

University of Cape Town
Department of Civil Engineering

*How the sustainability transition in energy is transforming the built environment of
South African cities.*

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ABSTRACT

South Africa is undergoing a sustainability transition (ST) in its energy sector as part of its broader move towards a low-carbon future. Past studies of the nascent ST using a multi-level approach have already proven obsolete after strong resistance from the incumbent energy regime almost derailed the fledgling renewable energy (RE) industry. After initially going to ground and contracting, the industry re-emerged strongly in South Africa's cities, mostly in the form of rooftop solar photovoltaic (PV) systems. This study applies an integrated approach utilizing the Multi-level Perspective (MLP) to trace the current ST trajectory, whilst employing the Technology Innovation Systems (TIS) framework as a focal lens, recently adapted to the follower country context, to empirically investigate system development in the solar PV TIS. A survey was conducted to assess the drivers and challenges facing consumers of solar PV technology in cities, the results indicating that the rapid growth in distributed embedded generation (EG) was sparked by recent tax incentives and not the introduction of Feed-in Tariffs (FIT) offered by city municipalities. Whilst the RE sector and solar PV market have grown through consumer demand for EG, they still face resistance from the existing energy regime, needing further development in policy and regulation in order for South Africa's ST to support a more complex web of distributed and embedded generation, mostly underpinned by RE technologies.

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LIST OF ACRONYMS

CRSES	Centre for Renewable Energy Studies
CLD	Causal Loop Diagram
CSP	Concentrated Solar Power
DoE	Department of Energy
DoF	Department of Finance
DoPE	Department of Public Enterprises
EG	Embedded Generation
EGS	Embedded Generation System
EHA	Event History Analysis
EPP	Electricity Pricing Policy
ERA	Electricity Regulation Act
ESCO	Energy Service Companies
FIT	Feed-in Tariff
GIS	Global Innovation Systems
GEAR	Growth, Employment and Redistribution
GHG	Greenhouse Gas
IPP	Independent Power Producers
IS	Innovation System
KZN	Kwa-Zulu Natal
LOCE	Levelized Cost of Electricity
LTMS	Long-Term Mitigation Scenarios
MEC	Minerals-Energy Complex
MLP	Multi-Level Perspective
Moi	Motors of Innovation
NERSA	National Energy Regulator of South Africa
NDP	National Development Plan
NIS	National Innovation System
NPC	National Panning Commission
NT	National Treasury
PFMA	Public Finance Management Act
PPA	Power Purchase Agreement
PV	Photovoltaic
R&D	Research and Development
RE	Renewable Energy
RED	Regional Electricity Distribution
REFIT	Renewable Energy Feed-in Tariff
REIPP	Renewable Energy Independent Power Producer
REIPPPP	Renewable Energy Independent Power Producers Procurement Programme
RET	Renewable Energy Technology
RDP	Reconstruction and Development Programme
SANEDI	South African National Energy Development Institute
SANERI	South African National Energy Research Institute
RIS	Regional Innovation System
ROI	Return on Investment
RSA	Republic of South Africa
SA	South Africa
SHS	Solar Home System
SIS	Sectoral Innovation System
SM	Survey Monkey
SNM	Strategic Niche Management
ST	Sustainability Transitions
TIS	Technology Innovation System
TM	Transition Management
TT	Technological Transition

CHAPTER 1 INTRODUCTION

1.1 BACKGROUND - ENERGY IN THE ERA OF CLIMATE CHANGE

Climate change is one of the most serious challenges to ever face humanity. Limiting global climate change to two degrees above pre-industrial temperatures has been determined by science as the threshold after which it will become increasingly dangerous for human survival. Critically, climate change will not be consistent, with every degree of global warming translating into almost two degrees in Africa (New, 2015). Consequently, 'climate change will amplify existing stress on water availability and on agricultural systems particularly in semi-arid environments' (Barros et al., 2014:75), meaning food security will suffer while increasing the number and severity of outbreaks of disease affecting humans.

Yet, Africa suffers from a multitude of challenges that reduce its capacity to adapt to climate change (Barker et al., 2007). High rates of inequality and poverty mean that 621 million people do not have access to electricity, with universal access only likely by 2080 at the current rate of electrification (Panel, 2015). However, if Africa pursues higher levels of income and human development in line with other first world countries, then its consumption of energy and contribution to GHG emission will increase dramatically, and with it the prospect of worsening the effects of climate change in Africa. To put the global imbalance into perspective, Spain consumes more energy than all of Sub-Saharan Africa, while South Africa's consumption alone accounts for 60% of this energy (Panel, 2015).

However, a continent where two-thirds of the population do not have access to electricity presents the unique opportunity to pursue an alternative development pathway compared to the carbon-intensive pathway taken by the developed world. Africa currently only accounts for 2.3% of global CO₂ emissions and could help save the world and itself by embracing the renewable energy revolution, thereby leapfrogging to a low-carbon economy whilst improving the lives of its people (Panel, 2015).

1.1.1 SOUTH AFRICA'S ENERGY REGIME

South Africa's electrical energy sector at the dawn of democracy was completely encapsulated in ESCOM (later renamed Eskom), a vertically-integrated, wholly coal-dependent and centralized state-owned energy utility. Wielding a total monopoly over electrical generation and transmission infrastructure country-wide (Morris & Martin, 2015), Eskom effectively represents three businesses in the one entity. In 2010, Eskom accounted for 95% of all electricity produced in South Africa (Pegels, 2010).

This was not supposed to be the case however, with the 1998 White Paper on energy, the new government looked to liberalize the national energy sector and increase competition, starting with the restructuring of Eskom into separate generation and transmission companies (Energy, Department of Minerals, 1998), while Eskom's distribution business and the many municipal distributors would merge into six Regional Electricity Distribution (RED) companies (Eberhard, Anton 2005). This was partly driven by South Africa's neo-liberal macro-economic strategy of Growth, Employment and Redistribution (GEAR) (D.o.F, 1996), as well as international pressure to privatize and diversify certain economic sectors, looking to allow independent power producers (IPP) into the energy space (McDonald, 2012).

By 2005 however, plans to semi-privatize parts of the South African energy regime were shelved after strong opposition from labor unions who believed that the public sector would sustain job creation and drive economic development (Morris & Martin, 2015). With no regulatory framework materializing to allow IPPs into the market and the disinvestment by government in new generation capacity in the anticipation of privatization, this period of policy uncertainty coupled with Eskom's underestimation of growing demand would sow the seeds of a looming energy crisis (Pollet, Staffell & Adamson, 2015).

1.1.2 SOUTH AFRICA'S RELIANCE ON CHEAP, DIRTY COAL

South Africa's isolation during the apartheid era and abundant coal reserves have resulted in an energy regime with a high path dependency, relying almost exclusively on fossil fuel as its primary energy source (Pegels, 2010, Pollet, Staffell & Adamson, 2015, Tait & Winkler, 2012). What the new government inherited was an ageing fleet of coal-fired power stations, mostly built during the 80's, yet largely amortized by consumers and able to provide some of the cheapest electricity on earth (Eberhard, Anton 2005).

The industry and mining sectors are by far the largest consumers of electricity in South Africa (Deloitte, 2017), consuming just under two-thirds of total energy generated, while relying on highly subsidized electricity to remain competitive. Much of South Africa's economic output was therefore structurally tied to cheap energy, making it economically and politically difficult to pursue a climate-friendly development path (Tait & Winkler, 2012). This energy is primarily generated by burning low-grade coal, resulting in disproportionately high GHG emissions. Consequently, in 2005 South Africa had a very high average emission rate of 9 metric tons (CO₂ equivalent) per person, almost equaling the European Union average per capita rate of 10.7 (Pegels, 2010).

1.1.3 UNIVERSAL ACCESS TO ELECTRICITY

Besides the growing challenge of climate change, South Africa has had to also grapple with a highly unequal society, a legacy of the apartheid system. Achieving universal access to electricity for households denied by the previous government became one of the key objectives under the Reconstruction and Development Programme (RDP) (Presidency, 1994). Mass electrification programmes increased the number of households connected to electricity from 36% in 1994, to 72% in 2004 (Pegels, 2010). While this possibly contributed to the eventual energy supply crisis, the reality is that the residential sector has a very low per capita consumption. Connecting the additional 3.4million households estimated by the Department of Energy (DoE) in 2011 would have a negligible impact on South Africa's total energy demand or GHG emissions profile (Tait & Winkler, 2012).

1.1.4 ENERGY SECTOR IN CRISIS

January 25th, 2008 arguably marks the beginning of South Africa's energy supply crisis, with government officially declaring a "national electricity emergency" (Patel, 2008). South Africans would quickly realize their absolute dependence on electricity, feeling the bite of frequent supply disruptions in daily life and to the economy (Pollet, Staffell & Adamson, 2015). Eskom and government was fully aware that the energy crunch was coming, with a net reserve margin (excess generating capacity) at a peak of 27.1% in 1999 steadily declining to 5.1% in 2007 (Patel, 2008).

Investment in new generation capacity in the form of coal-fired power plants Medupi and Kusile, simply came too late to avoid the rolling blackouts (Krupa & Burch, 2011, Morris & Martin, 2015). The perfect storm of mass electrification, strong economic growth, poor load planning, erosion of management and technical expertise, and deficient coal supplies led to demand outstripping available supply. Compounding matters, Eskom's net reserve margin has effectively remained at or below 10% since 2004, resulting in generation capacity routinely operating at peak levels, ruling-out preventative maintenance and further increasing supply instability (Krupa & Burch, 2011).

1.1.5 CLEANER WINDS OF CHANGE

The era of cheap energy (by global standards) however had come to an end. NERSA approved sharp energy tariff increases after consistent pressure from Eskom looking to increase revenue to fund the construction of Medupi and Kusile. Companies and sectors that had previously benefitted from subsidized electricity prices had to quickly adapt, investing in energy efficient technologies and optimizing processes to reduce operating overheads tied to energy consumption (Deloitte, 2017).

Increasing pressure to move away from coal came in December 2009 when former President Jacob Zuma, speaking at the United Nations Climate Change Conference (COP15) in Copenhagen, "pledged to reduce the country's greenhouse gas emissions by 34 per cent by 2020 and 44 per cent by 2025, which he claimed was consistent with its Long-Term Mitigation Scenarios (LTMS) endorsed by his Cabinet in 2008" (Baker, Lucy, Newell & Phillips, 2014:791). This was not however a commitment to reduce emissions in absolute terms, but was in relation to a 'Growth without Constraints' baseline representing projected growth in emissions based on a 'business-as-usual' scenario.

This commitment was still a significant gesture, especially considering that South Africa as a non-Annex 1 country, had no obligation under the Kyoto Protocol to contribute to GHG reduction (Eberhard, Anton, Leigland & Kolker, 2014). As astonishing as this commitments seems, it is still shy of the 76% plus reduction highlighted by the LTMS to curb GHG emissions to levels as required by science (Scenario Building Team, 2007:25). Whether South Africa will meet these targets remains to be seen, but the LTMS continues to inform future generation planning that firmly includes renewables in the country's energy mix (Morris & Martin, 2015).

1.1.6 SOUTH AFRICA'S NASCENT ENERGY TRANSITION

Perhaps fortuitously, South Africa's energy supply crisis could not have occurred at a better time in history. After much faltering, the crisis provided the impetus to resolve the policy and regulatory barriers that had hampered the entry of renewable technologies and IPPs into the energy space (Morris & Martin, 2015). Plans in 2006 by the National Energy Regulator of South Africa (NERSA) to introduce the Renewable Energy Feed in Tariff (REFIT) (to incentivize private investment in renewable energy generation) were stalled by national Treasury in 2011 after deemed non-compliant with procurement regulations. With the country continuing to suffer from intermittent load-shedding, Eskom's resistance towards renewables decreased as pressure mounted to find alternative to plug the generation gap. By the end of 2011, the Renewable Energy Independent Power Producer Program (REIPPP) was finally launched by the Department of Energy (DoE) on a competitive bidding process, with quickly realized renewable energy projects presenting an opportunity to bring additional generating on line. This confluence of crisis coupled with concerted bureaucratic effort finally opened a window of opportunity to establish a nascent renewable energy sector in South Africa. With world leaders headed to South Africa for COP17, hosted in Durban in December 2011, the REIPPP was launched just a few months before in anticipation of world attention.

1.1.7 A WINDOW OF OPPURTUNITY

The REIPPP in its first 3-4 years was a resounding success, attracting over US\$14 billion in mostly foreign and private investment by 2015 (Pollet, Staffell & Adamson, 2015), resulting in over 3900MW of renewable energy committed to South Africa's energy sector. This early success would however temporarily grind to a halt towards the end of 2014 and would only again gain momentum in mid-2016. It was around this time that forces of 'state capture' within Eskom had begun stalling the finalization of approved REIPPP projects. Resources within Eskom were being redirected to assist politically connected individuals to acquire uranium and coal mines, negotiate new lucrative supply contracts, and push the agenda to build a fleet of new nuclear power stations. Before the nuclear-build contract could be signed by the government, a successful court challenge and change in political leadership would spare South Africans committing to an estimated debt of close to R1 trillion. During this period, energy experts argued that Eskom and the Department of Energy deliberately underestimated the true cost of electricity generated by nuclear in order to rationalize the massive investment programme. In contrast, with each successive REIPPP bid window, the cost of generating energy from renewable power stations quantifiably and steadily decreased (Bischof-Niemz, Tobias, 2015, Eberhard, Anton & Naude, 2017), following global trends where the Levelized Cost of Electricity (LCOE)¹ for solar photovoltaics (PV) and onshore wind is comparable or cheaper than fossil fuel generation (NERSA, 2018).

In 2016, 88% of all electricity generated in South Africa came from burning coal (Maluleke, 2016), highlighting the country's continued dependence on this fossil fuel. This should however slowly improve, with the Draft Integrated Resource Plan 2018 calling for an additional generating capacity of 19 400MW by 2030 from various RETs (NERSA, 2018). Included in this renewable energy future are cities, with 200MW planned annually for new embedded generation capacity, mostly expected to come from rooftop PV exploiting South Africa's vast solar energy potential (Fluri, 2009, Kritzinger, 2017). The Feed-in Tariff (FIT) type pricing schemes introduced by cities and allowed by NERSA have also eroded Eskom's monopoly control over energy generation (NERSA, 2011). Although still very limited in scope and capacity, embedded generation directly challenges established generation and power purchase norms between local level government and the national utility.

1.1.8 RESISTANCE TO CHANGE

Although South Africa's energy future looks bright, there remains structural challenges that continue to pose a risk to the nascent sustainability transition in the energy regime. Eskom remains a vertically integrated monopoly, still able to control the energy value chain through access to its distribution and transmission networks, while under the Electricity

¹ LCOE is the cost of generating electricity in relation to the capital investment over the lifetime of the power plant levelized across all generation technologies.

Regulation Act 2006 remaining the sole purchaser of any power generated at a significant scale (Morris & Martin, 2015). Eskom's future is highly uncertain however, with rampant corruption crippling good governance, the risk of facing a 'utility death spiral' caused by hiking tariffs and growing debt (Eberhard, Anton & Godinho, 2017), the likelihood that it remains in its current configuration is practically impossible.

1.2 SUSTAINABILITY TRANSITIONS – A THEORETICAL LENS

South Africa's energy sector has seen significant change over the last twenty years, particularly the introduction of REFIT incentives and entry of renewable energy IPPs through the REIPPPP, challenging Eskom's centralized generation fleet, dependence on fossil fuels and monopoly control over transmission and distribution networks. This reflects a system in transition; in the process of slowly reconfiguring to a more sustainable mode of energy generation.

This process of change is often driven by the emergence of an innovative technology or new disruptive way of doing things, and often involves a complex network of individuals, companies, institutions and organizations representing different interests and goals. There is a large body of research dedicated to these so-called sustainability transitions, exploring the relationship between technology, its adoption, diffusion and eventual wide-spread use by a society.

One key theory in this the literature of sustainability transitions is the Multi-Level Perspective (MLP), which has proven its utility in understanding these processes. There have been several recent studies of South Africa's changing energy sector that have employed a multi-level approach to the unpack the complex subject matter (Baker, Lucy, Newell & Phillips, 2014, Morris & Martin, 2015, Swilling, Musango & Wakeford, 2015), resulting in a detailed narrative and sequence of events (political and structural) affecting the transition.

The MLP looks to understand the changes in the socio-technical system and how innovations in technology or landscape changes in society force existing regimes to transform. MLP focuses on three analytical levels and the interactions between various actors within these. The Niche level is where the disruptive technology is located and challenges the existing Regime, which represents the current state of the socio-technical system. The third level, Landscape, looks to understand how slow changes in broader society also exerts pressure on the existing Regime. MLP is mostly founded on the study of historic socio-technical systems and therefore has a distinctly narrative based approach, relying heavily on the in-depth insights of actors such as experts or innovators involved in the system. Another suitable theoretical framework used to analyses STs are Innovation Systems (IS), which look to understand how new technology is *generated*, *diffused* and *used* by society. This can be done at various system levels, either looking at the generation of knowledge that leads to emergent technology at the national (NIS); regional (RIS) and sectoral (SIS) level. Innovation systems can also zoom into the niche level by focusing on a specific technology using the Technology Innovation System (TIS). TIS and the MLP are therefore complementary frameworks that work at understanding STs using similar socio-technical levels as suitable layers to be studied.

1.3 PROBLEM STATEMENT

South Africa has abundant renewable energy resources that remain largely untapped, yet the existing energy regime is characterized by its persistent and mostly homogenous generation fleet of coal-fired power stations. State-owned energy utility Eskom, represents a centralized energy monopoly system with few alternatives for customers seeking alternate supply options or wishing to contribute to mitigating climate change through renewable energy sources.

Embedded generation (EG) of electrical power in the South African built environment had for 3 decades been characterized by the lone wind turbine or cluster of photo-voltaic panels in isolated island installations. The recent introduction of feed-in tariffs in the major cities represents a shift in the energy regime that could transform buildings; where whole facades and roof-tops become mini power stations, not only meeting their own energy needs, but generating excess power to be sold back to the grid. The diffusion of renewable energy technologies (RETs) embedded throughout South African cities has seen sudden and exceptional growth.

It thus seems that a transition towards a more sustainable built environment has started to happen. Such transitions have been theorized elsewhere, but have seen very few studied through appropriate theoretical frameworks in the context of South Africa's built environment (Bulkeley et al., 2010).

1.4 OBJECTIVES

The primary goal of this research is to gain valuable insights into the sustainability transition South Africa is undergoing in its energy sector and specifically how this could impact the built environment of the major cities. The inspiration for this research has been broadly founded on R.B. Melamu's study of waste-based bioenergy in South Africa (Melamu, 2014), adopting similar objectives to understand the ongoing transition. Yet, sustainability transitions themselves are very complex and lengthy processes and any observations that might be understood at a present point in time might quickly change. By identifying a specific renewable energy technology embedded in the transition, it is hoped that more lasting observations could be gleaned, at least aiding the diffusion and use of a specific TIS in South Africa's cities. To achieve this, a market survey of built environment professionals and users of EG will be conducted to identify a dominant technology, while also serving to analyze the motivations and considerations of these niche-level actors. The objectives of this research are therefore threefold:

1. To explore how embedded generation has developed to date in South Africa's major cities
2. To explore the utility of an interdisciplinary approach using different aspects of the MLP and TIS theoretical frameworks to better understand the trajectory of the ongoing sustainability transition in the South African energy sector.
3. To investigate how the TIS approach can support the diffusion of RETs, thereby exploiting South Africa's abundant renewable energy potential and how this could impact embedded generation applications in major city centers.

1.5 SCOPE

This research will trace the journey of the incumbent South African energy regime over the last 20 years, from its repositioning in post-apartheid South Africa to the sustainability transition visibly taking place in the built environment of its cities. It will investigate what technologies are being adopted for embedded generation (EG) applications and how EG is being dealt with in the current regime.

The study is focused on the metro cities that have implemented REFIT structures, based on the premise that due to the scale of these localized economies there will be the greatest demand (reliable energy, marketing, global awareness) and capital to implement EG solutions in the built environment. It is expected that EG will be more prevalent in these centers and will therefore provide the most available data. Other smaller cities might have consumers faced with similar or other pressures (geographic distance from generation sources etc.) that make EG desirable but may lack the capital to implement. This study will therefore not assume to be representative of all South African built environments, but it is expected to provide insights to global system challenges and issues that are likely to be encountered.

The growth of RETs in cities is also believed to be structurally coupled to the REIPPPP, which has driven foreign investment; entry of renewable product manufacturers and suppliers into the local market; has increased the legitimacy and diffusion of renewable products; increased competition and has driven down the cost of embedded generation systems dramatically. Therefore, whilst the REIPPPP is not the focus of this research, its history is relevant and thus included in the analysis.

An interdisciplinary research approach is intended, using the MLP to frame a broad contextual narrative of the energy sector, while a specific TIS located within the current transition was identified as a focal lens to guide the research and limit system complexity. A market survey of RET in EG applications was conducted early on in the study to identify a dominant technology. The survey is used here as a theoretical bridge between the two frameworks, simultaneously providing data on the focal technology (satisfying the analytical requirements of the TIS component), while also studying the users of the technology at the niche level of the MLP. The survey was targeted at actors involved in the procurement, design, specification, installation and supply of RETs in the built environment. It was quickly determined that solar PV was the most prevalent RET of choice. This became the focus of the TIS study and also the lens through which to study the broader national RE transition as reflected by the REIPPPP. Although PV (as identified by the market survey) represents a mature technology that crosses geographical boundaries and could be studied on a global scale (Hekkert et al., 2007), this research will limit itself to the local context.

CHAPTER 2 LITERATURE REVIEW

2.1 TECHNOLOGICAL TRANSITIONS & SUSTAINABILITY

This literature review will discuss key concepts, analytical methods and theoretical touch points between two specific frameworks guiding this research, how they have evolved over time and how they complement each other in research applications. The first is the Multi-level Perspective (MLP), a mid-range (meso-level) framework developed to understand socio-technical transitions through a construction of a narrative. The second theoretical framework is the Technology Innovation System (TIS), an offshoot from other innovation systems frameworks that focusses on a specific technology, see **Figure 1**. Both theoretical frameworks have grown out the field of research known as *technological transitions*. This body of literature concerns itself with how innovative novelties replace an incumbent technology widely used by a society. Since the technological dimension cannot be separated from user practices, habits and institutional structures (cognitive, normative and formal rules) that society constructs around the use of technology, this process is more accurately referred to as socio-technical transitions (Geels, Frank W., 2002, Geels, Frank W., 2004, Markard, Raven & Truffer, 2012).

Awareness of unsustainable resource consumption and environmental degradation caused by human activity has grown globally and across all fields of research. The link was soon made through understanding technological transitions in relation to human-driven climate change and the duality of technology's role, implicated as a historical 'source of the problem', while also offering the 'possible solution' (Rip & Kemp, 1998). As such, the view of socio-technical transitions has become more purposive than the mere changeover from one technology to another and they are now also studied under the umbrella of sustainability transitions (ST). "Sustainability transitions are long-term, multi-dimensional, and fundamental transformation processes through which established socio-technical systems shift to more sustainable modes of production and consumption" (Markard, Raven & Truffer, 2012:956), the understanding of which can be used to provide guidance to policy-makers and institutions to support these transitions (Smith et al., 2005).

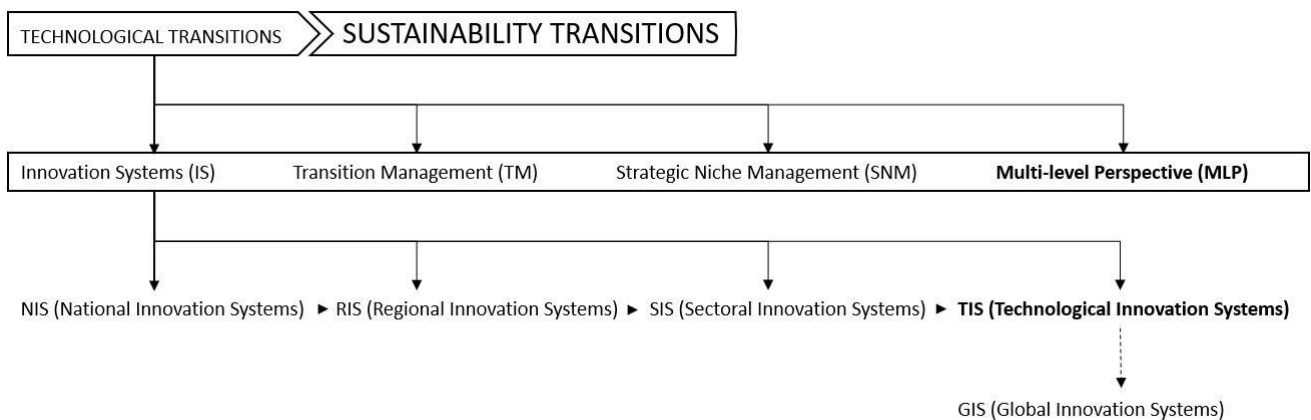


Figure 1: Stylized theoretical landscape, adapted from (Binz & Truffer, 2017, Markard, Raven & Truffer, 2012).

2.2 THE MULTI-LEVEL PERSPECTIVE & TECHNOLOGICAL INNOVATION SYSTEMS

Both the MLP and TIS describe transitions through innovation processes and both share roots in evolutionary economic theory (Suurs, Roald AA, 2009). From an evolutionary perspective, both socio-technical transitions and innovation systems are fundamentally concerned with understanding the 'selection process' that occurs when a new technology emerges in society. Naturally, there has been significant interplay between MLP and TIS literature over the years, with dominant authors from both theoretical camps engaging in critical discourse.

The MLP grew out of the 'multi-layered backdrop of novelty and irreversibility' (Rip & Kemp, 1998) and primarily is concerned with the processes that lead to fundamental change at the regime-level of sociotechnical transitions (Geels,

Frank W., 2004, Rip & Kemp, 1998), as understood through the interactions between actors located in the micro-level niche and the meso-level regime of the socio-technical regime; against the backdrop of the macro-level socio-technical landscape (Geels, Frank W., 2002, Geels, F. W., 2005). Changes in the regime are seen as a continuous process of co-creation and reconstruction by actors within the socio-technical system.

TIS on the other hand is a more rigid ‘functional’ theoretical framework established to measure the performance the innovation and system building processes through ‘actors’ or a ‘network of agents’ working within institutional structures whose goal it is to ‘develop, diffuse and use’ new technologies (Carlsson & Stankiewicz, 1991, Jacobsson & Bergek, 2011, Markard & Truffer, 2008). TIS evolved out of larger-scale innovation system frameworks (national, regional and sectoral innovation systems) to focus on a specific technology or area of knowledge production and is focused mainly on institutions as drivers of technological transitions.

2.3 FRAMEWORK SIMILARITIES

MLP and TIS theoretical frameworks have similar structuration, although TIS is not based on a nested hierarchy like the MLP, the key focal areas of analysis display a degree of equivalence. What differentiates the approach of both frameworks is that MLP is concerned with understanding processes at the regime level while TIS focuses on the complementary functions delivered by different actors related to the technology studied, refer to **Table 1**.

Table 1 below: Theoretical structure comparison adapted from (Bergek et al., 2008, Bergek et al., 2015, Geels, F. W., 2005, Geels, Frank W. & Schot, 2007, Grin, Rotmans & Schot, 2010, Hekkert et al., 2007, Markard & Truffer, 2008)

FRAMEWORK EQUIVALENCE			
MLP	TIS	MLP	TIS
GOALS		Regime change and therefore focusses on the regime level Meso-level focus on the structure of the incumbent regime and how this resist change	Support the creation, diffusion and use of innovative technologies in society – Micro-level focus on specific technology
ACTORS & NETWORKS ² (socio-technical system)		<i>Financial Network:</i> Venture capital suppliers; Insurance firms <i>Suppliers:</i> of labour (skilled & unskilled), materials, components, tools, machines <i>User Groups:</i> Consumer markets; Distribution networks; Repair and maintenance <i>Societal Groups:</i> Media; NGO’s, Advocacy groups; Schools <i>Producer Network:</i> Design firms; Consultancies; <i>Public Authorities:</i> National Ministries; Regulators; Policymakers; Standards organizations <i>Research Network:</i> Universities; Technical institutions	Entrepreneurs Organizations: private firms, governmental departments, NGO’s, universities, research facilities, venture capitalists, associations (Markard & Truffer, 2008) Networks of agents interacting through institutional structures involved in the <i>generation, diffusion and utilization</i> of technology (Carlsson & Stankiewicz, 1991)

² Actor networks adapted from Geels, 2002 pg. 1260 and Geels, 2004 pg. 901

NICHE	↔	TECHNOLOGY	Protected evolutionary spaces in which innovative technological emerges and is free to experiment	Focused on a specific innovative technology
REGIME	↔	INSTITUTIONS	'rules of the game' & 'lock-in' MLP places a great deal of emphasis on the Regime as it defines the entrenched rules of the system and is therefore the most resistant to change - 'lock-in'. Formal - Laws Normative – Norms and standards Cognitive – Beliefs and values	Institutions represent the 'rules of the game' ³ (Suurs, Roald A. A. et al., 2010) Institutions: Culture Norms Laws Regulations Routines Shared expectations
LANDSCAPE	↔	CONTEXT ⁴	Landscape, in the broad sense can be describe as the context within which the socio-technical system is located. The landscape can slowly exert pressure that can effect change but these are entirely external to the regime.	Context was introduced into the TIS framework to represent external landscape forces impacting the transition (Bergek et al., 2015)

Table 1: Theoretical structure comparison adapted from (Bergek et al., 2008, Bergek et al., 2015, Geels, F. W., 2005, Geels, Frank W. & Schot, 2007, Grin, Rotmans & Schot, 2010, Hekkert et al., 2007, Markard & Truffer, 2008)

2.4 THE MULTI-LEVEL PERSPECTIVE (MLP)

The multi-level perspective as an overall framework explains socio-technical transitions by the interplay of processes and event sequences through the nest hierarchy of the niche, regime and landscape levels of the socio-technical system (Geels, Frank W., 2002, Geels, F. W., 2005, Grin, Rotmans & Schot, 2010). The basic structure of the sociotechnical systems is the Production of Artefacts; Distribution (networks/markets/infrastructures); Use of artefacts in user practice (Geels, Frank W., 2004:900). Individual actors, communities and larger networks groups constitute the organizational fields of the niche and regime level.

“The key concept of the framework is the socio-technical regime, a coherent, highly interrelated and stable structure at the meso-level characterized by established products and technologies, stocks of knowledge, user practices, expectations, norms, regulations, etc. From the evolutionary perspective, a regime represents the selection environment for technological development in a certain field or sector, thus exerting a significant barrier for radical innovations to diffuse” (Markard & Truffer, 2008:603).

2.4.1 NICHE

Niche represents the micro-level ‘incubation room’, protected from mainstream market and regime selection pressures, where ‘radical’ and ‘unstable’ innovations or new socio-technical practices can emerge and survive as they look to destabilize the incumbent regime and push for far-reaching change (Geels, Frank W., 2002, Geels, Frank W. & Schot, 2007, Markard & Truffer, 2008). Transition Management (TM) is sub-theory of IS that looks to support niches by guiding policy to encourage “desirable technological configurations by promoting protected institutional and market niches in which favored configurations are supported and allowed to prosper, enabling them either to replace or transform dominant, unsustainable regimes” (Berkhout, Smith & Stirling, 2004:3).

³ The phrase ‘rules of the game’ first used by North, D.C., 1990. Institutions, Institutional Change and Economic Performance. Cambridge University Press, New York.

⁴ Context framework that begins to represent the socio-technical landscape of the time introduced by Bergek et al., 2015

2.4.2 REGIME

Regime represents the meso-level (Geels, Frank W., 2002) in which the incumbent technology is located (Hekkert et al., 2007). The regime can also be considered as the selection environment as well as potential barrier to the diffusion of a radical innovation (Markard & Truffer, 2008). Regimes consist of larger and highly structured networks of actors that have a highly developed set of rules that govern their actions. These rules could be *regulative*: legally sanctioned 'rules of the game' like laws and regulations; *normative*: the morally governed values, norms and codes of how things should be done; or *cognitive*: the culturally supported beliefs, priorities, heuristics or paradigms of shared ideas (Geels, Frank W., 2004). The regime is therefore very stable, "embedded in a complex of engineering practices, production process technologies, product characteristics, skills and procedures, ways of handling relevant artefacts and persons, ways of defining problems; all of them embedded in institutions and infrastructures" (Rip and Kemp, 1998: 340). Regimes in an environment devoid of external landscape pressures or radical innovations will change very slowly as they 'generate incremental innovations that strengthen the regime' and perpetuate 'lock-in' (Markard & Truffer, 2008).

2.4.3 LANDSCAPE

The socio-technical landscape represents the macro-level of the MLP (Geels, Frank W., 2002). Unlike the niche or regime, the landscape figuratively describes a structure that changes very slowly, like a literal geological landscape slowly shaped by wind and water erosion (Rip & Kemp, 1998). This landscape does not directly determine change or act, instead it represents the deep structure of the socio-technical system, which can make some actions easier or place slow but gradual pressure on socio-technical regimes (Geels, Frank W. & Schot, 2007). One example of deep structure would be cultural or social values, located in the landscape level, these will guide the configuration of regimes on a very subtle but fundamental basis.

2.5 TRANSITION PATHWAYS OF THE MLP

Geels built his dynamic multi-level perspective model on the on the 'innovation journey' described by Rip & Kemp (Rip & Kemp, 1998). This dynamic model stylizes how the niche, regime and landscape levels interact during a socio-technical transition, refer **Figure 2**. The ideal model demonstrated how many experimental 'novelties' slowly coalesce into a dominant technology that begins to exert pressure on the incumbent regime. Greater diffusion relies on some form of landscape development that disrupts the regime and opens 'windows of opportunity' for the niche innovation break through. From an evolutionary perspective, the landscape and regime levels mimic the environmental conditions and selection processes in which the niche technology must seek to survive and thrive.

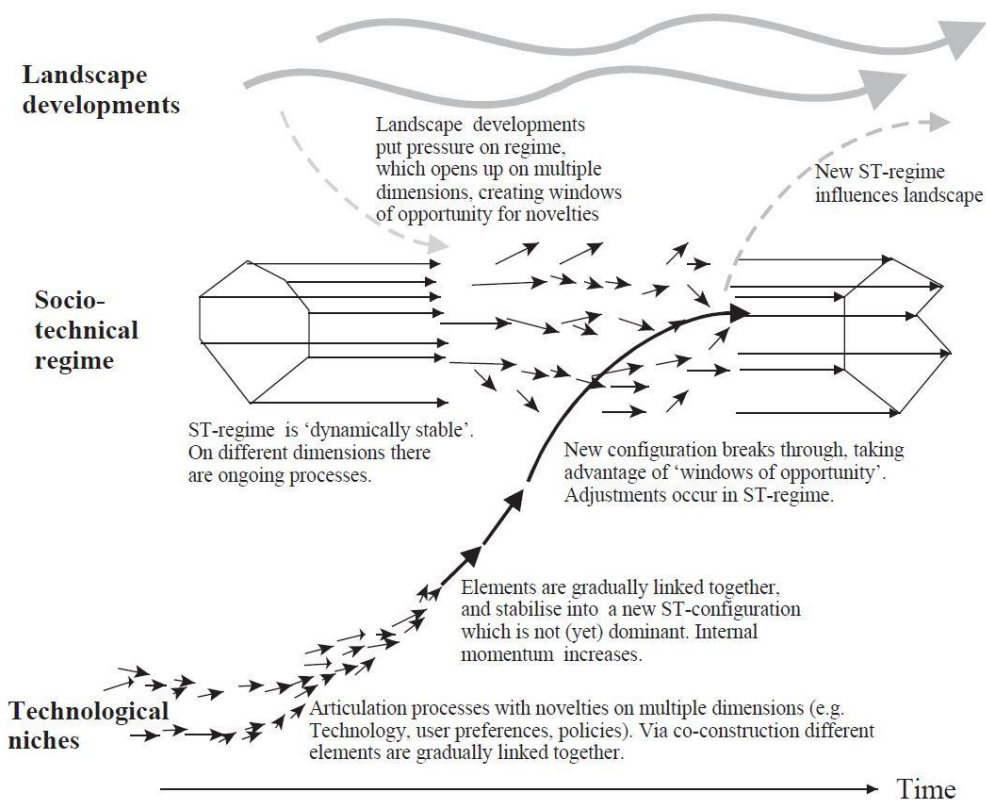


Figure 2: A dynamic multi-level perspective on system innovations (Geels, F. W., 2005).

Early iterations of the MLP were constructed by analyzing historical transitions and therefore the narrative approach resulted in the framework appearing teleological and preoccupied with niche level processes, focused on ‘*unilinear*’ bottom-up system change (Berkhout, Smith & Stirling, 2004). It was also argued that narratives of regime change in the literature seemed ‘*unidimensional*’ when it came to describing transition contexts. Calling for a more robust and nuanced analytical framework, Berkhout, Smith & Stirling proposed four ‘ideal types’ of transitions that regimes could undergo; ‘*endogenous renewal*; *re-orientation of trajectories*; *emergent transformation*; and *purposive transitions*’ (Berkhout, Smith & Stirling, 2004, Smith, Stirling & Berkhout, 2005). In response, Geels built on these ‘ideal types’ and developed two early transition models to overcome a ‘bottom-up’ niche bias and disaggregate timing of events in the three levels of the framework (Geels, F. W., 2005, Geels, Frank W., 2011, Geels, Frank W. & Schot, 2007). These early models quickly progressed with Suarez & Oliva’s study of attributes of change and their resulting typologies (Suarez & Oliva, 2005), with Geels presenting the four ‘*transition pathways*’ that are now fundamental to the MLP framework. The definitions of the transition pathways that follow combines descriptions from both recent socio-technical transition and innovation system scholars.

Transformation pathway

Moderate landscape pressure causes disruptive change when niche-innovations or a TIS are not yet substantially developed. Regime resistance is large because of internal efforts of regime-actors to respond to the landscape pressure, by changing the direction of development paths within the dominant socio-technical design and increasing innovation activities. The pressure to look beyond regime boundaries is not significant, with regime actors looking to incrementally develop upon the incumbent technology system, only slowly and hesitantly looking outside the regime for alternatives. (Grin, Rotmans & Schot, 2010, Walrave & Raven, 2016)

De-alignment and re-alignment pathway

If landscape pressure is sudden, divergent and large (avalanche change) regime-actors lose faith in the existing socio-technical regime with regime resistance to change being low. This leads to de-alignment and erosion of the incumbent regime and encourages the proactive search for alternatives by regime-actors. If this occurs when niche-innovations or a TIS are not yet substantially developed, then there is no clear substitute, creating space for multiple niche-innovations

or TIS to emerge, temporarily co-exist and compete for attention and resources. Eventually, one becomes dominant, forming the core for re-alignment of a new regime. (Grin, Rotmans & Schot, 2010, Walrave & Raven, 2016)

Technological substitution pathway

If there is much landscape pressure (specific shock, avalanche or disruptive change) occur at a moment when niche-innovations or a TIS has benefited from previous substantial support and development efforts, then it is possible that the new innovation may break through and replace the existing regime. Regime resistance may be high if regime-actors continue to support the incumbent socio-technical configuration through innovative efforts. This pathway can be considered to potentially be the quickest but most contested transition route. (Grin, Rotmans & Schot, 2010, Walrave & Raven, 2016)

Reconfiguration pathway

If landscape pressures occur at a moment when niche-innovations or a TIS are already substantially developed and regime-actors have already started adapting (elements of) this innovation system into the existing socio-technical regime to solve local problems, this implies that these innovations are already partially symbiotic with the regime and therefore resistance is relatively low. This slow adoption will subsequently trigger further adjustments in the basic architecture of the regime. (Grin, Rotmans & Schot, 2010, Walrave & Raven, 2016)

2.6 TECHNOLOGICAL INNOVATION SYSTEMS (TIS)

The formalized TIS analytical framework emerged as a specific technology focused evolution of the earlier innovation systems; NIS, SIS and RIS frameworks (Bergek et al., 2006, Bergek et al., 2008, Hekkert et al., 2007). Innovation Systems are based on systems theory, where the “system is a theoretical construct, a model of reality designed to be analyzed” (Markard & Truffer, 2008:598). Development processes in the system are understood through the logic of sequential events and ‘functions’ (Suurs, Roald AA, 2009). Functions are emergent processes that describe the ‘structural characteristics and dynamics of an innovations system’ through the ‘interplay between actors and institutions’ (Bergek et al., 2008, Markard & Truffer, 2008). Innovation systems can therefore be assessed by the functions achieved or fulfilled in order to support developments within transitions through targeted recommendations, policy decisions and goals (Bergek et al., 2006, Bergek et al., 2008, Hekkert et al., 2007, Markard & Truffer, 2008). Seven functions have been identified ‘that directly influence the development, diffusion and use of new technology’ in a focal TIS (Bergek et al., 2008). An analytical framework was developed to represent the various activities or actions of actors and institutions in the system building process. Key events are identified in the creation of an *event history analysis* (EHA) timeline (Suurs, Roald AA, 2009) with functions assigned to each event depending on the activity and its set of indicators.

Table 2 summarizes the seven functions and their indicators (Bergek et al., 2008, Hekkert et al., 2007) as adapted by Kebede & Mitsufuji to suit their TIS study of solar PV introduction in Ethiopia (these functional indicators have been adopted for this study as they are better suited to the South African context). Another significant change to the earlier functional frameworks was their reclassification of government procurement programs as an indicator of [F5] *market formation* as opposed to [F6] *resource mobilization* events. This has proved to be more nuanced as an analytical tool while constructing the EHA timeline and will be discussed in greater detail in the analysis section of this research.

Table 2 below: System functions and indicators as adapted by (Kebede & Mitsufuji, 2017:244)

Functions	Descriptions	Indicators
F1: Entrepreneurial activities	Such activities form the core of any innovation system and involve trials of innovative commercial and/or demonstration experiments.	Entry of firms to PV market; Launching pilot PV projects; Experimenting new applications of PV
F2: Knowledge development	This function involves learning by doing and searching and addressing the socio-economic, technical and market related issues about the new technology.	Conducting feasibility studies; PV market research, appraisal and evaluation studies; Testing new models

F3: Knowledge diffusion	This function involves learning by using and interacting through networks and/or communication of knowledge among actors in networks.	Trainings of PV technicians, entrepreneurs, users; Organizing seminars, workshops & conferences; Conducting promotion campaigns
F4: Guidance of the search	This function encompasses activities positively affecting the visibility and clarity of specific wants among technology users.	Formulating policies, rules & regulations; Planning targets; Publicizing expectations; Showing interest
F5: Market formation	It involves the creation of markets, where new technologies have a possibility to grow.	Providing subsidies, tax exemptions, and other incentives; government procurement programs; Standardizations
F6: Resource mobilization	This function involves mobilizing material and nonmaterial resource inputs to the innovation system development.	Providing R&D budgets; Launching PV related educational programs; Providing financial grants and loans for companies; Funding scale up PV projects
F7: Creation of legitimacy	This function encompasses advocacy efforts for enhancing stakeholder support to the new technology.	Conducting lobbying and advocacy programs

Table 2: System functions and indicators as adapted by (Kebede & Mitsufuji, 2017:244).

2.6.1 MOTORS OF INNOVATION

Motors of Innovation (MoI) has emerged as the principal analytical framework for assessing the strength and describing the performance of a TIS (Suurs, Roald AA, 2009). Four motors have been described through the analysis of multiple case studies and identifying common activities and dynamic motors that drive certain phases of the development of a TIS, from early formation through to technological and institutional maturity. The motors of innovation were derived to work in harmony with the EHA timeline. Each event in the EHA is assigned a function (**Table 2**), after which the MoI can be used to identify phase of TIS development within the timeline and then provide an analytical tool to determine what motors are present and dominant in each discreet phase, refer to **Table 3**. This is particularly valuable from an innovation policy perspective as it allows the researcher and policy-makers to identify what blocking mechanisms are present and are preventing development of the TIS.

Table 3 below: Summary of functions present in the Motors of Innovation (Suurs, Roald AA, 2009). Functions most significant to the formation of a particular motor shown in **[BOLD]**.

Motor of Innovation	Indicators in the EHA	Dominant Functions
The Science and Technology Push (STP) Motor	This motor is dominated by activities and institutions that direct and create knowledge (research institutes, universities, feasibility studies, workshops, conferences, R&D etc.). Resource Mobilization [F6] is focused on R&D programs that will kickstart [F1] activities (pilot and demonstration projects). All other system functions may be very weak or totally absent.	[F2], [F3], [F4], [F6]
The Entrepreneurial Motor	This motor sees the strong fulfilment of functions present in the STP Motor; [F2], [F3], [F4], [F6]. This period represents an emerging technology looking to enter the market. [F1] activities increase as entrepreneurs explore commercial applications and opportunities. [F7] activities also increase as innovation champions advocate for the technology's	[F1], [F2], [F3], [F4], [F5], [F6], [F7]

	diffusion and use, lobbying government or venture funding to invest. This could unlock funding [F6] that kickstarts more [F1]. Also important is the formation of market niches [F5].	
The System Building Motor	This motor is functionally similar to the previous motor but market formation [F5] plays a stronger role. This period should also see [F4] and [F7] activities that support [F5] through the formulation of conducive policy, rules and regulations, helping in reconstructing the incumbent regime. This should mobilize more resources [F6], thereby encouraging new entrants [F1] and formation of a mass market.	[F1], [F2], [F3], [F4] , [F5] , [F6], [F7]
The Market Motor	This motor represents the substantial acceptance of the TIS within the regime. All functions are being reinforced by a fully-formed consumer market. Reliance on subsidies and incentives should decrease as the market becomes self-sustaining. [F7] advocacy activities become less important as [F5] is no longer reliant on political intervention to support market formation.	[F1], [F2], [F3], [F4], [F5], [F6], [F7]

Table 3: Summary of functions present in the Motors of Innovation (Suurs, Roald AA, 2009). Functions most significant to the formation of a particular motor shown in **[BOLD]**.

2.7 THEORETICAL CONVERGENCE – TOWARDS AN INTEGRATED FRAMEWORK

The MLP and TIS frameworks have evolved quite separately, although they have often intersected when researchers in both fields have applied an interdisciplinary approach to deal with spatial and historical context (Markard & Truffer, 2008, Markard, Raven & Truffer, 2012). While leading scholars from both camps were happy to critique, propose changes or borrow from the other theoretical framework, it was Markard & Truffer that first explored a formalized integrated approach, fusing aspects of MLP and TIS to overcome perceived and persistent weaknesses in both analytical frameworks (Bergek et al., 2015, Markard & Truffer, 2008).

Two of the key reoccurring criticisms of the MLP and TIS frameworks is that the former is often too ‘fuzzy’, lacking the ability to make concrete findings that can be used to impact the trajectory of a transition; while the latter is so focused on the emerging technology that it lacks a greater awareness of the contextual landscape in which it is embedded (Grin, Rotmans & Schot, 2010). MLP has emerged as a mid-level (meso) framework (Geels, Frank W., 2004, Geels, Frank W., 2011), mostly focused on the regime which “provides a useful overall plot (‘global model’) for studying transitions,” (Geels, Frank W., 2011:35). Even though TIS has been critiqued for its narrow specific technology focus, the functionalist approach could still account for “both endogenous and exogenous structural elements that influence the dynamics of the system” (Markard, Hekkert & Jacobsson, 2015:76). Numerous socio-technical scholars however have argued that the goal of TIS, where ‘success’ depends on the performance of a specific technology, might make it myopic to the interplay of multiple niches within the regime, thereby misreading the overall sustainability transition.

TIS does not differentiate between radical and incremental innovations like the MLP (Markard & Truffer, 2008), yet it can still either display regime or niche-like characteristics depending on the maturity of the technology being analyzed. The functional analysis highlights production activities as the dominant functional process, this could suggest incremental technological change and that the TIS is regime-like. If innovation processes are dominant (like R&D), then the TIS could be considered to be niche-like. Another advantage of TIS is that the focus on technology can help to functionally understand regime resistance as it can be analyzed both at the meso-level (regime) and at the micro-level of the niche (Markard & Truffer, 2008). A focal TIS could therefore be appropriately representative of niche(s) present in the socio-technical system.

The MLP and its narrative driven analytical approach has been used in the past to frame the contextual surroundings of TIS studies (Melamu, 2014). However, the narrative approach is highly dependent on the ‘experts’ to validate or refute findings, which is where the more elaborate and systematic analytical framework of TIS, using structural and functional tools can possibly strengthen the narrative (Markard & Truffer, 2008). Both frameworks rely on the analysis of events, however the TIS framework provides a more robust methodology for constructing an EHA timeline. Geels acknowledges that the MLP could benefit from ‘process theory’ methods like event-sequence analysis but cautions that the framework should not be reduced to a mechanical procedure (Geels, Frank W., 2011).

2.7.1 CONSTRUCTING CONTEXT IN TIS

Responding to this call for greater contextualization and perhaps an integrated MLP & TIS framework, Bergek et al. (2015) attempted to develop a coherent conceptual framework that explicitly accounts for interactions between a TIS and its context (Bergek et al., 2015). Greater understanding of the context in which a focal TIS is embedded can improve the TIS framework as a tool for developing favorable policy. Context can vary widely, change over time and will impact the development of technologies differently. Understanding the unique contextual landscape that a focal TIS finds itself in will therefore assist the researcher in the creation of a relevant event-sequence and functional analysis process. The relationship between the TIS and context are labeled ‘TIS-context’ interactions. These interactions can be further classified as either ‘external links’ or ‘structural couplings’, which reflect differing degrees of interdependence (Bergek et al., 2015).

External links represents a similar concept to landscape pressure in the MLP, either sudden shocks or longer-term macro-level developments that occur outside of the TIS. In terms of the South African energy regime context, long-term landscape pressure has been driven by a growing social awareness and political commitments to mitigate climate change. More immediate external links include the development of policy that calls for greater investment in renewable generation capacity in the national energy mix, as well as ongoing episodes of unreliable energy supply from Eskom, resulting in rolling load shedding. Over time, the TIS will mature and external links can become structural couplings, whereby the niche slowly diffuses and becomes aligned within the regime.

Structural couplings are seen as a more important form of interaction, reflecting “shared elements (actors, networks, institutions, technologies) between a TIS and specific context structures” (Bergek et al., 2015:53). Structural couplings can be considered established links between the niche and regime levels of a sociotechnical system. These links can represent a slow progressive transition to a new technology through natural regime reconstruction, or the sudden adoption forced by external landscape shocks. These couplings can either be supported from within the regime or encounter strong resistance; “a renewable energy feed-in tariff (REFIT) is one such example, which may represent a complex compromise of the interests of different renewable energy advocates and broader concerns of political parties, energy sector incumbents and other stakeholders” (Bergek et al., 2015:53). Another area of contention as structural coupling form is the conflict of interest within the regime, particularly where other niches (or TISs) compete for dominance and resources⁵.

To structure these interactions, Bergek et al. propose four typical TIS-context typologies, which have been summarized in the **Table 4** below.

INTERACTION BETWEEN FOCAL TIS & CONTEXT STRUCTURE	DESCRIPTION	COMMON COUPLING

⁵ Conflict of interest in the South African energy generation space is evident in the interactions between IPPs and Eskom throughout the REIPPPP. On the one hand policy documents like the IRPs set generating capacity for renewable technologies, with Eskom mandated as both custodian of the program and mandated as sole energy purchaser. On the other hand, Eskom is still building coal power stations on the basis of utilizing clean coal technologies, while pursuing a new nuclear build program under heavy political pressure and as a sustainable generation technology.

Focal TIS ↔ Other TISs	Interactions between related technologies can either be interdependent ⁶ or competitive ⁷ . Couplings can be structural (e.g. RE policy and REFITT can connect multiple RE technologies and institutions). External couplings are driven by landscape pressure or the sudden need to introduce a new technology.	External/Structural
Focal TIS ↔ Relevant Sectors	Main sector in which the TIS is located will impact the dynamics and function of the focal TIS (e.g. renewable technologies that generate electricity would form part of the energy sector). This interaction can best be understood as the TIS's integration within the regime. If integration is low, then the TIS will appear niche-like and will not participate strongly in sectoral affairs. Sector-level institutions will also impact the focal TIS through policy and sectoral frameworks ⁸ . Couplings will mostly be of an external nature, beyond the control of the TIS as the incumbent regime deals with pressure exerted by the TIS.	External
Focal TIS ↔ Geographical Context	Geographical context can imply the socio-technical landscape in which a novel technology emerges locally, or the broader global context, where a technology has been primarily developed in another country and has been adopted. In the case of a global context, structural couplings with TIS structures may include transnational research institutions, consultants, product suppliers or manufacturers located across the globe ⁹ . These actors may either directly introduce and drive the diffusion of a specific technology or enter a specific territory as local policy, incentives or investment opens up new potential markets ¹⁰ . Couplings will mostly be structural except for unique landscape pressures (e.g. developing country or unstable geo-political context) or global pressures that impact TIS actors and networks globally (e.g. decline support for new nuclear generation and investment).	External/Structural

6 In small to medium scale embedded generation applications for example, the solar PV TIS has been highly linked to innovation and developments in the battery storage TIS.

7 An example of this would be the competition for resources and legitimation within the basket of renewable energy technologies in any energy mix (i.e. solar PV vs. wind vs. hydro vs. CSP etc.).

8 In the case of the South African energy sector, IRPs have externally influenced renewable power generation technology. On one hand policy and IRPs have marginally liberalized the energy sector by permitting IPPs, but on the other hand, the contribution of renewable technologies in the energy mix has been structurally limited by identifying specific technologies that may participate and assigning maximum quotas for installed generation capacities.

9 The recent conceptual GIS framework proposed by Binz & Truffer provides more detailed analytical tools for unpacking transnational relationships than existing IS frameworks (NIS, RIS, SIS, TIS), which is particularly relevant for technology follower countries Binz, C. & Truffer, B. 2017. Global Innovation Systems—A conceptual framework for innovation dynamics in transnational contexts. *Research Policy*. 46(7):1284-1298. DOI:<https://doi.org/10.1016/j.respol.2017.05.012>.

10 REIPPPP is a good example where local policy and programs encouraged multiple renewable technology companies, financiers and consultants from outside South Africa to enter the nascent local energy market.

Focal TIS ↔ Political Context	Large-scale transformation processes are highly dependent on political context. Institutional alignment, conflict of interest or resistance will impact resource mobilization, allocation, policy decisions and the crafting of norms and regulations that either support or hinder the TIS. This mostly effects market formation and legitimation processes. Couplings in this instance will almost always have a structural impact, either creating a positive regulatory and economic environment that protects and supports the TIS, or withholding resources and supportive regulation to restrict diffusion ¹¹ . This interaction can impact investment in entrepreneurial activities, market formation and undermine technology legitimacy.	Structural
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Table 4: Summary of TIS context structures and interactions (Bergek et al., 2015).

2.7.2 FUNCTIONAL MODELLING WITH MLP

Another approach to constructing an integrated theoretical framework has been proposed Walrave & Raven (2016). TIS is fundamentally a functionalist approach and therefore suitable for modeling of system building processes. Some researchers have utilized causal loop diagram (CLD) modelling to analyses which motors of innovation are present in the system (Melamu, 2014). Walrave & Raven build on this concept, proposing an unified systems dynamic model that integrates concepts from the MLP to answer the question, “how do technological innovation systems emerge (or decline) in the context of various socio-technical transition pathways?” (Walrave & Raven, 2016:1834)¹². Walrave & Raven have built transition pathways directly into their system modelling to overcome TIS’s contextual shortcomings, refer **Figure 3**.

¹¹ One area where the coupling would have an external link would be the deliberate manipulation of national discourse that drives negative sentiment against the focal TIS at institutional and societal levels, or even advocates for another TIS (e.g. solar in the South African context was frequently pitched against nuclear in terms of daily availability during peak load times).

¹² For another recent exploration of system dynamics modelling with regard to socio-technical transitions refer to Papachristos, G. 2018. System dynamics modelling and simulation for sociotechnical transitions research. *Environmental Innovation and Societal Transitions*. <https://doi.org/10.1016/j.eist.2018.10.001>. DOI:<https://doi.org/10.1016/j.eist.2018.10.001>.

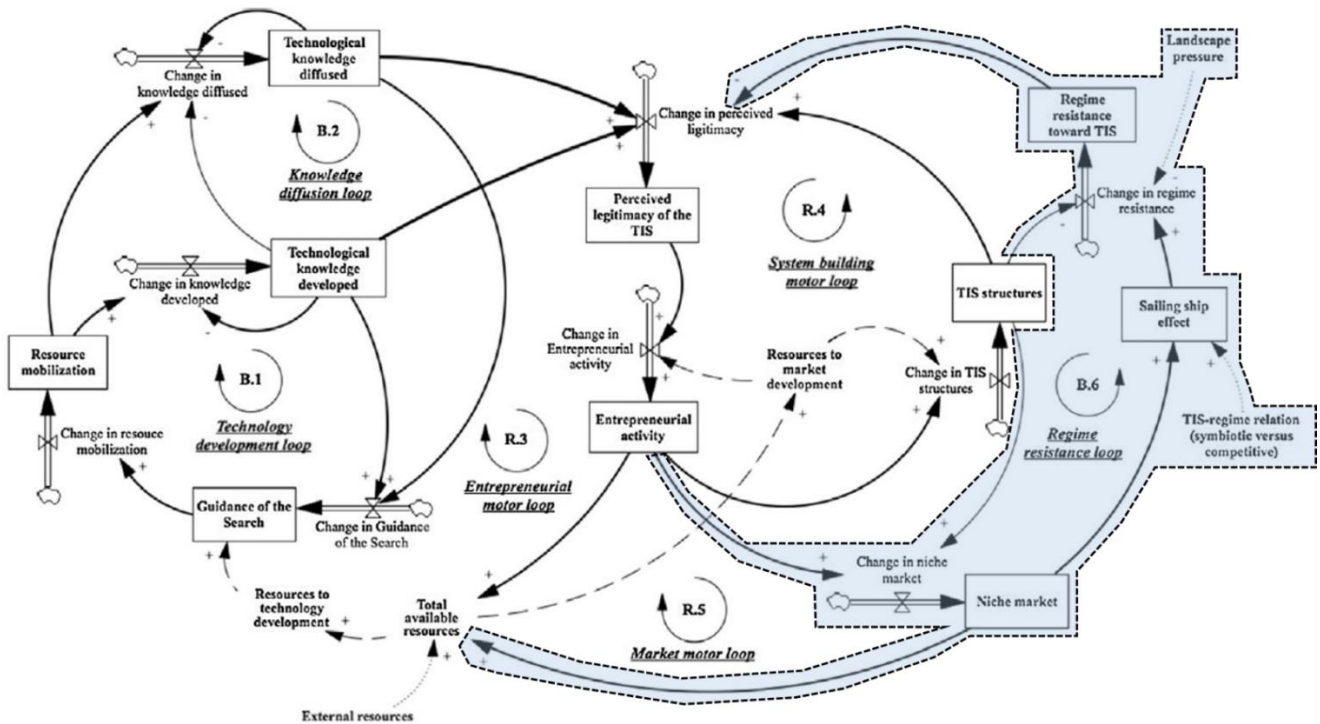


Figure 3: Stylized overview of Walrave & Raven's system dynamics model highlighting the integration of regime, niche and landscape from the MLP (Walrave & Raven, 2016:1837)

Their unified system model is built upon the 'motors of innovation' (Suurs, Roald AA, 2009) and introduces the novel 'regime resistance loop' developed from the MLP to account for TIS-context interactions. They also propose the concept of the 'sailing ship effect' to describe the level of alignment between the TIS and the socio-technical regime. Initially when a niche first emerges, the sailing ship effect represents the efforts of the regime to leave the emergent technology behind, implying that regime actors increase resistance towards the TIS (Walrave & Raven, 2016). The strength of the 'sailing ship effect' also varies depending on which socio-technical transition pathway is present in the system (Geels, Frank W. & Schot, 2007). As the TIS structures develop and mature, it is expected the 'sailing ship effect' or regime resistance decreases. Landscape pressure is also introduced into the system and again dependent on the transition pathway, will temporarily reduce the resistance to change in the regime to reflect events like sudden landscape shocks (Geels, Frank W. & Schot, 2007).

2.8 AGENCY, POWER AND POLITICS

Both theoretical frameworks have been critiqued for perceived limitations particularly when dealing with large-scale transformation processes that are greatly dependent on and influenced by political context. The underrepresentation of agency, power and politics in socio-technical frameworks and their effect on governance and policy can severely impact the trajectory of regime change (Smith, Stirling & Berkhout, 2005). MLP has also been criticized for its 'univalent' representation of regime change, creating narratives that underplay problems of political intentionality and social choice in the transition process (Berkhout, Smith & Stirling, 2004). It is acknowledged that the MLP needs to broaden its analytical view on agency beyond the regime and niche, particularly when it comes to power struggles and politics (Geels, Frank W., 2011, Smith, Voß & Grin, 2010). Greater recognition of dispositional powers, both economic and political needs to be better understood in terms of how allocation of resources and the authoritative power of policy makers can either support or hinder niche and regime actions (Grin, Rotmans & Schot, 2010, Markard & Truffer, 2008).

Functionalist frameworks like TIS also don't give much explicit attention to the dynamics of surrounding contexts and the political environment in which it is embedded (Bergek et al., 2015, Markard & Truffer, 2008, Markard, Hekkert & Jacobsson, 2015, Walrave & Raven, 2016). Political actions can be seen as a particular 'soft failure' (Weber & Rohracher,

2012) which can directly impact resource mobilization, influence norms; policy; regulation; beliefs and institutional support or resistance, thereby impacting system development and legitimation processes. To date, the conceptual framework of 'TIS-context' interactions by Bergek et al. (2015) and specifically how it identifies political influence in system development, seems to offer the most developed approach to systematically analyze power and political agency.

2.9 TECHNOLOGY FOLLOWER COUNTRIES

Innovation systems have been criticized for focusing disproportionately on the '*development of knowledge*' and less on its *diffusion* and *use* (Geels, Frank W., 2004). The use of TIS as an analytical framework on technology adopter/follower countries was therefore consider unsuitable. While 'generation' certainly refers to *new* technologies, 'diffusion and utilization' may also include *established* technologies" (Markard & Truffer, 2008:599). A growing body of research studies have shown that TIS can be successfully applied to mature technologies (Bento & Fontes, 2016, Huang et al., 2016, Kebede & Mitsufuji, 2017). Until recently, TIS had been sparsely applied to emerging economies or developing countries and it had been expected that extending its use to the Global South could enrich the conceptual framework (Bergek et al., 2015).

In terms of a technology specific innovation however, there is no clear framework in the literature that suggests how an introduced technology should be analyzed, other than vague reference to how a particular technology might overlap multiple national, regional, sectoral innovation systems and geographical boundaries. Kebede & Mitsufuji frame a new language for such situations in their study of PV in Ethiopia. Traditionally the focus of IS has been on research & development (R&D) processes and the overall innovation system was considered as *generating, diffusing, using* technology. As a more appropriate alternative, Kebede & Mitsufuji propose that the system structure be replaced with *introducing, diffusing, using* (Kebede & Mitsufuji, 2017). They further differentiate these two scenarios as '*R&D-based*' and '*diffusion-based*' TIS respectively. The *introducing* process acknowledges more the international firms or institutions that facilitate the transfer of technology specific knowledge into an adopting country.

2.10 SUMMARY

The study of sustainability transitions driven by innovation in technology has become increasingly more important as humanity has become aware that current growth and consumption of resources are not only unsustainable but positively detrimental human existence on earth. The MLP and TIS theoretical frameworks have proven their use in many case studies looking to understand socio-technical transitions driven by changes in technology. They are also complimentary frameworks, using many similar concepts and structural components although they focus on different levels of system analysis. While innovation systems traditionally focus on the creation of knowledge (effectively the micro-level niche in MLP), the MLP is more concerned with understanding the possible transition pathways that lead to regime change, or those that perpetuate regime 'lock-in'. The regime-level is a common concept to both frameworks, representing the structuration of institutions, organizations, rules and networks that combine to govern the use of technology in a society.

The different levels of the system at which these two frameworks operate have made them useful in studies where simultaneous micro and meso-level analysis could generate a deeper understanding of the ST. Consequently, there have been attempts by researchers to motivate that they be combined into an integrated theoretical framework. While this has not yet happened to date, there have been sufficient critical discussions and studies conducted using aspects of both frameworks to suggest useful methodological and analytical approaches. The common rationale is to utilize the MLP as a narrative tool to frame a 'global', while the more structured methods of TIS, with its focus on functional analysis to support system development has been argued to offer the ability to draw conclusions that can translate into concrete recommendations that can intervene in the development of the innovation system

CHAPTER 3 METHODOLOGY

3.1 METHODOLOGY OVERVIEW

“Technological innovation systems and the multi-level framework are closely related concepts for the study of far-reaching technological change. They draw on common theoretical roots and analyze similar empirical phenomena” (Markard & Truffer, 2008:596), both having proved their utility in previous studies of RET innovation systems and sustainability transitions in energy sectors.

The literature review supports an interdisciplinary approach (Bergek et al., 2015, Markard & Truffer, 2008, Walrave & Raven, 2016) combining the MLP and TIS frameworks in a complementary manner. The MLP framework “provides a useful overall plot (‘global model’) for studying transitions” (Geels, Frank W., 2011:35) and offers a broad entry point that will be used to craft a narrative around the South African energy sector. The use of the MLP to frame the TIS analysis is used precisely to address criticisms that specific technology focused research often neglects multi-level dynamics, particularly where processes of innovation are distributed across micro and macro-levels of the system (Ametowobla, Baur & Jungmann, 2015). Equally, the integrated approach using TIS methods addresses criticisms that the MLP lacks an objective methodology for transition analysis (Markard & Truffer, 2008, Melamu, 2014, Walrave & Raven, 2016, Weber & Rohracher, 2012). There is as yet no formally integrated framework so the study will be guided by the literature as to which tools and methods should be employed and could prove appropriate to the local context.

This chapter looks to understand what is driving or holding back South Africa in its transition towards a more sustainable energy regime and how this may impact its cities. The MLP and TIS frameworks will be utilized as they have proven themselves effective analytical tools for the research of technological driven transitions. There is a large body of research using the MLP and TIS frameworks to study transitions (Markard, Raven & Truffer, 2012, Savaget et al., 2019) although these mostly stem from the Global North, with few studies undertaken on the African continent (Baker, Lucy 2015, Bergek et al., 2015, Kebede & Mitsufuji, 2017, Melamu, 2014, Morris & Martin, 2015, Swilling, Musango & Wakeford, 2015). However, both frameworks have underrepresented political influence in the past (Bergek et al., 2015), requiring greater recognition, particularly of how dispositional power and political agency can impact national conversations and sentiment towards particular technologies (Geels, Frank W 2014).

3.2 RESEARCH QUESTIONS

In order to meet its objectives (as stated in chapter 1), the research therefore overlaps the macro-level developments in the energy regime at the utility scale, drawing insights from the national programmes like REIPPP to understand the growth of EG at the scale of cities (micro-level). In order to do this, a specific focal TIS needed to be identified that proved an appropriate proxy for system developments at both levels of study. Two research questions are formulated to structure the methodology:

1. Can the TIS approach be used as a lens through which to locate and describe the growth of RETs and specifically solar PV in South Africa’s built environment using the seven systems functions as adapted by Kebede & Mitsufuji (2017)? Can insights gained from utilizing the TIS analytical methodology improve the MLP narrative of the broader sustainability transition in South Africa’s energy sector, thereby addressing shortcomings in the MLP framework and supporting the call for an integrated framework?
2. Will the inclusion of ‘TIS-context interactions’ (Bergek et al., 2015) influence the understanding of functional events in the TIS, thereby better informing how interventions can improve the operation of the innovation system? Will a greater awareness of political power and agency provide greater awareness of the potential impact that policy-makers can have on the development of the innovation system?

3.3 QUALITATIVE RESEARCH APPROACH

Both the MLP and TIS frameworks are founded on the construction of event-sequence timelines to analyze system processes with the literature suggesting qualitative research approaches to gathering and analyzing data. The TIS

framework will form the basis of this study due to its more structured research methodology (Markard & Truffer, 2008). The event-sequence approach requires the building of narratives to analyze thematic issues and is usually constructed through in-depth interviews of experts or ‘gurus’ in the specific industry or sector, and the reading of available data in the form of documents, reports, studies, news articles etc. (Bergek et al., 2008). In the case of this study, in-depth interviews of energy experts were conducted via email correspondence with engagements revolving around the construction of the EHA timeline and the interpretation of the Mol.

3.3.1 SURVEY DESIGN

Both the TIS and MLP framework rely heavily on expert interviews to garner deep insights into the socio-technical system in construction. This does not always give voice to many actors located at various levels within the regime or in the niche-level. Surveys can therefore prove useful collect a broader spread of data for the analysis of certain segments within the system being studied. This research commenced with the collection of available literature that could build a narrative of the South African energy regime and the circulation of an on-line survey: ‘*ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES*’; looking at the diffusion of renewable technologies in the built environment.

One key function of the survey was to identify a specific RET that could be used for the TIS analysis and inform the MLP narrative, while at the same time providing direct insight into the niche-level of socio-technical system. The online survey was conducted using Survey Monkey (SM). It took the form of a market survey targeting *selectors* and *users* of RET in the built environment of cities. These included but was not limited to; Building Designers, Electrical Contractors, Electrical Engineers, Architects, Property Developers, Property Owners, Facility Managers, Renewable Technology Supplier/Developers and Business/Brand Owners. The survey was circulated on social media platforms and to members of professional and industry associations, including niche-level RET technology suppliers or manufactures¹³. These are all actors in terms of TIS and MLP, either representing the technological niche or end users of the technology and should therefore contextualize the ‘real world’ application of renewables in the built environment. As will be discussed later in the analysis chapter, the survey verified early research assumptions, identifying solar PV as the leading RET in embedded generation applications; a technology well represented in the REIPPP.

3.4 TIS DESCRIPTION & ANALYSIS

This part of the research engages analytical tools from TIS, constructing an event history analysis (EHA) timeline that can inform both the MLP narrative and determine the state of the innovation system by functionally identifying motors of innovation (Mol) in the timeline. A TIS approach focusing on a central RET present in the transition should prove useful in mapping the interactions and relationship between actors in the energy regime and niche, thereby drawing more concrete conclusions on the current state of the transition. Specifically, how the system is being driven by various interests and how this could impact the future of EG in the built environment. TIS functionalist approach might also highlight potential interventions to support the overall transition, an immediacy of action that many scholars have argued lacking in the MLP.

3.4.1 DELINEATION OF RESEARCH & SYSTEM BOUNDARIES

¹³ The survey was circulated to the following: SACAP (South Africa Council for the Architectural Profession), ECASA (Electrical Contractors Association SA), SAIEE (South African Institute of Electrical Engineers), SAPOA (South African Property Owners Association), GBCSA (Green Building Council of South Africa), SAAEA (South African Alternative Energy Association), SAPVIA (South African Photovoltaic Industry Association), The Energy Blog (@energyblog_sa) | Twitter

Transitions by their very nature are extremely complex systems undergoing change. Several choices were made to delineate the system for the purpose of analysis (descriptive delineation) (Markard & Truffer, 2008). The first was to locate the research in South Africa and more specifically to frame the research questions in the context of the of the built environment of cities. While the research objectives are conscious of the national energy transition and regime, TIS as the chosen system concept therefore focuses the study on the *introduction, diffusion and use* of solar PV in South Africa's major cities. Solar PV consequently becomes the lens through which macro-level and micro-level system development is analyzed.

3.4.2 TIS ANALYTICAL APPROACH - CONSTRUCTING THE EHA

The general scheme of analysis, methods for collecting data, constructing the EHA timeline and process analysis are laid out by Bergek et al. (2008) and Suurs (2009), adapted in this study to include contextual events that represent developments at the regime or landscape level (Geels, Frank W 2014, Ivanov, 2018, Melamu, 2014); with specific reference to 'TIS-context' interactions and particularly events demonstrating the impact of political agency on system development (Bergek et al., 2015). The research approach used is as follows:

Step 1: *Define the focal TIS*

The focus of a TIS can either be a field of knowledge or a specific artefact/product. In this case a market survey was employed to identify the dominant RET used in EG applications in cities. Solar PV was confirmed as the dominant renewable technology, confirming empirical observations that the built environment has seen significant growth in roof-top solar installations over the last 10 years.

Step 2: *Determine the TIS structure*

Actors, networks and institutions form the structural components of a TIS.

Actors include firms across the whole value chain including university-based research, venture capital, research institutes, lobby groups, industry associations, public bodies, standards organizations, NGOs, NPOs etc. These can be identified through *industry associations, patent analysis* (for emerging technologies), *bibliometric analysis* (used to identify firms, universities, or research institutes through analyzing publications and citations), *interviews and discussions with technology or industry experts/'gurus', financiers, firms, research organizations etc.* (Bergek et al., 2008).

Networks can either be formal or informal. These can include standardization networks (e.g. ISO), supplier networks, public-private partnerships, professional networks, associations, buyer-seller relationships, industry-university links etc. (Bergek et al., 2008)

Institutions are representative of the regime or 'rules of the game'. These can reflect cultural beliefs or values, routines, laws, norms and regulations (Bergek et al., 2008). From the multi-level perspective, institutions or the regime are the environment of selection in which the innovation must adapt, or exert pressure to force change in the regime to survive. This process of alignment or acceptance by the regime is characterized by resistance.

Step 3: *Mapping the functional pattern of the TIS; 3a: Assign functions, 3b: Achieved functional pattern*

The mapping of functions for analysis employs the operational method for constructing the *event history analysis* (EHA) as described by Suurs (2009). The purpose of the EHA is to construct the narrative or storyline as told by sequences of events critical to system processes or development. The 'event' is held to be suitable both as an indicator of system functions and describe what is going on in the TIS structurally (Suurs, Roald AA, 2009).

Data is collected from a variety of literature sources; journals, news articles, websites, press releases, reports, periodicals, studies, research papers, conference presentations etc., so long as the literature is related to the focal technology. This forms a database where events related to system formation and processes are captured chronologically, in this study presented as a timeline (refer Appendix A - EHA). Each event is then assigned a function to which it corresponds. In this study, functions are mostly assigned based on the functional indicators adapted by Kebede & Mitsufuji (2017), refer to **Table 2** (section 2.6). Specifically, government

procurement programmes have been disaggregated as an F5: *Market Formation* event, as opposed to F6: *Resource Mobilization* under previous schemes of functional indicators (Bergek et al., 2008, Hekkert et al., 2007, Suurs, Roald A. A. et al., 2010). Entry of international PV manufactures and suppliers however were assigned F6 and seen as events of *investment* (resource mobilization) in the local market.

The current set of motors of innovation (Suurs, Roald AA, 2009) were built around previous iterations of the TIS framework (Bergek et al., 2008, Hekkert et al., 2007) and will therefore be slightly misaligned with the functional indicators adapted by Kebede & Mitsufuji (2017) used here in this study. This is particularly true in a follower country context like South Africa, where there are few [F1] activities present in the *Entrepreneurial Motor* or the *Market Motor*.

Context events (not assignable to functions) are also included in the EHA timeline to help build the narrative of the overall system in which the TIS is embedded (Geels, Frank W 2014, Ivanov, 2018, Melamu, 2014). These events are categorized where appropriate using the four 'context structures' proposed by Bergek et al. (2015).

Step 4: *Assessing the functionality of the TIS and setting process goals*

Once events are ascribed to functions, it is possible to analyze the dynamics of the system through the seven key processes (functional descriptions). This should begin to describe the evolution or development of the TIS and how strong or weak the processes are (Bergek et al., 2008). It is useful at this time to divide the timeline into discreet episodes of analysis (Ametowobla, Baur & Jungmann, 2015), distinguishing between the different phases in the TIS development, i.e. *formative*, *growth* or *consolidation* phase (Bergek et al., 2008).

The aim is to identify interaction or trend patterns in the event data (Suurs, Roald AA, 2009). Trend patterns do not necessarily refer to the frequency of certain functions in a given episode of analysis but rather an accretion of events that indicate the fulfillment of individual system functions. Interaction patterns on the other hand looks to track causal 'chain of events' in the event sequence (Suurs, Roald AA, 2009). These functional patterns should not be assessed merely in terms of how strong or weak they are, but rather their '*goodness*' should describe how well the system is functioning (Bergek et al., 2008).

Step 5: *Identify inducements and blocking mechanisms*

By this stage of the analysis there should be a rich narrative created of the innovation system. The EHA analysis and delineation of the phases of development can seem fairly subjective and it is recommended that personal bias be minimized by verifying the interpretation of events and the overall narrative (seeking expert opinion through interviews is one common option).

The Motors of Innovation (Moi) (refer **Table 3**, section 2.6.1) as described by Suurs (2009) should emerge with the assessment of the system functionality, and will be used in this research to ascribe possible inducements and blocking mechanisms to the system.

Functional modelling using a CLD approach is an alternative analytical method that can be used. Walrave & Raven (2016) present a compelling unified model that combines the MLP and TIS to model the Motors of Innovation. The scope of this study will exclude CLD modelling but will mobilize their TIS-centric interpretation of the transition pathways when analyzing the incumbent regime using the MLP framework.

Step 6: *Specify key policy issues*

The TIS analysis presents a useful tool to understand innovation systems, particularly what policy, material or resource failures may be holding back the transition. Having established what blocking mechanisms are present in the system, the potential arises to influence system development through policy interventions that support specific functions (Bergek et al., 2008).

CHAPTER 4 ANALYSIS & OBSERVATIONS

4.1 SURVEY ANALYSIS & DISCUSSION

A survey (referred to in chapter 3) was conducted as part of this study to address two potential flaws in the research framework. The first rests with the MLP macro and meso-level focus, well established as a tool for 'global' narratives, but often too broad in scope to result in useful policy recommendations. While TIS is therefore often employed to address this shortcoming by focusing on a specific technology present in transition, the reliance on bibliographic data and industry experts may not necessarily capture the opinions and perspectives of all the users and selectors of an emerging technology.

Though there is most certainly a sustainability transition starting to occur in the South African energy sector, with government policy and programs opening the door to the wide-spread diffusion of RETs at the utility scale, the survey was constructed to specifically answer two key questions in the study. Firstly, is there a dominant renewable generation technology being used in the built environment; and secondly, what are the key considerations or challenges that are driving its use, and what conditions are holding back its further growth?

The survey therefore targeted both the selectors (or specifiers) of RETs, namely professionals or consultants, and the end users of the technology in the built environment, specifically property developers, owners or managers, as well as business owners or tenants. Also included in the survey are the suppliers and developers of RETs. It is hoped that their responses will reveal the motivations that drive their *use* of RETs in cities.

Throughout the analysis the term Feed-in-Tariff (FIT) has been utilized as this terminology is specifically referred to by municipalities that allow grid-tie-in connections. It must be pointed out however, as it was to this researcher, that FIT is a misleading description in the South African context. Whereas FITs have traditionally referred to direct subsidies offered elsewhere in the world to encourage early adoption of RE systems like solar PV, these subsidies usually reduce over time. In South African cities, FITs more accurately reflect a net-metering model that involves a cost-recovery mechanism. Excess energy generated by a RE system is credited to the generator and allows for a limited off-set against their overall energy consumption. The off-set is capped and any energy generated beyond the maximum goes to the municipality without compensation. Although in theory this allows municipalities to profit from the resale of excess energy from EG systems, current legislation does not technically support municipalities from effectively buying and reselling energy from these small-scale IPPs.

The survey data has been disaggregated between those that select (or specify) versus those respondents that supply the technology and those that represent the end users of the technology. Selectors represent the largest group of respondents and was broken down further into two disciplinary categories in order to determine if different professional groups were driven by different perspectives. For the full survey results including graphs and tabulated responses, refer to Appendix B – Survey Results (pg. 1-84).

4.1.1 ELECTRICAL ENGINEERS & CONTRACTORS (SELECTORS & SPECIFIERS)

Electrical engineers were the second largest category of survey respondents (112), with almost 70% indicating having had experience in the design or implementation of renewable technology (RET) embedded generation (EG) applications in the built environment.

4.1.1.1 ECONOMIC DRIVERS & CHANGING PRIORITIES

Economic considerations (reducing daily operating costs) was the primary driver when designing or specifying RET EG applications for clients. Second place was equally split between ensuring the reliability of daily energy supply and the client's desire to 'Going Green' (generally responding to the need to become sustainable), although reliability was slightly more important.

Of the respondents (58), over half (59%) believed that the prioritization of these considerations had changed over the last ten years. Most agreed that the rapid fall in RET cost (mostly PV) coupled with the rising electricity tariffs have

made EG more economically viable (quicker return on investment (ROI)). They also thought that clients are now more aware and committed to becoming energy efficient. On-going load-shedding and loss in confidence in Eskom and Municipalities to maintain distribution infrastructure were also of concern, driving clients to become more self-reliant. In general, electrical engineers seemed quite aware and committed to the 'Go Green' movement, although increasing efficiency was the primary driver, closely followed by concern for environmental sustainability.

4.1.1.2 EGS 'PAYBACK' PERIOD

Of the respondents (57), almost 74% agreed that the 'payback period' was a critical determinant of the design and specification of the EGS where economic considerations were most important. The range of critical 'payback period' ranged widely from 3 to 10 years, but the median goal appeared to be 5 years as the break even, which also impacted the scale of the EG installation and the choice of RET.

4.1.1.3 COMMON EGS APPLICATIONS

Commercial offices were the most common building on which EG applications were considered. This was followed by retail and leisure (shopping centers) applications with industrial buildings following closely. Residential¹⁴ and institutional buildings were the least common in terms of EG applications. Of the respondents (49), 65% believed that the order of the building types that are likely to explore EG has not changed over the last 10 years. Of those that believed there had been a change of order, the majority identified the residential sector as seeing the most growth and becoming more prominent.

4.1.1.4 SCALE OF EGS APPLICATIONS

Of the 35 respondents, the most common size of EG applications considered was medium-scale (which was understood in the survey as supplemental or independent power supply for day-to-day operation of selected circuits like lighting, computers etc. for up to 8 hours). Least common EG applications were large-scale (independent power supply making the building self-sufficient in terms of power needs or even generating excess power).

There was a fairly even split between respondents on whether the scale of EG applications have changed in the last 10 years. Falling cost of technology and storage devices has seen EGS installations generally increasing in size. It was also suggested that scale is less of an indicator but rather that scope and breadth of applications have become more varied with growing interest.

4.1.1.5 TECHNOLOGY SELECTION DRIVERS

Cost and reliability of the technology were the primary factors that determined the RET chosen, with almost 79% of the 37 respondents identifying solar PV as the technology of choice. PV was generally considered more suitable because installations were more discreet (vs wind turbine), more easily integrated into existing buildings and availability of sunlight resources for primarily day-time applications were sufficient and more consistent (again compared to wind turbines, particularly in dense urban environments).

4.1.1.6 SCALE OF EGS

According to the 32 responses the size of EG installations varied from 5kW to IPP scales well over 3000 MW with interest in embedded generation systems (EGS) believed to be increasing steadily. Where batteries were included in the EGS, the two most common design criteria were storage capacities for up to four hours and up to eight hours respectively. The most common type of battery is still lead-acid due to cost, although Lithium-ion and Gel batteries were close behind where budgets allowed.

4.1.1.7 GRID CONNECTION & INCENTIVES

Only 55% of the 34 electrical engineers and contractors that chose to respond had experience with grid connected systems. Most of these were in the major cities, Johannesburg, Durban Cape Town, Port Elizabeth, Richards Bay and

¹⁴ This isn't surprising as the scale and complexity of an EG installation in a residential application does not necessarily involve electrical engineers and is likely handled by the PV supplier/installer.

Pretoria. Of those that responded, most did not believe that the feed-in tariffs were sufficient as incentives to positively impact the viability of the ESG (i.e. FIT were not a significant driver behind the installation of the EGS for clients).

Of 33 respondents, the majority (85%) had not been involved in an EGS that generated a surplus of electricity that could be used for commercial gain (sale to a third party or building tenant). Of 36 respondents, over 60% did not feel that they had a reasonable understanding of policies and regulations that govern the installation of EGS in the built environment. Those that did have a reasonable understanding suggested there were few restrictions so long as the system was not tied to the grid. Issues that generally discouraged the EGS from being connected to the grid were the cost of bi-directional meters, new restrictive regulations (SANS 10142) and general grid codes. However, the majority believed that trading (wheeling) of surplus energy was viable in the future if regulatory, statutory and maximum generation limitations could be resolved by NERSA and Eskom. Therefore, the perceived barriers to the wide-spread diffusion of EGS tended to relate to regulation, inadequate incentives and particularly the current FITs.

4.1.2 ARCHITECTS / BUILDING DESIGNERS (SELECTORS & SPECIFIERS)

This was by far the largest category of survey respondents (521), with 74% having had experience in the design or implementation of renewable technology (RET) embedded generation (EG) applications in the built environment. This group also included respondents that had selected 'other' as their category of occupation. Most of these identified themselves as interior designers, draughting professionals, project managers and architectural technologists. There were also a small number of educators, renewable technology consultants and a researcher.

4.1.2.1 ECONOMIC DRIVERS & CHANGING PRIORITIES

Economic considerations (reducing daily operating costs) was the primary driver when designing or specifying RET EG applications for clients. Almost of equal importance was ensuring the reliability of daily energy supply. Unlike the electrical engineers, 'Going Green' was clearly a secondary concern and very surprising considering the 'green' initiative tends to focus on buildings and prominently features in architectural discourse. This was clarified in the follow up question however, with the analysis of the responses (113) suggesting that clients now have a much higher awareness of issues like sustainability and efficiency, and that they are already aware that 'going green' has proven economic benefits. The current conversation has therefore shifted beyond the 'green' trend and that economic considerations are now synonymous with 'Going Green'.

Over half (56%) of the 234 respondents believed that the prioritization of these considerations had changed over the last ten years. Most agreed that the rapid fall in RET costs coupled with the rising electricity tariffs have made EG more viable however, building designers (and therefore their clients) were by far most concerned about a reliable electricity supply. Again, it was generally felt that clients are now more aware and committed to becoming energy efficient, while wanting less reliance on the existing energy regime for their energy needs. In general, building designers and architects expressed that the market is now more aware of the economic benefits of 'going green'.

4.1.2.2 EGS 'PAYBACK' PERIOD

Of the 228 respondents, 59% agreed that the 'payback period' was a determining factor in the scale and design of the EGS installation where economic considerations were a primary concern. This was noticeably less than the electrical engineers and contractors and although a consideration, 'payback' period seemed less significant compared with the responses from the electrical consultants. The range of critical 'payback period' ranged more widely in this group. Like the electrical consultants, around 5 years was the most common goal, although building designers also seemed equally resigned to long payback periods of around 10 years. Also apparent from the responses was the desire that the payback period should decrease to less than 3 years.

4.1.2.3 COMMON EGS APPLICATIONS

Commercial offices and residential buildings were tied for the most common building types on which EG applications were considered. Institutional buildings (schools, hospitals, community halls etc.) were the next most frequent typology to explore EGS, followed by retail and industrial applications respectively. The responsibility for EG installations on commercial offices seem to be equally shared between electrical consultants and building designers, whereas industrial and retail applications more often fall under the electrical specialist. Residential applications are clearly driven by the building designer, while they also appear to deal more often with the application of EG on institutional buildings than

electrical consultants. Of 199 respondents, around 60% (slightly less than the electrical consultants) believed that the order of the building types that are likely to explore EG has not changed over the last 10 years. Of those that felt there had been a change of order, believed that the biggest shift in priority has been in the residential sector. In the past an EGS would have been considered a “luxury”, but due to falling technology cost, unreliable energy supply and a greater awareness driven by Part-XA (part of SANS 10400 national building regulation that deals with energy efficiency), small-scale applications on houses now competes with offices as the most common building application.

4.1.2.4 SCALE OF EGS APPLICATIONS

According to the 175 responses, the average size of EG applications was of a small-medium scale (which was understood in the survey as emergency back-up power including limited circuits supplying computers, fridges etc. for up to 4 hours). The next most common scale was evenly split between small (emergency back-up power for critical building systems like emergency lighting for up to 4 hours) and medium-scale (supplemental or independent power supply for day-to-day operation of selected circuits like lighting, computers etc. for up to 8 hours). This bias to smaller average applications compared to electrical consultants could be due to the greater number of smaller-scale residential EGS applications. Least common EGS applications were large-scale.

Again, there was a fairly even split between respondents on whether the scale of EG applications have changed in the last 10 years. Of 169 respondents, 45% felt there had been a change in scale and due to a large sample size, it was possible to discern the primary reasons (unlike for the electrical consultants). PV technology in particular is now seen as more mature, reliable and increasingly cheaper, which results in clients prepared to increase the scale of their EGS installations. Commercial offices and residential applications have seen the greatest growth in the scale of EGS installations. Other than falling technology costs, the increase in scale seemed to be partly attributed to SANS 10400 Part-XA (responsible for increased awareness of energy efficiency in buildings), while times of increased frequency/length of load-shedding encouraged larger EGSs, thereby reducing the client’s reliance on grid supplied power for longer periods.

4.1.2.5 TECHNOLOGY SELECTION DRIVERS

Again, cost and reliability of the technology were the primary factors that determined the RET chosen, with almost 64% of the 140 respondents identifying solar PV as the technology of choice. Interestingly, building designers were more prepared to consider hybrid systems with almost 30% of respondents exploring wind turbines. PV was seen to be the most mature, reliable and proven technology for EGS applications. Solar resources also seen as the most reliable in terms of availability. Wind turbines were perceived to suffer from more restrictions, with height caps, required scape, noise pollution and wind flow in dense urban environments making the technology more problematic, particularly in residential applications. Building designers also pointed out solar hot water systems should be a common consideration particularly in residential applications where orientation and solar resources are abundant.

4.1.2.6 SCALE OF EGS

Of 92 respondents, the typical size of EG installations ranged from 2-10kW with around 5kW the most common size. Interest is steadily increasing in EGS as the PV technology becomes more affordable, with clients more aware of sustainability or energy efficiency while also wanting to be more independent from the current electrical network. Where batteries were included in the EGS, the two most common design capacity was up to 8 hours followed by storage for up to 4 hours. The most common type of battery considered for storage was lithium-ion because of its increased life-span and greater storage capacity. Lead acid was the next most common due its lower cost and wide-spread availability.

4.1.2.7 GRID CONECTION & INCENTIVES

Just over 80% of the 117 building designers that responded confirmed that they did not have experience in grid-connected EGS applications. Those that were grid-connected were mostly located in the major cities, Johannesburg, Durban and Cape Town, with one from Port Shepstone.

Of 113 respondents, almost 79% believed that trading of surplus energy will be viable, but only if regulatory barriers and stifling Eskom bureaucracy can be overcome. Building designers also noticeably felt that political interference is a barrier to transforming the energy regime. City-level and national government policies are too erratic, while cities also lack the capacity to implement and manage wide-spread EG networks. There was also an awareness that EG will impact

revenue collections in cities and therefore EG was not fully supported in metro municipalities. Just over 12% had any experience with EGS that could generate surplus energy.

Almost 76% of 116 respondents felt that they did not have a reasonable understanding of policies and regulations that govern EGS in the built environment. Improving awareness and accessibility to regulations and policy for professionals was one of the most common recommendations. Those aware of current policies and regulations felt that these were too restrictive and need to be simplified. Most respondents also felt that current FITs were of no value and needed to increase to be a constructive incentive. Respondents were also concerned that municipalities lacked the necessary skilled people, capacity and ability to implement, enforce and manage EG applications.

4.1.3 RENEWABLE TECHNOLOGY SUPPLIER/DEVELOPER

There were only 8 respondents in the RET supplier/developer category. This group was entirely represented by photovoltaic suppliers.

4.1.3.1 ECONOMIC DRIVERS & CHANGING PRIORITIES

As suppliers of RETs, this group strongly believed there has been a shift in what drives investments in EGS. Economic considerations (reducing daily operating costs) are by far the primary driver of an EGS installation. Ensuring reliability of daily energy supply was the next most important consideration with reducing GHG emissions and 'Going Green' respectively considered the least important. This was not because GHG mitigation and 'Going Green' were no longer considerations, but rather that consumers are now sensitized to issues of sustainability and the general necessity of being 'green'. It was believed that 'Going Green' was previously driven as part of a brand or business identity, whether to capitalize on positive market sentiment towards being environmentally sustainable or for marketing purposes. Where before 'Going Green' was the deciding factor when RETs were more expensive, the falling cost of generation technology and cost parity with grid supplied electricity, the economic benefits now tend to drive investments in EGS.

4.1.3.2 EGS 'PAYBACK' PERIOD

Again, around 5 years seemed to be the market expectation based on the system lifespan and due to the falling cost of PV technology. The payback period or ROI was also highly dependent on the increasing electricity tariffs and bound to conditions set by project financiers.

4.1.3.3 COMMON EGS APPLICATIONS

From the perspective of the technology suppliers, the most common applications were retail/leisure (shopping malls) and industrial applications, followed by commercial offices, with residential and institutional applications equal last. Logically this would reflect the much larger scale of EGS installations required by high energy consuming activities and building typologies. Again, larger scale EGS installations most likely directly involve the technology supplier in the project, whereas small-scale applications on residential houses for instance, are most likely handled by smaller PV installers.

There was the opinion that previously the residential sector was a larger consumer of PV modules but has been displaced by larger commercial and industrial applications because of increasing operation costs felt by high energy consumers.

4.1.3.4 SCALE OF EGS APPLICATIONS

Not surprisingly, this group of respondents believed that the medium-large scale of application was the most common size of EGS installation (described in the survey as supplemental or independent power supply for day-to-day operation of selected circuits which could include higher load applications like cooking, manufacturing equipment, cold rooms, etc. for up to 8 hours). This was followed by medium-scale EGS installations (understood in the survey as supplemental or independent power supply for day-to-day operation of selected circuits like lighting, computers etc. for up to 8 hours) as the next most common. Least common EGS applications was again large-scale which was described as fully independent or even excess energy generation.

This category of respondents believed there has been a significant increase in the scale of EGS installation over the last 10 years. Larger installations are becoming more prevalent as the falling cost of installations make the technology more attractive. One respondent commented that the numerous small-scale applications in the residential sector have

proven the reliability and helped legitimize the technology over the last 10 years, encouraging larger commercial clients to adopt the technology as the perceived risk has declined.

4.1.3.5 TECHNOLOGY SELECTION DRIVERS

Cost and reliability of the technology were seen as the most significant factors when choosing a technology for energy generation.

4.1.3.6 SCALE OF EGS

Common EG applications ranged from 5-30kW installations. Common larger scale applications ranged between 150-1MW. The largest solar rooftop system was 4.755MWp while another system was a grid-tied 3MWp installation used to off-set power consumption by a municipality. Battery storage most commonly provided 4-8 hours of storage, followed by storage of up to 4 hours. These suppliers would only recommend Gel or Lithium-ion storage systems.

4.1.3.7 GRID CONNECTION & INCENTIVES

All the suppliers have dealt with grid connected systems. Generally, FITs were too insignificant or variable to have any bearing on the decision-making process when it came to investing in an EGS. This group did have experience in EGS that provided power to third parties, particularly power purchase agreements (PPAs) between landlords and tenants, although the current regulation was identified as a constraint.

Suppliers felt that trading of surplus energy was viable but again, only if clear policies are established that support EG. Currently, Eskom is implementing restrictive standards in the absence of clear and conducive regulatory and policy frameworks that govern EGS. One good suggestion is the establishment of a dedicated EG office modeled on the successful REIPP office.

4.1.4 PROPERTY OWNERS, TENANTS, DEVELOPERS & MANAGERS (TECHNOLOGY USERS)

There were 21 respondents in this category that represent end users of renewable technologies. This group included property developers, owners, businesses and facility managers.

4.1.4.1 ECONOMIC DRIVERS & CHANGING PRIORITIES

Almost 81% of this category have considered or implemented EGS in their buildings. Interestingly, reliability of daily energy supply trumped economic considerations in terms of reducing day-to-day operating costs. This could suggest that they view the cost of lost productivity to be greater than general operating costs. Around 58% did not believe that priorities had changed over the last 10 years.

While renewable energy generation was seen to be a fundamental part of the green trend, it was believed that only now, with the rising cost of electricity and the falling cost of RETs, have EGSs become economically viable. It was also noted that EGS are also becoming a common requirement when developing for property funds.

4.1.4.2 EGS 'PAYBACK' PERIOD

The 'payback' period was a critical factor when determining the scale of investment for almost 67% of the respondents. There were two dominant views when it came to time frames however. Half of the respondents preferred a short-term 'payback' period of around 3 years, while the other half took a more medium-term view, with 7 years being the average 'payback' period.

4.1.4.3 COMMON EGS APPLICATIONS

Offices were the most common building type where EGSs were installed for this group of respondents, with residential developments being the next most common application. 80% did not feel there had been a change in the order of the building types where EGSs were employed. Those that felt there had been a change identified offices and retail as the growth sectors, driven by property investment funds requiring EGSs and corporate responsibility considerations.

4.1.4.4 SCALE OF EGS APPLICATIONS

This group of respondents identified medium-scale EGS installations (understood in the survey as supplemental or independent power supply for day-to-day operation of selected circuits like lighting, computers etc. for up to 8 hours) as the most common.

Respondents did not believe there had been any significant change in the scale of application over the last 10 years. It was noted that ensuring productivity and eliminating down-time due to power outages were previously mitigated by installing backup generators, but now renewable EGS have slowly replaced these systems.

4.1.4.5 TECHNOLOGY SELECTION DRIVERS

Interestingly, cost was not the primary driver for 75% of respondents in this category. Unlike all the other categories of respondents, system reliability was far more important, followed by technical support. Again, solar PV was confirmed as the most suitable technology to meet these needs. While location and surrounding building density were challenges in urban settings, PV was still the technology of choice.

4.1.4.6 SCALE OF EGS

Common EG applications ranged from 4-15kW installations. Larger installations ranged from 100kW to 2 MW with the most common size of battery storage being 8 to 24 hours, followed by 4 to 8 hours. The preferred battery technology was Lithium-ion followed by Gel.

4.1.4.7 GRID CONNECTION & INCENTIVES

Only a small handful of respondents had dealt with grid connected systems and mostly in Cape Town and therefore few had experience with FITs. While this category of respondents also felt that trading surplus energy could be viable, their perceptions of the structural barriers were specifically focused at the city level. While they acknowledged that there were yet no mechanisms that allowed for wheeling of power to nearby buildings, the biggest barrier was old infrastructure and cities protecting their revenue from electricity sales.

Again, the majority of respondents did not feel they had a reasonable understanding of the policies or regulations governing EGSs in the built environment. Their biggest frustration was that each city had their own FIT structures, with one useful recommendation suggesting that metro municipalities should install bi-directional meters for all new applications and whenever existing meters need to be replaced.

4.2 OBSERVATIONS & DISCUSSION

The survey clearly highlighted that weakness in the regime, specifically that the rising cost of electricity and the unreliability of supply, are the primary drivers of selection of the EG niche. All categories of respondents (except for property owners) identified economic considerations (reducing daily operating costs) and ensuring the reliability of daily energy supply respectively as the two most important drivers of investment in EG. Only property owners varied slightly in these drivers, placing reliability of supply ahead of economic considerations. This could indicate that the lost opportunity cost for businesses during load-shedding events are much higher and therefore more critical than simply looking to reduce daily operating costs. This category of respondent was mostly represented by property fund managers, developers and facility managers and it could likely indicate that their perspective is based on larger commercial and retail properties.

The survey data also indicated that feed-in tariffs (FIT) are predominantly regarded as offering no real incentive to connect EG installation to the grid. EG systems were therefore primarily sized to provide supplemental power to building or business critical systems for between 4-8 hours and were primarily off-grid installations. Consumers seemed content to simply reduce daily electricity costs and did not leverage the FITs to increase the capacity of the EG system and nor did they actively look to generate additional energy to benefit from the FITs. Many respondents also felt that the regulatory requirements, municipal application process and the associated connection costs discouraged grid-tied systems.

Electrical engineers seemed by far more experienced in larger-scale EGS applications which seem more contingent on ROI. At smaller scales however, building designers and their clients seem less concerned with the 'payback' and ROI. Whether there is more room to maneuver in terms of budget on smaller scale installation, building designers or their clients seem more able or willing to invest in storage technologies and particularly more expensive Lithium-ion batteries. Although the scale is smaller, the residential sector seems to have a higher capacity to absorb more

expensive technology and should not be underestimated as a sector that can increase diffusion and ultimately reduce costs associated with newer technology over the long-term.

It was initially expected that the 'Going Green' trend would have featured more prominently in the drive to invest in EG applications, particularly since solar PV has become synonymous with the green building movement. The survey results confirmed that cost and reliability have overtaken any market trend linked to sustainability. The survey responses did indicate however that 'Going Green' is primarily understood to mean energy 'efficiency' in the built environment. Follow up responses to this question suggested that the conversation has moved beyond the 'green' trend, with designers, consultants and clients believing that considerations of energy efficiency in buildings is now automatic. While consultants linked 'Going Green' with environmental sustainability as a secondary consideration, property owners and developers placed social responsibility ahead of the environment. Technology suppliers however, still perceive that commercial or corporate customers are mostly driven by the marketing potential and positive brand image that comes from being 'green'. While none of this seeming disconnect in priorities is problematic, knowing what drives a potential client or customer could help the decision making and design process.

4.2.1 SURVEY DATA QUALITY

A total of 662 respondents were collected. Of these, 347 were considered to have completed the survey according to the pre-set condition on the online survey (i.e. had responded to the final survey question as a metric of completeness). On deeper analysis however, this metric as an applied filter did not accurately reflect the value or usefulness of the data. Some respondents had for example not answered the final questions but had provided responses to most of the in-depth or follow-up questions. 'Time spent' to complete the survey was found to be a better metric, with more than 10 minutes generally found to indicate whether useful data had been collected. It was determined that 269 respondents had provided valuable data for in-depth analysis.

Multiple choice questions and those that required the rating of predetermined answers were by far the most frequently responded to questions. Most of the 662 respondents answered the multiple-choice questions and these have proved useful in understanding general trends, sentiments and common drivers for adopting RETs in EGS applications. Had more time and thought gone into the crafting of the survey, some follow-up questions could have been framed in a multiple-choice manner, although this was only obvious in retrospect once the question results were analyzed.

4.3 TIS ANALYSIS & DISCUSSION

4.3.1 INTRODUCTION

Fundamentally, the aim of the TIS framework is to support development of the innovation system in order to achieve wide-spread acceptance and use of the specific technology (Hekkert et al., 2007). The TIS analytical framework has also proven its utility in the context of technology follower countries (Bergek et al., 2015) and specifically in African case studies (Kebede & Mitsufuji, 2017, Melamu, 2014).

The diffusion of solar PVs in South Africa does not lend itself to a typical R&D-based TIS analysis, which is focused on the *generating, diffusing and using* of an emergent technology. Therefore, this TIS analysis will concentrate on the *introducing, diffusing and using* process as suggested for follower countries by Kebede & Mitsufuji (2017). It was expected that there would be few events pointing towards establishment of the Science and Technology Push Motor. Since solar PV represents a mature technology with well-developed TIS structures globally, it was expected more advanced motors would arise from the EHA and functional analysis, as supported by other studies (Suurs, Roald A. A. et al., 2010).

Building on the interdisciplinary TIS and MLP method proposed by Melamu (2014), the *event history* approach will be used to track the evolution of the solar PV industry innovation system. This section will refer to the EHA constructed of PV in South Africa and is included in the study under Appendix A – EHA. The EHA in turn has been divided into four periods of system development. These periods were determined by assessing the strength and dominance of system functions. While this process can arguably be considered subjective, the reading of system development in conjunction with an MLP approach does lead to an emergent plot, that should reinforce the distinct 'chapters' within the global

narrative. Each period of system development is discussed here in terms of the dominant *motors of innovation* (Suurs, Roald AA, 2009, Walrave & Raven, 2016) to describe the fulfilment of system functions. Contextual events reflecting developments in the broader socio-technical system impacting the focal TIS will be included in the EHA (Melamu, 2014). Concepts from the Multi-level Perspective will be employed for narrative building purposes where needed.

4.4 EXPLORATION & PREMATURE MARKET FORMATION: 1993 – 2003

This early period of solar PV in South Africa can best be described as a period of limited local exploration and premature market formation. There was local research in PV modules happening at the University of Johannesburg from 1993 onwards but this experimentation was an outlier in the overall TIS trajectory. More importantly, two critical policy documents were released in this period, namely the White Paper on Energy Policy of 1998 and the White Paper on Renewable Energy in 2003, both foundational to the renewable energy future of South Africa.

This phase of development also sees an early attempt by government to establish a local market through the Solar Home System (SHS) launched under the 1999 National Electrification Programme. This programme was supposed to electrify rural homes located far from existing electricity transmission and distribution networks. The Department of Energy (DoE) initially issued six concessions to Energy Service Companies (ESCO), but by 2013 only 3 remained; NuRa Energy (servicing Northern KZN), Kwazulu Energy Services (servicing Southern KZN & Eastern Cape) and Solar Vision (responsible for Limpopo Province), with one more wishing to opt out (Azimoh et al., 2015).

4.4.1 FUNCTIONAL ANALYSIS

This period is characterized by two notable system functions, namely the Guidance of the Search [F4] in both government White Papers, and Market Formation [F5] through public investment in the SHS concession programme. The White Paper on Energy was particularly important as it allowed for non-grid connected electrification systems exploited by the SHS programme. This period would end with the publication of the Integrated Energy Plan [F4].

4.4.2 STRUCTURAL DRIVERS AND BARRIERS

The principal structural driver during this period was the SHS concession programme, effectively establishing a niche market for solar PV systems.

Ironically, the largest barrier at the time was the still relatively high cost of solar PV technology of that time. The technology had also not seen wide-spread testing in the South African environment. These challenges were exacerbated by technical support networks that had to service vast areas and thinly-spread installations. Coupled with a customer (willing or not) largely uneducated in the TIS, maintaining these SHS systems proved to be a significant challenge.

4.4.3 SYSTEM BUILDING MOTOR

The Motor of Innovation (Moi) of this period has all the hallmarks of a nascent System Building Motor. This was principally driven by the SHS programme, creating niche market conditions [F5]. Significant policy events [F4] allowed government to mobilize necessary resources [F6], with 80% of the programme funding coming from the public purse. But this early foray into system building was premature, predicated on a very weak market formation motor. It was unreasonable to expect the market to be sustained by installing expensive technology on poor, rural households. This vulnerable niche market failed to create lasting legitimacy [F7] in the TIS and failed to support further entrepreneurial activities [F1]. This period is also notable for its lack of user education programmes, vocal lobby groups, industry associations or advocacy groups [F7] (short of government's own actions).

From the perspective of Walrave & Raven's (2016) integrated model of TIS and MLP, there was little resistance from the regime. The SHS programme did not compete with nor challenge the incumbent regime at any scale. Instead it actually relieved pressure on Eskom, servicing a market distant from existing transmission and distribution networks, mitigating the requirement to expand infrastructure networks.

4.5 GUIDANCE OF THE SEARCH: 2004 – 2008

Following on from the 2003 White Paper on Renewable Energy, government continues to formulate policies needed to introduce renewables into the nation's energy mix. Perhaps learning from the previous phase of system development, government also mobilizes resources to establish critical support structures needed to establish and sustain a renewable energy market. This period sees the formation of organizations that will support and promote growth in the renewable energy sector. These organizations will aid in the guidance of the search, knowledge development and knowledge diffusion, with the establishment in 2004 of the South African National Energy Research Institute (SANERI), the Centre for Renewable Energy Studies (CRSES) at the University of Stellenbosch in 2006, and the renaming of SANERI to the South African National Energy Development Institute (SANEDI) in 2008. Also, of critical importance to the regulatory space is the establishment of the National Energy Regulator of South Africa (NERSA) in 2005.

There is an episode of entrepreneurial activity from the University of Johannesburg with the patenting of thin-film solar module technology by Professor Vivian Alberts, attracting government investment and the establishment of a pilot manufacturing plant. Again, even though this represents experimentation that would be expected in a traditional TIS analysis, this activity was an outlier and not fundamental to system development.

During this period, the Electricity Regulation Act (ERA) of 2006 reinforces Eskom's role in the energy regime as the sole purchaser of generated electricity. Already anticipating a possible shortage in power generation capacity, Eskom embarks on a new build programme with construction starting on the Medupi coal-fired power station, funded in part by the first of many steep increases in electricity tariffs.

This period is characterized by slow structural development in policy and organizations, as there is yet no sense of urgency until the period ends in 2008, a year punctuated by the abrupt collapse in reliable power supply from Eskom (the sudden landscape shock), a mere hint of the looming energy crisis that will grip the country for years to come.

4.5.1 FUNCTIONAL ANALYSIS

This period is dominated by two functional processes; there are more Guidance of the Search [F4] events as government still tries to formulate a coherent renewable energy strategy (establishment of NERSA, the ERA and Electricity Pricing Policy). Many resource mobilization [F6] events are implemented in order to strengthen capacity of [F2], [F3] and particularly [F4].

4.5.2 STRUCTURAL DRIVERS AND BARRIERS

Resources were mobilized by government to lay the foundations of a more sustainable renewable energy market. Organizations were established that would mostly support the Guidance of the Search [F4].

However, the sudden shock felt in the landscape when weakness in the regime manifested itself in the collapse of reliable energy supply, opening a window of opportunity as government and Eskom looked to quickly address the supply crisis. Weak policy and regulatory frameworks remained the biggest barrier, with yet no clear path for independent power producers (IPP) and renewable energy systems to be incorporated in the energy mix.

4.5.3 ENTREPRENEURIAL MOTOR

After the premature attempt at System Building of the SHS concession programme, government and the energy regime turn their attention back to strengthening system development structures. More attention and resources [F6] are spent on building capacity in institutions and organizations that will support [F2], [F3] and [F4].

The Entrepreneurial Motor of this period is quite weak, lacking coherent policy that would drive the market formation [F5] that one would expect. Most critical during this period was a small group within NERSA formulating regulations for the nascent renewable energy IPP programme (Baker, Lucy, Newell & Phillips, 2014). This niche group would explore a renewable energy feed-in tariff (REFIT) system (based on studies of similar German and European RE incentive programmes) in order to kick-start the renewable energy IPP sector, though formulating such policy [F4] was the legislated responsibility of the DoE.

Although NERSA was predominantly aligned to Eskom and its needs, this small group performed a critical lobbying and niche support [F7] function in the Entrepreneurial Motor. Their attempts at formulating REFIT [F4] would build

momentum and lay the groundwork for strong market formation [F5] later. These efforts would eventually lead to conflict within NERSA and other regime structures like the DoE; whose mandate it was to formulate such policy. The regime resistance loop (Walrave & Raven, 2016) starts to build slowly, as push-back against this niche group builds within NERSA in support of Eskom and the existing regime. The supply crisis however prevents Eskom from exercising its monopolistic power as quick-to-market RE technologies are seen as one possible solution that could help mitigate load-shedding in the short to medium-term.

4.6 RAPID MARKET FORMATION: 2009 – 2013

The next 5 years marks the break-out period of renewable energy generation technologies in South Africa. 2009 sees the inauguration of a new South African President, Jacob Zuma in May. Shortly after, regulations are released that gazette the IPP bid and REFIT programme. Behind the scenes however, the new nuclear build programme is taking shape, with the first of many bilateral agreements on nuclear energy signed with the USA.

May 2010 sees two significant events marking the beginning of divergence of views and agenda in the political landscape, with regard to the future direction of South Africa's energy regime. The one event is the establishment of the National Planning Commission (NPC), that would later release the National Development Plan 2030 (NDP) in November 2011. A visionary roadmap, chapter 5 of the NDP would forecast the transition to a low-carbon economy, more reliant on renewable energy generation (envisaging 20 000MW installed by 2030) to ensure an equitable and environmentally sustainable future for South Africa (Commission, 2012).

The other sees the purchase of the Dominion uranium mine by the Gupta family and the son of the president; the embryonic networks of state capture securing access to an anticipated fuel of the future. By October 2010, the draft Integrated Resource Plan (IRP) for Electricity 2010 would solidify South Africa's future policy on energy confirming a significant commitment to new nuclear generating capacity of 9.6GW by 2030, at an estimated cost between US\$36 and 90 billion (Pollet, Staffell & Adamson, 2015). This new nuclear build programme was expected to commence by 2023. October also marks a major shift in the socio-political landscape, with the first of many cabinet reshuffles that will become the hallmark to the Zuma presidency.

In December of 2009, the President makes the commitment on the world stage at the Copenhagen Climate Summit to reduce South Africa's GHG emissions (relative to a business as usual growth scenario) by 34% by 2020, increasing to 44% by 2025. This period sees many regulations, policies and standards enacted in support of the renewable energy sector. Standards and regulations are introduced that also mark the beginning of embedded generation systems (EGS) in cities; now allowed to be connected to the grid and compensated for excess generated power through feed-in tariffs (FITs).

For IPPs, 2011 marks the critical tuning point. With the support of National Treasury, the DoE wrests control over the REFIT programme back from NERSA and Eskom, arguing that the REFIT is non-compliant with the Public Finance Management Act (PFMA) as it represented a non-competitive incentive scheme. Significantly, change in leadership of the IPP programme sees the generation capacity earmarked for renewable technologies jump from 1025MW under NERSA/Eskom, to 3725MW under the DoE and National Treasury. In the same year, the Renewable Energy Independent Power Producer Programme (REIPPPP) is launched with IPPs awarded contracts on a competitive price-based bid system. The first tenders of Bid Window 1 are announced to the world at COP17 held in Durban, signaling the beginning of massive investments by local and international finance institutions and private sector capital funds.

Two more bid windows are launched during this period, with the cost of electricity generated by solar PV power plants falling sharply with each subsequent bidding process (Bischof-Niemz, T & Fourie, 2016). REIPPPP Bid Window 1 reaches financial closure in September 2013, with the first IPPs ready to be connected to the grid thereafter once PPAs have been signed with Eskom. This period sees the establishment of three solar PV manufacturing and assembly plants in South Africa by international (US and French/Chinese consortium) and local companies to capitalize on the REIPPPP. The excitement in the international and local renewable energy sector results in South Africa hosting many energy conferences. By the end of 2013, the renewable energy sector seems well on its way to consolidating its place in the national energy mix and South African market.

4.6.1 FUNCTIONAL ANALYSIS

This period of system development is dominated by strong Market Formation [F5] events in the REIPPPP bid windows 1-3, accompanied by many critical Guidance of the Search [F4] events. Noteworthy policy events [F4] include the release of The White Paper on National Climate Change and the Draft IRP 2010 Rev2 (introduces nuclear generation capacity requirements). Significant regulation and standards [F4] come in the form of the 2009 revision of Electricity Regulation Act (ERA) 2006 (IPP grid connection & EG regulations); Eskom specification NRS 097-2-1:2010 (guidance on grid interconnection of EG) and NERSA's standard conditions for EG within Municipal boundaries. These events trigger much local and international interest in the growing renewable energy market, with many [F3] events reflecting multiple energy conferences held during this period. Industry support and technical training firms [F3] also establish themselves during this time. The strength of the [F5] drives many solar PV manufactures and suppliers to invest directly in the South Africa market [F6] (Eberhard, Anton & Naude, 2017). It also sees the formation of renewable industry lobby and advocacy groups [F7] like the South African Photovoltaic Industry Association (SAPVIA) to represent a growing body of interests.

4.6.2 STRUCTURAL DRIVERS AND BARRIERS

Sustained regime instability in the form of regular load-shedding by Eskom and landscape pressure in the form of a ramp-up in international efforts to reach a global consensus on climate change continues to drive interest in the renewable energy generation systems. Increasing electricity tariffs concerns for ensuring reliable energy supply drives many customers to explore alternative embedded generation systems. There appears to be few barriers holding back the formation of the renewable energy market and the solar PV TIS during this period.

4.6.3 SYSTEM BUILDING MOTOR

The System Building Motor is revisited in this period, although the REIPPPP now ensures that a strong market motor is in effect. The TIS structure develops quickly with the entry of many solar established PV suppliers and manufacturers into South Africa. Support networks and training programs are quickly established. Legitimacy of the technology is quickly reinforced as the TIS structures mature. Each new REIPPPP bid window sees the cost of PV generated energy fall while local and international investment continues to grow (Eberhard, Anton & Naude, 2017), increasing the total available resources in the system.

With the niche market rapidly growing, the increased competition sees the regime resistance loop begin to increase in strength, although continued regime weakness resulting in regular load-shedding curtails Eskom's ability to push-back. For the time-being, the energy supply challenge is benefiting many interests embedded in the incumbent regime, with transport companies and coal mines being handsomely compensated to supply additional resources to Eskom in order to keep the lights on.

4.7 STALLED MARKET CONSOLIDATION: 2014 – 2018

With the great strides of the previous five years, it may have been expected that this period would be characterized by market consolidation as the TIS structure matured and became self-sufficient. Instead, the REIPPPP grinds to a halt as political interests start to influence with the South African energy regime.

At the national level, REIPPPP continues drive local and foreign investment, with the next two Bid Windows 4a and 4b launched in August 2014; Market Formation activities still seem to be on track. Resource Mobilization continues in 2014 as solar PV manufacturers and suppliers keep investing in local facilities and production. This period sees eight more international PV module suppliers open manufacturing and assembly operations (1 US, 1 Canadian, 1 Indian, 1 German and 5 Chinese), and two major PV technology suppliers of inverters from the UK and Germany. Local entrepreneurial activity continues with PTiP's (Prof. Vivian Alberts) locally developed thin-film PV modules semi-commercialized in conjunction with a German partner.

The dramatic growth in the RE sector facilitated largely by REIPPPP necessitates the formation of the South African Renewable Energy Council (SAREC), an umbrella body representing multiple RE lobby groups and industry

associations¹⁵. Financial close of REIPPPP Bid Windows 2 & 3 are achieved in November 2014 and September 2015 respectively, with more RE IPPs ready to connect to the national grid. This momentum in the REIPPPP is suddenly cut short however, when the then Eskom CEO announces in October 2015 that the utility would no longer enter into PPA after Bid Window 3. This marks the beginning of a concerted pushback by the regime and a shift in focus away from renewables at the political level.

Eskom would progressively increase resistance towards the RE transition in this period, effectively stalling the REIPPPP by exploiting its control over the value-chain, either exercising its power as sole purchaser of generated electricity by delaying the signing of PPAs, or using its monopoly control over transmission infrastructure by obstructing connection to the grid on technical grounds (Morris & Martin, 2015). This resulted in the flatlining of installed PV capacity in the REIPPPP as evident in **Figure 4** (refer section 4.8). Over the next year the solar PV industry goes to ground, with some international companies like Germany's SMA Solar (world's biggest manufacturer of solar power inverters) announcing their exit from the country in August 2016, after having just opened manufacturing facilities in Cape Town in December 2014.

Although the PV industry (heavily reliant till then on the REIPPPP) shows the signs of contracting, the amendments to Section 12b of the Income Tax Act (South Africa) in January 2016 suddenly unlocks a substantial new market for EG installations under 1MW. This amendment effectively translated into a 28% rebate for companies that install solar PV EG systems on their buildings¹⁶(Steenkamp, 2016). In the City of Cape Town, merely two months after the introduction this tax incentive, the market for solar PV EG systems begins to take-off as evident from **Figure 5** (refer section 4.8). Although the tax amendment was the trigger event, the creation of this new market was also precipitated by regime weakness (steep electricity price increases and continued unreliability in grid electricity supply), driving customers to consider EG systems to guarantee their daily energy supply and reduce operating costs. The cost of PV technology had also substantially decreased during this period, the result of increased market competition with the entry of PV manufacturers and suppliers into South African due to the REIPPPP.

The growth of the EG niche in cities during this period also relied on two key codes and standards released in 2014, namely *NRS 097-2-3:2014 – Grid Interconnection of Embedded Generation* issued by Eskom and NERSA's *Grid Connection Code for Renewable Power Plants (RPPs) Connected to the Electricity Transmission System (TS) or the Distribution System (DS) in South Africa*. Subsequently, eThekweni Municipality (Durban) and the City of Cape Town (CoCT) introduce EG Feed-in Tariffs (FITs) in July 2014, followed by the City of Johannesburg (CoJ) in July 2015 and Nelson Mandela Bay (NMB) municipality in Port Elizabeth in July 2016. What is however evident, both from the survey conducted and the statistics of installed EG in CoCT shown in **Figure 5** (refer section 4.8), the FITs had very little impact on EG market formation. This tremendous growth in the EG niche does see its potential curtailed however, with further regulation in the 2017 update of ERA 2006, requiring consumers to register as IPPs with NERSA if their EG installations exceed 1MW.

What is clear from the EHA during this period is the significant increase in political events that could influence the energy regime. This period sees no less than five cabinet reshuffles by the president and the introduction of new board members and senior management at Eskom. The rapid pattern of change of key actors within the regime structure and the seeming political urgency to commit South Africa to the new nuclear build programme comes to dominate the news headlines of this period.

¹⁵ SAREC represents the South African Photovoltaic Industry Association (SAPVIA); the South African Wind Energy Association (SAWEA); the Sustainable Energy Society of Southern Africa (SESSA); the Solar Thermal Association of Southern Africa (STASA) and the Southern African Solar Thermal and Electricity Association (SASTELA).

¹⁶ "What does this mean for your company? Currently, company tax in South-Africa is 28%. With this incentive, you can deduct the value of your new solar power system as a depreciation expense from your companies' profits. This means that your companies income tax liability will be decreased by the same value as the value of the installed solar system. This reduction can also be carried over to the next financial year as a deferred tax asset. In effect it is the same as getting a 28% discount on the price of your solar system!" Solutions, G.E. *Updated SARS Tax Incentive for Solar Power!* : Green Energy Solutions. Available: <http://www.greenenergysolutions.co.za/updated-sars-tax-incentive-for-solar-power/> [2018, 14/11/18].

Eskom's continued refusal to sign-off agreements with successful REIPPs during this period was blamed on financial constraints facing the utility (even after significant government bailouts), meaning it could not allocate budgets towards PPAs after Bid Window 3. Projects from the REIPPPP Bid Windows 3.5, 4a & 4b remained to be connected to the national grid, despite Window 3.5 reaching financial closure in April 2016 and Windows 4a & 4b in July 2016. The regime resistance appears to strengthen dramatically towards the end of this period, with a narrative building against the reliability of renewable energy generation in support of nuclear energy as the preferred low-carbon, base-load solution (*Koko, 2016*). Policy in the form of IRPs 2016 and 2017 continue to reflect government's commitment to the large nuclear build programme however, South Africa's trade unions, religious organizations and civil society groups begin to mobilize resistance against the nuclear programme, fearing that the mega-project will herald a new era of rent-seeking and corruption.

During this time, industry associations and lobby groups are expending great amounts of energy challenging Eskom in the interest of their members. By the beginning of February 2017, the sign-off of the outstanding REIPP PPAs had yet to be resolved, despite assertions to the contrary by the then Energy Minister Joemat-Pettersson. Eskom, after having been confirmed as the procuring entity for the nuclear build programme in October 2016 by the Energy Minister, forges ahead with their Request for Information (RFI), the precursor to going out to tender. The push-back from civil society steadily increases against the nuclear programme, with contestation through the courts eventually resulting in the Western Cape High Court ruling that aspects of the nuclear procurement program unlawful in late April 2017. Political efforts to push through the new nuclear procurement program in the face of the court's decision seem to become more urgent, with yet another replacement in the Energy Minister (Mmamoloko Kubayi only appointed in March 2017) through another cabinet reshuffle in October 2017.

This period ends with a change of President in February 2018 and the appointment of the new Energy Minister, Jeff Radebe, who shortly after commits to signing-off the outstanding PPAs and the REIPPPP seems to slowly get back on track.

4.7.1 FUNCTIONAL ANALYSIS

This period is not dominated by any particular function, with political interactions seeming to have the greatest impact on system development. Market Formation [F5] continues with the REIPPPP Bid Windows 4a & 4b although it had largely been stalled by the regime. Resource Mobilization [F6] accelerated during this period, with many international solar PV manufacturers and suppliers entering the local market due either to earlier commitments or buoyed by the early success of the REIPPPP. Guidance of the Search [F4] continues to feature prominently, with the release of IRPs 2016 and 2017, both reflecting a continuation of existing policy commitments to increase renewable energy generation, although also maintaining the prominence of nuclear capacity in the energy mix.

In terms of Market Formation [F5] in the EG niche, Eskom's standard *NRS 097-2-3:2014* [F4] and NERSA's code [F4] on grid connection, coupled with the incentive offered by the amendments to Section 12b of the Income Tax Act (South Africa) [F5] unlock a significant new market for the solar PV industry. Although most major cities introduce FITs during this period, they have no effect on driving Market Formation [F5] other than to allow EG systems to connect to the grid. The refusal of Eskom to sign out-standing PPAs effectively stalling the REIPPPP and negatively impacts continued market formation [F5].

The formation of SAREC [F7] is a substantial indication the RE sector has reached critical mass. RE associations and lobby groups [F7] mobilize to challenge Eskom's refusal to sign PPA committed to under the REIPPPP. Notably, the then Mayor of City of Cape Town, Patricia De Lille challenged the Minister of Energy to allow cities to sign their own PPAs directly with IPPs instead of through Eskom, effectively challenging current policy and regulation [F4] (though this remains to be decided).

4.7.2 STRUCTURAL DRIVERS AND BARRIERS

This period sees many barriers to system development, driven mostly by certain political agenda. In this period, political power is exercised through patronage networks within the regime; agents within Eskom, ministry of energy and public enterprise. The REIPPPP is effectively stalled by the regime, starving the RE industry of resources and stalling market formation processes. Attempts are also made to capture the ministry of finance, although this institution manages to hold out long enough for changes in the socio-political regime. In contrast, rising electricity tariffs finally become a

significant driver of system development once conducive regulation (codes and standards) and the correct level of incentive (tax incentive 12B) suddenly unlocks growth and diffusion of the solar PV TIS by opening the EG niche.

4.7.3 STALLED MARKET MOTOR

At the end of 2013, the TIS trajectory had all the ingredients to suggest that a strong Market Motor could have been expected in this period. Early signs of continued investment by international solar PV firms, based largely on the success of the first three REIPPPP Bid Windows, would seem to confirm this assumption. Instead, system development displayed qualities of a slowing Market Motor, triggered by Eskom refusing to sign out-standing PPA with REIPPs causing market formation to temporarily stall. The only thing that prevents a total collapse in the solar PV market is the emergence of the EG niche, unlocked by the amendments to Section 12b (tax incentive). This incentive allows companies to take advantage of the falling cost in PV technology and results substantial growth in EG installations. This new market opportunity is exploited by the solar PV industry and a weak Market Motor is maintained

What is clear is that the regime resistance loop became very strong during this period, to the point where Eskom could ignore its legal commitments to IPPs and refuse to act on government policy by exercising its power to withhold signing PPAs. This period clearly showed the monopolized power vested in Eskom as sole purchaser of generated electricity. While Eskom never openly declared war on the REIPPPP, it definitely dragged its feet and confounded the situation by controlling the renewable energy narrative and conflating power stability concerns with the unavailability of renewables at times of peak-load requirement (*Theron, 2016*).

4.8 PHOTOVOLTAICS – TECHNOLOGY OF CHOICE

Early assumptions about what may be driving the transition, particularly at the landscape level, were tested and proved incorrect by the survey results. While environmental and climate change commitments were present in the EHA and MLP analysis, at the consumer level, green and environmental issues were significantly less important drivers of change than energy resilience and the cost of electricity. The survey outcome largely correlated with a survey conducted by the DoE in 2012, which confirmed the majority of South African energy consumers (75%) believed that the priority of government should be to keep the price of electricity low (DOE, 2012)

Cost as primary driver of EG comes as no surprise considering that Eskom tariffs have increased by over 300% in real terms between 2007-2015 (Johannesburg, 2016). This is in stark comparisons to the falling average tariff price at which Eskom purchases electricity generated by PV IPPs through the REIPPPP, having fallen by 83% from the first bid window to bid window 4.5 (Bischof-Niemz, T & Fourie, 2016). There are an increasing number of studies in South Africa that look to quantify the required electricity price that will see small-scale EG PV installations compete directly with grid supplied electricity in terms of cost (Kritzinger, 2017, Numbi & Malinga, 2017). These studies would indicate that for the moment solar PV rooftop installations are still too expensive to be truly competitive, although this does not seem to be strictly supported by the survey results. While the survey responses did not indicate that PV had reached price parity with grid electricity, the cost of lost business during load-shedding (particularly in the commercial sector) seems to be factored into the consumers calculation of whether the EG is perceived to be economically viable or not.

The growth of solar PV industry in South Africa certainly relied heavily on the investment opportunity provided by the REIPPPP. The significant dates impacting the growth of solar PV projects at the utility-scale are extracted from the EHA in **Table 5**. The rapid diffusion of solar PV facilitated by the REIPPPP is illustrated in **Figure 4**, showing the cumulative solar PV generation capacity of operational projects, chiefly from bid windows 1 & 2 up to the end of December 2014.

2011 Nov	REIPPPP Bid Window 1
2012 March	REIPPPP Bid Window 2
2013 Aug	REIPPPP Bid Window 3
2013 Sep	REIPPPP Bid Window 1 – Financial Close: Feb 2012 to Sep 2013 (20 months)
2014 Aug	REIPPPP Bid Window 4(a) & additional
2014 Aug	REIPPPP Bid Window 4(b)
2014 Nov	REIPPPP Bid Window 2 – Financial Close: Aug 2012 to Nov 2014 (27 months)
2015 Sep	REIPPPP Bid Window 3 – Financial Close: April 2014 to Sep 2015 (17 months)
2015 Oct	Eskom begins to stall on the REIPPPP by halting the issue of budget quotes due to financial constraints, claiming no budget for IPPs after Bid Window 3
2015 Nov	REIPPPP Bid Window 4(b) expedited
2016 April	REIPPPP Bid Window 3.5 – Financial Close: April 2015 to April 2016 (12 months)
2016 July	REIPPPP Bid Window 4(a) – Financial Close: June 2015 to July 2016 (13 months)

2016 July	REIPPPP Bid Window 4(b) – Financial Close: June 2015 to July 2016 (13 months)
2016 July	Eskom Chair Ben Ngubane sends letter to Minister of Energy Joemat-Pettersson that the utility will not sign any further power purchase agreements after REIPPPP window 4.5 are signed.

Table 5: Crucial dates in the REIPPPP.

After December 2014, a very obvious flatline appears in the growth of installed renewable generation capacity in the national grid. Projects from bid windows 1 & 2 are mostly connected by this date, but thereafter, IPPs from bid window 3 and beyond fail to conclude PPAs with Eskom. Whether due to increased resistance from the incumbent regime protecting its monopoly of energy supply, or the influence from the shift in political visions for South Africa’s energy future, by October 2015, Eskom management begin to openly blame financial constraints on finalizing PPAs after Bid Window 3. While not expressly stated at the time, REIPPPP projects were also delayed access to transmission infrastructure as Eskom increasingly found technical reasons to stall connection to the national grid during a time of greatly constrained power supply and volatility. Although generating capacity does begin to pick-up around mid-2016, the rate of growth in operational solar PV is far more measured than it was up till the end of 2014.

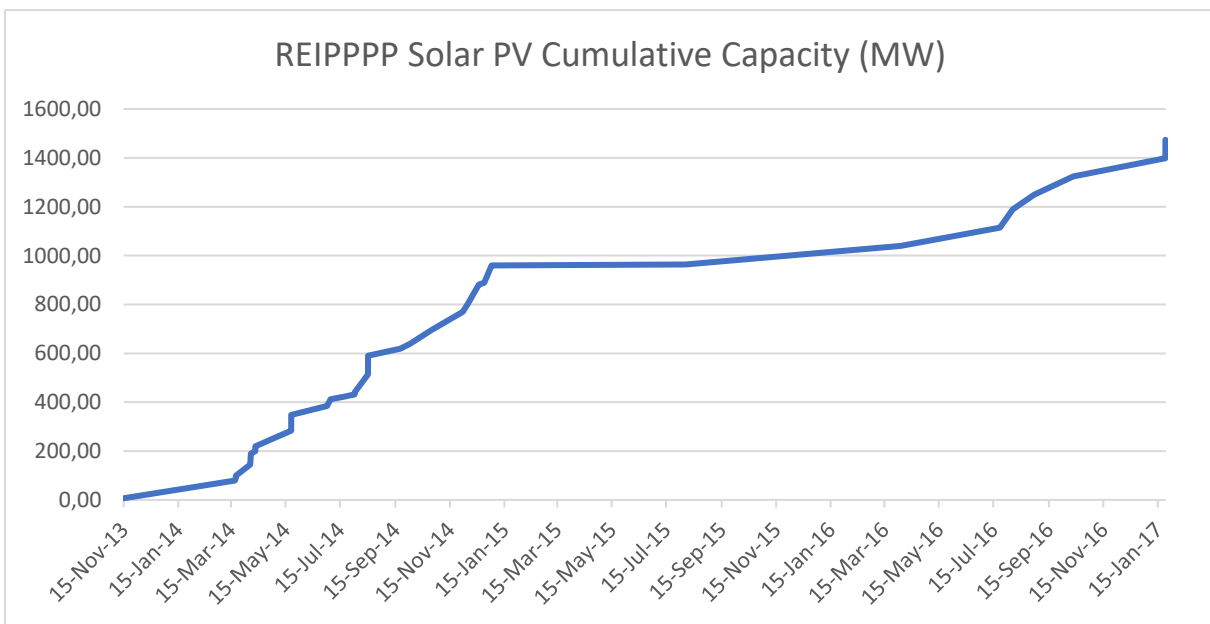


Figure 4: Cumulative solar PV generation capacity of operational REIPPPP projects generated with data from DoE (Energy, 2018).

In contrast, the EG market explodes shortly after the introduction of amendments to Section 12B of the Income Tax Act in January 2016, which allows commercial companies to deduct the full cost of their PV installations from their taxable income in their first financial year of installation (Kritzinger, 2017, Krupa & Burch, 2011). Its impact on the formation of the EG market can be seen in **Figure 5**, showing the cumulative EG installation capacity in the CoCT¹⁷. This ably illustrates how resistance from the regime stalled one niche, while the formation of another in EG sustained the solar PV market.

¹⁷ EG installations in the City of Cape Town are almost entirely solar PV according to the data from CoCT’s Directorate of Energy.

1.2 Approved, commissioned, grid-tied, embedded generation | Capacity

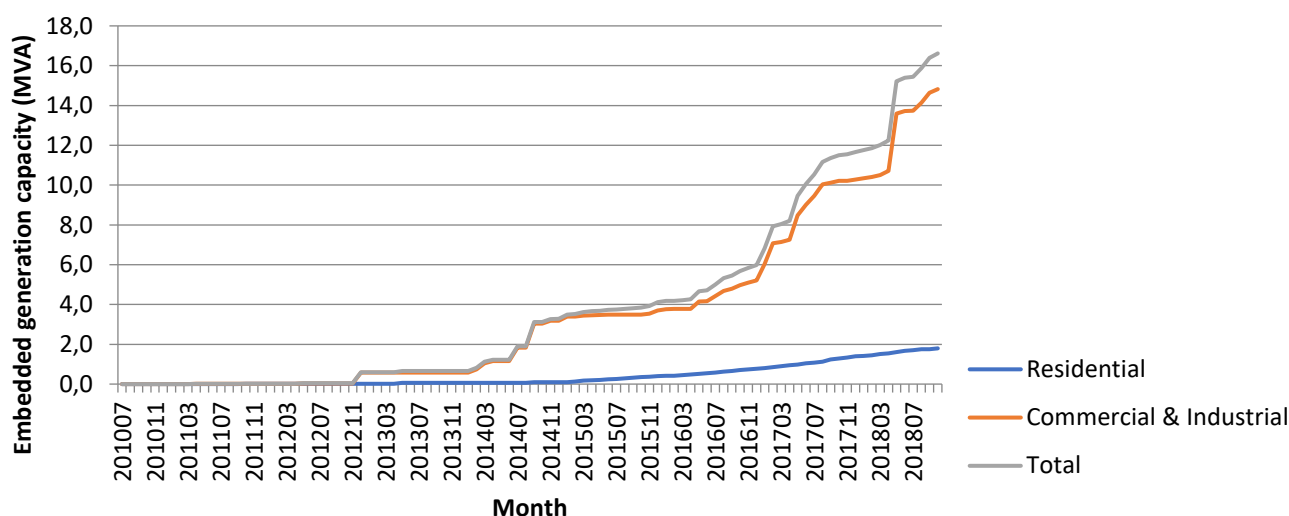


Figure 5: CoCT Statistics of cumulative EG installation capacity (data supplied by the CoCT Directorate of Energy)

4.9 REGIME, POWER & POLITICS

The period of 2014-2018 highlighted the impact that both regime and political actors could have on the ST. This period of the EHA is overwhelmed by political and contextual events, supporting its formal inclusion in the TIS framework (Bergek et al., 2015). Much of the activity during this period focused on shaping the future of the South African energy regime. At the heart of this lies the complex relationship between politics and the 'Minerals-Energy Complex' (MEC) (Fine, 2018), which describes both South Africa's reliance on coal as a principle source of energy, but also how the economy is highly bound to cheap and abundant electricity to support energy intensive industry and mining (Baker, Lucy, Newell & Phillips, 2014, Fine, 2018, Krupa & Burch, 2011, Morris & Martin, 2015, Swilling, Musango & Wakeford, 2015).

The emergence of renewable energy in the SA energy regime was believed by many to herald a 'just' ST (Swilling, Musango & Wakeford, 2015), with much hope placed on the REIPPPP as the mechanism by which the MEC-Eskom monopoly nexus would finally be challenged (Baker, Lucy, Newell & Phillips, 2014, Morris & Martin, 2015). The success of South Africa's embryonic energy transition has been attributed to the relative independence of the nascent IPP office within NERSA, creating the niche space required for renewable energy IPPs to enter the sector. This is contrast to the cases like the Bulgarian renewable energy transition, where politically connected actors highjacked much of the REIPP market (Ivanov, 2018).

This initial success arguably led to the increasing resistance within the energy regime and from the alternative future heralded by new nuclear build programme. Where the REIPPPP partially liberalized the energy sector, the nuclear build programme would have perpetuated a regime 'lock-in' reliant on centralized, state-owned utility scale energy (Morris & Martin, 2015, Swilling, Musango & Wakeford, 2015).

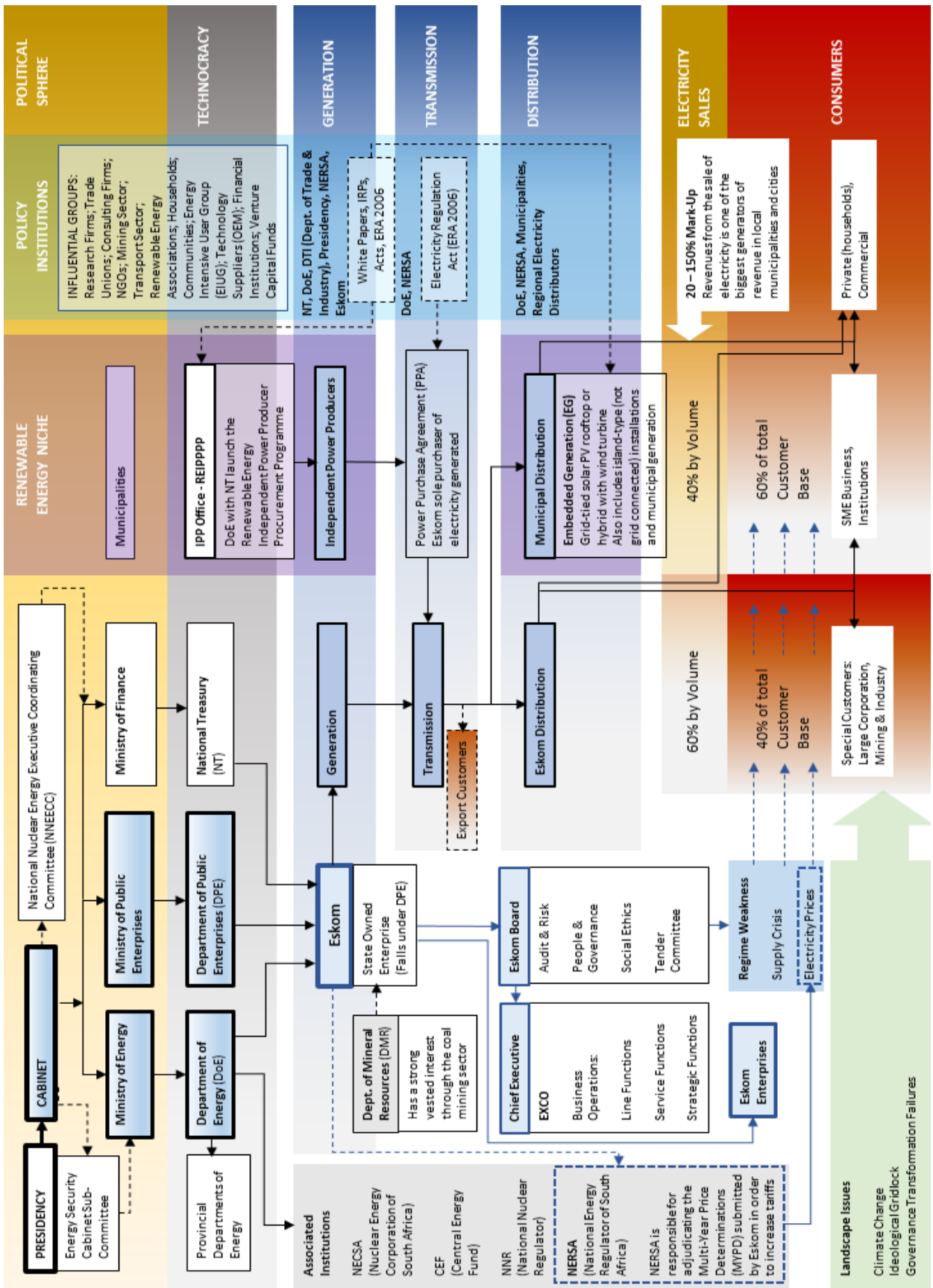


Figure 6: Socio-technical landscape of South Africa's energy regime. Adapted from (Eberhard, Anton 2005, Jaglin & Dubresson, 2016, Morris & Martin, 2015).

4.9.1 CITY REGIME

Regime resistance at this time was not only felt at the utility-scale towards REIPPPP, but was also experienced in the EG niche from the city-level regime. South Africa's current energy regime depicted in **Figure 6** shows how EG in cities is located in the renewable energy niche. Cities are highly dependent on electricity sales revenue (Morris & Martin, 2015), with significant mark-ups of between 20-150%. Yet the ever-increasing electricity tariffs coupled with the positive impact of the tax incentive (amendment to Section 12B), have created a fertile EG niche in cities. The survey results have shown that under the current conditions, electricity consumers are strongly driving demand for EG, not needing to rely on FITs to make EG economically viable. Compared to other countries in Europe where FITs are strong structural drivers of EG in cities, the survey results showed that in practical terms, the FITs offered by municipalities are so low that they cannot be considered as incentives. This highlights the dual struggle that these local-level energy regimes face; on the one hand they encourage EG to ensure a greater degree of localized energy supply reliability (Morris & Martin, 2015), while on the other hand they are highly dependent on the resale of energy to collect revenue. The socio-technical model of

City municipalities have been shown in local studies to effectively disincentivize the widespread diffusion of rooftop solar PV in order to protect electricity sales revenue (Mayr et al., 2015), with one survey respondent fuming at the R11 000 cost to install a reverse meter in Cape Town. In another study of grid-interactive solar PV in Durban, it was shown that FITs would need to increase by 75% to reach a pay-back period of 8.6 years on a two bedroom family home (Numbi & Malinga, 2017), far more than the 5 year average that most consumers were looking for in the survey. This then raises the question of how cities will deal with falling revenue irrespective of whether EG is subsidized or not. There are real concerns that these municipalities will need to address besides negative impact on revenue, including network instability from the diffusion of PV systems and added administrative burden to regulate and enforce compliance (Kritzing, 2017).

4.10 THE PATHWAY OF SOUTH AFRICA'S ST IN ENERGY

So, when did the transition in the SA energy sector begin? Genus & Coles argue in their research that transitions begin when "a prevailing socio-technical regime starts to display significant problems" (Genus & Coles, 2008:1438). It could be reasoned that the collapse in reliable energy supply by Eskom as sudden regime instability marks the beginning of the ST. It could likewise be argued that policy decisions (White Paper 1998) taken before the energy crisis herald the transition's starting point. In reality, STs may require multiple transition pathways to fully emerge (Grin, Rotmans & Schot, 2010) and this is most likely the case as described through the various MLP analyses of the South African ST in energy (Baker, Lucy, Newell & Phillips, 2014, Morris & Martin, 2015, Swilling, Musango & Wakeford, 2015). This fluid nature of the MLP, where 'transition pathways' can shift over time (Geels, Frank W. & Schot, 2007), could see further changes in the political landscape and governance within Eskom, making the utility the driver of the 'just transition' needed in the South African economy. However, this would require substantial changes in Eskom's basic architecture; leadership actively embracing renewable generation; breaking-up Eskom's monopoly on generation and transmission; and moving to a more decentralized and distributed model of generation.

As it is, the global landscape pressure of climate change mitigation most probably started South Africa on a very slow *Reconfiguration pathway* to begin with. By the time South Africa toyed with seriously introducing renewables into its energy mix, solar PV was already a mature global TIS, making its gradual adoption into the incumbent regime inevitable and only a matter of time (Grin, Rotmans & Schot, 2010, Walrave & Raven, 2016). This slow and steady approach was quickly replaced by a *Technological substitution pathway* (Grin, Rotmans & Schot, 2010, Walrave & Raven, 2016) when South Africa's incumbent regime was faced with the sudden, but not unexpected, collapse in reliable energy supply. Generating capacity goals were quickly revised post 2008 to increase the contribution of renewables and help plug the generating shortfall. Regime resistance was certainly high as key actors and predators in the dominant MEC, aided by political motivation, turned to new nuclear and additional coal investments to address both the capacity deficit and claim its progressive shift towards a low-carbon regime. Where does this leave the future of EG in South Africa's cities? The most likely outcome is that they will continue to change with rooftop solar PV installations becoming an increasingly common sight. What is certain from the market survey, is that the increasingly affordable cost of PV technology coupled with the guaranteed increases in electricity tariffs will continue to provide fertile ground for the ST in South Africa's cities even if there are no further positive changes to support system development.

CHAPTER 5 CONCLUSIONS & RECOMMENDATIONS

5.1 RENEWABLE ENERGY & A LOW-CARBON FUTURE

While climate change is a global challenge, the dangerous repercussions of increasing world temperatures will be more acutely felt in Africa. High rates of poverty, inequality and lack of access to infrastructure are structural barriers to growth, yet any significant economic development could worsen Africa's future if historic patterns of high-carbon development trodden by the global North are replicated. The widespread diffusion of RETs in Africa's energy regime has been identified as one potential solution that could drive low-carbon and sustainable growth (Panel, 2015).

South Africa (SA) in particular has an important role to play in this low-carbon future considering that it currently accounts for 60% of all energy consumed in Sub-Saharan Africa (Panel, 2015). A large portion of this energy can be attributed to SA's electricity sector, heavily dependent on coal-fired power stations. However, SA has seen the beginnings of a nascent sustainability transition (ST) in its energy regime, leading the African continent in renewable energy investment (REN21, 2018). This transition is not only occurring at the national utility-level, but also in the built environment of SA's cities, having seen rapid growth in embedded generation (EG) mostly in the form of rooftop solar PV installations.

5.2 GROWTH OF EMBEDDED GENERATION IN SOUTH AFRICA'S CITIES

This research sought to explore how EG has developed in the built environment of SA's cities in the context of the ongoing ST in the energy sector. This was done by looking specifically at the growth of solar PV in EG applications and at the utility-scale as broader context, in order to understand changes in the incumbent regime and what barriers exist preventing the wider diffusion of solar PV in cities. An integrated theoretical approach using elements from the MLP and TIS was employed to focus simultaneously on a specific technology and the regime-level.

A survey was utilized to generate insights into the renewable energy niche at the city-level by targeting built environment professionals, their clients and technology suppliers. The survey confirmed solar PV as the RET of choice in cities. Solar PV is no longer seen as experimental or high-risk, with the survey indicating high consumer confidence in the reliability of the technology and aftermarket support networks. It was also considered the most flexible technology for EG applications, with overshadowing in dense urban environments the only noteworthy limitation.

It was also perceived to generally have the greatest acceptance in society, being the least obtrusive visually with no other significant negative impacts when compared to other available RETs; unlike wind turbines (the next most common RET in EG applications) that were considered 'noisy' and had a high visual impact on the built environment.

Initial assumptions that landscape considerations of climate change and sustainability were drivers of EG were proved incorrect by the survey results. The biggest factors impacting the growth of EG in cities were primarily the result of weaknesses in the regime, namely the rapidly rising cost of electricity and the continuing unreliability of energy supply provided by Eskom. Economic considerations (reduction of costs associated with electricity consumption) and supply reliability were therefore the biggest drivers of investment in embedded solar PV.

5.2.1 USELESS FITs

What also emerged from the survey was the ineffectiveness of current feed-in tariffs offered by metro municipalities to support wider diffusion of solar PV in the built environment. FITs represent a first attempt by the city-level incumbent regime at managing the ST. Increased EG can affect the stability of municipal electricity distribution networks and negatively impact revenue collection from electricity sales that are relied upon by metro municipalities. Current FITs are therefore not structured to encourage very rapid growth in grid-tied EG systems. The survey results confirmed that most EG applications remain off-grid, with consumers mostly content to supplement daily supply and provide a reasonable degree of resilience against load-shedding. The consequence is that the vast majority of EG applications do not attempt to generate excess electricity to generate revenue from the FITs.

5.3 SUPPORTING EMBEDDED GENERATION IN CITIES

Despite the challenges faced by the RE niche in South Africa's cities, extensive data tracking the cumulative installed EG capacity in the City of Cape Town reflects exceptional growth, particularly over the last 3 years. Analyzed in conjunction with the EHA it becomes evident that the amendment in January 2016 of Section 12b of the Income Tax Act, effectively translating into a 28% rebate for businesses that invest in EG applications, is the actual trigger of this exceptional growth.

In terms of the overall ST this came at a crucial time. At the beginning of 2015, building resistance within the regime effectively stalled the REIPPPP and growth of the fledgling renewable energy niche. This period also saw intense political pressure to redirect the narrative and state resources in pursuit of an alternative transition pathway reliant on nuclear energy, one that would have perpetuated the current lock-in of a centralized and monopolized energy regime, albeit one with reduced reliance on coal.

Although some PV technology suppliers did close and exit the sector during this period, the industry reemerges strongly, taking advantage of a rapidly growing market segment unlocked by an incentive that makes the investment in solar PV installations more financially viable. While the initial growth of the South African renewable energy sector depended heavily on the REIPPPP, the ability of the industry to survive outside of the REIPPPP niche suggests that there is indeed potential for a sustainable local market. The survey results reinforce this growth potential in the private and commercial market. Consumers of smaller-scale PV installations, particularly in the residential sector appeared more prepared to invest in newer and more expensive components like lithium-ion battery back-up. This 'high-end' market has the potential to drive demand and promote the use of newer components, thereby helping push down the cost of emerging technology in the long-term.

5.4 THE UTILITY OF AN INTEGRATED THEORETICAL APPROACH

Early applications of the MLP to case studies (Geels, Frank W 2005) were criticized for their historicist nature, while useful for retrospectively describing a transition, they seemingly lacked a robust analytical framework that could be applied to more current transitions. This criticism was based on the possible subjective framing of an innovation in terms of its historic context and period of analysis by the researcher, potentially undermining the narrative created (Genus & Coles, 2008). The TIS approach is far more structured than MLP and therefore there have been multiple researchers that have called for an integrated framework using both MLP & TIS. Both frameworks have proved complimentary in application, with the MLP providing "a useful overall plot ('global model') for studying transitions," (Geels, Frank W., 2011:35) while the EHA that underpins TIS brings a more structured analytical methodology. There are sufficient studies that have also shown that TIS need not to be applied in a narrow techno-centric approach as originally proposed to still provide valuable insights to an overall transition scenario. The inclusion of political and structural context in the event-history analysis has made particular strides in aligning the TIS and MLP frameworks.

One reason the integrated approach proved valuable was that the initial research questions posed had both macro and meso dimensionality. The general transition in the energy regime could be better described by the MLP, whereas to gain insights on how this would specifically impact the built environment, a TIS approach was more appropriate. The MLP narrative proved both a useful contextual framing tool and entry point into the analysis of the ST, while the TIS could account for any fuzziness the MLP might suffer from when assessing the ST at the micro-level niche.

Employing a market survey in the study proved a useful tool to delineate system boundaries of the research topic by identifying a specific technology present that could provide an appropriate lens through which to study the ongoing ST. Combined with the construction of the EHA (a key component of the TIS methodology) the survey provided valuable insights at the smaller-scale niche level which enriches the regime-centric MLP narrative. The functionalist approach of TIS could also highlight potential interventions to support the overall transition, an immediacy of action that many scholars have argued lacking in the MLP.

5.5 SYSTEM COMPLEXITY, DATA LIMITATIONS & DELIMITATIONS

Although the research was designed to meet the objectives set, the research had time constraints which ultimately limits scope. The context of the sustainability transition in the SA energy sector and how this is interrelated to the diffusion of RE technology in cities represents a very large and complex system. The use of a specific TIS as a lens is precisely employed to reduce system complexity for analysis purposes. This reductive approach obviously leads to underrepresentation of many actors engaged in the socio-technical system (Ametowobla, Baur & Jungmann, 2015). Much of the analysis and observations surrounding political and regime actors (governmental ministries, Eskom, NERSA etc.) is inferred purely from bibliographic data. These actors were not directly interviewed, with interpretation of their actions coming from the EHA construction process and engagement with energy experts (whose own views could potentially be prejudicial towards the existing regime). One potential risk that was evident in the heavy reliance on news articles to construct the political context in the EHA, was the potential bias in the editorial narrative of specific publishers, reflecting broader ideologies or agenda. There is also a potential risk that the researcher inadvertently filters such articles based on their own opinions regarding the topic of research.

While the survey engaged technology suppliers, selectors and users through various professional and voluntary associations, this does not represent all the potential customers of RETs in the built environment. It is assumed however, that these associations would reflect the majority of small to medium EG installations in cities and therefore be reasonably representative of the current rate of technology diffusion patterns in the private and commercial RET market, while highlighting the barriers or challenges to system development. There was a very positive response to the survey (over 600 completed surveys) but questions requiring an answer to an in-depth follow-up question were less successful (approx. 100 useful respondents). The high level of response emphasized the current relevance of the subject matter to built environment professionals and consumers looking to install EG systems.

The survey proved a valuable tool to engage actors at the niche level; the *promoters; choosers; and users*, a significant group that could otherwise be underrepresented if relying solely on 'expert' perspectives as recommended by the MLP and TIS frameworks. The survey could have generated better quality data using more refined and nuanced multiple-choice questions, by far the most responded to question format when compared to follow-up questions. However, the risk with the multiple-choice question format is that the researcher falls into an overly reductionist framing of questions, which is the antithesis of the nuanced insights encouraged by MLP and TIS.

Parts of the research also relied on available data held by city electrical departments to validate the findings of the market survey. This relied heavily on the records kept and ability of the metro electrical departments to share data on existing and new embed generation systems in their respective cities. Ultimately only data from the City of Cape Town (CoCT) was freely available in a useable format for analysis. The City of Johannesburg (CoJ) did not respond to requests for data while eThekweni municipality (Durban) was willing to share available data, but this was not in a disaggregated format and due to time constraints could not be collated into a useable dataset.

Lastly, the literature review is not an exhaustive exploration of the Sustainability Transition body of literature. The study focused primarily on two complementary theoretical frameworks; the MLP from the socio-technical transition literature and the TIS from innovation systems as these have proven to be most useful and are commonly employed in an interdisciplinary approach in the field of transition research.

5.6 RECOMMENDATIONS

Innovative technologies usually go through long development trajectories of generation, diffusion and eventual use. This was not the case however for a mature technology like solar PV in the case of a follower country like South Africa. Analysis of the solar PV TIS confirmed that more advanced motors of innovation emerge more quickly, but in local context, coherent policy and regulation was first required to create a fertile niche environment through the REIPPPP. At the level of EG within cities, reasonable incentives were necessary to encourage growth in diffusion and use. There were no obvious issues of technology legitimization present in the survey or EHA, with barriers and failures coming mainly from resistance within the incumbent regime and political pressure from outside the system.

Although the solar PV sector has survived its first test of market sustainability, strengthening of the private consumer segment could occur through greater support networks between industry associations, municipal electrical

departments, built environment professionals and end consumers. The survey results highlighted how professionals and their clients are struggling to understand the regulatory space of EG, particularly when it comes to grid-tied EG systems. Solar PV associations, manufacturers and suppliers could look to assist the consumer market to navigate the regulatory requirements and municipal application processes through training courses for built environment professionals.

Although one of the objectives of this study was to better understand the trajectory of the ST by using an integrated theoretical approach, transitions by their very nature are complex socio-technical systems in construction. While the integrated TIS and MLP framework proved effective in unpacking the ST in the South African energy regime and provided valuable insights, this research should be repeated in order to recalibrate the findings of the study and track the ST trajectory as it continues to unfold.

The TIS function-based analytical framework was initially developed to identify systemic barriers and failures holding back the development of a focal TIS. This enables the researcher to make recommendations that can target resource mobilization or draft conducive policy and regulations in order to unlock the creation, diffusion and use of innovative technologies. In the case of the ST transition in the South African energy regime, further research focusing on strategic niche management could help formulate valuable interventions in the policy and regulation space to support further diffusion of EG using solar PV in the built environment of cities.

The research identified a 3-way contest of alternative transition pathways, in particular utility-scale nuclear versus utility scale renewables versus distributed embedded renewables¹⁸. The TIS-context interaction framework exposed the strong influence political agency and power could exert in building negative regime resistance towards the niche. Ultimately, significant change in the socio-political regime was required to restart system development at the utility-level, although the agile renewable niche was able to maintain a market motor by redirecting its energy into an alternative market segment. Additional research focusing on political agency could bring greater awareness to its impact on innovation system development and sustainability transitions.

After utilization of Bergek et al.'s (2015) TIS-context framework the significant impact of political agency and power on system development could warrant further investigation with Walrave & Raven's (2016) MLP influenced system model, which was used only conceptually in this study to understand system motor formation in relation to regime resistance. Although it could be argued that politics is accounted for in the Guidance of the Search system function (mostly accounting for policy formation and regulatory mechanisms), this study has highlighted how political factions can exert significant negative pressure on the system building process from outside of the mainstream political milieu. This could suggest further studies to test whether external political agency warrants the inclusion of a separate input or feedback loop into their model in relation to the *Regime resistance motor*. With particular reference to this research, more attention could be applied to the development of the motors of innovation present in the solar PV TIS by exploring the utility of the CLD model proposed by Walrave & Raven (2016).

Finally, in order for Africa to achieve the necessary ST to a low-carbon society while equally ensuring a 'just transition', more studies applied broadly across the African continent are needed and could employ the integrated MLP and TIS approach used in this study. The approach could look to other renewable technologies present on the continent, including wind, concentrated solar power (CSP) or even the very nascent platinum fuel cell industry. And lastly, the introduction of mature renewable technologies into follower countries like South Africa bring investment from international technology companies, bringing with them access to associated global industry and research networks. This particular study of solar PV and other similar case studies could be extended beyond the local context by exploring the recently developed GIS conceptual framework (Binz & Truffer, 2017) that has been proposed specifically for such a globally embedded sustainability transition.

¹⁸ One of many insights kindly pointed out by my supervisor during the course of multiple discussions.

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APPENDICES

APPENDIX A - EHA

Functions Legend:

Entrepreneurial experimentation	F1
Knowledge development	F2
Knowledge diffusion	F3
Guidance of the search	F4
Market formation	F5
Resource mobilization	F6
Creation of legitimacy	F7
Context (Melamu, 2014) (Bergek et al., 2015)	

Year	Events (1993 – 2003)	Activity/Category	Function	Source
1993-2002	Prof V Alberts research in PV at UJ.	Research	F2	http://www.engineeringnews.co.za/article/solar-energy-2014-02-14 Accessed 24 11 18
1998	White Paper on Energy Policy – Allows for non-grid electrification systems, specifically development of home solar systems (SHS).	Discussion	F4	(Energy, Department of Minerals, 1998)
1999	Solar Home System (SHS) concession programme launched under 1999 National Electrification Programme. Focussed on rural electrification (Lemaire, 2011) to plug gaps in national targets in poor rural communities.	Government Procurement Programme	F5	(Wlokas, 2010) (Lemaire, 2011)
1999	Publication of UL1741 and IEEE1547 standards – Eskom and local municipalities address safety concerns for maintenance staff should reverse feeding occur when the grid is switched off.	Standards	F4	https://www.ee.co.za/wp-content/uploads/legacy/Energize_2013/08_ST_01_tying-small-scale.pdf Accessed 24 11 18
2001 Dec	NuRa concession begins SHS installations	Investment/Incentive	F5	(Lemaire, 2011)
2002	Cabinet resolution establishes SANERI (the South African National Energy Research Institute) to boost R&D capacity in SA.	Research and Development	F6	http://www.cefgroup.co.za/wp-content/uploads/2014/02/ENERGY-JOURNAL-2010-Issue-2.pdf Accessed 24 11 18
2003	White Paper on Renewable Energy (Discussion)	Discussion	F4	(Kritzinger, 2017) (Reinecke et al., 2013)

2003	Integrated Energy Plan	Plan	F4	(Kritzinger, 2017, Reinecke et al., 2013)
Year	Events (2004 – 2008)	Activity/Category	Function	
2004	SANERI formalised and becomes a subsidiary of CEF	Research and Development	F6	http://www.cefgroup.co.za/wp-content/uploads/2014/02/ENERGY-JOURNAL-2010-Issue-2.pdf Accessed 24 11 18
2004 Jan	Energy Projects Division (EPD), a division of CEF, focusses on investment in renewable and alternative energy ventures, including solar.	Investments	F6	http://www.cefgroup.co.za/clean-energy-division/ Accessed 26 11 18
2004 Aug	REEEP establishes regional secretariat in South Africa	Global Resource Mobilisation	F6	http://www.engineeringnews.co.za/article/southern-africa-joins-renewableenergy-drive-2004-08-05/rep_id:4136 Accessed 19 11 18
2005	Professor Vivian Alberts of South Africa develops thin film solar modules locally	Entrepreneurial	F1	(Engelbrecht, 2006)
2005 Nov	National Energy Regulator of South Africa (NERSA) established.	Regulator	F4	
2006	Department of Science and Technology fund R12mill pilot manufacturing plant at UJ. Supported by NRF	Resource Mobilisation	F6	http://www.engineeringnews.co.za/article/solar-energy-2014-02-14 Accessed 24 11 18
2006	Electricity Regulation Act	Policies	F4	(Kritzinger, 2017, Reinecke et al., 2013)
2006	UJ pilot manufacturing plant producing semi-commercial products	Pilot Plant	F1	http://www.engineeringnews.co.za/article/solar-energy-2014-02-14/rep_id:4136 Accessed 22 11 18
2006 Aug	Centre for Renewable and Sustainable Energy Studies (CRSES) - SANERI awards Stellenbosch University the contract to act as the national hub for postgrad programme in Renewable and Sustainable Energy (RES).	Resource Mobilisation R&D, Funding	F6	http://www.crses.sun.ac.za/files/home/about-us/annualreport2008.pdf Accessed 24 11 18
2006 / 2007	PTiP (Photovoltaic Technology Intellectual Property) license their thin-film solar technology internationally. Patented in 100 countries. PTiP CEO is Prof. V Alberts.	Entrepreneurial	F1	http://www.engineeringnews.co.za/article/sa-developed-solar-panels-beat-european-intellectual-property-challenge-2016-03-04 Accessed 24 11 18
2007	Small group within NERSA explore REFIT. Marks the establishment of the nascent IPP office.	Policy	F4	
2007 June	Construction begins on 4200-4500MW Medupi Power station. Budget of R70-billion, completion scheduled for January 2015.	Context		http://www.engineeringnews.co.za/article/civils-construction-to-begin-on-eskom039s-new-medupi-power-station-by-yearend-2007-06-08 Accessed 01 02 19
2007 Sep	Cabinet decision of 5 September 2007 – Eskom designated as the “central buyer of power from IPP’s” (Fritz, 2013)	Policy	F4	https://www.ee.co.za/wp-content/uploads/legacy/Energize_2013/08_ST_01_tying-small-scale.pdf Accessed 24 11 18
2008	SANEDI (SA National Energy Development Institute) formed when SANERI amalgamated with NEEA (National Energy Efficiency Agency) within CEF (Central Energy Fund).	Resource Mobilisation R&D, Funding	F6	http://www.cefgroup.co.za/wp-content/uploads/2014/02/ENERGY-JOURNAL-2010-Issue-2.pdf Accessed 24 11 18

2008 Jan	South Africa's energy supply crisis begins with Black Friday – January 25th ¹⁹	Context		(Patel, 2008)
2008 Aug	Construction begins on 4800MW Kusile power station, completion scheduled for 2017	Context		https://www.brandsouthafrica.com/investments-immigration/business/economy/infrastructure/kusile-110808 Accessed 02 01 19
2008	Electricity Pricing Policy (EPP)	Policies	F4	(Kritzinger, 2017, Reinecke et al., 2013)
Year	Events (2009 – 2013)	Activity/Category	Function	
2009	Electricity Regulations on new generation capacity (Kritzinger, 2017, Reinecke et al., 2013) Max FIT directive given in EPP, MFMA and PFMA for municipalities can compensate SSEG fed into their network.	Regulations/Incentive Max FIT for SSEG defined	F5	
2009 May	Jacob Zuma becomes president of South Africa Announces new Department of Energy in his cabinet address on the 10 th May.	Context Political		(Eberhard, Anton & Godinho, 2017) http://www.energy.gov.za/files/au_frame.html
2009 Aug	ELECTRICITY REGULATION ACT, 2006 ELECTRICITY REGULATIONS ON NEW GENERATION CAPACITY No.32378 GOVERNMENT GAZETTE, 5 AUGUST 2009 - Introduces IPP bid Programme and REFITT regulations	Regulation	F4	http://www.energy.gov.za/files/policies/22736_reg_721.pdf Accessed 20 11 18
2009 Sep	USA and South Africa sign bilateral agreement to develop nuclear energy to support sustainable economic growth	Context		https://www.sanews.gov.za/features/us-sa-sign-cooperation-agreement-nuclear-energy Accessed 02 01 19
2009 Dec	President Jacob Zuma pledges to reduce GHG emissions by 34% by 2020, increasing to 44% by 2025 at the Copenhagen climate change summit.	Context		(Baker, Lucy, Newell & Phillips, 2014)
2010	Integrated Resource Plan for Electricity	Plan	F4	
2010	NRS 097-2-1:2010 GRID INTERCONNECTION OF EMBEDDED GENERATION Specifications formulated by Eskom in association of SABS (not yet a SANS standard).	Standard	F4	http://www.goingsolar.co.za/uploads/NRS%20097-2-1.pdf Accessed 20 11 18
2010	ARTsolar – PV manufacturer established in Durban (100% locally owned). 250MW annual capacity	Entrepreneurial South African	F1	https://artsolar.net/about-us/ Accessed 19 11 18
2010 May	Uranium One sells its SA Dominion mine to Duduzane Zuma and Gupta family. Local media suggest President Zuma helped secure funding through the Public Investment Corporation (PIC), then headed by Brian Molefe.	Context		https://mg.co.za/article/2010-05-14-zuma-meddled-in-mine-buyout Accessed 02 01 19
2010 May	Eskom signs contract with Russian uranium trader Techsnapexport to supply low enriched uranium for Koeberg power station till 2017. This accounts for 45% of South Africa's uranium needs.	Context		https://www.iol.co.za/business-report/economy/eskom-sources-uranium-from-russia-806907 Accessed 02 01 19
2010 May	National Planning Commission (NPC) established.	Vision	F4	

19 "In desperation, Eskom declared force majeure on Jan. 25, requesting that key industrial customers implement a 10% load reduction to prevent a grid collapse". Government declares a "national electricity emergency."

2010 Oct	DRAFT Integrated Resource Plan for Electricity 2010, Revision 2 Released 8 th of October and calls for a nuclear build commencing in 2023, contributing at least 9,6 GW by 2030.	Plan	F4	http://www.energy.gov.za/IRP/irp%20files/INTEGRATED_RESOURCE_PLAN_ELECTRICITY_2010_v8.pdf Accessed 20 11 18
2010 Oct	Korea and SA sign Nuclear Cooperation Agreement. Signed by Acting Foreign Minister Shin Kak-soo and Energy Minister Dupio Peters on October 8th.	Context		http://www.mofa.go.kr/eng/brd/m_5676/view.do?seq=309421&srchFr=&srchTo=&srchWord=&srchTp=&multi_itm_seq=0&itm_seq_1=0&itm_seq_2=0&company_cd=&company_nm=&page=487&titleNm= Accessed 02 01 19
2010 Oct	Cabinet reshuffle on 31 st October sees Public Enterprises Minister Barbara Hogan replaced with Malusi Gigaba.	Context Political		https://mg.co.za/article/2010-10-31-zuma-replaces-seven-ministers-in-cabinet-reshuffle Accessed 02 01 19
2010 Nov	ELECTRICITY REGULATION ACT, 2006 ELECTRICITY REGULATIONS ON NEW GENERATION CAPACITY No.33819 GOVERNMENT GAZETTE, 30 NOVEMBER 2010 - Further regulation on IPP	Regulation	F4	https://sawea.org.za/wp-content/uploads/2016/02/30112010-Electricity-Regulation-Act.pdf Accessed 20 11 18
2011	SANEDI established under the National Energy Act, 2008 (Act No. 34 of 2008). SANEDI to direct, monitor and conduct energy R&D, promote energy research and technology innovation and promote energy efficiency.	Direct, monitor and conduct research in energy	F6	http://www.sanedi.org.za/About%20us.html Accessed 18/11/18
2011	White Paper on National Climate Change Response Policy	Discussion	F4	(Kritzinger, 2017, Reinecke et al., 2013)
2011	Maxx-Solar Academy – NPO training centre for solar technology established when German company maxx-solar & energie GmbH opened maxx-solar & energy PTY Ltd. in South Africa.	Knowledge Diffusion	F3	https://www.maxx-academy.org/about/history/ Accessed 22 11 18
2011 March	NERSA's revised FITs were considered too high, National Treasury and DoE commission legal opinion that confirm FITs are non-competitive procurement, prohibited by the PFMA. Auction approach adopted in REIPPPP bids.	Rules and Regulations	F4	(Alam, Mokate & Plangemann, 2016) Pg. 182
2011 March	Fukushima Daiichi Nuclear Disaster – Power station struck by a 15m tsunami triggered by a major earthquake, disabling emergency power supply and cooling, resulting in three reactor cores partially melting down.	Context		http://www.world-nuclear.org/information-library/safety-and-security/safety-of-plants/fukushima-accident.aspx Accessed 23 11 18
2011 May	SAPVIA holds inaugural AGM in Cape Town	Association	F7	http://www.sapvia.co.za/sapvia-announces-management-board-chairman/ Accessed 18/11/2018
2011 May	Electricity Regulation Act No.4 of 2006 Electricity Regulations on New Generation Capacity No.34262 GOVERNMENT GAZETTE, 4 MAY 2011 - Further regulation on IPP	Regulation	F4	http://eolstoragewe.blob.core.windows.net/wm-698609-cmsimages/AnnexureB-ElectricityRegulationsonNewGenerationMay2011.pdf Accessed 20 11 18
2011 Aug	Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) launched. ²⁰	Resource Mobilisation	F6	(Kritzinger, 2017) PG 4 (Alam, Mokate & Plangemann, 2016) PG 182
2011 Sep	Standard Conditions for Embedded Generation within Municipal Boundaries Released by NERSA, this decision notice gives guidance to municipalities on EG installations	Standard	F4	(NERSA, 2011)

²⁰ Outlining the REIPPPP <http://www.energy.gov.za/files/PPMO/2018/Outlining-the-REIPPPP.pdf> Accessed 19 11 18: PowerPoint Slide

2011 Sep	Energy Minister Dipuo Peters signs-off proposal for 9.6GW of new nuclear build to be approved by cabinet. Bidding process expected to start in 2012 with first reactor to be connected to the national grid in 2014/25.	Context Political		https://www.fin24.com/Economy/SA-to-build-new-nuclear-power-plants-20110915 Accessed 22 12 18
2011 Nov	REIPPPP Bid Window 1 – R 3.65/kWh (Average Tariff calculated with Apr-2016-R)	Govt Procurement Program Cost of PV electricity reducing	F5	(Bischof-Niemz, Tobias, 2015)
2011 Nov	National Development Plan – Vision for 2030 Further commits SA to climate change mitigation, including at least 7000 MW of renewable energy by 2020 procured from private IPPs, increasing to 20 000 MW by 2030	Vision (Policy)	F4	
2011 N/Dec	COP17 held in Durban. Green Climate Fund established with US\$100 billion p.a. pledged from public and private funds till 2020 to support developing countries' mitigation and adaption to low carbon economies.	Context External Link		https://theconversation.com/after-durban-is-an-agreement-to-agree-better-than-no-agreement-at-all-4682 Accessed 9 12 18
2012	"South Africa's renewable energy sector experienced explosive growth in the past few years with investment of more than \$5.5 billion in 2012, up from \$30 million in 2011- representing an impressive increase of 20,500%."	Context Investment	F6	http://record.org.za/ Accessed 18 11 18
2012 Feb	Africa Energy Indaba 2012 – 3-day conference (SAPVIA supported)	Conference	F3	http://www.sapvia.co.za/sapvia-supports-the-africa-energy-indaba-2012/ Accessed 18 11 18
2012 March	REIPPPP Bid Window 2 – R 2.18/kWh (Average Tariff calculated with Apr-2016-R)	Govt Procurement Program Cost of PV electricity reducing	F5	(Bischof-Niemz, Tobias, 2015)
2012 March	Power & Electricity Conference held in Sandton. SAPVIA represented solar interests.	Conference	F3	http://www.sapvia.co.za/power-electricity-conference-2012/ Accessed 18/11/18
2012 June	Clean Power Africa – focussed on opportunities in the hydro and solar industries Second year running. Held Cape Town	Conference	F3	https://www.pressportal.co.za/energy-and-environment/item/6248-clean-power-africa-in-cape-town-to-focus-on-new-opportunities-in-hydro-and-solar-industries.html Accessed 18/11/18
2012 July	Sustainable Energy Seminar – held at Sustainability Week Expo, Sandton	Seminar	F3	http://www.sapvia.co.za/sustainable-energy-seminar/ Accessed 18/11/18
2012 Sep	ART solar opens manufacturing plant in Durban, fully operational in 2013.	Entrepreneurial South African Company	F1	http://m.engineeringnews.co.za/article/art-solar-boosts-local-solar-pv-module-manufacturing-capacity-2013-05-23/rep_id:4433 Accessed 19 11 18
2012 Oct	SA first solar power plant – Ekurhuleni – "200 kW of electricity through 860 PV (photovoltaic) solar panels on 2,500 m ² of land generating enough energy to power about 133 low cost houses"	Public Investment	F6	http://www.sacommercialpropnews.co.za/infrastructure/5298-south-africa-unveils-first-solar-plant-in-ekurhuleni.html 14 11 18
2012 Nov	Eastern Cape holds 3-day European Union Renewable Energy Conference 2012	Conference	F3	http://www.sapvia.co.za/eastern-cape-european-union-renewable-energy-conference-2012/ Accessed 18/11/18
2012 Nov	Renewable Energy World Africa 2012 / POWER-GEN Africa – 3-day event, Sandton	Conference Expo	F3	http://www.sapvia.co.za/renewable-energy-world-africa-2012/ Accessed 18 11 18
2012 Dec	First Solar establishes South African office in Cape Town.	Investment USA	F6	https://www.pv-tech.org/news/first-solar-establishes-south-african-office-and-regional-director Accessed 22 12 18
2013 April	Solairedirect to produce PV modules in SA as part of a three-year 120 MW manufacturing deal signed with ReneSola (Deign, 2016)	Investment France/China	F6	http://newenergyupdate.com/pv-insider/south-africas-module-industry-grows-local-content-push-0 Accessed 9 12 18

2013 May	African Utility Week / Clean Power Africa	Conference	F3	https://www.esi-africa.com/african-utility-week-2013-16282/ https://www.esi-africa.com/clean-power-africa-2013/ Accessed 18/11/18
2013 June	Stellenbosch University holds 5-day Renewable Energy Training Workshop	Workshop	F3	http://www.sapvia.co.za/renewable-energy-training-workshop-skilpadvlei-conference-centre-stellenbosch/ Accessed 18/11/18
2013 July	Medupi power station budget climbs to R105-billion	Context		https://www.property24.com/articles/r105b-to-complete-medupi-power-station/18006 Accessed 02 01 19
2013 July	President Zuma installs himself as the head of the National Nuclear Energy Committee (Mail & Guardian)	Context Political		https://mybroadband.co.za/news/government/83223-zuma-now-heads-national-nuclear-energy-committee.html Accessed 29 01 19
2013 Aug	REIPPPP Bid Window 3 – R 1.17/kWh (Average Tariff calculated with Apr-2016-R)	Govt Procurement Program Cost of PV electricity reducing	F5	(Bischof-Niemz, Tobias, 2015)
2013 Sep	REIPPPP Bid Window 1 – Financial Close: Feb 2012 to Sep 2013 (20 months)	Govt Procurement Program Financial Close	F5	(Eberhard, Anton & Naude, 2017)
2013 Aug	Eskom CSP/Solar Augmentation Conference – Eskom Academy of Learning Midrand	Conference	F3	http://www.eskom.co.za/AboutElectricity/RenewableEnergy/Pages/CSP-Solar-Augmentation-Conference.aspx Accessed 15 11 2018
2013 Oct	Africa Electricity: Powering the Growth of Africa held at Sandton Convention Centre, JHB	Conference	F3	http://www.sapvia.co.za/africa-electricity-powering-the-growth-of-africa-9-11-october-2013/ Accessed 18/11/18
2013 Oct	Eskom releases: STANDARD FOR THE INTERCONNECTION OF EMBEDDED GENERATION ²¹ Min. technical and regulatory requirements to connect Embedded Generators (EG) to EHV, HV and MV networks.	Standard	F4	http://www.eskom.co.za/Whatweredoing/Documents/StdInterconnecEmbedGen.pdf Accessed 20/11/18
Year	Events (2014 – 2018)	Activity/Category	Function	
2014	NRS 097-2-3:2014 - GRID INTERCONNECTION OF EMBEDDED GENERATION (Eskom issued specification). Part 2: Small-scale embedded generation & Section 3: Simplified utility connection criteria for LV connected generators	Quasi-Standard	F4	http://pgrs.co.za/wp-content/uploads/2015/03/NRS-097-2-3-final-2014.pdf Accessed 20/11/18
2014 Jan	JA Solar and Powerway JV to open 150MW PV module assembly plant in Port Elizabeth, 2Q 2014. Max. expected capacity of 600MW with 200 employment opportunities. (Osborne, 2014)	Investment China	F6	https://www.pv-tech.org/news/ja_solar_and_powerway_to_open_150mw_pv_module_assembly_plant_in_south_africa Accessed 9 12 18
2014 Jan	ReneSola South Africa (Pty) Ltd launched by ReneSola in Cape Town. Will serve as regional sales office looking to expand into other emerging African markets like Ghana, Rwanda, Namibia, Kenya. (Deign, 2016)	Investment China	F6	http://www.greenbusinessguide.co.za/renesola-launches-sales-office-in-cape-town/ Accessed 9 12 18

²¹ “This standard serves to fulfil Eskom’s obligation under Section 8.2 (4) of the South African Distribution Code: Network Code (SADCNC) which is applicable to all users of the distribution system and states the following: “The Distributor shall develop the protection requirement guide for connecting Embedded Generators to the Distribution System to ensure safe and reliable operation of the Distribution System””.

2014 Feb	PTiP and Singulus Technologies (German) JV open R180mill, 3500m2 semi-commercial facility in Stellenbosch with finance from UJ, Industrial Development Corporation (IDC) and Technology Innovation Agency (TIA).	Entrepreneurial South African	F1	http://www.engineeringnews.co.za/article/sa-developed-thin-film-solar-technology-debuts-in-stellenbosch-2014-02-03 Accessed 20/11/18
2014 March	AfricaPVSEC (Africa Photovoltaic Solar Energy Conference and Exhibition) – First edition Partnering with EU PVSEC and SNEC to bring together PV sector experts, researchers, NGOs, donors, int. orgs etc.	Conference & Exhibition	F3	http://www.africapvsec.info/cms/index.php?page=about-the-event&hl=en_US#.W_FHbegzaUk Accessed 18/11/18
2014 March	CEO Brian Dames leaves Eskom (resigned Dec '13) with fleet generation reserves below 80% due to deferred maintenance. Using 2426 MW of emergency diesel open-cycle gas turbines (OCGT) with R10b spent on fuel.	Context		https://www.biznews.com/thought-leaders/2014/04/01/goodbye-brian-dames-now-consider-the-real-reasons-he-quit-eskom Accessed 02 01 19
2014 March	After declaring a state of emergency, Eskom announces load shedding, warning of possible power cuts nationwide (6 th March).	Context		https://businessstech.co.za/news/general/53971/eskom-announces-load-shedding/ Accessed 02 01 19
2014 May	SAREC (The South African Renewable Energy Council) officially launched. Umbrella body representing all renewable energy associations in SA: SAPVIA, SAWEA, SESSA, STASA, SASTELA	Lobby Association	F7	http://sarec.org.za/new-umbrella-body-for-renewables-sector-formally-launched/ Accessed 18/11/18 – By Terence Creamer
2014 May	Cabinet reshuffle on the 25 th May sees Nhlanhla Nene replace Pravin Gordhan as Minister of Finance. Ms Lyn Brown appointed Minister of Public Enterprises, Tina Joemat-Pettersson made Minister of Energy.	Context Political		https://www.biznews.com/undictated/2014/05/25/jacob-zuma-appoints-new-cabinet-sa-gets-new-finance-minister Accessed 02 01 19
2014	Small scale on-grid PV embedded generation by Paul Tuson, PrEng – PV growth and projections ²²	Study	F2	http://www.ee.co.za/wp-content/uploads/2014/05/energize-may-14-pg-41-45.pdf Accessed 24/11/18
2014 July	NERSA releases: GRID CONNECTION CODE FOR RENEWABLE POWER PLANTS (RPPs) CONNECTED TO THE ELECTRICITY TRANSMISSION SYSTEM (TS) OR THE DISTRIBUTION SYSTEM (DS) IN SOUTH AFRICA	Code	F4	http://www.nera.org.za/Admin/Document/Editor/file/Electricity/TechnicalStandards/South%20African%20Grid%20Code%20Requirements%20for%20Renewable%20Power%20Plants%20-%20Version%202%208.pdf Accessed 20/11/18
2014 July	eThekweni Municipality introduces Residential Embedded Generation Tariffs. Allows for EXPORT tariffs not exceeding 65% of imported power consumed. Feed-In-Tariff for Residential EG only (including to date)	Subsidy/Incentive	F5	http://www.durban.gov.za/City_Services/electricity/Tariffs/Pages/default.aspx Accessed 19 11 18
2014 July	CoCT introduces Residential and Commercial Embedded Generation Tariffs	Subsidy/Incentive	F5	http://resource.capetown.gov.za/documentcentre/Documents/Financial%20documents/Annexure%204%20-%20Consumptive%20Tariffs%20-%20Electricity.pdf Accessed 20/11/18
2014 July	President Zuma announces new Energy Security Cabinet Sub-committee ²³	Context Political		https://www.esi-africa.com/zuma-announces-energy-security-cabinet-sub-committee-members/ Accessed 19/01/19

²² “The IRP 2010-30 update [2] states that 9770 MW of solar photovoltaic (PV) capacity is planned for South Africa by 2030. The update also estimates that embedded generation (EG) of residential and commercial PV could reach 22,5 GW by 2030 based on LSM7 households with 5 kW PV household installations [2]. Even if this estimate is partially correct, this points to a significant level of installed small-scale solar PV embedded generation (SSPVEG) capacity in South Africa by 2030.”

²³ The sub-committee comprises cabinet members – Minister of Energy, Tina Joemat-Pettersson; International Relations and Cooperation Minister Maite Nkoana-Mashabane; Public Enterprises Minister Lynne Brown; Finance Minister Nhlanhla Nene; State Security Minister David Mahlobo; Trade and Industry Minister Dr Rob Davies; Economic Development Minister Ebrahim Patel; Mineral Resources Minister Adv Ngoako Ramathodi; Environmental Affairs Minister Edna Molewa and Defence Minister Nosiviwe Mapisa-Nqakula.

2014 Aug	REIPPPP Bid Window 4(a) & additional – R 0.87-0.95/kWh (Average Tariff calculated with Apr-2016-R)	Govt Procurement Program Cost of PV electricity reducing	F5	(Bischof-Niemz, Tobias, 2015)
2014 Aug	REIPPPP Bid Window 4(b)	Govt Procurement Program Cost of PV electricity reducing	F5	(Eberhard, Anton & Naude, 2017)
2014 Aug	Jinko Solar (China-based PV manufacturer) opens first plant outside of Chin in Cape Town. Can produce 1,300 solar PV modules a day.	Investment China	F6	http://www.sapvia.co.za/80m-solar-pv-factory-officially-opens-in-cape-town/ Accessed 18/11/18
2014 Sep	CoCT concludes first SSEG contract with Black River Park Investments ²⁴	Government Investment	F6	http://resource.capetown.gov.za/documentcentre/Documents/Speeches%20and%20statements/Mayor_speech_23Sept_BlackRiverParkInvest.pdf Accessed 19 11 18
2014 Sep	Russia and SA sign Agreement on Strategic Partnership in Nuclear Energy on September 22 nd in Vienna during 58 th session of the International Atomic Energy Agency General Conference.	Context		http://www.energy.gov.za/files/media/pr/2014/MediaRelease-Russia-and-SA-sign-agreement-on-Strategic-Partnership-in-Nuclear-Energy-22September-2014.pdf Accessed 02 01 19
2014 Oct	Solar Indaba held in Johannesburg, 2-day conference	Conference	F3	http://www.sapvia.co.za/solar-indaba-23-24-october-2014-johannesburg/ Accessed 18/11/18
2014 Oct	SA and France sign the Inter-Governmental Framework Agreement on Nuclear Cooperation on the 14 th October. Signed by the Minister of Energy Tina Joemat-Pettersson and the Minister of Foreign Affairs Laurent Fabius.	Context		https://www.enca.com/money/south-africa-signs-nuclear-co-operation-agreement-france Accessed 9 12 18
2014 Nov	REIPPPP Bid Window 2 – Financial Close: Aug 2012 to Nov 2014 (27 months)	Govt Procurement Program Financial Close	F5	(Eberhard, Anton & Naude, 2017)
2014 Nov	Oakbay Resources & Energy (74% owner of Shiva Uranium) listed on the JSE in anticipation of expected demand for uranium with 9.6GW of nuclear build programme slated to come on line in 2030.	Context		https://www.iol.co.za/business-report/companies/the-gupta-family-plans-r800m-uranium-mine-1785026 Accessed 9 12 18
2014 Nov	Nationwide load-shedding begins	Context		(Eberhard, Anton & Godinho, 2017)
2014 Dec	German company SMA Solar opens manufacturing facilities in Cape Town	Investment Germany	F6	https://www.brandsouthafrica.com/governance/sustainable/sma-solar-factory-cape-town-111214 Accessed 08 02 2019
2015 Jan	Financial benefits of renewables in South Africa in 2014 (Bischof-Niemz, Tobias, 2015) study compares costs saved on running diesel OCGT with introduction of the first 1 600 MW of wind & PV during the year 2014 .	Study	F2	http://www.sapvia.co.za/financial-benefits-of-renewables-in-south-africa-in-2014-actual-diesel-and-coal-fuel-savings-and-avoided-unserved-energy-from-the-first-approximately-1-6-gw-of-wind-and-pv-projects/ Accessed 18 11 18

²⁴ “Black River Park’s solar project at the 74 000 m² office park is the largest integrated photovoltaic plant in Africa. Their panels cover an area of 11 000 m², which is just over two full-sized rugby fields, and generate between 20 – 30% of the complex’s electricity requirements. The Black River Park’s PV installation has already saved around 1 300 tons of coal through the use of renewable energy. It has produced around 1 368 megawatt hours, which is equivalent to keeping 157 Cape Town houses running for a year.” STATEMENT BY THE CITY’S EXECUTIVE MAYOR, PATRICIA DE LILLE

2015 March	Suntech - supplier of PV modules to SA solar projects opens warehouse in Cape Town. No commitment yet to open local manufacturing facility. (Deign, 2016)	Investment China	F6	http://newenergyupdate.com/pv-insider/south-africas-module-industry-grows-local-content-push-0 Accessed 9 12 18
2015 March	Ben Ngubane is appointed Eskom Chairman despite allegations of unethical and improper conduct	Context		(Eberhard, Anton & Godinho, 2017)
2015 March	Medupi power station generates first electricity Unit 6 synchronised to national grid.	Context		https://www.brandsouthafrica.com/south-africa-fast-facts/news-facts/medupi-030315 Accessed 02 01 19
2015 April	Minister Lyn Brown seconds Brian Molefe to Eskom as acting CEO.	Context		https://www.sanews.gov.za/south-africa/transnets-molefe-seconded-eskom Accessed 02 01 19
2015 May	Eskom CEO Brian Molefe refuse to sign new coal supply agreement with Glencore, sending Optimum Holdings into business rescue later that year.	Context		(Eberhard, Anton & Godinho, 2017)
2015 July	Nationwide load-shedding ends	Context		(Eberhard, Anton & Godinho, 2017)
2015 July	City Power Johannesburg introduces Embedded Generation Feed-in Tariffs for Residential or Commercial properties	Incentive	F5	https://www.citypower.co.za/customers/Pages/Tariff-Info.aspx Accessed 19 11 18
2015 July	Vikram Solar (founded 2006) opens South African office in Johannesburg but yet to establish a local manufacturing plant (Deign, 2016).	Investment India	F6	http://newenergyupdate.com/pv-insider/south-africas-module-industry-grows-local-content-push-0 Accessed 9 12 18
2015 July	DoE signs two new MOAs with Rosatom at the 7 th Brics summit in Ufa, Russia. One to train 200 South Africans at Russian universities in nuclear energy, while the second aims to improve public awareness of nuclear energy in SA.	Context		https://www.enca.com/south-africa/new-nuclear-agreements-shows-sas-bias-towards-rosatom Accessed 02 01 19
2015 July	Eskom Chair Ben Ngubane announces 16 th July that Anoj Singh seconded from Transnet as acting CFO at Eskom.	Context		http://www.politicsweb.co.za/news-and-analysis/anoj-singh-seconded-to-eskom-from-transnet--ben-ng Accessed 02 01 19
2015 Aug	DEPARTMENT OF ENERGY - RENEWABLE ENERGY IPP PROCUREMENT PROGRAMME 2015, No. 39111 GOVERNMENT GAZETTE, 18 AUGUST – revised renewable allocations with 2200MW Solar PV (years 2021-2025)	Determination	F4	http://www.energy.gov.za/files/policies/Renewable-Energy-IPP-Procurement-Programme-2015-Determination.pdf Accessed 20/11/18
2015 Sep	REIPPPP Bid Window 3 – Financial Close: April 2014 to Sep 2015 (17 months)	Govt Procurement Program Financial Close	F5	(Eberhard, Anton & Naude, 2017)
2015 Sep	Cabinet reshuffle late at night on the 23 rd September sees Ngoako Ramatlhodi moved from mineral resources to public service and administration to make way for relatively unknown Free State MP, Mosebenzi Zwane.	Context Political		https://businesstech.co.za/news/government/99162/zuma-announces-surprise-cabinet-reshuffle/ Accessed 02 01 19
2015 Oct	SAIREC – SA International Renewable Energy Conference held in Cape Town – SAIREC Declaration	Conference	F3	http://www.sairec.org.za/ Accessed 02 01 19
2015 Oct	SegenSolar (Pty) Ltd formed with offices in Johannesburg and Cape Town. Part of Segen Ltd group, UK's largest PV wholesaler and distributor. Supplies JA Solar and Canadian Solar products	Global Supplier	F6	https://segensolar.co.za/about-us/ Accessed 02 01 19
2015 Oct	Eskom begins to stall on the REIPPPP by halting the issue of budget quotes due to financial constraints. Claiming no budget for IPPs after Bid Window 3	Context		https://mybroadband.co.za/news/energy/142988-eskom-cant-support-new-independent-power-producers.html Accessed 08 02 19

2015 Nov	REIPPPP Bid Window 4(b) expedited – R 0.62/kWh (Average Tariff calculated with Apr-2016-R) ²⁵	Govt Procurement Program Cost of PV electricity reducing	F5	(Bischof-Niemz, Tobias, 2015)
2015 Nov	SunPower to open PV module manufacturing plant in Cape Town. ²⁶ Expected to create up to 150 local jobs.	Investment US	F6	http://www.engineeringnews.co.za/article/sunpower-to-open-solar-panel-manufacturing-facility-in-cape-town-2014-11-04 Accessed 9 12 18
2015 Nov	South Africa and China sign nuclear energy cooperation pact in Beijing.	Context		https://www.sowetanlive.co.za/news/2015-11-16-south-africa-and-china-sign-nuclear-energy-cooperation-pact/ Accessed 02 01 2019
2015 Dec	COP21 - Paris Climate Change Agreement - “Almost 200 countries sign historic pledge to hold global temperatures to a maximum rise of 1.5C (2C target with 1.5C aspiration) above pre-industrial levels” (Harvey, 2015).	Context		https://www.theguardian.com/environment/2015/dec/13/paris-climate-deal-cop-diplomacy-developing-united-nations Accessed 9 12 18
2015 Dec	Cabinet reshuffle – On the 9 th Dec, President Zuma removes Nhlanhla Nene as finance minister on the pretext of a possible appointment to the BRICS bank. Backbencher David van Rooyen appointed new Minister of Finance.	Context Political		https://mg.co.za/article/2015-12-09-nhlanhla-nene-removed-as-finance-minister Accessed 29 12 18
2015 Dec	President Zuma forced to appoint Pravin Gordhan as Minister of Finance, replacing David Van Rooyen after just 4 days in the position as the Rand plummets below R16 to the dollar.	Context Political		https://mg.co.za/article/2015-12-13-zuma-appoints-pravin-gordhan-as-finance-minister Accessed 29 12 18
2016 Jan	Section 12b of the Income Tax Act amended from a three-year accelerated depreciation allowance on renewable energy to an even quicker allowance of ONE year.	Tax Incentive	F5	http://www.greenenergysolutions.co.za/updated-sars-tax-incentive-for-solar-power/ Accessed 14 11 18
2016 Feb	According to news articles, Minister of Mineral Resources, Mosebenzi Zwane was directly involved in negotiations in Zurich between Tegeta and Glencore to purchase the Optimum Coal mine during December 2015.	Context		https://www.iol.co.za/business-report/companies/glencore-worked-with-govt-on-gupta-deal-1978025 Accessed 02 01 19
2016	Draft Integrated Resource Plan The 2016 draft IRP includes a cap on SSEG installations.	Plan	F4	(Kritzinger, 2017)
2016	Integrated Energy Plan	Plan	F4	(Kritzinger, 2017, Reinecke et al., 2013)
2016 April	REIPPPP Bid Window 3.5 – Financial Close: April 2015 to April 2016 (12 months)	Govt Procurement Program Financial Close	F5	(Eberhard, Anton & Naude, 2017)

²⁵ “Between 2011 and 2015 four such bidding rounds have been completed, referred to as Bid Windows, with an additional round for CSP only. Competition has been fierce, with 390 submissions resulting in just under a quarter (92)1 of these being selected for procurement of 6,328 MW amounting to R193bn (USD 20.5bn)2 in investment.” Eberhard, A. & Naude, R. 2017. *The South African renewable energy independent power producer procurement programme: a review and lessons learned*. Cape Town.

²⁶ “The capacity of these four manufacturing plants adds up to around 400 MW a year, and in comparison, 415 MW of new PV projects were selected in round 4 of the REIPPPP” <http://newenergyupdate.com/pv-insider/south-africas-module-industry-grows-local-content-push-0>

2016 April	Tegeta Exploration & Resources conclude the purchase of Optimum Coal Holdings using a R585m prepayment by Eskom to Tegeta for undelivered coal. This would emerge later in 2017 after initial denials by Eskom executives.	Context		http://www.miningweekly.com/article/sale-of-optimum-coal-to-tegeta-concluded-2016-04-14 Accessed 02 01 19 https://www.timeslive.co.za/news/south-africa/2017-11-01-eskom-organised-payment-to-tegeta-of-amount-needed-to-buy-optimum-mine/ Accessed 02 01 19
2016 June	National Treasury Designated Sectors Instruction Number 2 of 2016/2017 - Instructs how accounting officers and accounting authorities should adjudicate tenders with min. local content for PV components & installations.	Procurement Regulation	F5	http://www.sapvia.co.za/national-treasury-designated-sectors-instruction-number-2-2016-2017/ Accessed 18 11 18
2016 July	Mayor of Cape Town writes to the minister of energy for a Section 34 determination to procure 150MW of solar and 280MW of wind energy directly from IPPs (municipalities can do so with ministerial approval).	Challenging Policy and writing new rules	F4	https://www.businesslive.co.za/bd/national/2016-07-26-cape-town-wants-to-control-its-energy-future-says-de-lille/ Accessed 9 12 18 https://www.businesslive.co.za/bd/national/2016-07-27-de-lille-has-to-get-nod-for-energy-acquisition/ Accessed 9 12 18
2016 July	Nelson Mandel Bay Municipality introduces Interim requirements for Small Scale Embedded Generation (SSEG). Any LV customer (residential, business, industrial or commercial) can apply	Incentive	F6	http://www.nelsonmandelabay.gov.za/datarepository/documents/nmbm-requirements-for-small-scale-embedded-generation.pdf Accessed 21 11 18
2016 July	REIPPPP Bid Window 4(a) – Financial Close: June 2015 to July 2016 (13 months)	Govt Procurement Program Financial Close	F5	(Eberhard, Anton & Naude, 2017)
2016 July	REIPPPP Bid Window 4(b) – Financial Close: June 2015 to July 2016 (13 months)	Govt Procurement Program Financial Close	F5	(Eberhard, Anton & Naude, 2017)
2016 July	Eskom Chair Ben Ngubane sends letter to Minister of Energy Joemat-Pettersson that the utility will not sign any further power purchase agreements after REIPPPP window 4.5 are signed.	Context		https://www.esi-africa.com/eskom-slams-door-ipp-projects/ Accessed 02 01 19
2016 Aug	German company SMA Solar closes solar power inverter plant after opening its manufacturing facilities in Cape Town in 2014, citing the decision by Eskom to no longer sign PPA with IPPs.	Context		https://www.itweb.co.za/content/z5yONPvEnkx7XWrb Accessed 01 02 19
2016 Sep	Medupi power station synchronises 2 nd Unit to the grid.	Context		https://www.esi-africa.com/medupi-syncs-unit-5-grid/ Accessed 01 02 19
2016 Oct	Energy Minister Tina Joemat-Pettersson announces Eskom as procuring agent for new nuclear build programme. Eskom confirms Department of Environmental Affairs (DEA) authorises Final Environmental Impact Report (F-EIR) in the same month.	Context Political		https://www.iol.co.za/business-report/economy/eskom-to-procure-nuclear-power-2078607 Accessed 23 01 19 https://www.iol.co.za/business-report/companies/eskom-gets-environmental-go-ahead-for-new-nuclear-power-site-in-western-cape-11568338 Accessed 23 01 19
2016 Nov	The Public Protector, Thuli Madonsela releases 'The State of Capture' report implicating Eskom executives and the Gupta family. The report calls for the establishment of a commission of inquiry into state capture of SOEs.	Context		https://ewn.co.za/2016/11/02/state-capture-report-findings Accessed 01 02 19
2016 Nov	Brian Molefe resigns as CEO of Eskom - media report 11 th November	Context		https://www.fin24.com/Economy/Eskom/full-statement-eskom-ceo-brian-molefe-quits-20161111 Accessed 02 01 19
2016 Dec	Eskom, in conjunction with the Nuclear Energy Corporation of South Africa (NECSA) release a request for information (RFI) to the market for the procurement of 9.6GW of new build nuclear generation capacity.	Context		http://www.engineeringnews.co.za/article/eskom-releases-nuclear-rfi-2016-12-21/rep_id:4136 Accessed 28 12 18

2016 Dec	Kusile power station's first unit connected to the national grid. Completion date revised to 2022.	Context		https://www.enca.com/south-africa/kusile-power-station-connected-to-national-grid Accessed 02 01 19
2017	33 operational PV power plants in SA due to REIPPP	Context		(Kritzinger, 2017) PG 4
2017	Market research shows a significant rise in Small-Scale Embedded Generation (SSEG) PV installations on residential, commercial, industrial rooftops. Around 280MW installed as of Feb 2017 (PQRS, 2017).	Market Research Declining PV costs vs. Eskom	F2	(Kritzinger, 2017) PG 4
2017	Electricity Regulation Act (update 2017) (Kritzinger, 2017) - The updated ERA exempts generators from a NERSA licence; under 1MW; Demonstration facilities; Existing facilities and Electricity resellers. ²⁷	Policies	F4	(Kritzinger, 2017) PG 6
2017 Jan	IBC SOLAR South Africa (Pty) Ltd formed in JV between IBC SOLAR AG and maxx-solar & energy (Pty) Ltd based in Cape Town and Johannesburg. Suppliers of IBC and Jinko Solar PV modules.	Investment Germany	F6	https://www.ibt-solar.co.za/corporate/about-us/ Accessed 9 12 18
2017 Jan	The South African Renewable Energy Council (SAREC) threatens to take Eskom to court to enforce Power Purchase Agreements on behalf of Independent Power Producers (IPPs)F.	Context		https://www.iol.co.za/business-report/energy/power-producers-to-sue-eskom-7442219 Accessed 02 01 19
2017 Feb	Excerpts from the Dentons report on governance failure at Eskom released in the media. Poor planning, lack of skills, poor quality control and labour unrest blamed for delays at Medupi and Kusile.	Context		https://www.fin24.com/Economy/Eskom/dentons-report-why-eskom-fell-behind-on-medupi-kusile-20170209 Accessed 02 01 19
2017 Feb	Energy Minister Joemat-Pettersson insists that Eskom's refusal to sign-off PPA with IPPs has been resolved.	Context		http://www.engineeringnews.co.za/article/deadlock-broken-between-eskom-and-ippes-joemat-pettersson-insists-2017-02-28/rep_id:4136 Accessed 02 01 19
2017 March	The Coal Transporters Forum (CTF) approach the high court to interdict Eskom from signing further PPA contracts with renewable energy IPPs, arguing jobs in the coal and transport sector will be lost.	Context		https://www.iol.co.za/business-report/energy/coal-transporters-take-eskom-government-to-court-8310231 Accessed 01 02 19
2017 March	Cabinet reshuffle – Finance Minister Pravin Gordhan replaced with Malusi Gigaba after an intelligence report implicating Gordhan and his Deputy. MP Mmamoloko Kubayi replaces Joemat-Pettersson as Minister of Energy.	Context Political		https://www.esi-africa.com/south-african-energy-minister-axed/ Accessed 28 12 18 https://www.news24.com/SouthAfrica/News/breaking-gordhan-motsoaledi-among-the-axed-20170331 Accessed 28 12 18
2017 April	On 26 th of April, the Western Cape High Court ruled that aspects of the South African government's procurement of new nuclear generation capacity were unlawful, unconstitutional and were set aside. ²⁸	Context Political		http://www.polity.org.za/article/south-african-high-court-rules-on-south-african-new-nuclear-build-2017-05-02 Accessed 28 12 18
2017 April	Eskom abandons nuclear RFI due to be submitted on the 28 th of April, two days after the Western Cape High Court ruling.	Context Political		https://www.fin24.com/Economy/Eskom/eskom-terminates-nuclear-request-for-information-20170503 Accessed 28 12 18

²⁷ The updated ERA exempts the following generators from needing a licence from NERSA:

Generators less than 1MW (needs a use-of-system agreement with grid operator and capped by the IRP allocation); Demonstration facilities (cannot operate for more than 36 months); Existing facilities; Electricity resellers (tariff is less or equal to existing tariff, agreement in place with distributor and approved by NERSA).

²⁸ Full judgement can be accessed here: <http://www.saflii.org/za/cases/ZAWCHC/2017/50.html>

2017 May	New Minister of Energy says SA government will in June begin renegotiating intergovernmental cooperation agreements on nuclear energy with five vendor nations after losing court case in the Western Cape High Court.	Context		https://www.iol.co.za/business-report/sa-to-start-renegotiating-nuclear-agreements-in-june-energy-minister-9230986 Accessed 28 12 18
2017 June	Medupi power station Unit 4 connected to national grid.	Context		https://citizen.co.za/news/south-africa/1531189/eskom-connects-medupi-power-station-unit-4-national-grid/ Accessed 01 02 19
2017 June	Ben Ngubane resigns as Eskom board chair under a cloud of controversy.	Context		https://www.news24.com/SouthAfrica/News/eskom-board-chair-resigns-20170612 Accessed 01 02 19
2017 June	'What does South Africa's Energy Future look like?' - Public lecture by Jarrad Wright (CSIR) at Wits business School	Lecture	F3	http://www.wbs.ac.za/events/2017/what-does-south-africas-energy-future-look-like/ Accessed 18 11 18
2017 June	Energy Minister Kubayi met with Russian counterpart, Alexander Novak and Alexey Likachev (DG of Rosatom) while attending AtomExpo nuclear conference in Moscow, telling audiences that SA still committed to nuclear.	Context Political		https://www.fin24.com/Economy/sa-still-on-nuclear-train-energy-minister-tells-russian-audience-20170621 Accessed 28 12 18
2017 Aug	DoE (Energy Minister Mmamoloko Kubayi) and NERSA taken to court by the CoCT. CoCT demands the right to purchase electricity from IPPs, challenging the 'single buyer' (Eskom) model. (Yelland, 2017)	Challenging Policy writing new rules	F4	https://www.dailymaverick.co.za/article/2017-08-07-op-ed-energy-minister-calls-on-city-of-cape-town-to-engage-over-independent-power-producers/#.WYgP15WQyM8 Accessed 9 12 18
2017 Aug	Another unit of Kusile power station connected to the grid ahead of schedule according to Eskom.	Context		https://www.enca.com/money/eskom-brings-another-unit-of-kusile-online-ahead-of-schedule Accessed 02 01 19
2017 Sep	Assessing the impact of increasing shares of variable generation on system operations in South Africa – Flexibility Study (Obert & Pöller, 2017)	Study	F2	http://www.sapvia.co.za/assessing-impact-increasing-shares-variable-generation-system-operations-south-africa-flexibility-study/ Accessed 18 11 18
2017 Sep	With rising costs and falling sales of electricity leading to tariff increases, more and more analysts believe Eskom represents a classic utility death spiral.	Context		https://businesstech.co.za/news/energy/199662/eskoms-20-price-increase-points-to-the-beginning-of-a-death-spiral-analysts/ Accessed 28 12 18
2017 Sep	Media reports claim that Minister Gordhan's refusal to sign a R1-trillion treasury guarantee for the nuclear build programme was one of the reason President Zuma tried to have him removed from office.	Context Political		https://www.news24.com/Columnists/AdriaanBasson/the-two-signatures-gordhan-wont-give-zuma-20160829 Accessed 9 12 18
2017 Oct	Cabinet reshuffle – On the 17 th Oct, David Mahlobo (minister of state security) replaces Minister of Energy Mmamaloko Kubayi (appointed as Communications Minister)	Context Political		https://www.iol.co.za/business-report/energy/zuma-appoints-new-energy-minister-in-cabinet-reshuffle-11600615 Accessed 28 12 18
2017 Oct	On the 17 th of Oct, Parliament's Public Enterprises Committee begins its first day of hearings into state capture and corruption at Eskom.	Context Political		https://www.fin24.com/Economy/Eskom/live-state-capture-inquiry-begins-with-focus-on-eskom-20171017 Accessed 02 01 19
2017 Nov	Integrated Resource Plan for Electricity (IRP) 2017 Report published by DoE	Plan	F4	http://www.ee.co.za/wp-content/uploads/2017/12/Eskom-IRP-2017-study-report-for-DoE-November-2017.pdf Accessed 28 12 18
2017 Dec	Energy Minister Mahlobo announces at the Energy Indaba that the revised IRP 2017 will be gazetted in February 2018 without further consultation, with nuclear remaining an integral part of the Energy Mix.	Context Political		https://www.esi-africa.com/irp-2017-leaves-south-africa-darkness/ Accessed 28 12 18
2017 Dec	President Zuma loses bid in the Pretoria High Court to dismiss the State of Capture report's recommendations on Wednesday the 13 th Dec. Judge-president Dunstan Mlambo finds Zuma's challenge 'ill-advised and reckless'.	Context Political		https://www.huffingtonpost.co.za/2017/12/13/zuma-loses-bid-to-dismiss-state-capture-recommendations_a_23305878/ Accessed 02 01 19
2017 Dec	Cyril Ramaphosa wins ANC presidency at Nassrec on the 18 th of December	Context Political		https://www.news24.com/SouthAfrica/News/live-anc-voting-results-expected-20171218 Accessed 01 02 19

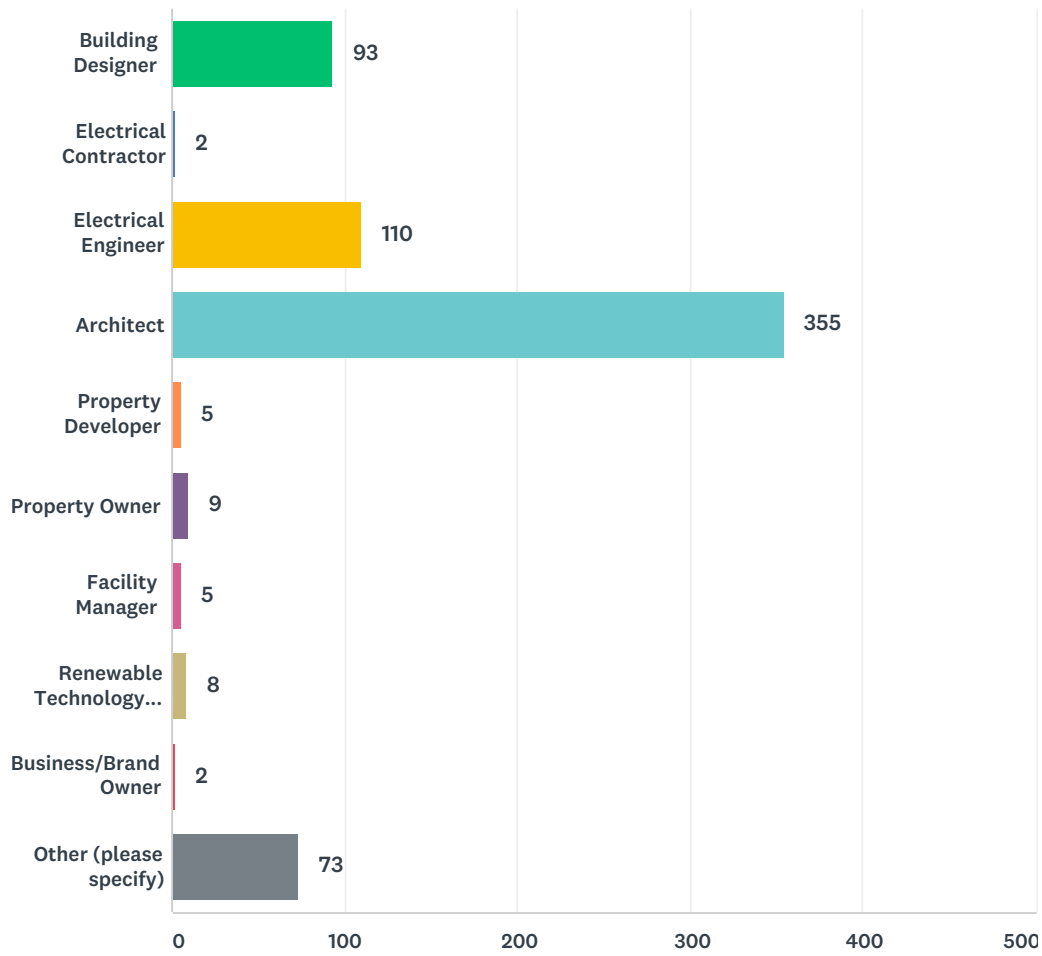
2018 Jan	Suspended Eskom CFO Anoj Singh resigns 'with immediate effect' on the 22 nd of January	Context Political		https://www.fin24.com/Economy/Eskom/breaking-embattled-eskom-cfo-anoj-singh-resigns-with-immediate-effect-20180122 Accessed 02 01 19
2018 Feb	Monday 5 th of February, the ANC's top six officials meet with President Zuma where he refuses to resign before the end of his presidential term.	Context Political		https://mg.co.za/article/2018-02-07-president-jacob-zuma-agrees-to-resign-according-to-reports Accessed 02 01 19
2018 Feb	Tuesday 6 th of February, the ANC convenes a special national working committee (NWC) meeting to discuss the President's refusal to leave office.	Context Political		https://mg.co.za/article/2018-02-07-president-jacob-zuma-agrees-to-resign-according-to-reports Accessed 02 01 19
2018 Feb	Wednesday 7 th of February it's reported that President Zuma has agreed to resign as head of state after a constructive meeting with ANC President Cyril Ramaphosa in Cape Town.	Context Political		https://mg.co.za/article/2018-02-07-president-jacob-zuma-agrees-to-resign-according-to-reports Accessed 02 01 19
2018 Feb	Tuesday 13 th February, the ANC national executive committee (NEC) decides to recall Jacob Zuma after he continues to insist on a three to six-month transition period to leaving office.	Context Political		https://www.timeslive.co.za/politics/2018-02-13-anc-confirms-it-has-recalled-jacob-zuma/ Accessed 02 01 19
2018 Feb	Wednesday 14 th February, Mr Jacob Zuma resigns as president of South Africa.	Context Political		https://www.news24.com/SouthAfrica/News/jacob-zuma-resigns-as-president-of-south-africa-20180214 Accessed 02 01 19
2018 Feb	Thursday 15 th February, Cyril Ramaphosa elected and sworn in as president of South Africa.	Context Political		https://www.timeslive.co.za/politics/2018-02-15-cyril-ramaphosa-has-been-elected-president-of-south-africa/ Accessed 02 01 19
2018 Feb	Friday 16 th February, suspended Eskom executive and former CEO Matshela Koko resigns.	Context		https://mg.co.za/article/2018-02-16-suspended-eskom-executive-matshela-koko-resigns Accessed 02 01 19
2018 Feb	Cabinet reshuffle – 27 th February, President Cyril Ramaphosa appoints Mr Jeff Radebe as new Minister of Energy, Mr Nhlanhla Nene as Minister of Finance and Mr Pravin Gordhan as Minister of Public Enterprises.	Context Political		https://www.ecr.co.za/shows/east-coast-breakfast/full-list-of-ministers-following-ramaphosas-cabinet-reshuffle/ Accessed 28 12 18
2018 March	13 th March, trade union Numsa and civil society group Transform SA head to North Gauteng High court for an urgent interdict preventing Eskom concluding R56-billion deal with IPPs.	Context		https://city-press.news24.com/News/r56bn-renewable-energy-deal-postponed-as-parties-head-to-court-20180313 Accessed 22 12 18
2018 March	29 th March, the High Court struck from the roll Numsa and Transform SA's bid to block IPP signing as it was not deemed urgent.	Context		https://www.fin24.com/Economy/Eskom/court-rejects-numsas-urgent-bid-to-block-ipp-signing-20180329 Accessed 01 02 19
2018 June	Energy Minister Jeff Radebe announces 5 th REIPPPP Bid Window launching in November. Calls for additional 1800 MW of RE. (Creamer, 2018)	Govt Procurement Program	F5	http://www.engineeringnews.co.za/article/south-africa-to-release-new-look-renewables-bid-window-in-november-2018-06-01 Accessed 9 12 18
2018 June	Energy Minister Jeff Radebe tells media that SA no longer had an agreement with Russia to procure nuclear energy.	Context		https://www.thesouthafrican.com/sa-nuclear-deal-no-agreement-russia/ Accessed 28 12 18
2018 June	Eskom implements stage 1 load shedding after workers go on strike because the parastatal's decision to freeze wage increases due to financial difficulties.	Context		https://ewn.co.za/2018/06/14/eskom-implements-stage-1-load-shedding-due-to-severe-constraints Accessed 22 12 18
2018 Aug	Draft Integrated Resource Plan 2018 published for public comment	Plan /Policy	F4	http://www.sapvia.co.za/wp-content/uploads/2018/09/IRP-Update-2018-Draft-for-Comments.pdf Accessed 18 11 18
2018 Aug	Canadian Solar Inc. establishes a joint venture with ET Energy South Africa (Koigi, 2018).	Investment Canada	F6	https://africabusinesscommunities.com/news/canadian-solar-and-et-energy-announce-investment-in-south-africa/ Accessed 9 12 18

2018 Aug	Eskom to investigate cause of fire at Kusile power station after disgruntled workers damaged power stations the previous month during strikes over a wage dispute.	Context		https://www.businesslive.co.za/bd/companies/energy/2018-08-11-eskom-investigating-cause-of-fire-at-kusile-power-station/ Accessed 02 01 19
2018 Sep	Canadian Solar supplies PV modules for a 4.755kWp rooftop installation on the Mall of Africa, the 10 th largest installation in the world (Villiers, 2018).	Investment Context		https://www.businessinsider.co.za/mall-of-africa-just-installed-the-worlds-10th-biggest-solar-roof-2018-9 Accessed 9 12 18
2018 Oct	Nene testifies at the Zondo Commission of Inquiry into State Capture. Believes his refusal to approve nuclear deal was one of the reasons he was removed as finance minister.	Context Political		https://www.timeslive.co.za/news/south-africa/2018-10-03-nene-zuma-fired-me-because-i-refused-to-toe-the-gupta-line/ Accessed 22 12 18
2018 Oct	Medupi power station Unit 2 connected to the grid	Context		https://www.fin24.com/Economy/eskom-announces-unit-2-of-medupi-is-operational-20181009 Accessed 01 02 19
2018 Oct	Greenpeace release analysis of new satellite data on the 29 th of October showing Mpumalanga to have the highest concentration of NO2 emissions in the world.	Context		https://www.greenpeace.org/archive-africa/en/Press-Centre-Hub/New-satellite-data-reveals-the-worlds-largest-air-pollution-hotspot-is-Mpumalanga---South-Africa/ Accessed 01 02 19
2018 Nov	SARETEC (South African Renewable Energy Technology Centre) established at CPUT. 100 Wind Turbine Service Technicians already graduated and the centre now includes courses in solar PV.	Technical Training	F3	http://www.capetalk.co.za/articles/327326/cput-launches-the-sa-renewable-energy-technology-centre Accessed 22 11 18
2018 Nov	Eskom warns of pending load-shedding due to a critical coal supply shortage at its power stations.	Context		https://mybroadband.co.za/news/energy/285228-eskom-coal-crisis-blackouts-and-load-shedding-coming.html Accessed 01 02 19
2018 Nov	Gordhan tells the Zondo inquiry into State Capture that Zuma was obsessed with the Russian nuclear deal. He openly opposed the deal because it was unaffordable, ultimately being fired as minister in March 2017.	Context Political		https://www.timeslive.co.za/news/south-africa/2018-11-19-zuma-obsessed-with-russian-nuclear-deal-gordhan-tells-zondo-inquiry/ Accessed 28 12 18
2018 Nov	Parliament's Public Enterprise report on Eskom is released and adopted by the National Assembly. Eskom debt at over R400-billion. Eskom executives and Gupta-linked consultants named for further criminal investigation.	Context		https://www.fin24.com/Economy/Eskom/national-assembly-adopts-brilliant-eskom-inquiry-report-20181129 Accessed 02 01 19
2018 Dec	Seraphim Solar System announce new 500 MW solar cell factory in Port Elizabeth, along with 200 MW module assembly expansion in Eastern Cape.	Investment China	F6	http://www.ee.co.za/article/inauguration-of-new-500-mw-solar-cell-factory.html#.XBfxu03RY0M Accessed 22 12 18

APPENDIX B – SURVEY RESULTS (Pages 1-84)

Q1 Which category below best describes your role or occupation?

Answered: 662 Skipped: 0



ANSWER CHOICES	RESPONSES	
Building Designer	14.05%	93
Electrical Contractor	0.30%	2
Electrical Engineer	16.62%	110
Architect	53.63%	355
Property Developer	0.76%	5
Property Owner	1.36%	9
Facility Manager	0.76%	5
Renewable Technology Supplier/Developer	1.21%	8
Business/Brand Owner	0.30%	2
Other (please specify)	11.03%	73
TOTAL		662

#	OTHER (PLEASE SPECIFY)	DATE
1	interior designer	12/6/2018 7:09 AM
2	Institutional infrastructure delivery management	11/24/2018 11:51 AM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

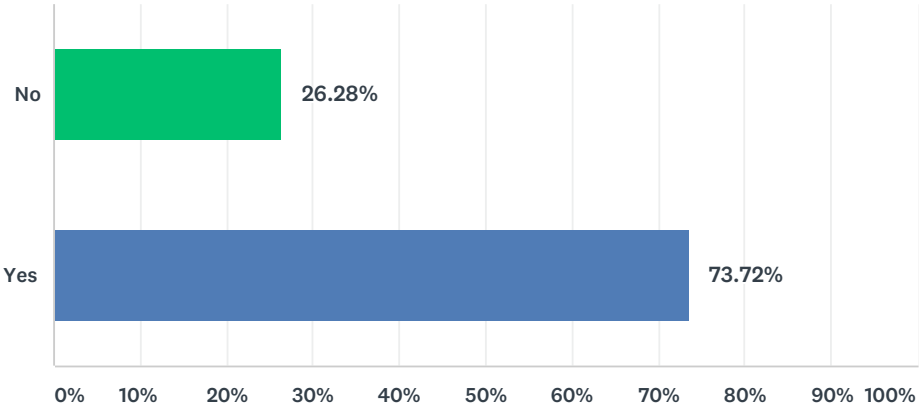
3	Architectural Technologist / Designer	11/21/2018 12:41 PM
4	Architectural Technologist	11/20/2018 5:24 PM
5	Interior Designer	11/20/2018 3:49 PM
6	Construction coordinator	11/20/2018 2:16 PM
7	Investor and project developer	11/16/2018 8:01 PM
8	architectural technologist	11/16/2018 2:22 PM
9	Design Draughtsman	11/15/2018 12:34 PM
10	Senior Architectural Technologist - Self Employed	11/15/2018 8:49 AM
11	Infrastructure Programme Manager	11/14/2018 5:31 PM
12	Architecture and Engineering Company	11/14/2018 1:51 PM
13	Lecturer of Photovoltaic Systems	11/14/2018 1:42 PM
14	Candidate Architectural draughtsperson	11/14/2018 1:40 PM
15	Interior Designer	11/14/2018 12:13 PM
16	Senior Architectural Technology	11/14/2018 11:18 AM
17	PAD	11/14/2018 11:00 AM
18	Professional Architectural Draughts Person	11/14/2018 10:30 AM
19	Environmental Health Practitioner	11/14/2018 9:47 AM
20	TECHNOLOGIST	11/14/2018 9:31 AM
21	Architectural Draughtsman	11/14/2018 8:26 AM
22	draughtsperson	11/14/2018 7:46 AM
23	PrSAT & Director of company	11/14/2018 6:12 AM
24	Municipality	11/14/2018 6:10 AM
25	Urban development specialist	11/13/2018 10:21 PM
26	Architectural Technologist	11/13/2018 7:59 PM
27	Project Manager with a Pr.Arch	11/13/2018 4:36 PM
28	Draughts person	11/13/2018 4:18 PM
29	Architectural Draughtsperson	11/13/2018 3:51 PM
30	Pre d draft	11/13/2018 3:36 PM
31	archiect and urban designer	11/13/2018 3:10 PM
32	Architectural Technologist	11/13/2018 2:57 PM
33	Project Manager	11/13/2018 2:35 PM
34	Interior Designer	11/13/2018 2:00 PM
35	Construction project manager	11/13/2018 12:53 PM
36	Draughtsman	11/13/2018 12:46 PM
37	Professional Architectural Technologist	11/13/2018 12:45 PM
38	Interior Designer	11/13/2018 12:39 PM
39	Landscape Architect	11/13/2018 12:26 PM
40	Architectural Technologist - Building designer	11/13/2018 12:16 PM
41	Architectural draughtsperson	11/13/2018 12:06 PM
42	Profession Architectural Draughtsperson	11/13/2018 12:04 PM
43	Urban Infrastructure	11/13/2018 12:00 PM
44	Education	11/13/2018 11:56 AM
45	Draughtsman	11/13/2018 11:48 AM
46	Interior Designer	11/13/2018 11:38 AM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

47	Interior design	11/13/2018 11:37 AM
48	Geographic Information Officer	11/13/2018 11:34 AM
49	Architectural Draughtsman	11/13/2018 11:32 AM
50	Interior Designer	11/13/2018 11:32 AM
51	Architectural Technologist	11/13/2018 11:31 AM
52	Interior designer	11/13/2018 11:28 AM
53	Architectural Draughtsperson	11/13/2018 11:27 AM
54	Architect, project manager, property owner	11/13/2018 11:26 AM
55	Architectural Draughtsman	11/13/2018 11:22 AM
56	Fuelling Stations & Flammable liquids Design Layouts	11/13/2018 11:20 AM
57	Technician Utility Company	11/13/2018 10:38 AM
58	Electrical Network Analyst	11/12/2018 11:33 AM
59	Engineering Manager	11/12/2018 8:09 AM
60	Electronic Technologist	11/9/2018 4:38 PM
61	Student	11/9/2018 4:26 PM
62	Mechatronics Engineering Student	11/9/2018 3:13 PM
63	Electrical Technologist	11/9/2018 3:12 PM
64	mechatronics Engineering student	11/9/2018 2:04 PM
65	Electrical Engineering consultant involved in evaluating solar plant transformers	11/9/2018 1:56 PM
66	Renewable energy consultant	11/9/2018 1:28 PM
67	Signalling Engineer (Railways)	11/9/2018 11:12 AM
68	municipal officer approving SSEG installations	11/9/2018 10:57 AM
69	Project Analyst	11/9/2018 10:14 AM
70	Electrical engineering educator (lecturer)	11/9/2018 10:06 AM
71	policy maker	11/9/2018 10:00 AM
72	ELectronic Engineer	11/9/2018 9:09 AM
73	researcher	11/2/2018 8:47 AM

Q2 Have you ever considered, designed or implemented a renewable energy generation system in a building?

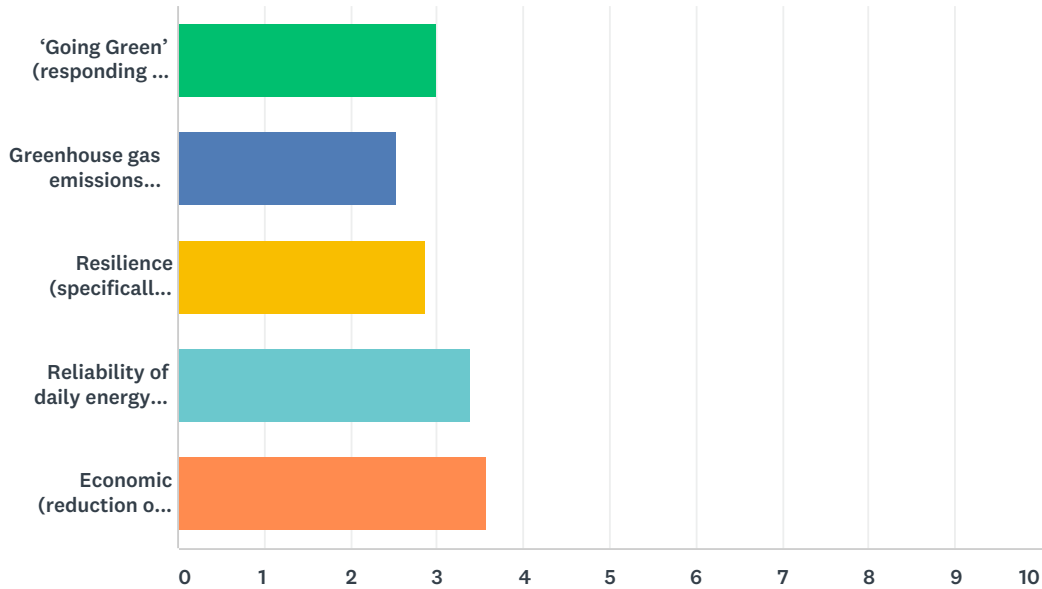
Answered: 662 Skipped: 0



ANSWER CHOICES	RESPONSES	
No	26.28%	174
Yes	73.72%	488
TOTAL		662

Q3 Which considerations below best describe the driving forces behind including an energy generation system (EGS) in a building? Rank from 1 – 5, with 1 being the most important and 5 being least relevant (select N/A where it was not a consideration)

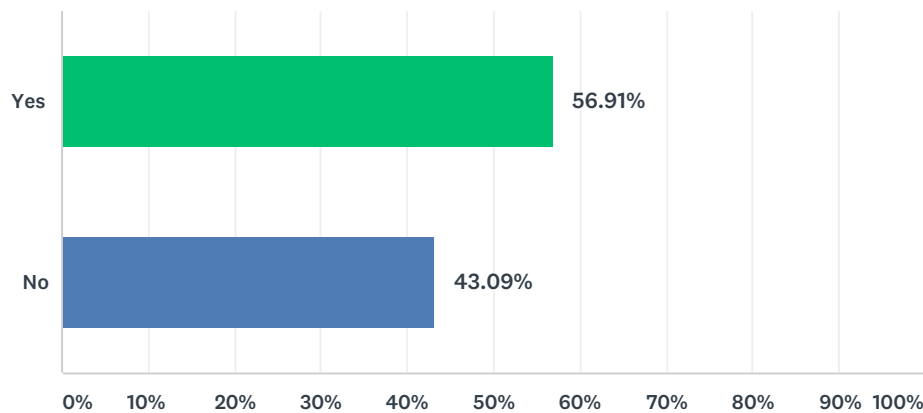
Answered: 314 Skipped: 348



	1	2	3	4	5	N/A	TOTAL	SCORE
'Going Green' (responding to the general global sustainability trend)	20.86% 58	16.91% 47	20.14% 56	19.42% 54	20.14% 56	2.52% 7	278	2.99
Greenhouse gas emissions (mitigation/reduction concern)	12.04% 33	12.41% 34	16.42% 45	25.55% 70	27.74% 76	5.84% 16	274	2.53
Resilience (specifically the supply of energy to critical building systems or function)	10.58% 29	21.90% 60	23.36% 64	23.36% 64	16.06% 44	4.74% 13	274	2.87
Reliability of daily energy supply	23.30% 65	25.09% 70	25.81% 72	15.41% 43	9.32% 26	1.08% 3	279	3.38
Economic (reduction of operating costs)	36.04% 102	24.03% 68	14.49% 41	11.31% 32	13.78% 39	0.35% 1	283	3.57

Q4 In your experience, has the order of considerations above changed over the last 10 years?

Answered: 311 Skipped: 351



ANSWER CHOICES	RESPONSES	
Yes	56.91%	177
No	43.09%	134
TOTAL		311

#	IF YES, DESCRIBE WHICH HAVE BECOME MORE OR LESS IMPORTANT AND WHY	DATE
1	Facilities management in line with a new cyber-physical economy is now key	12/7/2018 9:33 AM
2	the environment	12/6/2018 7:10 AM
3	Economic has become a much more important factor. As the implementation cost goes down and electricity tariffs go up, the pay back period reduces making it a much more viable option.	11/30/2018 6:38 PM
4	The cost of electricity has increased considerably in the last few years, the supply of energy is not reliable since the load shedding period a few years ago and solar panels and other system are becoming more affordable.	11/26/2018 3:18 PM
5	Economic impact of sustainable operation & maintenance has come to the fore with the development of greater maturity in a holistic understanding of infrastructure delivery.	11/24/2018 11:56 AM
6	4.Reliability of daily energy supply moved up, 1."Going Green" moved down	11/21/2018 8:45 PM
7	Reliability of supply as demand creates pressure on the grid leading to power outages Going green. More awareness over the years has made impacts	11/20/2018 2:00 PM
8	economic factors more important due to state of economy.	11/19/2018 10:37 PM
9	'Going Green' was a trend. Now, sustainability has become a much more centralised around the concept of utilising local methods and tech to design not only energy efficient buildings, bit also socially conscious spaces.	11/19/2018 2:18 PM
10	Economic and 'going green' issues have become more important and feasible	11/19/2018 9:26 AM
11	Economics is more a driving force	11/18/2018 1:23 PM
12	Previously renewable technology was expensive and the decider was "green". Lately renewables are cost effective interventions.	11/18/2018 10:39 AM
13	Up until about 2013, renewable generation was not really economical in a building. Since then it has started to make good business sense.	11/17/2018 3:54 PM
14	Highly significant is the inclusion of energy-saving by-laws in the National Building Laws. However, there are flaws in this.	11/17/2018 8:09 AM
15	Going green is becoming a bigger factor at the moment. Economic makes also more an impact with the affordability of the technology.	11/16/2018 8:11 PM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

16	Energy efficiency in buildings specifically is receiving more attention over the past few years since it is now included in the the building regulations.	11/16/2018 11:49 AM
17	The Eskom power supply is now very unreliable, hence my number 1	11/15/2018 4:22 PM
18	resilience displaced economics. truer cost of short term benefits have become clearer to client and all professionals, so consensus easier.	11/15/2018 2:49 PM
19	Reliability of energy supply and operating costs	11/15/2018 2:11 PM
20	PV prices have come down, Eskom prices have gone up, and most importantly clients have a better understanding of what benefits there are from other sources of power.	11/15/2018 2:06 PM
21	Resilience of energy supply has increased in importance	11/15/2018 12:41 PM
22	Due the unreliability of the provision of public services, one can give the client peace of mind if their building does not have to rely on municipal supplies.	11/15/2018 11:21 AM
23	Going green is more because of the greenhouse emissions	11/15/2018 7:29 AM
24	due to the reliability of power supply etc	11/14/2018 11:34 PM
25	Saving power	11/14/2018 8:56 PM
26	EGS makes more economic sense now than 10 years ago - cheaper to install, and energy costs are now higher	11/14/2018 8:01 PM
27	Going Green.	11/14/2018 6:18 PM
28	Designers are more informed about the sustainable energy	11/14/2018 5:37 PM
29	INcrease in receptivity by market	11/14/2018 3:43 PM
30	Previously energy was available cheaply and in a reliable consistent supply, therefore there was less incentive for renewable energy. No the incentives are cost as well as gearing towards autonomy from municipal infrastructure and poorly run Eskom.	11/14/2018 3:14 PM
31	Movement from 'Going green' to realisation that it is also economically the best long term decision	11/14/2018 2:46 PM
32	Going Green, environmental issues and global warming.	11/14/2018 2:13 PM
33	Decrease cost of the PV systems Increase of technology	11/14/2018 1:46 PM
34	Improvement of budget in long run and minimise pollution in environment.	11/14/2018 1:36 PM
35	It is not only a buzz word, it is a real design consideration	11/14/2018 12:18 PM
36	Greenhouse gas Emissions: South Africa is still a developing economy, we are not a major global player/contributor to the overall amounts of greenhouse gas emissions especially when comparing totals generated by giant economies in the manufacturing and industrial game like experienced in countries - China & the USA. Reliability of Daily Energy Supply: South Africa despite the irregular inconsistencies in supply, (load shedding, faults etc), it still has an abundance of readily available energy supply. The greater question which arises is the need to be more economical especially when building projects are more extensive in size, where the long term benefits become more apparent and necessary to ensure that the project(s) being built are viable.	11/14/2018 11:09 AM
37	Insulation, water storage, reduced reliance on grid electricity.	11/14/2018 10:06 AM
38	A few years ago going "green" would have been the reserve of the hippy community and a few very wealthy eccentric individuals but due to the plunder at the states generation utility mines and providers the cost of electricity is predicted to escalate yearly into the unforeseeable future to compensate for the severe mismanagement at the providers, there is an ongoing concern that the generation process is still not run efficiently or sustainable and that blackouts will continue to occur, defaulting municipalities are crippling the utilities cash flow and the taxpayer will yet again be expected to fund the shortfall. These real concerns are motivating ordinary people who would not have considered alternative energy generation to invest in it to become independent; The fact that most alternative solutions would be "green" is then a by product of their decisions not the primary reason for it.	11/14/2018 9:49 AM
39	"Sustainability" has various parameters fluctuating. Consistency is not guaranteed in SA, hence the mitigation herein the exchange changes accordingly.	11/14/2018 9:36 AM
40	Saving the planet from global warming	11/14/2018 8:54 AM
41	reliability is not such an issue since load shedding is not common	11/14/2018 8:42 AM
42	DAILY ENERGY SUPPLY RELIABILITY IS BETTER	11/14/2018 8:34 AM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

43	Energy Efficiency Laws now being enforced as per building regulations.	11/14/2018 8:32 AM
44	As my understanding grew, I realised that all the green buildings in the world would not make for a sustainable built environment, changes in behaviour and significant changes to shortening distances between living and work, and flexible hours without peak demands would make a greater difference	11/13/2018 10:30 PM
45	The regulation have made my perspective different	11/13/2018 8:47 PM
46	More important as clients are more aware of their responsibility.	11/13/2018 7:42 PM
47	Sustainability and Going Green have become more important	11/13/2018 7:24 PM
48	High electricity costs, taking the recession as a factor of concern.	11/13/2018 7:05 PM
49	The 'newness' of the idea has died down and people are beginning to consider it for long term investment and practical everyday use.	11/13/2018 6:06 PM
50	Reliability, because of the imminent coal shortage, and energy disruption.	11/13/2018 5:50 PM
51	Resilience - off the grid is becoming a greater reality - previously it was all about marketing an meeting social responsibility covenants	11/13/2018 4:33 PM
52	Reliability of State Enterprises has plummeted	11/13/2018 4:31 PM
53	Economic in the long term	11/13/2018 4:11 PM
54	Clients request that the operating costs of their buildings are reduced.	11/13/2018 4:08 PM
55	reliability is critical. Cannot rely on Eskom	11/13/2018 3:46 PM
56	1 due to Eskom	11/13/2018 3:29 PM
57	Greenhouse gas emission and its effect on the atmo- sphere thereby impacts on all the other factors needs be minimised. If global warming can be arrested even to a small extent, then a major battle is won.	11/13/2018 3:26 PM
58	To use sun and wind power and high cost to install but safe in the long run and less carbon use.	11/13/2018 3:15 PM
59	Greenhouse gas emissions has become important and reliability of daily energy has shifted in behind this.	11/13/2018 3:03 PM
60	Costs & alternative to inconsistent grid supply	11/13/2018 2:49 PM
61	Energy efficiency in buildings	11/13/2018 2:44 PM
62	Using of Electrical power energy has become less important	11/13/2018 2:40 PM
63	More awerness of the factors involved	11/13/2018 2:35 PM
64	Economics has always been and is currently a consideration but as the cost of energy rises and the unreliability of supply increases, there seems to be a shift in what we consider important but in reality, a paradigm shift occurs.	11/13/2018 2:27 PM
65	Cost of electricity and future cost increases	11/13/2018 2:23 PM
66	Economic factors (operational costs) and reliability of supply (electrical) have increased in importance over the last few years	11/13/2018 2:20 PM
67	Heating and lighting have become more important in saving energy and green house emissions.	11/13/2018 1:26 PM
68	more important , due to lack of energy resource	11/13/2018 1:23 PM
69	There has been a growing concern toward the ethical question about sustainability, and not only logistics.	11/13/2018 1:16 PM
70	Large scale systemic collapse probable around the world	11/13/2018 1:15 PM
71	GHG emissions as a narrative has subsided. Although it is still a valid argument, it cannot be implemented sustainably if it does not make sense economically.	11/13/2018 1:10 PM
72	Eskom has become less reliable and more expensive. Solar systems have become more economic. Amareness has increased.	11/13/2018 1:06 PM
73	More conscious of going green than 10 years ago as well as more systems available	11/13/2018 1:02 PM
74	tenants want to rent green star rated buildings	11/13/2018 12:59 PM
75	A few years ago the reliability of energy supply was a huge driving force	11/13/2018 12:59 PM
76	reliability if daily energy supply has become an increasingly important factor.	11/13/2018 12:58 PM
77	Energy has become a lot more expensive and at times there are shortages.	11/13/2018 12:54 PM

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78	Going green is the easiest thing for everybody to talk about	11/13/2018 12:53 PM
79	The green laws has been in place for so long that in many cases the economic faction has given way to reliability. In some cases my clients are more concerned about "going green" than the economic faction.	11/13/2018 12:53 PM
80	reliability ranks higher	11/13/2018 12:50 PM
81	To be more self reliant with a smaller carbon footprint	11/13/2018 12:37 PM
82	Economic	11/13/2018 12:35 PM
83	The "going green" has raised to be seen more as a status of being "green" than having any other specific role.	11/13/2018 12:35 PM
84	In a country with a transition phase, the reliability of services are highly questionable, and unpredictable	11/13/2018 12:27 PM
85	All energy to be reused, solar instead of electricity Gas, faster, less problematic than electricity	11/13/2018 12:27 PM
86	In terms of reducing costs on both energy consumption and construction methods.	11/13/2018 12:24 PM
87	Reliability more, Going green less.	11/13/2018 12:20 PM
88	Systems have reduced in cost	11/13/2018 12:15 PM
89	While reliability of daily energy is still first on my list, the absence of rolling blackouts and the like have made it less important	11/13/2018 12:13 PM
90	Greenhouse Gas Emissions have increased	11/13/2018 12:07 PM
91	my value of the concept has moved from trend following to necessity	11/13/2018 12:04 PM
92	Energy supply has become unreliable, so to be off grid becomes more important.	11/13/2018 12:00 PM
93	Unreliable electricity supply has become a reality that is here to stay. Clients have to safeguard their businesses against this, they have no choice.	11/13/2018 11:56 AM
94	Energy supply has become more reliable	11/13/2018 11:52 AM
95	reliability of energy and water serources	11/13/2018 11:52 AM
96	For others, the green trend has picked up in the last 10 years. For myself, I am more interested in providing a sustainable solution to my clients regardless of trends.	11/13/2018 11:52 AM
97	There is more concern for the environmental impact in a broad sense, but the main factor for clients remain economic	11/13/2018 11:51 AM
98	Going green wasn't really a consideration 10 years ago, now the concept has become a commercial topic.	11/13/2018 11:51 AM
99	People are more aware of the impact we have on our planet.	11/13/2018 11:48 AM
100	It has become a popular trend which people want to follow.	11/13/2018 11:48 AM
101	economic	11/13/2018 11:48 AM
102	Greenhouse emisions has become more importand , due to the earths worsen condition	11/13/2018 11:47 AM
103	Improved technology More accessible More information about it	11/13/2018 11:47 AM
104	Peoples response to sustainability has for the most part been influenced more by the growing trend of sustainable practices in business, in that companies can begin to put a marketable value to being "green" whilst simultaneously showing care for their environment, though my belief is that the majority of conformers do so for economic value before they do so by conscience.	11/13/2018 11:44 AM
105	'Going Green' can often be placed higher in the rank of importance simply due to companies attempting to appear more 'Green' in the eyes of the public.	11/13/2018 11:44 AM
106	Reliability of daily supply gotten more important as traditional supply less predictable	11/13/2018 11:41 AM
107	Economic consideration has become more important with the country going through bad economic times	11/13/2018 11:39 AM
108	Municipal water and electricity less reliable than before	11/13/2018 11:39 AM
109	Reliability of supply is less of an issue now	11/13/2018 11:37 AM
110	Electricity and water shortages are now more prevalent than before so we try design greener buildings to conserve these resources and ultimately make the last longer	11/13/2018 11:34 AM
111	Energy supply issues. Improved enviromental awareness.	11/13/2018 11:33 AM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

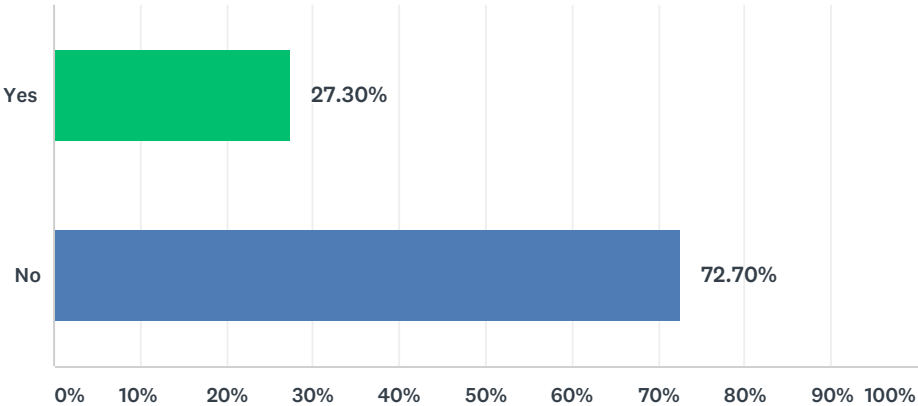
112	Global sustainability	11/13/2018 11:33 AM
113	New Eskom connections becoming prohibitive	11/13/2018 11:31 AM
114	Clients have become more conscious of the "green movement".	11/13/2018 11:28 AM
115	Due to the high cost of Municipal Services, the need to an alternative green source of energy is particularly incentive to the ROI	11/13/2018 11:24 AM
116	response to climate change - world weather patterns changing droughts/flood -rising sea temperatures / levels- Resilience - response to effects of climate change- sustainability-using wisely	11/13/2018 11:22 AM
117	Larger demand	11/13/2018 11:14 AM
118	Item 1: Cost of service supplied by others	11/13/2018 11:06 AM
119	Where people may have first considered implication on the environment, now they see these considerations as a way to alleviate day to day costs, as well as by pass inadequate municipal supply and quality by becoming self sufficient (onsite water, electricity production)	11/13/2018 11:03 AM
120	Economic reasons are the main driving force enticing developers	11/13/2018 11:02 AM
121	Economic considerations are being supplanted by Greenhouse gas emissions because of global warming.	11/13/2018 10:46 AM
122	Economic has become more important with the introduction of renewable energy, but not considering storage	11/12/2018 7:23 PM
123	Cost of renewable has become economical viable and the fragility of the Eskom supply.	11/12/2018 11:40 AM
124	Reliability of daily energy supply has become more important due to the constant 'load shedding' threats in SA. The drive to 'go-green' has also increased, however this is sometimes hampered by the cost.	11/12/2018 10:28 AM
125	Load shedding has become less common post 2008	11/12/2018 8:15 AM
126	With rolling load shedding reducing Reliability and Resilience have become less important	11/12/2018 8:14 AM
127	Eskom power used to be affordable and reliable, in the last ten years however, it has become expensive and unreliable. Solar generation equipment has decreased in cost to the point where grid parity has been reached. Global warming awareness has increased, as has the need to mitigate against emissions for the good of the environment and to avoid punitive taxation, especially with the new carbon tax being implemented in SA in 2019.	11/12/2018 7:54 AM
128	More important due to unreliability of utilities. Also clients long term concerns over costs (water, power)	11/12/2018 7:43 AM
129	Reliability of supply	11/11/2018 7:38 PM
130	Economic due to tariff hikes I	11/11/2018 7:04 AM
131	Reduction of operating costs has become more important.	11/10/2018 8:41 PM
132	Cost/return has become more important	11/9/2018 7:54 PM
133	As the cost of renewable energy drops it has become a an economically viable alternative for buildings and businesses with an unreliable or prohibitively expensive power supply connection. ie Going Green is no longer the main consideration and independence from the grid has become more important.	11/9/2018 4:02 PM
134	Public became more aware of Green energy needs and benefits. Renewable supply units have become more affordable. Better understanding that it is not about peak demand control, but about fuel saving.	11/9/2018 3:27 PM
135	The government has done a tremendous job in addressing the issue	11/9/2018 3:16 PM
136	Supply authority lack of maintenance and power capacity causing power outages.	11/9/2018 2:46 PM
137	Going green more important, economics less important	11/9/2018 2:01 PM
138	Pressure from environmentalists	11/9/2018 1:57 PM
139	Greenhouse gas emissions because the economy is now the driving force of everything in the world.	11/9/2018 1:42 PM
140	I believe that greenhouse gas emissions was less of a driving force compared to today, as people are starting to understand the urgency of this aspect.	11/9/2018 1:36 PM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

141	Reduction in the cost of PV equipment while the cost of grid supplied energy has escalated rapidly has resulted in such systems becoming economically more viable with shorter pay back times.	11/9/2018 1:36 PM
142	Reliability due to Eskom and the municipalities failing in their duties and economics due to the massive rise in electricity costs	11/9/2018 1:31 PM
143	Due to various Eskom power outages- reliability of supply became more important	11/9/2018 12:28 PM
144	Lots of people are now interested in renewable energy	11/9/2018 12:00 PM
145	Going green, and the economic benefits of going green have become more important than the economic benefit. Customers have turned into prosumers so the economic benefit is considered by the developer and the prosumer hence the consideration is now about being green and sustainable as more economic incentives have also been unlocked for being green and this has brought being green more to the forefront as years pass. We also see MDGs become SDGs that are also reflective of a change in the above selected order of considerations.	11/9/2018 11:51 AM
146	Going Green more important	11/9/2018 11:19 AM
147	Due to regular power cuts in South Africa, alternatives to Eskom need to be considered.	11/9/2018 11:15 AM
148	Economic has increased due to the price escalations and equipment cost reductions	11/9/2018 11:15 AM
149	Economic became more important as the cost of renewables has dropped.	11/9/2018 11:13 AM
150	Electricity used to be cheap but has now become almost prohibitively expensive, especially for the poor.	11/9/2018 10:58 AM
151	financial savings have become much higher and therefore most projects are now implemented for economic reasons.. previously more green reasons	11/9/2018 10:55 AM
152	Electricity from the power utilities has become extremely expensive	11/9/2018 10:46 AM
153	Reliability became more important as supply networks aged (i.e. municipality supply).	11/9/2018 10:40 AM
154	Economic factors and resilience is now top where this was in the past a draw back	11/9/2018 10:35 AM
155	ESKOM will only get deeper and deeper in dept.	11/9/2018 10:25 AM
156	resilience & reliability now much lower	11/9/2018 10:25 AM
157	environmental awareness	11/9/2018 10:09 AM
158	Solar PV has become cheaper	11/9/2018 10:09 AM
159	going green. global warming due to greenhouse gas emissions	11/9/2018 10:04 AM
160	Economics and 'going green'	11/9/2018 9:58 AM
161	Reduction in operating cost	11/9/2018 9:34 AM
162	The green aspects	11/9/2018 9:32 AM
163	Increase of GHG emissions and to reduce our dependence on fossil fuels	11/9/2018 9:30 AM
164	Going Green has become a major trend. In terms of the Economic factor - the overall living cost is increasing exponentially therefore the need for savings on utilities.	11/8/2018 7:43 AM

Q5 Were there any other considerations not listed above?

Answered: 304 Skipped: 358



ANSWER CHOICES	RESPONSES	
Yes	27.30%	83
No	72.70%	221
TOTAL		304

#	IF YES, BRIEFLY DESCRIBE WHAT THEY WERE	DATE
1	facilities management	12/7/2018 9:33 AM
2	Direct Investment, Advertising/Brand/Imaging (public image), Value improvement (value of office/residential building sometimes increases even more than the actual cost) - perceived value upon sale of asset	11/30/2018 6:38 PM
3	off the grid energy	11/22/2018 12:08 PM
4	Compliance to building regulations	11/21/2018 8:45 PM
5	By-Law implementation SANS10400XA	11/20/2018 5:29 PM
6	legislation,	11/19/2018 10:37 PM
7	Loss of confidence in supply authorities	11/19/2018 6:20 PM
8	Top down forces are required. With that in place, bottom up ideas can be given better consideration.	11/18/2018 1:23 PM
9	Grid shortages for new development	11/18/2018 10:39 AM
10	Unreliability of Eskom/Municipal power	11/18/2018 10:24 AM
11	Orientation of buildings, using materials to control heat transmission and storing, proper understanding of different climates, etc.	11/17/2018 8:09 AM
12	To comply with SANS XA	11/16/2018 2:26 PM
13	Compliance with statutory requirements.	11/16/2018 11:49 AM
14	source of materials (imported wood) workers employed in manufacture of a product maltreated/ underpaid...	11/16/2018 11:10 AM
15	cost of materials and building costs	11/15/2018 2:11 PM
16	wealthy clients showing off to their friends	11/14/2018 11:34 PM
17	Regulations	11/14/2018 2:46 PM
18	Running-off system is required to be introduced into green building issue.	11/14/2018 1:36 PM
19	Inflation: We can acknowledge that in South Africa the economy growth rate verses the inflation rate are not running in coherence, the differences between the two are not proportionate. Which is not an economy that encourages individual growth and can become detriment within the poverty spectrum.	11/14/2018 11:09 AM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

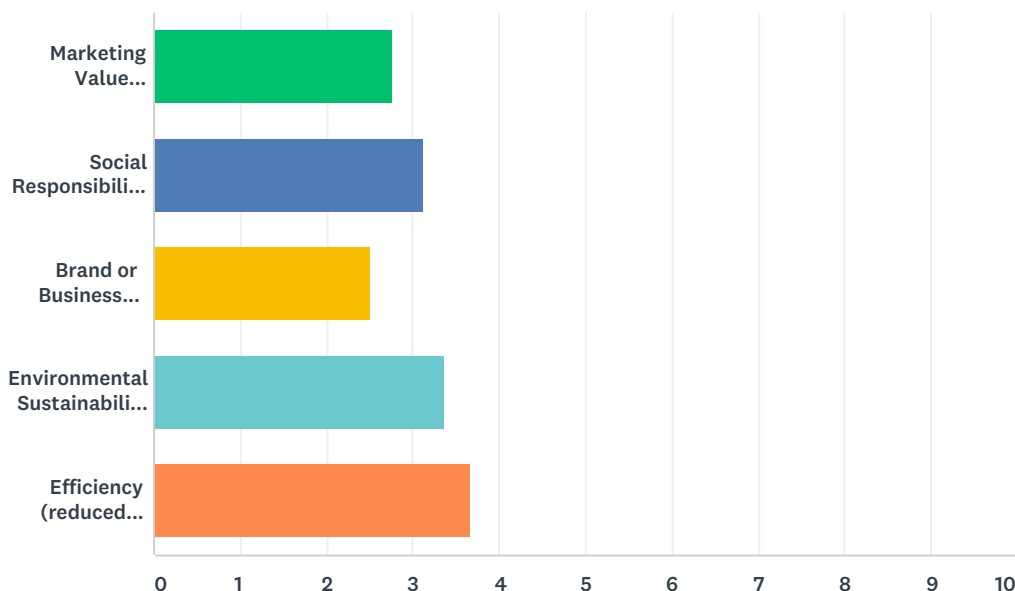
20	The effect rapid urbanisation will have on the infrastructure cost and management is completely ignored. The government promised the poor that they will be providing either a whole host of services without considering that in order to deliver on their promise they will also have to provide infrastructure to the millions of informal settlements who are continuing to migrate to the cities. Since there is also extremely high levels of unemployed, lack of building codes and formal management of the services in informal settlements power is simply siphoned off the grid. These factors will continue to undermine the providers ability to get paid for the services they promised and will affect their ability to expand the grid as required, which will add to more unrest and cashflow problems	11/14/2018 9:49 AM
21	Feasibility cannot be accurately recorded if we cannot get off the Municipal grid with over 66%, especially if the Grid fails due to the need for revenue being dependent on the user. We are very much a third world country with first-world compliance & regulation imposition.	11/14/2018 9:36 AM
22	Renewable resources	11/14/2018 9:27 AM
23	Independence from escom / government	11/14/2018 8:42 AM
24	Behaviour changes towards less consumption	11/13/2018 10:30 PM
25	Sustainability of communities surrounding employment, skills transfer & development	11/13/2018 8:03 PM
26	Availability - Way more opportunities are available now	11/13/2018 7:39 PM
27	Being considered for an award or achievement that makes a building unique. Technological innovation	11/13/2018 6:06 PM
28	Sustaibility, perhaps included reliability, but also an approach to combine systems or the flexibility to migrate to new systems.	11/13/2018 5:50 PM
29	Sun control via orientation,	11/13/2018 5:07 PM
30	To maintain business during loss of power	11/13/2018 4:31 PM
31	Ability of Eskom to supply perpetual electricity and recent drought	11/13/2018 4:23 PM
32	Turning to alternative energy sources.	11/13/2018 3:26 PM
33	energy saving through alternative work methods to achieve the same ends	11/13/2018 3:12 PM
34	Maintenance	11/13/2018 3:11 PM
35	The client wanted to prove that a variation of installations can all be implemented in our environment, in order for the public to follow suit.	11/13/2018 3:03 PM
36	Aesthetics - finding an acceptable aesthetic solution.	11/13/2018 2:57 PM
37	Capital cost	11/13/2018 2:43 PM
38	Spacial concerns	11/13/2018 2:33 PM
39	Rainwater harvesting Solar panels	11/13/2018 2:24 PM
40	It is important to 'teach' the lessons of energy generation and conservation (amongst other environmental factors) in the design and construction of schools	11/13/2018 2:20 PM
41	Availability of new technologies	11/13/2018 2:08 PM
42	Maintenance and asset management	11/13/2018 1:26 PM
43	The effect of the level of affluence and level of education (i.e. ranging from most affluent and educated to the least affluent and educated) in communities to support the sustainability initiative.	11/13/2018 1:16 PM
44	The inability to feed back into the grid is still an issue	11/13/2018 1:10 PM
45	Green Star SA rating	11/13/2018 1:02 PM
46	The political "state capture" of the ANC	11/13/2018 12:59 PM
47	In the farming community it is sometimes more cost effective reliable to install green energy than going with conventional power due to distance from network.	11/13/2018 12:53 PM
48	Site specific considerations	11/13/2018 12:50 PM
49	Maintenance reduction almost zero	11/13/2018 12:37 PM
50	Lack of distribution infrastructure.	11/13/2018 12:35 PM
51	Creating social and rehabilitating features to a development which does not only increase and incorporate the above in the building but also increases the psyche health.	11/13/2018 12:35 PM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

52	Maintaining the service from a national point of view.	11/13/2018 12:27 PM
53	Common sense - as a member of the built environment, we must take more responsibility for the environment.	11/13/2018 12:00 PM
54	I would take all the above at 1	11/13/2018 11:54 AM
55	water and the recycling of grey water	11/13/2018 11:52 AM
56	Water sustainability, especially long term use in times of drought	11/13/2018 11:51 AM
57	Varying types of energy demands have varying levels of appropriateness and varying reasons for application, eg. Water recycling to form grey water, solar panels vs wind turbines, etc.	11/13/2018 11:44 AM
58	In SA, complete developments are being bought by funds who have signed up to the GBCSA methodology and insist on all their developments to be EDGE certified as a green rating.	11/13/2018 11:34 AM
59	water department need to learn to clean the water,maybe nets over the storm water pipes that catches up all plastic,metal all rubbish thrown in water today.	11/13/2018 11:33 AM
60	Compliance with national building regulations partX	11/13/2018 11:28 AM
61	Often there are periods when local authorities, fail to provide a constent reliable source of energy and an alternative self sourced means is required	11/13/2018 11:24 AM
62	Cost of bringing in AC to a certain site vs Renewables	11/13/2018 10:33 AM
63	location and weather pattern	11/12/2018 5:19 PM
64	Possible income generation	11/12/2018 10:28 AM
65	Being less dependant on the main electrical supply.	11/12/2018 8:15 AM
66	Self reliance.	11/10/2018 8:41 PM
67	Aesthetics	11/9/2018 7:54 PM
68	Generally, more and better use of natural base sources such as wind and sun.	11/9/2018 6:35 PM
69	Most commercial public buildings need electricity for cooling during the day hours, when PV is available.	11/9/2018 3:27 PM
70	Reworking of waste for power and to reduce emission to municipality	11/9/2018 2:46 PM
71	Independence from the national grid and the associated tariff increases.	11/9/2018 1:36 PM
72	Limiting carbon dioxide	11/9/2018 12:00 PM
73	Being up to date with tech trends is also why people go green. The impression in public opinion has begun to change from it being a service from the utility to something that one can be involved in and it is displayed on social media a lot more and that trend of clean energy related social media posts has really risen over the past 10 years to show that.	11/9/2018 11:51 AM
74	Still no reliable information on how "green" batteries are considering the whole life cycle. Feel suppliers of systems and batteries are "ducking" the issue	11/9/2018 11:19 AM
75	Lead times Availability locally	11/9/2018 11:15 AM
76	scalability upgradability lifecycle costing	11/9/2018 11:03 AM
77	Fossil fuels are not sustainable in the long term. these have finite reserves, and are becoming more expensive than solar and wind generated electricity.	11/9/2018 10:58 AM
78	Becoming independent of government based services	11/9/2018 10:55 AM
79	Efficiency: will the new System be as efficient (or more or less) that the traditional source.	11/9/2018 10:40 AM
80	cost factor 2 - ever increasing eskom kwh costs	11/9/2018 10:25 AM
81	Demonstration of distributed microgrid control capabilities	11/9/2018 9:32 AM
82	Advancements in technology that opens doors to sustainable living	11/9/2018 9:30 AM
83	Requirement when developing for property funds.	11/8/2018 7:43 AM

Q6 If 'Going Green' was a consideration, which factors below drove the green initiative? Rank from 1 – 5, with 1 being the most important and 5 being least relevant (select N/A where it was not a factor)

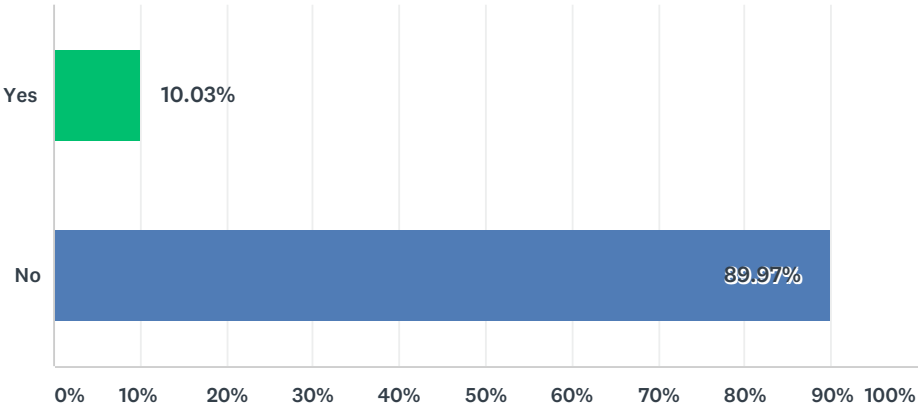
Answered: 297 Skipped: 365



	1	2	3	4	5	N/A	TOTAL	SCORE
Marketing Value (perceived value add to the building or property)	13.31% 35	16.35% 43	15.97% 42	25.86% 68	19.01% 50	9.51% 25	263	2.77
Social Responsibility (quality of life / improved occupant health and comfort / reduced demand on local infrastructure)	14.94% 39	23.37% 61	25.29% 66	21.07% 55	10.73% 28	4.60% 12	261	3.11
Brand or Business Identity (increased value by identifying with the 'Green' movement)	8.53% 22	15.50% 40	15.89% 41	19.77% 51	27.91% 72	12.40% 32	258	2.51
Environmental Sustainability (conserve natural resources, reduced pollution/carbon footprint)	30.57% 81	20.38% 54	16.23% 43	11.32% 30	17.36% 46	4.15% 11	265	3.37
Efficiency (reduced operating costs)	33.70% 91	22.22% 60	25.56% 69	8.15% 22	8.15% 22	2.22% 6	270	3.67

Q7 Were there any other factors not listed above?

Answered: 299 Skipped: 363



ANSWER CHOICES	RESPONSES
Yes	10.03% 30
No	89.97% 269
TOTAL	299

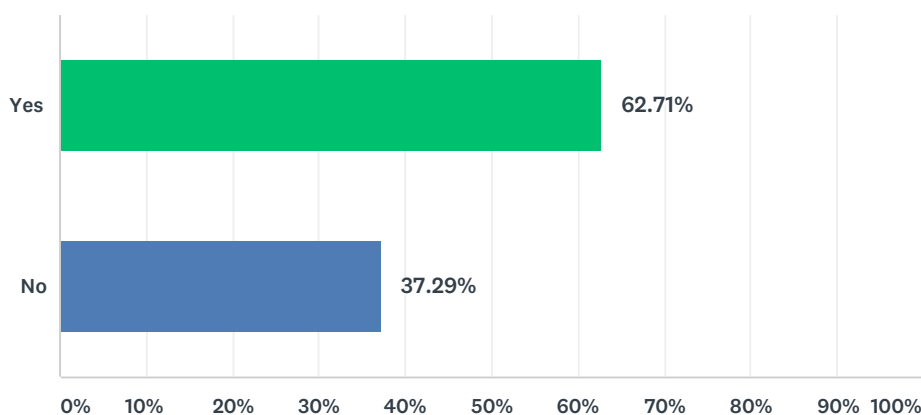
#	IF YES, BRIEFLY DESCRIBE WHAT THEY WERE	DATE
1	The occupant or owner of an individual single dwelling property, is given little say. Compared to big property developers, their viewpoints are not regarded worthy of proper consideration.	11/18/2018 1:23 PM
2	Densification and the destruction of the eco-system to meet this demand.	11/17/2018 8:09 AM
3	recycling ... circular economy	11/16/2018 11:10 AM
4	Other sources: wind energy, water (wave) energy, re-cycling, sustainable building techniques and materials, food etc	11/15/2018 7:49 AM
5	Confort indoor (thermal, acoustic and lighting)	11/14/2018 2:00 PM
6	Legislation / Law: Laws in place to assist with the development to using a more sustainable generation of energy is in place. However, whether this legislation is being implemented/exercised is another story.	11/14/2018 11:09 AM
7	There is a world wide concern about the environment. This concern led to massive progress in the development of alternative systems, the technology and its affordability is finally making it possible for ordinary people to do the right thing even if the government is not doing so, the fact that it might also soon pay for it self is making it an easier decision.	11/14/2018 9:49 AM
8	"Local" manufacturing & branding for cost effective solutions are needed but by avoiding imports we are subject to poor local quality with lower guarantee periods, more product returns & sustainable maintenance which adds to poor economic return. A very significant problem that generally hampers "moving forward" long enough to create drive for investor confidence.	11/14/2018 9:36 AM
9	the UN says we have 12 years to curb carbon emissions. However to do this trade would have to cease or be radically transformed. Products with no carbon footprint are required. For this to happen home produced everything will be essential. Our way of existing on this planet has to alter dramatically.	11/13/2018 3:12 PM
10	Actively researching most effective renewable energy sources and diversifying. ie also installing monitoring systems for data collection.	11/13/2018 3:03 PM
11	Reliability of future energy supply and cost!	11/13/2018 2:57 PM
12	Again the effect of affluence and education, as mentioned above, has not been accounted for.	11/13/2018 1:16 PM
13	Due to green laws being implemented.	11/13/2018 12:53 PM
14	Ease of use	11/13/2018 12:37 PM
15	The GBCSA tools	11/13/2018 12:35 PM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

16	Cost	11/13/2018 11:56 AM
17	The cost of making a building green is slowly becoming more affordable.	11/13/2018 11:51 AM
18	Time efficiency of the incorporation into a project of the required energy services needed to move the project forward, local authority have pre-requisite requirements that if not meet services are not provided	11/13/2018 11:24 AM
19	weather pattern and location	11/12/2018 5:19 PM
20	Highly variable depending on user requirements/company ethos	11/9/2018 7:54 PM
21	Basically comparison of high costs (Nuclear) and construction time for "renewable" resources	11/9/2018 6:35 PM
22	Reduced dependence on diesel generators (fluctuating cost and additional environmental impact of transport of diesel)	11/9/2018 4:02 PM
23	environmental impact	11/9/2018 2:46 PM
24	Availability of alternative supply of energy in the event of grid failure or load shedding.	11/9/2018 1:36 PM
25	Saving moneys	11/9/2018 12:00 PM
26	Long term costs of electricity in RSA.	11/9/2018 10:58 AM

Q8 If economic considerations were a primary driver, was the 'payback period' critical in determining the scale of investment in the EGS?

Answered: 303 Skipped: 359



ANSWER CHOICES	RESPONSES	
Yes	62.71%	190
No	37.29%	113
TOTAL		303

#	IF YES, BRIEFLY DESCRIBE WHAT THE CRITICAL 'PAYBACK PERIOD' NEEDED TO BE IN ORDER TO MAKE AN EGS VIABLE	DATE
1	depends	12/7/2018 9:33 AM
2	In theory one would want the payback period to be in line with longevity of the business and as short as possible. Typically about 5 years or less would be acceptable to most. One would have to consider the diversion of capital into the EGS investment as a factor which should not negatively impact on normal business or way of life. Immediate savings offsetting the cost of the investment would be the best outcome.	11/30/2018 6:38 PM
3	I can't rememebr the period but in the case of residential need to be short enough to cover for when there is more people in the house. Once the kids become independent the parents might change house.	11/26/2018 3:18 PM
4	Varies relative to the level of intervention.	11/24/2018 11:56 AM
5	It varies from client to client and place to place. This is not a fixed variable, and cant be treated as such.	11/21/2018 4:04 PM
6	6-7years depending on the project and cost of electricity	11/20/2018 2:00 PM
7	That will differ for each user. The shorter the better, obviously.	11/20/2018 7:28 AM
8	payback period needed to be shorter than proposed lease term of tenant for developer to consider.	11/19/2018 10:37 PM
9	8 years	11/19/2018 6:20 PM
10	I would say 5 years	11/19/2018 3:56 PM
11	Less than 5 years.	11/19/2018 10:46 AM
12	Payback shorter than 24 months is easy to motivate, generally paybacks shorter than the leases period for hte property under consideration are considered feasible	11/19/2018 9:26 AM
13	lower than 5 years	11/19/2018 6:23 AM
14	An initial up-front relief would make the "user" a driver. This up-front cost should be funded by govt. If not it should be spread over not more than 10 years. The property owner should somehow to repay more than initially imposed.	11/18/2018 1:23 PM
15	LCOE need to be favourable given the tariff from the grid	11/18/2018 10:39 AM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

16	5 years	11/18/2018 10:35 AM
17	5 Years	11/18/2018 10:24 AM
18	5 years	11/18/2018 10:15 AM
19	The payback period of about 6-7 years translated into a good investment that would provide a better IRR (internal rate of return) than long term property and equity growth of ~14%p.a.	11/17/2018 3:54 PM
20	5 to 7 years	11/16/2018 8:11 PM
21	5 years	11/16/2018 2:26 PM
22	2 to 3 years	11/16/2018 9:41 AM
23	Considerably less that the lifespan of the items installed	11/15/2018 4:22 PM
24	payback is incremental according to affordability, not so much according to quantum of loan financing	11/15/2018 2:49 PM
25	The adopted time frame seems to be 5 years, at which point maintenance becomes expensive.	11/15/2018 2:11 PM
26	Five years appears to be the norm.	11/15/2018 2:06 PM
27	Max 10 years	11/15/2018 1:36 PM
28	between 5 - 10 years	11/15/2018 12:41 PM
29	Yes. The shorter the better !1	11/15/2018 7:49 AM
30	By calculation only	11/15/2018 7:29 AM
31	five years or less	11/14/2018 8:01 PM
32	Government should subsidize those who implement it in their buildings	11/14/2018 5:37 PM
33	2 year what what people were looking at	11/14/2018 3:43 PM
34	Approx. 5 -10 years.	11/14/2018 3:14 PM
35	n/a	11/14/2018 2:15 PM
36	Payback relates to maintenance and life span of installation. To make it marketable it must compare to buying electricity from a service provider.	11/14/2018 2:13 PM
37	5 years	11/14/2018 2:00 PM
38	4 to 6 years	11/14/2018 1:46 PM
39	Share contribution from the state in green initiatives.	11/14/2018 1:36 PM
40	I feel that any thing over 2 years is a bit far for clients to really consider it	11/14/2018 12:18 PM
41	This can only be determined once a project has gone through an extensive viability process. Such process will determine: 1. What green elements are going to be used; 2. The levels / advantages of such green elements; 3. The initial cost to install, the duration of the payback period. With that information in mind and provided that all areas are extensively researched will afford the client/developer a clearer indication on what their limitations/deliverables are likely to be.	11/14/2018 11:09 AM
42	10 Years and more	11/14/2018 10:33 AM
43	5 yrs	11/14/2018 10:06 AM
44	typically 7-10 years	11/14/2018 9:49 AM
45	To what extent does economic involvement prepare objectives that are actually achieved? Like Funding & Subsidising, until this system is well executed, this will remain a very difficult task to understand the scale of investment & more so the impact herein. We must deal with the current problems to get us into the range of taking advantage of an opportunity, which is a direct reason for failure. "We" think big but "our" actions are without appropriate effort.	11/14/2018 9:36 AM
46	mostly people see 5 years as the limit, but even 10 years or more is viable	11/14/2018 8:42 AM
47	Dependant on investment made and socio- economic benefits	11/13/2018 10:30 PM
48	I think if the payback period outlasts the system itself, in terms of its reliability and longevity, then its not worth it.	11/13/2018 8:09 PM
49	3 to 4 years	11/13/2018 7:26 PM
50	The payback period would be relative to the energy cost cost over a specified period of time	11/13/2018 7:24 PM
51	10 years	11/13/2018 6:06 PM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

52	5 years	11/13/2018 5:50 PM
53	Payback	11/13/2018 5:03 PM
54	This can be answered by a QS - I would say a payback period in a commercial venture would be critical	11/13/2018 4:45 PM
55	5 years or less	11/13/2018 4:33 PM
56	Around 5 years	11/13/2018 4:23 PM
57	"To long period" was the comment I received.	11/13/2018 4:08 PM
58	5-7years	11/13/2018 3:46 PM
59	3 years	11/13/2018 3:29 PM
60	It is accepted that the capital cost of going green is higher. The attractiveness of the system lies in the break-even being achieved within the economic life of the building. After the break-even there is saving. In addition this adds value.	11/13/2018 3:26 PM
61	5 years	11/13/2018 3:15 PM
62	128 years	11/13/2018 3:12 PM
63	5 year	11/13/2018 3:11 PM
64	The period was between 5 and 6 years.	11/13/2018 3:03 PM
65	Anything from 5 to 1 year	11/13/2018 2:57 PM
66	Approximately 5-10 years maximum	11/13/2018 2:43 PM
67	5 yrs	11/13/2018 2:40 PM
68	100% payback in 5 years	11/13/2018 2:33 PM
69	I don't have direct experience in this area but payback period is always critical but life cycle costs are more important. If a systems payback period is 5 years but the maintenance costs increase dramatically, that can skew payback.	11/13/2018 2:27 PM
70	8 years	11/13/2018 2:23 PM
71	Generous donor funding was available in this instance	11/13/2018 2:20 PM
72	20 years	11/13/2018 2:08 PM
73	the faster the better	11/13/2018 1:41 PM
74	less than 5 years	11/13/2018 1:30 PM
75	less than 5 years	11/13/2018 1:23 PM
76	10 years or below	11/13/2018 1:16 PM
77	Within 5 years	11/13/2018 1:10 PM
78	5 Years	11/13/2018 1:06 PM
79	the quicker the better. depends on size of project and size of investment	11/13/2018 12:59 PM
80	Max 5 years	11/13/2018 12:59 PM
81	5-7 years	11/13/2018 12:58 PM
82	A couple of years	11/13/2018 12:55 PM
83	5 years	11/13/2018 12:54 PM
84	5 to 10 years	11/13/2018 12:54 PM
85	Depending on the cost of the system it has been calculated to be between 10 and fifteen years. Unfortunately the systems are still very expensive to buy and maintain. Some systems are cheaper but last only 8 to 12 years where as the more expensive systems, economically viable systems, are sometimes just to pricey.	11/13/2018 12:53 PM
86	as quickly as possible, or within the intended period of occupancy	11/13/2018 12:35 PM
87	Usually within a year.	11/13/2018 12:35 PM
88	Being a governmental initiative, the public impact should have been to make a longterm payback low cost investment	11/13/2018 12:27 PM
89	payback period must be within a 18 month period and not be a time consuming saving	11/13/2018 12:27 PM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

90	10 years	11/13/2018 12:06 PM
91	5 to 10 years, depending on the scale of intervention and sector that determines the finance (ie commercial vs private residential)	11/13/2018 12:04 PM
92	It is always a factor, and the payback period always needs to be as short as possible. the viability depends on the client. Some are more risk averse and therefore no payback period is viable.	11/13/2018 12:00 PM
93	5 year return on investments. No financial institution will look at a longer term, unless there is a good(sound) motivation.	11/13/2018 11:56 AM
94	7 years or shorter	11/13/2018 11:52 AM
95	at least 12 months	11/13/2018 11:52 AM
96	It varies between projects, reliability was a key concern and was a driver if it could be proven to reduce issues caused by load shedding	11/13/2018 11:51 AM
97	Most clients like the payback period to not be more then 5 years, but the lower the payback period the more attractive the system so this scale will shift with the market and its increasing expectations.	11/13/2018 11:51 AM
98	5 years	11/13/2018 11:49 AM
99	8 to10 years	11/13/2018 11:48 AM
100	5 years	11/13/2018 11:46 AM
101	5 years or less	11/13/2018 11:44 AM
102	This value would be determined by the product in specific and the scale by which the product has been implemented. Eg. Some solar panel companies state that their products have been fully paid back and are producing benefits for the consumer after 10 - 15 years only.	11/13/2018 11:44 AM
103	Based on length of tenant lease	11/13/2018 11:35 AM
104	Just the long term reassurance that the investment will be worthwhile over time	11/13/2018 11:33 AM
105	promoting Green businesses,that use biodegradable material to build.	11/13/2018 11:33 AM
106	Not sure, client's decision	11/13/2018 11:31 AM
107	1/2 years	11/13/2018 11:29 AM
108	Critical payback period was within replacement cost period.	11/13/2018 11:28 AM
109	5 to 7 years	11/13/2018 11:24 AM
110	Shorter the better	11/13/2018 11:22 AM
111	return on investment	11/13/2018 11:22 AM
112	Within 5 years.	11/13/2018 11:19 AM
113	5 years max	11/13/2018 11:17 AM
114	Funding cycles for institutions need to be considered in payback periods	11/13/2018 11:05 AM
115	A period of pay back should not be more than 5 years to leverage technological innovation for renewal of EGS	11/13/2018 10:46 AM
116	+/- 7 Years	11/12/2018 7:23 PM
117	Investment and rate of return - faster payback for commercail customers	11/12/2018 11:40 AM
118	Less than 5 years	11/12/2018 8:15 AM
119	Five years	11/12/2018 8:14 AM
120	Depending on the deployment model used for EGS installation, payback of under 4-5 years is favourable, assuming a 20 year lifespan of the generation system.	11/12/2018 7:54 AM
121	This is a typical SA answer. Ja/nee. As resilience is vital, however, not so much payback period by Capital Cost.	11/12/2018 7:43 AM
122	As the MYPD determines about five years of farly reliable information	11/11/2018 7:38 PM
123	The payback period of not more than five years.	11/11/2018 9:23 AM
124	Detailed calcs not done for domestic application	11/11/2018 7:04 AM
125	Variable 5- 10 years typically	11/9/2018 7:54 PM

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126	Renewables construction is quicker than conventional "power stations"	11/9/2018 6:35 PM
127	5 years - ideal 10 years - accepted. Additional cost of battery storage (and shorter replacement period) taken into consideration.	11/9/2018 4:02 PM
128	Perceived - I have no actual info.	11/9/2018 3:27 PM
129	3 to 6 years	11/9/2018 2:46 PM
130	3 - 5 years	11/9/2018 2:01 PM
131	We achieved a 5 year payback on the study I did .	11/9/2018 1:57 PM
132	Last I checked 15 years considering the price of components although the source is free ,the system to harvest is expensive.	11/9/2018 1:42 PM
133	Most people were not interested in systems with a payback period longer than 3-4 years.	11/9/2018 1:36 PM
134	Payback withing 5-8 years	11/9/2018 1:36 PM
135	not more than 10 years	11/9/2018 1:31 PM
136	5 years	11/9/2018 12:00 PM
137	A payback period that the financier is happy with. If that changes, there is nothing one can do, so it has always been whatever the financier decides.	11/9/2018 11:51 AM
138	5 years	11/9/2018 11:19 AM
139	3 years	11/9/2018 11:15 AM
140	payback needs to less than warranty period of system installed	11/9/2018 11:03 AM
141	An estimate of what Eskom price increases are likely to be [unknown since politically driven and inefficiency of the Eskom SOE] vs. the savings of generating own reliable power with EGS	11/9/2018 10:58 AM
142	below 5 years	11/9/2018 10:55 AM
143	For at least the period that the property will be used, i.e within 5 years.	11/9/2018 10:40 AM
144	Most investments should be less than 7 years with 5 year preferred. Depending on New-Build vs Refurbishment	11/9/2018 10:35 AM
145	5 Years or less.	11/9/2018 10:31 AM
146	3years max	11/9/2018 10:25 AM
147	as short as possible	11/9/2018 10:09 AM
148	4 years	11/9/2018 10:09 AM
149	Accept that it will be medium term, i.e for us 5 to 8 years.	11/9/2018 10:04 AM
150	Around 3-4 years	11/9/2018 9:58 AM
151	3 years	11/9/2018 9:46 AM
152	in a year or two ROI should achieved	11/9/2018 9:34 AM
153	7 years	11/9/2018 9:30 AM
154	expected payback period is 2 years, need to see a substantial amount of return on the investment.	11/9/2018 9:05 AM
155	<5 yrs	11/9/2018 9:00 AM
156	5 year	11/9/2018 8:45 AM
157	It varies from development to development as different interventions are used - on residential developments: 2 x bed 1 x bath: +/- 3 years.	11/8/2018 7:43 AM
158	7 years	11/5/2018 11:30 AM
159	A maximum of 3 years.	11/2/2018 2:06 PM

Q9 Did consideration of the 'payback period' impact the scale of the EGS installed or the generation technology chosen?

Answered: 231 Skipped: 431

#	RESPONSES	DATE
1	yes	12/7/2018 9:33 AM
2	YEs	12/7/2018 9:19 AM
3	definetly	12/6/2018 7:10 AM
4	Yes	11/30/2018 6:38 PM
5	partly	11/29/2018 11:51 AM
6	Possibly	11/28/2018 7:40 AM
7	no	11/26/2018 3:18 PM
8	No.	11/24/2018 11:56 AM
9	no	11/22/2018 12:08 PM
10	No	11/21/2018 8:45 PM
11	Probably	11/21/2018 4:04 PM
12	yes	11/21/2018 2:18 PM
13	No comment	11/21/2018 10:56 AM
14	Yes, with the increase of electricity prices pushes demand for EGS. Prices of solar pv is becoming cheaper contributing to shorter payback period	11/20/2018 2:00 PM
15	Yes.	11/20/2018 7:28 AM
16	Yes.	11/19/2018 10:37 PM
17	yes	11/19/2018 6:20 PM
18	Yes	11/19/2018 3:56 PM
19	No	11/19/2018 2:18 PM
20	Yes.	11/19/2018 10:46 AM
21	Yes	11/19/2018 9:26 AM
22	No, not really	11/19/2018 6:23 AM
23	yes	11/18/2018 1:23 PM
24	Yes	11/18/2018 10:39 AM
25	Yes	11/18/2018 10:35 AM
26	Yes	11/18/2018 10:24 AM
27	yes	11/18/2018 10:15 AM
28	Yes, among other criteria. For example, the desired payback period influenced the type of mountings utilised for PV panels and acceptable pricing for the inverters.	11/17/2018 3:54 PM
29	Yes. At first "green" was considered too expensive, but, with time, the benefits came to light.	11/17/2018 8:09 AM
30	Yes	11/16/2018 8:11 PM
31	yes	11/16/2018 11:10 AM
32	yes	11/16/2018 9:41 AM
33	Yes	11/15/2018 4:22 PM
34	yes, but only as per capacity to pay back, as per 8 above	11/15/2018 2:49 PM
35	Yes,as technology develops so newer systems are added. One only hopes the additions are compatible	11/15/2018 2:11 PM

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36	Yes	11/15/2018 2:06 PM
37	yes	11/15/2018 1:36 PM
38	Yes, but need to factor in initial investment cost	11/15/2018 12:41 PM
39	It did, primarily by including other (all) the other EGS's.	11/15/2018 7:49 AM
40	no, upfront cost limits this being a consideration	11/14/2018 11:34 PM
41	no	11/14/2018 8:56 PM
42	yes	11/14/2018 8:01 PM
43	Yes	11/14/2018 6:18 PM
44	Yes it dose as more people are concerned about the cost	11/14/2018 5:37 PM
45	Yes	11/14/2018 3:14 PM
46	I have not been involved in large scale implementations where it would definitely influence the decision	11/14/2018 2:46 PM
47	n/a	11/14/2018 2:15 PM
48	Yes	11/14/2018 2:13 PM
49	Yes	11/14/2018 2:00 PM
50	yes	11/14/2018 1:46 PM
51	Yes	11/14/2018 1:36 PM
52	yes, but I think it is more social responsibility an reliability that was key	11/14/2018 12:18 PM
53	Yes	11/14/2018 11:40 AM
54	1. Yes as the technology chosen will in some cases be determined by what can be afforded verses what will provide the greatest benefit. 2. However, this is purely dependent on the individual client/developer(s) available tangible expenditure. If they are within their capacity to utilize the aforementioned EGS technology the payback period can become less of a concern when the chosen technology is determined based upon preference. 3. Will depend on the project model provided. Some organizations have been known to provide additional funding for utilizing a EGS technology. This being provided by: NPO's (Non-Profit Organization), Government Entities , foreign investors, financial corporations etc.	11/14/2018 11:09 AM
55	sometimes	11/14/2018 10:33 AM
56	No	11/14/2018 10:26 AM
57	yes	11/14/2018 10:19 AM
58	yes	11/14/2018 10:06 AM
59	Yes; in some building types or instances but not in all.	11/14/2018 9:49 AM
60	Any investment duration is directly linked to the scale of outcome. Impacts are not only from a "Payback Period" but from failed attempts noted as "Market testing" & leaves a negative effect "with a bad taste". this with technology simply being considered a tool. Testing the market is the only way we can offer some type of feedback considering said failed attempts that also add to low confidence.	11/14/2018 9:36 AM
61	no	11/14/2018 8:42 AM
62	YES	11/14/2018 8:34 AM
63	The generation technology chosen	11/14/2018 8:32 AM
64	Absolutely.....	11/14/2018 1:47 AM
65	No	11/13/2018 10:30 PM
66	Yes. Often efficiency and reliability comes at a cost far out weighing the systems technology longevity. i.e you still paying off the system and it becomes outdated.	11/13/2018 8:09 PM
67	yes	11/13/2018 7:42 PM
68	Yes, the bigger or "younger" techniques seemed more risky yet the payback would pay off - especially with the energy costs being so high	11/13/2018 7:39 PM
69	No	11/13/2018 7:24 PM
70	Yes	11/13/2018 7:07 PM

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71	No	11/13/2018 7:05 PM
72	yes	11/13/2018 6:31 PM
73	Yes	11/13/2018 6:06 PM
74	Because systems are improved fast, and material are not reliably gauranteed.	11/13/2018 5:50 PM
75	Yes	11/13/2018 5:37 PM
76	Yes	11/13/2018 5:32 PM
77	yes	11/13/2018 5:11 PM
78	Yes	11/13/2018 5:03 PM
79	Definitely	11/13/2018 4:45 PM
80	Yes - in commercial projects	11/13/2018 4:33 PM
81	No	11/13/2018 4:31 PM
82	Yes. Limitations in terms of how holistic the design was. Finances is always critical. Expenditure needed to be recouped in the shortest possible time frame	11/13/2018 4:23 PM
83	Yes	11/13/2018 4:11 PM
84	Yes	11/13/2018 4:08 PM
85	yes but not more than the green credentials	11/13/2018 3:52 PM
86	yes	11/13/2018 3:46 PM
87	No, rather it was implemented to reduce on operating costs.	11/13/2018 3:32 PM
88	yes	11/13/2018 3:29 PM
89	The project is commercial. The occupants in the previous premises suffered 'huge' setbacks with power outages and cuts in water supply. Use of natural lighting rather than artificial during the day and battery stored energy at other times and grey water for non- consumption purposes has virtually cancelled the disadvantages suffered previously.	11/13/2018 3:26 PM
90	yes. The installment cost and equipment are still high	11/13/2018 3:15 PM
91	no. Client wanted to not be reliant on Escom or the grid.	11/13/2018 3:12 PM
92	Yes	11/13/2018 3:11 PM
93	Not really. Everything that was needed was implemented.	11/13/2018 3:03 PM
94	Yes. If one recovered your investment in one year, it was a no-brainer!	11/13/2018 2:57 PM
95	Yes	11/13/2018 2:49 PM
96	Yes	11/13/2018 2:43 PM
97	yes	11/13/2018 2:40 PM
98	No	11/13/2018 2:35 PM
99	Yes	11/13/2018 2:33 PM
100	No	11/13/2018 2:24 PM
101	Yes	11/13/2018 2:23 PM
102	No, available funding determined it	11/13/2018 2:20 PM
103	Yes.	11/13/2018 2:08 PM
104	not consistently	11/13/2018 1:41 PM
105	no	11/13/2018 1:36 PM
106	No	11/13/2018 1:30 PM
107	No	11/13/2018 1:26 PM
108	yes	11/13/2018 1:23 PM
109	yes	11/13/2018 1:16 PM
110	yes	11/13/2018 1:15 PM
111	Yes	11/13/2018 1:10 PM

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112	Yes	11/13/2018 1:06 PM
113	yes	11/13/2018 12:59 PM
114	Yes	11/13/2018 12:59 PM
115	Yes	11/13/2018 12:55 PM
116	No	11/13/2018 12:54 PM
117	Yes	11/13/2018 12:54 PM
118	yes	11/13/2018 12:53 PM
119	no	11/13/2018 12:50 PM
120	no	11/13/2018 12:37 PM
121	yes	11/13/2018 12:35 PM
122	Yes!	11/13/2018 12:35 PM
123	Yes.	11/13/2018 12:35 PM
124	Not sure	11/13/2018 12:27 PM
125	yes	11/13/2018 12:27 PM
126	Yes	11/13/2018 12:24 PM
127	Yes	11/13/2018 12:20 PM
128	YES	11/13/2018 12:19 PM
129	Yes	11/13/2018 12:15 PM
130	no	11/13/2018 12:13 PM
131	N/A	11/13/2018 12:12 PM
132	no	11/13/2018 12:11 PM
133	Yes	11/13/2018 12:06 PM
134	yes, it comes down to feasibility. but the value of having reliable power and water supply is now more valuable that a few years ago when 'going green' was just a trend and 'the right thing to do'. it has hence become an unmissable component in the feasibility calculation.	11/13/2018 12:04 PM
135	No	11/13/2018 12:02 PM
136	Yes, a large capital investment is nearly always going to lengthen the payback period, so sometimes a full scale system is declined in favour of a smaller, less impactful system.	11/13/2018 12:00 PM
137	Yes	11/13/2018 11:56 AM
138	No	11/13/2018 11:56 AM
139	yes	11/13/2018 11:54 AM
140	Yes	11/13/2018 11:52 AM
141	yes definately	11/13/2018 11:52 AM
142	Yes	11/13/2018 11:52 AM
143	In some cases yes, if the payback period became longer than 3-5 years it was difficult to convince clients and some elements were scaled back	11/13/2018 11:51 AM
144	yes.	11/13/2018 11:51 AM
145	Yes	11/13/2018 11:49 AM
146	yes	11/13/2018 11:48 AM
147	No	11/13/2018 11:48 AM
148	yes	11/13/2018 11:48 AM
149	Yes	11/13/2018 11:47 AM
150	no	11/13/2018 11:45 AM
151	Yes	11/13/2018 11:44 AM
152	Yes	11/13/2018 11:44 AM

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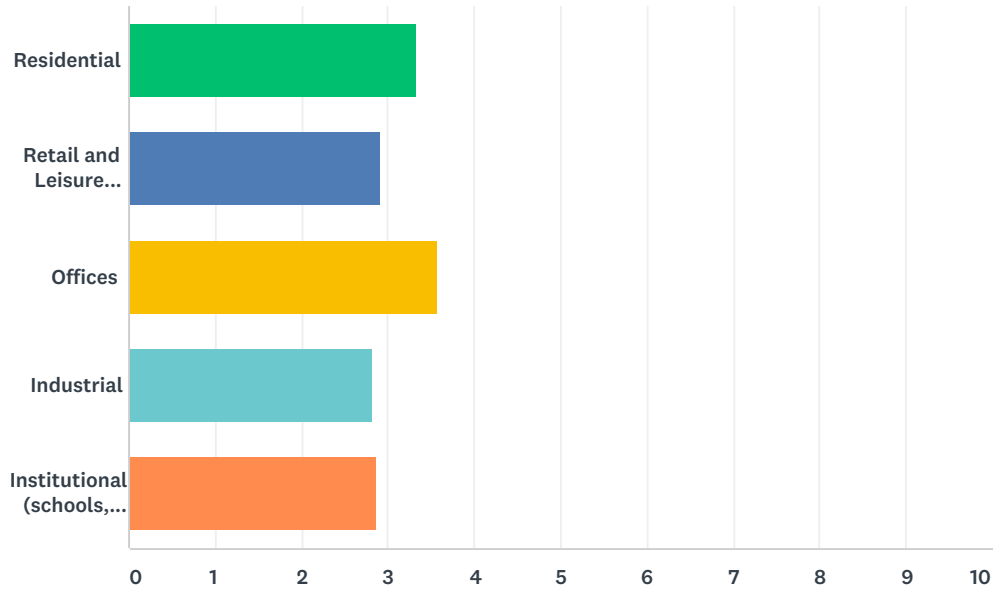
153	Yes, this begins to affect the installation and overall maintenance costs planned to be incurred.	11/13/2018 11:44 AM
154	no	11/13/2018 11:39 AM
155	Yes	11/13/2018 11:39 AM
156	Yes. Capital outlay required is critical	11/13/2018 11:37 AM
157	Yes	11/13/2018 11:35 AM
158	No, the scale was calculated as the minimum installation to conform to Part XA 10400 and EDGE certification so that it deemed-to-satisfy	11/13/2018 11:34 AM
159	no	11/13/2018 11:33 AM
160	no	11/13/2018 11:33 AM
161	yes	11/13/2018 11:33 AM
162	Most likely	11/13/2018 11:31 AM
163	Yes	11/13/2018 11:30 AM
164	yes	11/13/2018 11:29 AM
165	yes	11/13/2018 11:29 AM
166	Yes. If technology is too expensive, it does not make business sense.	11/13/2018 11:28 AM
167	yes	11/13/2018 11:24 AM
168	No, the global 'payback' was far more important than the short-term 'payback period' for the specific building.	11/13/2018 11:23 AM
169	Yes	11/13/2018 11:22 AM
170	yes	11/13/2018 11:22 AM
171	Yes	11/13/2018 11:19 AM
172	yes	11/13/2018 11:17 AM
173	n/a	11/13/2018 11:06 AM
174	Yes it did	11/13/2018 11:02 AM
175	Yes	11/13/2018 10:46 AM
176	N/A	11/13/2018 10:33 AM
177	No	11/12/2018 7:23 PM
178	yes	11/12/2018 5:19 PM
179	Yes - economics high on the agenda for resilience	11/12/2018 11:40 AM
180	Yes	11/12/2018 10:28 AM
181	Yes, in part. The base load of the building determined the scale of the EGS; in this case a solar rooftop PV system. However, if the payback period could not be achieved, the project would be deferred until it became more cost effective.	11/12/2018 8:15 AM
182	Yes.	11/12/2018 8:14 AM
183	Yes - capital investment in large EGS requires a favourable ROI, and compromises on scale and technology for best efficiency and fastest payback period are common.	11/12/2018 7:54 AM
184	N/A	11/12/2018 7:43 AM
185	yes	11/11/2018 7:38 PM
186	Yes	11/11/2018 9:23 AM
187	No	11/11/2018 7:04 AM
188	No	11/10/2018 8:47 AM
189	Generally no.	11/9/2018 7:54 PM
190	Yes, particular with nuclear.	11/9/2018 6:35 PM
191	No. Scale of plant not changed.	11/9/2018 4:02 PM
192	Yes - it must still be proven to be affordable and economically justifiable.	11/9/2018 3:27 PM
193	yes	11/9/2018 3:16 PM

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194	yes	11/9/2018 2:46 PM
195	Yes	11/9/2018 2:01 PM
196	Yes	11/9/2018 1:57 PM
197	Yes	11/9/2018 1:42 PM
198	The payback period and the capital cost were the two main factors that often resulted in the system not being installed, or the scale being reduced.	11/9/2018 1:36 PM
199	Yes	11/9/2018 1:36 PM
200	Yes	11/9/2018 1:31 PM
201	Yes	11/9/2018 12:28 PM
202	Yes	11/9/2018 12:00 PM
203	Yes, only to the extent it limited the initial installation size.	11/9/2018 11:51 AM
204	no	11/9/2018 11:19 AM
205	no	11/9/2018 11:15 AM
206	no	11/9/2018 11:13 AM
207	yes	11/9/2018 11:03 AM
208	It seems to. Most businesses mainly need electricity during the day and less so at night. The EGS must consider this and hence tends to be smaller than the average used during the daytime.	11/9/2018 10:58 AM
209	no	11/9/2018 10:55 AM
210	yes	11/9/2018 10:55 AM
211	Yes	11/9/2018 10:46 AM
212	Yes.	11/9/2018 10:40 AM
213	Capital Cost is the more relevant factor	11/9/2018 10:35 AM
214	Yes.	11/9/2018 10:31 AM
215	yes	11/9/2018 10:25 AM
216	Yes and no, depends on the size	11/9/2018 10:09 AM
217	Yes	11/9/2018 10:09 AM
218	yes	11/9/2018 10:04 AM
219	yes	11/9/2018 10:04 AM
220	Yes	11/9/2018 9:58 AM
221	NO	11/9/2018 9:52 AM
222	yes	11/9/2018 9:46 AM
223	Yes	11/9/2018 9:40 AM
224	No	11/9/2018 9:34 AM
225	No	11/9/2018 9:32 AM
226	In most cases ROI is the main consideration. Other constrains are prevalent such as capital, space, maintenance.	11/9/2018 9:30 AM
227	Yes	11/9/2018 9:00 AM
228	YES	11/9/2018 8:45 AM
229	Yes.	11/8/2018 7:43 AM
230	yes	11/5/2018 11:30 AM
231	We have not as yet made any significant investment in EGS	11/2/2018 2:06 PM

Q10 From your experience, in which building types is the application of EGS most common? Rank from 1 – 5, with 1 being the most common and 5 being least common (select N/A if you have not experienced the application of EGS in that building type)

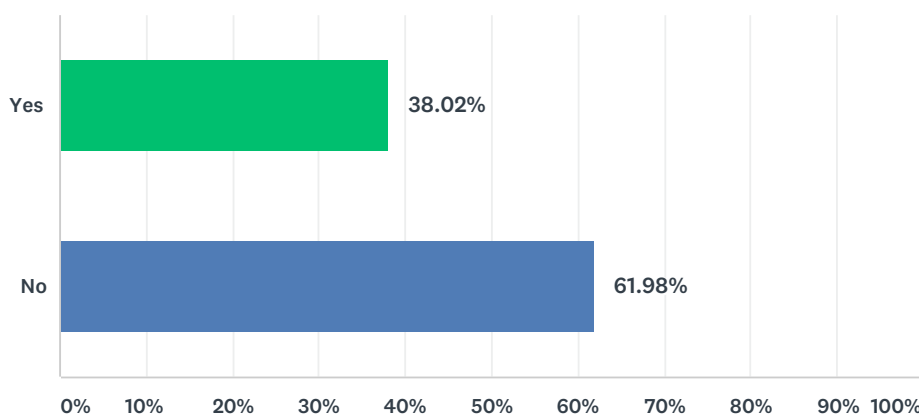
Answered: 263 Skipped: 399



	1	2	3	4	5	N/A	TOTAL	SCORE
Residential	37.40% 92	13.01% 32	11.79% 29	16.67% 41	19.51% 48	1.63% 4	246	3.33
Retail and Leisure (shopping centers, restaurants, cafes etc.)	11.86% 28	17.80% 42	24.58% 58	19.07% 45	15.25% 36	11.44% 27	236	2.91
Offices	23.95% 57	31.09% 74	18.49% 44	11.76% 28	7.14% 17	7.56% 18	238	3.57
Industrial	18.22% 43	13.56% 32	15.68% 37	17.80% 42	23.73% 56	11.02% 26	236	2.83
Institutional (schools, hospitals, police stations, airport, community halls, museums etc)	9.66% 23	20.59% 49	22.69% 54	21.01% 50	15.13% 36	10.92% 26	238	2.87

Q11 In your experience, has there been a change in the order of building types ranked above over the last 10 years?

Answered: 263 Skipped: 399



ANSWER CHOICES	RESPONSES	
Yes	38.02%	100
No	61.98%	163
TOTAL		263

#	IF YES, BRIEFLY DESCRIBE IN WHICH BUILDING TYPES APPLICATIONS OF EGS HAS BECOME MORE OR LESS COMMON AND WHY	DATE
1	water and electricity shortages	12/6/2018 7:11 AM
2	I mainly work on residential so can't compare	11/26/2018 3:19 PM
3	Commercial & retail swap on occasion. The necessity of Institutional delivery following suit is better assimilated.	11/24/2018 11:59 AM
4	In most cases the double story buildings has changed so much.	11/21/2018 10:57 AM
5	Offices seem to be taking the forefront now.	11/20/2018 5:31 PM
6	Residential interest has picked up over the last 5 years or so.	11/20/2018 7:30 AM
7	I feel that residential was the stepping stone, then office spaces started incorporating more sustainable systems. I think owners of residential property do not necessarily care as much as what the impact of office space in an urban environment would mean to a community. Therefore larger projects are more likely to have a sustainability factor to it.	11/19/2018 6:42 PM
8	Industrial, because of the effect that a non reliable energy source has on business.	11/19/2018 3:58 PM
9	Initially residential sector was the most proactive but due to financials they moved down the ladder as other sectors entered the market	11/19/2018 10:47 AM
10	Profit driven developments seem to be pressurized by outsiders to allow costly "green" considerations to lower their profits	11/18/2018 1:29 PM
11	Whilst previously predominantly niche residential and institutions used EGSs, offices and retail are now the primary drivers.	11/17/2018 3:57 PM
12	Commercial properties v state owned	11/16/2018 11:11 AM
13	Much more Retail now	11/15/2018 4:23 PM
14	industry started early; now public sector moves up	11/15/2018 2:51 PM
15	residential	11/15/2018 2:13 PM
16	Yes, almost only residential was considering EGS 10 years ago as vanity projects	11/15/2018 12:43 PM
17	Have not really been following the changes but would like to think it's still as above	11/15/2018 7:52 AM
18	Residential also got on board	11/15/2018 7:30 AM

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19	reliability of power supply has a negative impact on business, retail etc	11/14/2018 11:35 PM
20	offices, institutions,retail - because it makes economic sense and ensures security of energy supply	11/14/2018 8:02 PM
21	Designers are designing more environmentally friendly buildings	11/14/2018 5:39 PM
22	More retail applications	11/14/2018 2:47 PM
23	From residential to commercial.	11/14/2018 2:14 PM
24	EGS has become a compulsory requirement and not luxury commodity.	11/14/2018 1:38 PM
25	Perhaps it was just a bunch of "home engineers" looking for DIW projects, but now it is a necessity	11/14/2018 12:20 PM
26	Residential: In the last 10 years Solar Generation technology has dropped in price making the consumer market more favorable, Due to: 1. abundant availability of the technology, 2. competitive markets, 3. Development of said technology. 4. Efficiency of energy generation	11/14/2018 11:17 AM
27	building regs	11/14/2018 10:07 AM
28	Possibly but highly unlikely, this due to the Impact Scale vs Expenditure within a sector that has the ability to afford this scope of work.	11/14/2018 9:39 AM
29	The notion is the cost that comes along with the use of environmentally sustainable solutions. One fails to realise the implementation of such solutions will benefit the user and the environment in the long run. I see this at present used by those who have the choice and wealth to implement the solutions.	11/14/2018 8:22 AM
30	Residential - a requirement of SANS 10400	11/14/2018 1:48 AM
31	people build in a new way	11/13/2018 8:48 PM
32	Institutional applications have become policy of government and large institutions.	11/13/2018 7:44 PM
33	Medical , because of the critical situation of patients.	11/13/2018 5:52 PM
34	Offices	11/13/2018 5:04 PM
35	Residential has overtaken commercial	11/13/2018 4:32 PM
36	Office complex	11/13/2018 4:25 PM
37	The EGS trend started mostly with residential typologies, but in my opinion there is much more application within the Institutional category today.	11/13/2018 3:34 PM
38	Corporate environment uses this as a means to gain social approval	11/13/2018 3:31 PM
39	Schools and Hospitals are making more and more use of renewable energy.	11/13/2018 3:05 PM
40	Home owners to save on costs	11/13/2018 2:45 PM
41	N/a	11/13/2018 2:35 PM
42	In my view there has been significant growth in office and industrial use of EGS in SA while residential and others have lagged. The reasons are probably access to finance and corporate image	11/13/2018 2:34 PM
43	It is more common to see EGS systems in office buildings recently, as companies have more to save and gain from these systems than individuals. Individuals rarely can afford to implement entire systems.	11/13/2018 1:32 PM
44	Industries have become more environmentally aware and responsible implementing measures to save energy and reduce green house emissions.	11/13/2018 1:27 PM
45	In the recent past there has been a growing consciousness in the provision of civic or institutional building to rural communities in a more economical and sustainable manner. Commercially orientated buildings have not been as responsive.	11/13/2018 1:24 PM
46	More common in Residential buildings	11/13/2018 1:03 PM
47	Offices - to be more eco concious	11/13/2018 12:39 PM
48	Greater impact on the users, during peak hour usage.	11/13/2018 12:32 PM
49	Residential. Daily Energy cost saving.	11/13/2018 12:26 PM
50	Retail has become more common.	11/13/2018 12:16 PM
51	Corporates have become involved	11/13/2018 12:15 PM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

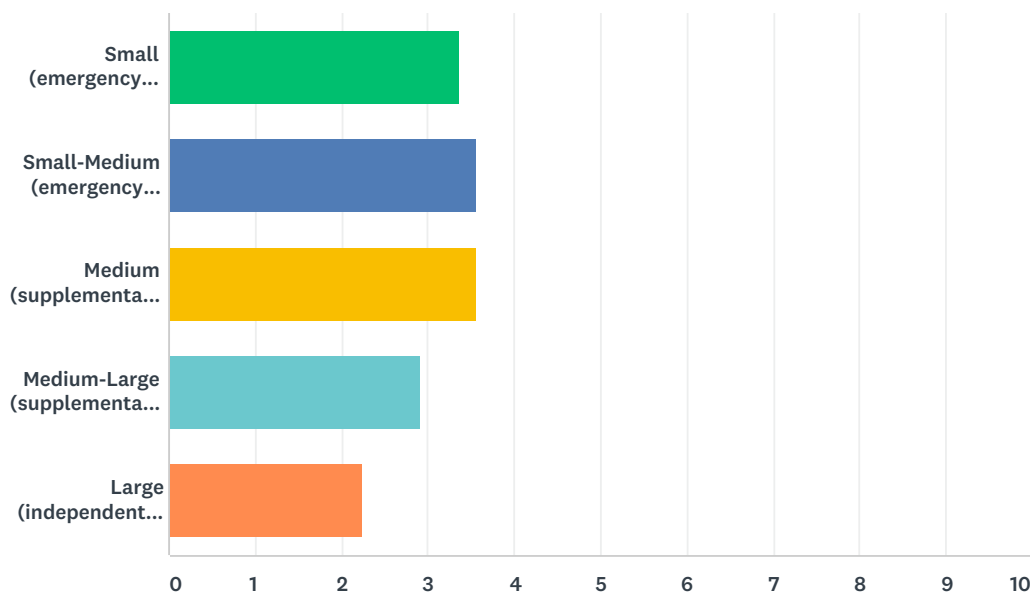
52	Production has become more fast passed and working ours has become a mean of 24/7 therefore people spend more time at work than at home	11/13/2018 12:14 PM
53	EGS was a nice to have in the residential field ten years ago. Now businesses cannot afford to have down time.	11/13/2018 11:57 AM
54	Industry	11/13/2018 11:55 AM
55	Offices have moved ahead of industrial in terms of number, not Rand value	11/13/2018 11:54 AM
56	residential has risen to the top due to the smaller scale and the reducing cost of egs systems as well as new regulations in SANS 10400 such as part xa	11/13/2018 11:54 AM
57	Residential has becaome more crucial to comply	11/13/2018 11:52 AM
58	Residential. Environmental awareness and unstable supply have increased the adoption of EGS in this area most significantly in recent times	11/13/2018 11:47 AM
59	There could be a change made between 'Offices' and 'Residential' due to the increased popularity in the use of energy saving products and services in private dwellings.	11/13/2018 11:46 AM
60	More common in residential as Clients are becoming more aware and involved in EGS	11/13/2018 11:46 AM
61	Water and elec less reliable therefore a more economic decision than environmental	11/13/2018 11:40 AM
62	Residential is less common	11/13/2018 11:38 AM
63	residential is most important because the human race is ever growing and more,houses need to be built each year to accommodate that growth.	11/13/2018 11:35 AM
64	Residential due to unreliable energy supply	11/13/2018 11:34 AM
65	Industry has come to the fore recently	11/13/2018 11:33 AM
66	Previously private owners installed more "off the grid systems". It was also very experimental. Government seems to be driving this more as a sustainability strategy and to comply with the NBR.	11/13/2018 11:30 AM
67	Perhaps the technology was priced out of the means of the private dwelling owner	11/13/2018 11:30 AM
68	Residential, due to EE & Fenestration guidelines and requirements	11/13/2018 11:25 AM
69	retail-long term benefits	11/13/2018 11:23 AM
70	RESIDENTIAL: COST AND RELIABILITY OF SERVICE	11/13/2018 11:07 AM
71	industry has become more common main factor being greener energy and cost saving	11/12/2018 5:21 PM
72	Residential has become more economical viable and has started on the bottom end of the S Curve	11/12/2018 11:42 AM
73	Residential applications has become more.	11/12/2018 10:30 AM
74	Yes, retail and Leisure (shopping malls) investing in solar energy	11/12/2018 8:16 AM
75	Residential EGS used to be more common, where people were wanting solar hot water of small solar systems to mitigate against grid unreliability and expensive utility bills. Increasingly however, large commercial and industrial clients are turning to PV for cost saving and even income generation options (if wheeling solar production through the grid via POWERX or selling on to tenants). NERSA allowing sites up to 1MW without a generators license, the decrease in cost of generation equipment and the increase in Eskom tariffs have all driven this.	11/12/2018 7:58 AM
76	We never even considered EGS until 2008	11/12/2018 7:51 AM
77	Residential is increasing	11/11/2018 7:06 AM
78	Previously Renewable energy systems considered on a large scale for big office parks and malls. Now considered viable on a smaller scale - for example at ATMs in remote areas.	11/9/2018 4:04 PM
79	Increasingly common in premises where peak loads match period of peak output from PV systems. This is typical of Offices and to a lesser extent Retail premises	11/9/2018 1:41 PM
80	Shopping centres more important now than before	11/9/2018 1:33 PM
81	Schools and offices seems more interested	11/9/2018 12:02 PM
82	As before, Eskom supply issues have forced individual home owners to reassess their supply sources.	11/9/2018 11:21 AM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

83	The above ranking applies to RSA. In Germany [or Europe] Residential seems to be the most common since electricity can be fed back into the network and one gets a monetary credit for this, irrespective of time of day. This is however changing with regen tariffs becoming dependant on the time of day [TOU tariffs = time of generation tariffs].	11/9/2018 11:02 AM
84	Residential, as it became more affordable.	11/9/2018 10:42 AM
85	residential first, now commercial	11/9/2018 10:26 AM
86	schools hospitals and other public government buildings The government is spearheading the going green initiative. leading by example .	11/9/2018 10:07 AM
87	In the early days we saw mostly high end residence designs	11/9/2018 9:02 AM
88	Property investors/funds are insisting on EGS interventions as this forms part of their corporate responsibility.	11/8/2018 7:52 AM

Q12 Which description below best describes the most common use of an EGS in a building when determining the scale of the system?(scale does not refer to total generation capacity but rather the scale relative to the building type or function) Rank from 1 – 5, with 1 being the most common and 5 being least common (select N/A if you have not experienced an EGS of that scale)

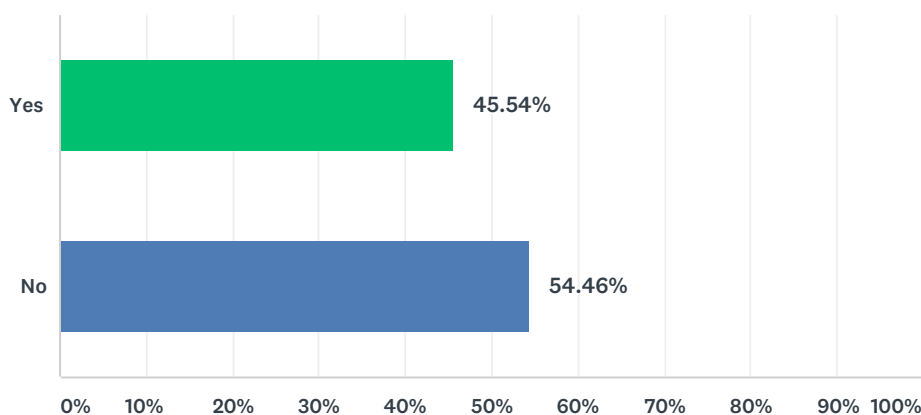
Answered: 226 Skipped: 436



	1	2	3	4	5	N/A	TOTAL	SCORE
Small (emergency back-up power for critical building systems like emergency lighting for up to 4 hours)	33.16% 65	16.84% 33	10.20% 20	11.73% 23	18.88% 37	9.18% 18	196	3.37
Small-Medium (emergency back-up power including limited circuits supplying computers, fridges etc. for up to 4 hours)	15.00% 30	42.50% 85	15.50% 31	16.50% 33	2.50% 5	8.00% 16	200	3.55
Medium (supplemental or independent power supply for day-to-day operation of selected circuits like lighting, computers etc. for up to 8 hours)	24.88% 51	14.63% 30	44.39% 91	6.34% 13	2.93% 6	6.83% 14	205	3.56
Medium-Large (supplemental or independent power supply for day-to-day operation of selected circuits which could include higher load applications like cooking, manufacturing equipment, cold rooms, etc. for up to 8 hours)	12.32% 25	17.24% 35	12.32% 25	41.87% 85	3.94% 8	12.32% 25	203	2.91
Large (independent power supply making the building self-sufficient in terms of power needs or even generating excess power)	14.90% 31	5.77% 12	9.62% 20	8.17% 17	46.63% 97	14.90% 31	208	2.23

Q13 In your experience, has there been a change in the scale of application of EGS over the last 10 years?

Answered: 224 Skipped: 438



ANSWER CHOICES	RESPONSES	
Yes	45.54%	102
No	54.46%	122
TOTAL		224

#	IF YES, BRIEFLY DESCRIBE IN WHICH BUILDING TYPES THE APPLICATION OF AN EGS HAS BECOME MORE OR LESS COMMON AND WHY	DATE
1	In all; movement has been from backup only into operational generation	11/28/2018 4:17 PM
2	Hot water supply by solar panels or/& heat pump is now done in every house. PV panels are more common as they are more affordable. Not many people store the electricity as batteries take space, are expensive and need maintenance. Heating system to warm up pools is more common/cheaper.	11/26/2018 3:24 PM
3	The size of installations has increased as the cost of installation has come down. Also a factor of feed-in tariffs.	11/20/2018 7:33 AM
4	large to feed into the grid was previously considered the bench mark... but now being completely off grid is not really a concern.	11/19/2018 10:40 PM
5	This question is silly and doesn't consider the different technologies...Grid tied supplemented power is number one.	11/19/2018 10:50 AM
6	An awareness of the necessity is coming through the media. I feel Not enough	11/18/2018 1:35 PM
7	Larger scale has grown where before off-grid was the norm	11/18/2018 10:41 AM
8	New residential and Office business premises.	11/18/2018 10:40 AM
9	EGSs were previously battery and/or generator backup systems for critical circuits, which were usually not recharged from renewable sources. More recently grid-tie renewable systems have been added as a supplementary source for all circuits.	11/17/2018 4:04 PM
10	Prestige office buildings and high-end residential multi-storey buildings. That's where the know-how and the money is.	11/17/2018 8:15 AM
11	Failure by Eskom /local authorities to provide reliable service ... greater awareness ... potential 'cash'benefit	11/16/2018 11:13 AM
12	geysers, bore hole pumps, street lighting	11/15/2018 2:17 PM
13	To assist with lowering costs for power consumption during the day in retail applications	11/15/2018 2:09 PM
14	Institutional buildings due to gov policies, rising electrical cost and resilience	11/15/2018 12:46 PM
15	Again, have not been following these trends. Accurate Information re: these trends would be useful	11/15/2018 7:55 AM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

16	Commercial and residential	11/15/2018 7:31 AM
17	reduction in costs, awareness, power supply	11/14/2018 11:36 PM
18	ESKOM blackouts and higher cost of electricity, coupled with lower cost of EGS's has made them more feasible for commercial buildings of all types, and for homeowners who can afford EGS	11/14/2018 8:05 PM
19	Office and retail spaces as well as residential due to enforced requirements by SANS 10400XA.	11/14/2018 6:21 PM
20	technology has improved	11/14/2018 5:40 PM
21	Residential - Impact o services reliability	11/14/2018 3:45 PM
22	Small becoming very affordable	11/14/2018 2:48 PM
23	Parking lots at shopping centres.	11/14/2018 2:16 PM
24	Slowly and steadily improved every since new 'going green' was introduced into SA.	11/14/2018 1:40 PM
25	1. More buildings today are being encouraged to be more sustainable - energy efficient, this is partly through legislaton, building plans today have to undergo an energy efficiency analysis for approval to ensure that each building has been designed to maximize its energy efficiency and usage. 2. Using a EGS Technology in a massive development is in the best interests for the developer when the outlined benefits are substantial great.	11/14/2018 11:28 AM
26	residential - due to necessity	11/14/2018 11:18 AM
27	More office building are now being fitted out with PV due to a better understanding of the duration of use of these buildings and more houses, farms and small industry are using PV Less buildings are fitted out with Diesel or petrol generation unless it is clients requirement, directly linked to production processes or a public safety consideration. There is also more landlord / tenant policies around how buildings will be used in the event of a complete power failure, to avoid massive costs due to fossil fuel driven installations	11/14/2018 9:58 AM
28	Due to the upfront vs overall costs, the execution of these parameters generally remain the same. Sustainability = Revenue return, Returns = Expansion, Expansion = sustainability.	11/14/2018 9:44 AM
29	residential - eskom to unreliable	11/14/2018 8:57 AM
30	Yes it has been enforced as per latest building regulations amendment	11/14/2018 8:36 AM
31	Residential - SANS 10400	11/14/2018 1:49 AM
32	this is used most in away that people see its working	11/13/2018 8:53 PM
33	I think since load shedding become a reality, the scale shifted to larger, more critical industries that need backup power for day to day basis. As opposed to just having back up renewable power on a small scale just to supplement energy usage.	11/13/2018 8:13 PM
34	Technology maturity and support.	11/13/2018 7:46 PM
35	In SA load shedding was experienced during 2015 which prompted many small to medium scale EGS installations. Not so common anymore.	11/13/2018 6:11 PM
36	Residential has implemented more than small retail buildings.	11/13/2018 5:54 PM
37	Many installations include sufficient battery storage for all circuits except resistance devices, eg stove, etc	11/13/2018 5:36 PM
38	All the usual reasons as listed in the previous points - sustainability, operational cost, resilience, cachet.	11/13/2018 4:35 PM
39	It has got bigger	11/13/2018 4:33 PM
40	Industrial	11/13/2018 4:27 PM
41	Its becoming a necessity not a luxury	11/13/2018 3:49 PM
42	Much more common now in Institutional buildings than it was before.	11/13/2018 3:36 PM
43	With the power shedding you must invest in generators, specially where there are food that can rot	11/13/2018 3:19 PM
44	We have designed an office for the Ministry of Mines and Energy in Namibia at the coast which can produce excess energy and collects moisture from dew and fog. The water tanks are full and supply the toilets and garden with water.	11/13/2018 3:11 PM
45	Gone much bigger	11/13/2018 2:42 PM
46	More awareness...	11/13/2018 2:36 PM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

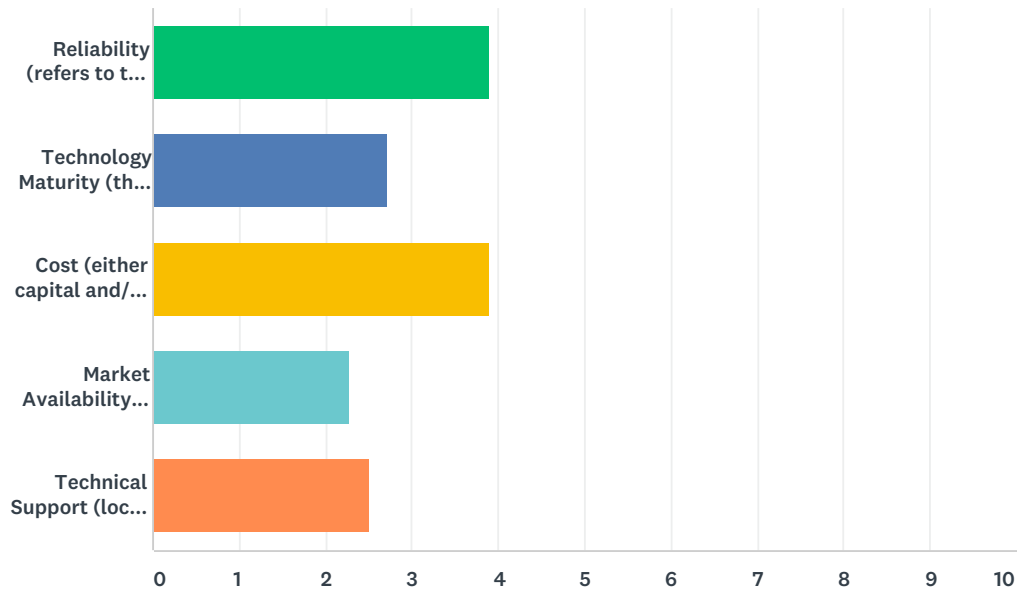
47	The cost of EGS is coming down	11/13/2018 2:26 PM
48	More industries are opting to have back-up power in recent years, as a result of a more conscientious approach to investments and returns in economic terms.	11/13/2018 1:30 PM
49	In office and retail developments	11/13/2018 1:29 PM
50	solar wind	11/13/2018 1:26 PM
51	A move toward independence rather than critical supplementation - i.e. more medium than small	11/13/2018 1:12 PM
52	Recent nation wide power shortages has forced people to be prepared for the future	11/13/2018 1:04 PM
53	Cost implication of the systems has made the list wobbly. Depending on the need and the cost, instead of going for small people tend to go for medium-large or even large. Specially in the farming community. In Cities and towns people are less willing due to the payment of availability of power to municipalities.	11/13/2018 1:00 PM
54	EGS has become much more common in new residential builds	11/13/2018 12:59 PM
55	System seem to one more viable and reliable	11/13/2018 12:56 PM
56	Clients feel the would want to be less reliant on energy suppliers	11/13/2018 12:42 PM
57	Domestic dwellings. Investment offset the growing cost tariffs	11/13/2018 12:37 PM
58	Most building types. This is probably due to dwindling power generation options, reducing the cost of power supply and a much higher awareness of sustainable living	11/13/2018 12:28 PM
59	Commercial / Retail , requirements to services customer ever more important	11/13/2018 12:13 PM
60	Efficiency increased for PV allowing it to be deployed at scale and cost effectively.	11/13/2018 12:09 PM
61	its become more feasible and relevant with unsure energy supply	11/13/2018 12:07 PM
62	The scale of implementation in industrial and retail applications have increased significantly. more and more residential clients are also moving in the direction of self sufficiency.	11/13/2018 12:00 PM
63	Offices - more common - economy Dwelling units - more common - autonomy	11/13/2018 12:00 PM
64	More common with residential property's	11/13/2018 11:54 AM
65	In residential the Client has generally wanted to increase power backup from 4 to 8 hours due to increased Eskom power cuts	11/13/2018 11:49 AM
66	Offices	11/13/2018 11:48 AM
67	With a rise in popularity both in the private, retail and public sectors there has been a notable increase in the application of EGS.	11/13/2018 11:48 AM
68	office buildings	11/13/2018 11:36 AM
69	Mostly in larger institutional projects.	11/13/2018 11:31 AM
70	Residential Medium to Large Structures due to the quicker ROI on EE investment	11/13/2018 11:27 AM
71	More interst	11/13/2018 11:23 AM
72	Small: reliability of service provider	11/13/2018 11:10 AM
73	In the past storage was a more prominent part in comparison with today	11/12/2018 8:41 PM
74	trend to larger, because lower capital costs, and legal allowances	11/12/2018 10:06 AM
75	Large commercial buildings have seen a good uptake of EGS systems.	11/12/2018 8:18 AM
76	EGS systems became more prevalent during the load-shedding era to mitigate against downtime due to unavailability of electricity. Generators and small solar systems became common place to provide emergency backup during blackouts. Now medium-large scale installations are more common, due to the attractiveness of the cost-benefit payoff, and corporate responsibility to increase sustainability.	11/12/2018 8:06 AM
77	Cape Town - water - driven by legal framework	11/12/2018 7:52 AM
78	Shops, Hospitals, Workshops to keep the function going.	11/9/2018 6:43 PM
79	This question was marked N/A - not understood what is asked.	11/9/2018 3:30 PM
80	None of the above work without storage . The availability of cost effective storage systems has improved considerably .	11/9/2018 2:05 PM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

81	Commercial buildings with large daytime loads where reduction of peak grid loading and significant energy savings can be achieved leading to short cost recovery periods. Good economic outcome.	11/9/2018 1:47 PM
82	EGS has become more common in commercial and industrial buildings. Residential uptake has also increased slightly.	11/9/2018 1:39 PM
83	Solar and wind has become cheap and competitive	11/9/2018 1:36 PM
84	Larger companies were slow to adopt because of perceived risk. As residential installations have grown, more larger customers who at first would not be interested in even small solution for backup, start to outnumber the slow adopting residential sector and I have seen this because after a residential installation multiple corporates then asked for a larger solution relative to their size as they believe the perceived risk has reduced so they will go in for a larger bet.	11/9/2018 12:04 PM
85	The big problem in RSA is the restrictions and licencing imposed by DOE / Nersa / Eskom / Munics in terms of regeneration back into the network and the tariffs users [generators] [customers] receive for it.	11/9/2018 11:08 AM
86	regulatory hurdle now at 1MW	11/9/2018 10:57 AM
87	Large % are now more achievable (cost effective).	11/9/2018 10:45 AM
88	Medium to large, but also residential	11/9/2018 10:11 AM
89	more common large scale supplying for total self sufficient the supply authority giving credit to those who feed back their own green generated power to the system	11/9/2018 10:09 AM
90	Mall & convenient store using more RE .	11/9/2018 9:36 AM
91	Commercial properties - time is money. If the staff members cant perform their duties the companies are losing out.	11/8/2018 7:55 AM

Q14 In your experience, which factors are the most important considerations when choosing an EGS technology? Rank from 1 – 5, with 1 being the most important and 5 being least important consideration (select N/A if it was not a consideration)

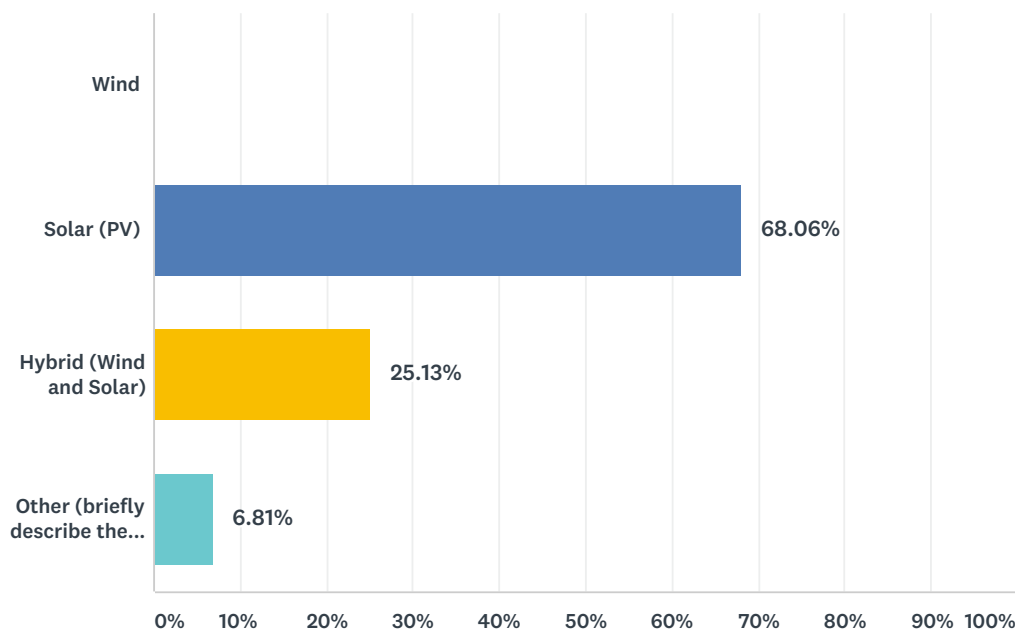
Answered: 189 Skipped: 473



	1	2	3	4	5	N/A	TOTAL	SCORE
Reliability (refers to the reliability or capacity of energy supply generated for the intended purpose)	39.16% 65	30.72% 51	15.66% 26	7.83% 13	6.02% 10	0.60% 1	166	3.90
Technology Maturity (the technology is reliable and proven)	8.28% 14	21.89% 37	24.85% 42	23.67% 40	20.71% 35	0.59% 1	169	2.73
Cost (either capital and/or operating costs)	43.43% 76	24.00% 42	16.57% 29	11.43% 20	4.57% 8	0.00% 0	175	3.90
Market Availability (easily available in your local market)	5.26% 9	12.28% 21	21.05% 36	26.90% 46	33.33% 57	1.17% 2	171	2.28
Technical Support (local technical competency to service, maintain and upgrade systems)	9.44% 17	13.89% 25	21.11% 38	27.22% 49	27.22% 49	1.11% 2	180	2.51

Q15 In your experience, which EGS technology best addresses the needs identified above?

Answered: 191 Skipped: 471



ANSWER CHOICES	RESPONSES	
Wind	0.00%	0
Solar (PV)	68.06%	130
Hybrid (Wind and Solar)	25.13%	48
Other (briefly describe the ESG system considered or implemented)	6.81%	13
TOTAL		191

#	OTHER (BRIEFLY DESCRIBE THE ESG SYSTEM CONSIDERED OR IMPLEMENTED)	DATE
1	solar for hot water supplied, heat pump for warming pool, PV for electricity	11/26/2018 3:32 PM
2	Understanding of climate, orientation, use of suitable materials and systems, how people actually use the buildings, etc.	11/17/2018 8:38 AM
3	Not only energy production but also energy efficiency in building (HVAC and building envelop)	11/14/2018 2:12 PM
4	gas ?	11/14/2018 11:20 AM
5	Have no more time for this questionnaire, much like the "Payback Period". Who in his right mind wants to keep investing in questions whilst seemingly being locked in with "No end in sight" yet the proposition of success is based on the scale of investment. This is the perfect example of contradiction as to why the system keeps failing.	11/14/2018 9:53 AM
6	Dependent on context rather than the above. Mix of energy seems best.	11/13/2018 10:40 PM
7	water energy for coastal applications is hardly recognised. I have used it to power lifts.	11/13/2018 3:33 PM
8	Depending on where you are. A combination best addresses the need. Hybrid and gas with a alternative back-up, eg generator.	11/13/2018 1:15 PM
9	Backup generators	11/12/2018 12:12 PM
10	Yes Solar PV (and Hot Water Generation) but VIP is the use of secondary water systems	11/12/2018 7:55 AM
11	Scale of installation is very flexible, enabling easily increasing size	11/9/2018 6:50 PM
12	All the above are intermittent and without a battery storage system can only supply power when the wind blows or the sun shines .	11/9/2018 2:13 PM

Q16 Are there any challenges or restrictions that make one technology more suitable than the others in an urban setting?

Answered: 160 Skipped: 502

#	RESPONSES	DATE
1	Solar, just due to our climate	12/7/2018 9:30 AM
2	Legacy buildings not easily able to cater for certain types of EGS, tall office buildings, buildings in shadow or where wind flow is blocked in some way, space constraints, many rented buildings where the owner is not willing to invest and the tenants have little incentive or are on a shorter lease (a lot more movement these days).	11/30/2018 6:45 PM
3	location	11/29/2018 11:55 AM
4	Wind or the lack thereof as well as space	11/28/2018 7:47 AM
5	PV can't hardly supply the electricity for the whole household unless the roof area is huge. Also a problem to store the energy in batteries. It will help people to invest more if you could feed back into the net. Wind is not common in residential	11/26/2018 3:32 PM
6	Wind is problematic due to size of equipment	11/20/2018 5:43 PM
7	Solar PV is the least intrusive in a non-rural setting. Approval from local government and acceptance by neighbours become a challenge in an urban environment.	11/20/2018 7:55 AM
8	of course. Climate, availability, space and service of end product as well as education.	11/19/2018 10:41 PM
9	Well, yes. In dense urban spaces, solar energy might not be utilised as efficiently as wind energy. Taller buildings overshadowing smaller ones, does not allow for sunlight to effectively be used on lower floor level. However, wind energy could be harnessed if proper studies are being done wind tunnel effects of prevalent winds in urban settings. Each approach is very site specific, and that's where modern day tech can come into play and calculate the best way to construct sustainably.	11/19/2018 6:49 PM
10	Shading, thin film over traditional crystalline	11/19/2018 10:52 AM
11	Municipal approvals.	11/19/2018 6:26 AM
12	Availability. The sun is always there	11/18/2018 1:57 PM
13	Size and noise of a wind turbine is a challenge.	11/18/2018 10:52 AM
14	Solar PV is quiet and aesthetically less intrusive than wind on smaller scale.	11/18/2018 10:46 AM
15	Visual integration and compatibility	11/18/2018 10:33 AM
16	climate	11/18/2018 10:24 AM
17	Buildings often have height constraints, so structures significantly above roof height require separate municipal approvals. Roof structure, size, orientation and shadowing from adjacent structures can influence the viability of PV.	11/17/2018 4:23 PM
18	Stupid question because too general. In arid areas water harvesting and control may be the main consideration but in others, it could be economic sustainability of the economy.	11/17/2018 8:38 AM
19	Reliability of wind power affected by high surrounding buildings.	11/16/2018 12:11 PM
20	retrofitting - access to suitable 'space' / regular cleaning of PV panels (weight of installations)	11/16/2018 11:15 AM
21	Turbines are difficult to maintain and need a high level of expertise. Solar panels, while sensitive are easier to maintain and service.	11/16/2018 10:15 AM
22	building density	11/16/2018 9:45 AM
23	Estate guidelines, orientation	11/15/2018 4:25 PM
24	densification of built environment supports combined, less stand-alone responses. scale of generation is affected.	11/15/2018 3:16 PM
25	Expense of power storage and Eskoms monopolistic refusal to allow power to be sold back into the grid.	11/15/2018 2:13 PM
26	Cost, aesthetics, support and availability.	11/15/2018 12:53 PM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

27	Depending on the site specifics	11/15/2018 11:24 AM
28	No, not really.	11/15/2018 8:09 AM
29	Height zones and council resolutions on approval of the systems	11/15/2018 7:33 AM
30	wind not suitable in many urban setting in JHB	11/14/2018 11:37 PM
31	aesthetics, impact on neighbours	11/14/2018 8:14 PM
32	Wind generation could be a problem in an urban setting due to space constraints for turbines.	11/14/2018 6:23 PM
33	product support	11/14/2018 5:44 PM
34	Solar exposure	11/14/2018 3:47 PM
35	Depends more on specific climate of city (eg Pretoria has less wind than Cape Town)	11/14/2018 2:52 PM
36	Yes, location of buildings. Roof support, Inclination of structures, etc.	11/14/2018 2:26 PM
37	Architects and engineers technical skills and creativity	11/14/2018 2:12 PM
38	Availability of sun Irradiation Availability of wind	11/14/2018 1:52 PM
39	Availability and ready use.	11/14/2018 1:47 PM
40	Cost Cost Cost industry need more power more reliable, where a cold shower at home every now and again is not the end of the world	11/14/2018 12:23 PM
41	In a South African context, Solar is a more viable EGS technology based upon it climatic conditions annually favor the generation through Solar.	11/14/2018 12:03 PM
42	Space requirements for wind technology	11/14/2018 11:46 AM
43	cost in 3rd world economy	11/14/2018 11:20 AM
44	wind	11/14/2018 10:36 AM
45	For PV it is finding sufficient accessible correctly orientated roof space. The reflection from the panels can be a nuisance in certain circumstances For diesel generators it is the noise pollution and ongoing servicing that is a problem	11/14/2018 10:21 AM
46	Have no more time for this questionnaire, much like the "Payback Period". Who in his right mind wants to keep investing in questions whilst seemingly being locked in with "No end in sight" yet the proposition of success is based on the scale of investment. This is the perfect example of contradiction as to why the system keeps failing.	11/14/2018 9:53 AM
47	LAW, NOISE, ORIENTATION	11/14/2018 8:52 AM
48	cost of wind turbine more than solar pv	11/14/2018 8:50 AM
49	Yes since incase of solar the challenge is mostly in winter where the sun is minimal	11/14/2018 8:42 AM
50	one has to always consider the context in which the technology is implemented and the functionality of the building. Whilst most buildings will benefit from the technology, the area in which the technology is introduced has to work hand in hand with the type solution used.	11/14/2018 8:29 AM
51	Yes, the application of the various "green" systems and the programming thereof - many systems are still very unreliable....	11/14/2018 1:52 AM
52	Key challenge is failure to recognise independent power suppliers, including individual households. And, city dependency on income from non- renewable energy sources.	11/13/2018 10:40 PM
53	cost of the equipment	11/13/2018 8:56 PM
54	The space needed to implement certain technologies	11/13/2018 7:43 PM
55	Solar is more suitable, because of lack of wind, availability of sun, and how these panels can be used as roofs and windows.	11/13/2018 5:58 PM
56	Building regulations	11/13/2018 5:42 PM
57	positioning of equipment. cost of ESG	11/13/2018 5:18 PM
58	Designing the placing and size(s) of wind turbines in a residential setting is very challenging	11/13/2018 4:54 PM
59	Environmental factors, shading, orientation, building morphology, building usage, location etc. etc.	11/13/2018 4:38 PM
60	Lack of honesty	11/13/2018 4:34 PM
61	Solar is easily accessible as apposed to wind. Wind turbines and infrastructure take up too much real-estate	11/13/2018 4:33 PM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

62	aesthetics	11/13/2018 3:56 PM
63	Closeness of buildings restricting air movements and casting shadows for longer hours than sunshine	11/13/2018 3:44 PM
64	Yes, spatial restrictions. (ie not enough space to roll out ECG technology for the intended catchment population)	11/13/2018 3:40 PM
65	Can rely more on sunny days than windy days in areas away from the coast	11/13/2018 3:39 PM
66	I would like to see individual systems per household so that no grid exists. that way you are not dependant on ulilities like power , water or sewerage. In this way urban development would not be dependant on infrastructure at all. This would free up urban development enormously.	11/13/2018 3:33 PM
67	The wind are not feasible in some places	11/13/2018 3:24 PM
68	Availability	11/13/2018 3:19 PM
69	yes, financial	11/13/2018 3:01 PM
70	Yes	11/13/2018 2:54 PM
71	Size, aesthetics	11/13/2018 2:51 PM
72	Visibility of EGS on buildings	11/13/2018 2:49 PM
73	Area of space needed for a system to be efficient. Installation cost separated from capital cost.	11/13/2018 2:38 PM
74	The lack of wind. The size of wind turbines. The perceived unsightliness of wind turbines.	11/13/2018 2:18 PM
75	The looks and cost of the equipment	11/13/2018 1:43 PM
76	Not necessarily.	11/13/2018 1:41 PM
77	Wind power may not be suitable for residential implementation.	11/13/2018 1:40 PM
78	Height restrictions ... wind	11/13/2018 1:32 PM
79	Cost challenges are number one	11/13/2018 1:16 PM
80	Wind creates noise which some people find offending. Solar has become the target of robbers but still more liked by the general public.	11/13/2018 1:15 PM
81	Solar is tried and tested. Wind power is as developed or readily available.	11/13/2018 1:04 PM
82	Cost and Availability	11/13/2018 1:04 PM
83	Only the obvious	11/13/2018 1:03 PM
84	No	11/13/2018 1:02 PM
85	local availability.	11/13/2018 1:00 PM
86	Wind can be noisy, so choose carefully!	11/13/2018 12:52 PM
87	space, orientation & application	11/13/2018 12:47 PM
88	Regulating the installation cost to the consumer	11/13/2018 12:46 PM
89	Yes.	11/13/2018 12:40 PM
90	yes. overshadowing of pv panels is a consideration, as well as geo-location of the city.	11/13/2018 12:40 PM
91	Wind - too noisy for urban areas	11/13/2018 12:35 PM
92	Current polution levels, wind turbines generally not suitable for urban power generation	11/13/2018 12:31 PM
93	solar is the most common and explored option and the easiest obtainable. it is according to me not the most sustainable but accessible due to easy maintenance and availability of installers and components.	11/13/2018 12:23 PM
94	Climate of the site, resources in the region (e.g. lots of sun and no wind)	11/13/2018 12:23 PM
95	COST AND EASE OF INSTALLATION	11/13/2018 12:21 PM
96	Aesthetics - and area available for installation equipment	11/13/2018 12:20 PM
97	Wind - noise and space	11/13/2018 12:18 PM
98	Wind power generation not feasible at building scale. PV less obtrusive.	11/13/2018 12:11 PM
99	Solar can be easily integrated into a building structure. Wind EGS is more space consuming.	11/13/2018 12:09 PM
100	There is more sun than wind in Johannesburg.	11/13/2018 12:05 PM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

101	there are many examples, estate guidelines for an example often don't make provision for the aesthetics of pv panels and wind turbines, orientation of buildings can also impact the efficiency of pv panels etc.	11/13/2018 12:04 PM
102	The availability of a natural/sustainable resource, eg. some areas have too little wind to justify the use of a wind turbine. Space could be a factor as often the EGS systems require space for technical machinery and/or clearance room for health and safety.	11/13/2018 12:02 PM
103	no	11/13/2018 11:58 AM
104	Storage of energy is an challenge (solar)	11/13/2018 11:57 AM
105	Solar is available, easy to install and does not create a perceived eyesore or noise problem	11/13/2018 11:56 AM
106	Overshadowing Lack of sufficient wind	11/13/2018 11:54 AM
107	Contractors willing to implement	11/13/2018 11:51 AM
108	Visual impact in guideline controlled estates	11/13/2018 11:49 AM
109	Wind turbines might not be suitable for a high density urban environment	11/13/2018 11:41 AM
110	PV easiest to fit	11/13/2018 11:40 AM
111	Aesthetics and proximity t others, eg wind makes a noise.	11/13/2018 11:40 AM
112	Municipal participation in rewarding cost savings for example in electricity generation and on-site sewerage treatment.	11/13/2018 11:39 AM
113	Possibly noise factors.	11/13/2018 11:35 AM
114	Solar in residential areas is more acceptable and of less visual impact than wind power	11/13/2018 11:31 AM
115	yes	11/13/2018 11:26 AM
116	Yes , wind for coast lines , solar for inland settings.	11/13/2018 11:23 AM
117	wind technology in the urban home is difficult and costly to install	11/13/2018 11:13 AM
118	Zoning and Controlling authority understanding of the problem	11/13/2018 11:06 AM
119	Concentration of the resource	11/13/2018 10:55 AM
120	Size of the storage systems	11/13/2018 10:37 AM
121	Aesthetic considerations	11/12/2018 8:47 PM
122	PV is more economical than wind and is the least impact on the enviroment	11/12/2018 12:12 PM
123	space available; obstruction to adjacent buildings; aesthetics	11/12/2018 10:10 AM
124	Solar PV appears to be most suited to the South African application. Wind is too unpredictable; exception being in the eastern Cape Corridor. Conduit hydro is starting to penetrate the market recently.	11/12/2018 8:22 AM
125	PV is well suited to urban settings, as it requires only unshaded and stable roof space, and can usually be connected to existing infrastructure. Wind generation is difficult to scale in an urban setting. PV also has a more or less predictable generation curve whereas wind can be slightly less predictable.	11/12/2018 8:16 AM
126	Roof space (W/SQM)	11/12/2018 7:55 AM
127	Yes. The availability of the natural sources i.e, wind and or sunlight	11/11/2018 9:27 AM
128	Physical size	11/10/2018 10:59 AM
129	Aesthetics	11/9/2018 8:03 PM
130	Solar panels are more suitable	11/9/2018 6:50 PM
131	Wind is not suited to an urban setting. Solar is more discreet and scalable (ie the client can start small and grow)	11/9/2018 4:08 PM
132	Enough roof space for PC, thus not great visual impact in urban area. Wind turbines would be less viable as it is much more visible in urban setting.	11/9/2018 3:34 PM
133	Yes , it's the geographical area and the socio economy of the place concerned	11/9/2018 3:18 PM
134	Yes the natural resource occurrence, i.e. wind availability and effectiveness.	11/9/2018 2:43 PM
135	Solar PV has the least restrictions in terms of public safety	11/9/2018 2:23 PM
136	In this country sun power is generally more available and predictable than wind .	11/9/2018 2:13 PM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

137	Space and noise	11/9/2018 2:07 PM
138	Noise, height restrictions, aesthetics, ease of installation without major structural issues.	11/9/2018 1:52 PM
139	Wind is too expensive and no suitable sites near the typical buildings. Wind is for larger scale coupled to a transmission system.	11/9/2018 1:41 PM
140	Weather	11/9/2018 12:32 PM
141	Property related restrictions from landowners, not from governmental red tape.	11/9/2018 12:08 PM
142	Municipal by law need to change	11/9/2018 12:07 PM
143	visual pollution and birds if wind chosen	11/9/2018 11:23 AM
144	Solar PV is the most common [or only technology] since it is available in a wide range of powers for various users. Wind is not common in RSA for these small installations. Wind in say 1000kW will be more unsightly in urban environments.	11/9/2018 11:21 AM
145	NOice pollution of wind generation makes it un-implementable in domestic environments	11/9/2018 11:20 AM
146	I worked mostly in an urban environment thus due to space constraints PV is the preferred option.	11/9/2018 11:12 AM
147	Wind is less useful in urban setting, micro climate and wind barriers in cities not adequately identified. Data not available, noise, turbulence due to buildings etc. Height restrictions on buildings. And lastly maintenance requirements	11/9/2018 11:02 AM
148	The noise that wind turbines make is an issue in an urban environment. Solar is therefore more "acceptable" (and cheaper).	11/9/2018 10:39 AM
149	Available space	11/9/2018 10:37 AM
150	location ie buildings in the area solar is preferred to wind. which is mostly chosen for outbacks like farms	11/9/2018 10:20 AM
151	Solar PV fr applicationsd that use electricity in the day (commercial, buildings, factory, warehouse, campus)	11/9/2018 10:14 AM
152	The physical configuration (size, erection complexity) of wind generators makes it much more unsuitable than PV.	11/9/2018 10:11 AM
153	No	11/9/2018 9:50 AM
154	More benefit and buy back power from small user will impact RE	11/9/2018 9:39 AM
155	Wind technology has limitations of wind blowing particularly inland. Solar coupled with battery is more suitable, however, the cost and size of battery might be a challenge.	11/9/2018 9:12 AM
156	Space	11/9/2018 9:07 AM
157	Location	11/9/2018 8:50 AM
158	Municipal Bylaws.	11/8/2018 7:56 AM
159	Practicality of installation	11/5/2018 11:39 AM
160	How built up the area is as surrounding buildings can hamper both wind and sun	11/2/2018 2:11 PM

Q17 Briefly describe the most common size of EGS you have experience with in the built environment. Where possible, specify the EGS technology, generation capacity and battery storage system in kWh where applicable.

Answered: 140 Skipped: 522

#	RESPONSES	DATE
1	3KW Inverters Stand alone or Hybrid	12/7/2018 9:30 AM
2	Rooftop PV	11/30/2018 6:45 PM
3	solar	11/29/2018 11:55 AM
4	Not enough experience to be able to comment. Been on pension for past 3 years	11/28/2018 7:47 AM
5	panel for 250l geyser	11/26/2018 3:32 PM
6	PV Panels	11/20/2018 5:43 PM
7	Residential, 3 kVA solar PV, no storage.	11/20/2018 7:55 AM
8	N/A	11/19/2018 6:49 PM
9	No such thing. Each application will determine the size.	11/19/2018 10:52 AM
10	Solar PV, from 30kWp up to 1MW	11/19/2018 6:26 AM
11	Trying to impose environmental driven up-front costs in low-cost housing proposals. It gets kicked out as soon as financiers become involved	11/18/2018 1:57 PM
12	Grid Tied Solar, 20kW, no batteries.	11/18/2018 10:52 AM
13	Solar PV - 500kWp-1MWp. Batteries ranging from 10kWh to 200kWh.	11/18/2018 10:46 AM
14	6-10kVA PV with inverters and battery bank, gel type, deep cycle.	11/18/2018 10:33 AM
15	1.5kwh	11/18/2018 10:24 AM
16	15kWp. PV. Grid-tied. No batteries. Tenant UPSs for IT infrastructure and tenant-based generators if required by their particular businesses.	11/17/2018 4:23 PM
17	Frankly, I am not impressed with some of Johannesburg's recent "green buildings" because they ignore fundamental issues of orientation, use of materials, climate controls, etc. The systems are unnecessarily expensive in our temperate climate just to follow fashionable trends like glass curtain walling.	11/17/2018 8:38 AM
18	Wind power by means of a vertical axis wind turbine generation 5000kWh per annum.	11/16/2018 12:11 PM
19	varies	11/16/2018 11:15 AM
20	In households these range typically between 5kW and 10kW solar systems. House Marais – 6Kw grid tied solar system without battery back-up House Viljoen – 5.3Kw grid tied solar system without battery back-up House Delius - 4Kw grid tied solar system with 720Ah battery back-up	11/16/2018 10:15 AM
21	160 kva	11/16/2018 9:45 AM
22	2 to 3 kWh for cost limits, short term back-up . PVs and	11/15/2018 3:16 PM
23	Apologies - Don't have my reports here.	11/15/2018 2:13 PM
24	solar ~ 60 to 3 KW ~ grid tied, no batteries.	11/15/2018 12:53 PM
25	Solar 2-panel solar (4m2 collector area) Battery low peak re-charge demand 20kWh	11/15/2018 8:09 AM
26	Medium - 6 panel slar	11/15/2018 7:33 AM
27	solar power back up for residential	11/14/2018 11:37 PM
28	only one - on a block of flats photovoltaic panels without battery storage 60 x 265W panels	11/14/2018 8:14 PM
29	Not Sure.	11/14/2018 6:23 PM
30	PV Panels - Lead Battery panels	11/14/2018 3:47 PM

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31	PV panels for residential application, 2kW, limited battery storage	11/14/2018 2:52 PM
32	10kW charging capacity, 102 Ah 24V lead acid batteries. Providing 30kWh per day.	11/14/2018 2:26 PM
33	1,5Mw solar plant	11/14/2018 2:12 PM
34	5 to 10 KW in residential 15 to 85 KW in commecial	11/14/2018 1:52 PM
35	A minimum of 10kWH, and a back-up battery storage to be a minimum of 8hours and a water tank to 5k litre tank for every average-sized home.	11/14/2018 1:47 PM
36	Unavailable	11/14/2018 12:03 PM
37	gas generator - 4- 8kwh	11/14/2018 11:20 AM
38	3-6 kW PV in residential setups. Battery storage is still the weakest link in any PV installation as a result some clients choose to not install batteries and manage their consumption around the PV generation during day time and buying from the grid for night time or having a much smaller battery installation only for night time	11/14/2018 10:21 AM
39	Have no more time for this questionnaire, much like the "Payback Period". Who in his right mind wants to keep investing in questions whilst seemingly being locked in with "No end in sight" yet the proposition of success is based on the scale of investment. This is the perfect example of contradiction as to why the system keeps failing.	11/14/2018 9:53 AM
40	GEASERS	11/14/2018 8:52 AM
41	2 - 4 kWh for average house	11/14/2018 8:50 AM
42	60kWh	11/14/2018 8:42 AM
43	the most common would be solar panels for medium sized buildings such as schools or residential homes.	11/14/2018 8:29 AM
44	Whole off grid solar and battery backup systems - residential application only	11/14/2018 1:52 AM
45	N/A	11/13/2018 10:40 PM
46	the were out of product	11/13/2018 8:56 PM
47	-	11/13/2018 7:43 PM
48	Solar - electricity and to hotwater	11/13/2018 7:11 PM
49	Solar [pv] 24kwh capacity and storage	11/13/2018 5:42 PM
50	roof solar panels heat pumps 4,5 to 5,5 kWh	11/13/2018 5:18 PM
51	Small, on houses. A Mechanical Engineer can best answer this item more fully	11/13/2018 4:54 PM
52	Sorry	11/13/2018 4:38 PM
53	15	11/13/2018 4:34 PM
54	Standard 65kwh. 4 to 6 storage capacity of batteries for single household. With 2 to 4 solar panels	11/13/2018 4:33 PM
55	I am currently building a house for myself which has solar power for everything other than large consumers of power eg oven, washing machine, tumble dryer, kettle, hair dryers, etc. I have a gas hob and geyser. Lithium Battery backup is 4.8kwh	11/13/2018 3:56 PM
56	unsure	11/13/2018 3:39 PM
57	I have powered most of a harbour with water and innovation. It reduced the present energy demands to a third of current demand I have powered a house with over a millions rand of gadgetry. One reduced energy demand significantly the other kept energy demand as current but altered the energy source.	11/13/2018 3:33 PM
58	150KWh	11/13/2018 3:24 PM
59	n/a	11/13/2018 3:19 PM
60	Solar Panel residential	11/13/2018 3:01 PM
61	PV panels for Institutional buildings as low demand supply	11/13/2018 2:54 PM
62	Solar heated geysers. Photovoltaic electricity generation on the roofs of houses and shopping centers	11/13/2018 2:18 PM
63	The provision of air-conditioning and solar panels at a small to medium scale.	11/13/2018 1:41 PM
64	3.5 - 4 KW	11/13/2018 1:40 PM

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65	medium sized PV systems in office blocks	11/13/2018 1:37 PM
66	residential solar powered geysers , and generator back up	11/13/2018 1:32 PM
67	Solar water heating for domestic properties required by the building regulations	11/13/2018 1:16 PM
68	4kW	11/13/2018 1:15 PM
69	Medium	11/13/2018 1:04 PM
70	8kVA	11/13/2018 1:04 PM
71	Small	11/13/2018 1:03 PM
72	Unknown	11/13/2018 1:02 PM
73	5kw pv system	11/13/2018 1:00 PM
74	Application dependent.	11/13/2018 12:52 PM
75	Total off-grid power supply to 5 bedroom house	11/13/2018 12:47 PM
76	2 kW	11/13/2018 12:46 PM
77	between 250kw and 1000kw	11/13/2018 12:40 PM
78	High-end homes with limited voltaic capacity	11/13/2018 12:35 PM
79	N/A	11/13/2018 12:31 PM
80	single dwelling /office installations that supply back-up and supplementary power. we have not seen full (of the grid) installations in our environment.	11/13/2018 12:23 PM
81	Small-Medium Solar water heating and back up	11/13/2018 12:23 PM
82	n/a	11/13/2018 12:20 PM
83	PV.	11/13/2018 12:11 PM
84	Solar PV panels on the complete north facing roof slopes.	11/13/2018 12:09 PM
85	--	11/13/2018 12:05 PM
86	"Size" is dependent on the scale of the project, the most common would be efficient water heating solution, then PV panels to supplement consumption during the day.	11/13/2018 12:04 PM
87	The most common types would be that of standard 320W solar panels placed on the roofs of office and residential structures to supplement municipal supplied electricity and assist with night time and emergency lighting systems.	11/13/2018 12:02 PM
88	No experience	11/13/2018 11:58 AM
89	Not much experience	11/13/2018 11:57 AM
90	Small systems, single solar panels to provide light and charging stations. Single dwelling residential application	11/13/2018 11:56 AM
91	Photo voltaic, 5 kW	11/13/2018 11:54 AM
92	n/a	11/13/2018 11:51 AM
93	Unknown	11/13/2018 11:49 AM
94	Solar hot water heating - 1.9kw	11/13/2018 11:41 AM
95	PV panels over 750M2 roof	11/13/2018 11:40 AM
96	small	11/13/2018 11:40 AM
97	Use of solar geysers and heat pumps. Also rainwater harvesting.	11/13/2018 11:39 AM
98	Most common is entry level housing and - minimal battery storage, but solar supports water heating and minimal electricity usage.	11/13/2018 11:35 AM
99	Solar Gain, 5-10kWh systems	11/13/2018 11:31 AM
100	35kWh , for residential use on 3 bedroom housing .	11/13/2018 11:23 AM
101	10-12kVA / 48V hibrid solar systems	11/13/2018 11:15 AM
102	Domestic solar and heat pump specifications	11/13/2018 11:13 AM
103	22Ha solar PV panel for regional generation in King Shaka Peripheral buildings	11/13/2018 11:06 AM
104	Small. Solar panels configured for nominal voltage of 50V with 4 x 170 AH batteries	11/13/2018 10:55 AM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

105	Modules of 30kWp	11/12/2018 8:47 PM
106	Residential is coming of age so 1-5kw and commercial 25 - 150kW	11/12/2018 12:12 PM
107	pv; up to 1mw; mostly no storage as office demand matches solar pv output	11/12/2018 10:10 AM
108	350kWhp Rooftop Solar PV No battery system, as this increases the cost by more than 30%	11/12/2018 8:22 AM
109	Residential use 12-22 kWh per day	11/12/2018 8:19 AM
110	As an employee at a PV EPC, PV is the only technology I have experience with. Most of our systems range between 200kWp and 700kWp, although there are outliers in both directions (we are working on projects up to 1000kWp currently). Very few of our customers currently opt for storage systems as the technology is still expensive, and many of our larger systems wheel via POWERX and thus use PV generation as a revenue stream rather than for self-consumption.	11/12/2018 8:16 AM
111	Solar HW,	11/12/2018 7:55 AM
112	100KVA PV Commercial 5KVA domestic	11/11/2018 7:45 PM
113	Residential restricted	11/10/2018 10:59 AM
114	20 -500kW, generally without storage	11/9/2018 8:03 PM
115	data not available at the moment	11/9/2018 6:50 PM
116	solar 50 kW - 2MW	11/9/2018 4:08 PM
117	No personal experience.	11/9/2018 3:34 PM
118	PV array of 5kW , Inverter 5kVA, battery = 200 A/hour, 600kWh generation per month.	11/9/2018 2:43 PM
119	The system that I was involved in with had a capacity of 1200 kW where the total peak demand was 2300 kW . There was no storage .	11/9/2018 2:13 PM
120	180W on my roof solar, 4AH battery	11/9/2018 2:07 PM
121	Solar, grid coupled, 500kw	11/9/2018 1:41 PM
122	5W-150kW installed size with battery storage. Mostly embedded generation size of 5kW-33kW.	11/9/2018 12:08 PM
123	5KWh	11/9/2018 12:07 PM
124	No direct own experience, other than that used at own office buildings.	11/9/2018 11:21 AM
125	5kW Solar grid-tie	11/9/2018 11:20 AM
126	residential 2 - 5 kW SSEG grid-tied	11/9/2018 11:12 AM
127	PV, 4kW with 4kWh	11/9/2018 11:02 AM
128	4kWp	11/9/2018 10:58 AM
129	5kW grid-tied solar system - no batteries.	11/9/2018 10:39 AM
130	1-3kW, solar PV, no battery storage	11/9/2018 10:37 AM
131	5kVa home systems from EasyPower 2Kw solar panels mono 9.5kwh battery system 5Kva modified sine wave inverter 4800w mppt charger	11/9/2018 10:20 AM
132	50 to 500 kW	11/9/2018 10:14 AM
133	Not enough data	11/9/2018 10:11 AM
134	Solar Geyser 2kW Solar panel - investigated 1500kW	11/9/2018 9:50 AM
135	5KW off grid solar PV system for server room	11/9/2018 9:39 AM
136	NA	11/9/2018 9:12 AM
137	Technology - PV Capacity 50 to 10kW Battery mostly grid tie with very small emergency back up for essentials	11/9/2018 9:07 AM
138	IPP's Solar / wind	11/9/2018 8:50 AM
139	this varies form 100kw to 2mw	11/5/2018 11:39 AM
140	I am not technological enough to answer this.	11/2/2018 2:11 PM

Q18 Briefly describe the largest EGS you have experienced in the built environment. Where possible, specify its application (building type and intended function), the EGS technology used, generation capacity and battery storage system in kWh where applicable.

Answered: 128 Skipped: 534

#	RESPONSES	DATE
1	7Kw Inverter & 4,8Kwh batteries	12/7/2018 9:30 AM
2	Did not get into the specifics as the idea was shelved due to constraints of investment capital.	11/30/2018 6:45 PM
3	police station; prison	11/29/2018 11:55 AM
4	Solar PV in a 480 seater office building. No batteries.	11/28/2018 7:47 AM
5	PV to supply energy to a 1200m2 house with bateries	11/26/2018 3:32 PM
6	105KW PV plant for offices	11/20/2018 5:43 PM
7	~ 1,1 MVA solar PV, office block, no storage.	11/20/2018 7:55 AM
8	N/A	11/19/2018 6:49 PM
9	3 MWp, off set use from council. i.e. Grid Tied	11/19/2018 10:52 AM
10	1MW, solar PV on a warehouse roof.	11/19/2018 6:26 AM
11	Package deal self-build proposals for single houses. Getting individual (not major developers) to invest into environment friendly developments through easily understandable procedures	11/18/2018 1:57 PM
12	Large Storage/Sales Premises with Grid Tied 20kW	11/18/2018 10:52 AM
13	4.755MWp. Solar PV rooftop system.	11/18/2018 10:46 AM
14	As above	11/18/2018 10:33 AM
15	hospital emergency generation and dual use sytems	11/18/2018 10:24 AM
16	Note: Experienced, not experience with. I have observed the design and installation of a 400kWp rooftop PV system. Building type was a multi-storey car park with several storeys of offices. The system was a grid tie system with the purpose of being an investment for the property development company that owned the building.	11/17/2018 4:23 PM
17	The Houghton - 5-star hotel and residential medium rise upper class residential: I have no idea of the capacity of their systems but I did object very strongly to diesel being used for the back-up generators for electricity. (Diesel being delivered in residential areas!!!) I think they eventual used piped gas instead. Grey water serves the golf course, but they built on a wetland, severely compromising properties in the vicinity and down stream.	11/17/2018 8:38 AM
18	See above.	11/16/2018 12:11 PM
19	varies	11/16/2018 11:15 AM
20	The building features a 54.6kW thin film and 6.5kW poly crystalline photovoltaic hybrid solar system in conjunction with a 6.2kW vertical axis wind turbine system. 48V / 720Ah battery bank – lithium ion battery.	11/16/2018 10:15 AM
21	160 kva	11/16/2018 9:45 AM
22	institutional cooling and light industrial power gen. with PV's small scale 3kwh storage	11/15/2018 3:16 PM
23	Apologies again,	11/15/2018 2:13 PM
24	~120 KW, institutional building housing court room facilities.	11/15/2018 12:53 PM
25	Medium - 16 panel solar and small wind turbine	11/15/2018 7:33 AM
26	only one - on a block of flats no battery storage 15,9kWp grid connected	11/14/2018 8:14 PM
27	400Kw for a small shopping centre in cape town.	11/14/2018 6:23 PM
28	In a Hospital	11/14/2018 5:44 PM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

29	Residential, PV Panels, Lead Battery panels	11/14/2018 3:47 PM
30	PV panels for residential application, 2kW, electricity for lights, electronic devices etc2	11/14/2018 2:52 PM
31	10kW charging capacity, 102 Ah 24V lead acid batteries. Providing 30kWh per day.	11/14/2018 2:26 PM
32	XPS production industrial plant	11/14/2018 2:12 PM
33	85 KW	11/14/2018 1:52 PM
34	Use basic ones available, the higher the better as we are unable to solely depending on unreliable of business's source where there is corruption, hike of fee, etc.	11/14/2018 1:47 PM
35	Unavailable	11/14/2018 12:03 PM
36	8kwh	11/14/2018 11:20 AM
37	None directly but I have closely observed the installation of a very big PV setup (possibly the biggest installation for such a building type in SA at that time) Black River Office Park in Cape Town. The landlord aimed to generate 80-90% of the required peak summer energy, no batteries were installed.	11/14/2018 10:21 AM
38	Have no more time for this questionnaire, much like the "Payback Period". Who in his right mind wants to keep investing in questions whilst seemingly being locked in with "No end in sight" yet the proposition of success is based on the scale of investment. This is the perfect example of contradiction as to why the system keeps failing.	11/14/2018 9:53 AM
39	SMALL-MEDIUM	11/14/2018 8:52 AM
40	100kWh / 380 V for heavy current for instance buildings which use a lot of airconditioners	11/14/2018 8:42 AM
41	n/a	11/14/2018 8:29 AM
42	Residential	11/14/2018 1:52 AM
43	N/A	11/13/2018 10:40 PM
44	water recirculation	11/13/2018 8:56 PM
45	-	11/13/2018 7:43 PM
46	Housing (Private)	11/13/2018 7:11 PM
47	Residential 24kwh	11/13/2018 5:42 PM
48	Heat pumps. residential application. 5,5 Kwh	11/13/2018 5:18 PM
49	Small, on houses. A mechanical and/or Electrical Engineer can best answer this item	11/13/2018 4:54 PM
50	ditto	11/13/2018 4:38 PM
51	150	11/13/2018 4:34 PM
52	Same as above	11/13/2018 4:33 PM
53	see above	11/13/2018 3:56 PM
54	Sorry, I'm in retirement and I cannot remember the details.	11/13/2018 3:44 PM
55	unsure	11/13/2018 3:39 PM
56	my proposal for Singapore harbour is only a design proposal. Sadly. It would have been staggeringly large.	11/13/2018 3:33 PM
57	500KWh	11/13/2018 3:24 PM
58	n/a	11/13/2018 3:19 PM
59	Solar panel & heat pump installations in res flats	11/13/2018 3:01 PM
60	N/A	11/13/2018 2:39 PM
61	Photovoltaic electricity generation on the roofs shopping centers. Owner of property leases the roof space to a company installing and maintaining the system and selling it to the tenants at municipal rates.	11/13/2018 2:18 PM
62	1. The provision of solar panels for a township development, off the grid.	11/13/2018 1:41 PM
63	432 KW	11/13/2018 1:40 PM
64	solar fully powered residential , as well as centres like Makro and rand ridge mall now implementing solar power to the building	11/13/2018 1:32 PM
65	Diesel power generator for a large super market. I do not know the size.	11/13/2018 1:16 PM

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66	Factory wanted to install a bio plant to halve their R1.9m a month account. Never realized due to Local Authority issues.	11/13/2018 1:15 PM
67	Capacity not known, but in a domestic home, in an urban area, which is now totally off the grid.	11/13/2018 1:04 PM
68	8kVA - Normal Private Dwelling	11/13/2018 1:04 PM
69	Not much other than solar panels, rainwater collection/harvesting etc	11/13/2018 1:03 PM
70	Unknown	11/13/2018 1:02 PM
71	5kw pv system	11/13/2018 1:00 PM
72	2000kwh battery bank, 5 kw inverter charge controller	11/13/2018 12:52 PM
73	Office block in Astralia - water, waste recycling, power generation & natural ventilation	11/13/2018 12:47 PM
74	Large retailing business. OK Mini Market.Reliant on electricity to maintain their service.	11/13/2018 12:46 PM
75	the largest i've personally seen was in the karoo.	11/13/2018 12:40 PM
76	n/a	11/13/2018 12:35 PM
77	N/A	11/13/2018 12:31 PM
78	as above	11/13/2018 12:23 PM
79	n/a	11/13/2018 12:20 PM
80	Busy designing full scale solar capacity for a client's headquarters. System should be able to make the entire campus self sufficient - details as yet not calculated.	11/13/2018 12:05 PM
81	Same answer as above.	11/13/2018 12:02 PM
82	N/a	11/13/2018 11:58 AM
83	Mixed system in residential development. I was part of the project team but was not involved in final specification of the system. Each unit was equipped with solar panels.	11/13/2018 11:56 AM
84	Photo voltaic, 100kW, Eastern Cape	11/13/2018 11:54 AM
85	n/a	11/13/2018 11:51 AM
86	Unknown	11/13/2018 11:49 AM
87	PV panels for office building with battery storage system - 48 batteries with 3 No. 6kW inverters.	11/13/2018 11:41 AM
88	Factory roof PV panels, power required to run large refrigeration areas. (drive in)	11/13/2018 11:40 AM
89	medium	11/13/2018 11:40 AM
90	PV installation over whole roof large residence to large battery pack storage	11/13/2018 11:39 AM
91	Institutional project - call centre for SAPS.	11/13/2018 11:35 AM
92	Industrial Cold Storage System - 50 kWh	11/13/2018 11:31 AM
93	mall of Africa	11/13/2018 11:26 AM
94	50 kWh	11/13/2018 11:23 AM
95	16kVA / 48V hibrid solar systems	11/13/2018 11:15 AM
96	Domestic home new builds or alterations	11/13/2018 11:13 AM
97	22Ha Solar PV plant, Heat recycling centre, CO2 recapture plant, Natural passive cooling systems	11/13/2018 11:06 AM
98	None	11/13/2018 10:55 AM
99	200kWp Education	11/12/2018 8:47 PM
100	1 MW - PV Old Mutual Park Pinelands	11/12/2018 12:12 PM
101	1mw; big office; pv; no batteries	11/12/2018 10:10 AM
102	2MWhp Corporate Head Office No battery system	11/12/2018 8:22 AM
103	Our largest operational system is around 700kWp, and has no integrated storage as it is a wheeling system.	11/12/2018 8:16 AM
104	NA	11/12/2018 7:55 AM
105	1000KVA sawmill off cuts Tp reduce municipal off take and demand control	11/11/2018 7:45 PM
106	N/A	11/10/2018 10:59 AM

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107	Complete rooftop PV of a large commercial building. 500kW peak and no storage	11/9/2018 8:03 PM
108	unknown at the moment, most installations in the country-side	11/9/2018 6:50 PM
109	No personal experience.	11/9/2018 3:34 PM
110	10 MW Solar Polar , feeding the Eskom grid.	11/9/2018 2:07 PM
111	500kw grid coupled on shopping center roofs for economic reasons. No battery storage	11/9/2018 1:41 PM
112	150kW, Solar PV for an air force base with battery storage and remote monitoring.	11/9/2018 12:08 PM
113	Farm	11/9/2018 12:07 PM
114	nil until battery situation clear	11/9/2018 11:23 AM
115	Our offices have 1000kW with a relatively small battery of some 300kWh to simply bridge variability during the daytime of the Solar PV installation in the car park.	11/9/2018 11:21 AM
116	5kW Solar grid-tie	11/9/2018 11:20 AM
117	5 MW SSEG - Old Mutual Pinelands	11/9/2018 11:12 AM
118	n/a	11/9/2018 11:02 AM
119	5.4kW solar system with battery backup - house in Port Elizabeth.	11/9/2018 10:39 AM
120	3kW, solar PV, rooftop, supplement daily consumption, no battery storage	11/9/2018 10:37 AM
121	micro grid 100kwh	11/9/2018 10:20 AM
122	800 kW (ABB), 500 kW (Eaton), 5 MW (Mall of Africa)	11/9/2018 10:14 AM
123	8 kW, PV	11/9/2018 10:11 AM
124	None	11/9/2018 9:50 AM
125	NA	11/9/2018 9:12 AM
126	2MW for resort campus	11/9/2018 9:07 AM
127	Wind 3 357.3MW Solar PV 2 291.83MW	11/9/2018 8:50 AM
128	2mw	11/5/2018 11:39 AM

Q19 Briefly describe how many EGS you have been involved in over the last 10 years and whether you believe the interest in EGS is increasing or decreasing and at what rate.

Answered: 144 Skipped: 518

#	RESPONSES	DATE
1	30 increasing	12/7/2018 9:30 AM
2	Increasing interest, but not a particularly fast adoption rate.	11/30/2018 6:45 PM
3	Most clients enquire but more are opting to implement as affordability and generation capacities increase. City supporting reverse metering has helped substantially as has battery storage capacity. Similarly, integration of technologies (notably PV and solar water heating) has helped make installations viable from both a cost and energy efficient POV.	11/28/2018 4:20 PM
4	2 and interest is increasing	11/28/2018 7:47 AM
5	7 or 8. Interest is increasing hugely	11/26/2018 3:32 PM
6	Increasing and quite substantially.	11/20/2018 5:43 PM
7	~800 Installations. Steady increase, 50-70% pa.	11/20/2018 7:55 AM
8	None. None, however I have a keen interest in EGS. Interest is very subjective. Some people believe, others completely disregard it. I would think that younger professionals are more prone to be 'conscious' of their environments and the systems that impact them.	11/19/2018 6:49 PM
9	I cannot count them. >100 systems	11/19/2018 10:52 AM
10	Around 20-30	11/19/2018 6:26 AM
11	Nil. I abandoned all my efforts about 15 years ago after finding top down forces (government and financiers) lacked awareness of the long-term impacts	11/18/2018 1:57 PM
12	One because of severe Municipal restrictions at the time.	11/18/2018 10:52 AM
13	40MWp. Interest is increasing at an exponential rate due to the increases in the costs of electricity from the grid.	11/18/2018 10:46 AM
14	My family homes only, I am an industrial Electrical Engineer where EGS is not practical. The interest is increasing based on installations seen where I live.	11/18/2018 10:33 AM
15	all (numerous) residential units in last 10 years increased interest as costs come down	11/18/2018 10:24 AM
16	Two. EGSs are not my business, but I am an engineer that owns a share in an office block. From my experience there was significant interest in EGSs during periods of load shedding (2008, 2015), although renewable EGS's are not necessarily the most appropriate solution for this problem. Subsequently interest ticked down, but commercial property owners are driving the market because of the investment case for EGSs. Over the past 10 years there has definitely been an increase, probably 25% y-on-y on average.	11/17/2018 4:23 PM
17	"Involvement" is a relative term. I was not a consultant and earned no money for any input I gave. But I have made a noise about ground water control, rivers, etc. and whether Johannesburg's infrastructure, with its lack of maintenance, can handle all this. Yes, the interest in EGS is increasing - but that does not mean it is always on the right track.	11/17/2018 8:38 AM
18	5, interest increasing	11/16/2018 12:11 PM
19	mostly teaching the subject	11/16/2018 11:15 AM
20	15. The interest is definitely increasing.	11/16/2018 10:15 AM
21	6 buildings and interest is level at present	11/16/2018 9:45 AM
22	0	11/15/2018 4:25 PM
23	two projects for private funded community centre meeting facilities and a municipal bus depot refit. reliability of performance drives interest as existing public systems slow down efficiency.	11/15/2018 3:16 PM
24	Probably 15 planned, only two installed.	11/15/2018 2:13 PM
25	4. Most definitely increasing	11/15/2018 12:53 PM

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26	Not many. Don't think it's a high priority.	11/15/2018 8:09 AM
27	8	11/15/2018 7:33 AM
28	4	11/14/2018 11:37 PM
29	one I believe it is increasing exponentially	11/14/2018 8:14 PM
30	4	11/14/2018 6:23 PM
31	5	11/14/2018 3:47 PM
32	2	11/14/2018 2:52 PM
33	3 residential 1 Outdoor 1 Commercial	11/14/2018 2:26 PM
34	20	11/14/2018 2:12 PM
35	More than 20	11/14/2018 1:52 PM
36	A solar-heating unit system per new house or new extension where there is a new bathroom and/or kitchen is added. and it remains the same for the past 10 years.	11/14/2018 1:47 PM
37	In many of the projects in South Africa that I have been involved in most is any have utilized small scale systems, such as solar geysers, pool solar heating etc. In my opinion, yes there will be an increase in the interest to use EGS technology in buildings, in many of our building projects to date we future proof the buildings allowing for easy installation of solar panels should the owner in the future decide they want to install a Solar generation system they have the ability to do so. Similarly, raised public awareness for the use and benefits thereof are becoming more transparent and available.	11/14/2018 12:03 PM
38	4- increasing	11/14/2018 11:20 AM
39	Not that many but interest is increasing and the technology is becoming more affordable.	11/14/2018 10:21 AM
40	Have no more time for this questionnaire, much like the "Payback Period". Who in his right mind wants to keep investing in questions whilst seemingly being locked in with "No end in sight" yet the proposition of success is based on the scale of investment. This is the perfect example of contradiction as to why the system keeps failing.	11/14/2018 9:53 AM
41	+/- 40 INTEREST DEFINITELY INCREASING RAPIDLY	11/14/2018 8:52 AM
42	+/- 10 interest is increasing	11/14/2018 8:50 AM
43	Interest in EGS is increasing as per building regulations enforcement	11/14/2018 8:42 AM
44	the last projects implemented the idea within school buildings. these were more for solar panels used and the idea of the beneficial results long term. To reiterate my previous statements, the cost outweighs the benefits when considering design at the moment , there is more focus on cost saving. However, there is some interest peaking in this sector, whether this is increasing at the moment, my feeling is there is not much application to the products despite the large amount of information on this.	11/14/2018 8:29 AM
45	Over 200 - it is becoming more and more common place in the residential market, prices are falling as well..	11/14/2018 1:52 AM
46	N/A	11/13/2018 10:40 PM
47	10	11/13/2018 8:56 PM
48	-	11/13/2018 7:43 PM
49	5	11/13/2018 7:11 PM
50	3 Yes definitely increasing	11/13/2018 5:42 PM
51	approx. 60 EGS	11/13/2018 5:18 PM
52	Approx. 6. I believe the INTEREST is MARGINALLY increasing	11/13/2018 4:54 PM
53	Increasing - mostly in residential developments - or high end boutique commercial developments	11/13/2018 4:38 PM
54	+/-50	11/13/2018 4:34 PM
55	A few but not enough. The demand for them is increasing	11/13/2018 4:33 PM
56	only two. Will definitely increase	11/13/2018 3:56 PM
57	1 commercial and 1 residential. I do believe that interest in EGS is increasing al beit at a slow rate.	11/13/2018 3:44 PM

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58	2 Projects and yes, the trend is increasing but much slower than in other parts of the world.	11/13/2018 3:40 PM
59	MAYBE 50 000 LOW COST HOUSES. YES INTEREST IS INCREASING. UNSURE ABOUT RATE.	11/13/2018 3:39 PM
60	Interest exists within an educated group. the likes of Trump denying climate change have a large destructive following. Irresponsible opinions are a great threat to our survival.	11/13/2018 3:33 PM
61	Six	11/13/2018 3:24 PM
62	Increasing as costs fall	11/13/2018 3:19 PM
63	20	11/13/2018 3:01 PM
64	8	11/13/2018 2:54 PM
65	1	11/13/2018 2:51 PM
66	3 Shopping centers and various residential houses Yes, I do believe it is increasing as it is become the norm when designing buildings	11/13/2018 2:49 PM
67	Stable. The need or lack there of is 100% generated by crisis and government policy.	11/13/2018 2:38 PM
68	9. Increasing steadily as energy prices escalate and ready-made solutions come to market.	11/13/2018 2:18 PM
69	About 20, and interest is growing at 80 %	11/13/2018 1:41 PM
70	2	11/13/2018 1:40 PM
71	Only about 10 projects to date, but yes, I believe interest will continue to grow in EGS systems.	11/13/2018 1:37 PM
72	All my high end residential designs include EGS	11/13/2018 1:32 PM
73	All new residential properties as required by the building regulation. I believe the interest is increasing.	11/13/2018 1:16 PM
74	?	11/13/2018 1:15 PM
75	approx 10	11/13/2018 1:04 PM
76	Quite a few	11/13/2018 1:04 PM
77	20, yes	11/13/2018 1:03 PM
78	Unknown	11/13/2018 1:02 PM
79	6 one flat 10 years. of these 4 were in the last year, so definitely increasing	11/13/2018 1:00 PM
80	3,interest is increasing.	11/13/2018 12:52 PM
81	±10 definitely on the increase	11/13/2018 12:47 PM
82	Every new domestic building, and or additions to the existing building is to comply with energy efficient installations. Estimate approximately>15 per year.	11/13/2018 12:46 PM
83	5, increasing quite fast / annum. it's becoming almost a norm on any new building.	11/13/2018 12:40 PM
84	Decreasing as Eskom proofs reliable	11/13/2018 12:35 PM
85	7, increasing at a rate to make it an everyday application	11/13/2018 12:31 PM
86	3	11/13/2018 12:23 PM
87	n/a	11/13/2018 12:20 PM
88	2. Interest increasing.	11/13/2018 12:11 PM
89	2. Clients are not interested in the capital cost and the lack of incentives provided by government. Electrical Engineers are sometimes also not very supportive with EGS as some of them do not understand the systems or the options.	11/13/2018 12:09 PM
90	Increasing	11/13/2018 12:05 PM
91	Weve been involved in about 20+ projects of varying scale, interest is increasing at an exponential rate but that doesn't always motivate clients to make a larger provision in their budgets.	11/13/2018 12:04 PM
92	I have been involved in approximately 6 projects over the last 5 years. Sadly I feel that the trend may begin to decrease due to slow economic conditions currently being experienced in South Africa.	11/13/2018 12:02 PM
93	None	11/13/2018 11:58 AM

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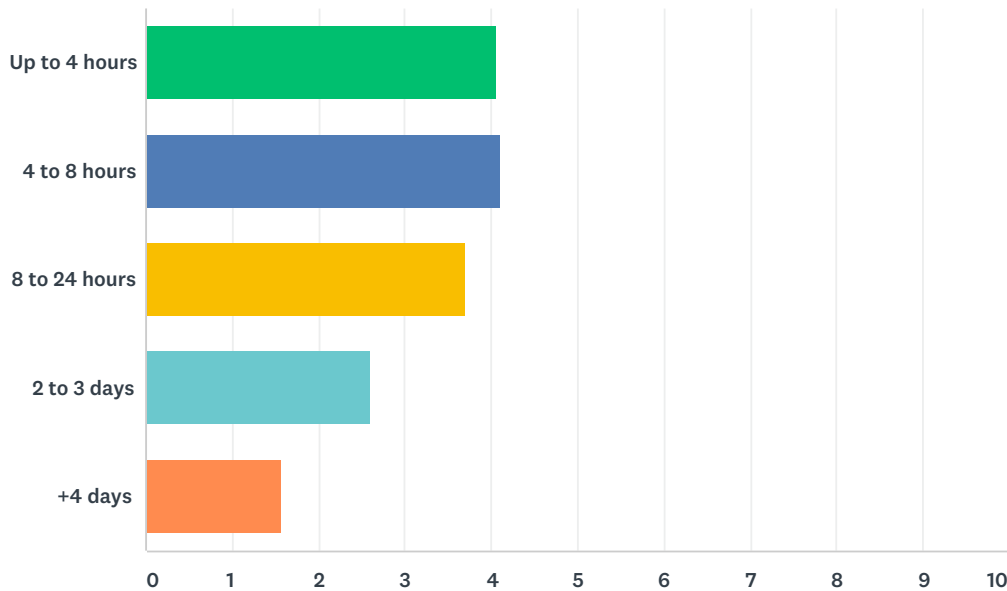
94	5, I believe it is slowly increasing, residential clients are becoming more eager to use these types of technologies to save money and be independent should load shedding be a problem	11/13/2018 11:56 AM
95	5 installations. Interest is increasing.	11/13/2018 11:54 AM
96	Don't understand the question	11/13/2018 11:51 AM
97	Unknown	11/13/2018 11:49 AM
98	3 projects. Interest in EGS is increasing but impossible to say at what rate.	11/13/2018 11:41 AM
99	3 factories and 8 houses. Almost every house has solar water heating and PV is increasing	11/13/2018 11:40 AM
100	2, i thin its increasing but my business is small and so fairly contained.	11/13/2018 11:40 AM
101	5 or 6	11/13/2018 11:39 AM
102	It has remained the same. Mostly in residential developments.	11/13/2018 11:35 AM
103	35 - 40	11/13/2018 11:31 AM
104	1	11/13/2018 11:26 AM
105	done 6 designs using PV panels and solar geyser , rain water collection etc.. Its increasing in intertest as costs for technology drops	11/13/2018 11:23 AM
106	3 Commercial buildings Increasing in over the last 10 years with about 50%	11/13/2018 11:21 AM
107	10 Increasing	11/13/2018 11:15 AM
108	5	11/13/2018 11:13 AM
109	60	11/13/2018 11:06 AM
110	Several small EGS for radio sites in our area of responsibility. With the current interest in EGS increasing due to the energy demand/supply, the demand for these technologies are at a premium	11/13/2018 10:55 AM
111	7 Increasing	11/12/2018 8:47 PM
112	+ - 50 Interest in growing as the electricity price is making more affordable for big and small customers	11/12/2018 12:12 PM
113	increasing; 5	11/12/2018 10:10 AM
114	One. I believe that there is an ever increasing interest in EGS, especially as costs come down and systems demonstrate reliability.	11/12/2018 8:22 AM
115	My company has installed about 80 PV systems, with the trend moving towards fewer, larger projects. EGS for residential is no longer part of our portfolio, so this is possibly a contributing factor. Interest is definitely increasing.	11/12/2018 8:16 AM
116	NA	11/12/2018 7:55 AM
117	I am retired and hence have not been involved with many.I am however mentoring young Technicians , and I believe that interest is growing	11/11/2018 7:45 PM
118	Two	11/10/2018 10:59 AM
119	Around 20 proposals of which around 8 have proceeded to completion.	11/9/2018 8:03 PM
120	Involvement in the (about 20) powerlines from windfarms	11/9/2018 6:50 PM
121	six it is increasing.	11/9/2018 4:08 PM
122	No personal experience. However perception from articles and discussions is that interest is definitely increasing.	11/9/2018 3:34 PM
123	3 EGS interest remains high	11/9/2018 2:07 PM
124	about 10, increasing	11/9/2018 1:41 PM
125	3	11/9/2018 12:08 PM
126	Is increasing	11/9/2018 12:07 PM
127	Only 5 or so. There is a steady increase which will increase further once restrictions and licencing becomes easier to deal with. The increase will rise depending on Eskom tariff increases since these are well above inflation.	11/9/2018 11:21 AM
128	10	11/9/2018 11:20 AM
129	4. Increasing. As electricity costs increase and reliability of supply decreases.	11/9/2018 11:19 AM

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130	over 100 SSEG installations	11/9/2018 11:12 AM
131	a lot	11/9/2018 11:02 AM
132	2	11/9/2018 10:58 AM
133	4 projects. Interest is waning due to substantial cost increases and very little financial benefit to the man on the street (no real government driven incentives).	11/9/2018 10:39 AM
134	4	11/9/2018 10:37 AM
135	its increasing better and efficient solar modules with higher output.	11/9/2018 10:20 AM
136	Increasing fast	11/9/2018 10:14 AM
137	Very few, directly. However, the interest is increasing dramatically, as the cost effectiveness increases, and the reliability of ESKOM decreases.	11/9/2018 10:11 AM
138	Only water heating	11/9/2018 9:50 AM
139	NA	11/9/2018 9:12 AM
140	15 Interest is growing fast	11/9/2018 9:07 AM
141	3	11/9/2018 8:50 AM
142	3	11/8/2018 7:56 AM
143	10 , yes . The appetite is based on cost	11/5/2018 11:39 AM
144	Interest is increasing.	11/2/2018 2:11 PM

Q20 If you have experienced battery storage in an EGS, what capacity of storage is most commonly specified?(storage capacity refers to the duration of available energy if the EGS is unable to recharge batteries)Rank from 1 – 5, with 1 being the most common and 5 being least (select N/A if you have not experienced that capacity of storage)

Answered: 151 Skipped: 511



	1	2	3	4	5	N/A	TOTAL	SCORE
Up to 4 hours	33.09% 45	19.85% 27	11.03% 15	3.68% 5	3.68% 5	28.68% 39	136	4.05
4 to 8 hours	27.74% 38	30.66% 42	8.03% 11	2.92% 4	2.19% 3	28.47% 39	137	4.10
8 to 24 hours	20.71% 29	10.00% 14	32.14% 45	2.86% 4	0.71% 1	33.57% 47	140	3.71
2 to 3 days	2.96% 4	10.37% 14	6.67% 9	37.04% 50	1.48% 2	41.48% 56	135	2.59
+4 days	2.21% 3	2.94% 4	2.94% 4	6.62% 9	38.97% 53	46.32% 63	136	1.56

Q21 In your experience, what is the most common type of storage battery (lithium-ion, lead acid, gel etc.) and why?

Answered: 124 Skipped: 538

#	RESPONSES	DATE
1	do not know	12/7/2018 9:32 AM
2	Lithium Ion and lead acid - established and economical. Efficiency is also a common important consideration. A bit of interest in Vanadium flow too.	11/30/2018 6:48 PM
3	Gel as it is widely used in battery rooms/sub stations	11/28/2018 7:50 AM
4	Lithium as far as I know.	11/20/2018 5:45 PM
5	N/A	11/19/2018 6:50 PM
6	Gel.	11/19/2018 10:54 AM
7	Lithium Ion, due to price.	11/19/2018 6:30 AM
8	Don't know	11/18/2018 2:04 PM
9	N/A	11/18/2018 10:59 AM
10	Lithium-ion	11/18/2018 10:48 AM
11	Gel	11/18/2018 10:36 AM
12	Lead acid gel	11/17/2018 4:31 PM
13	For large scale storage I have no experience.	11/17/2018 8:41 AM
14	sealed ... readily available; cheaper but less reliable than LI	11/16/2018 11:17 AM
15	The lead acid or gel batteries are the most common as this is an approved storage facility which is not as sensitive to over-charging and discharging. Lithium-ion batteries have a very good consumption profile but they have only been on the market for a few years and no records about their sustainability have been recorded so far. These Li-Ion batteries however will be the future once all initial problems are resolved.	11/16/2018 10:21 AM
16	storage battery	11/16/2018 9:46 AM
17	lead-acid availability, price and sub-contractor preference.	11/15/2018 3:16 PM
18	Not sure.	11/15/2018 2:15 PM
19	LI	11/15/2018 7:34 AM
20	no experience	11/14/2018 8:17 PM
21	lithium-ion	11/14/2018 5:47 PM
22	lead	11/14/2018 3:49 PM
23	Lithium-ion	11/14/2018 2:54 PM
24	Lead-Acid	11/14/2018 2:29 PM
25	1) Li FE 2) Gel 3) Lead Acid	11/14/2018 1:57 PM
26	Lithium-ion hold the energy longer and more reliable than other types.	11/14/2018 1:52 PM
27	lead acid	11/14/2018 12:24 PM
28	No long term experience?	11/14/2018 10:26 AM
29	Have no more time for this questionnaire, much like the "Payback Period". Who in his right mind wants to keep investing in questions whilst seemingly being locked in with "No end in sight" yet the proposition of success is based on the scale of investment. This is the perfect example of contradiction as to why the system keeps failing.	11/14/2018 9:53 AM
30	lead acid - easily available - cheapest	11/14/2018 8:53 AM
31	lead acid because of availability in the market	11/14/2018 8:46 AM
32	n/a	11/14/2018 3:48 AM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

33	Li-iron - durable....	11/14/2018 1:55 AM
34	N/A	11/13/2018 10:45 PM
35	lithium ion	11/13/2018 8:59 PM
36	-	11/13/2018 7:45 PM
37	Lithium battery have long sustainable life, and easy to replace	11/13/2018 7:19 PM
38	Lead acid and Lithium ion	11/13/2018 7:14 PM
39	Lithium-ion	11/13/2018 5:44 PM
40	lead acid availability	11/13/2018 5:21 PM
41	No experience - a technical matter for an Electrical Engineer	11/13/2018 4:58 PM
42	Uncommon	11/13/2018 4:40 PM
43	Gel. Longer life span. Replacement period is longer hence cost is lower over the life of the battery. Downside is the upfront purchase price which is slightly more expensive	11/13/2018 4:37 PM
44	Lithium ion	11/13/2018 4:36 PM
45	I use Lithium. Compact and clean	11/13/2018 3:58 PM
46	lithium-ion. The electrical consultant says it is newer technology and per size it has greater storage capacity	11/13/2018 3:48 PM
47	LITHIUM-ION DON'T KNOW WHY	11/13/2018 3:42 PM
48	Lead acid, because of cost.	11/13/2018 3:41 PM
49	diesel generators in tandem with inverters	11/13/2018 3:39 PM
50	Lithium - ion	11/13/2018 3:30 PM
51	Lithium-ion	11/13/2018 3:23 PM
52	na	11/13/2018 3:08 PM
53	Lead acid	11/13/2018 2:51 PM
54	Lithium-ion. Common and effective.	11/13/2018 2:23 PM
55	I am not informed about the types of storage, I have only experience concerning the duration of available back-up power.	11/13/2018 1:54 PM
56	Lithium-ion batteries	11/13/2018 1:44 PM
57	lithium-ion	11/13/2018 1:38 PM
58	Lithium-ion popular but to expensive. most settle for lead acid	11/13/2018 1:36 PM
59	Lithium-ion , as far as i know .	11/13/2018 1:34 PM
60	Lead acid. I rarely get involved with battery storage systems.	11/13/2018 1:20 PM
61	Lithium - Most reliable	11/13/2018 1:07 PM
62	Gel. Seems to be what's commonly quoted on.	11/13/2018 1:02 PM
63	Lead acid, lithium-ion is still too expensive.	11/13/2018 12:57 PM
64	Lead acid, cost and service cycle	11/13/2018 12:53 PM
65	lithium-ion - lifespan	11/13/2018 12:51 PM
66	Lithium-Ion. Most commonly available and cost effective.	11/13/2018 12:44 PM
67	lead acid to my knowledge. lithium-ion still quite expensive	11/13/2018 12:42 PM
68	Lithium-ion - cost effective	11/13/2018 12:36 PM
69	lithium-ion is the latest technology and very efficient	11/13/2018 12:33 PM
70	litium	11/13/2018 12:24 PM
71	LITHIUM ION	11/13/2018 12:22 PM
72	Unsure.	11/13/2018 12:06 PM
73	lead acid. My Ups is giving me 4hours which is fine.	11/13/2018 12:01 PM
74	Lithium-ion	11/13/2018 11:57 AM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

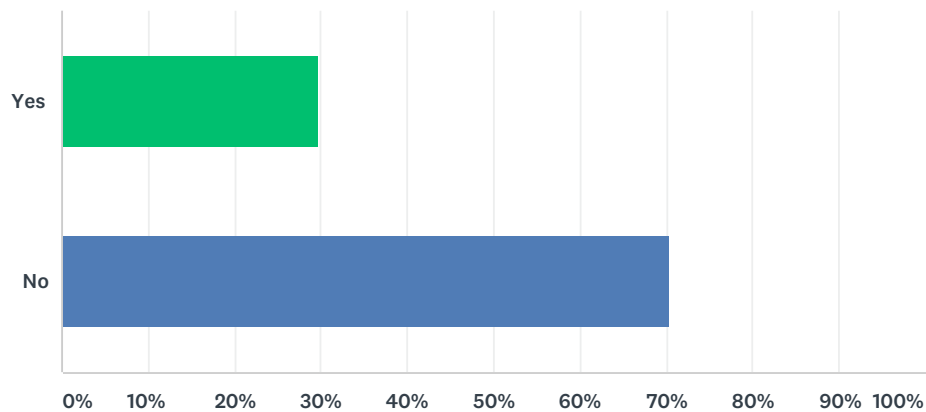
75	Lead acid, cost.	11/13/2018 11:56 AM
76	Unknown	11/13/2018 11:50 AM
77	Lead acid - on advice from electrical engineer	11/13/2018 11:44 AM
78	lithium ion	11/13/2018 11:42 AM
79	not sure - done by specialist	11/13/2018 11:40 AM
80	lithium-ion, availability in market place, handling of system and replacement of materials	11/13/2018 11:37 AM
81	lead acid	11/13/2018 11:27 AM
82	lithium-ion	11/13/2018 11:27 AM
83	Gel	11/13/2018 11:24 AM
84	lithium-ion	11/13/2018 11:17 AM
85	Lithium Ion, availability and price gives best efficiencies	11/13/2018 11:08 AM
86	Gel. portability and handles easier than the others. Lithium-ion is still too expensive and lead-acid batteries pose a greater danger to the environment when a spillage occurs	11/13/2018 10:59 AM
87	Tubular Gel	11/13/2018 10:39 AM
88	Lead Acid	11/12/2018 8:55 PM
89	lithium-ion - "cleanest " battery least maintenance and extendable	11/12/2018 12:16 PM
90	n/a	11/12/2018 10:12 AM
91	Unknown, but value would be key. It is known that costs of these systems are very high.	11/12/2018 8:24 AM
92	lead acid	11/12/2018 8:21 AM
93	Costs!! Lead Acid (sealed)	11/12/2018 7:57 AM
94	Lithium-ion.	11/10/2018 8:45 PM
95	lead acid	11/10/2018 11:01 AM
96	Lead acid, cheap and readily available	11/9/2018 8:10 PM
97	no comment	11/9/2018 6:51 PM
98	I don't know	11/9/2018 4:11 PM
99	No personal experience, however would guess 4-8 hours. Lithium-ion seems most known with at this stage least negative impact (e.g. gassing of lead acid).	11/9/2018 3:42 PM
100	Deep-cycle Lead Acid, and Li.Ion	11/9/2018 2:48 PM
101	lead acid. Cost and availability	11/9/2018 2:25 PM
102	Lead Acid	11/9/2018 2:09 PM
103	Lithium-ion. Allows more cycles to greater discharge and a longer life than alternatives	11/9/2018 1:44 PM
104	Lithium Ion. Because we recommend it to clients and potential clients.	11/9/2018 12:17 PM
105	Lead	11/9/2018 12:10 PM
106	All above do not relate to RSA. The bridging times should be a lot shorter from 15 mins in steps up to 12 hours. Litium iron is most common, with advanced lead acid next.	11/9/2018 11:34 AM
107	lithium-ion	11/9/2018 11:24 AM
108	Lead Acid Availability and price	11/9/2018 11:22 AM
109	lead acid. Capital Cost.	11/9/2018 11:22 AM
110	lithium-ion - maintenance requirements and charging cycles	11/9/2018 11:20 AM
111	GEL or AGM, where it was Typical Lead Acid prior. Cost and ease of maintenance.	11/9/2018 11:05 AM
112	lead gel	11/9/2018 11:03 AM
113	Gel type batteries (No maintenance)	11/9/2018 10:45 AM
114	Probably still lead acid	11/9/2018 10:39 AM
115	gel	11/9/2018 10:23 AM
116	Lithium Ion	11/9/2018 10:16 AM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

117	Li Ion	11/9/2018 10:13 AM
118	n/a	11/9/2018 9:52 AM
119	lithium-ion more common but in large scale Vanadium redox flow storage is a great solution due to simplicity & durability.	11/9/2018 9:43 AM
120	Lithium-ion and Lead acid	11/9/2018 9:15 AM
121	Advanced lead acid but now giving way to lithium Reason - cost and reliability. Early lithium technology was not very reliable and had safety issues.	11/9/2018 9:13 AM
122	Lead acid - availability	11/9/2018 8:51 AM
123	I - ion	11/5/2018 11:41 AM
124	Not sure	11/2/2018 2:12 PM

Q22 Have you had any experience with grid connected EGS?

Answered: 162 Skipped: 500



ANSWER CHOICES	RESPONSES
Yes	29.63% 48
No	70.37% 114
TOTAL	162

#	IF YES, BRIEFLY DESCRIBE IN WHICH CITY METRO AND YOUR EXPERIENCE OF THE APPLICATION/CONNECTION PROCESS	DATE
1	Buffalo City, Makana. Mostly commercial projects.	11/30/2018 6:48 PM
2	City of Cape Town. I've been involved on the registration side of embedded generation owners applying for grid connection.	11/20/2018 8:03 AM
3	All but Durban	11/19/2018 10:54 AM
4	Cape Town, Johannesburg, Durban	11/19/2018 6:30 AM
5	Yes! Johannesburg and Pretoria	11/18/2018 10:59 AM
6	All Munics and Eskom	11/18/2018 10:48 AM
7	Richards Bay	11/18/2018 10:36 AM
8	cape town	11/18/2018 10:28 AM
9	City of Cape Town	11/17/2018 4:31 PM
10	In Swakopmund and Langstrand (Walvis Bay). Swakopmund – Delius With House Delius no problems were experienced during the application/connection process. But we were not allowed to connect. Erongo Red grid infrastructure cannot manage. Langstrand – Marais House Marais had no problem with the application/connection process During the application process of the project House Viljoen, Erongo Red notified us of the 12% overall generation capacity generated by renewable sources. Due to a substantial increase in solar systems in the region since last year, Erongo Red was instructed by the ECB to stop this power source. Currently we have to apply with Erongo Red before offering this option to our clients. Once approved the process can go ahead.	11/16/2018 10:21 AM
11	Soshanguve, Pretoria, Port Shepstone, Durban	11/15/2018 12:55 PM
12	Cape Town protracted and non transparent application process	11/14/2018 8:17 PM
13	Where energy is sold to the local municipality	11/14/2018 5:47 PM
14	Johannesburg, connection process as not smooth initially	11/14/2018 2:54 PM
15	Sishen Solar Facility	11/14/2018 2:29 PM
16	In italy	11/14/2018 2:13 PM
17	Ekurhuleni PE CT	11/14/2018 1:57 PM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

18	Not my responsibility	11/14/2018 10:26 AM
19	Have no more time for this questionnaire, much like the "Payback Period". Who in his right mind wants to keep investing in questions whilst seemingly being locked in with "No end in sight" yet the proposition of success is based on the scale of investment. This is the perfect example of contradiction as to why the system keeps failing.	11/14/2018 9:53 AM
20	JHB - Steyn City - Local electricity suppliers are not in favour, as they loose revenue...	11/14/2018 1:55 AM
21	Living in Munich Germany	11/13/2018 10:45 PM
22	Johannesburg	11/13/2018 4:36 PM
23	city of cape town	11/13/2018 1:38 PM
24	It is not legal or permitted in South Africa! Stupid hey!	11/13/2018 12:57 PM
25	Nelson Mandela Metro	11/13/2018 12:53 PM
26	Not advisable - cost to supply grid is almost more than return	11/13/2018 12:51 PM
27	City of Cape Town. Electrical engineer and subcontractor dealt with application process.	11/13/2018 12:14 PM
28	Windhoek, Namibia. It was a somewhat illegal connection, with a meter running backwards when delivering power into the grid. The City did not have a system in place	11/13/2018 12:12 PM
29	Tshwane Did not do the application only worked on additions	11/13/2018 11:27 AM
30	Ethekwini King Shaka Airport	11/13/2018 11:08 AM
31	City Power Bad support	11/12/2018 8:55 PM
32	Nelson Mandela Bay Municipality - the application process can be a little cumbersome, inconsistent and unstructured, but we have navigated it numerous times.	11/12/2018 10:20 AM
33	I have seen such systems in Johannesburg, though.	11/12/2018 8:24 AM
34	Cape Town, reasonable experience of connection process	11/9/2018 8:10 PM
35	micro grid with selection to balance the load with a combination of solar, grid and generator (in that order of preference)	11/9/2018 4:11 PM
36	Not in urban area - my experience was in rural setting.	11/9/2018 3:42 PM
37	Northern Cape	11/9/2018 2:09 PM
38	Cape Town. Application and connection was handled by the supplier/installer.	11/9/2018 1:56 PM
39	Gauteng, Western Cape, Namibia	11/9/2018 1:44 PM
40	Sasol	11/9/2018 12:35 PM
41	The process required intimate links with the relevant department and Eskom also said the could not help or refer me directly to whom to get help from. No clear process or admin assistant on registration in Mpumalanga and Johannesburg. In Cape Town I believe the process would be different.	11/9/2018 12:17 PM
42	Nelson Mandela Metro	11/9/2018 11:22 AM
43	City of Cape Town	11/9/2018 11:20 AM
44	Cape Town	11/9/2018 11:03 AM
45	Port Elizabeth. Process was difficult initially, but runs smooth at present.	11/9/2018 10:45 AM
46	Northern Cape initial Greenfield to commissioning	11/9/2018 10:23 AM
47	Johannesburg	11/9/2018 10:16 AM
48	Pretoria - relatively simple for a government interaction Durban - headaches	11/9/2018 9:13 AM

Q23 Have you had any experience with feed-in tariffs offered by metro municipalities and how has this impacted the viability of current or future EGS installations (e.g. less reliance on battery storage or faster payback period etc.)?

Answered: 130 Skipped: 532

#	RESPONSES	DATE
1	No	12/7/2018 9:32 AM
2	No	11/30/2018 6:48 PM
3	No	11/28/2018 7:50 AM
4	As far as I am aware households are not able to feed back into the grid which sometimes reduce the investment they do into PV installation	11/26/2018 3:35 PM
5	No	11/20/2018 5:45 PM
6	It has a big impact. However, from a local utility point of view, it doesn't make sense to have a FIT that's lower than what the utility would pay Eskom for power at the time of peak solar PV generation.	11/20/2018 8:03 AM
7	No	11/19/2018 6:50 PM
8	Yes. Depending on the metro it has significant	11/19/2018 10:54 AM
9	Yes, less reliance on battery storage.	11/19/2018 6:30 AM
10	No	11/18/2018 2:04 PM
11	Municipalities provide NO feed-in incentive and penalize the customer/generator by charging for the Grid Tied Generation over and above the cost of actual consumption.	11/18/2018 10:59 AM
12	Yes - FIT does not impact decisions. FIT is usually too low to make sense on its own and is subject to political will.	11/18/2018 10:48 AM
13	No	11/18/2018 10:36 AM
14	No. Theoretical only	11/18/2018 10:28 AM
15	Yes	11/17/2018 4:31 PM
16	NO	11/17/2018 8:41 AM
17	No	11/16/2018 12:17 PM
18	No - works well in Germany	11/16/2018 11:17 AM
19	no	11/16/2018 9:46 AM
20	yes. not incentivised for individuals to increase feed-in.	11/15/2018 3:16 PM
21	No	11/15/2018 2:15 PM
22	no	11/15/2018 12:55 PM
23	No	11/15/2018 8:13 AM
24	NO	11/15/2018 7:34 AM
25	no	11/14/2018 11:38 PM
26	no	11/14/2018 8:17 PM
27	no	11/14/2018 3:49 PM
28	Yes, Jhb Was not considered in installation	11/14/2018 2:54 PM
29	No	11/14/2018 2:29 PM
30	In italy	11/14/2018 2:13 PM
31	NO	11/14/2018 1:57 PM
32	Not applicable	11/14/2018 1:52 PM

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33	No	11/14/2018 11:47 AM
34	no	11/14/2018 11:22 AM
35	No not my field of expertise	11/14/2018 10:26 AM
36	Have no more time for this questionnaire, much like the "Payback Period". Who in his right mind wants to keep investing in questions whilst seemingly being locked in with "No end in sight" yet the proposition of success is based on the scale of investment. This is the perfect example of contradiction as to why the system keeps failing.	11/14/2018 9:53 AM
37	NO	11/14/2018 9:03 AM
38	Have disused with municipality, who are not keen as much of their revenue comes from electricity sales	11/14/2018 8:53 AM
39	Faster payback	11/14/2018 8:46 AM
40	No.	11/14/2018 3:48 AM
41	nope - JHB does not offer this....	11/14/2018 1:55 AM
42	Highly subsidised take up programmes to incentivise users to switch to renewable energy sources	11/13/2018 10:45 PM
43	yes and always	11/13/2018 8:59 PM
44	-	11/13/2018 7:45 PM
45	No experience	11/13/2018 7:19 PM
46	No	11/13/2018 7:14 PM
47	No	11/13/2018 5:44 PM
48	no	11/13/2018 5:21 PM
49	No	11/13/2018 4:58 PM
50	no	11/13/2018 4:40 PM
51	No	11/13/2018 4:37 PM
52	no	11/13/2018 4:36 PM
53	no	11/13/2018 3:58 PM
54	No	11/13/2018 3:48 PM
55	NO	11/13/2018 3:42 PM
56	No.	11/13/2018 3:41 PM
57	I have travelled on the Amsterdam trams that operate on Green Stream. Public transport that operates on wind generated power is an excellent option.	11/13/2018 3:39 PM
58	No. I personally got nothing back.	11/13/2018 3:30 PM
59	no	11/13/2018 3:23 PM
60	no	11/13/2018 3:08 PM
61	No	11/13/2018 2:51 PM
62	No.	11/13/2018 2:23 PM
63	I do not have experience with this subject.	11/13/2018 1:54 PM
64	Yes, but there is in this instance no financial gain to the energy producer.	11/13/2018 1:44 PM
65	no	11/13/2018 1:36 PM
66	no	11/13/2018 1:34 PM
67	No	11/13/2018 1:20 PM
68	No	11/13/2018 1:07 PM
69	no	11/13/2018 1:02 PM
70	No, not as yet	11/13/2018 12:53 PM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

71	Yes. It works beneficial in some cases as it might relieve you from any dependency from the municipality to provide the services. It results in a rebate to the development at times as well.	11/13/2018 12:44 PM
72	no	11/13/2018 12:42 PM
73	no	11/13/2018 12:36 PM
74	No	11/13/2018 12:33 PM
75	no	11/13/2018 12:24 PM
76	NO	11/13/2018 12:22 PM
77	Yes, more viable than batteries	11/13/2018 12:20 PM
78	As above.	11/13/2018 12:14 PM
79	As above	11/13/2018 12:12 PM
80	No	11/13/2018 12:07 PM
81	Unsure.	11/13/2018 12:06 PM
82	no	11/13/2018 12:01 PM
83	no	11/13/2018 11:57 AM
84	No	11/13/2018 11:56 AM
85	No	11/13/2018 11:54 AM
86	No	11/13/2018 11:50 AM
87	No	11/13/2018 11:44 AM
88	no	11/13/2018 11:42 AM
89	no	11/13/2018 11:40 AM
90	Yes, when subsidised more residential dwellings changed from local power to solar power systems	11/13/2018 11:37 AM
91	no	11/13/2018 11:27 AM
92	Yes less storage and feed-in helped with other fields of saving	11/13/2018 11:27 AM
93	No	11/13/2018 11:24 AM
94	NO	11/13/2018 11:14 AM
95	No	11/13/2018 11:08 AM
96	No	11/13/2018 10:59 AM
97	No	11/13/2018 10:39 AM
98	Feed-in tariffs are so low that it is not considered as part of feasibility	11/12/2018 8:55 PM
99	no	11/12/2018 12:16 PM
100	The NMBM doesn't offer a feed-in-tariff, but many of our clients chose to trade via POWERX, which increases the viability and profitability of the PV system by decreasing payback and allowing excess or all energy to be exported or stored in the grid.	11/12/2018 10:20 AM
101	n/a	11/12/2018 10:12 AM
102	No	11/12/2018 8:24 AM
103	No	11/12/2018 7:57 AM
104	No	11/10/2018 11:01 AM
105	Although grid tied my experience is not with feed-in systems. All on site consumption.	11/9/2018 8:10 PM
106	no	11/9/2018 6:51 PM
107	No	11/9/2018 4:11 PM
108	No. But it is clear that just deducting infeed from usage is not cost-viable for a Munic, as feed-in of PV is at low cost time, but usage need would be at high cost-of-use time!	11/9/2018 3:42 PM
109	No.	11/9/2018 2:48 PM
110	No	11/9/2018 2:09 PM
111	No direct experience.	11/9/2018 1:56 PM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

112	No	11/9/2018 1:44 PM
113	No	11/9/2018 12:17 PM
114	Its faster	11/9/2018 12:10 PM
115	Munics principally do not want EGS, and hence make life very difficult, and can vary the feed-in tariffs at any time they unilaterally want, thus jeopardising reliable economic calculations.	11/9/2018 11:34 AM
116	Somebody has to either store power or have other generating capacity available. Also don,t believe Eskom etc are allowing for the impact of the electric car when the increase in load in the early evening will be higher than what is currently a peak load.	11/9/2018 11:29 AM
117	No	11/9/2018 11:22 AM
118	yes, experience feed-in tariffs. faster payback period dependent on installation type of consumer	11/9/2018 11:20 AM
119	In City of Cape Town it actually does not make sense to install one with FIT in mind	11/9/2018 11:05 AM
120	yes	11/9/2018 11:03 AM
121	Yes, my client has not had to pay a municipal account for electricity, water and property tax for the past 2 years due to the power he has pushed into the grid.	11/9/2018 10:45 AM
122	No	11/9/2018 10:39 AM
123	yes domestic installation with dual tariff meters with feedback to municipal grid.	11/9/2018 10:23 AM
124	No	11/9/2018 10:16 AM
125	No	11/9/2018 10:13 AM
126	No	11/9/2018 9:52 AM
127	Never used - not viable for the projects I have seen. Now looking at wheeling tariffs	11/9/2018 9:13 AM
128	NO	11/9/2018 8:51 AM
129	No.	11/8/2018 7:58 AM
130	No	11/2/2018 2:12 PM

Q24 Are you satisfied with the smart metering system and how the tariffs are calculated or limited?

Answered: 130 Skipped: 532

#	RESPONSES	DATE
1	Yes The problem is you are paying a tariff at the time of purchase not when using that power bought.	12/7/2018 9:32 AM
2	Yes	11/30/2018 6:48 PM
3	No comment	11/28/2018 7:50 AM
4	About to see a system now on a project, so cannot tell yet.	11/20/2018 5:45 PM
5	It will still develop.	11/20/2018 8:03 AM
6	No	11/19/2018 6:50 PM
7	No	11/19/2018 10:54 AM
8	No--tariffs not lucrative enough.	11/19/2018 6:30 AM
9	No. The service providers seem to be enabled to use the system for their own in-house advantages	11/18/2018 2:04 PM
10	Not experienced any.	11/18/2018 10:59 AM
11	No	11/18/2018 10:48 AM
12	NA	11/18/2018 10:36 AM
13	No. Apparently don't support pay back for original installation	11/18/2018 10:28 AM
14	The metering system works well. The calculation of the tariffs leaves much to be desired. If a fixed service charge is paid, import and export tariffs should be identical.	11/17/2018 4:31 PM
15	In principle yes, but, sadly and annoyingly, not properly implemented and maintained.	11/17/2018 8:41 AM
16	We are satisfied with being able to see the reading but not satisfied with the tariff calculation since it varies according to location irrespective of quantity used.	11/16/2018 12:17 PM
17	Current system in JNB seems toward ok	11/16/2018 11:17 AM
18	yes	11/16/2018 9:46 AM
19	see 23, above	11/15/2018 3:16 PM
20	No	11/15/2018 2:15 PM
21	underqualified to answer	11/15/2018 12:55 PM
22	Not aware	11/15/2018 8:13 AM
23	NEUTRAL	11/15/2018 7:34 AM
24	no experience	11/14/2018 8:17 PM
25	yes	11/14/2018 5:47 PM
26	yes	11/14/2018 3:49 PM
27	Not sure	11/14/2018 2:54 PM
28	Yes	11/14/2018 2:29 PM
29	Yes	11/14/2018 2:13 PM
30	No	11/14/2018 1:57 PM
31	Poorly service, and need to better in management system and promptly attend to on daily, weekly or monthly basis where applied.	11/14/2018 1:52 PM
32	no	11/14/2018 12:24 PM
33	No	11/14/2018 11:47 AM
34	not satisfied- more expensive form of electric	11/14/2018 11:22 AM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

35	they must make all tariffs to same	11/14/2018 10:38 AM
36	no comment	11/14/2018 10:26 AM
37	Have no more time for this questionnaire, much like the "Payback Period". Who in his right mind wants to keep investing in questions whilst seemingly being locked in with "No end in sight" yet the proposition of success is based on the scale of investment. This is the perfect example of contradiction as to why the system keeps failing.	11/14/2018 9:53 AM
38	dont know	11/14/2018 8:53 AM
39	Yes i am satisfied	11/14/2018 8:46 AM
40	for now, the metering system is sufficient. However, there is still cost involved and this can always be bettered.	11/14/2018 8:31 AM
41	N/a	11/14/2018 3:48 AM
42	No, the metering is so varied from province to province..	11/14/2018 1:55 AM
43	N/A	11/13/2018 10:45 PM
44	no	11/13/2018 8:59 PM
45	-	11/13/2018 7:45 PM
46	Not satisfied	11/13/2018 7:19 PM
47	Yes	11/13/2018 7:14 PM
48	No	11/13/2018 5:44 PM
49	not sure	11/13/2018 5:21 PM
50	No knowledge of this item	11/13/2018 4:58 PM
51	no	11/13/2018 4:40 PM
52	N/A	11/13/2018 4:37 PM
53	no	11/13/2018 4:36 PM
54	unsure	11/13/2018 3:58 PM
55	NA	11/13/2018 3:42 PM
56	N/A	11/13/2018 3:41 PM
57	metering implies municipal involvement. If each household had its own services kit there would be no need for meters or service providers.	11/13/2018 3:39 PM
58	No. I am still be overcharged	11/13/2018 3:30 PM
59	no choice n the matter.	11/13/2018 3:23 PM
60	no	11/13/2018 3:08 PM
61	n/a	11/13/2018 2:23 PM
62	I do not have experience with this subject.	11/13/2018 1:54 PM
63	Not really. I have heard mixed reactions to smart metering	11/13/2018 1:44 PM
64	Yes	11/13/2018 1:38 PM
65	not that much knowledge of system	11/13/2018 1:36 PM
66	not really	11/13/2018 1:34 PM
67	I am not knowledgeable about smart meters. I believe the system how tariffs are calculated is to complex. There is no way the man in the street can check his account.	11/13/2018 1:20 PM
68	N/a	11/13/2018 1:07 PM
69	no	11/13/2018 1:02 PM
70	No experience	11/13/2018 12:53 PM
71	yes	11/13/2018 12:51 PM
72	It can be improved.	11/13/2018 12:44 PM
73	i know nothing about this as there is basically no knowledge distribution or info available (in my experience)	11/13/2018 12:42 PM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

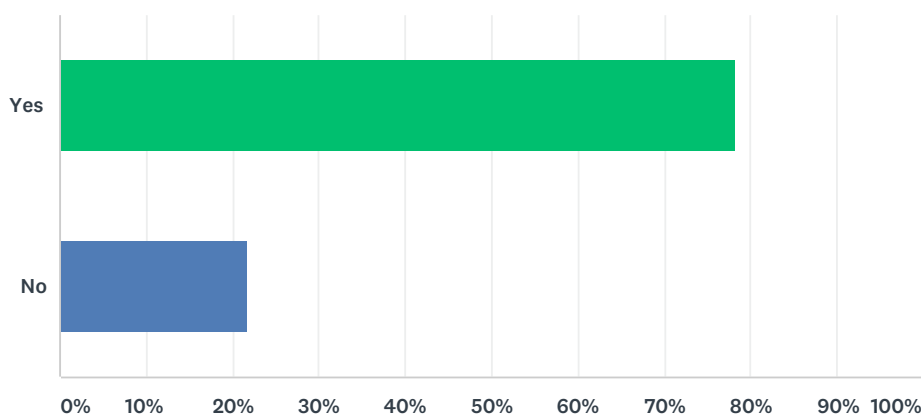
74	n.a	11/13/2018 12:36 PM
75	Yes	11/13/2018 12:33 PM
76	limited	11/13/2018 12:24 PM
77	NO	11/13/2018 12:22 PM
78	Yes	11/13/2018 12:20 PM
79	Not sure	11/13/2018 12:07 PM
80	Unsure.	11/13/2018 12:06 PM
81	not satisfied because I pay more now.	11/13/2018 12:01 PM
82	no experience	11/13/2018 11:57 AM
83	Don't know	11/13/2018 11:56 AM
84	n/a	11/13/2018 11:54 AM
85	Unknown	11/13/2018 11:50 AM
86	I have no particular view on this	11/13/2018 11:44 AM
87	no	11/13/2018 11:42 AM
88	n/a	11/13/2018 11:40 AM
89	Not familiar	11/13/2018 11:37 AM
90	Not to common known with the system	11/13/2018 11:27 AM
91	No	11/13/2018 11:24 AM
92	N/A	11/13/2018 11:14 AM
93	No	11/13/2018 11:08 AM
94	NA	11/13/2018 10:59 AM
95	The systems lack easy differentiation between tariffs.	11/12/2018 8:55 PM
96	They are biased towards the supply authority and not made to promote EGS	11/12/2018 12:16 PM
97	There are some issues with metering consolidation that have caused us some headaches - specifically the balancing of energy exported vs energy consumed for billing purposes.	11/12/2018 10:20 AM
98	n/a	11/12/2018 10:12 AM
99	Yes	11/12/2018 8:24 AM
100	Not Exp	11/12/2018 7:57 AM
101	No	11/10/2018 8:45 PM
102	N/A	11/10/2018 11:01 AM
103	N/A	11/9/2018 8:10 PM
104	n/a	11/9/2018 6:51 PM
105	No personal experience. However, I believe we need to install smart metering and use its capabilities!	11/9/2018 3:42 PM
106	No because they are always faulty	11/9/2018 3:19 PM
107	N/A.	11/9/2018 2:48 PM
108	No	11/9/2018 2:09 PM
109	No	11/9/2018 1:44 PM
110	No many mistakes on billing	11/9/2018 12:35 PM
111	No	11/9/2018 12:17 PM
112	Not really because some municipalities doesn't allow such kind of installation and	11/9/2018 12:10 PM
113	NO.	11/9/2018 11:34 AM
114	n/a	11/9/2018 11:22 AM
115	yes, AMI metering technology is matured. feed-in tariffs should be on 1-to-1 basis	11/9/2018 11:20 AM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

116	No	11/9/2018 11:05 AM
117	NO - Solar system owners get penalized by higher availability chargers that non solar people - not a level playing field. Smart meter cost of R11000 in Cape Town is absolutely ridiculous	11/9/2018 11:03 AM
118	Yes, although the tariffs could be better to serve as an incentive.	11/9/2018 10:45 AM
119	N/A	11/9/2018 10:39 AM
120	yes	11/9/2018 10:23 AM
121	No. Needs time of use.	11/9/2018 10:16 AM
122	N/A	11/9/2018 10:13 AM
123	n/a	11/9/2018 9:52 AM
124	no	11/9/2018 9:43 AM
125	Yes	11/9/2018 9:15 AM
126	The technology is fine. The regulations vary widely	11/9/2018 9:13 AM
127	YES	11/9/2018 8:51 AM
128	Yes.	11/8/2018 7:58 AM
129	yes	11/5/2018 11:41 AM
130	Yes	11/2/2018 2:12 PM

Q25 Do you think that trading surplus energy from increasingly larger EGS is viable in the future under current conditions?

Answered: 157 Skipped: 505



ANSWER CHOICES	RESPONSES	
Yes	78.34%	123
No	21.66%	34
TOTAL		157

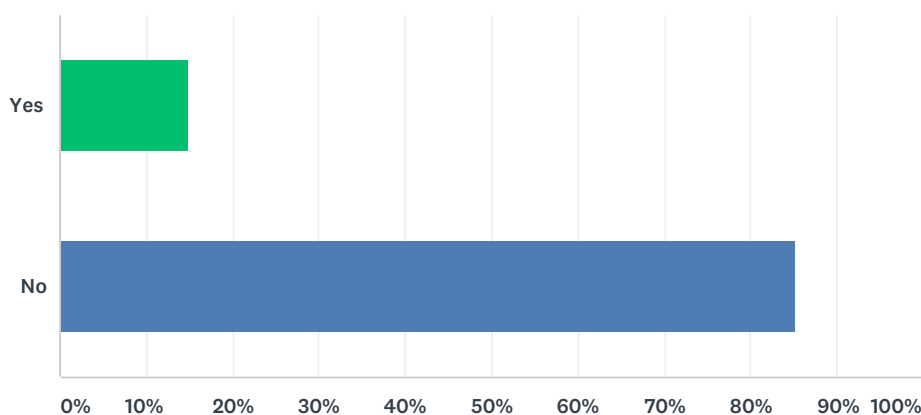
#	IF NO, WHAT IS PREVENTING THIS FROM HAPPENING IN THE FUTURE?	DATE
1	Eskom and regulations	12/7/2018 9:32 AM
2	It's marginal at the moment but will improve.	11/20/2018 8:03 AM
3	Too expensive	11/19/2018 6:30 AM
4	Insufficient current knowledge. Still too politically driven	11/18/2018 2:04 PM
5	Because the Municipality does not want to lose the income from their sales and discouraged User Generation.	11/18/2018 10:59 AM
6	Eskom will need to revise their policies on PPS installations.	11/18/2018 10:36 AM
7	There are still numerous grid challenges that need to be overcome. Local trading at a small scale should be feasible - e.g. wheeling to a building next door.	11/17/2018 4:31 PM
8	This type of power generation is the answer to our country's shortage. The systems are financed, installed and maintained by the house owners which in turn get some return for their investment. Nampower will have to maintain the national electricity grid, sell power and become controller of the power producers without spending big amounts of money. The only way forward. If NO, what is preventing this from happening in the future? See question 28.	11/16/2018 10:21 AM
9	pricing	11/15/2018 3:16 PM
10	City and Central Government policy is too erratic and unpredictable	11/14/2018 8:17 PM
11	Budget is the major issue within SA due to corruption and lacking of financial management in fairness and honesty.	11/14/2018 1:52 PM
12	Eskom bureaucracy	11/14/2018 11:22 AM
13	Eskom will not allow it.	11/14/2018 10:26 AM
14	Have no more time for this questionnaire, much like the "Payback Period". Who in his right mind wants to keep investing in questions whilst seemingly being locked in with "No end in sight" yet the proposition of success is based on the scale of investment. This is the perfect example of contradiction as to why the system keeps failing.	11/14/2018 9:53 AM
15	Failure to recognise independent power suppliers	11/13/2018 10:45 PM
16	Inability of metro's to implement the system	11/13/2018 5:44 PM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

17	Not under CURRENT conditions - government is not equipped to address this matter ("future" and "current" clash)	11/13/2018 4:58 PM
18	ESCOM SEE IT AS OPPOSITION	11/13/2018 3:42 PM
19	Municipalities monopolizing energy selling to protect income generated by up selling power bought from Eskom.	11/13/2018 2:23 PM
20	With careful and balanced calculations concerning the rate of trade and reuse, versus the rate at which energy is saved; it may be determined that trade is regulated so as not to exceed the rate of saving energy, while incentivising a net preservation of resources in a growing manner. It must be noted, however that policies must be concise, although flexible.	11/13/2018 1:54 PM
21	Escom, Government legislation and too many in local authorities, with the power to make a change, who do not believe in sustainable generation of green power	11/13/2018 1:36 PM
22	metros and government are still resisting this as it intervenes with corruption	11/13/2018 1:34 PM
23	Politics and the inability of really being serious about this from the ANC government	11/13/2018 1:07 PM
24	Government and Escom need to wake up!	11/13/2018 12:57 PM
25	Greed and overhead cost. Poor service provider vision	11/13/2018 12:53 PM
26	The greatest focus is on the poor and their supply of electricity for either for free or very cheap	11/13/2018 12:24 PM
27	City of Cape Town appears not be ready for such an installation.	11/13/2018 12:14 PM
28	Government needs to get serious about an implementation model/s	11/13/2018 11:44 AM
29	Trade unions	11/13/2018 11:43 AM
30	Distrust in local authorities ability to and handling of such systems	11/13/2018 11:37 AM
31	Under current conditions utilities are not realizing the potential of coordinating generation within their areas.	11/12/2018 8:55 PM
32	Critical success factor.	11/12/2018 8:21 AM
33	Not financially attractive	11/9/2018 8:10 PM
34	Yes - especially using it to reduce loading on constrained lines by supplying from local sources - but then need local storage too.	11/9/2018 3:42 PM
35	Requires a sophisticated smart grid network and policy/legislative support	11/9/2018 2:25 PM
36	Old infrastructure, no way to measure generation and no method to pay generators or manage demand centrally	11/9/2018 12:35 PM
37	Current conditions do not allow for efficient independent operation of certain parts of the power delivery process. Having trading occur publicly with so much uncertainty with the current lack of skills and high unemployment is preventing surplus energy trading from happening.	11/9/2018 12:17 PM
38	Users / generators must work with Munics to generate their stored surplus energy during peak times at high tariffs. This will assist the network.	11/9/2018 11:34 AM
39	The storage problem has to be overcome.	11/9/2018 11:29 AM
40	Cities are protecting their electricity market and will do anything to prevent others taking their business away. Laws will have to change	11/9/2018 11:03 AM
41	Awaiting standards and regulations and tariffs	11/9/2018 10:16 AM
42	1. Low feed in tariff 2. Technical difficulties in maintaining safety with a wide variety of installers	11/9/2018 9:13 AM

Q26 Have you experienced any existing EGS that is scaled to generate surplus energy directly to a tenant or third party for commercial gain?

Answered: 161 Skipped: 501



ANSWER CHOICES	RESPONSES	
Yes	14.91%	24
No	85.09%	137
TOTAL		161

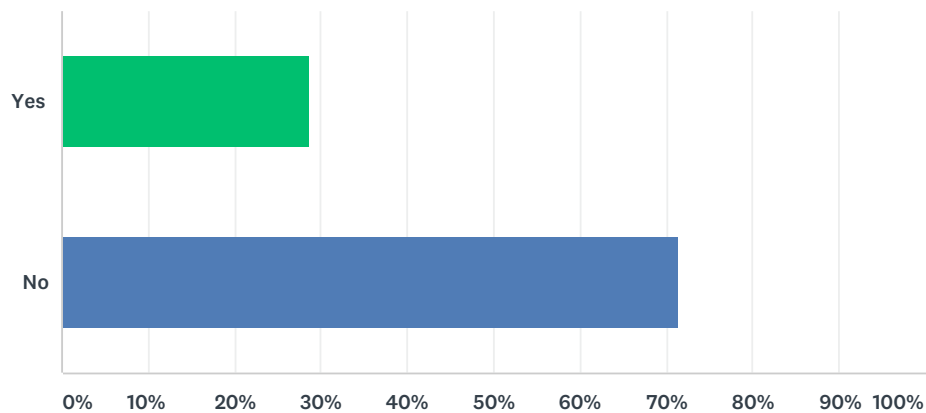
#	IF YES, BRIEFLY DESCRIBE THE SYSTEM AND WHAT COMMERCIAL ARRANGEMENTS ALLOW FOR THE METERING AND SALE OF ENERGY BETWEEN THE PARTIES?	DATE
1	Fluor Woodmead Solar PV installed by Landlord and savings realized taken by the Landlord over a 10 year payback period	11/28/2018 7:50 AM
2	Lots of interest but many restrictions from NERSA and Eskom.	11/20/2018 8:03 AM
3	large photovoltaic system implements to off set tenants huge energy demand. Lease holder sold elec back to tenant at reduced rate.	11/19/2018 10:43 PM
4	PPA between land lord and tenant. 730 kWp system in Boksburg	11/19/2018 10:54 AM
5	Clients wish to do so but couldn't as yet due to regulatory constraints	11/18/2018 10:48 AM
6	Partial. As a building owner, we generate energy that is consumed on premise by the tenants. Tenants are billed at the same tariffs as those applied to the building by the municipality.	11/17/2018 4:31 PM
7	no experience	11/14/2018 8:17 PM
8	where surplus energy is sold to the local municipality	11/14/2018 5:47 PM
9	PV on top of the roof that generate enough surplus energy for the municipality and have revenue from that installation	11/14/2018 1:57 PM
10	Have no more time for this questionnaire, much like the "Payback Period". Who in his right mind wants to keep investing in questions whilst seemingly being locked in with "No end in sight" yet the proposition of success is based on the scale of investment. This is the perfect example of contradiction as to why the system keeps failing.	11/14/2018 9:53 AM
11	AT A GUEST HOUSE, SOLAR PANELS THAT GENERATES MORE POWER THAN NEEDED DURING THE DAY. SURPLUS GO INTO THE GRID AND METER RUN BACKWARDS. USE MORE ENERGY DURING THE NIGHT	11/14/2018 9:03 AM
12	Houses in housing estate supplies surplus power to the estate	11/13/2018 2:51 PM
13	Agrizone in KZN produces over 600KW of electricity and is feeding into the local grid.	11/13/2018 1:44 PM
14	Most household power is generated during the day, which means some could be routed to the grid when not used	11/13/2018 12:51 PM
15	King Shaka, Agrizone	11/13/2018 11:08 AM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

16	We have multiple sites export energy into the grid via our PPA with POWERX, and some sites where property owners have bulk supplies that are submetered and billed to tenants - in this case the PV energy is sold to tenants via the same billing and metering arrangement.	11/12/2018 10:20 AM
17	Solar policy in Germany.	11/12/2018 8:21 AM
18	In gated communities	11/9/2018 1:44 PM
19	Legally difficult to do in RSA especially if one wants to do this via the network. This is called 'wheeling' of power / energy.	11/9/2018 11:34 AM
20	recently had query from installer that wishes to install a free SSEG system on consumer roof and sell power to consumer	11/9/2018 11:20 AM
21	dual purpose smart meters installed.	11/9/2018 10:23 AM
22	Presently working with a wheeling contract	11/9/2018 9:13 AM

Q27 Do you have a reasonable understanding of the policies and regulations that govern the use of EGS in the built environment?

Answered: 164 Skipped: 498



ANSWER CHOICES	RESPONSES	
Yes	28.66%	47
No	71.34%	117
TOTAL		164

#	IF YES, BRIEFLY DESCRIBE WHICH POLICIES OR REGULATIONS ARE THE MOST RESTRICTIVE WHEN TRYING TO INCLUDE EGS IN AN EXISTING OR NEW BUILDING IN AN URBAN CENTER?	DATE
1	Grid codes of South Africa	11/30/2018 6:49 PM
2	A piece of string question. It depends what you want to do. Municipal by-laws and grid-connection criteria are restrictive but only really if you don't ascertain beforehand what they are and which inverters are approved, for instance. People tend to install first and try to regularise the installation afterwards.	11/20/2018 8:08 AM
3	None are restrictive but we lack policies so Eskom come up with non sense to restrict their clients. even charging them for the energy they push into the network.	11/19/2018 10:56 AM
4	At the time of start-up the Municipal laws did not allow for a feed-in tariff which was vigourously discouraged.	11/18/2018 11:03 AM
5	feed in tariff policies	11/18/2018 10:30 AM
6	The policies are not unnecessarily restrictive in Cape Town. The cost charged by the city for installing a bidirectional meter is exorbitant and can discourage the installation of smaller systems.	11/17/2018 4:36 PM
7	"Reasonable" is a relative term. In new buildings cannot comment because too soon. In retro-fitted buildings it depends on the system and how it was installed.	11/17/2018 8:46 AM
8	One is not allowed to go off the grid when generating sufficient energy to be self sustainable.	11/16/2018 12:22 PM
9	When renewable energy power sources become less restrictive, every existing or new dwelling will be equipped with some form of energy saving device . This trend will have an effect on house designs to accommodate these new technologies.	11/16/2018 10:24 AM
10	sending excess electricity back into the grid	11/16/2018 9:47 AM
11	'active' system approach, prioritised as per best practice mentality. passive system 'housekeeping' not appreciated. obsession with emphasis data and quantification.	11/15/2018 3:16 PM
12	Height	11/15/2018 7:35 AM
13	not sure	11/14/2018 8:18 PM
14	Limited number of municipalities offer feed into grid	11/14/2018 2:55 PM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

15	SANS 10142 Registration of solar modules.	11/14/2018 2:31 PM
16	Have no more time for this questionnaire, much like the "Payback Period". Who in his right mind wants to keep investing in questions whilst seemingly being locked in with "No end in sight" yet the proposition of success is based on the scale of investment. This is the perfect example of contradiction as to why the system keeps failing.	11/14/2018 9:53 AM
17	not having feed in tariffs or not being allowed to grid tie a system	11/14/2018 9:01 AM
18	buy back systems....., these are common place in Europe and America, but ZA is way behind...	11/14/2018 1:55 AM
19	Besides, failure to recognise independent power suppliers, even SANS 10400 is too lenient and exempts a large portion of households from compliance	11/13/2018 10:54 PM
20	Are there any policies & regulations ? Where would one get these ?	11/13/2018 5:01 PM
21	permission to go off grid is NEVER permitted. Municipalities will go broke if they loose their revenues.	11/13/2018 3:44 PM
22	Energy supplier force developer to also pay for connection	11/13/2018 2:53 PM
23	The municipal bylaws are most restrictive.	11/13/2018 1:58 PM
24	Not too much. Using a competent person to deal with that issues. My own is more how the system fit in with the design and implications on the structural system if placed on roofs etc.	11/13/2018 1:38 PM
25	The combination of old ideas and new tech does not mix well	11/13/2018 11:55 AM
26	The conversion of bio-waste materials into usable source of hydration systems	11/13/2018 11:39 AM
27	Feed-in tariffs	11/12/2018 8:59 PM
28	Safety in respect to back feeding and tariffs of selling power back to the supply authority	11/12/2018 12:19 PM
29	Regular changes and variation in local authority requirements	11/9/2018 8:13 PM
30	SANS 10142 : New regulation requirements. Under 1KV no regulations that are restrictive. Regulations to complete when grid-tie is done.	11/9/2018 2:48 PM
31	High fixed charges for connection of bidirectional grid-tied systems which affects viability and affects sizing.	11/9/2018 2:01 PM
32	Not allowing to feed back excess energy into the grid	11/9/2018 1:47 PM
33	Grid Code interconnection rules.	11/9/2018 12:19 PM
34	This depends on the power rating of the system. And if one wants to generate surplus into the network. Wheeling is presently not done in RSA and not legislated.	11/9/2018 11:38 AM
35	Lead acid batteries give off hydrogen new regulations with regard to safety will have to be instituted depending on technology.	11/9/2018 11:34 AM
36	feed in tariff	11/9/2018 11:23 AM
37	NRS 097 is the standard we currently process SSEG applications on and meets in excess of 90% of our current applications recieved	11/9/2018 11:22 AM
38	The RE Grid Code (for larger plants) NRS requirements No clear design criteria available	11/9/2018 11:07 AM
39	TAriffs structure for end user, requirement for Prg certification for domestic households , cost of smart energy meters	11/9/2018 11:05 AM
40	Not too bad if there is no feed in	11/9/2018 9:14 AM

Q28 What changes in regulation or policy would you recommend to increase the diffusion of EGS in the built environment?

Answered: 110 Skipped: 552

#	RESPONSES	DATE
1	Maybe a government sponsored adoption programme. Regulation and policy is reasonable currently and doesn't really need amendment.	11/30/2018 6:49 PM
2	house holds to feed back into the grid	11/26/2018 3:35 PM
3	IPP and wheeling restrictions from NERSA and Eskom need to be lifted. The licence requirement ceiling set by NERSA must be raised.	11/20/2018 8:08 AM
4	SANS 10142 part 1 LV part 2	11/19/2018 10:56 AM
5	More knowledgeable persons are needed at high levels of regularity organizations	11/18/2018 2:07 PM
6	Freedom for energy interchange at reasonable rates.	11/18/2018 11:03 AM
7	Too many to mention. We could engage in a direct conversation to discuss this perhaps.	11/18/2018 10:49 AM
8	Re-instate the subsidy system to encourage developers and owners to install EGS systems.	11/18/2018 10:37 AM
9	requires surplus capacity for unit installations incorporated into Feed in Tariff systems to augment pay back period for capital costs	11/18/2018 10:30 AM
10	Fair tariffs that charge a fair "network charge" after which import and export tariffs are the same. Bidirectional meters are installed as a matter of course by the municipality when performing scheduled end-of-life replacements of old meters.	11/17/2018 4:36 PM
11	What's use of regulation or policy if there is poor implementation and no law enforcement?	11/17/2018 8:46 AM
12	It would be difficult to make the use of EGS mandatory other than solar panels since you cannot rely on the climatic conditions.	11/16/2018 12:22 PM
13	Probably rethink of how we live > revitalise the rural areas with local 'self sufficient' new tech ... avoid losses in long power lines ...phase out coal fired powerstations ...	11/16/2018 11:20 AM
14	Currently the ECB (Electrical Control Board) is controlling the power generation and supply of this country. The prices of power are increasing yearly at a rapid rate and nothing is done about it. What will happened in the future if nothing changes: 1 The people with money will invest into renewable off grid systems, considering the new storage technologies. 2. The people without money will not be able to keep up with the ever increasing prices. The end result will be that nobody will pay to maintain the national electrical grid and its controlling body.	11/16/2018 10:24 AM
15	the above	11/16/2018 9:47 AM
16	To be able to put power back on the grid	11/15/2018 4:27 PM
17	increae implementation capacity at regulatory "official" level, ie capacity building, to allow discretionary not tick-box responses.	11/15/2018 3:16 PM
18	Allow anyone the option of supplying energy into the grid.	11/15/2018 2:15 PM
19	Deregulate the processes involved for EGS systems to connect to the grid. Promote Grid tied systems.	11/15/2018 12:56 PM
20	I would suggest Municipalities install equipment at no cost for a period to encourage greater penetration in the market esp. to small residential consumers, like they did in Germany	11/15/2018 8:25 AM
21	Height zones and wind turbines	11/15/2018 7:35 AM
22	certainty fair tariffs for power sold to the grid	11/14/2018 8:18 PM
23	Allow third parties to facilitate feed-in	11/14/2018 2:55 PM
24	None at this stage.	11/14/2018 2:31 PM
25	Fiscal and economic incentives	11/14/2018 2:13 PM
26	Free Renewable energy to be bartered or sold to the public without monopoly	11/14/2018 1:59 PM
27	Simplified - less complication in wording and/or statement.	11/14/2018 1:53 PM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

28	wind	11/14/2018 10:39 AM
29	cannot comment	11/14/2018 10:27 AM
30	Have no more time for this questionnaire, much like the "Payback Period". Who in his right mind wants to keep investing in questions whilst seemingly being locked in with "No end in sight" yet the proposition of success is based on the scale of investment. This is the perfect example of contradiction as to why the system keeps failing.	11/14/2018 9:53 AM
31	BUYING OF ENERGY BY THE ENERGY REGULATOR	11/14/2018 9:05 AM
32	I suggest a grid and meter system that allows a certain quota of units, and then cuts the power. If you require more electricity than your quota, then you need to generate it yourself. This will leave it up to the individual to decide how they will save energy, rather than complex regulations for fenestration and insulation etc. Punitive tariffs only work to a point. We cannot allow those without budget constraints to waste energy just because they can afford to pay more. They are the ones who can actually afford to be independent of the system	11/14/2018 9:01 AM
33	To have more workshops to built invironment students about energy efficiency laws	11/14/2018 8:48 AM
34	Electricity buy-back or off-set against accounts could be useful, but may be problematic for local governments in terms of revenue (they have limited revenue avenues, such as rate and mark-up on electricity and water supply). There may have to be some regulation around how this is dealt with on a national level, to prevent revenue loss to local councils. Feedback into the grid could also be problematic for power supply, as it affects power usage from power stations - particularly where users have limited batteries and use daylight hours to generate their own electricity. May be worth speaking to high voltage engineers about this.	11/14/2018 3:51 AM
35	as per Q27	11/14/2018 1:55 AM
36	Compliance with global energy use standard to prevent more than 2 degree increase in global temperatures at all levels and functions/ uses of built environment. Increased public transport investments, and mixed land use imperative to sustainability. Independent power suppliers including households to feed excess power back into grid and duly compensated. Incentives to role out at massive scale I.e. Instead of a budget to build Modupi, each household could have received a R50K subsidy for eggs (E.g start up solar panels+ battery)	11/13/2018 10:54 PM
37	n/a	11/13/2018 8:59 PM
38	-	11/13/2018 7:45 PM
39	I dont have knowledge of any regulations	11/13/2018 7:21 PM
40	IF there are policies & regulations, then such information must be made MUCH MORE readily to all design professionals, with guidelines & examples showing how to use same	11/13/2018 5:01 PM
41	Government needs to accept that it can rely on this supply to the grid and relax the regulatory obstacles around it. Also implement metering technology that makes it simple and viable.	11/13/2018 4:41 PM
42	Too soon to tell	11/13/2018 4:39 PM
43	na	11/13/2018 4:36 PM
44	tax incentives	11/13/2018 3:59 PM
45	- More "rewards" (eg tax breaks) for using ECG and allied Green technology in the built environment. - Legislation from the Govt. encouraging uptake of ECG especially within its own Public Works which is responsible for most of the construction in the country.	11/13/2018 3:45 PM
46	let all who want to go off grid do so. relax controls to permit innovation and self reliance. Dont keep civilians as children.	11/13/2018 3:44 PM
47	SELL ESCOM TO PRIVATE BIDDERS WHO WILL BE MORE WILLING TO STEER AWAY FROM THE STATUS QUO	11/13/2018 3:43 PM
48	All new houses and business buildings must be supplied with the equipment. It are match essayer to design a building from the start than do modifications to existing buildings	11/13/2018 3:39 PM
49	Allowing feed-in to the grid for over generation.	11/13/2018 3:26 PM
50	na	11/13/2018 3:08 PM
51	Better system that allows stakeholders to engage with suppliers on regular basis to find solutions for all	11/13/2018 2:53 PM
52	Much like SANS204, some form of EGS needs to be forced into legislation for new builds of all types, with tax kickbacks for 5 to 10 years.	11/13/2018 2:39 PM
53	Selling solar generated energy to the grid.	11/13/2018 2:24 PM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

54	More skilled administrators of policies, and the provision of a greater variety of allowable resolutions.	11/13/2018 1:58 PM
55	Subsidies for lower income families from the government to install EGS.	11/13/2018 1:46 PM
56	?	11/13/2018 1:34 PM
57	Not sure	11/13/2018 1:07 PM
58	Not negotiable with current shareholders ? The service provider should have a long term investment policy to encourage public interest.	11/13/2018 12:57 PM
59	be able to supply energy back into to the grid at a reasonable credit	11/13/2018 12:53 PM
60	mentionable legislation and a will for change	11/13/2018 12:43 PM
61	No regulation please! Keep governments dirty fingers as far from private initiatives as possible. They already started toying with the idea of regulating and licensing small private home solar users! ... for the money	11/13/2018 12:39 PM
62	Environmental management requirements should be improved. A set tariff rate for supplying the grid, related to industry rated norms	11/13/2018 12:35 PM
63	Start Implementing the latest technologies now	11/13/2018 12:24 PM
64	Unsure.	11/13/2018 12:09 PM
65	Not sure - make it easier to implement, incentives will increase its implementation dramatically.	11/13/2018 12:08 PM
66	To be frank I know too little about the regulations to give a educated answer. Sorry.	11/13/2018 12:03 PM
67	Clear policies linked to the building regulations, additional information made available - largest problem however remains the financial incentive	11/13/2018 11:59 AM
68	Changes would be beneficial to the smaller user, i.e. residential, small business, etc.	11/13/2018 11:57 AM
69	Unknown	11/13/2018 11:51 AM
70	N/A	11/13/2018 11:42 AM
71	Clarity in regulation - clear municipal incentives to encourage the use of such technologies.	11/13/2018 11:41 AM
72	Standardisation and attainable guidelines from local authorities for implementation of available EE systems	11/13/2018 11:39 AM
73	Introduce ability to pay back customer if they can generate electricity that can feed into the grid	11/13/2018 11:35 AM
74	Move with technology - sell to the grid , all 1st world countries have started and so far its successful.	11/13/2018 11:30 AM
75	reduction in oil and coal use wherever possible/viable, leading to stop dates.	11/13/2018 11:29 AM
76	N/A	11/13/2018 11:14 AM
77	Planning and Zoning	11/13/2018 11:08 AM
78	N/A	11/13/2018 11:00 AM
79	Feed-in tariffs and coordinated management of embedded systems	11/12/2018 8:59 PM
80	Deregulation of rules with Nersa and a win - win situations with EGS producers and supply authorities.	11/12/2018 12:19 PM
81	Approvals for grid connection need to be refined and standardised in order to create stability and predictability in the process	11/12/2018 10:54 AM
82	Not sure, but the issue of licensing EGS, may be a hindrance.	11/12/2018 8:26 AM
83	Ensure buy back of surplus energy	11/12/2018 8:21 AM
84	Nett metering of commercial connections should be provided in all new installations	11/11/2018 7:47 PM
85	N/A	11/10/2018 11:01 AM
86	Better feed in tariffs. Less restriction on approval of products/systems	11/9/2018 8:13 PM
87	It seems to be working OK at the moment!	11/9/2018 6:52 PM
88	Speed up time to register EGS at NERSA and Munics/Eskom. Ensure Munic staff understand the dangers of high voltage, and back-feeding during line outages, and change tariffs to cover connection charges even at low usage, not just energy usage.	11/9/2018 3:47 PM
89	Complete Regulations so that Municipalities can continue with grid-tie.	11/9/2018 2:48 PM

ADOPTION OF EMBEDDED RENEWABLE ENERGY GENERATION SYSTEMS IN CITIES

90	Governance of roof top PV feeding back to grid	11/9/2018 2:10 PM
91	Lower fixed connection charges for bidirectional systems.	11/9/2018 2:01 PM
92	feed back excess energy into the grid, Create nodes/hubs of storage systems (batteries) to supply small communities of industrial parks.	11/9/2018 1:47 PM
93	Small Scale Embedded Regulation document should be enforced and supported so there can be support for ESG on a practical level by government such as the REIPP where a dedicated office to manage the process helped show government was prepared.	11/9/2018 12:19 PM
94	EGS must allowed to feedback to the grid	11/9/2018 12:11 PM
95	I do not believe that EGS is the best option. But users are forced into it due to price and unreliability of supply from Eskom who are a bad monopoly.	11/9/2018 11:38 AM
96	We will have to arrange our "work" to suit the available energy. Eg work daylight hours. Purify water (desalination) during daylight hours.	11/9/2018 11:34 AM
97	Easier legislation to sell electricity back into the grid for all users.	11/9/2018 11:25 AM
98	clear feed in tariff and time of use tariff	11/9/2018 11:23 AM
99	subsidy of SSEG installations instead of upfront capital costs	11/9/2018 11:22 AM
100	none	11/9/2018 11:22 AM
101	Clear Design criteria and approved supplier's list for each municipality or nationally (SANS standards would be best). Grid Code compliance testing be clarified for variety of scales	11/9/2018 11:07 AM
102	Tariff structures to be uniform across the country - every municipality has their own Tariff structure and policy. Policies need to be national	11/9/2018 11:05 AM
103	Bigger incentives?	11/9/2018 10:45 AM
104	Feed-in tariff	11/9/2018 10:44 AM
105	Allow trading of surplus, introduce tariffs	11/9/2018 10:17 AM
106	n./a	11/9/2018 9:52 AM
107	N/A	11/9/2018 8:51 AM
108	Subsidies on bulk services contributions and tariffs.	11/8/2018 7:59 AM
109	n/a	11/5/2018 11:41 AM
110	Not sure	11/2/2018 2:13 PM