed through careful use of water, energy and other resources, and through minimizing waste, recycling wherever possible and using features of the site such as the dams.

2. INTRODUCTION

Acceptance of the Basic Design Guidelines (BDG) is a part of the sales agreement when properties in the Village are purchased. Building plans will be submitted for approval to the Home Owners Association, which will ensure that they conform to the BDG, and then to the Local authority. The BDG have been submitted to the Local Authority for approval.

2.1 INTENTION OF THE GUIDELINES

The BDG:

- advises on the site, views, climate and local ecology
- controls building form, height and colour while encouraging individual design
- seeks to encourage a pleasing look for the village
- sets out an approach to the architecture, technology and methods to be used on the development
- enables buyers to be sure of what they can expect at Lynedoch

2.2 BYE-LAWS AND REGULATIONS

In addition to the BDG, builders must comply with the local bye-laws and the National Building Regulations.

2.3 ARCHITECTURAL DESIGN

In principle, the house designs will be done by one of the architects of ARG Design. Buyers may, however, use other architects to be agreed by the Association and ARG Design.

2.4 RIGHTS OF THE HOME OWNERS ASSOCIATION

The Association has the right to assess proposed house designs and how these comply with the BDG bearing in mind desired environment for the Village.

The Association may also from time to time make small changes to the BDG and new house designs must comply with the latest version. If major changes are made to the BDG they will be submitted to the local authority for approval.

3. ENVIRONMENTAL DESIGN DETERMINANTS

Environmental sustainability is a basic design ideal and water use, energy, biodiversity (the variety of living things) and building materials are important.

Building designs should therefore take into account sunshine, wind, rainfall, topography (land shape), micro- (i.e. plot) climate and views (the diagram below shows the climate patterns) and these plus the following will be looked at when the designs are being assessed:

- pollution, including global warming, ozone depletion, toxicity, embodied energy
- exhausting of resources
- land use
- sensory effects
- disaster potential
- waste
- renewal and/or reuse and/or dispose
- durability
- strength
- skills.

Buyers should submit with their building designs, a note describing their plans for minimizing water and energy use and for achieving biodiversity. NIBE documentation, which sets out standards for materials, will be kept in ARG's offices where they can be inspected. Special attention will be given to:

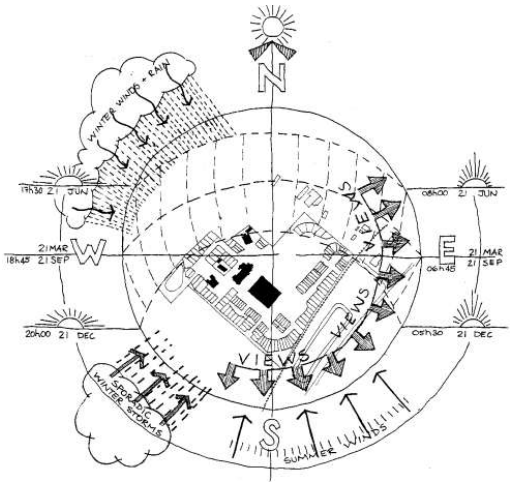
- water saving and reuse measures

- energy consumption during construction
- energy consumption during use
- adequacy of passive ventilation system
- appropriateness of landscaping/planting programme

All these can be thought of together as “environmental cost”. Buildings with the lowest environmental cost are preferred. Additional documents providing more information are available:

- Indoor Climate Control
- Design Details and their Environmental Rating

4. SITE DEVELOPMENT GUIDELINES



4.1 – 4.4 OVERVIEW, ZONING, COVERAGE, HEIGHT RESTRICTION, BUILDING LINES

The BDG and the Boland Zoning Scheme Regulations both apply to Lynedoch. Owners must find out what zoning regulation and building line regulation applies to their erf. The building may cover up to 75% of the plot area. Buildings may not be more than two stories high and chimneys may not be more than 75 cm above the roof ridge.

4.6 – 4.7 PARKING, EXTERIOR LIGHTING

One parking bay may be on each erf and at least one additional parking bay per erf is to be included in the communal parking areas spread around the village.

SOURCE: LEV HOA Design document

Addendum M: Description of Housing Typologies

Type 1 = 1	
	solar heating
	embedded pv
	north east
	LSF with magma board
	insulation
	some overhang

Type 2 = 6	
	solar heating
	most embedded pv
	mixed
	recycled bricks
	insulation
	some overhang

Type 3 = 2	
	solar heating
	embedded pv
	north east
	sandbag
	insulation
	some overhang

Type 4 = 1	
	solar heating
	embedded pv
	north east
	timber
	insulation
	some overhang

Type 5 = 1	
	solar heating
	no embedded pv
	north
	container
	insulation
	some overhang

Type 6 = 8	
	solar heating
	most embedded pv
	mixed
	reclaimed bricks
	insulation
	some overhang

Type 7 = 13	
	solar heating
	most embedded pv
	mixed
	adobe
	insulation
	some overhang

Type 8 = 1	
	solar heating
	embedded pv
	north
	soil-cement bricks
	insulation
	some overhang

SOURCE: Sharné Bloem

Addendum N: Energy Use by Lynedoch EcoVillage

Unit	Energy Imported Grid	Solar	Energy to Battery	Energy from Battery	Load
1	no reading				
2	363.5	592.3	796.2	760.5	484.3
3	797.1	768.1	959.5	788	1077.5
4	1044.8	805.4	1082	859.8	1355.1
5	no reading				
6	908.3	1042.4	1390.3	1011.6	1260.5
7	1833.4	813.3	1267.3	811.9	1971.6
8	1144.6	862.4	1274.3	791	1271.8
9	1236	1079.3	1347.6	1184.9	1686.7
10	368.7	714.8	1341	717.1	321.5
11	1325.3	890.3	1350.8	874.3	1491.3
12	497.8	981.9	1174.1	984.6	594.5
13	293.3	558.9	728.2	759.6	312.2
14	no reading				
15	455.2	924.3	1454.7	943	581.3
16	2083.9	1083.3	1689.5	1008.4	2200.5
17	1338.2	1032.6	1453.9	983.5	1546.1
18	252.9	311	632.1	454.8	258.7
19	1465.7	1150.9	1684.6	1058.4	1805.7
20	433.1	769.7	1301	894.1	360.6
21	910.1	1012.3	1482.9	1017.3	1103.8
22	779.4	1050.7	1519.6	1102.9	882.3
23	486.6	857.1	1392.7	822.5	646
24	1231.4	759.2	1019.1	729.2	1370.2
25	434.7	?	806	457.8	313.3
26	803.7	819	1743.7	941.8	1016.6
27	no reading				
IN TOTAL:	**20 487,7**	**18 879,2**	**28 891,1**	**17 548,7**	**20 995,2**

SOURCE: Home Owners Association
(The data in this table was recorded from 1 October 2017 until 1 July 2018 and measured at kWh).

Addendum P: Interview Questions for Lynedoch EcoVillage

Most household in the village took part in answering the following questions on Survey Monkey:

General:

1) *How long have you been living in LEV?*
    - *0-7 years*
    - *7-15years*
    - *15 years and more*

2) *What is your age, as the owner or main tenant of the household?*
    - *18-25*
    - *25-35*
    - *35-50*
    - *Older than 50*

3) *How many people live in your house?*
    - *1*
    - *2-4*
    - *4-8*
    - *More than 8*

4) *How many people contribute to the economy of the house?*
    - *1*
    - *2*
    - *3*
    - *4*
    - *More than 4*

5) *Which bracket describe your own monthly income best before tax or any deductions?*
    - *Less than R4 000*
    - *Between R4 000 and R16 320*
    - *Between R16 320 and R25 487*
    - *Between R25 487 and R35 275*
    - *More than R35 275*

6) *How many appliances do you use in your house?*
    - *3 or less*
    - *Between 3 and 5*
    - *Between 5 and 8*
    - *Between 8 and 12*
    - *More than 12*

7) *What is the general feeling you have knowing that you are part of a pilot project for Eskom?*
    - *Excited*
    - *Neutral*
    - *Waiting for the catch*
    - *Other*

8) *What do you think about Eskom's contribution in the village so far?*
   - *Good*
   - *Average*
   - *Pleasantly surprised*
   - *Empty promises*
   - *Aweful*
   - *Other*

9) *Any monthly savings since the mini-grid system has been installed?*
   - *Yes*
   - *No*
   - *Other*

10) *Did the new mini-grid change your life in any way?*
   - *Yes*
   - *No*
   - *If Yes, how did it change your life?*

Sustainability:

11) *I switched off lights in rooms that are not in use*
   - *Every time*
   - *Almost every time*
   - *Sometimes*
   - *Almost never*
   - *Never*

12) *I turn off the tap when I brush my teeth*
   - *Every time*
   - *Almost always*
   - *Sometimes*
   - *Almost never*
   - *Never*

13) *I separate my organic waste and recycle my trash*
   - *Every time*
   - *Almost always*
   - *Sometimes*
   - *Almost never*
   - *Never*

14) *I buy my food on how sustainable they are (eg. Locally, organic, free range, GMO free)*
   - *Every time*
   - *Almost always*
   - *Sometimes*
   - *Almost never*
   - *Never*

15) I believe I am more sustainable than my neighbours

- *Every time*
- *Almost always*
- *Sometimes*
- *Almost never*
- *Never*

16) I believe I am living a more sustainable life than people living outside the village, in South Africa

- *Every time*
- *Almost always*
- *Sometimes*
- *Almost never*
- *Never*

Some household in the middle class neighbourhoods as a controlled group took part in answering the following questions on Survey Monkey:

Neighbourhoods:

17) Do you sometimes walk in your neighbourhood?

- *Yes*
- *No*

18) When you walk in your neighbourhood, is it to…

- *Get fresh air*
- *For exercise*
- *To bump into your neighbour*

19) How often do you bump into friends or acquaintances when you walk in your neighbourhood?

- *Never*
- *Rarely*
- *Sometimes*
- *Mostly*
- *Always*

Sustainability:

20) I switched off lights in rooms that are not in use

- *Every time*
- *Almost every time*
- *Sometimes*
- *Almost never*
- *Never*

21) I turn off the tap when I brush my teeth

- *Every time*
- *Almost always*
- *Sometimes*
- *Almost never*
- *Never*

22) I separate my organic waste and recycle my trash

- *Every time*
- *Almost always*
- *Sometimes*
- *Almost never*
- *Never*

23) I buy my food on how sustainable they are (eg. Locally, organic, free range, GMO free)

- *Every time*
- *Almost always*
- *Sometimes*
- *Almost never*
- *Never*

24) I believe I am more sustainable than my neighbours

- *Every time*
- *Almost always*
- *Sometimes*
- *Almost never*
- *Never*

SOURCE: Sharné Bloem through Survey Monkey

Addendum Q: LSM Calculator

Most household in the village took part in this online questionnaire to determine the LSM level of LEV:

Your LSM value is: LSM 0			
☐	Metropolitan dweller (250 000+)	☐	DVD Player / Blu Ray Player
☐	Living in a non-urban area	☐	Refrigerator or combined fridge/freezer
☐	House / Cluster House / Town House	☐	Electric Stove
☐	Tap water in house / on plot	☐	Microwave oven
☐	Flush Toilet inside house	☐	Deep Freezer - Free Standing
☐	Hot running water	☐	Have a washing machine
☐	Built in Kitchen Sink	☐	Have a tumble dryer
☐	No Domestic Workers or Gardeners	☐	Dishwashing Machine
☐	Home security service	☐	PayTV (M-net / DSTV / TopTV) Subscription
☐	2 Cellphones in Household	☐	Home Theatre System
☐	3 or more Cellphones in Household	☐	Vacuum Cleaner
☐	Zero or One Radio set in Household	☐	Motor Vehicle in Household
☐	Air conditioner (excl. fans)	☐	Computer - Desktop / Laptop
☐	Have TV set(s)	☐	Land line (excl. Cellphone)
☐	Swimming Pool		

The SAARF Living Standards Measure (LSM) developed the most widely used segmentation tool in South Africa. It is a means of segmenting the South African market that cuts across race, gender, age or any other variable used to categorise people. Instead, it groups people according to their living standards.

SOURCE: Eighty20 Website