Gordon Institute of Business Science
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Energy procurement in the South African electricity supply industry – future scenarios for large power users

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Abstract

Whilst the procurement of electricity within South Africa for large power users is currently done through the incumbent utility, Eskom, the future of electricity purchases within South Africa may be radically different. Structural changes to the South African electricity supply industry is likely in the next few years spearheaded by the unbundling of Eskom.

In order to survive in this new world, procurement offices for large power users need to design strategies that are agile enough to adapt to these changes yet stable enough to ensure security of supply. This need may be facilitated by having a view of the possible futures and the factors responsible for driving it.

This paper identifies the drivers of change for a future electricity supply industry through utilising scenario planning. The scenario planning framework is applied qualitatively through two subject matter expert focus groups. The results indicate there are seven drivers likely to influence the future electricity supply industry with two drivers, a desire to deregulate the electricity supply industry and an increased pressure to decarbonise the energy sector, having the biggest impact. Based on this, four alternative future narratives are derived to describe the plausible future of the electricity supply industry.

Keywords: electricity supply industry, large power user, energy procurement, scenario planning

Declaration

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

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Abbreviations

DFFE	Department of Forestry, Fisheries and the Environment
DMRE	Department of Mineral Resources and Energy
DPE	Department of Public Enterprises
EAF	Electricity Availability Factor
EIUG	Energy Intensive Users Group
EKC	Environmental Kuznets Curve
EPP	Electricity Pricing Policy
ERA	Electricity Regulation Act
ESI	Electricity Supply Industry
GDP	Gross Domestic Product
GHG	Greenhouse Gasses
IPP	Independent Power Producer
IRP	Integrated Resource Plan
LPU	Large Power User
MYPD5	Fifth Multi-Year Price Determination
NERSA	National Energy Regulator of South Africa
PAR	Participatory Action Research
PPA	Power Purchase Agreement
RCA	Regulatory Clearing Account
REFIT	Renewable Energy Feed-In Tariff
REIP3	Renewable Energy Independent Power Producer Procurement
SADC	Southern African Development Community
SAWEA	South African Wind Energy Association

SONA	State of the Nation Address
TSO	Transmission System Operator

Chapter 1

Large Power Users (LPUs) typically see the procurement of electrical energy as an involved process requiring great care and an investment of time. That is because, unlike residential and small commercial clients, electrical energy costs contribute significantly to the overall cost make-up of LPUs. LPUs typically deal in commodities where local and global events can have a significant impact on the price and demand of the commodity thereby impacting on the profitability of the LPU. For this reason, LPUs need to carefully manage their electricity costs and strategies as this cannot be detached from their business environment. A view of the future price and availability of electricity can greatly enhance a LPU's ability to adapt to its business environment. Scenario planning is one framework that can be used to determine a future view and this research paper explores this framework from a South African context.

LPUs usually have highly specialised personnel dealing with determining its electrical energy sourcing and execution plans. These plans may differ depending on where the LPU is situated geographically as well as the structure of the Electricity Supply Industry (ESI) in that region. Procurement of energy globally and specifically in developed countries consist of three to four levels along with its associated prices.

Levels of Energy Procurement

In the first level, procurement has been affected by the move away from vertically integrated utilities into its three major components including Generation, Transmission and Distribution (Banshwar, Sharma, Sood, & Shrivastava, 2017). Although the Generation of electrical energy and the Distribution of that electrical energy to the final consumers have been subjected to privatization and competition, the Transmission System Operator (TSO) remain state-owned and mandated to protect the energy system integrity (Dolega, 2010).

If Distribution systems can be described as the roads within suburbs, the Transmission system is akin to the highways linking everything together. It is therefore crucial for the TSO to ensure the effective and secure operation of the Transmission system as well as the expansion of the Transmission grid to ensure projects and loads may connect to it (Dolega, 2010). In the case of cross-border Transmission systems, the TSO of each region needs to ensure the smooth cross-over between those Transmission systems as well (Knops, 2003).

Ensuring the effective and secure operation of the Transmission system has, as in the case of California (Razeghi, Shaffer, & Samuelsen, 2017), necessitated the need for the TSO to purchase very specific electricity products to stabilize the grid – these electricity sources (or services) are known as ancillary services (Banshwar et al., 2017; Le Cadre, Mezghani, & Papavasiliou, 2019) and although they may be bought through market mechanisms (Banshwar et al., 2017) or Distribution entities (Le Cadre et al., 2019) their costs are recovered through fixed “use of system” costs charged by the TSO. These costs are therefore paid regardless of whether a LPU purchases electricity or not. The first level is shown graphically in Figure 1 below.

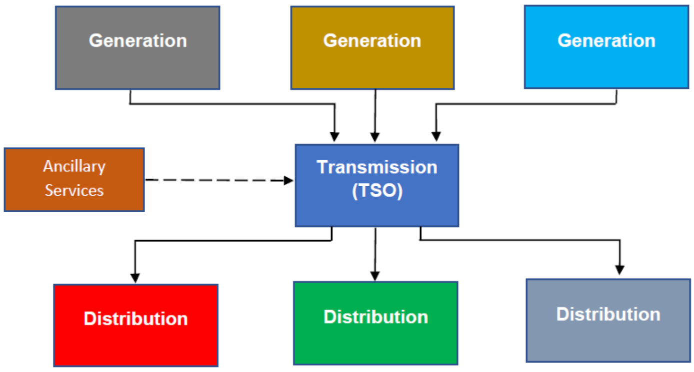

Figure 1: TSO ancillary services fixed costs

The second level consist of energy purchases that the LPU will use and is typically done through medium- to long term Power Purchase Agreement (PPAs) (Banshwar et al., 2017; Razeghi et al., 2017) – South Africa will in future likely follow the same route given the draft amendment to the Electricity Regulations Act (ERA) published by the Department of Mineral Resources and Energy (2021). Medium- to long term PPAs will secure supply in a constraint environment but are largely inflexible as noted by The World Bank (2019). According to The World Bank (2019) PPAs are bankable if they adhere to ten principles.

Firstly, the generator of power needs to receive revenue for electricity generated regardless of whether the off-taker (or LPU) can take the electrical energy or not. The Independent Power Producer (IPP), which is the owner of the generator, also needs to charge the off-taker a fixed tariff in the PPA which escalates annually; this tariff should be sufficient to cover the IPP’s cost of generation, debt service requirements as well as provide the IPP a reasonable rate of return commensurate with the project’s risk profile (The World Bank, 2019).

A third requirement for a bankable PPA is that the debt and capital requirements should either be in the PPA tariff currency or the IPP should hedge against these. The IPP also needs to be kept financially whole in the event of a change in law requiring the IPP to pay additional charges where the potential increase in tariff and revenue is to ensure debt may be serviced. A fifth requirement is that IPPs need to be protected during Force Majeure events with the exit clauses in such cases subject to commercial discussions (The World Bank, 2019).

Dispute resolution should also be done in a neutral venue and the PPA should clearly set out what happens in the event of termination when termination payments are due. To facilitate the termination construct, the eighth and ninth requirements for bankable PPAs stipulate the PPA should allow assignment to the lenders and that the off-taker needs to provide payment support (both short-term liquid security as well as long term guarantees) to ensure the off-taker's creditworthiness does not impact project risk (The World Bank, 2019).

The last requirement is that the PPA should clearly indicate who bears the risk for grid connection and related network events with common practice being the off-taker carrying the most of this (The World Bank, 2019). Some of the PPAs LPUs sign may be with previously monopolised generators.

Although medium- and long term PPAs have clear benefits, the risks the off-taker needs to assume are quite onerous with significant guarantees from the LPU being required to make the project bankable. Figure 2 below indicates an example of a PPA structure.

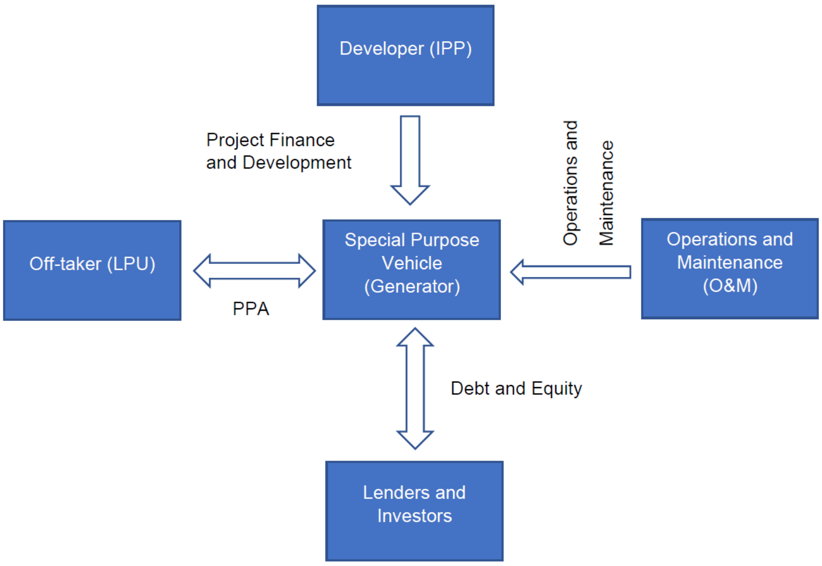

Figure 2: Typical Power Purchase Agreement (PPA) structure

Adapted from the United States Department of Energy (2022)

The third pricing level for LPUs is brought about by trading which consists of shorter-term auction schemes where supply and demand is only committed a day or more ahead in order to avoid price volatility. Trading is done by IPPs which do not wish to (or cannot due to price or other factors) commit to a single off-taker and is rather connected to a trader. The trader on-sells to off-takers (LPUs or Distributors) either through very short PPAs of a few months at most (Dovgalyuk, Saidov, & Yakovenko, 2019) or through the day-ahead trading market (Lange & Focken, 2008). Since the trader takes on the risk with the generator to make the project bankable, the trading market exposes the LPU to very little risk. This does however come at a premium price. Figure 3 below depicts a typical trader structure, connecting the generator (IPP) with the LPU and distributers.

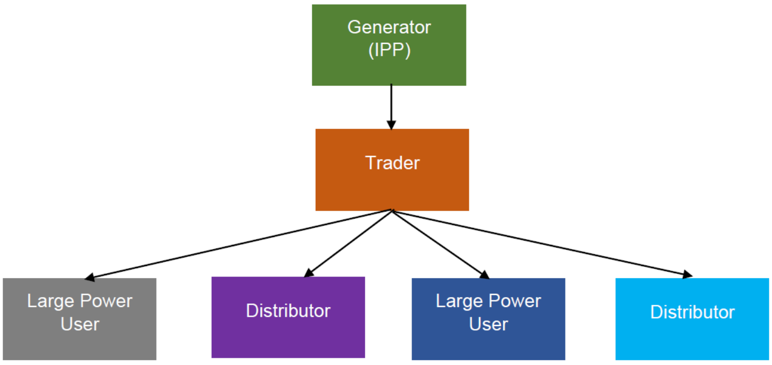

Figure 3: Typical trading structure

A potential fourth level is described by Carrion, Philpott, Conejo and Arroyo (2007) where LPUs face the additional decision whether to invest in own generation or not. Although this is capital intensive and a long-term commitment, large power users may have the available capital and desire to lower their operational expense through lower electricity prices by putting a large capital investment up front. This decision has the added benefit to the LPU of little to no risk exposure. Figure 4 which follows graphically show the various electrical energy procurement opportunities available to a global procurement office of LPUs.

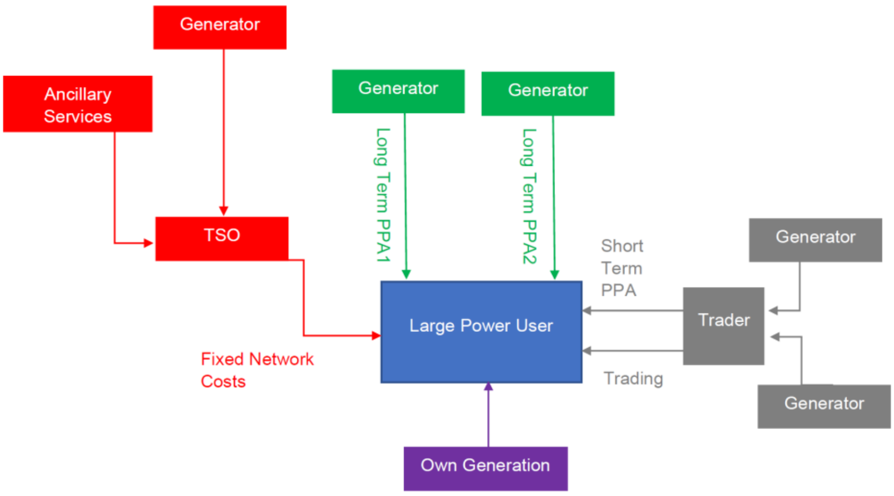

Figure 4: Electrical energy procurement available to LPUs

Notwithstanding the options available as indicated in Figure 4, the ESI is complex in nature (Ravetz, Neuvonen, & Mäntysalo, 2021) and the calls for a more *just energy transition* (Healy & Barry, 2017) which include social inclusion and poverty eradication (Smith, 2017) is increasing. Procurement offices can therefore not design a perfect energy procurement strategy but rather need to be able to adapt its strategy regularly for a dynamic environment. In general, procurement offices for LPUs globally face an uphill battle to ensure their procurement strategies are stable enough to enable operations planning yet agile enough to ensure relevance in a dynamic industry.

World events can have drastic impacts on energy procurement strategies and prices. Events such as the Russian invasion of Ukraine (Sangal et al., 2022) has had a significant impact on commodity prices and demand, such as natural gas and nickel (Fickling, 2022). This volatility can have major impacts on LPUs as these are the users that normally extract or use the commodities affected. Although some events may pass quickly, others have long lasting or even permanent consequences

(Roberts & Bowden, 2022). Procurers of energy for LPUs therefore do not have the luxury of having its energy price path (and consumption guarantees) removed from the context of its business environment. Electricity purchases are not only characterised by a need for savings or even decarbonization but rather to follow a path of least regret given these global events.

Energy Procurement within South Africa

The ESI within South Africa is not yet liberalised as is the case with most global markets. Instead, South African LPUs purchase its power from the state-owned Eskom which supplies generated power along with ancillary services. Currently there is no trading market within South Africa only long term PPAs may be signed and should be below a specific capacity threshold, which has recently been lifted (Tucker, 2021) to 100MW.

However, failings by Eskom (Burkhardt, 2021; BusinessTech, 2021) with its lack of new generation capacity and financial concerns (Burkhardt, 2021) has resulted in various policy discussions focussed on the reform of the South African ESI. With the draft amendment of the ERA (Department of Mineral Resources and Energy, 2021) and draft Electricity Pricing Policy (EPP) (Department of Mineral Resources and Energy, 2022) indicating that the South African Government is considering a move to a more merchant market as seen in developed countries, LPUs need to rethink their procurement strategies.

Procurement offices will no longer only have own generation or long term PPAs as their alternative to Eskom, but may partake in shorter term PPAs as well as trading. The fixed cost owing to ancillary services are also likely to increase. However, South Africa's ESI faces the added complexity of having differences in views between generators and users of electricity and even between politicians from the same political party regarding the right mix and approach to the transition (BusinessTech, 2022b; Stoddard, 2021, 2022) to a liberalised ESI.

While some politicians push for a faster move to a deregulated market with private generators (Stoddard, 2021), Stoddard (2022) notes that another faction of the South African Government punts state-owned nuclear energy as the future of the South African energy system. This uncertainty as to the future structure of the South African

ESI causes a need for LPUs to be able to adapt their procurement strategies; sometimes at short notice.

The use of Scenario Planning for Energy Procurement

This need to adapt the energy procurement strategy is addressed if the energy procurement office has a view on the possible alternative futures that may play out. For this, to map out the alternative possible futures for energy procurement, scenario planning may be done. Although scenario planning has found great application in the policy domain (Oosthuizen, Linde, Durrant, & Gopaldas, 2018; Oosthuizen, Pooe, Mathu, & Alexander, 2015) it has not yet been used to help LPUs design their procurement strategies for energy. It is also unclear how scenario work done on energy policy may be applied to a large power user procurement office. This study therefore addresses this need and fills the gap in the theory and practice related to the use of scenario planning to examine alternative futures for energy procurement in South Africa.

The problem, of the procurement of energy that is both competitive in terms of pricing in the short term and future proof in terms of security of supply in the long term, was therefore selected as the focus of this study. In terms of business and management practice, the study aims to assist procurement offices of LPUs in support of their long-term decision-making. From a scholarly perspective, the current research will add insights from a procurement perspective to the body of knowledge describing the possible alternative futures of the South African ESI. Current research has focused on the possible reactions by utilities (Oosthuizen et al., 2018) to a changing regulatory and user profile environment. This research looks at possible alternative futures procurers of energy for LPUs face as a result of the steps taken by the utilities and the changing regulatory environment.

Chapter 2

In order to understand the alternative futures a procurer of energy may face in South Africa, an understanding of the Electricity Supply Industry (ESI) along with the research and analysis done on the ESI is required. Any past research done on the future of the ESI would take into consideration the drivers of change responsible for changing the ESI and apply these drivers using an analytical approach such as systems thinking. Therefore, to identify the drivers that may be responsible for determining the future ESI in South Africa from a procurement perspective (the subject of Chapter 5) without first understanding the structure of the ESI would lead to a possible prediction (or guess) as opposed to possible alternative futures. The distinction between a *predictive forecast* versus a set of alternative scenarios is an important distinction which underpins the choice to use scenarios, which emphasise the exploration of persistent uncertainty as opposed to probability as the system changes. To this end, this chapter is divided as described below.

Firstly, a discussion around the history of ESIs and the policy trade-offs Governments face aim to provide some context. Next, the impact of the ESI on economic growth and environmental commitments is given to provide an introduction as to why ESI structures differ and what these structures are. The different ESI structures are then discussed with the last section on ESIs focusing on the transition between these different structures, whether natural or forced.

After ESI structures and transition pathways are discussed, focus is drawn to the South African context and what is known and not known regarding the future structure and transition pathway. The literature survey is concluded with a discussion on the status quo of the procurement of energy within South Africa's current environment.

It should be noted that this paper sometimes refers to energy whilst at other times the word electricity is used. Energy is the potential to carry out work or generate heat through a carrier where electricity, a more narrow definition, is one such carrier (Westley, 2017). Therefore, electricity is a form of energy but not all energy is necessarily electricity. In this context of power generation, energy is converted from one form such as gas or coal to electricity. The ESI is therefore used to refer to energy that has already been converted whereas a country's energy imports (in the context of this paper) refers to the raw form of energy that is still to be converted to electricity. Therefore, although every effort is made to remain consistent in the usage of energy and electricity, these words sometimes have the same meaning in practice.

The Electricity Supply Industry

Through the use of mainly water- and steam power, the First Industrial Revolution transformed economies from being mainly agriculture based to that of industrial economies (Sharma & Singh, 2020). This transformation occurred through the ability to produce goods in larger volumes using mechanised processes.

However, it was not until the Second Industrial Revolution that mass production truly emerged, since through advances in electricity, steel and chemicals (Sharma & Singh, 2020) countries experiencing the Second Industrial Revolution saw periods of rapid growth and industrialisation.

The Third Industrial Revolution saw the advent of the Digital Age as described by Lee and Lee (2021) where automation and the invention of the Internet marked a period of rapid growth. Although this period was described as the Digital Age, the economic structure which underpinned the emerging telecommunication and information system, was still mostly that of an industrial economy.

There is some debate about whether the Fourth Industrial Revolution which promotes artificial intelligence is a new revolution or merely a continuation of the Third Industrial Revolution (Lee & Lee, 2021). As pointed out by Lee and Lee (2021) the reach of innovations from the Fourth Industrial Revolution is not as widespread as that of the Third Industrial Revolution. Popkova (2019), on the other hand, argues that the Fourth Industrial Revolution is something on its own as it is existing within a knowledge economy as opposed to an industrial economy.

The Role of Electricity in Industrial Revolutions

With the exception of the First Industrial Revolution, electricity has played a significant role in each of the revolutions and is therefore an integral part of human (and technological) growth. The generation of electricity within a country is organised to form its Electricity Supply Industry (ESI). More specifically, the ESI describes the generation, transmission and distribution of electricity within a country.

The ESI was essentially born in 1831 when Michael Faraday discovered that electricity could be generated through mechanical power using electromagnetic induction. In an effort to solve poor household lighting within the UK, arc lighting and later incandescent lights were introduced into households (McGovern & McLean, 2017). To power this new invention, small generators (mostly sterling engines) popped up around the UK and, although these generators were usually housed in basements and provided electricity only to a very small radius (McGovern & McLean, 2017), this constituted some of the first distribution systems in the world. In South Africa, electricity usage was increasing at a faster pace. In 1860, the first telegraph system was installed between Cape Town and Simon's Town, marking the start of the ESI in South Africa (Eskom Holdings, 2022). By 1882, Kimberley had installed electrical street lights whereas London was still using gas to power its street lights (Eskom Holdings, 2022).

In much the same way that fire is understood to have started the continuous improvement in quality of life and societies, electricity and energy has been driving this social development journey (Niembro-García, Alfaro-Martínez, & Marmolejo-Saucedo, 2022). The proper functioning of electricity and energy systems have therefore not only historically been understood to be crucial for a country's economic progress (Falil & Nasir, 2021) but for the wellbeing of its citizens as well.

It is for this reason that National Governments place high emphasis on the correct policies and regulations to ensure the ESI is in a well-functioning state. Not managing the ESI correctly could place the country at risk. As an example, Chapman and Itaoka (2018) note that Japan still has a high dependence on imported energy where availability, price and geo-political factors may play a big role in Japan's energy sufficiency. A more recent example is the current energy crisis within Europe due to the Russian invasion of Ukraine (von Homeyer, Oberthür, & Dupont, 2022), which has drastically undermined the energy security of major European economies such as Germany thereby not only undermining their social safety as winter approaches but also undermining their economic security.

Role of Policies and Regulations in ESI Management

Governments control the ESI through policies and regulations. Policies are usually aimed at the ESI as a whole whereas regulations mostly only affect those portions of the ESI in which the Government has a controlling interest. One of the main goals of energy policy is to balance demand and supply (Cherp, Vinichenko, Jewell, Suzuki, & Antal, 2017) to ensure enough generated electricity is available to meet the needs of consumers of electricity.

Today humans use three times more energy per person compared to 1970 (Niembro-García et al., 2022). With increasing population growth and likely higher electricity consumption per person in future (Niembro-García et al., 2022) it is of paramount importance that electricity generators of the future plan for this increased demand. A second goal of energy policy is therefore to ensure security of supply (Cherp et al., 2017). Security of supply in most countries refer to security of raw material supply. As in the case of Japan (Chapman & Itaoka, 2018) if security of supply is at risk due to external factors, the Government's policy will likely favour electricity generation technologies, such as nuclear, that are not reliant on external factors (Cherp et al., 2017).

This policy position may be favourable for the Government in terms of security of supply, but burdens the national fiscus as Governments have to financially support the large capital expenditures and long lead times for such projects (Terlikowski, Paska, Pawlak, Kaliński, & Urbanek, 2019). Policy positions and regulations regarding the ESI therefore usually amount to trade-offs as the Government of the day tries to balance security of supply, financial support required and its wish to control the industry.

Although stable policy positions and regulations seems favourable, this has proven disastrous for ESIs in the past. For example, in developing countries, the COVID19 pandemic has caused years of potential backlog to the fulfilment of energy access and reliability commitments and goals (Mujjuni, Chivunga, Betts, Lin, & Blanchard, 2022) since its ESI was not agile enough to react fast enough.

This leads to contradicting stances in that the ESI should be both stable to enable long term planning but agile to react to system shocks. In light of this, different countries take different approaches to mitigate what it sees as its biggest threat whilst at the same time ensuring the prosperity of its citizens and economy.

The Impact of the ESI

> *"Energy is the golden thread that connect economic growth, increased social equity and a healthy environment. Sustainable development is not possible without sustainable energy"* (Ki-Moon, 2012).

The above quotation on the importance of energy to sustainable development is what the then Secretary-General of the United Nations, Ban Ki-Moon, told the Center for Global Development, highlighting the global appreciation for the importance of energy in ensuring sustainable growth.

The importance of electricity supply as an ingredient for economic growth has been written about extensively. For example, Falil and Nasir (2021) notes economic growth requires a reliable electricity supply, without which economic growth will plateau and decline. Keeping with the theme of a reliable supply of electricity, Khobai, Sanderson and Le Roux (2016) asserts that industrial performance is the driver of economic growth and industrial performance relies on a reliable electricity supply. Completing the enthymeme leads to the conclusion that a reliable electricity supply is a driver of economic growth.

Qualifying the statement of Khobai et al. (2016), Khobai (2017) further argues that electricity supply does cause economic growth but only in the presence of positive national trade openness, high employment levels and a willingness to invest in infrastructure from the Government. Perhaps tellingly, the argument by Khobai (2017) relates to the supply of electricity as opposed to a reliable electricity supply. This suggests notably, according to Khobai (2017), even an unsecure supply of electricity may lead to economic growth under certain conditions. This point is significant as it implies that even poor policy positions or a poorly executed policy which adversely affects the reliability of electrical supply may still be absorbed by the country's infrastructures under certain conditions.

Niembro-García et al. (2022) also do not make the argument that a reliable electricity supply leads to economic growth but rather advocate that economic growth and energy consumption is linked. The authors argue that economic growth is not reliant on the supply of electricity but rather on the consumption thereof. Norouzi, Zarazua de Rubens, Choupanpiesheh and Enevoldsen (2020) takes a less direct stance and merely indicates that the ESI is an essential part and vital ingredient for economic growth without indicating whether it is the supply, reliable or not, or consumption of electricity that may cause economic growth.

It is clear from the work done by various authors (Falil & Nasir, 2021; Khobai, 2017; Khobai et al., 2016; Niembro-García et al., 2022; Norouzi et al., 2020) that although electricity is important for economic growth, there is no consensus as to whether it is the supply or consumption of electricity that causes economic growth. Complicating the matter, for those arguing electricity consumption and economic growth is linked, there is no consensus as to the rapport between electricity consumption and economic growth, resulting in an ongoing debate in the literature about the importance of electricity.

Studies to determine the relationship between electricity consumption and economic growth have been ongoing for decades with Kraft and Kraft (1978) taking a position in 1978 that there is a unidirectional causality between economic growth and electricity consumption but no causality between electricity consumption and economic growth (Kraft & Kraft, 1978). Economic growth causes higher electricity consumption but higher electricity consumption does not necessarily cause economic growth. In direct contrast to this, authors such as Warr and Ayres (2010) found that higher electricity consumption causes economic growth but that economic growth does not necessarily translate to higher electricity consumption. Authors including Erdal, Erdal and Esengün (2008) on the other hand, found bidirectional causality between electricity consumption and economic growth. That is, higher electricity consumption causes economic growth and economic growth stimulates higher electricity usage patterns.

Bekun, Emir and Sarkodie (2019) did not focus their study on the causality but rather concluded that higher income countries have higher per capita usage of electricity compared to middle- and lower income countries (Bekun et al., 2019). Furthermore, Bekun et al. (2019) found that South Africa has an inverted U-shape when it comes to electricity usage and economic growth. It seems higher levels of usage causes higher economic growth until a threshold point is reached. At this point, higher degrees of economic growth results in lower levels of consumption.

Electricity, Economic Growth and Environmental Degradation

With scholars traditionally focusing on the relationship between electricity consumption and economic growth, authors including Ozcan, Tzeremes and Tzeremes (2020) and Wen et al. (2021) argue that a third dimension, environmental degradation, needs to be considered as well. Although the direction of the nexus between economic growth and energy consumption is akin to a discussion on the "chicken and egg", there is more certainty on the causal direction involving environmental degradation.

Economic growth leads to environmental degradation – at least to a certain point (Ben Nasr, Gupta, & Sato, 2015; Ozcan et al., 2020; Wen et al., 2021). This is the finding by researchers using a framework called the Environmental Kuznets Curve (EKC) (Dinda, 2004) which suggests the relationship between economic growth and environmental degradation, inclusive of more than CO2 emissions (Ozcan et al., 2020), may be illustrated by an inverted U-shape as shown in Figure 5.

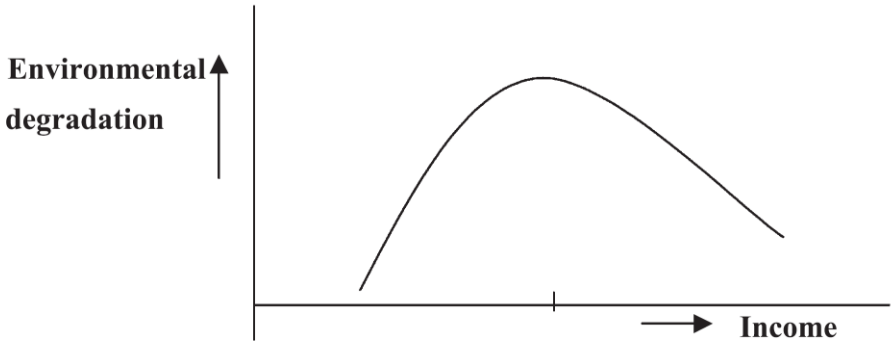

Figure 5: Environmental Kuznets Curve

Source: Dinda (2004)

Initially economies cause more environmental harm as economic growth increases, likely driven by an increased demand on the environment by fossil-fuel powered heavy industry (Ozcan et al., 2020). However, a threshold point exists where environmental degradation not only stabilizes but actually decreases as economic activity increases (Ozcan et al., 2020) due to structural reform to a more service-oriented economy in developed countries (Wen et al., 2021) as well as a deeper penetration of renewable energy sources (Ozcan et al., 2020). The latter indicates a structural change in the electricity generation mix as well which implies a change in the ESI.

It is clear from the discussion that although electricity and by extension the ESI plays a significant role in the economy of a country, it is unclear exactly how this role is defined and even whether the impact is the same for all countries. The impact of the ESI on environmental degradation and economic growth, at least in the case of South Africa (Bekun et al., 2019), seem to depend on the structure of the economy. This may be true during the normal course of events but, as described by Norouzi et al. (2020), external shocks such as the COVID19 pandemic alter the ESI. For example, Norouzi et al. (2020) argue that the COVID19 pandemic has not only altered generation and consumption patterns, but have delayed many countries in reaching the threshold point of the EKC as depicted in Figure 5.

Compounding this effect, since the ESI is essentially structured to carry out the mandate of the Government, the decisions of the actors within the ESI typically fall in line with that of the Government. For example, during the COVID19 lockdown, most countries' System Operators were expected to send non-essential staff home yet have enough generation capacity available to supply both domestic consumption and essential services (Mujjuni et al., 2022). To achieve this, scheduled maintenance in most countries were suspended (also due to a result of service providers not being available) (Mujjuni et al., 2022) resulting in a backlog globally which may impact the reliability of supply in the future.

Besides the impact on economic growth of a country, and without affecting the EKC, the ESI also has an impact on Greenhouse Gas (GHG) and Carbon Dioxide (CO2) emissions. As argued by Li and Trutnevyte (2017), in order to meet environmental commitments made during the Paris Agreement, most countries would need to rapidly decarbonise their electricity sector and not wait for the natural transition as shown in Figure 5.

ESI's are also not limited to single countries with regional interaction common in places such as Europe. Interconnecting generation and transmission systems across borders may influence not only assumptions on the causality between electricity consumption and economic growth but the level of decarbonisation between supply and consumption as well. It is for this reason that the argument for reliable supply causing economic growth (Falil & Nasir, 2021; Khobai, 2017; Khobai et al., 2016) may not hold true as electricity may be reliably generated in one country but through infrastructure limitations not reach the consumption destination in another country.

To achieve its environmental mandates and economic aspirations besides uncertain variables, Governments make use of different ESI structures.

Five Types of ESI structures

According to Falil and Nasir (2021) there are four types of energy markets, including the single buyer model, bilateral contracts or PPAs, trading market and multilateral/hybrid model. A fifth type was presented in Figure 1 as being own generation.

The ESI has traditionally been considered to be a natural monopoly where a single company (usually state-owned) could focus on producing electricity efficiently and at low cost, not needing to guard against competitors and keeping its market position (Niembro-García et al., 2022). Since it became clear that natural monopolies did not deliver on their stated benefits, States began buying power through long term PPAs (typically 20 years) from IPPs. To allow for this to happen, the State had to set in motion a degree of deregulation of the ESI (Niembro-García et al., 2022).

A Power Purchase Agreement (PPA) is a stable and predefined contract between two parties consisting of the seller of electricity and the buyer of electricity (Wallace & Saidov, 2019). By moving away from vertically integrated entities responsible for the generation, transmission and distribution of electricity, Governments relinquish some control in the ESI in terms of generation. However, by entering into PPAs with private generators, the State may still control some aspects of the generation sector within the ESI without necessarily providing the capital to fund the generators. In this manner, the Government's policy positions may be advanced through PPAs as competition within the generation sector is introduced and security of supply is enhanced through contracting a diverse mix of generation whilst ensuring prices remain as low as possible (Wallace & Saidov, 2019). From the IPP's side, a PPA with the State will ensure stability in future prices (Teichler & Levitine, 2005) which is a crucial ingredient for funding the electricity generation projects.

Not all PPAs are entered into between the State and an IPP. Corporate PPAs play a significant role when allowed within an ESI structure. For example, according to Kobus, Nasrallah and Guidera (2021) corporate PPAs could add between 55 – 85 GW of solar and wind generation to the United States' generation capacity up to 2030. This would increase the United States' 1,200 GW capacity (Zummo, 2022) by between 4.5% and 7.1%. The terms of a PPA typically span 15 to 20 years with the largest project cost being capital expenditure during construction. The tariff during a PPA is also fixed save for an annual escalation usually linked to the Consumer Price Index (The World Bank, 2019). A major risk of PPAs are therefore the macro-economic conditions at the date of signature as this will influence the price of electricity for the term of the PPA (Bhimji, 2022). Should unfavourable macro-economic conditions influence costs negatively during construction, the price of the PPA may rise to unaffordable levels (Bhimji, 2022).

A third ESI structure is a trading model and requires complete deregulation of the ESI. As discussed within *Chapter 1* and shown in Figure 3, a trading model consists of either short-term PPAs (Dovgalyuk et al., 2019) or day-ahead trading (Lange & Focken, 2008). The trader enters into a long-term PPA with several generators and assumes the risk required to make the PPA bankable for the generator or IPP. In turn, the trader on-sells the electricity through either short-term PPAs or day-ahead trading to distributors or LPUs (Lange & Focken, 2008). The electricity is sold at a premium to account for the risk the trader assumes as short term PPAs or day-ahead trading requires little to no guarantees from the buyer whereas the trader has to provide significant guarantees to the generator in its long term PPA.

A concern often raised with trading markets is the potential abuse of market power by incumbents (Prete & Hobbs, 2015). As noted by Prete and Hobbs (2015) a move away from vertically integrated supply chains removes the risk of vertical market power abuse where the incumbent can raise prices in one or more of the supply chain segments, thereby increasing overall profit. However, trading markets still allow for horizontal market power abuse where incumbents exploit concentration in a single segment within the value chain to keep prices high by reducing supply (Prete & Hobbs, 2015; Werden, 1996).

Exercising horizontal market power may have detrimental effects on the ESI in the long run as noted by Prete and Hobbs (2015). According to Prete and Hobbs (2015) when an IPP withholds available capacity in order to increase prices, another IPP may perceive this to be the true market price and build new generation capacity based on the inflated price. In the long run this may lead to oversupply which decreases the market price below that of the marginal cost of the generator, leading to stranded assets. This potential abuse of market power has led to the scepticism of the trading market structure as authors such as Sweeting (2007) found evidence of market power abuse by incumbents in the English and Welsh ESI. Incentives for incumbent regimes to abuse horizontal market power was found to be due to small profit margins experienced during efficient markets (Sweeting, 2007). With trading, electrical energy is a commodity and there is no differentiation between one electron and the next (however, there is differentiation in the source of generation), leading to the small profit margins for incumbent regimes (Niembro-García et al., 2022).

Hybrid markets constitute a mix of PPAs and trading markets and incorporate aspects of both to optimise the benefits of these types of market structures. Electricity markets are created through the monopoly (or existing regime) first being liberalised, with certain portions then being privatised following deregulation. This causes a restructuring of the ESI (Niembro-García et al., 2022). The studies by Wen et al. (2021) and Ozcan et al. (2020) imply that countries simply have to focus on economic growth and the reforms will follow naturally as seen as in the Environmental Kuznets Curve.

This may be true for most countries (Ozcan et al., 2020; Wen et al., 2021) but not for all. For example Ben Nasr et al. (2015) found no linkage for South Africa in particular, arguing that energy reforms may a have to precede the EKC threshold point. At first glance, this seems to contradict the work done by Bekun et al. (2019); however, a critical review reveals that these views are not contradictory but merely taken from different perspectives as to the current structure of the economy. It is therefore reasonable to assume that the structure of the ESI may depend on the perspective of the Government as to the current and desired structure of the economy. The Government will decide on and implement an ESI structure it deems the most appropriate to meet its goals given this perceived economic structure.

The ESI is a dynamic process and transitions from one market structure to another cannot be done in a single step or by a single process (Grubb & Newbery, 2018). This often causes hardship for the industry during the transition.

Transitions between different ESI structures

ESI market structure transitions have been the theme of various studies (Ben Nasr et al., 2015; Cherp et al., 2017; Geels et al., 2016; Grubb & Newbery, 2018; Ozcan et al., 2020) and usually describe the transition from vertically integrated single buyer models to liberalised trading markets, where incumbent socio-technical regimes (or alliances) give way to previously protected niche regimes (Cherp et al., 2017).

For example, Grubb and Newbery (2018) describes the UK's first energy transition in 1990 from a state-owned and operated ESI to a semi-liberalised market. Baseload electricity was still procured through the State in the form of nuclear power plants and gas-fired power plants, but with the deindustrialisation of the economy and increasing energy efficiency leading to less energy per person required, intermittent supplies from renewable energy could easily fill additional demand requirements (Grubb & Newbery, 2018). This allowed IPPs in the renewable energy sector to flourish. All power plants were still pooled together and centrally dispatched by the System Operator.

In 2001, another energy transition within the UK occurred whereby the centrally dispatched model gave way to a fully deregulated, self-dispatched and energy-only market (Grubb & Newbery, 2018). However, this market structure did not offer security of supply because, as Grubb and Newbery (2018) notes, no new investments of significance in either battery storage or capital intensive wind projects were made. With an energy-only market, generators were dispatched based on price alone and day-ahead trading mostly dictated this price (Geels et al., 2016). Therefore, with no futures market and no price stability in the medium- to long term, investors were disincentivised to make decisions on large capital projects that would require price views of 20 to 30 years (Grubb & Newbery, 2018).

In 2013, the UK Government undertook yet another electricity market reform with the energy-only market moving towards a capacity- and energy market (Grubb & Newbery, 2018). In this market structure, generators were paid a baseload tariff regardless of whether they were dispatched or not; this ensured some price certainty with a possible upside of energy tariffs should the generator be dispatched (Grubb & Newbery, 2018). Although critics felt this was a step back towards a single buyer model (Li & Trutnevyte, 2017) the intent was to incentivise investment in low carbon and capital intensive technologies that would bring about system stability (Grubb & Newbery, 2018).

The UK's transition in 2013 is defined by Geels et al. (2016) as one of transformation where, due to a lack of niche actors or innovations, the Government pressures the incumbent into change (Geels et al., 2016). The UK's transition pathway has taken this route where market regulation has enabled (or forced) large scale renewable energy installations by the incumbent actors (Geels et al., 2016).

In fact, using socio-technical scholarly theory, Geels et al. (2016) defines and describes a further three transition pathways including technological substitution, reconfiguration and de-alignment with subsequent re-alignment. This is supported by Cherp et al. (2017) which found that transitions are based on interchanges between techno-economic, socio-technical and political processes.

Transition pathways characterised by technological substitution occur when radical innovations by niche actors upset and overtake the dominant incumbent regime (Geels et al., 2016). An example of this is in the German market where innovations in renewable energy enabled smaller players to enter the electricity market with small installations (Geels et al., 2016). Although most observers point to the Fukushima incident and the subsequent *Energiewende* in Germany as the main point of divergence from nuclear energy for Germany, the path away from nuclear in actual fact started in 1970 (Cherp et al., 2017). The creation of the original niche market was supported by State funding and driven by Germany’s desire to become a global leader in renewable energy, mostly at the expense of nuclear energy (Cherp et al., 2017). Unlike a country like Japan (and the UK’s unintentional case), Germany did not have a security of supply concern as it could easily substitute electricity with readily available gas or biomass for applications such as space heating, reducing demand pressure on its electricity generation sector (Cherp et al., 2017).

Along with transformation and technical substitution, Geels et al. (2016) also found reconfiguration as a potential ESI structure transition pathway. In reconfiguration, niche innovations are present but not radical enough to displace incumbents. Instead, as Geels et al. (2016) argues, the existing and established regime incorporates the innovation to form a symbiotic relationship between the niche actor and incumbent actor or regime. Although not an ESI structure transition in the strict sense, Laakso, Aro, Heiskanen and Kaljonen (2021) does demonstrate reconfiguration in the Netherlands mobility sector where the incumbent actors adopted the niche applications of electric vehicles. This adoption has led to a new regime out of the old one where both the niche actors and the incumbent regime found benefit (Laakso et al., 2021).

A final ESI structure transition pathway described by Geels et al. (2016) is de-alignment with subsequent re-alignment and involve the forceful break-up of an incumbent regime by landscape or external pressures and shocks and the subsequent reforming of a regime around niche innovations. Although Geels et al. (2016) concede that not a lot is understood around this pathway, the authors note the major difference between the de-alignment and re-alignment pathway and other transition pathways is that there is no head-on confrontation between the incumbent regime and niche actors. Instead, the external shocks removes the incumbent regime, only after which the structure is re-aligned by the niche actors forming new regimes (Geels et al., 2016).

Although not intentional, Mujjuni et al. (2022) may have inadvertently described a scenario of de-alignment in their review of damage to the ESI as a result of the COVID19 pandemic. Mujjuni et al. (2022) found that, due to the pandemic which may be described as an external shock, CO2 emissions in Uganda fell some 9% due to changing behaviour and usage patterns. This resulted in increased penetration of renewable energy of between 8% and 13% (Mujjuni et al., 2022). The higher penetration of niche actors in the renewable space may come to form a new regime and subsequent re-alignment of the Uganda ESI due to the pandemic and changing usage patterns.

In the case of transitions from one ESI structure to a next, context clearly matters. For example, Germany and Japan had very similar energy paths in the 1970's which has diverged since (Cherp et al., 2017). Germany followed technological substitution through its renewable energy drive. Japan instead opted for nuclear power as this would address security of supply concerns as well as satisfy a fast growing demand base owing to higher per capita energy consumption (Cherp et al., 2017). Japan subsequently transitioned using a transformation pathway as described by Geels et al. (2016) with its retail energy market the first to be deregulated followed by generation, transmission and distribution (Chapman & Itaoka, 2018).

As seen in the UK's case, it is possible for energy transitions to go through multiple of the four transition pathways. In fact, in transition pathways, periods of growth may be followed by periods of consolidation or stagnation, sometimes causing a shift to a different pathway (Geels et al., 2016). It is for this reason pathways chosen are done deliberately and requires continuous and conscious effort on the part of the actors (Geels et al., 2016). The failures (and successes) of the transition can be ascribed to a lack of understanding by Governments of the impact of policy choices made. Ravetz et al. (2021) explain that energy systems are complex systems with mostly unknown or poorly understood boundaries meaning there is no “one size fits all” policy position regarding the transition. This leads to considerable uncertainty for countries transitioning or about to transition.

Successfully transitioning from one market structure to another also does not mean success throughout the entire ESI. For example, Germany’s Renewable Energy Feed-In Tariff (REFIT) guaranteed a fixed (higher) price for renewable energy generators by utilities where utilities were allowed to pass these through to the customer as a blended price (FuturePolicy.org, 2022), resulting in the highest residential electricity prices in the world for German households (International Energy Agency, 2019).

Markets undergoing energy transitions may vary from state lines (Razeghi et al., 2017) to collaborative spaces such as the European Union (Jamasb & Pollitt, 2005). Figure 6 below graphically shows the interaction between the State, the incumbent regime and niche actors that may influence the transition pathway chosen.

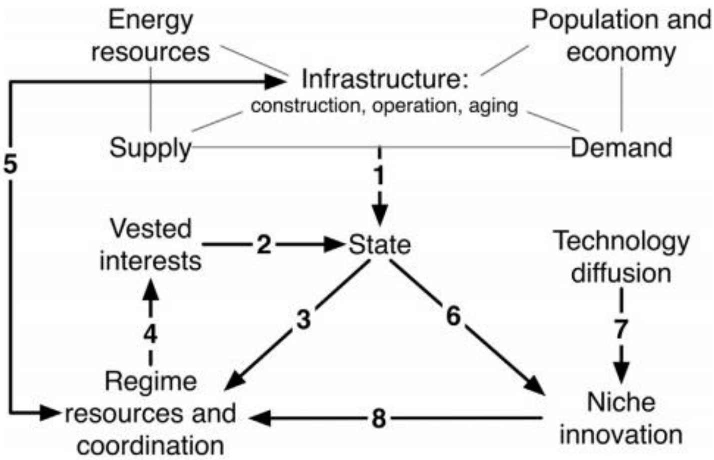

Figure 6: Interaction between actors to indicate transition pathway

Source: Cherp et al. (2017, p. 615)

The South African ESI context

To understand the South African context as to the potential transition away from a vertically integrated and single buyer model, two questions need to be answered.

Firstly, what is the likely future ESI structure for South Africa and, secondly, what transition pathway would be taken to reach the new structure.

A first glimpse of the then proposed future structure of the South African ESI was given in 1998 with the publication of South Africa's White Paper on energy (Department of Mineral Resources and Energy, 1998). In this policy position, the South African Government envisaged a future ESI structure dominated by competition, private participation and low carbon generation sources. The South African Government was clearly contemplating a liberalised market.

A further literature survey for the years following the publication of the White Paper in 1998 has revealed a lot of promise but with little progress. For example, also in 1998, Galen (1998) described the South African ESI as complex with non-related but relevant factors such as political, social and financial issues potentially hampering any progress towards transitioning to a different ESI market structure. Interestingly, Galen (1998) described the ESI as *"performing relatively well"* (Galen, 1998, p. 1) which *"has not been a priority"* (Galen, 1998, p. 1) which is in direct contrast with how the ESI is described today with authors such as Berahab (2022) describing the ESI as being in crisis and a top priority.

In 2005, Eberhard (2005) chronicled the Government's imminent restructuring of the ESI where the state-owned Eskom would be unbundled and a market with bilateral contracts would be the order of the day. The intention was for Government to partly move out of the generation sector with the partial privatisation of Eskom as well as leaving any new generation investments to the private sector (Eberhard, 2005). This restructuring never occurred and instead, as Eberhard (2005) noted, Eskom was reinforced as the leader and monopoly leader in the South African ESI. This appeared a logical decision at the time as Eberhard (2005) noted Eskom's performance as being *"reasonably good"* (Eberhard, 2005, p. 5309). In contrast to 2005 where power outages were few and far between, Eskom's performance has been described as poor by authors such as Pram, Kambule and Adepoju (2022).

In 2010, Tsikata and Sebitosi (2010) described yet another failed attempt to restructure the ESI. In 2009, the National Energy Regulator of South Africa (NERSA) tried to introduce Renewable Energy Feed-In (REFIT) tariffs similar to that of Germany in order to incentivise private participation in the renewable energy generation sector (Tsikata & Sebitosi, 2010). However, as noted by Tsikata and

Sebitosi (2010) this never materialised and the authors ascribed this to a reluctance from the South African Government to move away from coal as primary feedstock for generating electricity. This dependency on a natural resource is akin to Dutch disease in which there is reluctancy to move away from the resource that has provided good fortune (Behzadan, Chisik, Onder, & Battaile, 2017).

It is clear from earlier literature that although there was clear intent to restructure the South African ESI, this never occurred and the conditions under which the transition would take place are also no longer valid. In 2019, President Cyril Ramaphosa announced in his State of the Nation Address (SONA) that Eskom would be unbundled and that the electricity market would be restructured (Eyewitness News, 2019). However, reconducting a literature search with the same search term as for the earlier years ("*future structure of the South African ESI*" and "*future structure of the South African electricity supply industry*") but confined to the years after the announcement (post 2019) yields little to no results on the possible future ESI structure or transition pathway. Instead, research seems to focus on failings within the ESI and potential solutions to increase security of supply. For example, although Covary (2020) alludes to the ESI structure, this is merely to describe the role municipalities play within the ESI along with its failures. Kumar (2020) instead focusses on smart grids and the role it can play to strengthen the distribution sector within the ESI whilst Boamah (2020) does look at the effects of decentralised solar PV installation, but this is done from a socio-economic perspective and does not shed light on the possible ESI structures that may evolve in future.

Focusing on the topic of transition pathways, a literature search reveals multiple studies on the subject for South Africa (Ambole, Koranteng, Njoroge, & Luhangala, 2021; Monteith, 2021; Oyewo, Aghahosseini, Ram, Lohrmann, & Breyer, 2019). However, these are mostly centred around the Just Transition, a term championed by the South African Government to ensure the transition takes into account and achieves socio-economic development goals as well as environmental commitments (Monteith, 2021).

du Plooy, Brent and de Kock (2017) describe criteria for an ESI structure transition in South Africa, but these are described more as practical criteria as opposed to pathways in principle. For example, whilst du Plooy et al. (2017) describe criteria such as energy efficiency, economic competitiveness and supply security in generation, the authors seem to imply that the transition pathway South Africa will follow is likely that of transformation as defined by Geels et al. (2016). Although this may very well be the case, the pathway may not simply be assumed and could affect the criteria described.

Based on recent research it is therefore unclear what the future structure of the ESI will be or what transition pathway will be taken in the South African case. Cherp et al. (2017) asserts that since most structure transitions are started by political agendas, an analysis of the country's political, technical and financial aspects may reveal a likely transition pathway.

South Africa faces increasing pressure to reduce its carbon emissions (Baker & Phillips, 2019; Huxham, Anwar, & Nelson, 2019). South Africa is the 15th largest emitter of CO2 emissions globally (Worldometer, 2016) and generates roughly 90% of its energy needs from coal (Huxham et al., 2019) making it an attractive destination for global decarbonisation pressures. This had led to conflict within the political sphere in South Africa with President Ramaphosa (Stoddard, 2021) and the Minister of Public Enterprises (DPE) (BusinessTech, 2022b) seeking to abide by international views on decarbonisation by promoting green energy and hydrogen (Stoddard, 2021) whilst the Minister of Mineral Resources and Energy (DMRE), Gwede Mantashe, is advocating for more coal and nuclear energy (Stoddard, 2021, 2022).

Transitions between one ESI structure and another usually causes short-term hardship in that country (Razeghi et al., 2017) without the added political complexities South Africa faces. Should Government decide on a structure favouring renewable energy, Oosthuizen et al. (2015) and Healy and Barry (2017) argue South Africa's coal resources have led to investment being *"locked in"* (Healy & Barry, 2017, p. 4) in coal technology making it more difficult to move to more renewable forms of energy generation – this is mostly due to a lack of collaboration between the public and private sector (Oosthuizen et al., 2015).

Whichever pathway the ESI and generation mix moves into, it will have considerable social implications with close to 100,000 people in the coal mining industry (Huxham et al., 2019) requiring new skills and employment opportunities. This inability to align and fear to make the wrong decision greatly impacts the decision-making process for both Government and in particular the democratically selected which may opt for a wait-and-see strategy.

From a technical perspective, South Africa is also not in the ideal position to transition to a new ESI structure. The existing utility Eskom is performing poorly (Burkhardt, 2021; BusinessTech, 2021) resulting in great hardship and disincentivising new investment in the country (Bowman, 2020). In 2021, the utility was unable to meet national demand for a total of 1,165 hours leaving approximately 1.8 TWh of potential energy unserved (Roff et al., 2022). Unfortunately this has not been the peak with 2022 surpassing 1,949 hours of loadshedding as of 3 October 2022 (BusinessTech, 2022d). Although the technical performance of the incumbent regime is not described by Geels et al. (2016), an argument can be made that this may enable transition pathways through either transformation or technical substitution.

Financially, Eskom is not performing well either. As indicated by Bowman (2020), Eskom's financial difficulties exist not only due to its inability to collect owed revenue or its massive R392bn debt book (Naidoo, 2022) but due to political interference in the utility's day-to-day operations as well. On the flipside of Eskom's finances, its vast coal reserves (Oosthuizen et al., 2015) earn South Africa around R61bn per annum in exports (Huxham et al., 2019).

From the literature it is not clear what South Africa's future ESI structure is going to be or what the chosen transition pathway will entail. However, by assessing the political, technical and financial context, it is clear the ESI is no longer in the same condition as described by Galen (1998) and Eberhard (2005). It is also clear from the literature that should South Africa wish to achieve economic growth and reduce environmental degradation, electrical energy is going to play an important role. It is argued that a new ESI structure is therefore not only necessary but inevitable with the questions remaining as to what it will look like and how South Africa will achieve it.

Procurement of Energy

Approximately 35.37% of the electricity Eskom sells are to large industrial and mining companies (or Large Power Users - LPUs), contributing 31.37% to its sales revenue (Eskom Holdings, 2021a). This is despite the fact that LPUs represent a mere 0.05% of Eskom's customer numbers (Eskom Holdings, 2021a).

Despite the seemingly important role that LPUs play in the current ESI, research on LPUs within South Africa remain low. For example, Bowman (2020) does include

LPUs in his analysis of Eskom but merely by stating that Eskom relies on the LPUs for financial survival. Similarly, Baker and Phillips (2019) acknowledges that, despite declining contribution to the country’s GDP, LPUs still play an important role in supporting Eskom and should be regarded in decisions. The author, however, does not go as far as describing how LPUs may be affected by decisions regarding the ESI. Lastly Rennkamp (2019) provides a rather scathing rendition of LPUs and their organised opposition to use power and influence in opposing carbon tax and related environmental policy. However, the author relies heavily on personal correspondence with some of the actors involved and therefore run the risk of anchoring bias when forming arguments representing all LPUs.

LPUs also cannot survive with the incumbent Eskom as confirmed by the Energy Intensive Users Group (EIUG) (News24, 2017). According to the EIUG, low reliability or high prices within the ESI may place considerable pressure on LPUs to maintain global competitiveness which could ultimately threaten their survival (News24, 2017).

It may be deducted that LPUs play an important role in the current ESI structure. LPUs make up a considerable portion of Eskom’s sales and without its financial support Eskom would not survive. Conversely, LPUs require Eskom for its own survival and cannot afford to pay too high a price or receive unreliable electricity supply. Both LPUs and Eskom are therefore significant actors within the ESI and its structure and transition pathway will have a significant impact on Eskom’s business.

Therefore, both sets of actors may utilise market power to influence decisions in order to protect its interests. For example, several LPUs have made use of an emergency arrangement by the DMRE to lift the licensing threshold for generation to 100MW (Tucker, 2021) to enter into PPAs with renewable IPPs to reduce their dependency on Eskom (BusinessTech, 2022a, 2022c).

The literature review has clearly articulated that the ESI plays an important role in the economic growth, environmental health and general wellbeing of countries and societies. Not choosing the right ESI structure can have dire consequences. Transition pathways from one ESI structure to another is a conscious decision by the actors involved and generally may be classified as one of four possible pathways. It is also clear that South African LPUs play a significant role in the South African ESI and, in turn, is significantly impacted by the structure and functioning of the ESI.

What is not clear from the literature is what a possible future ESI structure will look like for South Africa. Although it is argued a new structure is inevitable, it is unclear how the current structure will transition to a new structure and when this may happen. It is also unclear what the potential impacts of this transition may be, specifically on procurement regimes, which is the focus of this study. The inherent uncertainty relating to South Africa's alternative future ESI pathways constitutes the basis for the scenario analysis undertaken.

Chapter 3

Procurement offices for LPUs need to be aware of the current and potential structures of the country's ESI, as this impacts their procurement choices in the present and the future. The world is increasingly concerned with limiting the average temperature rise to below 2 degrees Celsius (and decreasing or slowing environmental degradation) and a move from fossil fuel energy to renewable energy sources represent the low hanging fruit (Wang & Lo, 2021). Notwithstanding the transition pathway, authors such as Oosthuizen et al. (2018) and Oosthuizen et al. (2015) have attempted to determine possible futures for the South African energy systems given the uncertainties using the framework of scenario planning. These papers focus mostly on energy suppliers as well as the policies guiding their investment strategy. Although important, this does leave a gap in terms of the procurement offices responsible for purchasing power for LPUs in South Africa – the end users on the demand side. This study contributes to filling that gap in scholarship.

Given the uncertainty in the ESI due to its complex nature (Ravetz et al., 2021) and the calls for a more just energy transition (Healy & Barry, 2017), procurement offices for LPUs globally face an uphill battle to ensure their procurement strategies are stable enough to make current PPAs bankable yet agile enough to ensure relevance in a dynamic industry.

This need to adapt is aided if the energy procurement office has a view on the possible scenarios that may play out in the future. Although scenario planning has found great application in the policy domain (Oosthuizen et al., 2018; Oosthuizen et al., 2015) it is unclear how this may be applied to a LPU procurement office.

The problem of grappling with the uncertainties represented for LPUs by a changing ESI, was therefore selected to assist procurement offices of LPUs to procure energy that is both competitive in the short term and future proof for the longer term. Theoretically the current research add insights from a procurement perspective to the body of knowledge describing the possible alternative futures of the South African ESI. Current research has focused on the possible reactions by utilities (Oosthuizen et al., 2018) to a changing regulatory and user profile environment. This research looks at possible alternative futures that procurers of energy for LPUs face as a result of the steps taken by the utilities and the changing regulatory environment.

Research Question

In light of this, the research question is stated below.

1. What are the potential future scenarios for the South African ESI given a timeframe of 20 years?

The scenarios do not seek to simply describe the ESI structure or the transition pathway, but give an overall view of the ESI as this may assist the procurement offices of LPUs in understanding the drivers behind any structure which may enable LPUs to prepare for the transition before it actually occurs, and play a proactive role in the transition in line with their own imperatives for competitiveness.

Although a timeframe of 20 years is given, particular focus was given to the period ten years from now. Scenario planning insights greatly enhance the longer the timeframe under influence is as the uncertainty increases (Amer, Daim, & Jetter, 2013) with general timeframes of 20 years into the future (Amer et al., 2013; Ramirez, Mukherjee, Vezzoli, & Kramer, 2015). However, since South Africa is transitioning in the near future with a draft Electricity Regulation Amendment already published (Department of Mineral Resources and Energy, 2021) it is the view of this author that the most significant changes to the ESI will likely happen within the next ten years.

Chapter 4

Exploring changes in the external environment using scenario planning, a strategic foresight method

External shocks can cause ripples through a company or an entire industry (Haarhaus & Liening, 2020). For example, on 17 October 1973 an announcement was made by six oil-producing nations that it would cut 5% of its oil supply immediately with more cuts to follow (Mitchell, 2010). This was, according to Mitchell (2010) in response the United States of America's perceived interference in the conflict between Palestine and Israel. What followed the announcement was previously unheard of in the Western world. The price of oil, and therefore gasoline, rose by the day with supply dwindling leaving millions to scurry for what they could find (Mitchell, 2010). From an organisational perspective, most major Western oil companies lost their market power and billions of dollars along with it (Mitchell, 2010). This event in history would later become to be known as the 1973 oil crisis.

A few decades later, in 2020, another external shock took the world by surprise. On 11 March 2020, the World Health Organisation declared the COVID19 outbreak as a global pandemic (World Health Organization, 2020) fundamentally challenging and changing most aspects of life and institutions. For example, Gariboldi, Lin, Bland, Auplish and Cawthorne (2021) found that the health policy sector of the Western Pacific was not able to cope with the dynamic and unstable nature of the pandemic since it did not foresee that this could happen.

As the pandemic was winding down, another external shock occurred. On 24 February 2022, Russia launched a major offensive on neighbouring Ukraine (Reuters, 2022). Initially assumed to be confined to the European continent, the impact of the invasion has proven to be wide and far-reaching. For example, Orhan (2022) found that the invasion could have a significant impact on global trade through financial sanctions against Russia, supply chain disruptions and an increase in commodity prices.

Amidst all the external shocks, some organisations managed to not only withstand these shocks but benefit from them. For example, as noted by Haarhaus and Liening (2020) Royal Dutch Shell realised in the 1960's that traditional methods for predicting the future was no longer appropriate. Therefore, Royal Dutch Shell started using strategic foresight, and scenario planning in particular, to guide its view of the future allowing it to foresee the 1973 oil crisis (Haarhaus & Liening, 2020). Similarly, the study by Gariboldi et al. (2021) concluded that had the health policy sector of the Western Pacific incorporated strategic foresight into its decision-making processes, it would have been able to deal with the COVID19 pandemic more successfully.

Strategic foresight is, as so eloquently put by Slaughter (1997) *"the ability to create and maintain a high-quality, coherent and functional forward view and to use the insights arising in organisationally useful ways"* (Slaughter, 1997, p. 287). Therefore, to do strategic foresight is not merely to have a view of the future but to internalise this view and apply it to the benefit of the organisation.

This internalisation, as stated by Slaughter (1997) and supported by Haarhaus and Liening (2020) is in developing the organisation's dynamic capabilities. In fact Haarhaus and Liening (2020), who holds the view that dynamic capabilities are the way to deal with uncertain futures, asserts that strategic foresight develops two types of dynamic capabilities, namely rationality and strategic flexibility.

Dynamic capabilities are referred to as the firms' ability to reorganise internal and external competencies to deal with the dynamic environment (Haarhaus & Liening, 2020). While managers dealing with uncertainty and dynamic environments in the traditional way tend to focus too much on the past and the present, foresight-minded managers overcome these boundaries and tend to focus on things with the future in mind (Sarpong, Eyres, & Batsakis, 2019). This allows the manager or organisation to conduct environmental scanning where trends, events and relationships in the organisation's external environment is collected (Haarhaus & Liening, 2020). The information is then used to identify drivers of change which the organisation perceives will determine the future. Reaction by the organisation is triggered by movement within these drivers (Haarhaus & Liening, 2020; Sarpong et al., 2019).

Reviews by Gordon, Ramic, Rohrbeck and Spaniol (2020) of the last decade's strategic foresight literature indicate that scholars specify there are three major roles that strategic foresight play in organisations – the strategist role which provides over-arching guidance to the activities within the organisation, the initiator role which identifies new opportunities or events or the opponent role which reviews existing methods and identify vulnerabilities (Gordon et al., 2020).

Strategic foresight not only develops dynamic capabilities but allow these to be transferred to practical insights (Haarhaus & Liening, 2020). Whereas longer term uncertainties do not allow an outcome to be predicted, the threats and opportunities may be foreseen to allow resources to be obtained and reorganised and, in the most severe cases, for the organisation's core competencies to be altered.

The future South African ESI or the transition pathway cannot be predicted. Therefore, procurement offices for LPUs in South Africa may use strategic foresight to foresee the possible futures and determine the drivers of change. Acting on these drivers will allow LPUs to adapt their strategies. It is for this reason strategic foresight was used in this paper.

In order to conceptualise the process and insights arising from the use of strategic foresight, narratives may be used which allows the participant to mentally travel to the possible different futures, thereby bettering the participant's understanding of the alternative futures (Sarpong et al., 2019). This is done using the framework within strategic foresight called scenario planning.

Overview of Scenario Planning

Scenario planning is a form of *"disciplined imagination"* (Ramirez & Wilkinson, 2014, p. 255) where possible alternative futures, good or bad, are determined given a set of driving forces and factors (Glenn & Gordon, 2009). Although the scenarios developed may be seen as the end goal by some practitioners (Glenn & Gordon, 2009), others use the process and its outcomes as the departure point for further discussions where the normal and stagnant way of thinking has been broken (Ramirez & Wilkinson, 2014). This is because, as Glenn and Gordon (2009) affirms, the success of scenario planning is not whether the scenario turned out to be right or not but rather the valuable insight it gives the decision maker now. This insight feeds into the organisation's dynamic capabilities.

One such insight is the process of making assumptions about a complex and uncertain future explicit (Ramirez & Wilkinson, 2014). This is achieved through scenario planning forcing the decision maker not to try and predict the drivers and trends that shape an alternative future but rather to describe them (Gordon, 2013). In this way, the decision maker may learn to appreciate a deeper understanding of how the future is shaped given these drivers and trends and the challenges or opportunities that are presented with that (Gordon, 2013). It is of little surprise that strategic foresight and more specifically scenario planning has been widely adopted, from government planners to military analysts, as a vital tool in their strategic planning arsenal (Chen, Ren, Mu, Sun, & Mu, 2020).

A form of scenario planning commonly employed is known as the intuitive logic method where decision makers are interested in the causal relationship among the different economic, political, social and environmental factors influencing the future as opposed to the future itself (Amer et al., 2013). Intuitive scenario building assumes all scenarios are equally probable and instead focus on its plausibility (Ramirez & Wilkinson, 2014) with the investigation centring around what would make the impossible possible and the possible impossible.

Typical scenarios may be either explorative or normative in nature. Whereas explorative scenarios describe the possible alternative futures given the current environment and assumptions relating to drivers and trends, a normative scenario starts with a desirable end-state and describes the possible way this end-state can emerge given the current environment (Glenn & Gordon, 2009). Whereas normative scenarios have valuable roles to play in business strategy and sustainability planning, the interests of energy procurement specialists specifically, are what the alternative futures might look like given the current environment. This paper is therefore limited to explorative scenario planning. As indicated by Chen et al. (2020) explorative scenario planning may be broken down into "*defining the purpose, finding the drivers, generating the scenarios, and analysing the implications*" (Chen et al., 2020, p. 3).

Once the drivers and trends have been described, the scenarios themselves are determined and presented. What makes scenarios different from other models is the narrative nature of the scenarios, the differences in assumptions that are highlighted across scenarios rather than within them and the ease which each complex and uncertain possible future is showcased (Ramirez & Wilkinson, 2014). These narratives may be presented in different ways but the most widely used representation tool for scenarios is the 2x2 matrix (Ramirez & Wilkinson, 2014).

In a 2x2 matrix, the highest impact and/or most uncertain variables are located on two axes to show plausible futures given these two variables (Ramirez & Wilkinson, 2014). The variables on the two axes are chosen to *"force the worlds under examination to differ"* (Glenn & Gordon, 2009, p. 11) where the differences are based on the events at certain points in time. This is where the scenarios are separated through their respective plausibility; aptly described as being processed through a "*cone of plausibility*" (Glenn & Gordon, 2009, p. 21).

Scenarios should form naturally and the outcome (or given scenarios) should not be bound by the process. Should a possible alternative future not fit within the context the decision maker requires right now, this alternative future should not be discarded but written as a scenario not for discussion right now (Glenn & Gordon, 2009). Scenarios are also not static. Rather, the regular check for directions the drivers and trends are moving into (signposts) indicate whether the current set of scenarios are still adequate and whether new scenarios need to be developed (Glenn & Gordon, 2009). This constant check whether the output is still applicable is both a strength and limitation of scenarios.

Purpose of the Research Design

Saunders and Lewis (2018) adequately summarises the difference between exploratory-, descriptive- and explanatory research. According to Saunders and Lewis (2018) exploratory research is appropriate when there is not a great deal of knowledge regarding a body of work and there are new insights to be gained. Descriptive research, on the other hand, acknowledges the relationship between two variables and aims to describe that relationship with explanatory research attempting to explain the nature of the relationship between the variables (Saunders & Lewis, 2018).

By its very nature, scenario planning utilises a qualitative methodology. This is since the outcome of the scenarios do not rely on quantifiable forecasts regarding data but rather focus on the relationships in a complex system (Gordon, 2013), implying an understanding of that system (Glenn & Gordon, 2009). The outcome of these relationships leads to plausible alternative futures that may be either explorative or normative in nature (Amer et al., 2013; Chen et al., 2020; Glenn & Gordon, 2009; Ramirez et al., 2015).

Therefore, rather than predicting the future, scenario planning tells a story about alternative plausible futures by inspecting the linkages between, recognising the events involving and describing the decisions with respect to factors influencing those possible futures (Glenn & Gordon, 2009). Given exploration to determine the factors and making them explicit (Ramirez & Wilkinson, 2014) research done in the scenario planning domain using qualitative approaches may be none other than exploratory research. Concurring with this, Ramirez et al. (2015) acknowledge that the semi-structured interviews and workshops (or focus groups) used in scenario planning lack the necessary depth to be considered anything other than exploratory research. This research therefore followed an exploratory research design.

Philosophical paradigm of scenario planning and this study

Saunders and Lewis (2018) compare a positivist outlook to those of the natural sciences and set regulations where there is no influence of interpretation of bias. Directly opposite this stance is interpretivism which focusses on the interpretation of the social actors involved (Saunders & Lewis, 2018).

Authors such as Ramirez et al. (2015) indicate interviews and multiple workshops as their means of gauging the driving factors for scenario planning whereas Chen et al. (2020) uses a Delphi technique to arrive at the driving factors before a quantitative survey is used. In fact Gordon (2013) asserts qualitative research is in essence phenomenological as the researcher is not capturing the data from the subject without ascribing the meaning the subject attributes to the data.

Bias of participants are therefore expected and a great deal of work (such as triangulation) is done by practitioners of scenario planning to ensure quality controls (Chen et al., 2020; Gordon, 2013; Ramirez et al., 2015). Perhaps most critically, Ravetz et al. (2021) are quite scathing of their critique on how scenarios determined by cities and Governments alike lack the dimension of a social impact assessment.

It is therefore clear that bias and interpretation (or the social actor's perception) are critical factors forming part of scenario planning. Concurring with this, this research was interpretivist in nature.

Approach Selected

As indicated by Saunders and Lewis (2018) the main difference between deductive and inductive approaches is pre-existence of theory in deductive approaches. For an inductive approach, theory is developed based on data collected.

At first glance, it would be assumed scenario planning follows an inductive approach as theory is seemingly developed through the process. This may be true in certain instances but is not universally applicable. In fact, as described by Ramirez et al. (2015) a scenario planning method known as the deductive method exists and has as an output a 2x2 matrix with four quadrants and representing four scenarios.

This method relies on new insights gained from existing theory rather than the building of the theory itself. The factors that form the drivers and trends emerge from existing theory with the linkages between them the new insights gained. This research therefore took a deductive approach.

Methodological Choices

There is no one approved methodological choice of conducting scenario planning research (Chermack, Lynham, & Ruona, 2001). Instead, various authors have used different methods to building and stress-testing scenarios. A widely used methodology is that described by Schwartz (2012) who, for the first time in 1991 (Chermack et al., 2001), described a process for building scenarios based on a number of steps. These steps include obtaining a focal question, identifying the key factors as well as drivers and trends, conducting impact and uncertainty analysis on the findings before deriving the scenario logics and finally building scenario narratives (Chermack et al., 2001).

Within these steps, various authors have opted for either a mixed-method approach or a mono-method approach. Work done by Chen et al. (2020) on renewable energy scenarios for China towards 2030 start with a qualitative Delphi survey identifying key drivers and trends of renewable energy policy in China followed by a quantitative survey sent to experts to conduct the impact and uncertainty analysis. Ramirez et al. (2015) describe three projects entailing scenario planning. In two of the projects a mixed-method approach is used whereby multiple iterations of workshops are followed by surveys to validate the scenarios identified. A third project follows a mono approach in which multiple workshops are held to determine cultural impacts on the Indian retail sector.

Illustration of systematic research process and logic of this study

In general, the use of intuition and judgement in developing scenarios are seen as qualitative approaches to scenario planning (Chermack et al., 2001). This seemingly mono-method is supported by Van der Heijden (1997) where it is suggested the key factors and drivers and trends may be determined independently and validated through focus groups where plausible combinations of the drivers and forces are obtained in a qualitative manner. Following this logic and the steps as described by Schwartz (2012) a qualitative mono-method as shown in Figure 7 below was followed.

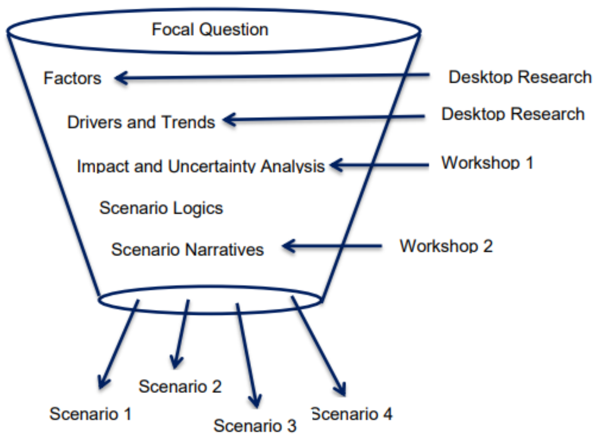

Figure 7: Research Methodological Choice

Firstly, comprehensive desktop research was done using multiple sources such as journal articles, Government documents (including Eskom), news articles and reports from research institutions (both for profit and not for profit). The findings from the desktop research were not categorised or sorted in any way, but noted as factors. In order to ensure all possible factors were identified, the STEEP framework as described by Alipour, Hafezi, Amer and Akhavan (2017) was used wherein desktop research was conducted for each of the social, technological, economic, environmental and political factors influencing the ESI.

After the first desktop research step was completed, the data was coded and analysed to determine underlying themes and drivers and trends. If a factor kept on emerging as integral to the ESI or the future ESI, the factor was identified as a driver for change. This is consistent with the work done by Glenn and Gordon (2009) and Alipour et al. (2017) in which both sets of authors note that the drivers for change are those identified as critical to start or drive a change. Factors that were not identified as drivers for change but being driven by these drivers for change were categorised as trends of those drivers. Alipour et al. (2017) note that the drivers for change and trends are determined from the factors identified as part of environmental scanning, which was the STEEP analysis done.

Once the drivers for change and trends were provisionally determined, the first focus group (or Workshop 1) was conducted with subject matter experts. The purpose of Workshop 1 was to firstly validate the drivers for change and trends that was identified in the desktop research and, secondly, to determine the impact and uncertainty of each driver and resultant trend. This step was done in order to rank the drivers for change in order from most impactful driver to the least impactful driver, as done by Chen et al. (2020) and Glenn and Gordon (2009).

Once Workshop 1 was completed, scenario logics were conducted as explained below. The workshop transcripts were first coded to ensure validation of data was complete. Validation of data included whether the correct drivers for change and trends were identified. After validation, scenario logics were conducted which is described by Konno, Nonaka and Ogilvy (2014) as reducing the infinite number of alternative futures to just a few whereas Alipour et al. (2017) describe scenario logics as setting the context and framework for the scenario descriptions. The scenario logics are therefore akin to the narrowing of the "cone" depicted in Figure 7 to arrive at a few alternative futures. In order to facilitate this, all drivers for change were linked to their trends in an exploratory systems thinking manner. Trends and drivers for change that may be linked to other trends or drivers for change were also identified and mapped. The two to three most impactful links were also identified and highlighted.

Finally, in Workshop 2, the observations arising from the scenario logics were validated. The exploratory system thinking exercise was done and the top two drivers for change used in the scenario narratives were determined. Scenario narratives were done where the workshop conducted in a "*disciplined imagination" (Ramirez et al., 2015)* by imagining four possible futures using the top two mutually exclusive drivers for change. As noted by Niembro-García et al. (2022), it was important for these drivers to be mutually exclusive as the one driver for change should not affect the second driver for change that is to be kept constant. The scenario narratives were developed as a storyline of the future ESI for each of the four quadrants of the 2x2 matrix. Although Workshop 2 provided the input that would go into the scenario narratives, due to time constraints and analysis required by the author these narratives were developed at the conclusion of Workshop 2.

A summary of the research methodological choice is given in Table 1.

Table 1: Summary of Methodological Choice

Activity	Data Source	Data it validates	Outcome
Factors	Journal articles, Government documents, news articles, reports	None	Factors concerning the ESI and the possible future ESI
Drivers for change	Factors identified	None	Drivers for change and trends
Workshop 1	Drivers for change and trends	Drivers for change and trends	Validated drivers for change which as ranked in order of impact
Scenario Logics	Workshop 1 data	None	Linked drivers for change and trends
Workshop 2	Scenario Logics	Drivers ranked, trends ranked, impact of drivers and trends on each other	Four scenarios of possible futures of the South African ESI

Research Strategy

Although scenarios are built on a good theoretical base, relying on this method alone may result in the omission and/or lack of ranking of the drivers and trends affecting the scenarios. Since the formulation of scenarios are enhanced through interaction between the practical and the theoretical as opposed to the theoretical alone, it is beneficial for the researcher to conduct research in the field (Gordon, 2013).

Participatory action research (PAR) is described by Creswell, Hanson, Clark Plano and Morales (2007) as research in which the participants and the researcher share a collaborative relationship to solve a social or community-based problem. Although PAR was originally intended to address social problems of an ethical nature (Creswell et al., 2007) the ideology of the researcher and the participant being on equal footing holds water in other instances as well.

For example, Balarezo and Nielsen (2017) and Ramirez et al. (2015) describe action research as the methodology of choice in scenario planning research reviewed by the authors. For the current research, PAR was selected to be the chosen strategy as it allows the researcher active collaboration with the participants in order to converge on the key drivers and factors required to address the research problem.

Time Horizon Selected

Cross-sectional research is akin to a snapshot of the current environment whereas longitudinal studies consider changing events over a period of time (Saunders & Lewis, 2018). Scenario planning has a defined starting point where alternative futures may play out depending on how events occur. The scenarios may be updated over time to reflect branches that were taken; this, however, was not part of this study and a cross-sectional perspective was selected, examining change in the ESI within a specific time horizon.

The timeframe of the time horizon of 20 years was selected, but with a focus on the midpoint of ten years. Although Amer et al. (2013) advocates for the longer periods (20 years) due to increased uncertainty in the possible alternative futures, the pending transition of the South African ESI provided sufficient uncertainty to make a study valuable given a shorter timeframe as well.

Population

Saunders and Lewis (2018) define the population as all members forming a group based on some common attribute. For the current research the population may be described as specific persons responsible for procuring electrical energy for large power users in South Africa. Persons involved in the general short-term administration of electrical energy for large power users (that is, buyers) was not included as part of the population – rather persons responsible for the medium- to long term strategy of electrical energy procurement was seen as being part of the research population.

Large power users are defined as either those belonging to the industrial and mining customer segments for Eskom or private companies not included in Eskom's customer segments but consuming a similar amount of electricity as those that are included. According to Eskom Holdings (2021a) for the period 1 April 2020 to 31 March 2021 industrial and mining customers made up only 0.05% of its total customer base but contributed 35% and 33% to its total sales and revenue, respectively (Eskom Holdings, 2021a, p. 138). Justification of this choice of population is in line with the work done by Chen et al. (2020) where Delphi survey respondents were chosen based on their expertise in the field contributing to the quality of scenarios developed. Being participatory action research by strategy, the current research also relied on expert input to develop scenarios.

Unit of analysis

The unit of analysis for a PAR study is the community or group as a whole (Creswell et al., 2007). This is due to the researcher and participant in PAR working together to solve a common problem or come to a common insight. For the current research, common insight was measured from the workshops making the unit of analysis the perceptions of procurement officers of the possible changes to the ESI.

Sampling method and size

When the sampling frame consist of all members of the population, the correct sampling method is probability sampling since the researcher knows what the probability is of picking each member of the population (Saunders & Lewis, 2018). In instances where a complete list of all members of the population is not known, the correct sampling method is non-probability sampling (Saunders & Lewis, 2018).

In light of the above, the current research has a population consisting of energy procurement managers of large power users. Although organisations such as the Energy Intensive Users Group of Southern Africa (EIUG) exist where large power users are typically members, no such complete list exist. Even in the event of Eskom, the advent of independent power producers has ensured that no single entity can lay claim to a complete list of large power users in South Africa. The current research therefore deployed a non-probability sampling method.

As indicated by Saunders and Lewis (2018) there are certain varieties within non-probability sampling including quota sampling, purposive sampling, volunteer sampling as well as convenience sampling. Purposive sampling consist of typical case, critical case, extreme case, heterogeneous as well as homogeneous sampling

(Saunders & Lewis, 2018) where typical case purposive sampling is defined as a sample selected that is representative of the population. Given that large power users typically join similar organisations, such as the EIUG, due to shared interest in power regulations and security of supply, a member of such a group is deemed as representative of the entire population.

This is justified by the claim of the Energy Intensive Users Group of Southern Africa (2022) that its members collectively contribute about 40% of Eskom's sales. Although this number is slightly more than the 35% of sales attributed to industrial and mining customers by Eskom Holdings (2021a) it is similar enough to deduce that the majority of sales Eskom attribute to these segments come from companies which are members of the EIUG. Therefore, typical case purposive sampling was used where the 25 current member companies of the EIUG was invited to participate in the focus group.

For qualitative research, an adequate sample size is one where saturation has been achieved (Saunders & Lewis, 2018) and no new information is gained by including more respondents. Hennink, Kaiser and Weber (2019) counters by saying saturation is not about sample size but rather about adequate conceptual depth being reached. There is however no widely accepted method for determining the number of participants within a focus group or the number of focus groups required to reach this required depth (Hennink et al., 2019).

The current research used desktop research along with focus groups to gather data. The factors and drivers and trends reached a point of saturation from desktop research where new data sources did not reveal any new codes or significantly changed the factors and drivers and trends already observed.

Although the focus group participants ascribe meaning to the data they provide, data is still being collected. Participants may not be added or omitted to reach data saturation as in the traditional way and depth of the insights gained was the deciding factor whether saturation has been reached or not.

Measurement Instrument – Focus Groups

Focus groups are widely accepted to be an appropriate method for exploring topics for which there is little information (Stewart & Shamdasani, 2017). Seeing as the strength of scenario planning lies in its ability to deal with the uncertain (Amer et al., 2013) the use of focus groups, or so-called workshops by scenario planning users, are not only an appropriate way but an ideal way of conducting scenario planning research.

Focus groups are used to gain data from specific individuals rather than a representative sample of the entire population where different world views are welcomed (Nyumba, Wilson, Derrick, & Mukherjee, 2018). For this, the facilitator does not take the centre-stage role but sits on the side lines and engages along with the participants (Nyumba et al., 2018). It is mainly for this reason that Dufva and Ahlqvist (2015) describe the focus group setting as articulating as well as embodying knowledge.

Although focus groups have traditionally been face-to-face encounters, Stewart and Shamdasani (2017) indicate this is not always possible due to geographic space between the participants as well as difficulty in aligning schedules. Even though their article has been published before the onset of the COVID19 pandemic, Stewart and Shamdasani (2017) highlights that physical immobility also plays a role. This, along with the advances in information technology, has allowed the focus group setting to move from the physical world to the online world.

An initial concern of the researcher was that online focus groups would result in inferior results, specifically as Dufva and Ahlqvist (2015) indicate the success of a focus group is for the facilitator to extract both verbal (explicit) and non-verbal (implicit) messages from the participants. However, as found by Stewart and Shamdasani (2017), research in this area has indicated there is no difference in dynamics (or even stereotypes) between face-to-face interactions and online interactions. For example, eye contact seems to play just as important role in online conversations as in face-to-face interactions (Bailenson, Beall, Loomis, Blascovich, & Turk, 2006).

Besides the similarities between face-to-face interactions and online interactions and even before the onset of the COVID19 pandemic, Stewart and Shamdasani (2017) have found that participation numbers in focus groups were higher for those conducted online as opposed to those being conducted in physical space. This is likely due to the increased convenience of online focus groups as opposed to physical ones (Stewart & Shamdasani, 2017). Online focus groups may be both synchronous or asynchronous with the difference being the real-time facilitation and participation of the former as opposed to the latter's longer timeframe but limited messaging medium (chat only) (Stewart & Shamdasani, 2017).

The skill of the moderator is not less important in online focus groups as opposed to physical focus groups. In online focus groups, the moderator just has more tools at his/her disposal (Stewart & Shamdasani, 2017). For example, whereas an assistant is normally tasked with observing non-verbal ques and recording the content of the focus group in face-to-face interactions (Nyumba et al., 2018) online focus groups may use the recording function to allow the facilitator to revisit the session afterwards to study these ques and code data captured.

Just as with face-to-face focus groups, the facilitator should ensure that the online session is engaging whilst putting participants at ease. According to Dufva and Ahlqvist (2015) a focus group discussion should start with the facilitator providing the problem statement as well as the context of the workshop. This is concurred by Papamichail, Alves, French, Yang and Snowdon (2007) and Stewart and Shamdasani (2017) adding that the style and energy in which the facilitator handles the workshop will influence the participation of the participants. For online focus groups this means the list of questions should be short to discourage survey-type answers (Stewart & Shamdasani, 2017). According to Stewart and Shamdasani (2017) the facilitator should rather begin with easy questions and elaborate on those questions, paying special attention to move the discussion along and probing specific participants if required.

As opposed to an interview guide, a focus group uses a facilitation guide (Dufva & Ahlqvist, 2015) to help the facilitator keep the focus group discussion on track. The facilitation guide for Workshop 1 is shown in Appendix 1 with the presentation used included in the supporting documents accompanying this research submission (this is done to limit the document size). Before the commencement of Workshop 2, participants from Workshop 1 were provided with the presentation from Workshop 1 but with notes captured. This was done since the two workshops took place 14 days apart. The presentation with presenter notes is included as Appendix 2. The facilitation guide for Workshop 2 is found in Appendix 3 with the with the presentation submitted as part of the supporting documents. Along with the online focus group, the researcher used the online tool Menti (https://www.menti.com/) to facilitate discussion and keep the discussion engaging.

Data gathering process

As a result of the verbal and non-verbal communication methods used in focus groups, the tools used in the workshop become ways in which to articulate information (Dufva & Ahlqvist, 2015). This information is used to gain new insight from existing theory, adding to the deductive nature of the study.

The outcome of Workshop 1 was to firstly validate the factors and drivers and trends that relate to the focal question (see Table 1) through triangulation and secondly to conduct an impact and uncertainty analysis. This output was done via group consensus on the importance of each driver succeeding as well as the uncertainty regarding the force behind each driver (Chermack et al., 2001).

Once the scenario logics were determined based on the analysis of Workshop 1, Workshop 2 was designed to validate and stress-test the scenario logics as well as giving rise to scenarios given the set of options – these scenarios are provided in the form of alternative narratives or stories about the future of the ESI.

For the current research, the first data gathering process was via desktop research using existing data. This was followed by two workshops where data was gathered verbally as well as non-verbally via online focus groups (called Workshop 1 and Workshop 2). Verbal data gathering was in the form of transcribing debate and discussions among the participants and non-verbal data gathering is in the form of lists, diagrams and rankings.

Each workshop lasted 120 minutes in total to accommodate scheduling concerns the participants may have. To ensure quality of data, the ideal was to have consistency in participants between the workshops. This was facilitated by keeping the workshops relatively short (120 minutes) and scheduling the workshops as soon as ethical clearance had been gained.

Data analysis approach

As indicated by Chermack et al. (2001) and practised by authors such as Chen et al. (2020) and Ramirez et al. (2015) the original data analysis approach is by ascribing codes and factors to existing literature to determine driving factors and trends.

This was followed by Workshop 1 where data was analysed and summarised according to codes (impact ranking and uncertainty). The codes were used as input in determining the scenario logics where categories and linkages between drivers and trends where obtained. Data from Workshop 2 was subsequently analysed according to theme to determine the (typically) 2x2 scenario narrative.

Data was verified along multiple steps through utilising triangulation. Firstly, the data obtained through the desktop research was verified through the data collected from Workshop 1. The data from Workshop 1 was then verified through the scenario logics tying back to the original drivers and trends. Workshop 2, in turn, verified the scenario logics through the scenario narratives. Saturation of data was also used as a method of triangulation. Table 1 provides a summary of the data triangulation that was achieved.

Quality controls and triangulation

Gordon (2013) describes triangulation as verification of findings through the comparison of results using different data sources or methodologies. The different types of triangulation through which this can be done are data triangulation, investigator triangulation, theory triangulation, methodological triangulation and interdisciplinary triangulation.

Investigator triangulation, theory triangulation and methodological triangulation was not used in this research paper. Since there is a single author and facilitator of the focus groups, there was no opportunity to compare findings on the same data set from different researchers. The research approach was deductive (even though the study was qualitative in nature) since new insights were sought by using existing theory. Therefore, different theoretical perspectives were not used but a single perspective to interpret the data, rendering theory triangulation not applicable in this case. Lastly, since the study was time constraint a 2x2 scenario matrix with focus groups was chosen as the preferred method. Therefore, no methodological triangulation was done. However, triangulation between various iterations of analysis was enabled by the process occurring between the literature review and Workshop 1 and Workshop 2. As such, and in line with the action research process employed, the workshop participants contributed to the analysis of the study by providing their judgement of the analytical judgements being made by the researcher in the process of synthesis across the process.

As stated above, verification of the results were done through data triangulation and interdisciplinary triangulation. Data sources include both desktop research as well as participant views during the focus groups. These two data sources were compared after both Workshop 1 and Workshop 2 to ensure consistency with findings thereby conducting data triangulation. Once the scenario narratives were determined, this was compared to different scenarios involving the ESI but from a different perspective. Most notably, the work done by Oosthuizen et al. (2018) for African utilities was used to determine whether the current scenarios are plausible or not. This interdisciplinary triangulation further ensured the veracity of the narratives obtained.

To ensure the facilitation guide was adequate for the subject under study, both Workshop 1 and Workshop 2 was done with non-experts with participants chosen through convenience sampling. This ensured high quality workshops when the subject matter experts were part of the focus group.

Limitations of the study

The scenario planning framework has some limitations associated with it. Context and the environment the company operates in matters. Since intuitive scenarios focus on these contexts, the scenario framework may be used on incorrect intuition (Ramirez & Wilkinson, 2014).

The use of focus groups is also not without its limitations. The current or recent environment the participants find themselves in may not be structural in nature (or may not even impact the ESI in any way) but may affect the energy and direction of the conversation (Stewart & Shamdasani, 2017). This recency bias could lead to the incorrect impact analysis of drivers and trends or the wrong narratives developed. To ensure this limitation does not derail the scenario planning process, it was important for the facilitator to remain open-minded and encourage the participants to objectively discuss whether the current environment is structural in nature or not.

The construction of the scenarios was done using a 2x2 matrix. This method assumes the two variables are independent where there in fact may be some co-evolution between the two (Ramirez & Wilkinson, 2014). Although triangulation and Workshop 2 was designed to limit the possibility of this, this remains a limitation of the research.

Even when scenarios are done flawlessly using robust and unbiased data, the output has some limitations to it. As alluded to earlier in this paper, the strength of scenario planning lies not in its outcome but in the insights gained during its construction. Given that these scenario narratives are sometimes shared within companies and

Government departments, the outputs may be regarded as fact or forecasts with probabilities attached to them. In order to avoid this, scenario planning narratives such as those discovered during the course of this research may provide much needed insight only and lacks practical application beyond the population for which it is intended (Glenn & Gordon, 2009).

Scenarios are a snapshot in time of what alternative futures may look like. Should a certain path be taken over time, the scenarios may no longer be plausible and a new branch of scenarios are required, opening up avenues for further research.

In their reviews of scenario planning literature from the past 50 years, Gordon et al. (2020) found that recent questions that scholars are asking is what role does strategic foresight play in organisations. The current research did not consider this question when conducting workshops and this remains a limitation of the research methodology in terms of its contribution to scholarship on the methodological aspects of the study as it remains beyond the scope of the study.

Chapter 5

As discussed in Chapter 4 and indicated in Figure 7 and Table 1, the results for this research comprise of multiple phases. In order to allow a logical flow of data and results which build on each other, this Chapter is broken into segments comprising of the factors identified, the drivers and trends categorised, the qualitative date from Workshop 1, the scenario logics, qualitative data from Workshop 2 and, lastly, the scenario narratives.

Factors

Factors were determined and is arranged according to the STEEP framework and date of the source. In all, 26 sources resulted in 155 factors identified. Factors were coded to provide a brief description (no more than a phrase) along with the trend of that factor. An initial observation as to the underlying driver to that factor was also given. The results are shown in Table 2 with a brief description of certain factors that follow.

Following Table 2, a brief description of certain factors is given; the factors chosen are highlighted in bold within Table 2. This description is to enable the reader to appreciate the process the author followed.

Table 2: Factors identified during environmental scan

STEEP	Year	Description	Trend	Driver	Source
Social	2015	ESI Drivers	Unequal	Energy Poverty	Oosthuizen et al. (2015)
Social	2015	ESI Drivers	Massive	Urbanisation	Oosthuizen et al. (2015)
Social	2015	ESI Drivers	Select Few	Jobs	Oosthuizen et al. (2015)
Social	2015	ESI Drivers	Growing	Demand	Oosthuizen et al. (2015)
Social	2015	ESI Drivers	Rising	Expectations	Oosthuizen et al. (2015)
Social	**2017**	**Household energy intensity**	**Increasing**	**Population growth and urbanization**	**Spalding-Fecher et al. (2017)**
Social	2017	Transport energy volumes	Increasing	GDP growth and urbanization (linked to mobility)	Spalding-Fecher et al. (2017)
Social	2018	ESI Drivers	Urbanisation	Rising faster than infrastructure expansion	Oosthuizen et al. (2018)
Social	2018	Labour	Resistance to change and backlash to transition	Poorly managed transition	Oosthuizen et al. (2018)

Social	**2018**	**Labour**	**Increasing confusion and frustration**	**A lack of standardization and appreciation for the complexity**	**Meridian Economics (2018)**
Social	2021	Employment in energy sector dominated by Eskom	Declining	Eskom is no longer the only employer in the electricity sector and competes with other generators for skills	Eskom Holdings (2021b)
Social	2021	Consensus	Decreasing	Lack of consensus on what technologies to procure and how the market should be restructured. This is drawn from Meridian's opposition to the NERSA Section 34 determination for nuclear procurement	Meridian Economics (2021)
Social	2022	Role of Traders	Traders play disaggregating role from generators to consumers	Electricity needs of consumers differ requiring more options	National Energy Regulator of South Africa (2022)
Social	2022	Universal access to energy	Increased drive	African countries seek to have universal access to energy by 2030 – this will likely cause an intensity as opposed to a reprieve from subsidies	International Energy Agency (2022)
Social	2022	Universal access to energy	Increased drive	Population growth will be a key driver for change with urbanization the effect	International Energy Agency (2022)
Social	2022	Generation in decline	Lack of skills	Lack of upskilling and retraining	Slater (2022)
Techno-logical	2015	ESI Drivers	Developing	Renewable	Oosthuizen et al. (2015)
Techno-logical	2015	ESI Drivers	Infancy	Storage	Oosthuizen et al. (2015)

Techno-logical	2015	ESI Drivers	Distant	Disruptive Technology	Oosthuizen et al. (2015)
Techno-logical	2015	ESI Drivers	Under-developed	Supply Chain	Oosthuizen et al. (2015)
Techno-logical	2015	ESI Drivers	Misaligned	Infrastructure	Oosthuizen et al. (2015)
Techno-logical	2015	ESI Drivers	Future Dilemma	Centralisation vs Decentralisation	Oosthuizen et al. (2015)
Techno-logical	2015	ESI Drivers	Future Enabler	IT and connectivity	Oosthuizen et al. (2015)
Techno-logical	**2017**	**Supply**	**Reduction in existing fleet**	**Aging fleet**	**Wright, Bischof-Niemz, van Heerden, Calitz and Mushwana (2017)**
Techno-logical	2017	Wind deployment in South Africa	Increasing	Good wind resources and large land areas	Wright et al. (2017)
Techno-logical	2018	ESI Drivers	Private sector involvement increasing	PPAs on RE	Oosthuizen et al. (2018)
Techno-logical	2018	ESI Drivers	Small players seek to overtake large utilities	Slow uptake from utilities	Oosthuizen et al. (2018)
Techno-logical	2018	Distributed generation	Being de-centralised	Participation of private sector and small scale solar	Oosthuizen et al. (2018)
Techno-logical	2018	Grid reliance	Increased reliance on the grid as back-up by end users	End-users mitigate their own risks through own generation and use the grid as a back-up	Oosthuizen et al. (2018)
Techno-logical	2018	ESI Drivers		Entrants of new actors	Oosthuizen et al. (2018)
Techno-logical	2019	Eskom coal infrastructure	Aging and poorly maintained	Lack of investment in Eskom	The Council for Scientific and Industrial Research (2019)
Techno-logical	2019	Infrastructure backlog	Increasing	Lack of investment	The Council for Scientific and Industrial Research (2019)
Techno-logical	2019	Medupi and Kusile	Delays and performance issues	Lack of planning and oversight	The Council for Scientific and Industrial Research (2019)

Techno-logical	2019	Costs of renewables	Global cost reduction	Economies of scale – widespread adoption	The Council for Scientific and Industrial Research (2019)
Techno-logical	2019	Nuclear	Move from larger fleets to smaller plants more often	Flexibility and affordability of smaller plants required	Department of Mineral Resources and Energy (2019)
Techno-logical	2019	A move away from fossil fuels	Globally accelerated	Need for global transition	Department of Public Enterprises (2019)
Techno-logical	2019	Demand patterns	Changing	More affordable self-generation, energy efficiency and storage technologies	Department of Public Enterprises (2019)
Techno-logical	2019	Prosumer	Increase	Consumers are increasingly becoming prosumers due to the cost of electricity as well as the security of supply	Eberhard (2003)
Techno-logical	2020	Adoption of renewable energy	Slow	Lack of grid capacity and connection issues causes a physical constraint on the roll-out	Renaud, Tyler, Roff and Steyn (2020)
Techno-logical	2021	Eskom Electricity Availability Factor (EAF)	Declining with a negative outlook	Aging plant that was not adequately maintained	Eskom Holdings (2021b)
Techno-logical	2021	Loadshedding	Increasing	Abandonment of the REI4P resulted in insufficient new generation capacity	Roff et al. (2022)
Techno-logical	2022	So-called duck curve	Higher solar energy during lower demand and lower solar energy during higher demand	Solar Energy without battery storage penetrating the grid	National Energy Regulator of South Africa (2022)
Techno-logical	2022	No demand modelling	Move from baseload type of generation to baseload and	Solar and Wind Energy without battery storage	National Energy Regulator of South Africa (2022)

			variable generation		
Techno-logical	2022	Advances in technology	Greater monitoring, communi-cation and control	Smaller generators entering the system	National Energy Regulator of South Africa (2022)
Techno-logical	2022	Microgrids	More microgrids coming online	Smaller and geographically dispersed generators entering the system	National Energy Regulator of South Africa (2022)
Techno-logical	2022	Distributed Generation	More distributed generation coming online	Inadequate Eskom supply and prices becoming expensive enough to surpass threshold	National Energy Regulator of South Africa (2022)
Techno-logical	2022	Emergence of prosumers	More customers are becoming both generators and consumers of power	Inadequate Eskom supply and prices becoming expensive enough to surpass threshold	National Energy Regulator of South Africa (2022)
Techno-logical	2022	Big Data	More demand and generation data becoming available	Different consumer needs and generation profiles can be matched	National Energy Regulator of South Africa (2022)
Techno-logical	2022	Distribution network	More hands-on management is required	Greater variability in the system	National Energy Regulator of South Africa (2022)
Techno-logical	2022	Ancillary Services	Greater need to identify and compensate generators which contribute to ancillary services as well	Need for greater grid strengthening due to variable generation supply	Department of Mineral Resources and Energy (2022)
Techno-logical	2022	Ancillary Services	Greater need to recognize and compensate loads (customers) which contribute	Need for greater grid strengthening due to variable generation supply	Department of Mineral Resources and Energy (2022)

			to ancillary services as well		
Techno-logical	2022	Gas-to-Power	Uncertainty specifically those not linked to LNG	Funding for pipelines remain an issue	International Energy Agency (2022)
Eco-nomical	2015	ESI Drivers	Distant	Regional Integration	Oosthuizen et al. (2015)
Eco-nomical	2015	ESI Drivers	Inertia	Energy Paradigm	Oosthuizen et al. (2015)
Eco-nomical	2015	ESI Drivers	Trust Deficit	Public Private Partnerships	Oosthuizen et al. (2015)
Eco-nomical	2015	ESI Drivers	Finite	Capital	Oosthuizen et al. (2015)
Eco-nomical	2015	ESI Drivers	Debilitating	Fossil and Import Dependence	Oosthuizen et al. (2015)
Eco-nomical	2015	ESI Drivers	Stagnant	GDP Growth	Oosthuizen et al. (2015)
Eco-nomical	2015	ESI Drivers	Emergent Blind Spot	SMME and corporate provision	Oosthuizen et al. (2015)
Eco-nomical	2015	ESI Drivers	Crossroads	Investment in mining industry	Oosthuizen et al. (2015)
Eco-nomical	2015	ESI Drivers	Not competitive	Energy Pricing	Oosthuizen et al. (2015)
Eco-nomical	2015	ESI Drivers	Obscure	Perverse Incentives	Oosthuizen et al. (2015)
Eco-nomical	2015	ESI Drivers	Unfair	Subsidisation	Oosthuizen et al. (2015)
Eco-nomical	2015	ESI Drivers	Volatile	Mining and construction labour stability	Oosthuizen et al. (2015)
Eco-nomical	2018	Recognised revenue	Under-recovery of energy sold	Tolerance for non-payment due to political populism	Oosthuizen et al. (2018)
Eco-nomical	**2019**	**Eskom liquidity**	**Decreased liquidity and ability to be going concern**	**Under-recovery of required revenues**	**The Council for Scientific and Industrial Research (2019)**

Eco-nomical	2019	Coal	Increasing cost and dependency	Severely concentrated market	The Council for Scientific and Industrial Research (2019)
Eco-nomical	2020	Loadshedding	Increasing	Underperformance of Eskom fleet and delayed commissioning of new plant	Wright and Calitz (2020)
Eco-nomical	2020	Gas Capacity	Increasing as increased flexibility required	Higher penetration of RE	Wright and Calitz (2020)
Eco-nomical	**2021**	**The cost to produce electricity – Eskom**	**Continuously increasing**	**Large increase in the cost of IPPs and carbon tax**	**Eskom Holdings (2021b)**
Eco-nomical	2021	The cost of power from coal power stations	Cost is increasing	Coal power stations are getting older and less efficient at producing electricity cost-effective	Eskom Holdings (2021b)
Eco-nomical	2021	Shareholder return and Eskom as a going concern	Shareholder return is eroding and Eskom's ability to continue as a going concern under increasing pressure	Tariffs are not cost reflective and does not cover the cost of producing the power sold (or servicing debt)	Eskom Holdings (2021b)
Eco-nomical	2021	Investment in new generation plant	Eskom does not spend significant capital or invest in new generation plant	Shift from Eskom being the supplier of choice to the private sector increasing its participation	Eskom Holdings (2021b)
Eco-nomical	2021	Primary Energy	Costs declining and will be less than the costs of IPPs in FY24	Deep penetration in the energy mix for RE coupled with expensive first round costs in the REI4P	Eskom Holdings (2021b)
Eco-nomical	2021	Eskom financial position	In decline	Assistance on (artificially) low prices by politicians	Roff et al. (2022)

Eco-nomical	2021	Self-inflicted high cost on the system	Increasing	Abandonment of the REI4P resulted in insufficient capacity being added to grid which caused more diesel to be burnt and (inefficient) pumped storage to be used	Roff et al. (2022)
Eco-nomical	2021	New generation added in optimum geographies	Lack of	No or too little investment in the transmission system resulting in inadequate capacity to take the power	Steyn, Tyler, Roff, Renaud and Mgoduso (2021)
Eco-nomical	2021	Eskom's debt crises	Increasing	Too little is being done at any one stage. The "drip-feed" that is currently being done is not enough to solve the crises	Steyn et al. (2021)
Eco-nomical	2021	Eskom's credit rating	Worsening	Inability to service debt and obtain cost-reflective tariffs	Steyn et al. (2021)
Eco-nomical	2021	Cost difference between RE and coal	Widening	Due to learning curves obtained in RE, the cost of RE is declining and falling below that of coal generation	Steyn et al. (2021)
Eco-nomical	2022	Focus of price setting	Price setting is moving from the licensee (reasonable return) to the consumer	Disaggregated market makes it difficult to place focus on licensee	National Energy Regulator of South Africa (2022)
Eco-nomical	2022	Inefficiencies in Eskom hidden due to cross-subsidies		Drive to get tariffs more cost reflective	National Energy Regulator of South Africa (2022)
Eco-nomical	2022	Need to separate infrastructure and trading	Infrastructure to be dealt with (and	Disaggregated markets require different incentives	National Energy Regulator of South Africa (2022)

			compensated differently)		
Eco-nomical	2022	Cost dynamics	Becoming more complex	Partial self-generation which are variable, intermittent and non-dispatchable requiring grid back-up	Department of Mineral Resources and Energy (2022)
Eco-nomical	2022	Tariff structures	Discriminate between fixed (capacity) charges and variable (energy) charges to highlight cost reflectivity	Set up a wholesale tariff (price) to facilitate trading	Department of Mineral Resources and Energy (2022)
Eco-nomical	2022	Central Purchasing Agency	Purchase fixed system back-up costs through compulsory CPA tariffs	Mixture of self-generation and grid generation with the grid as back-up	Department of Mineral Resources and Energy (2022)
Eco-nomical	2022	Location of plants	Investors of generation plants should consider both the cost of their generation and the location to quantify the strain it places on the system	Localised IPPs should pay for the strain they put on the system	Department of Mineral Resources and Energy (2022)
Eco-nomical	2022	Net energy billing	Consumers should pay for when they use power and get paid for when they export power. These are for the	The advent of prosumers	Department of Mineral Resources and Energy (2022)

			variable portions only		
Eco-nomical	2022	Inability to make use of macroeconomic opportunities		Even though energy prices have soared since Russia's invasion of Ukraine, a lack of infrastructure has prevented African countries from scaling up production	International Energy Agency (2022)
Eco-nomical	2022	Large investment in infrastructure projects	Declining	The cost of capital remains high	International Energy Agency (2022)
Eco-nomical	2022	Large investment in infrastructure projects	Declining	Economic growth is a major driver for energy demand	International Energy Agency (2022)
Eco-nomical	2022	Fiscal risk due to Eskom	Increasing	Eskom's status as a going concern is under threat and the fiscus has to step in and take over the risk	Bloomberg (2022)
Environ-mental	2015	ESI Drivers	Growing Issue	Pollution	Oosthuizen et al. (2015)
Environ-mental	2015	ESI Drivers	Abundant	Sources	Oosthuizen et al. (2015)
Environ-mental	2015	ESI Drivers	Distant	Climate Change	Oosthuizen et al. (2015)
Environ-mental	2017	Regional demand	Increasing	Economic growth in SADC mainly through extractive means	Spalding-Fecher et al. (2017)
Environ-mental	2018	Coal burning and exports	Declining	Cost of burning coal becoming more expensive due to national mitigation policies and carbon tax	Merven et al. (2018)
Environ-mental	2019	Investment in renewable energy	Increasing	Climate change commitments of the Paris Agreement	Department of Mineral Resources and Energy (2019)

Environ-mental	2019	New coal investment	Move to highly efficient HELE technology	Funders require “clean coal” for investment	Department of Mineral Resources and Energy (2019)
Environ-mental	2020	Planning for future	Decrease with each IRP	CO_2 commitments and cost of RE	Wright and Calitz (2020)
Environ-mental	2021	Decommissioning of coal power stations	Increasing pressure to decommission even if not at the end of their design life	Global and local pressure to comply with air emission license conditions	Eskom Holdings (2021b)
Environ-mental	2021	CO_2 compliance	Adherence to	Whilst individual power plants are run based on economical factors, compliance to CO_2 emission targets will require a system-wide approach where the entire fleet is required	Steyn et al. (2021)
Environ-mental	2022	Climate Change	National and global emphasis increasing	Global warming	National Energy Regulator of South Africa (2022)
Environ-mental	2022	Electric Vehicles	Greater penetration	Global warming and international commitments	National Energy Regulator of South Africa (2022)
Environ-mental	2022	Demand shifts	Increasing	Building demands decrease due to more efficient designs; however fans and air conditioners used for cooling increase due to increase global warming	International Energy Agency (2022)
Environ-mental	2022	Access to foreign funds	Increasing	COP26 has laid a potential foundation to increase funding for African countries	International Energy Agency (2022)
Political	2015	Energy sector stability	Decreasing	Poor governance and failure to implement policy decisions	Oosthuizen et al. (2015)

Political	2015	Involvement of the State in providing guarantees	Decreasing	Energy technologies are no longer the exclusive domain of long term planning with shorter implementation times (<2yrs) for RE technologies	Derived from Oosthuizen et al. (2015)
Political	2015	Political interference	Hampering energy planning and policy implementation	Political interference	Oosthuizen et al. (2015)
Political	2015	ESI Drivers	Lacking	Institutional capacity	Oosthuizen et al. (2015)
Political	2015	ESI Drivers	Contested	Ideology	Oosthuizen et al. (2015)
Political	2015	ESI Drivers	Poor	Policy Implementation	Oosthuizen et al. (2015)
Political	2015	ESI Drivers	Constrained	Local Government Capacity	Oosthuizen et al. (2015)
Political	2015	ESI Drivers	Debilitating	Political interference	Oosthuizen et al. (2015)
Political	2015	ESI Drivers	Poor	Governance	Oosthuizen et al. (2015)
Political	2015	ESI Drivers	Hijacked	Procurement	Oosthuizen et al. (2015)
Political	2015	ESI Drivers	Archaic	Planning Coordination	Oosthuizen et al. (2015)
Political	2015	ESI Drivers	Not Evidence Led	Energy Mix	Oosthuizen et al. (2015)
Political	2015	ESI Drivers	Under Duress	Regulatory Independence	Oosthuizen et al. (2015)
Political	2015	ESI Drivers	Contested	State ownership	Oosthuizen et al. (2015)
Political	2018		Geological sources such as hydro and natural gas become more available	Regional conflicts subside	Oosthuizen et al. (2018)
Political	2018	Procurement processes	Drag	Conflict of interests and Government irregularities	Oosthuizen et al. (2018)
Political	2018	Distribution Governance	Increasing complexity	De-centralised distribution systems and energy production	Oosthuizen et al. (2018)
Political	2018	Regulations and legislation	Outdated	Fast-paced changes in the ESI	Oosthuizen et al. (2018)

Political	2018	Adoption of alternatives	Fast-tracked	Subsidies required to cover losses of state-owned enterprises drive the acceleration to alternatives	Oosthuizen et al. (2018)
Political	2018	ESI Drivers		Bankrupt utilities	Oosthuizen et al. (2018)
Political	2018	ESI Drivers		Government bailouts	Oosthuizen et al. (2018)
Political	2018	ESI Drivers		Partial privatization	Oosthuizen et al. (2018)
Political	2018	ESI Drivers		Poor interaction with city planners	Oosthuizen et al. (2018)
Political	2019	Lack of policy certainty	Continued lack of policy certainty regarding future ESI	Differing views among stakeholders	The Council for Scientific and Industrial Research (2019)
Political	2019	Municipal distribution model	Increasingly failing	Lack of oversight	The Council for Scientific and Industrial Research (2019)
Political	2019	Import of energy from SADC	More imports, albeit still below the reserve margin	Hydro opportunities in the SADC region	Department of Mineral Resources and Energy (2019)
Political	2020	Adoption of renewable energy	Slow	Lack of political commitment and policy certainty resulting in the inability to establish a local manufacturing base	Renaud et al. (2020)
Political	2020	Adoption of renewable energy	Slow	Regulatory restrictions and generation licenses and PPAs make it difficult to trade with someone other than Government	Renaud et al. (2020)
Political	2021	Energy procured on an emergency basis	Decreasing	Unrealistic local content requirements from the Procurement Office	Steyn et al. (2021)
Political	2021	Uncertainty regarding political future	Increasing	The SALGA court case has lead to substantial uncertainty as to the	Yelland (2021)

				future of the ESI and how this will be reformed. Key driver might be revenue linked to the sale of electricity by municipalities	
Political	2022	Regulating an industry	Moving towards regulating the industry as opposed to a monopoly	Disaggregated market justifies the need to regulate the industry	National Energy Regulator of South Africa (2022)
Political	2022	From regulated to market-based	Once market established, regulation to decrease	Disaggregated market will increase competition requiring less price regulation	National Energy Regulator of South Africa (2022)
Political	2022	Unbundling Eskom	Moving from state-owned monopoly to open market	Disaggregated market will lessen the burden on the fiscus and spread the risk of non-performance	National Energy Regulator of South Africa (2022)
Political	2022	Increase in 100MW exemption cap	Removal of 100MW cap for exemption requirements	Inadequate capacity to drive the economy	National Energy Regulator of South Africa (2022)
Political	2022	Regulation of the ESI	Changes required	ESI market is changing to become less aggregated with the introduction of IPPs	Department of Mineral Resources and Energy (2022)
Political	2022	Independent System Operator	Unbundling of Eskom with the establishment of an ITSO	Eskom risk to the fiscus and the introduction of IPPs	Department of Mineral Resources and Energy (2022)
Political	2022	EPP Update	More than one entity providing/generating power	Moving away from vertically integrated monopoly	Department of Mineral Resources and Energy (2022)
Political	2022	ERA and EPP Update	New regulations	Balance between social equity, economic growth, environmental goals and establishing a market environment	Department of Mineral Resources and Energy (2022)

Political	2022	EPP	Current problems with the EPP	Too many tariff structures, no standardized approach for developing tariffs, funding and capacity shortages, non-payment for bulk electricity services, maintenance and service backlogs, loss of revenue due to low tariffs and lack of bilateral agreements.	Department of Mineral Resources and Energy (2022)
Political	2022	Transmission Planning	Specific costs to be included to conduct independent planning	Due to the unbundling, Transmission can no longer rely on the input from Eskom Generation but must consider other IPPs as well	Department of Mineral Resources and Energy (2022)
Other	2018	Electricity demand		Driven by economic and population growth	Merven et al. (2018)
Other	2019	Demand for electricity	Not growing at the expected pace	Lower intensity, fuel switching, improved efficiencies and closing down of some plants	Department of Mineral Resources and Energy (2019)
Other	2021	Electricity demand	Declining sales for Eskom	Volatile commodity markets and low competitiveness	Eskom Holdings (2021b)
Other	2021	Correlation between electricity consumption and GDP growth	Electricity consumption is growing slower than the growth of the economy and this gap is widening	SA is moving from an industrial economy to a service economy. Energy intensive users are also becoming more efficient	Eskom Holdings (2021b)
Other	2021	National electricity demand	Influenced by factors other than price	Rather influenced by national growth, population growth, weather patterns, commodity prices and	Eskom Holdings (2021b)

				economic structural changes	
Other	2022	Advisory services from the private sector	Increasing	With a skills and funding shortage, Eskom and the Government is turning to the private sector to assist with matter usually not in its jurisdiction	Bulbulia (2022)

Spalding-Fecher et al. (2017) notes that population growth along with economic growth throughout Southern Africa results in higher levels of urbanisation. With populations moving from rural areas to urban areas, traditional forms of cooking and heating which utilises other forms of energy are replaced with electricity. This increases the overall energy intensity of households throughout the country and region.

Meridian Economics (2018) in a report prepared for the South African Wind Energy Association (SAWEA) have, through doing a gap analysis on the work done on employment during the ESI structure transition, found that a lot of the frustration and confusion experienced by workers and unions alike arise as a result of no standard employment metrics or categorisation plans between the current structure and the proposed structure. Meridian Economics (2018) assigns this to an oversimplification of the interconnected parameters at play.

Wright et al. (2017), in a report detailing the wind capability in South Africa, details the decommissioning schedule of the existing generation fleet within South Africa as stipulated in the Integrated Resource Plan (IRP) published by the Department of Mineral Resources and Energy (2019). Wright et al. (2017) concludes that the fleet is aging and a significant reduction in supply is imminent, as seen in Figure 8.

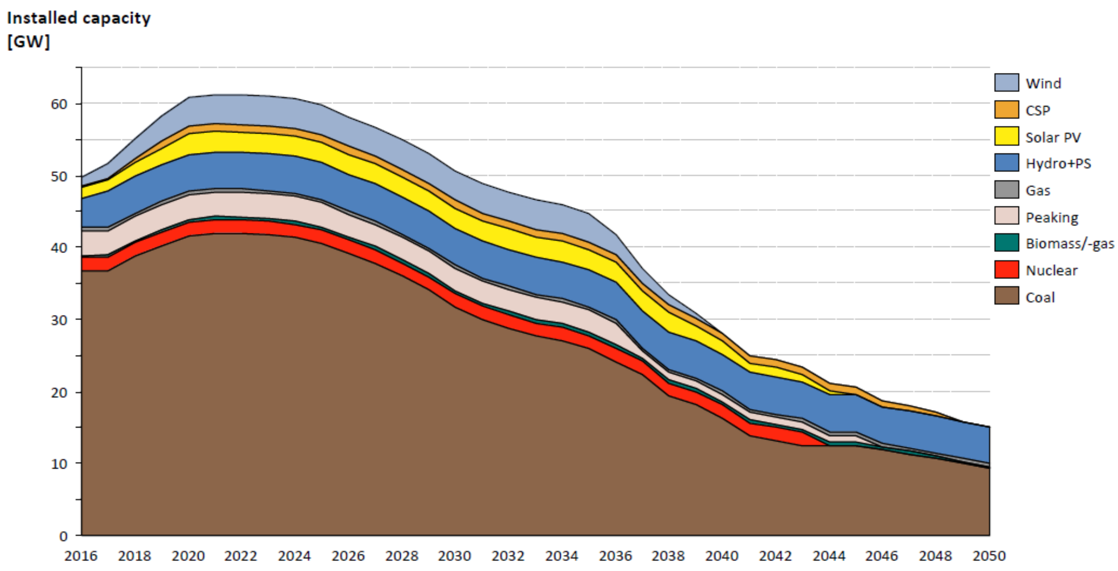

Figure 8: South African supply decommissioning schedule

Source: Wright et al. (2017)

The Council for Scientific and Industrial Research (2019) in a report addressed to the Portfolio Committee on Mineral Resources and Energy, note as one of the significant challenges facing South Africa and Eskom is Eskom's liquidity concerns where Eskom has insufficient cash on hand to fund operations. This is due to Eskom's inability to recover the required revenue from its operations. This is placing increased pressure on the national Government.

Eskom Holdings (2021b) in its application for a tariff increase during its fifth Multi-Year Price Determination (MYPD5) application, argued that despite renewable energy prices coming down in each bid window of the Government's REIP3 programme, the cost of renewable energy as part of Eskom's primary energy is increasing and should therefore be passed on to consumers in the form of an Eskom tariff increase.

Drivers and Trends

Once factors were determined using environmental scanning and as shown in Table 2, drivers and trends were determined. Each factor was analysed and determined by the author as being either a driver fundamental to changing the ESI or a trend resulting from a driver for change. In all, seven drivers for change were identified with 36 trends.

The first driver for change identified is that resources are finite with the extraction of resources becoming more expensive. With pressure on economic viability of opening new mines both locally and globally, resources are in most cases limited to the lives of current mines or easily extracted resources. Driver 1 has four trends linked thereto. Trend 1 is resources are becoming scarce, trend 2 is that labour is resisting change, trend 3 is that renewable sources are essentially infinite and trend 4 is that South Africa has a dependence on coal.

The second driver for change identified is that carbon dioxide emissions need to reduce. Global warming is becoming a real threat to the world with Sub-Saharan Africa seeing a particularly harsh impact. There is a need to limit global temperature rise to 1.5 °C to that of pre-industrial levels by reducing, amongst others, CO_2 emissions. The energy sector, with Eskom contributing 45% of South Africa's total CO_2 emissions, is seen as not only the easiest sector to decarbonise but also an important step in South Africa meeting its emission reduction targets. Driver 2 has four trends linked thereto. Trend 1 is that there is increased local and global pressure to decarbonise the South African ESI, trend 2 is that decarbonisation is linked to a Just Transition, trend 3 is that there is increased national and global costs and risks linked to climate change and trend 4 is that, both locally and globally, there is an increased demand for green products.

The third driver for change is deregulating the ESI. Eskom is proving a great burden to the national fiscus and the regulation of the industry has not helped. The concept of a single buyer and monopolistic state-owned entity has given way globally to decentralised distribution and increased participation from the private sector. Deregulating the industry has become a major driver for change. Driver 3 has seven drivers linked thereto. Trend 1 is there is a drive to unbundle Eskom, trend 2 is an increased removal of fiscal support for Eskom, trend 3 is that to deregulate the ESI requires Governance and Regulatory readiness, trend 4 is that increased private participation leads to collaboration and competition, trend 5 is the emergence of microgrids and decentralised distribution, trend 6 is the emergence of prosumers and trend 7 is the increased variability in the grid requiring ancillary services.

The fourth driver identified is a disconnect between supply and demand. Supply is decreasing and at risk of decreasing further. At the same time, demand is growing albeit slowly. More importantly, the demand profile is changing owing to a change in energy intensity levels (driven by a change in economic structure) and urbanisation.

The current ESI infrastructure is not aligned with this change. Driver 4 has six trends linked thereto. Trend 1 is generation supply is decreasing, trend 2 is demand is becoming diversified requiring customised solutions, trend 3 is universal access to electricity is failing or slowing, trend 4 is population growth and urbanisation is driving demand diversification, trend 5 is infrastructure is not aligned to where demand is and trend 6 is that demand is not growing as expected (and the gap between demand growth and Gross Domestic Product, or GDP, growth is widening).

The fifth driver of change is Governance failures. Governance failures caused by a lack of capacity in institutions and political infighting has caused corruption and oversight failures to occur. This has caused the need for an overhaul and greater transparency. Driver 5 has four trends linked thereto. Trend 1 is a move towards greater transparency, trend 2 is oversight failures are causing ESI shocks, trend 3 is there is political infighting and interference and trend 4 is there is a lack of institutional capacity of will to use that capacity.

The sixth driver identified is the cost and funding of electricity. The costs associated with generating electricity is not being recovered by Eskom. Tariffs are also not cost-reflective or transparent owing to the inclusion of subsidies, cross-subsidies and ancillary services used as back-up supply. Future prices are uncertain as a result of unclear methodologies used and a pushback on the true cost of alternative energy sources. Driver 6 has six trends linked thereto. Trend 1 is the cost of generation is not being recovered, trend 2 is the cost of alternative energy is being challenged, trend 3 is the insistence on the inclusion of subsidies and cross-subsidies, trend 4 is the costs of grid back-up is not being recovered, trend 5 is an uncertainty over allocation of costs due to de-regulation and trend 6 is that tariffs are not transparent.

The final driver for change identified is regarding generation technologies. Globally, generation technologies are undergoing change. Although renewable energy is not yet the dominant source in most countries, its share in the energy mix is outgrowing that of traditional energy sources. This mix will further increase with development in energy storage technologies which is still in its infancy. The future of baseload technologies is unclear but increasingly looking likely to be gas. Driver 7 has five trends linked thereto. Trend 1 is renewable energy technologies are seeing major development, trend 2 is storage of energy is still young but growing, trend 3 is new disruptive technologies are still too distant to predict, trend 4 is supply chains to exploit renewable energy technologies are underdeveloped and trend 5 is the future baseload technology is uncertain but likely to be gas.

Table 3 summarises the seven drivers with resultant trends. The number of sources confirming the trend is also given, adding to the 155 sources which make up the factors.

Table 3: Drivers for change and associated trends identified

Driver for Change	Underlying Trend	Number of Sources
Resources are finite	Resources are becoming scarce	2
	Labour is resisting change and a move away from coal	3
	Renewable sources are essentially infinite	2
	South Africa has a dependence on coal	2
	Total	**9**
Need to reduce CO2 emissions	Increased international and local pressure to decarbonise	11
	Decarbonisation through a Just Transition	3
	Increased costs and risks associated with climate change	5
	Greater demand for green products	1
	Total	**20**
Deregulation of the ESI	Drive to unbundle Eskom	1
	Remove fiscal support for Eskom	3
	Requires Governance and Regulatory readiness	8
	Increased private participation leading to collaboration and competition	11
	Emergence of microgrids and decentralised distribution	4
	Emergence of prosumers	3

	Increased variability in the grid requiring ancillary services	5
	Total	**35**
Disconnect between supply and demand	Supply is decreasing	9
	Diversified demand requiring customised solutions	9
	Universal access to electricity slowing (or failing)	1
	Population growth and urbanisation driving demand diversification	3
	Infrastructure not aligned to where demand is	6
	Demand is not growing as expected (and gap between growth and GDP growth is widening)	4
	Total	**32**
Governance failures	Move towards greater transparency	1
	Oversight failures causing ESI shocks	2
	Political infighting and interference	12
	Lack of capacity (or will to use capacity)	5
	Total	**20**
The cost and funding of electricity	Cost of generation not being recovered	14
	The costs of alternatives being challenged	5
	Insistence on inclusion of subsidies and cross-subsidies	3
	Costs of grid back-up not being recovered	3
	Uncertainty over allocation of costs due to de-regulation	2
	Tariffs not transparent	5
	Total	**32**
Generation Technologies	Renewable energy seeing major development	1

	Storage of energy still young but growing	1
	New disruptive technologies too distant	1
	Supply chains to exploit renewable energy technologies underdeveloped	2
	Future baseload technology uncertain (but increasingly likely to be gas)	2
	Total	**7**

Workshop 1

For Workshop 1, a total of 63 participants were invited of which 14 accepted, 2 tentatively accepted and 10 declined. The remaining 37 participants provided no response. A total of 10 participants excluding the facilitator participated in the Workshop.

Although the research is deductive in nature, new insights are gained from the research in order to come up with the scenarios. Therefore, no pre-existing codes were determined and rather the transcript of Workshop 1 was used to develop new codes. The transcript for Workshop 1 totals 33 pages. The entire transcript is therefore not submitted as part of this report but rather submitted as part of the supporting documents. The results for Workshop 1 are arranged as follows. First, each trend is relisted in Table 4 with changes made as a result of the Workshop. Table 4 also contains prominent quotes as evidence from the workshop. This step acts as the validation of the factors and drivers and trends.

Following Table 4 and the validation of the data and trends, impact and uncertainty results are given. Menti was used as a collaborative tool to allow for and encourage open discussion. Not all participants participated in the Menti exercise and the Menti results were not used and were merely to facilitate dialogue. The Menti results therefore do not form part of this Chapter 5 but is given in Appendix 4 for the sake of completeness.

Table 4: Data validation according to Workshop 1

Original Trend	Changed Trend	Prominent Quotes
Resources are becoming scarce	Although resources are finite, they are still in abundance and the question is more on economic viability as opposed to physical capability to extract	*"economic argument and green legislation…. make it more difficult to extract other than the ability to extract it"* *"the current legislation is possibly a larger hinderance"* *"if we are past peak cheap coal and energy is that we would have differently manage energy, mining energy, use of energy. So it's not only about getting it, it's about the whole use of that in your value chain"* *"there are still massive coal resources in Southern Africa that could be utilised"*
Labour is resisting change and a move away from coal	Labour is resisting change and a move away from coal	*"it doesn't impact the future much"* *"if we need to go to renewables we'll go to renewables. That is what the society requires"* *"The resistance to change could be because of a lack of knowledge of the people. So with time they will get used to the new ESI…"*
Renewable sources are essentially infinite	Renewable sources are essentially infinite, but their mounting space and grid connection is very much finite	*"… as much as solar energy is in abundance, we need to mount these solar panels somewhere"*
South Africa has a dependence on coal	South Africa's dependence on coal is due to its industrial legacy where the baseload requirement cannot be met	*"we don't have the technology for baseload applications that's economical at this stage… on coal I think the issue is for our industrial history"*

	by renewables alone at this stage	
Increased international and local pressure to decarbonise	Increased international and local pressure is directed at a move towards renewable energy. There is a resistance to alternatives such as nuclear power or carbon capture technologies	*"the resistance to alternatives like nuclear is also an issue that need to be addressed. The move away from coal cannot be fully addressed by renewables"* *"we've been bullied into decarbonising"* *"if you get more international pressure it will impact on your profitability of your business and the moment you start talking rands and cents, you will see an impact"*
Decarbonisation through a Just Transition	The "Just" in Just Transition carries more weight than the "Transition" with countries wanting to decarbonise as long as it does not negatively affect them	*"CO2 emissions becomes an energy discussion and becomes a wealth for your citizen discussion… everybody always wants someone else to reduce and they don't want to reduce themselves"*
Increased costs and risks associated with climate change	The increased costs associated with climate change and the cost associated with reducing emissions are more than the Government is able or willing to give. It is more of a window-dressing exercise	*"… coal is experiencing a boom"* *"South Africa is sort of committing and putting lots of good legislation and making all the right noises but practically I don't see us having implemented major changes"* *"our challenge is security. It is really not decarbonisation"*
Greater demand for green products	An increased demand for green products is driving the private sector to take more decisive action; this is not affecting the Government	*"the private sector does appear to be serious with investments being made. Legislation is slowing us down though"*

Drive to unbundle Eskom	Drive to unbundle Eskom	*"if you look at the US it had a major impact on the cost of electricity once they deregulated"*
Remove fiscal support for Eskom	Remove fiscal support for Eskom	
Requires Governance and Regulatory readiness	No trend	*"you require governance and regulator readiness to implement… I won't say it's something that's driving the future"*
Increased private participation leading to collaboration competition	Increased private participation leading to collaboration competition	*"being in competition giving you the best market. I think that is sort of one of the drivers"*
Emergence of microgrids and decentralised distribution	Emergence of microgrids and decentralised distribution trend is not as a result of deregulating the ESI but rather due to the driver of generation technologies	*"trends of the prosumers and the microgrids are not necessarily flowing out of the driver to deregulate the ESI… there is a technology driver that's made those possible"*
Emergence of prosumers	The emergence of prosumers trend is not as a result of deregulating the ESI but rather due to the driver of generation technologies	*"trends of the prosumers and the microgrids are not necessarily flowing out of the driver to deregulate the ESI… there is a technology driver that's made those possible"*
Increased variability in the grid requiring ancillary services	Increased variability in the grid requiring ancillary services	
Supply is decreasing	Eskom supply is decreasing	*"… there's lots of small users and other users increasing their own generation"*
Diversified demand requiring customised solutions	Diversified demand requiring customised solutions	*"… renewables coming online I think is adversely affecting the net demand that Eskom sees"*

Universal access to electricity slowing (or failing)	Formal access to electricity is slowing (or failing). Illegal connections are increasing	*"… illegal connections and all the people that are connected on the grid that we don't know, which Eskom doesn't know of"*
Population growth and urbanisation driving demand diversification	Population growth is driving demand diversification	*"… illegal connections and all the people that are connected on the grid that we don't know, which Eskom doesn't know of"*
Infrastructure not aligned to where demand is	Infrastructure not aligned to where demand is	*"… now we're also seeing the challenges within the transmission infrastructure and distribution infrastructure"* *"… there's a mismanagement of infrastructure"*
Demand is not growing as expected (and gap between growth and GDP growth is widening)	Demand is not growing as expected (and gap between growth and GDP growth is widening)	*"… illegal connections and all the people that are connected on the grid that we don't know, which Eskom doesn't know of"*
Move towards greater transparency	Move towards greater transparency	
Oversight failures causing ESI shocks	Oversight failures are causing ESI shocks and a technologically outdated ESI	*"… inability in the Governance side I don't think we're staying up to date with the technology"*
Political infighting and interference	Political infighting and interference	*"we need to look at both local Government and Eskom"*
Lack of capacity (or will to use capacity)	Lack of capacity (or will to use capacity)	*"there's always a need to bring in international experts instead of using local capacity and people who know the system"*
Cost of generation not being recovered	Eskom's generation fleet is not self-sustaining at this stage	*"… mismanagement of the NERSA Eskom methodologies, I'm sure we could have had better prices"* *"lack of transparency and mismanagement"*

		"the cost of prudence"
The costs of alternatives being challenged	The total cost of alternative energy is being challenged	*"issue is more around the back-up, the response, the spinning reserve"*
Insistence on inclusion of subsidies and cross-subsidies	Insistence on inclusion of subsidies and cross-subsidies	*"you can't have one guy subsidising another guy and he doesn't even know it"*
Costs of grid back-up not being recovered	Costs of grid back-up not being recovered	
Uncertainty over allocation of costs due to de-regulation	Uncertainty over allocation of costs due to de-regulation	
Tariffs not transparent	Tariffs are not transparent, and their future certainty is being questioned	*"biggest issue has really been with the uncertainties"*
Renewable energy seeing major development	Renewable energy seeing major development	
Storage of energy still young but growing	Storage of energy still young but growing	
New disruptive technologies too distant	New disruptive technologies too distant	*"you'll have some distant R&D"*
Supply chains to exploit renewable energy technologies underdeveloped	Supply chains and value chains to exploit and contract renewable energy technologies are underdeveloped	*"smart metering in South Africa is going to have a massive impact"* *"there is that gap"*
Future baseload technology uncertain	Future baseload technology uncertain	*"with sufficient batteries and solar and wind you don't need gas as a transition fuel"*

(but increasingly likely to be gas)		

Following the participant discussion on impact, each driver and trend was classified in terms of its impact on the future of the ESI along with the concentration of participant sentiment. For example, high concentration means a high number of the participants felt the same with a low concentration indicating diverse views on the matter. Once the impact analysis was done, the same procedure was repeated regarding the uncertainty of each driver and trend along with the level of concentration.

Scenario Logics

Workshop 1 conducted the impact and uncertainty analysis on the drivers for change and associated trends. The ranking of the drivers and trends formed part of the scenario logics.

Combining the impact and uncertainty analysis resulted in Table 5 for drivers for change and Table 6 for trends where each driver and trend is ranked. The driver and trend with the highest impact is ranked first, followed by the second highest until all drivers and trends are ranked. In instances where a driver or trend had an equal impact, the driver or trend with the higher concentration was ranked higher than the driver or trend with corresponding impact but lower concentration of consensus.

Table 5: Drivers ranked according to impact and uncertainty analysis

Driver Name	Driver Description	Impact	Ranking
Deregulating the ESI	Eskom is proving a great burden to the national fiscus and the regulation of the industry has not helped. The concept of a single buyer and monopolistic state-owned entity has given way globally to decentralised distribution and increased participation from the private sector. Deregulating the industry has become a major driver for change	High impact on the future of the ESI with the need to unburden the fiscus and introduction competition	1st

Disconnect between supply and demand	Eskom supply is decreasing and at risk of decreasing further. At the same time, demand is growing both legally and illegally. The demand profile is changing owing to population growth and a change in energy intensity levels. The current ESI infrastructure is not aligned with this change	High impact with an emphasis on Eskom's declining performance	2nd
Generation Technologies	Globally, generation technologies are undergoing change. Although renewable energy is not yet the dominant source in most countries, its share in the energy mix is outgrowing that of traditional energy sources. This mix will further increase with development in energy storage technologies which is still in its infancy. The future of baseload technologies is unclear.	High impact with an emphasis on storage technologies and the inclusion of prosumers and microgrids	3rd
Governance Failures	Governance failures caused by a lack of capacity in institutions and political infighting has caused corruption and oversight failures to occur. This has caused the need for an overhaul and greater transparency	Fairly high	4th
The cost and funding of electricity	Eskom generation is not self-sufficient. Tariffs are also not cost-reflective or transparent owing to the inclusion of subsidies, cross-subsidies and ancillary services used as back-up supply. Future prices are uncertain as a result of unclear methodologies used and a pushback	Moderate to high. Although the driver itself may have a high impact, not all the trends associated with it will have a high impact	5th

	on the true cost of alternative energy sources		
CO2 emissions need to reduce	Global Warming is becoming a real threat to the World with Sub-Saharan Africa seeing a particularly harsh impact. There is a need to limit temperature rise to 1.5°C by reducing CO2 emissions, 45% of which is from Eskom. Decarbonising the energy sector is therefore not only the easiest but also the most important step to reduce CO2 emissions	Moderate to high impact but only from the private sector perspective. Although it says it is, this is not a big driver for the SA Government	6th
Resources are finite	Extraction of resources are becoming more expensive. With pressure on economic viability of opening new mines both locally and globally, resources are in most cases limited to the lives of current mines or easily extracted resources	Fairly low as the argument of fossil fuel resources are not about the amount of resources but the viability of extracting it	7th

Table 6: Trends ranked according to the impact and uncertainty analysis

Trend	Driver	Impact	Rank
Increased private participation leading to collaboration and competition	Deregulating the ESI	Very high impact	1st
Increased variability in the grid requiring ancillary services	Deregulating the ESI	High Impact with high certainty	2nd
Emergence of prosumers	Generation Technologies	High impact with high certainty	3rd
Emergence of microgrids and decentralised distribution	Generation Technologies	High impact with high certainty	4th

Infrastructure is not aligned to where demand is	Disconnect between supply and demand	High impact with high certainty	5th
Formal access to electricity is failing (or slowing). Illegal connections are increasing	Disconnect between supply and demand	High impact with fairly high certainty	6th
Although resources are finite, they are still in abundance and the question is more on economic viability as opposed to physical capability to extract	Resources are finite	High impact with fairly high certainty	7th
Increased removal of fiscal support for Eskom	Deregulating the ESI	High impact with fairly high certainty	8th
An increased demand for green products is driving the private sector to take more decisive action; this is not affecting the Government	CO2 emissions need to reduce	High impact with fairly high certainty	9th
Eskom supply is decreasing	Disconnect between supply and demand	High impact with fairly high certainty	10th
Insistence on inclusion of subsidies and cross-subsidies	The cost and funding of electricity	Fairly high impact with high certainty	11th
Tariffs not transparent and their future certainty is being questioned	The cost and funding of electricity	Fairly high impact with high certainty	12th
Uncertainty over allocation of costs due to de-regulation	The cost and funding of electricity	Fairly high impact with moderate certainty	13th
Political infighting and interference	Governance failures	Fairly high impact with moderate certainty	14th
Drive to unbundle Eskom	Deregulating the ESI	Fairly high impact with moderate certainty	15th

The increased costs associated with climate change and the cost associated with reducing emissions are more than the Government is willing/able to give. More of a window-dressing exercise	CO2 emissions need to reduce	Fairly high impact with moderate certainty	16th
Resources are essentially infinite but their mounting space and grid connection is very much finite	Resources are finite	Fairly high impact with moderate certainty	17th
Oversight failures causing ESI shocks and a technologically outdated ESI	Governance failures	Moderate to high impact with high certainty	18th
This increased local and global pressure is directed at a move towards RE – there is a resistance to alternatives such as nuclear or carbon capture	CO2 emissions need to reduce	Moderate to high impact with high certainty	19th
Storage of energy still young but growing	Generation Technologies	Moderate to high impact with moderate certainty	20th
Supply chains and value chains to exploit and contract renewable energy technologies underdeveloped	Generation Technologies	Moderate impact with high certainty	21st
Lack of capacity (or will to use capacity)	Governance Failures	Moderate impact with high certainty	22nd
The “Just” in Just Transition carries more weight than the “Transition” with countries wanting to decarbonise but just as long as it does not negatively affect them	CO2 emissions need to reduce	Moderate impact with high certainty	23rd
The total cost of alternative energy being challenged	The cost and funding of electricity	Moderate impact with moderate certainty	24th

Renewable energy technologies seeing major development	Generation Technologies	Moderate impact with moderate certainty	25th
New disruptive technologies still too distant to predict	Generation Technologies	Moderate impact with moderate certainty	26th
Demand is not growing as expected (and the gap between demand growth and GDP growth is widening)	Disconnect between supply and demand	Moderate impact with low certainty	27th
Eskom's generation fleet is not self-sustaining at this stage	The cost and funding of electricity	Fairly low impact with moderate certainty	28th
The dependence on coal is due to our industrial legacy/history where the baseload requirement cannot be met by renewables alone at this stage	Resources are finite	Low impact with high certainty	29th
Diversified demand requiring customised solutions	Disconnect between supply and demand	Low impact with moderate certainty	30th
Costs of grid back-up not being recovered	The cost and funding of electricity	Low impact with moderate certainty	31st
Future baseload technology uncertain	Generation Technologies	Low impact with low certainty	32nd
Move towards greater transparency	Governance Failures	Low impact with low certainty	33rd
Population growth is driving demand diversification	Disconnect between supply and demand	Low impact with low certainty	34th
Labour is resisting change	Resources are finite	Low impact with low certainty	35th

Once the drivers and trends were ranked, a diagram akin to a system analysis was conducted to indicate the drivers and associated trends as validated in Workshop 1. The diagram is shown in Figure 9.

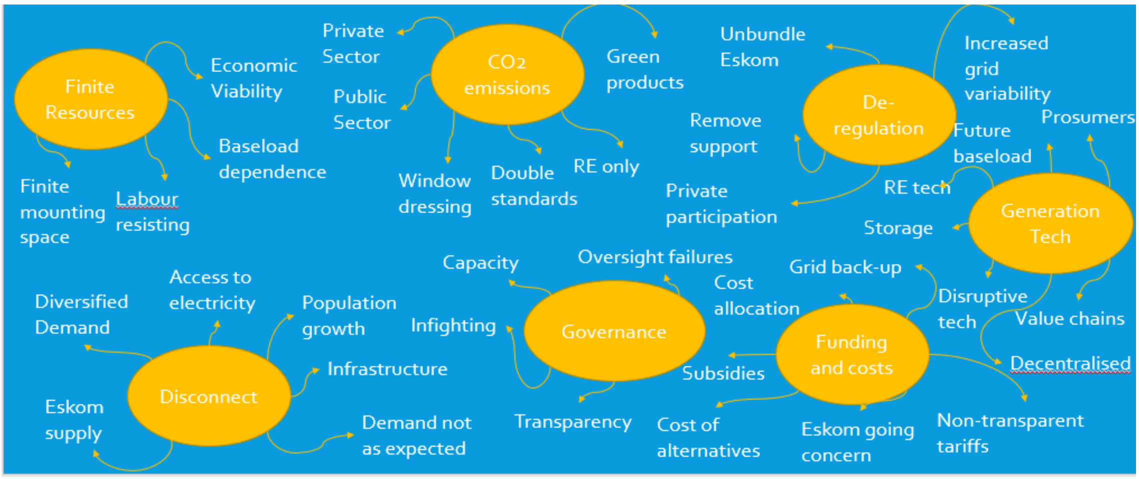

Figure 9: System Diagram indicating drivers and associated trends

During Workshop 1, it was recognised that certain drivers affect more than one trend and certain trends are affected by more than one driver. The linked drivers and trends that were recognised during Workshop 1 is displayed in Figure 9. The systems thinking exercise was conducted in Workshop 2 to validate the four links shown in Figure 10 and identify alternative linkages between drivers and trends. This is akin to setting the context as described by Alipour et al. (2017).

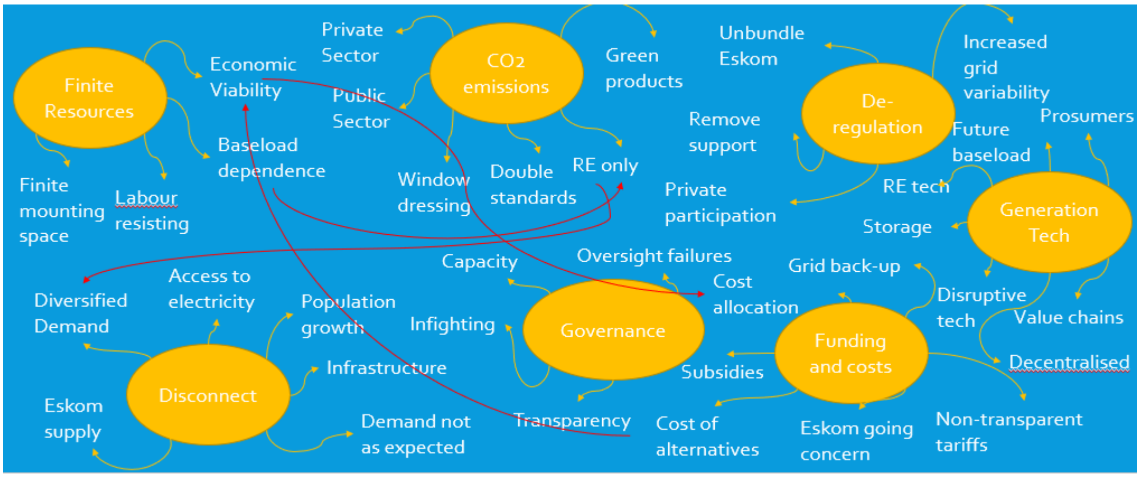

Figure 10: Linkages identified in Workshop 1

As indicated by Konno et al. (2014) an objective of scenario logics is the reduce the infinite number of possibilities to just a few. In line with this, the ranked drivers and trends were consolidated into a single table (Table 7) indicating the top 21 drivers and trends. All seven drivers were included (although not sequentially) with the top 14 trends.

Table 7: Top 21 drivers and trends according to impact and uncertainty analysis

Driver/Trend	Impact	Rank
Deregulating the ESI	High impact on the future of the ESI with the need to unburden the fiscus and introduction competition	1
Increased private participation leading to collaboration and competition	High impact on the future of the ESI with competition dominating the structure	2
Increased variability in the grid requiring ancillary services	High impact with the increased private participation increasing system variability	3
Emergence of prosumers	High impact with prosumers increasing due to generation technologies	4
Emergence of microgrids and decentralised distribution	High impact with generation technologies causing the emergence of microgrids and decentralised distribution	5
Disconnect between supply and demand	High impact with an emphasis on Eskom's declining performance	6
Infrastructure is not aligned to where demand is	High impact with infrastructure aligned with centralised distribution and legal connections	7
Formal access to electricity is failing (or slowing). Illegal connections are increasing	High impact with illegal connections causing havoc on system planning	8
Although resources are finite, they are still in abundance and the question is more on economic viability as opposed to physical capability to extract	High impact as funding is required to extract fossil fuels	9
Increased removal of fiscal support for Eskom	High impact as fiscal support withdrawal dries up Eskom funding for new projects	10
An increased demand for green products is driving the private sector to take more decisive	High impact as the private sector is pushing its own plan for generation technologies, not the country's plan	11

action; this is not affecting the Government		
Eskom supply is decreasing	High impact as the private sector increasingly has to secure its own supply for new projects	12
Generation Technologies	High impact with an emphasis on storage technologies and the inclusion of prosumers and microgrids	13
Insistence on inclusion of subsidies and cross-subsidies	Fairly high impact as the true cost of electricity is not known by the payer or receiver of subsidies	14
Tariffs are not transparent and their future certainty is being questioned	Fairly high impact as tariffs do not reflect the ancillary services that may be required	15
Uncertainty over allocation of costs due to de-regulation	Fairly high as higher renewable energy viability will rely on certain information for savings	16
Governance failures	Fairly high as the mismanagement of Eskom and State Departments has caused ESI shocks which the consumer needs to carry with them	17
Political infighting and interference	Fairly high with different actors not being able to agree on the way forward	18
The cost and funding of electricity	Moderate to high impact as the public and private sectors are not aligned as to the true cost of generation and distributing electricity	19
CO2 emissions need to reduce	Moderate to high impact but only for the private sector as local and global pressure may lead to a lot in profit in the short- to medium term	20
Resources are finite	Fairly low impact as the argument around finite resources are an economic viability one as opposed to an extraction ability one	21

Workshop 2

For Workshop 2, a total of 63 participants were invited of which 14 accepted, 2 tentatively accepted and 9 declined. The remaining 38 participants provided no response. A total of 11 participants excluding the facilitator participated in the Workshop. Although there was some overlapping, participants from Workshop 2 were mostly not the same as those from Workshop 1 as different subject matter experts accepted the invitation and participated in the workshop. Although this may introduce a limitation to the study, the sample for Workshop 2 was taken from the same population set as that of Workshop 1. Additionally, participants from Workshop 2 were provided with the insights gained from Workshop 1 in the form of an updated presentation of Workshop 1 with presented notes (Appendix 2). In validating the ranking done during scenario logics, participants in Workshop 2 also validated the data and insights gained from Workshop 1.

As with Workshop 1, no pre-existing codes were determined and rather the transcript of Workshop 2 was used to develop new codes. The transcript for Workshop 2 totals 31 pages. The entire transcript is therefore not submitted as part of this report but rather submitted as part of the supporting documents. Workshop 2 validated the 21 drivers and trends that were ranked.

Although participants mostly agreed with the ranking, there were some differences on views. The validation of data was done using Menti (attached as Appendix 5) which facilitated discussion. Three main themes emerged during the workshop that changes the order of the top 21 somewhat. Firstly, strong support was shown for ranking the deregulation of the ESI as the top driver and/or trend with one participant noting there should be *"distinction between the network business which is an asset management business… versus the generation business which is fundamentally a commodity business".* A second sentiment that emerged was that the trend of Eskom supply is decreasing should move up the order to the second most impactful driver and/or trend. Participants felt *"had Eskom's EAF (been) at 85%... the whole drive to an ESI change would be much less"* and *"the Eskom situation is driving the need for change as we speak".* A third and final theme emerging was the driver of CO2 emission reduction also needs to move up the ranking with one participant strongly feeling *"carbon emissions are actually drivers in the whole system in terms of approach to energy security, decarbonisation and all these other related factors".*

Table 7 is repeated in Table 8 but with the new ordering indicating the most impactful drivers and trends according to the workshop participants.

Table 8: Top21 drivers and trends reranked according to Workshop 2

Driver/Trend	Impact	Rank
Deregulating the ESI	High impact on the future of the ESI with the need to unburden the fiscus and introduction competition	1

Eskom supply is decreasing	High impact as the private sector increasingly has to secure its own supply for new projects	2
CO2 emissions need to reduce	Moderate to high impact but only for the private sector as local and global pressure may lead to a lot in profit in the short- to medium term	3
Emergence of prosumers	High impact with prosumers increasing due to generation technologies	4
Disconnect between supply and demand	High impact with an emphasis on Eskom's declining performance	5
Increased private participation leading to collaboration and competition	High impact on the future of the ESI with competition dominating the structure	6
Increased variability in the grid requiring ancillary services	High impact with the increased private participation increasing system variability	7
Emergence of microgrids and decentralised distribution	High impact with generation technologies causing the emergence of microgrids and decentralised distribution	8
Infrastructure is not aligned to where demand is	High impact with infrastructure aligned with centralised distribution and legal connections	9
Formal access to electricity is failing (or slowing). Illegal connections are increasing	High impact with illegal connections causing havoc on system planning	10
Although resources are finite, they are still in abundance and the question is more on economic viability as opposed to physical capability to extract	High impact as funding is required to extract fossil fuels	11
Increased removal of fiscal support for Eskom	High impact as fiscal support withdrawal dries up Eskom funding for new projects	12
An increased demand for green products is driving the private sector to take more decisive action; this is not affecting the Government	High impact as the private sector is pushing its own plan for generation technologies, not the country's plan	13

Generation Technologies	High impact with an emphasis on storage technologies and the inclusion of prosumers and microgrids	14
Insistence on inclusion of subsidies and cross-subsidies	Fairly high impact as the true cost of electricity is not known by the payer or receiver of subsidies	15
Tariffs are not transparent and their future certainty is being questioned	Fairly high impact as tariffs do not reflect the ancillary services that may be required	16
Uncertainty over allocation of costs due to de-regulation	Fairly high as higher renewable energy viability will rely on certain information for savings	17
Governance failures	Fairly high as the mismanagement of Eskom and State Departments has caused ESI shocks which the consumer needs to carry with them	18
Political infighting and interference	Fairly high with different actors not being able to agree on the way forward	19
The cost and funding of electricity	Moderate to high impact as the public and private sectors are not aligned as to the true cost of generation and distributing electricity	20
Resources are finite	Fairly low impact as the argument around finite resources are an economic viability one as opposed to an extraction ability one	21

Once the top drivers and trends were validated along with their trends, the subject matter experts participated in the exploratory systems thinking exercise to determine linkages between different drivers and trends. Again, Menti (Appendix 5) was used to facilitate the discussion with one participant noting *"… it's difficult questions. Most of them actually impact so you must almost think which has the most direct impact"*.

Some of the most relevant quotes are shown below with the most prominent and direct linkages for each driver shown in Figure 11 to Figure 17. This is done to facilitate reading as the linkages shown on a single diagram are difficult to read. The complete diagram is shown in Appendix 8 for completeness.

On the linkages from the CO2 emission reduction driver: *"There's also governance considerations as well. But now thinking from a policy perspective how does that also* *influence funding and costs and carbon emissions side of the input considerations. Deregulation as well, high participation in the energy space…".*

On the effect of generation technologies used for CO2 emission reduction: *"So now, we are not sure with the pressure that the green technology will bring to the Eskom supply more into the grid with our grid transmission lines, are they ready to accommodate this varying load".*

On business' needs to consider their clients' desire for greener products: *"… you cannot go that route without storage and there's that thing about storage again so I'm linking storage to the driver of CO2 emissions".*

On Eskom's supply which is decreasing and generation technologies: *"… we have a supply crisis and we need to look at alternatives… So they're kind of linked, it's just a question of what started it all and to which is linked to which in which manner".*

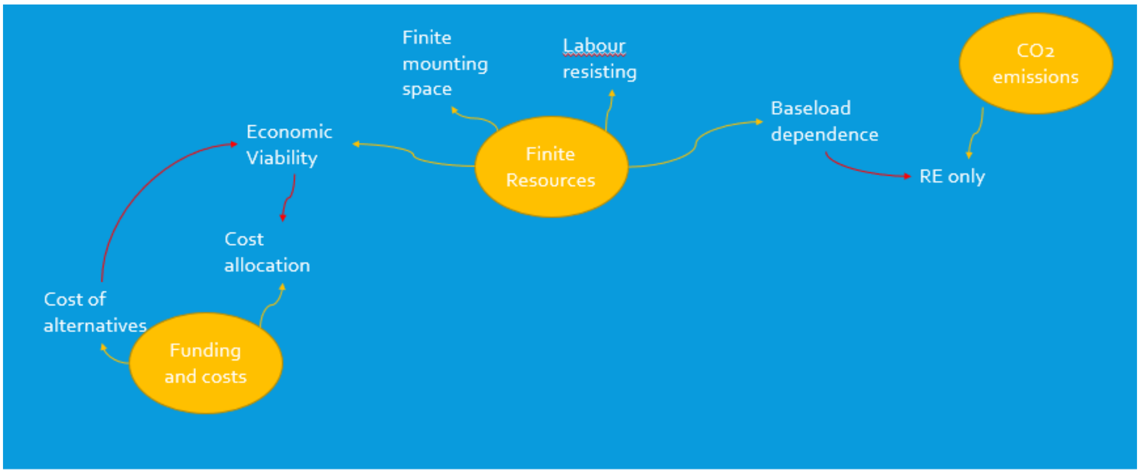

Figure 11: Prominent linkages for Driver 1 – Finite resources

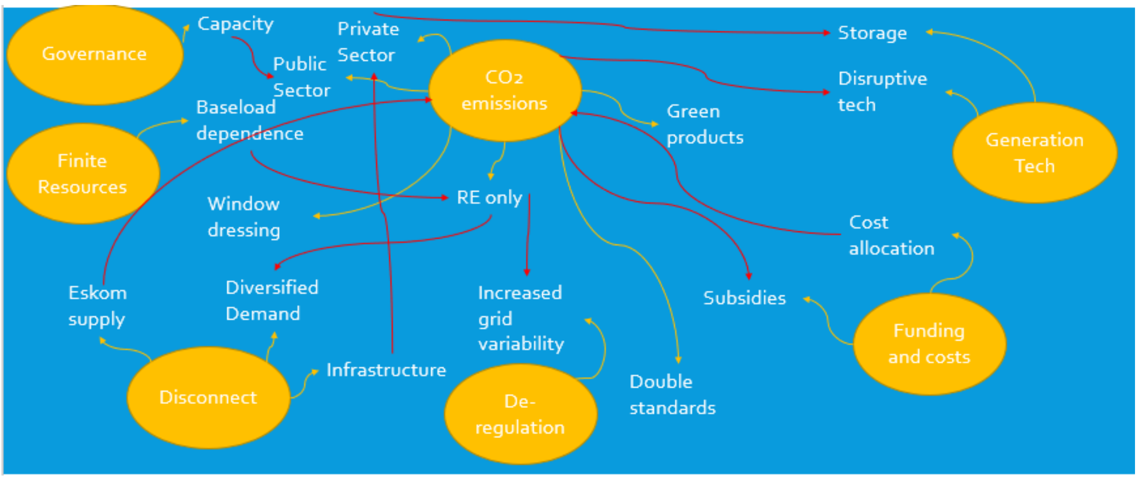

Figure 12: Prominent linkages for Driver 2 - CO2 emission reductions

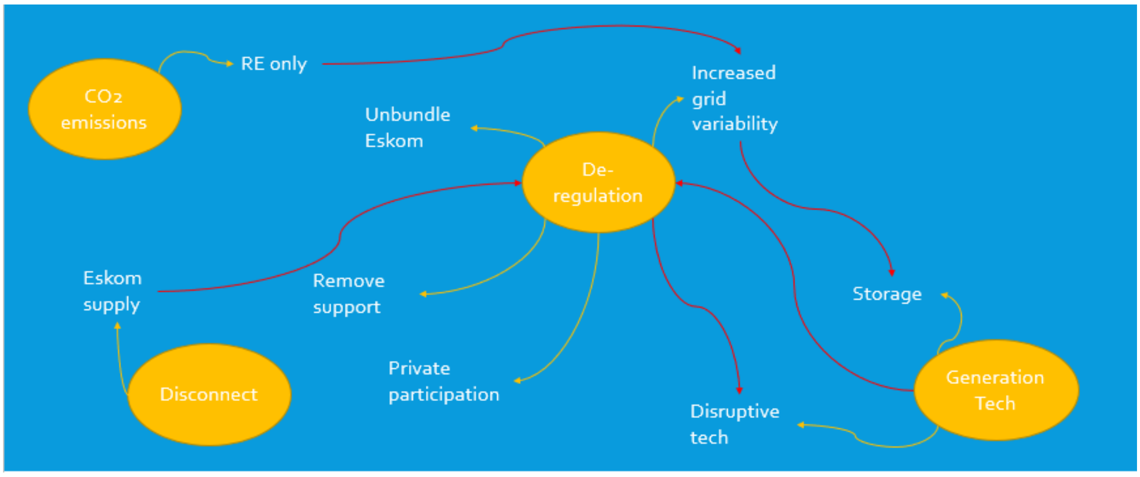

Figure 13: Prominent linkages for Driver 3 - De-regulation of the ESI

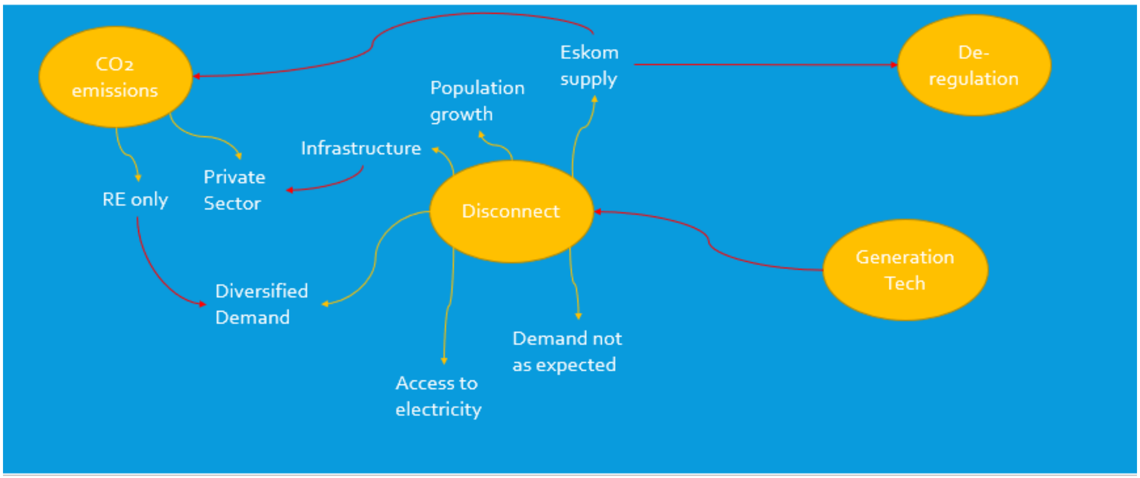

Figure 14: Prominent linkages for Driver 4 – Disconnect between supply and demand

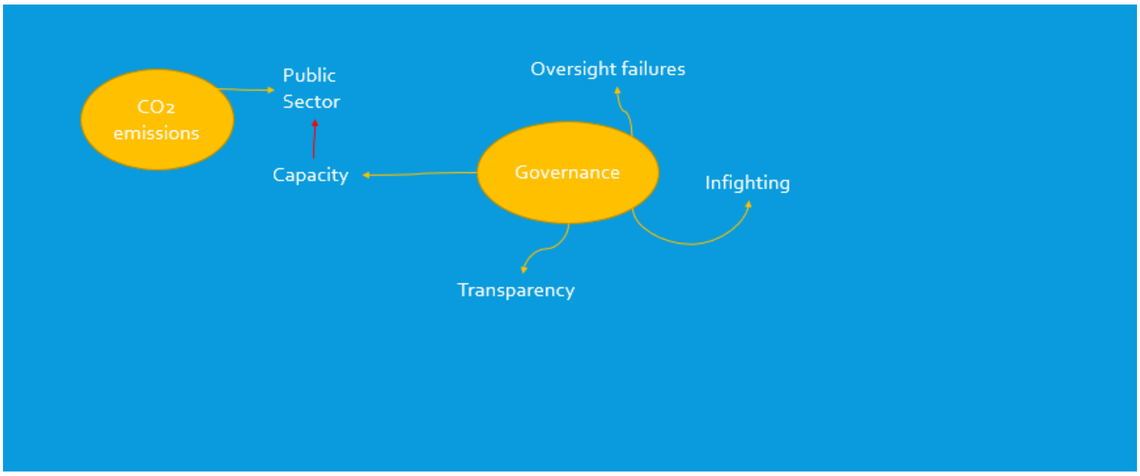

Figure 15: Prominent linkages for Driver 5 – Governance failures

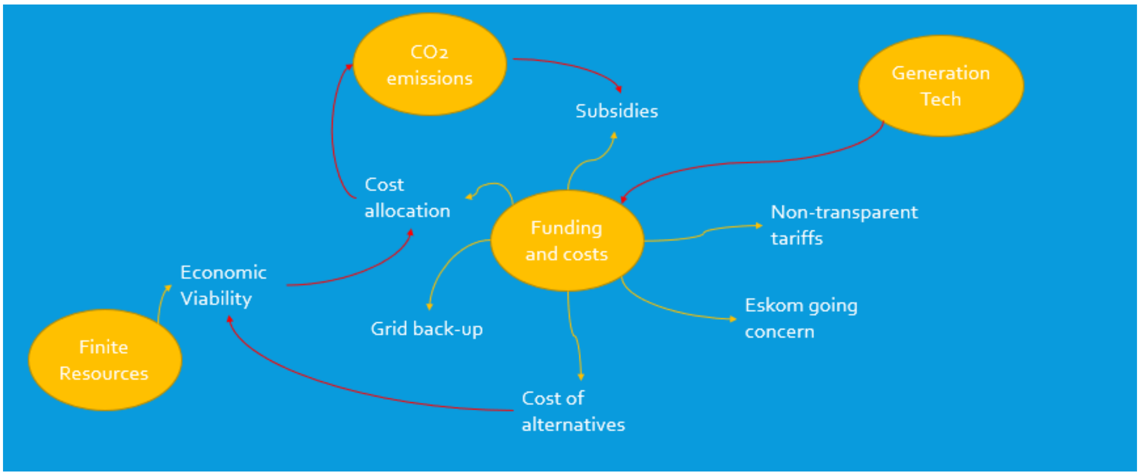

Figure 16: Prominent linkages for Driver 6 – Funding and costs

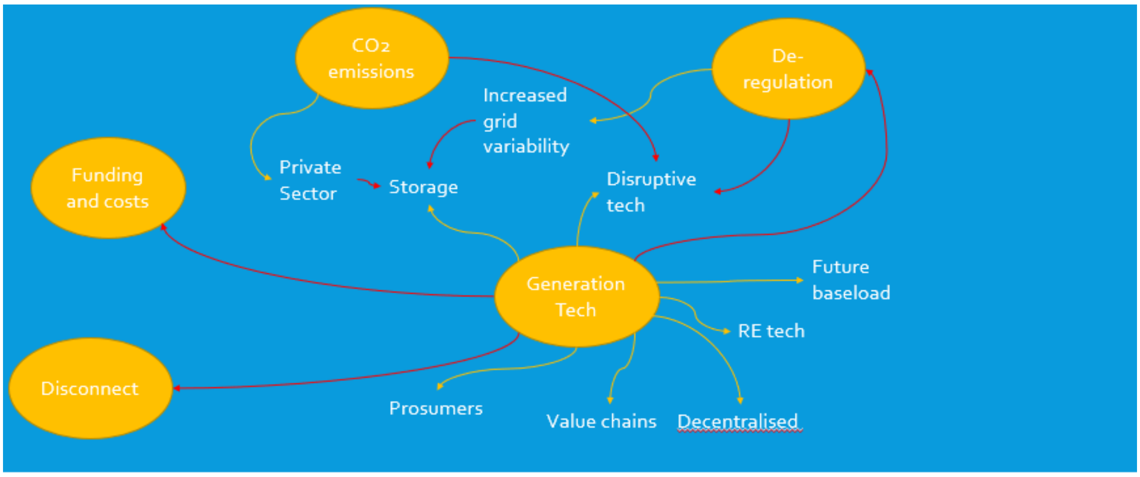

Figure 17: Prominent linkages for Driver 7 – Generation technologies

In constructing the 2x2 matrix to develop the four alternative scenarios, the workshop concluded on Driver 3 representing the x-axis and Driver 2 representing the y-axis. In particular the opposing ends on the x-axis was determined the ESI is regulated versus the ESI is deregulated. The y-axis represented an increased pressure for CO2 reductions versus a decreased pressure for CO2 reductions. The 2x2 matrix that was constructed during Workshop 2 is represented in Figure 18.

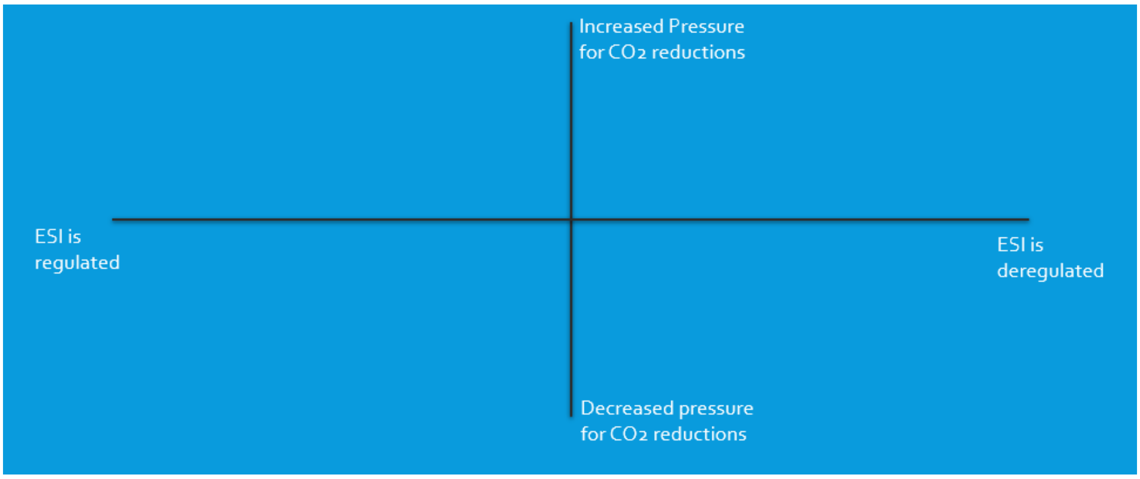

Figure 18: Two by two matrix used to construct the four alternative scenarios

Scenario Narratives

The scenario narratives were not constructed during Workshop 2. Although inputs from Workshop 2 was received and a brief discussion of the possible narratives were held between participants, the author completed the scenario narratives at the conclusion of Workshop 2. This was done since the author had to consider and incorporate the new rankings for drivers and trends and in particular the linkages determined Workshop 2 as this would affect the scenario narratives. The time allowed for Workshop 2 (120 minutes) did not allow for this to happen during the workshop.

Following the work done, the resultant scenarios were determined to be as described below.

Scenario 1

In this scenario, the ESI is deregulated and there is a decreased demand for CO2 reductions (bottom right scenario in Figure 18).

In order to solve Eskom's liquidity problem and close the gap on the supply and demand disconnect, the South African Government hastily and completely deregulates the ESI. With only the Transmission Network and System Operator monopolised, private entities are free to participate in both the generation and distribution spheres.

Globally, events such as the COVID19 pandemic and the Russia/Ukraine conflict and more recently the China/Taiwan conflict have firmly shifted the focus away from decarbonisation of the energy sector to the security of supply and cost of supply.

Although the ESI is deregulated, grid variability does not increase significantly as price is now the main driver. Consumers opt for the cheapest form of baseload energy meaning expensive energy storage installations lag that of new generation. This necessitates the System Operator to champion the procurement of energy storage facilities. The Government also takes over a portion of Eskom's debt to allow it to operate as a competitive market participant. Some of this cost along with the storage cost is added by the System Operator as a fixed cost to all consumers.

With a smaller debt burden and no more fiscal support, Eskom is forced and able to participate competitively in the market. Some of the older power stations are decommissioned and Eskom focusses on fixing its more reliable and cheaper power stations, adding little to no new capacity to the grid. The power stations Eskom offer has little debt and are close to fully depreciated meaning Eskom can offer short term PPAs at competitive prices. This, along with the fact that Eskom offers baseload generation makes Eskom a first generator of choice to large consumers and traders alike.

Although the supply and demand gap is quickly filled by the market and infrastructure alignment is achieved through private distributors, Municipal power supply remains a concern. Only a few Municipalities have the ability to conclude PPAs with private off-takers and the Government is forced to provide guarantees. Payment continues to be an issue and Government eventually decides to create a new state-owned entity, Generation 2, to supply to Municipalities. Generation 2 is dogged by inefficiencies and revenue shortfalls, the cost of which is passed on to distribution companies.

In general, LPUs have two options to procure energy. Either at the wholesale level where LPUs are not exposed to fixed costs owing to Generation 2 but are exposed to macro-economic influences that may cause price shocks or at the distribution level where LPUs are somewhat protected by price shocks but pay a premium for this and is exposed to Government-imposed tariffs to Generation 2. Overall, PPAs are characterised by shorter terms and is chosen by price.

Scenario 2

In this scenario, the ESI is deregulated and there is an increased demand for CO2 reductions (top right scenario in Figure 18).

In order to solve Eskom's liquidity problem and close the gap on the supply and demand disconnect, the South African Government hastily and completely deregulates the ESI. With only the Transmission Network and System Operator monopolised, private entities are free to participate in both the generation and distribution spheres.

Despite recent events such as COVID19 and geopolitical tensions, globally there is an appreciation that these are mere short-term hardships and the threat of long-term damage due to global warming exceeds this. Therefore, pressure on decarbonisation is not only maintained but increased with a hard line taken on companies seen as not contributing to the cause.

This, along with a deregulated ESI, increases grid variability significantly as private off-takers exercise their freedom to procure energy from variable renewable generators. However, due to pressure to keep up with product demand made from renewable energy, large consumers invest significantly in storage facilities effectively creating new baseload generation. The System Operator procures ancillary services to balance the system with the large penetration of renewable energy and passes this cost on as a fixed cost – this cost is significantly less than the fixed costs associated with battery storage.

Although the Government takes over a portion of Eskom's debt to allow it to operate as a competitive market participant, Eskom cannot secure PPAs with most large consumers as its power is generated from coal-fired power stations. Due to international and global pressures, the Department of Forestry, Fisheries and the Environment (DFFE) dismisses Eskom's application for non-compliance to air emission legislation causing the further decommissioning of Eskom generation. Eskom finds its role in providing ancillary services to the System Operator and as a supplier to dysfunctional municipalities as no other IPP is willing to sell to them.

The supply and demand gap is quickly filled by the market and infrastructure alignment is achieved through private distributors. LPUs prefer wheeling agreements with generators as opposed to short term trading as LPUs require certainty in the quantity and price for renewable energy and associated renewable energy certificates needed to certify their products. This leads to considerable competition to obtain the best generation projects with access to the grid where price is less of a determining factor as opposed to the availability. In the longer term, the market and LPUs have accepted the higher energy prices and since this is already priced into its products, LPUs prefer certainty of supply and supply source over buying at the cheapest price. Therefore, PPAs tend to be longer term (20+ years) coupled with energy storage with the occasional trading of energy to act as a balancing mechanism.

Scenario 3

In this scenario, the ESI is regulated and there is an increased demand for CO2 reductions (top left scenario in Figure 18).

Government decides that the ESI is of national interest and it could exercise greater control over a regulated industry as opposed to a deregulated industry. Therefore, in a move contrary to recent utterances, Eskom stays a wholly-owned and vertically integrated utility with a monopoly over the ESI. The Minister of Mineral Resources and Energy revokes Ministerial Determination allowing private generation and refers all new generation to Eskom as the per the guideline of the IRP.

Despite recent events such as COVID19 and geopolitical tensions, globally there is an appreciation that these are mere short-term hardships and the threat of long-term damage due to global warming exceeds this. Therefore, pressure on decarbonisation is not only maintained but increased with a hard line taken on companies seen as not contributing to the cause.

With private participation in the ESI requiring ministerial determination, most LPUs are left at the mercy of Eskom’s grid emission factors. In order to improve the grid emission factor, Government allows the private sector to prepay for renewable energy projects from Eskom where it commits to buy energy and renewable energy certificates at a predetermined premium above the normal Eskom price.

Grid variability does not increase significantly as Eskom is in control of new projects entering the grid and is free to procure required ancillary services at the cost of the

LPU. This constraint coupled with the limited institutional capacity of NERSA able to process and license these plants leads to a slow roll-out of new generation. In the meantime, Eskom continues decommissioning old plant leading to an increase in the supply and demand gap. Loadshedding increases significantly and an artificial threshold is reached in potential GDP growth owing to lack of electricity.

Although Government is under pressure to show progress towards a net-zero future, non-compliant power plants are kept online as long as it is technically feasible to do so in order to supply municipalities and consumers that cannot afford the premium for renewable energy. Eskom's debt continues to increase and a new utility, Generation 2, is eventually brought online to allow an unburdened balance sheet to procure new energy. Government sees this as an opportunity to provide an anchor client for gas and Generation 2 therefore mostly consist of gas generation. The cost of Generation 2 is added to the Eskom cost of primary energy and is mixed to determine an average tariff.

The procurement of energy from LPUs are characterised by a single invoice from Eskom with the proportion of renewable energy purchased receiving a premium over and above other energy purchased. Price uncertainty is the order of the day with Regulatory Clearing Accounts (RCAs) allowed to claw back unrealised revenue from Eskom's license applications.

Scenario 4

In this scenario, the ESI is regulated and there is a decreased demand for CO2 reductions (bottom left scenario in Figure 18).

Government decides that the ESI is of national interest and it could exercise greater control over a regulated industry as opposed to a deregulated industry. Therefore, in a move contrary to recent utterances, Eskom stays a wholly owned and vertically integrated utility with a monopoly over the ESI. The Minister of Mineral Resources and Energy revokes Ministerial Determination allowing private generation and refers all new generation to Eskom as per the guideline of the IRP.

Globally, events such as the COVID19 pandemic and the Russia/Ukraine conflict and more recently the China/Taiwan conflict have firmly shifted the focus away from decarbonisation of the energy sector to the security of supply and cost of supply.

Taking advantage of this release in decarbonisation pressure, the DFFE approves Eskom's application for non-compliance to air emission license legislation. Government injects further cash into Eskom in an effort to turn the ship around in line with its decision to keep the ESI regulated. In the short term, Eskom's supply keeps on decreasing and new projects come online slowly owing institutional capacity to install them. Over the medium to long term some generation units' availability improve and new capacity slowly comes online providing some reprieve from loadshedding.

However, the time it takes for supply to improve and the price uncertainty linked to the pricing methodology results in some LPUs closing shop. This leads to an overall reduction in baseload demand needed for voltage and frequency stabilisation. Grid variability actually increase, and the infrastructure is not aligned to deal with the new demand profile. Eskom procures ancillary services to try and stabilise the grid and a new era of loadshedding ensues as a result of transmission failures.

Eskom's debt continues to rise due to a utility death spiral where it reaches a stage where Government is forced to assume all of Eskom's debt in an effort to arrest the death spiral. This releases price pressure for consumers but has structurally altered South Africa's GDP from an industrial economy to a services economy.

The procurement of energy for LPUs is characterised by a single Eskom invoice. Price uncertainty is the order of the day with RCAs allowed to claw back unrealised revenue from Eskom's license applications. Subsidies are increasing to allow Government's electrification drive and to make up for non-technical losses experienced by Eskom.

Chapter 6

Throughout Chapters 1 to 3 various assertions and themes were identified that may relate to a country's ESI. Some of the themes identified are country-specific such as the Japanese and German ESI structures and transition pathways. Other themes are not country-specific but more industry-specific, such as the work done by Oosthuizen et al. (2018) on African power utilities.

A worthwhile discussion on the results of this research paper would incorporate the themes identified during Chapters 1 to 3 and test their validity against what was found in Chapter 5. This validity test would not seek to prove or disprove the results obtained but merely provide insight as to whether the theoretical base may enhance the results in any way. For example, given a possible future ESI structure obtained within the four scenarios, the work done by Geels et al. (2016) on transition pathways may provide insight as to the possible pathway that may be followed by the South African ESI. Knowing the possible pathway in advance can provide the signposts Glenn and Gordon (2009) discuss during their work on scenario planning.

Therefore, for the remainder of this Chapter 6, some of the major themes identified in Chapters 1 to 3 are discussed against the results obtained in Chapter 5. The themes are discussed as it relates to each phase of the scenario planning process. Headlines within Chapter 6 indicate major themes.

Security of Supply

Security of supply featured quite strongly within Chapter 5. Using the STEEP environmental scanning method in determining factors, it was found that various sources considered security of supply. For example, Slater (2022) in his reporting of the list sent to Eskom of up to 300 power experts that may be able to assist with the current power crisis, has noted that this is as a result of the generation that is in decline. Similarly, Wright et al. (2017) refers to an aging fleet which is reducing Eskom's supply. Even Eskom Holdings (2021b), in its application for a price increase during the MYPD5 period, notes a significant decline in its Electricity Availability Factor (EAF) which is a measure of the ability of its generation fleet to deliver energy at its installed capacity – the outlook Eskom gives is negative meaning a likely further reduction in supply.

The consequence of the insufficient or aging generation infrastructure is a decline in security of supply to consumers taking the form of loadshedding. Roff et al. (2022)

confirms this and speaks of increasing loadshedding owing to a slow roll-out of renewable energy programmes by the Government. Wright and Calitz (2020) also attribute loadshedding to a lack of new plant but couples this with the underperformance of existing plant. The National Energy Regulator of South Africa (2022) has recently confirmed a (temporary) removal of the 100MW threshold for licensing requirements which indicates a lack of installed energy capacity.

Security of supply, according to these sources, are therefore attributed to both a lack of new generation capacity and an inability to get satisfactory performance out of the existing generation plant. This is somewhat misaligned with the literature view as expressed in Chapter 2. As opposed to generation causing security of supply concerns, the literature review pointed to network related incidents as the source for security of supply concerns.

For example, Dolega (2010) asserted it is generally the TSO that is responsible for ensuring system integrity and therefore security of supply. Le Cadre et al. (2019) qualifies this statement by indicating the TSO can achieve this by purchasing and using ancillary services. Since ancillary services are typically a capacity type of function as opposed to energy-related services, it is reasonable for this author to deduct that Dolega (2010) and Le Cadre et al. (2019) was not implying that energy generation is the cause of security of supply concerns.

Given the above, the question arises as to whether South Africa’s network infrastructure is adequate to ensure security of supply; the answer is no. Oosthuizen et al. (2015), in his work on scenarios within the Southern African Development Community (SADC) region, speaks of infrastructure misalignment as one of the crucial ESI drivers. This may include generation but points to a larger infrastructure problem that includes transmission and distribution as well.

Similarly, The Council for Scientific and Industrial Research (2019) bemoans a lack of investment in South Africa’s energy infrastructure as affecting both Eskom’s coal infrastructure and causing a general infrastructure backlog in the transmission and distribution spheres. The National Energy Regulator of South Africa (2022) also indicates there is more variability in the system requiring more hands-on management whereas the Department of Mineral Resources and Energy (2022) not only supports this view but indicates a need to strengthen the grid to ensure stability. Lastly, Steyn et al. (2021) bemoans a lack of investment in the transmission system stating the consequence is an inability to support new generation capacity; any new generation capacity would therefore cause further grid variability and, by the Department of Mineral Resources and Energy (2022) view, instability.

The literature review is therefore not contradicted by the factors but extended. Whereas Cherp et al. (2017) indicated two of the most important goals of a country's ESI is to balance demand and supply and ensure security of supply, most authors have focused on the security of supply within the transmission and distribution of electricity. Whereas this is not wrong, applying security of supply and balance of demand and supply to the South African context broadens this scope to include the generation sphere as well.

Having determined the context within which security of supply should be seen within South Africa, it is worthwhile to discuss the importance of security of supply on the ESI within South Africa. This is since authors such as Khobai (2017) indicate that economic growth can take place under certain conditions even in the presence of an unsecure supply of electricity. The World Bank (2019) further indicates that entering into PPAs can alleviate security of supply concerns. Both these assertions are answered through analysing the results from Chapter 5. Firstly, the view from Khobai (2017) may be validated or not based on the ranking and linkages participants attribute to security of supply drivers and trends. Finally, The World Bank (2019) assertion is either confirmed or not through analysing the scenario narratives from a security of supply point of view.

The drivers extracted from the factors include a driver describing the disconnect between supply and demand. Two of the six trends speak to the security of supply constraint. Firstly, generation supply is decreasing and, secondly, infrastructure is not aligned to where demand is. The first trend speaks to generation as the source for security of supply concerns whilst the second focusses more on the transmission and distribution infrastructure.

As noted in Table 4, Workshop 1 commented on the supply is decreasing trend and felt that it is only Eskom's supply that is decreasing. The participants indicated there are various small users that generate power on their own. Linking this to LPUs, Eskom supply is decreasing does impede security of supply for LPUs. Secondly, the infrastructure that is not aligned trend garnered significant interest from participants as they strongly felt this is a problem that is becoming more evident and will play a bigger part in the security of supply in future. This is due to a mismanagement of infrastructure.

In scenario logics, the driver of security of supply was ranked second with a high impact on the ESI expected (listed in Table 5). This was done with an emphasis on Eskom's performance with a focus on the generation performance.

Although the driver does not speak of security of supply, the trend of increasing variability in the grid requiring ancillary services ranked second amongst trends impacting the ESI. This is a concern for participants regarding a future ESI and not due to current concerns. The trend of infrastructure is not aligned was ranked 5th with a high impact and high certainty, ranking higher than Eskom supply is decreasing which was ranked 10th. The lower ranking of Eskom supply is decreasing is due to a fairly high certainty meaning participants were overall aligned with some differences.

In the consolidated list of 21, increased variability was ranked 3rd, disconnect between supply and demand 6th and Eskom supply is decreasing was ranked 12th.

During workshop 2, the validation of ranking for drivers and trends saw participants placing a higher emphasis on Eskom supply is decreasing with particular mention made of the EAF of Eskom. This could indicate that participants are not necessarily of the view that there is too little generation but rather that the generation capacity that is installed is not sufficiently secure. In the updated ranking, Eskom supply is decreasing was ranked second, disconnect between supply and demand was ranked 5th and increased grid variability was ranked 7th. The promotion of both Eskom supply is decreasing and CO2 emissions need to reduce meant lower rankings for the security of supply trends.

From an exploratory system's thinking exercise, the driver of disconnect between supply and demand has linkages to the drivers of CO2 reductions, deregulation as well as generation technologies. Interestingly, the infrastructure trend is linked to the private sector with the Eskom supply is decreasing trend linked to CO2 emissions and deregulation. This could indicate that participants feel that the private sector, rather than the Government, is the ideal candidate to address the declining generation performance as well as the infrastructure misalignment. This may be due to a distrust in the Government to fix the problem.

Considering both the ranking by participants and linkages, it is evident that participants felt that either little to no economic growth is possible given unsecure supply of electricity, or that the “certain” conditions Khobai (2017) refers to is not present.

Although security of supply does not form part of the axis for the scenarios determined, it does play a significant role in determining the narrative. For example, in Scenario 1, the security of supply acts as decision points for both deregulating the ESI and pushing back the decarbonisation agendas globally as security of supply dominates discussions and policy positions.

Considering the scenarios, the assertion by The World Bank (2019) is somewhat supported. Entering into long term PPAs does provide the LPUs with security of supply but only in terms of generation. Grid instability mostly owing to larger grid variability is not alleviated through entering into these PPAs.

From a security of supply perspective, the results corroborate the view from literature with an expansion of the security of supply scope into the generation sphere. Although growth may be possible in some sectors within the economy even given an unsecure supply of electricity as premised by Khobai (2017) this is not the case for LPUs and obtaining a secure supply is of upmost importance.

Terlikowski et al. (2019) indicates that the security of supply burdens the national fiscus as huge capital projects are undertaken. Therefore, an important discussion on the results would include a discussion on financial considerations.

Financial Considerations

Conducting the STEEP scanning, three sub-themes within financial considerations were determined as 1) the funding of ESI related activities, 2) price setting within the ESI and 3) revenue collection and financial viability of actors within the ESI.

In terms of funding, environmental scanning highlights an inherent lack of consensus about which generation technologies should be funded and what can be afforded. For example, Meridian Economics (2021) opposes nuclear as being unaffordable for South Africa. The Department of Mineral Resources and Energy (2019) takes a somewhat contrary view and promotes the funding of smaller nuclear plants, indicating these are not only more flexible but more affordable as well. The literature review gives an indication of what might cause contrary views with Wallace and Saidov (2019) indicating Governments need to make a trade-off between the cost of supply and the security of supply. This could explain the view taken by the

Department of Mineral Resources and Energy (2019) as nuclear provides high reliability and a low dependence on external value chains.

The International Energy Agency (2022) cautions that funding for any large infrastructure projects is declining due to the macro-economic factors impacting the cost of capital with gas pipelines, in particular, facing pressure. The literature review supports this view with Bhimji (2022) indicating that macroeconomic factors are influencing the price and roll-out of PPAs.

Although Steyn et al. (2021) acknowledges that macro-economic factors play a role in the funding of large energy projects, the authors assert that the overall cost difference between renewable energy and coal is widening making renewable energy investments more attractive. The Department of Public Enterprises (2019) provides a similar view and indicates that more affordable generation technologies coupled with investment in storage technologies will alleviate pressure on the network due to changing demand patterns. Lastly, according to the The Council for Scientific and Industrial Research (2019), a general lack of funding of the Eskom infrastructure will cause a backlog in bringing online any new investment in renewable energy or storage technologies.

The subject of price setting has received wide interest in the South African ESI. For example, the Department of Mineral Resources and Energy (2022) has indicated that the price of electricity within South Africa has passed the threshold where it is now viable for consumers to become prosumers and pass excess electricity to the grid. The National Energy Regulator of South Africa (2022) supports this view and contends that the high price, along with inadequate supply, is pushing more distributed generation onto the grid. This, according to the National Energy Regulator of South Africa (2022), is shifting the price setting mechanism from the generator to the consumer.

The threshold referred to above is reached due to both high prices of the incumbent Eskom and falling prices from the alternative supply. High prices, according to Eskom Holdings (2021b), may be attributed to Eskom's power stations becoming dated and ineffective at operating cost-effectively. Roff et al. (2022), on the other hand, attributes high system costs of Eskom as being self-inflicted with expensive diesel burn and inefficient pump storage regimes pushing up prices. The National Energy Regulator of South Africa (2022) does not go as far as Roff et al. (2022) but does indicate inefficiencies within the Eskom system may be hidden by cross-subsidies. The cross-subsidies are supposed to only be used to subsidise Eskom's electrification drive to increase universal access to electricity which will, as noted by the International Energy Agency (2022), need to intensify should targets be met.

On the flip side, falling renewable energy prices are occurring which may be attributed to economies of scale according to the The Council for Scientific and Industrial Research (2019). The Department of Mineral Resources and Energy (2022) is disputing these claims somewhat by indicating that adding partial and intermittent self-dispatched generation is increasing cost dynamics of the entire system with these renewable generators in many occasions not contributing fairly to network-related costs (Department of Mineral Resources and Energy, 2022).

By comparing the results with the literature survey some conclusions are drawn. With the debate ongoing as to the causality between electricity consumption and economic growth (Bekun et al., 2019; Erdal et al., 2008; Warr & Ayres, 2010) the advent of prosumers may contribute to the confusion. Whereas traditionally studies were conducted assuming consumers only, a prosumer may export some electricity and still be a net (albeit lower) consumer of electricity. This may have some policy implications as Governments preferring a secure supply at a higher cost may not take into account the prosumer effect.

The work by Le Cadre et al. (2019) on ancillary services required to balance the system not only has an impact on the security of supply, but on the price of electricity as well. These ancillary services, of which diesel generators is one, are recovered through adding to the cost of energy to the consumer. The self-inflicting pain suggested by Roff et al. (2022) therefore does seem to be more of a generator inflicted charge as suggested by the Department of Mineral Resources and Energy (2022).

The last financial consideration is the revenue collection and financial position of incumbent actors within the ESI. In the STEEP analysis, various sources such as Bloomberg (2022), Eskom Holdings (2021b) and Steyn et al. (2021) have noted that Eskom's financial position is dire owing to reasons ranging from inadequate tariffs (Eskom Holdings, 2021b) to drip-feed solutions to slow to deal with Eskom's liquidity issues and R392bn debt burden (Steyn et al., 2021). Notably, Oosthuizen et al.

(2018) comments that this position is worsened by a tolerance for non-payment due to political populism considerations.

The literature on the matter is in alignment. Burkhardt (2021) views Eskom's financial concerns, along with its technical mishaps, as the main reasons why the ESI is currently being discussed with Bowman (2020) indicating Eskom simply cannot survive without fiscal support and its LPU base.

Four of the six drivers contain elements of financial considerations with Driver 3 devoted to Eskom's financial position indicating its importance in both the current ESI and driving the future ESI. Alongside the drivers, 11 trends contained elements of financial considerations. During Workshop 1, some details of the trends were altered without changing the outcome. For example, participants felt that illegal connections were causing the failing electrification drive as opposed to population growth; the outcome is ultimately the same with cross-subsidies required to formally electrify sectors of the population. Also, although participants agreed Eskom generation was not recovering its required revenue, they felt this was because of mismanagement of pricing methodologies as opposed to tariffs not being cost reflective. The outcome remains that Eskom cannot service its debt or run its operations.

During scenario logics, the need to unburden the fiscus was ranked the highest impact on the future ESI. This was followed by Eskom generation is not self-sufficient which was, according to participants of Workshop 1, the 5th highest impact.

Workshop 2 confirmed the deregulation of the ESI as the number one driver or trend but felt that an increased removal of fiscal support was only the 12th most important driver. Instead, prosumers were ranked 4th with increased private participation ranked 12th. This indicates that participants felt high prices played a bigger role than insufficient revenue collection. This concurs with the literature indicating the threshold point has been reached but does not concur with the literature on the recovery of ancillary services cost.

Considering Figure 13, it is also clear that participants felt the deregulation of the ESI is more of an enabler for private participation and dealing with Eskom's supply constraints as opposed to reducing fiscal support for Eskom; this is in line with the lower ranking received for the removal of fiscal support. Figure 16 concurs with the funding and costs driver more linked to CO2 emission reductions and the correct cost allocation than it is to the removal of fiscal support or Eskom's going concern status.

Lastly, from the scenarios it is clear participants felt that the financial considerations is not a major driver of the alternative futures but rather a consequence of the decisions made. This contradicts the literature somewhat in that the literature review highlighted Eskom's financial position as not only being a driver for change, but one of the most important drivers for change.

Decarbonisation Efforts

A third major theme is that of decarbonisation efforts and a need to reduce carbon dioxide emissions along with other greenhouse gases. Eskom is non-compliant with national legislation regarding air emissions (Eskom Holdings, 2021b). Although Eskom has applied for extension to comply at some of its power stations with an application for permanently not complying at some of its oldest power stations, Eskom Holdings (2021b) note there is increasing pressure both locally and globally for it to comply with standards or switch off plants. This supports the literature review with authors such as Healy and Barry (2017) indicating the calls for a just energy transition, inclusive of cleaner air, are enhancing.

This local and global pressure has been increasing for the past couple of years as critics note there is financial incentive in switching off non-compliant power stations. For example, Merven et al. (2018) argues that coal is expensive to burn and will become more expensive in the future due to aging plant's inefficiencies as well as carbon tax imposed on utilities such as Eskom. Steyn et al. (2021) agrees that the cost gap between coal and renewable energy is widening but cautions that complying with air emission license requirements will have a system-wide impact and therefore requires a system-wide approach as opposed to a power station for power station approach (Steyn et al., 2021). The views by Steyn et al. (2021) and Merven et al. (2018) are supported by the literature in process but not in timing. The work done by Wen et al. (2021) and Ozcan et al. (2020) does indicate that a threshold point is reached where lower environmental degradation is achieved by higher economic value (refer to the EKC in Figure 5) but this threshold is reached in mostly developed countries when an economic restructuring occurs. Neither Steyn et al. (2021) nor Merven et al. (2018) has indicated this point in their assertions.

Besides Eskom's air emission license requirements, Chapter 5 indicates there is a focus on the entire South African ESI to decarbonise with Oosthuizen et al. (2015) noting that pollution is becoming a growing concern and the Department of Public

Enterprises (2019) seeing an accelerated need for global energy needs to move away from fossil fuels.

The Department of Mineral Resources and Energy (2019) has seen an increase in global investment in renewable energy primarily due to the Paris agreement to facilitate the move away from fossil fuels with the International Energy Agency (2022) noting a particular focus on South Africa with $8.5bn of funding being made available by developed countries to accelerate South Africa's move away from fossil fuels. This is supported by the literature with Li and Trutnevyte (2017) arguing that significant investment and rapid decarbonisation is required if the Paris commitments are to be achieved.

Unfortunately reaching consensus as to how these funds may be utilised are still open for debate. On the one side, authors such as Wright et al. (2017) have for years argued that South Africa has enough wind and solar resources to completely (and hastily) move away from the fossil fuels. On the other side, the Department of Mineral Resources and Energy (2019) continues to see a future for coal within South Africa and has even included new “clean” coal in its latest energy plan for South Africa.

Determining drivers and trends from the factors identified, two of the seven drivers speak to decarbonisation efforts. Driver 1 talks about the extraction of coal becoming more expensive which could be due to pressure to stop funding coal mines. Secondly, Driver 2 is that carbon dioxide emissions need to reduce due to global warming and that Eskom contributes 45% of emissions. All four trends of Driver 2 are linked to decarbonisation.

During Workshop 1, participants took a somewhat more sceptical view. Firstly, participants felt that international pressure has a resistance to other forms of clean energy such as carbon capture or nuclear energy. Secondly, participants felt that countries would only support decarbonisation if it did not affect their welfare or security of supply. This point in particular is aligned with what was found in literature. For example, Chapman and Itaoka (2018) and Cherp et al. (2017) speak about security of supply concerns guiding policy within Japan. The same seems to be happening in Europe with the Russian invasion of Ukraine (Reuters, 2022) exposing Western Europe's reliance on Russian gas with one participant noting that Germany is restarting coal-fired power plants to alleviate supply constraints.

Participants also noticed that increased costs and climate impacts only affect the private sector with the public sector merely indicating they are committed without taking any real action. This is not aligned with what was found in the literature with no distinction made between the public and private sectors.

Possibly as a result of the perception of participants that security of supply is more important than decarbonisation for actors both locally and globally, decarbonisation efforts as a driver ranked rather low (6th out of seven). The resultant trends were also seen as less impactful with the first trend associated with the decarbonisation driver being ranked 9th and the second ranked 16th. This is contradictory with both the literature reviewed and factors identified as both indicated a high degree of pressure and therefore impact.

During Workshop 2, participants became more aligned with the literature and increased the ranking of decarbonisation to 3rd (Table 8). Although participants still felt there was a disconnect between the public and private sectors, the participants felt the pressure felt by the private sector and in particular LPUs meant a higher impact overall. The decarbonisation driver was also found to be the most prominently linked (Figure 12) with linkages to all six the other drivers. Interestingly, the participants indicated linkage directions (directions of the arrows in Figure 12) away from the decarbonisation driver indicating that this driver affects the other drivers more than it is affected by them. This concurs with the literature view of increased pressure for both a just transition (Healy & Barry, 2017) and at a faster pace (Li & Trutnevyte, 2017).

The pressure to decarbonise formed one of the axis of the 2x2 scenario matrix. The narratives seem to indicate that there is a decision to be made globally as to the balance of security of supply and decarbonisation of the ESI. This correlates strongly with the theory from Chapman and Itaoka (2018) and Cherp et al. (2017). The global decision also seems to influence the South African ESI according to the narratives where a concerted effort will be needed to align the South African ESI structure with the global trade-off decisions discussed above. This correlates well with the work done by Grubb and Newbery (2018) and Geels et al. (2016) on transition pathways. Should decarbonisation triumph over security of supply in policy decisions globally, pressure is likely to increase on decarbonisation efforts resulting in a transformation pathway followed by South Africa to align quickly or risk losing out on transition funding.

Political Considerations

The role politics play in the ESI of South Africa and African countries are generally seen in a poor light. For example, Oosthuizen et al. (2015) describes the energy sector stability as decreasing due to poor governance, a failure to implement policies and general political interference. Oosthuizen et al. (2018) continues this criticism noting that the resistance by labour to a changing ESI structure is due to a poorly managed transition plan. In fact, according to Oosthuizen et al. (2018), political populism extends beyond correctly dealing with the transition plan to a general culture of acceptance of non-payment for energy used severely hampering Eskom's liquidity.

A lack of policy certainty is further highlighted throughout the environmental scan with various sources indicating the impacts thereof. Renaud et al. (2020) attributes slow adoption of renewable energy to a lack of policy certainty whereas both Yelland (2021) and the The Council for Scientific and Industrial Research (2019) extend the impact of policy uncertainty beyond generation into the municipal sphere and distribution model as well. Lastly, Meridian Economics (2021) notes that a lack of consensus amongst politicians which causes policy uncertainty. The literature survey revealed a strong difference in views regarding the future ESI by politicians (BusinessTech, 2022b; Stoddard, 2021, 2022) supporting the factors determined. Although the lack of consensus is supported, the outcome thereof is contrary to what was found in literature. Whereas Falil and Nasir (2021) found that Governments place a high emphasis on the correct policies and regulations regarding electricity, this does not seem to be the case within South Africa.

The impact of political interference extends into the operational sphere of Eskom as well according to Roff et al. (2022) which indicates Eskom's financial position is in decline due to an insistence from politicians that tariffs should stay low. Instead of addressing this and other factors, the National Energy Regulator of South Africa (2022) is instead focussing its efforts on regulating a future ESI industry with the Department of Mineral Resources and Energy (2022) echoing those sentiments saying it is focused on the future. Although it is immediately unclear what the State departments mean by its assertion of focussing on the future, it may well be to ensure South Africa is not affected by geopolitical pressures which may impact energy supply, as noted in the literature by Sangal et al. (2022). Should this be the case, it concurs with what Chapman and Itaoka (2018) states as Governments' intention to align its policies with its own goals.

Extracting drivers and trends from the factors resulted in a driver dedicated not to the Government's role in the ESI but to its failures and the impacts thereof. This is a strong deviation of what was found during the literature survey (Chapman & Itaoka, 2018; Cherp et al., 2017; Grubb & Newbery, 2018) where the general discussion centred around what Governments was doing or could do to increase stability within the ESI.

During Workshop 1 there was unilateral consensus as to Government's failures with the only point of interception with the predetermined drivers and trends being that oversight failures are not only causing ESI shocks but a technologically outdated ESI as well. Although not explicit, the work by Geels et al. (2016) might help in explaining this as without the transition pathway being undertaken (or forced) through transformation, an incumbent will not be incentivised to innovate or become more efficient. Following this logic Eskom, which is a natural monopoly, was not forced or incentivised into innovating and therefore became outdated.

Although there was high consensus for the driver and its associated trends, participants did not score the driver highly on its impact. Governance failures is seen as something LPUs and other actors have to deal with as opposed to it being a driver of change. Therefore, Governance failures was ranked 17th.

During Workshop 2, Governance failures was moved to 18th out of the 21 due to the promotion of decarbonisation factors. Governance failure are also not seen as highly linked to other drivers (Figure 15) with its own linkages being that of institutional capacity within the public sector affecting CO2 emission reductions. This again contradicts literature (Chapman & Itaoka, 2018; Cherp et al., 2017; Grubb & Newbery, 2018) where Governments are one of the most prominent actors and drivers for change within an ESI.

Governance failures are not part of the 2x2 matrix but do play a prominent role in the scenario narratives. The Government has the ultimate decision as to the structure of the ESI with LPUs forced to adapt to this. However, contrary to the literature, Chapter 5 suggests there are other more impactful factors that will determine the future ESI structure.

System Analysis

Conducting the exploratory system analysis exercise during Workshop 2, it is clear from Figure 11 to Figure 17 that most drivers and trends are linked to one another in some way. The boundaries of the system were not tested but was clearly not visible. The results concur with Ravetz et al. (2021) which indicates that energy systems are complex with no clear boundaries.

The results also do not clearly support Niembro-García et al. (2022) which indicates that there will be a higher energy consumption per person in the future. Rather, the results indicate that the number of paying customers versus illegal connections will distort any attempt to determine such a number. Although not tested explicitly, the exploratory system analysis exercise showed no clear link between electricity consumption or demand growth and economic growth.

Scenario 1

If Scenario 1 was to be given a name, it may be called “release of the pressure cooker”. In this scenario, global concerns regarding security of supply have overtaken decarbonisation efforts with decreased pressure to decarbonise. In South Africa, the desire to unburden the fiscus has led to the deregulation of the ESI with an energy market emerging. Although there is still an ESI crisis with municipal supply not guaranteed, LPUs generally have the choice to not face this risk (in the medium term) and choose to enter PPAs of a few months or day-ahead trading as proposed by Dovgalyuk et al. (2019) and Lange and Focken (2008).

In terms of the structures proposed by Falil and Nasir (2021), Scenario 1 would fit into a hybrid model with both (shorter term) PPAs and trading being done. The transition to such a ESI structure would be substitution as proposed by Geels et al. (2016) where niche players are able to overtake the incumbent regime due to innovative solutions.

Scenario 2

This scenario may be called “the new world”. With Eskom’s technical and financial constraints increasing, the Government is forced to not make Eskom too big to fail to ensure survival of the ESI in Eskom’s absence. This may lead to a transformation transition pathway as described by Geels et al. (2016) where the incumbent regime is intentionally removed to make way for the niche market actors. Since there is competition for stable supply from the right generators, Scenario 2’s ESI structure would be considered as PPAs or bilateral agreements according to Falil and Nasir (2021).

Scenario 3

Scenario 3 would be called “business as usual”. Despite numerous attempts to deregulate, Government’s lack of consensus is implied as a decision in itself. No decision is also a decision. Scenario 3 would be characterised by Falil and Nasir (2021) as a single buyer model.

Scenario 4

If Scenario 4 had a name it would be “back to the old”. With a regulated ESI and decreased pressure to decarbonise, the South African Government would find itself in some perceived breathing space to try and fix in the incumbent regime in Eskom. Although the single buyer model is used, this soon collapses as LPUs which make up the majority of Eskom’s costs are forced to close shop. This is due to a global release of pressure to decarbonise intensifying competition.

Chapter 7

Principle Conclusions

This research paper set out to answer the research question of what are the potential future scenarios for the South African Electricity Supply Industry given a timeframe of 20 years. This question is of particular importance to Large Power Users as electricity costs for LPUs make up a significant portion of their overall costs. It is for this reason that procurers of energy for these LPUs invest a great deal of time and care to ensure the right procurement strategies are in place.

Looking into the past, the White Paper on Energy (Department of Mineral Resources and Energy, 1998) in 1998 envisaged a liberalised market where private participation would ensure competition amongst generators with the main source of generation being low-carbon technologies. In this way, the South African Government could achieve what is described by Terlikowski et al. (2019) as the need to balance security of supply and the cost of that supply.

The White Paper from 1998 was never implemented for a number of reasons. Firstly, as indicated by Healy and Barry (2017), South Africa's investment is locked in due to its vast coal reserves and, secondly, South Africa's ESI was "*performing relatively well"* (Galen, 1998, p. 1) at that stage meaning any transition to a different structure was not front of mind. Fast forward to 2015 and the Paris agreement has caused an urgent need for countries to decarbonise their electricity sectors if they are to meet their legally binding Paris agreement targets (Li & Trutnevyte, 2017).

This means that, at least in some alternative futures, the new structure of the ESI and certainly the pathway to transitioning to that structure is no longer at the sole discretion of the Government. Rather, the result from this research paper suggest there are seven drivers leading to at least four different alternative future scenarios. Although the most impactful driver, ESI deregulation, is still within Government's control the scenarios indicate a less than ideal situation for LPUs.

No matter the level of pressure felt by the Government and the private sector regarding the need to decarbonise, the continued regulation of the ESI will cause hardship to LPUs. In the case of a regulated ESI with increased decarbonisation pressures, LPUs will be burdened by carrying the inefficiency costs of the incumbent regime but will supplement this with additional so-called green energy. In this scenario although the general structure of the ESI remain as is, the private sector will likely fight Government and the incumbent regime at every opportunity.

In the alternative future where the ESI is regulated and there is decreased pressure to decarbonise, keeping to current ESI structure will lead to a slow demise of the industrial sector and the incumbent regime, Eskom. LPUs may increasingly look at own generation as described by Carrion et al. (2007). Even with some debt relief to Eskom, the own generation by some LPUs along with the closure by others will erode Eskom's ability to finance its operations since LPUs contribute significantly to Eskom's revenue (Eskom Holdings, 2021a).

Governments are required to ensure policies and regulations are in place to ensure an effective ESI that is conducive to growth (Falil & Nasir, 2021) whilst protecting the integrity of the system through the TSO (Dolega, 2010). Through its latest attempt to deregulate the ESI in a controlled manner (Department of Mineral Resources and Energy, 2021) the Government is attempting to retain some sort of control through purchasing ancillary services on the behalf of the TSO and allowing private off-takers to enter into PPAs with private generators. This alternative future is possible and is the basis for Scenario 1. According to the drivers, this scenario may only realise if the global pressure to decarbonise decreases.

Although the four scenarios were outlined in Chapter 5 providing the alternative future ESI for South Africa given a timeframe of 20 years, two further conclusions are drawn. Firstly, with the one driver impacting the future ESI being pressure to decarbonise, recent events such as the Russian invasion of Ukraine or the COVID19 pandemic will have major impacts on the future ESI in South Africa within the next few years; the uncertainty is therefore within the next few years as opposed to over the full 20 years. Secondly, Ravetz et al. (2021) indicated the ESI is complex in nature. This was found to be the case with interdependencies making it difficult if not impossible to discern system boundaries.

Theoretical Contribution

From a scholarly perspective, this research paper contributes in two ways. Firstly, the paper contributes to the scenario planning research done within South Africa. In 2015 a study conducted by Oosthuizen et al. (2015) provided certain trends within the South African ESI before concluding with alternative scenarios. Similarly, in 2018, Oosthuizen et al. (2018) conducted a study on scenarios of the ESI on the African continent focusing on the possible routes taken by utilities on the continent.

Rather than contradicting the work done by Oosthuizen et al. (2015) and Oosthuizen et al. (2018), the current research paper supplements that work. Firstly, the current research paper validates and updates the drivers and trends of those papers applicable to the ESI and, secondly, the current research paper provides the alternative futures of the ESI from a LPU procurement perspective. With Oosthuizen et al. (2015) looking primarily from a policy-making perspective and Oosthuizen et al. (2018) considering the alternative futures from a utility perspective, the current research paper does so from a consumer perspective, adding to the value chain and providing an opportunity for a consolidated view.

The second manner in which this paper contributes to the theory is by providing a base from which transition theory as stipulated by Grubb and Newbery (2018) and Geels et al. (2016) may be applied. With alternative futures of the ESI provided in this research paper acting as signposts, the transition pathways to those alternative future structures may be assessed.

Implications for Management

The real success of scenario planning is not whether the scenarios determined turned out to be right or not, but rather the valuable insight gained during the process (Glenn & Gordon, 2009). Scenarios are also seen by some as the departure point for further discussions (Ramirez & Wilkinson, 2014).

Therefore, the first and probably most valuable implication for management is the identification of the seven drivers. Each driver contributes to the user's decision-making process in some way. Although Driver 1 talks to extraction of coal for burning in power plants, LPUs typically use coal in other parts of the value chain as well (for example mining coal or for use in blast furnaces). Therefore, understanding this driver will provide insight not only into the possible future ESI, but may well provide some insight into the entire sector of the LPU.

Driver 2 indicates the pressure the South African Government and ESI may face when it comes to decarbonising the electricity sector. However, Driver 2 also provides insights into the demand for green products, both locally and globally. Furthermore, Driver 2 provides some insight as to what can be expected from a security of supply point of view should the ESI be deregulated. For example, the

Russian invasion of Ukraine (Sangal et al., 2022) has laid bare the risks faced by countries if it relies too heavily on gas for its energy needs.

Driver 3 refers to the deregulation of the ESI. Although the driver was listed as the most impactful driver for change for the future ESI, other insights were gained as well. For example, through the scenario narratives, the deregulation of the ESI may solve some problems but not all. Municipalities remain a concern and a deregulation of the ESI will likely not unburden LPUs from contributing financially for the non-payment of municipalities.

Perhaps the biggest insights gained from Driver 4 is the actors not previously considered. Whereas the incumbent regime and its shareholders are present within the driver, the South African Police Service was also identified as a crucial actor for the future ESI. LPUs would therefore be wise to ensure actors such as these receive the necessary support and that it's brought under their attention that they have a critical role to play.

Driver 5 speaks to Governance failures. Although most of the trends identified does not provide new insight, the impact of these Governance failures was reaffirmed in this research paper.

Driver 6 has provided, over and above the cost and funding of electricity, the insight that there is no consensus as to the cost of renewable energy. What makes this significant is the fact the LPUs could now be aware that Eskom or the TSO may charge additional fixed costs for LPUs with PPAs to capture what it views as the fair cost to serve the network.

The final driver for change is that of generation technologies. Driver 7 also provided valuable insight as to the supply and value chains LPUs need to invest in to ensure it can take advantage of renewable energy. For example, whereas IPPs negotiate and conclude PPAs on a frequent basis, LPUs do not. This skill set is required to ensure a smooth and effective negotiation tool.

Taking the drivers and trends into account, the main insights to management is the identification of the type of skills procurement personnel might need to poses in the future ESI. Furthermore, stakeholder maps and funding strategies may be drawn from the insights gained.

For the scenarios themselves, LPUs may realise there are two main drivers that will determine the alternative futures of the ESI. These two drivers are the deregulation of the ESI and the decarbonisation of the ESI. Creating signposts to determine if any of these scenarios are coming to fruition and acting on the early signs may prove highly beneficial for the LPU. An example of action may be that if day-ahead trading is likely to play a significant part in future, the LPU should not enter into too many long term PPAs where it cannot take advantage of day-ahead trading. However, if security of (renewable) supply becomes more important, the LPU should recognise this through the early signs and procure as much through PPAs as soon as possible to ensure it has sufficient grid access.

Limitations

Limitations listed here are confined to overall limitations of the research paper. For a discussion on limitations of the research methodology, refer to Chapter 4.

Like all research, this research paper has limitations. For Workshop 1, a total of 10 subject matter experts participated. For Workshop 2, 11 subject matter experts participated. There was some overlap between the two workshops and those from Workshop 2 acted as validation for Workshop 1. However, with the two workshops not being the same there is inherently a limitation that is introduced.

Another limitation of the study is the scenario narratives themselves. Although the narratives were done with information gathered from Workshop 2, the narratives themselves were not validated which may lead to some bias that may introduced by the author when writing the narratives.

Although every effort was made to ensure objectivity, the author may have also introduced bias into the workshop causing a limitation. The author is known to some of the participants in a professional capacity and may have caused anchoring bias where a participant anchors his or her views against the professional affiliation with this author which acted as facilitator.

The dynamic nature of drivers and trends and the cone of plausibility introduces another limitation. Although the research question has a timeframe of 20 years, unexpected events in future may alter certain drivers or reveal new ones. This may cause the current research paper to become dated if the drivers or trends are not updated from time to time as recommended by Glenn and Gordon (2009).

Suggestions for Future Research

Future research on based on this research paper may either expand on the current results or use the results as a basis for new research.

For example, expanding on the current results and based on the drivers, trends and scenarios, future research may be focused at identifying clear and appropriate signposts along with the actors involved. This research would also consider the transition pathways (Geels et al., 2016) as a crucial input.

Staying with the expansion of results contained in this research paper, future research could focus on the role the SAPS has to play in the future ESI and conduct a scenario planning exercise from its perspective as well. Although the current research has filled a gap by providing scenario planning from the consumer's viewpoint, gaps remain as to the other actors within the ESI.

Using the current research as a platform, future research could focus on the viewpoint from other consumer sectors such as agriculture, commercial, small industrial and residential. What is applicable to LPUs may not be applicable to the other sectors of the consumer base.

Lastly, future research could focus on the dynamic capabilities needed to adapt to the alternative futures determined within the scenario narratives. Building on the work done by authors such as Haarhaus and Liening (2020) future research can focus on the dynamic capabilities required to adapt in each alternative future.

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APPENDIX 1 – FACILITATION GUIDE FOR WORKSHOP 1

Name

Workshop 1

Duration

Two hours

Participants

Member companies of the EIUG

Purpose

1. To determine the impact of the identified factors, drivers and trends
2. To conduct uncertainty analysis on the identified factors, drivers and trends

Time	Activity	Details	Resource
2 minutes	Welcoming	Welcome participants and provide time for latecomers to join	
3 minutes (10:02 – 10:05)	Introductions	• Round of Introductions • Competition Law • Voluntary Participation • Results are aggregated • Session recorded and transcribed • No single view represented • May switch off cameras • During presentation mode, I cannot see hands so please interrupt me	Presentation
10 minutes (10:05 – 10:15)	Setting the scene	• Why are we here today • Objectives of the workshop • Your expectations of the workshop • Recency bias (example)	Presentation

10 minutes (10:15 – 10:25)	Driver 1 – Resources are finite	• Discuss main theme and ask if they agree • Trend 1 – Open discussion • Trend 2 – Open discussion • Trend 3 – Open discussion • Trend 4 – Open discussion • Impact analysis – Chat function (ranking) • Uncertainty analysis – Chat and open discussion	Presentation, Chat, Menti
10 minutes (10:25 – 10:35)	Driver 2 – Reduce CO2 emissions	• Discuss main theme and ask if they agree • Trend 1 – Open discussion • Trend 2 – Open discussion • Trend 3 – Open discussion • Trend 4 – Open discussion • Impact analysis – Chat function (ranking) Uncertainty analysis – Chat and open discussion	Presentation, Chat, Menti
10 minutes (10:35 – 10:45)	Driver 3 – Deregulating the ESI	• Discuss main theme and ask if they agree • Trend 1 – Open discussion • Trend 2 – Open discussion • Trend 3 – Open discussion • Trend 4 – Open discussion • Trend 5 – Open discussion • Trend 6 – Open discussion • Trend 7 – Open discussion • Impact analysis – Chat function (ranking) Uncertainty analysis – Chat and open discussion	Presentation, Chat, Menti

10 minutes (10:45 – 10:55)	Driver 4 – Disconnect between supply and demand	• Discuss main theme and ask if they agree • Trend 1 – Open discussion • Trend 2 – Open discussion • Trend 3 – Open discussion • Trend 4 – Open discussion • Trend 5 – Open discussion • Trend 6 – Open discussion • Impact analysis – Chat function (ranking) Uncertainty analysis – Chat and open discussion	Presentation, Chat, Menti
10 minutes (10:55 – 11:05)	Driver 5 – Governance Failures	• Discuss main theme and ask if they agree • Trend 1 – Open discussion • Trend 2 – Open discussion • Trend 3 – Open discussion • Trend 4 – Open discussion • Impact analysis – Chat function (ranking) Uncertainty analysis – Chat and open discussion	Presentation, Chat, Menti
10 minutes (11:05 – 11:15)	Driver 6 – The Cost and Funding of Electricity	• Discuss main theme and ask if they agree • Trend 1 – Open discussion • Trend 2 – Open discussion • Trend 3 – Open discussion • Trend 4 – Open discussion • Trend 5 – Open discussion • Trend 6 – Open discussion • Impact analysis – Chat function (ranking) Uncertainty analysis – Chat and open discussion	Presentation, Chat, Menti

10 minutes (11:15 – 11:25)	Driver 7 – Green Technologies	• Discuss main theme and ask if they agree • Trend 1 – Open discussion • Trend 2 – Open discussion • Trend 3 – Open discussion • Trend 4 – Open discussion • Trend 5 – Open discussion • Impact analysis – Chat function (ranking) Uncertainty analysis – Chat and open discussion	Presentation, Chat, Menti
10 minutes (11:25 – 11:35)	Drivers missed	Open the floor for any drivers or trends missed	Open Discussion
10 minutes (11:35 – 11:45)	Actors	Determine the actors within the ESI	Menti
5 minutes (11:45 – 11:50)	General	Wrap, recap and any feedback	

APPENDIX 2 – WORKSHOP 1 PRESENTATION WITH NOTES

DISCLAIMER

- Competition Law to remain applicable at all times. The industry to be discussed and not companies
- Participation is voluntary and you may leave at any time
- Results are aggregated – no names will be recorded in the transcribed data. Instead, participants will be mentioned only as Participant 1, Participant 2, etc.
- The session is recorded to enable transcribing
- The views expressed here will not represent a single view of any person or entity

WHY ARE WE HERE TODAY

- Given all the uncertainties in the ESI, we arrive at the focal question

What is the potential future scenarios for the South African Electricity Supply Industry given a timeframe of 20 years?

- Based on this question, each of us can plan our strategy to ensure we make the best decisions for now as well as in the future
- Understanding what drives the change and recognizing the trends, we are able to adapt the plan
- Of importance is that we remember to view this from a procurement perspective

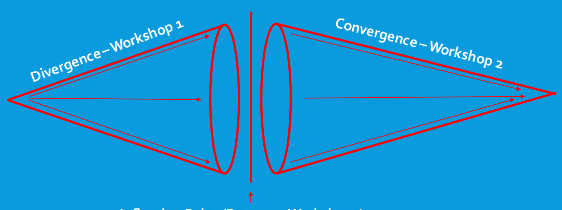
WHY ARE WE HERE TODAY

- Procure energy for Large Power Users (LPUs)
- Have the ability to decide, influence or recommend decisions
- Impact of decisions made today only known in the future
- Many uncertainties
  - Price
  - Supply
  - Transmission and Distribution
  - Wholesale versus Retail
  - Trading
  - Fixed Costs versus Variable Costs
  - Just Transition
  - Risk Allocation?

OBJECTIVES OF THE WORKSHOP

- Agree on the main themes impacting the ESI
- Identify trends evolving from the main themes – these could be subtle or not…
- Determine the possible impacts (from a procurement perspective) these trends may have on the future of the ESI
- Determine and highlight the uncertainties in these trends and their underlying drivers
- Identify the actors that will have the most significant impact in determining the outcome of the ESI

YOUR EXPECTATION OF THIS WORKSHOP



YOUR EXPECTATION OF THIS WORKSHOP

- Unfortunately, I have done my job correctly, you will leave here today with more questions than answers
- This is normal – it is ***Divergence***
- Between the two Workshops, I will take us over the ***Inflection Point***
- In Workshop 2, we will use ***Convergence*** to come to the possible alternative futures (not necessarily probable)
- By attending both Workshops, you will hopefully gain a deeper understanding of what will drive the change of our ESI (Workshop 1) and how they interact with each other to determine the alternative futures of the ESI (Workshop 2)
- In Workshop 2, we will also discuss and identify signposts to determine which future direction the ESI is heading

WHAT WE'LL COVER

- Seven main themes (drivers of change) form part of the preliminary observations
- We will discuss those drivers and potential trends
- You are encouraged to add on Mentimeter (www.menti.com) any additional drivers you consider important to note
- You are also encouraged to add on Mentimeter the actors that you consider to have the most influence or biggest impact on changing the ESI (actors should be defined in terms of their positions and not their names)
- www.menti.com

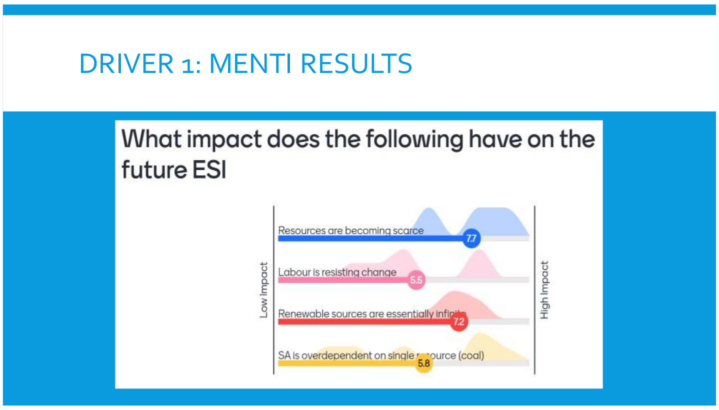
DRIVER 1: RESOURCES ARE FINITE

- Extraction of resources are becoming more expensive
- With pressure on economic viability of opening new mines both locally and globally, resources are in most cases limited to the lives of current mines or easily extracted resources
- ***Please evaluate the statement (do you agree or disagree or would you like to add?)***
- Trend: Resources are becoming scarce
- Trend: Labour is resisting change
- Trend: Renewable sources are essentially infinite
- Trend: SA has dependence on coal
- ***Please evaluate the statements (do you agree or disagree or would you like to add?)***
- ***www.menti.com***
- ***Impact Poll***
- ***Uncertainty Poll***

Participants felt the argument is more an economic and (green) legislation argument as opposed to an ability argument – SA has an abundance of coal that may be exploited but the economic viability as opposed to the technical capability is in question. The (economically and legislatively) finite resource coal requires large energy users to re-evaluate how they use energy in their value chain as it is no longer the “cheap” coal from the past

Although renewable energy is infinite, it cannot be considered without considering issues such as storage. Renewable energy cannot replace baseload generation (such as coal or nuclear) without sufficient battery storage. An alternative to renewable energy is coal with newer carbon-capture technologies

Participants agreed labour resisting the change will not have a significant impact on the future ESI as it will happen with or without their consent. Labour may be resisting due to a lack of knowledge on the subject.

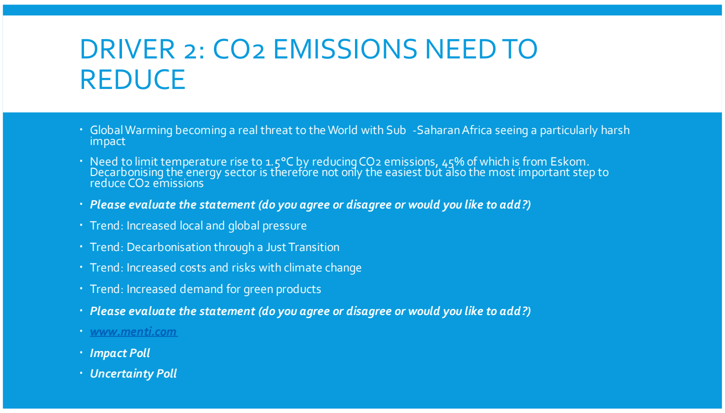


Resources are becoming scarce: Participants generally felt this has a high impact with some participants scoring it lower

Labour is resisting change: More widely spread opinion amongst participants with the general feeling that it will have a lower impact

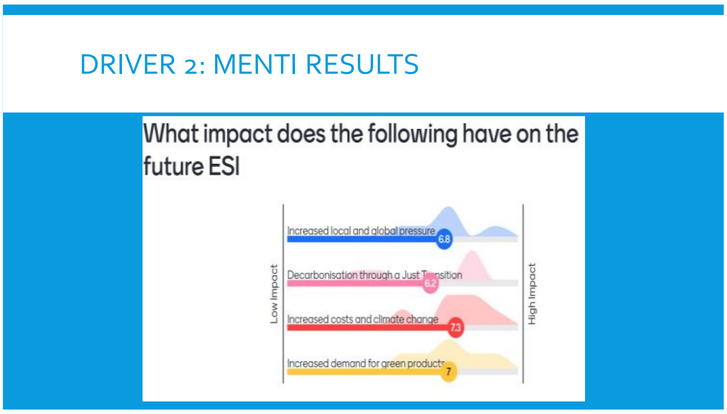
Renewable sources are essentially infinite: General acceptance of having a moderate to high impact on the future ESI

SA is dependent on single resource (coal): Wide spread between participants with some participants thinking it has a low impact and others considering the impact to be high



At least from the Government's side, participants felt decarbonization is more of a window-dressing exercise without much being done (a lot of promise with little action). The private sector is doing a lot more to decarbonize but this is more due to profit pressure than personal conviction. The bottom line is the one driving climate change response in SA with security of supply a much bigger concern than decarbonization to SA citizens and businesses.

Globally, the urgency has disappeared. With the Russian invasion, global leaders have reverted to coal to reduce its dependency on Russian gas.

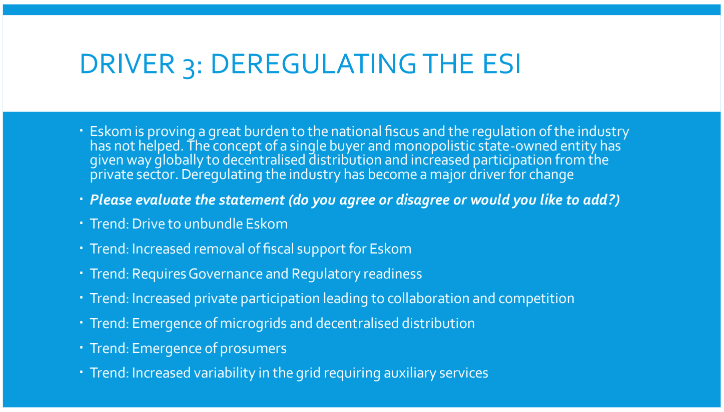


Increased local and global pressure: Some consensus around the moderately high impact (7) but some participants indicated a higher impact whilst others foresee a lower impact.

Decarbonisation through a Just Transition: A wide spread with some concentration in the higher impact region

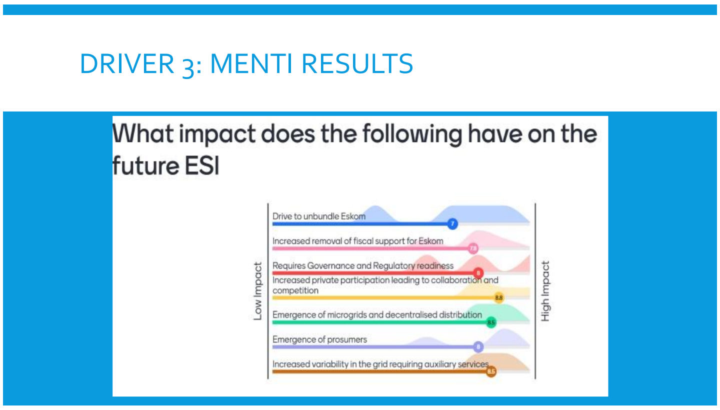
Increased costs and climate change: Consensus amongst participants that this has the highest impact on the ESI from the current driver

Increased demand for green products: A significant spread amongst participants with the general trend pointing towards a higher impact



Deregulation introduces competition which tends to drive down the price – US example. The driver is not just about unburdening the fiscus but also to introduce competition.

Prosumers and micrograms are not necessarily driven by the desire to unbundle Eskom but rather emerging as a result of an advance in generation technologies



Drive to unbundle Eskom: A general feeling amongst participants that the drive to unbundle Eskom will have a moderate to high impact on the future of the ESI with some feeling this will have a lower impact

Increased removal of fiscal support for Eskom: Consensus that this will have a high impact on the future of the ESI

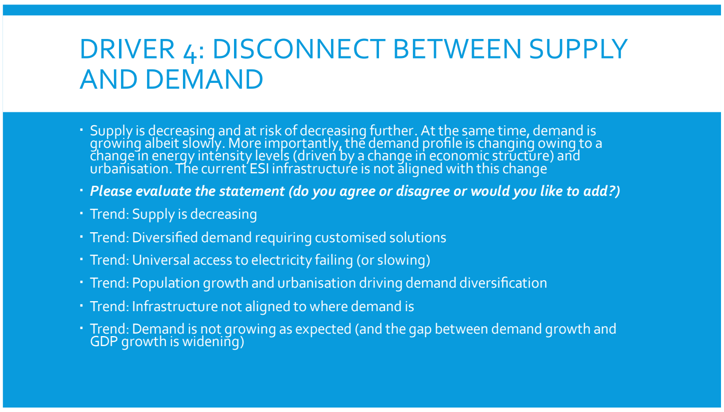
Requires Governance and Regulatory readiness: Although some participants feel this will have a high impact, other participants felt that this will follow naturally and will not impact the future ESI

Increased private participation: According to participants, this will have a high and significant impact on the future ESI

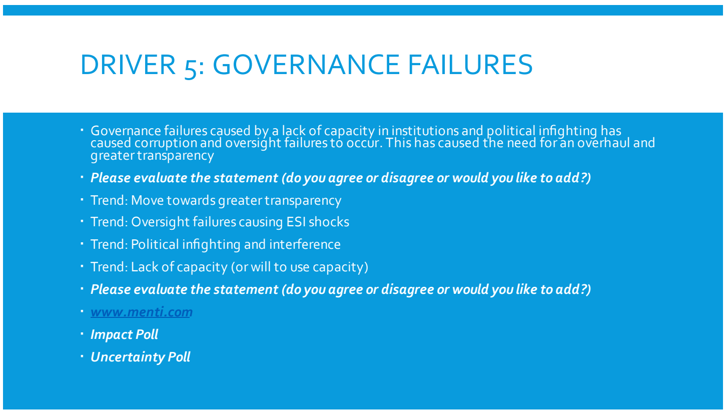
Emergence of microgrids: Although participants agree this will have a high impact on the future ESI, the emergence of microgrids is rather driven by new technology as opposed to a desire to deregulate the ESI

Emergence of prosumers: Similar to microgrids, the emergence of prosumers will have a high impact but is driven by a different driver

Increased variability in the grid: Consensus amongst participating that this will have a high impact on the future ESI

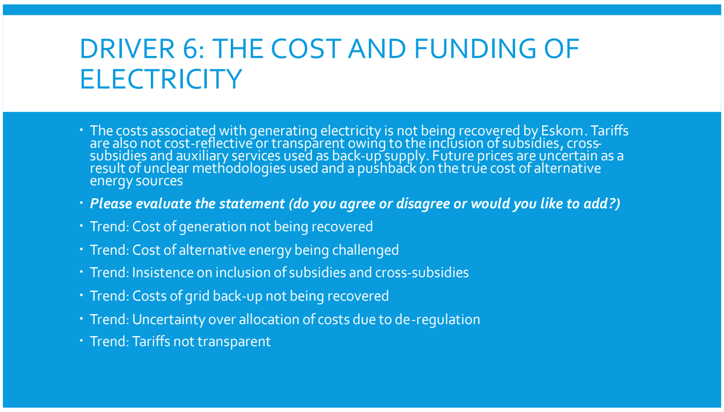


Participants feel strongly that the demand is defined in terms of the demand that Eskom sees as opposed to national demand. Supply is certainly decreasing, but this is not overall supply but rather Eskom supply. Demand is growing but not in the formal sector. Participants agree with population growth driving demand but feel that illegal connections are hiding a lot of demand – this is in competition with urbanisation



Participants felt that Governance failures can be linked to the disconnect between supply and demand driver as well. Governance failures are also causing SA to lag behind in terms of technology usages as well – not only in generation but in distribution (and pricing) as well.

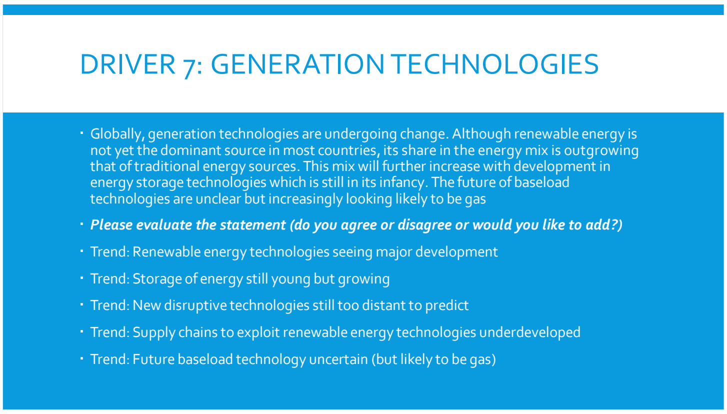
There is also an unwillingness to use the capacity that we have in the country with overseas experts being called in when there are people in SA that knows the system and what to fix.



This is seen by participants as a big driver. Some participants did however caution against the assertion that the cost of generation is not being recovered – they felt the mismanagement around the methodologies play a bigger role.

All participants felt that cross-subsidies is not sustainable and agreed this trend has a big impact on the future of the ESI.

A participant felt that trend 2 is misleading in its wording and clarified that the cost of alternative energy should include the technology (battery storage) needed to implement renewable energy at a large scale

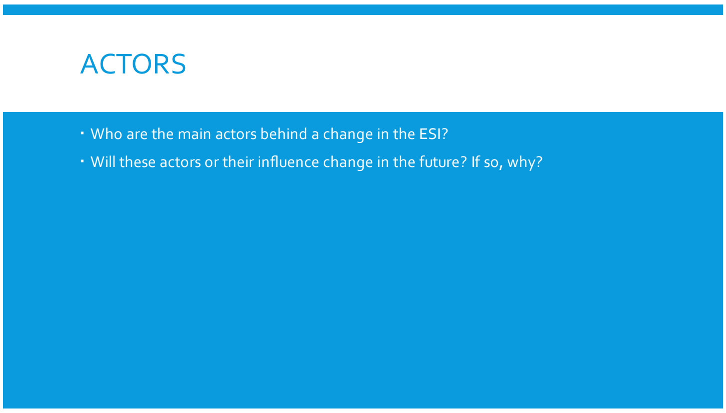


Participants agreed that generation technologies is a major driver for the new ESI but did not agree that gas is likely to be the baseload. Participants felt that either (small modular) nuclear or renewable energy coupled with battery storage could form part of the baseload of the future.

A discussion was held whether green hydrogen was driven by generation technologies or a need to decarbonize the ESI – participants agreed that green hydrogen is driven by the decarbonization driver as opposed to the generation technologies driver.

Participants agreed that supply chains are underdeveloped but broadened this definition to value chains which includes institutional knowledge in contracting as well

Although no specific drivers were mentioned by participants, a discussion was held around resilience. The war in Ukraine has caused a lot of countries to abandon (in the short term) decarbonization efforts in favour of supply security and independence.



Besides the actors already involved in the ESI, the participants flagged the following as actors having an influence on the future ESI:

South Africa Police Service: With illegal connections, theft and sabotage increasing, participants felt the SAPS will have a major role to play in the future ESI

Energy intensive users: Although users are implied in some of the actors, participants felt that this needed to be shown explicitly (including their relationship with Eskom which may become more transactional in future)

APPENDIX 3 – FACILITATION GUIDE FOR WORKSHOP 2

Name

Workshop 2

Duration

Two hours

Participants

Member companies of the EIUG

Purpose

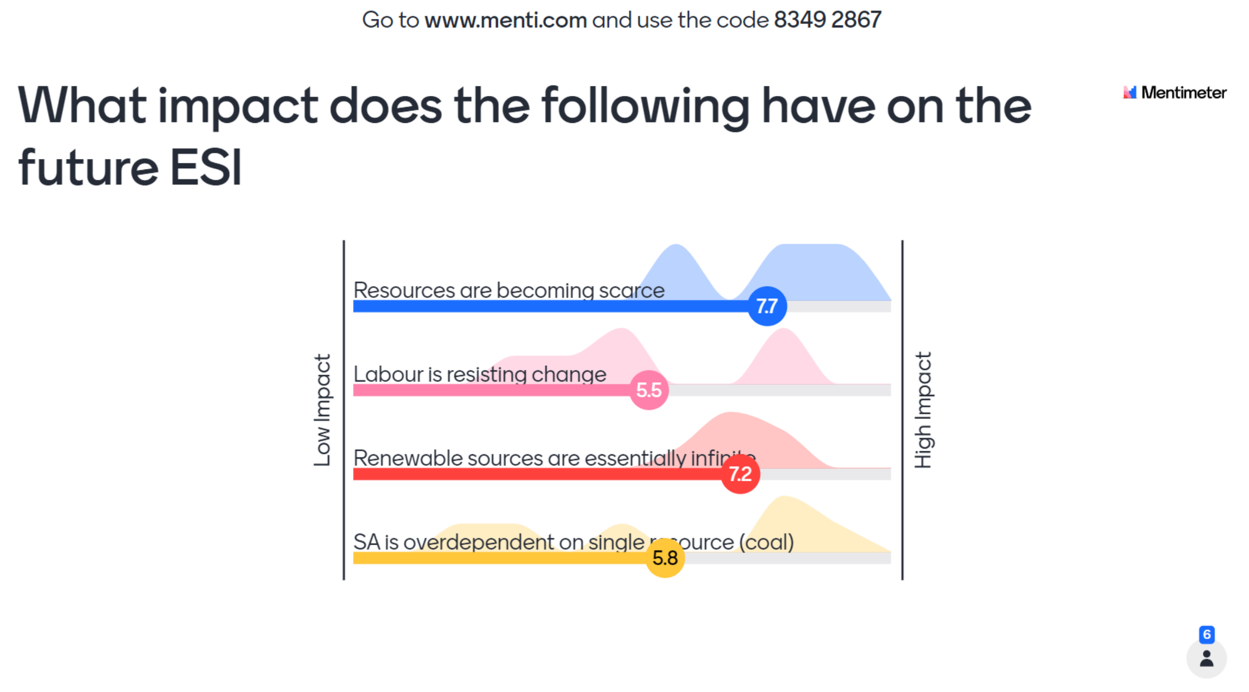
1. To validate the ranking of the drivers and trends according to impact
2. To validate the categories (or themes) of the drivers and trends as well as how they interact with each other
3. To develop scenario narratives

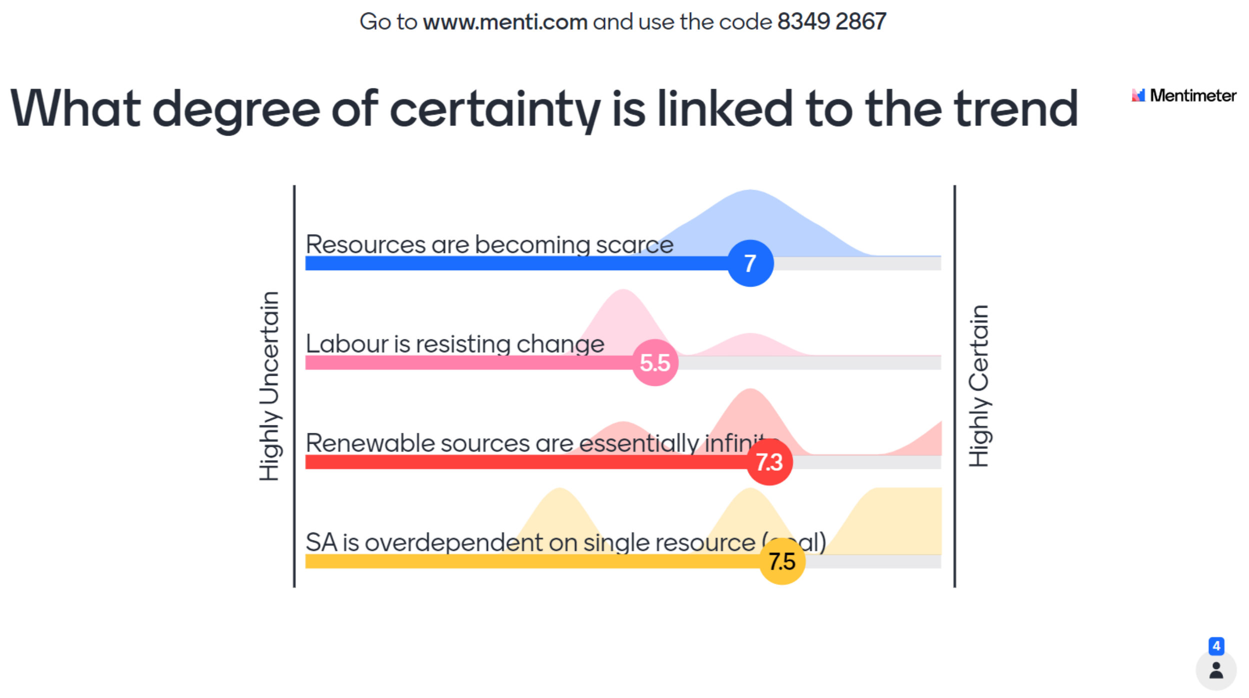
Time	Activity	Details	Resource
2 minutes	Welcoming	Welcome participants and provide time for latecomers to join	
3 minutes (10:02 – 10:05)	Introductions	• Round of Introductions • Competition Law • Voluntary Participation • Results are aggregated • Session recorded and transcribed • No single view represented • May switch off cameras • During presentation mode, I cannot see hands to please interrupt me	Presentation
10 minutes (10:05 – 10:15)	Setting the scene	• Why are we here today • Objectives of the workshop • Your expectations of the workshop	Presentation

		• Recap of the previous workshop findings • Explanation of Menti and what participants need to do	
10 minutes (10:15 – 10:25)	Ranking of the Drivers and Trends	• Indicate the preliminary observations as to the impact of the drivers and trends according to Workshop 1	Presentation
15 minutes (10:25 – 10:40)	Validation of ranking	• Do you agree with these uncertainty rankings? (Yes or no and why) • What would you rank as the biggest impact?	Chat and Menti
10 minutes (10:40 – 10:50)	Categorisation of drivers and trends	• Indicate which drivers and trends will impact each other – based on research and workshop 1	Presentation (System Analysis)
10 minutes (10:50 – 11:00)	Validation of categories and themes	• Do you agree with these categories or themes? (Yes or no and why) • Which two drivers according to you have the highest impact on each other?	Chat and Menti
10 minutes (11:00 – 11:10)	Recap of workshop findings	• According to the participants, these are the two (or three) drivers or trends with the highest impact • According to the participants, the selected highest impacts will influence in this way • The two selected cannot be causal in any way	Presentation

10 minutes (11:10 – 11:20)	Actors	• Determine/validate the actors involved in the high impact drivers and trends	
10 minutes (11:20 – 11:30)	Scenario 1 - Basecase	• Narrative of scenario 1 • Driver 1 and Driver 2 (0,0)	Open discussion, menti
10 minutes (11:30 – 11:40)	Scenario 2	• Narrative of scenario 2 • Driver 1 and Driver 2 (0,1)	Open discussion, menti
10 minutes (11:40 – 11:50)	Scenario 3	• Narrative of scenario 3 • Driver 1 and Driver 2 (1,0)	Open discussion, menti
10 minutes (11:50 – 12:00)	Scenario 4	• Narrative of scenario 4 • Driver 1 and Driver 2 (1,1)	Open discussion, menti
10 minutes (12:00 – 12:10)	Final description	• Provide a final description of the narratives obtained • Get final feedback if everyone is in agreement	Open discussion
5 minutes (12:10 – 12:15)	Closure	• Thank you and closure	

APPENDIX 4 – MENTI RESULTS FOR WORKSHOP 1

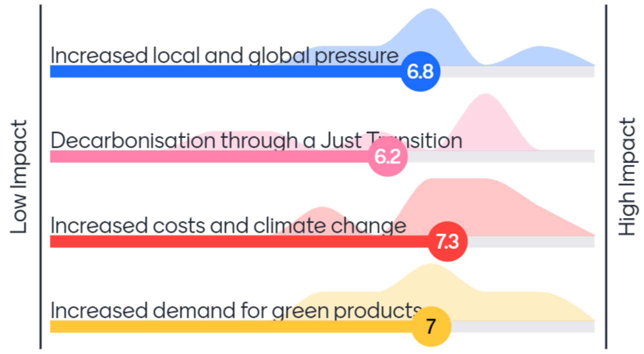




Go to **www.menti.com** and use the code **3317 2506**

What impact does the following have on the future ESI

Mentimeter



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Go to **www.menti.com** and use the code **3317 2506**

What degree of certainty is linked to the trend

Mentimeter

3

Go to **www.menti.com** and use the code **7205 0918**

What impact does the following have on the future ESI

Mentimeter

4

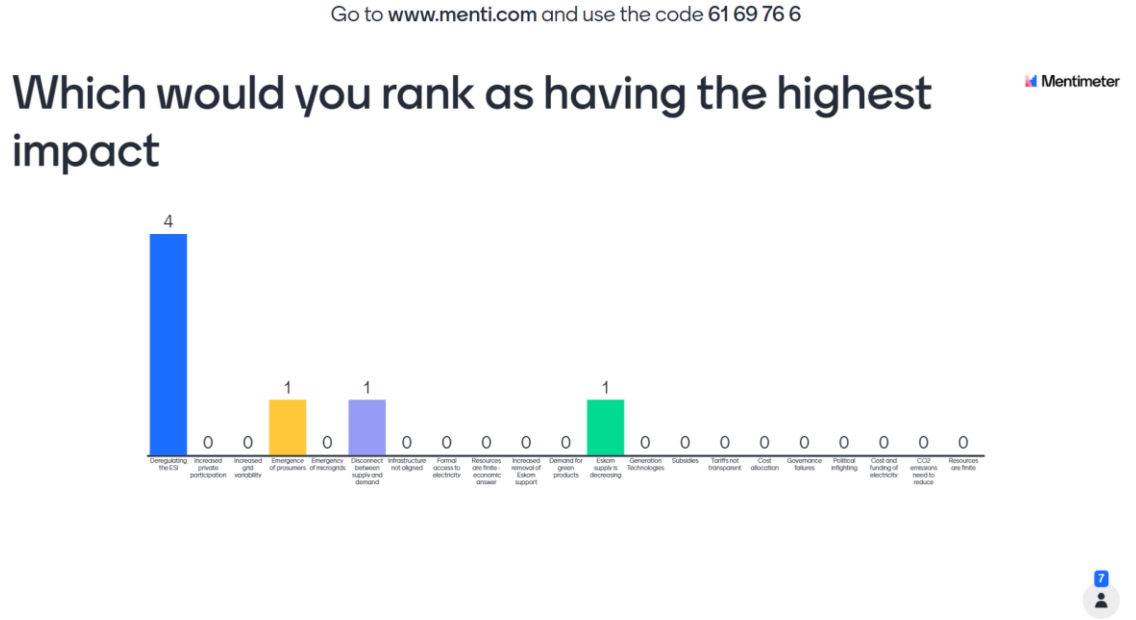
Go to **www.menti.com** and use the code **7205 0918**

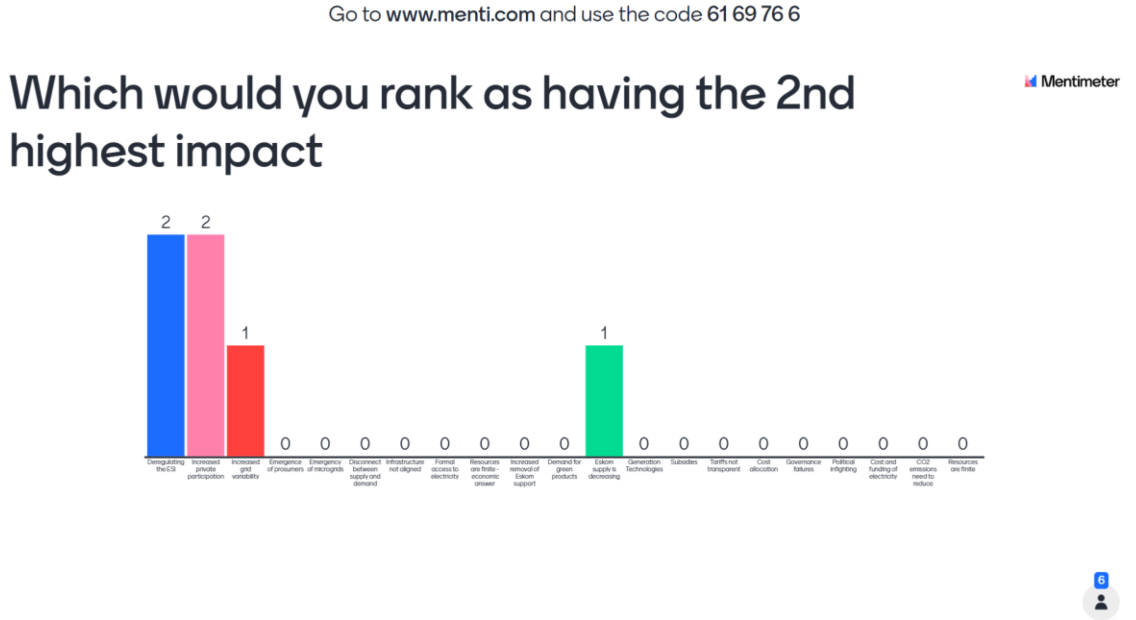
What degree of certainty is linked to the trend

Mentimeter

1

APPENDIX 5 – MENTI RESULTS FOR WORKSHOP 2





Which drivers/trends impact one another?

Mentimeter

Green Tech /Disconnect

It may be helpful to unpack the drivers into (1) the energy space (which will connect all drivers related to energy, new products, pro-sumers, variablility, emmissions, grid stability, etc), (2) the network business and (3) subsidies, socio economi

CO_2 emissions requirements drives the need for Renewable Energy, which leads to increasing Renewable Energy use naturally driving an increasing need for Storage, due to variability in RE supply.

The disconnect/supply shortage results in the need to look at new supply. With green tech being both cheeper and reducing co2 it trumps existing carbon resource alternatives. Deregulation enables the move to green tech.

carbon dioxide emissions and funding/costs

5

Which actors are involved?

Mentimeter

1) Private Business as primary drivers.2) Eskom/NERSA as regulators and role players in control in our regulated environment.3) Municipalities being uninformed and generally incompetent and uninformed to support Industry needs.

1

APPENDIX 6 – LINKAGES BETWEEN DRIVERS AND TRENDS