



SANEA

The South African National Energy Association NPC
Energy People Working Together

Member Committee



A c/o Turners Conferences and Conventions (Pty) Ltd, 37 Margaret Mncadi Avenue, PO Box 1935, Durban, 4000, South Africa
P +27 (0)31 368 8000 • F +27 (0)31 368 6623 • E sanea@turnergroup.co.za • W www.sanea.org.za

A SANEA ACTION FOR ENERGY EVENT

ENERGY MIX RE-BOOT -

Open Dialogue on Primary Energy Mix for Electricity in South Africa

Venue	Sandton Convention Centre, Sandton, Johannesburg
Date	23 February 2017
Time	07h00 – 15h30
Number of attendees	61
Nature of attendees	70 /30 split of SANEA Members / Non-Members

TABLE OF CONTENTS	
SUBJECT	PAGE
Introduction	2
Welcome and setting the scene	4
Energy Mix 1.0: The latest IRP – tried and tested options	5
Energy Mix 2.0: The potential for a new paradigm	7
Grid Considerations: Variable energy source integration	10
Risk – The Double Edge Sword	12
Economic Considerations: Co-ordination and deliberation	14
Challenges and Issues: Is Change Worth It?	15
Summary and Closing Remarks	18

Introduction

Background

The South African electricity supply system's primary energy mix has been heavily dependent on fossil fuels for almost a century.

Is it now time to re-boot the system and install "Energy Mix 2.0"?

In posing this question, this discussion forum sought to refresh thinking about an appropriate energy mix in a context of new realities and to catalyse transformation of the electricity sector.

South Africa is at a point where important decisions need to be made about the future installed capacity of the electricity supply industry. There are some in the country who are of the opinion that we may already have too much capacity. There are others that believe the opposite. What most agree on is that energy supply must precede demand in order to stimulate growth. Equally important are economic cost efficiency and grid dispatch efficiency, enhanced by an optimal supply demand balance. Given the need to stimulate growth in the light of an uncertain demand environment, the opportunity to use lower incremental supply growth at lower capital cost is worthy of exploring and understanding.

We also need to consider South Africa's commitment to deliver energy access to all its people and energy security for both suppliers and consumers. We need to do this in a way that is responsible and in line with our commitments and obligations to ensure a sustainable future.

The historical model of large coal-fired and nuclear power stations may not necessarily be appropriate for South Africa over the next 20 - 30 years. Already wind and solar power are playing an increasing role in generation [via the renewable energy IPP procurement programme] and many large consumers have already installed, or are considering, own generation and co-generation options.

Consumers too have to prepare themselves for this new world and make important decisions on how to position their businesses so as to extract full advantage from the new structures and systems. Regulators and other government bodies [national, provincial and local] will face many decisions as they work to ensure equity for all parties in this dynamic future. The difficulties of managing the interconnected grid with such diverse interfaces will be huge.

And all the above is without even considering the advent of off-grid and micro-grid energy solutions for those who currently have no, or limited, access to reliable and affordable electricity supply.

Decisions made over the next few months and years will set the framework for our future electricity supply systems. This is the time for bold and innovative ideas to be presented and debated so that we collectively ensure that the future electricity supply systems enable a prosperous South Africa.

Objectives

The objective of this dialogue was for the delegates to develop a clear and informed view of the current state of the electricity sector in South Africa relative to the global market, the issues and challenges that South Africa is facing, and what change is required to ensure growth in the sector.

Key role-players in the energy sector presented perspectives that were different yet all focused on the same end goal. This opened the opportunity to have a more open view of the electricity sector as a whole and how different areas impact the success or failure of the sector. The objectives of the discussion was to identify key ideas on how to be successful in the ever changing world, what critical variables should be considered, and how to approach the electricity sector for a dynamic future.

The SANEA Primary Energy Mix dialogue was hosted as a side event to the Africa Energy Indaba which took place from 20 -22 February 2017 at the Sandton Convention Centre in Johannesburg. The feedback from this and other Indaba events will provide the Department of Energy with high quality input towards the finalisation of the Integrated Energy and Integrated Resource plans.

Welcome and setting the scene

Time slot	08:00 – 08:15
Brian A Statham	Chairman SANEA

The day was opened by Brian Statham, who provided the context and objectives for the day. The main idea of the day was to bring individuals from a variety of backgrounds to collaborate and discuss the challenges and issues faced in the South African electricity sector to empower wise business decision making. The discussion included the following critical key points:

- Opportunities to transform the South African Energy sector.
- The drastic change of the entire nature of the energy sector.
- Shifting from grid connection as the only solution to off-grid and decentralised power solutions.
- Analysing and discussing the changing business models.
- Historic learning will not necessarily solve the issues and challenges faced in the sector in the context of the future dynamic, which provides equal opportunity for everyone to come to the table and provide innovative solutions.
- Energy is increasingly seen as an enabler for socio-economic development, where importance lies in having a more customer centric approach.
- Within the next five years, a tipping point between either advancing or missing the opportunity completely will be reached.

Energy Mix 1.0: The latest IRP – tried and tested options

Time slot	08:15 – 09:15
Mike Rossouw	Independent Consultant

Mike Rossouw initiated his presentation with the following: “Pursue a new future or struggle for a better past?” This speaks to energy planning in general but particularly to the IRP.

The extract of the National Energy Act 2008 which Mike Rossouw presented was the official policy of government and referred specifically to the IEP.

The following key points were discussed during the presentation:

- Analysis is conducted on a national level in South Africa, which is better termed as the National Planning Environment.
- The current IEP is referred to as more of a process rather than a plan, in which energy overall is considered and the focus is mainly on the integration of ideas.
- On the other hand, the IRP which applies specifically to electricity, is strictly followed and applied. In order to test a model’s behaviour, plausible or possible scenarios are input and balanced outcomes are produced. These outcomes are then submitted for both public comment and government input. Once this step is completed, discussions within government are held for final inputs before delivering the IRP.

Draft IRP Model Inputs

Mike Rossouw explained uncertainties in the energy sector:

- There is a high degree of uncertainty of what generator technology type is required.
- Even once the technology type is finalised, questions are raised on who will provide the chosen generators.
- A factor that provokes all the uncertainties deals with disconnection and changes occurring globally, as well as in South Africa.
- Analyses show that peak demand growth has been greater than South Africa’s overall energy demand. At the same time, electricity intensity is constantly declining. An assumption was made that the result of the latter could be due to energy being produced elsewhere (i.e. not by Eskom).

The draft IRP 2016 discusses a number of commitments made in terms of determinations and purchase commitments. The base case recognises these commitments and locks the commercial operational dates into the draft IRP which shows therefore sufficient capacity is provided for an adequate system from the present up until 2022.

The draft IRP 2016 reflects three time periods, as displayed in the table below.

Time period	Description
Committed (present – 2022)	Confirmed capacities are input to the model. For this time period, no changes are permitted. This was the policy decision as undertaken by the Department of Energy (DOE).
Policy options (2023 – 2030)	These are decisions that will be discussed during this draft IRP period. Policy directions will be determined on all issues and may provide different IRP results when compared to the committed time period model.
Pathways (>2030)	Pathways time period is unpredictable and any estimates will most likely be inaccurate. However, it is important to consider future scenarios and how they could shape the future energy sector.

For every run in the IRP model, six key criteria have been identified to analyse and are discussed in the table below:

Criteria	Description
EAF	Energy availability factor considerations must be noted to not overbuild the model. This is to ensure that there is a balance in the importance of the utility and IPPs.
Water usage	Water is particularly important for SA as it is a scarce commodity.
CO2 emissions	All technologies chosen for renewable energies focused on reducing CO2 emissions, which saves cost in future.
Reserve margins	Adequacy of the model is important. It should test the reserve margin with a resolution of one hour..
Price path	Differs depending on the model design.
Energy mix	South Africa is divided in different regions of energy, which has enabled greater accessibility to power in more places in the country than ever before. Power flows have reversed from predominantly coal fields in the Witbank area to a bottom-upwards flow. A change has also been seen from a net consumer to a net producer scenario.

Energy Mix 2.0: The potential for a new paradigm

Time slot	09:15 – 10:15
Dr. Tobias Bischof-Niemz	Head of the CSIR Energy Centre

Dr. Tobias Bischof-Niemz presented his analysis of the current draft IRP using the CSIR model run results developed when using the same input assumptions as used for the draft IRP but allowed the model to generate a number of solutions including the least cost solution. .

CSIR Approach

CSIR uses the PLEXOS software to develop models. It is the same system as used by many power system operators and planners globally and has been used by the DOE to produce the draft IRP. This work considered three different scenarios which include the Base Case scenario, Carbon Budget scenario and the techno-economical Least Cost optimisation scenario.

When the Least Cost scenario is developed, it is important to ask the questions as captured in the table below.

Criteria	Question
Demand forecasts	How much demand is there for the generator technology type?
Technology cost assumption	How much should be built?
Relative cost assumption	How does the optimal mix look like?

Draft IRP Assumptions

The draft IRP 2016 has introduced limitations on the annual build-out rates for solar PV and wind. The model is therefore unable to build more than these renewable energy limits in any given year. There has been no techno-economic justification to why these limits have been incorporated in the IRP, or why these limits are constant in absolute terms up until the year 2050, while the power system size more than doubles.

Draft IRP Results and Least Cost Scenario

The key points of the draft IRP results and Least Cost scenario were discussed as follows:

- In the Least Cost scenario, the results show that the capacity of the initial system doubles in size in the next 34 years, which means that a second power system of the same size of the existing power system would have to be constructed.
- It is predicted that by 2050, the electricity demand in South Africa per capita would still be less than that of Australia today.
- In developed countries, growth is driven by the service sector and not from manufacturing industry anymore.
- On the supply side, all power plants have been considered for the “existing fleet” that includes either systems existing in 2016, systems that are under construction, or systems that have been procured for.
- The Least Cost scenario fills the supply gap of the decommissioned power plants in the cheapest possible manner.
- Based on fixed and variable cost components, the PLEXOS model decides what and how the system must be built. The output displays the utilisation of the power system. All other input assumptions of the model were taken from the IRP 2016.

Key comments noted during the Q&A opportunity for this session:

- In developing the model, fuel prices for all relevant technologies are kept at a constant value. This is true for both coal and gas modelling. Additionally, gas costs are set at high LNG prices on a delivered to power station basis. Reduction in cost for gas will only occur if using shale gas or regional gas. In the Least Case model, gas is not reflected as a competitive energy form for the bulk energy provider and is rather reflected as a complimentary power generator. It will therefore have almost no impact in the modelling. However, this is not the case when considering the Base Case or Carbon Budget Case.
- Socio-economic impacts are not modelled in either the IRP or the CSIR model. Also, both IRP and CSIR analyses do not model who owns the power generators but rather provides information on what type of power generators are required.
- If capacity from coal IPP is purchased, then the PPA has two different tariff components. One is the available capacity to buy for R/MW/day and the other for what energy is actually produced. A guarantee that the R/MW/day will be achieved is dependent on the technical availability.
- To ensure that the model is not too complex, it does not include a high number of generator types. It does however contain a technical option for pumped storage in cases where it is economically viable to add.
- The supply gap that exists in the model is due to the assumption of decommissioning of the existing fleet.
- Additional advantages of the Least Cost scenario are that it results in much shorter lead times and has the ability to react to changes in demand at a much faster pace.

- The demand forecast should be updated on a rolling basis and depending on the assumptions made, it will deploy the renewables at the same speed as the forecast.
- With the Least Cost scenario, many different demand profiles were tested and all results were similar showing that wind and solar PV fill the gaps in energy demand.
- For the purposes of the power system model, fuel costs are a variable factor. The main reason for this assumption is that a decision can be made to not run a coal powered station.
- Another aspect not factored into the model is the residual value at the end of planning horizon. Instead, it is asked at the post-processing section in terms of least regret, as well as on how adaptable the circumstances are to changing input assumptions. In a situation where all input assumptions materialise, no issues will exist.
- The IRP did not consider life extension as an option for existing plant systems, which is why CSIR also does not include it in the modelling.

Grid Considerations: Variable energy source integration

Time slot	10:45 – 11:30
Andrea Buser	World Energy Council - UK

The World Energy Council is comprised of member committees of more than 90 countries across the world and is supported by companies across the energy sector.

Andrea Buser presented a study that summarises 32 country case studies, which investigates and identifies the state of renewable energies across the world. The impact on the increased renewable shares are based on different aspects of the electricity system including the grid, the electricity markets, consumer impact and traditional fee impacts. All recommendations focus on shaping policy decision making.

The key points discussed in the presentation include the following:

- The 32 countries in the study make up a total of 89% of the installed generation capacity of renewables.
- Investment in renewables is evenly distributed between developing and developed countries, China ranking as number one in highest investment in renewable energy.
- Hydro power makes the largest contribution to renewable power provided globally.
- Europe was the leader for renewable energy deployment for a number of years but has been overtaken by many developing countries especially in the Asian region.
- The cost of renewables is declining steadily.
- There is a distinct difference between the different technologies of the renewable power systems, however, certain renewables under certain conditions can be cheaper than certain fossil fuels.
- Renewables have priority dispatch in most policies.
- Traditional fleet's operating hours is expected to or has already significantly decreased.

Andrea Buser discussed concerns around renewables as captured in the table below.

Concern	Solution
What are the impacts on the electricity market?	<ul style="list-style-type: none"> • Case study from Italy shows that with additional solar PV generation, wholesale electricity prices are expected to decrease towards zero. In Germany and Denmark, electricity prices are already at negative values. • Dispatching costs more than double, including ancillary services and balancing services.
What are the implications on the grid?	<ul style="list-style-type: none"> • All countries require some sort of grid adaptations, such as an addition of transmission lines or updates to grid infrastructure.

	<ul style="list-style-type: none"> • Adding small-scale renewables changes the transmission flow from one direction to a bi-directional flow.
What are the implications on consumers?	<ul style="list-style-type: none"> • The case studies show that financial incentives supported the deployment of renewables. The implication is an increased cost to the end consumer.

The following conclusions and recommendations were discussed in terms of renewable energy future development:

- Energy Trilemma is a sustainability framework that balances energy equity, which is the affordability and accessibility of energy, as well as environmental and energy security considerations, which primarily looks at system resilience and security.
- Improved forecasting reduces operating costs. The cost of forecasting has reduced while accuracy of the forecasting has increased, flexibility of conventional generation has increased, there is an expansion of grid networks, as well as smarter networks.
- Infrastructure has to be improved to deal with the additional capacity of renewables.
- Regarding market design, capacity payments are popular. The emission trading scheme has to be updated to ensure accurate carbon prices. This is easier in continents like Europe where there is an integrated system with different member countries working together. In continents where countries are more isolated, there is no presence of a set emission trading scheme.
- Developing larger balancing areas, as well as pooling resources, may assist by pooling regional variability data and variability between resources.
- A holistic approach to an overall electrical system design is key to success but requires stakeholder collaboration. Collaboration between government, private sector, regulation and global collaboration is the key for success.

Key comments noted during the Q&A opportunity for this session:

- The regime for renewables where there is a flat payment rate is dependent on the resources available in South Africa, as well as government involvement.
- The bi-directional flow results from small-scale renewables being added to the power system.
- By taking nuclear out of the power system and adding lots of small-scale renewables, an impact may be realised on tariffs with an approximately 20% reduction in the price.

Risk – The Double Edge Sword

Time slot	11:30 – 12:15
Rob Ashdown	Senior Originator of Energy at Swiss Re

Rob Ashdown presented an overview of the risks and exposures that may arise in a renewable energy context. The key points highlighted include:

- No opportunity is without risk, but unmanaged risk could result in disasters.
- Another name for a disaster is a lack of resilience
- Risk is about resilience. When extreme weather events, catastrophes, water and food competition occur, countries need have a plan to overcome the impacts of these negative events.

Types of exposures that could impact renewable energy projects include:

- Extreme weather events and increasing frequency driven by human induced global environmental change (aka. climate change).
- Catastrophic major events such as earthquakes, fires and mega-storms etc.
- Water & food competition for a scarce resource and the need to prepare for it or lack thereof
- Cyber risk - most energy systems are linked and are vulnerable to attack that could cripple economies (this has already happened)
- Political risk - unstable governments or policy can stimulate unrest and the results are not savoury

Examples of risks that energy companies can be exposed to:

- Severe droughts in Brazil resulting in US\$4.3Bln losses for the energy sector and a potential downgrade in credit rating for Uruguay. An unplanned bill for Tanzania of >\$500MM and Zambia is still counting
- Severe earthquakes and pandemics impact whole sectors and industries, including luxury goods sales, e.g. the Japanese example
- Severe hurricanes/cyclones or typhoons – e.g. Haiti, 2013 Typhoon Haiyan \$200MM
- Water & Food competing for resource scarcity results in reduced overall performance
- Cyber Risk - SCADA system attacks bringing whole systems offline and halting economic activity
- Political Risk - nationalisation, non-payment etc.

Key comments noted during the Q&A opportunity for this session:

- More power is required in order to support South Africa's economy.
- Focus needs to be concentrated on policy certainty and governance.

- Renewable insurance products are designed on the basis of the client understanding on how money is lost and earned.
- The financial and energy sector are increasingly collaborating on ideas to manage risk.

Economic Considerations: Co-ordination and deliberation: SA future energy mix.

Time slot	12:15 – 12:45
Andre Snyders	Standard Bank: Sector Research Analyst

Andre Snyders presented information on how both buyers and sellers contribute to the energy sector. The key discussion points were as follows:

- In political economics, the general analysis is on the supply end rather than on the demand side. It is important to know the clearing price of the product produced.
- Markets are failing too often.
- In any long term plan, there are a number of individuals involved. No one understands the entire picture but each individual has the same end goal.
- The major challenge is in coordination and deliberation of a plan. Markets generally assist with the coordination. All people involved in a collaboration have a responsibility for deliberation.
- It is important to resist the temptation of making price the deciding factor.
- Every sector is dependent on one another in some way or another.
- Both investors and mass producers are required in South Africa's economy.
- It is important to scale things up at the right cost.
- The energy sector must accept and be made aware of the idea that failure will most probably result more often than not along the way.

When does the short term plan become the long term plan?

- A short term example is the tariff. Long term considers actual cost structures. The challenge occurs when the short term plan stops and never follows through to a long term plan. The result is that another short term plan is developed in its place.

What is the critical variable?

- Financial models often include one or two variables. An important one to consider is the ability to spot failure quickly and through this, be able to modify the design. An indicator that the latter has not been identified is when a certain plan has been discussed over a long period of time. This could be due to obtaining no quality feedback on where the point of failure has occurred in the process.

It is important to understand the difference between risk and uncertainty:

- It is important to reconsider the correct approach when analysing risk. There is a lot of data available that can be understood, quantified and manipulated to build better models in the future.
- There is a rise in radical uncertainty. Many situations that occur cannot be modelled. These situations do not have a normal probability distribution.

Challenges and Issues: Is Change Worth It?

Time slot	13:30 – 15:00
Facilitator	Brian Statham , Chairman: SANEA
Panellists	Kiren Maharaj , Management Consultant and Project Developer
	Johan van den Berg , Wind Energy Expert
	Erica Johnson , Independent Consultant
	Dudley Baylis , Investment Specialist

Kiren Maharaj, Johan van den Berg, Erica Johnson and Dudley Baylis were the panellists for the discussion involving the challenges and issues of the energy sector in South Africa and whether or not change is required.

Brian Statham facilitated the session and opened the discussion by directing questions to each panel member. One of the key concerns is whether the tried and tested plans of the past are still valid for the future, or whether it is time to make a move to new ideas and different thinking.

The initial discussion was on the key takeaways from the morning discussions and included:

- There is another way of looking at the energy mix. It is time to get out of the comfort zone of the common technologies and investigate alternative solutions.
- When considering the coal industry, awareness of the consequences that may result from decisions made is required.
- Would the coal industry make sustainable investment decisions to ensure that there is enough coal for the fleet to continue to the end of its life in any event?
- Demand forecasts and supply options are available but as the world changes, many planning assumptions become either validated or invalidated.
- Power capacity creates the opportunity for eventual long term employment.
- More investigation is required into distributed energy systems.
- There is a lot of working knowledge in five year time snapshots of the energy sector.
- A new energy paradigm is required. Investigation is required to answer South Africa's economic, technical, social, political, cultural and environmental issues through more than the techno-economic analyses. A conversation shift is a necessity.
- Identifying the uncertainties would assist with resilience requirements. An upfront cost discussion is required in South Africa to change the conversation from the last IRP.
- The world is becoming far less predictable. Anything that has a long time horizon adds complexity to the situation.
- The IRP was initially designed to be updated every two years, however this is not the case and needs to be addressed.

- The context for the IRP has a political reason to it, which adds difficulty to finding a resolution. The IRP should be contextualised on socio-economic factors and not only technically.

A general theme that often came through was that the world is becoming increasingly complex with a vast amount of information. There are many factors to consider. Two main questions were asked:

- What are the triggers?
- What will be the deciding factor on the way forward?

The discussion was extended for the panel to provide their views on what they think are the critical variables. The views on critical variables were as follows:

- On the role of utilities, who funds these utilities and how the energy sector is going to progress, it was stated that it would be important for utilities to adapt to the future.
- Energy should be seen as an enabler in a bigger delivery system.
- Confidence is required in the energy sector.
- Financial health of the sector is critical.
- The major energy policy document for South Africa is 20 years outdated. This results in a lack of a vision for the energy sector end goal in South Africa.

The following key comments were made during the Q&A session:

- Uptake of solar PV will occur irrespective of what is being planned centrally.
- Resistance to change is visible, especially in the central planning process. If not effective, this planning process will fall away, and utilities resisting change in the ever-changing world, will eventually die out. Change is not a question, it is happening regardless of what anyone does or says. Identify a solution to manage the change process in a manner that is least disruptive, as well as impactful, to the successful outcome of South Africa's entire society. Collective responsibility is required.
- In a world where demand cannot be forecast, flexibility is a necessity.
- Need to reconsider whether the view of funders or investors is influencing the planning process using long term models, since the outputs may not be accurate in the ever changing world.
- Free market approach may not produce optimal outcomes or certainties for investments. This may be balanced by installing a regulatory framework where government has a degree of leadership and allows for good things to happen but also steps back to allow for other good things to happen.
- Democratising the decision making process is complex. The outcome should be a more robust system than the past system.
- The energy economy should be divided into portions where there is competition but not too big to avoid failure.

- Another element to electricity demand has been missed completely. The relentless move to electrification at the expense of liquid fuels and a huge impact on the demand of electricity in an upward direction.

The panel discussion was closed off on the following key points:

- The best system in the country, which distributes renewables as broadly in the country as possible, is required.
- We need to be brave enough to give certainty where long term contracts are required and where every other consumer can take advantage of the cheapest energy cost.
- The trajectory of the energy system means analysis is required of all the possible opportunities.
- Significant leadership and capacity to make decisions is required.
- When the focus is only on centralised planning, the opportunity to change the eventual outcome of the South African energy future may be entirely missed.

Summary and Closing Remarks

Time slot	15:00 – 15:20
Heloise Nel	Director: SANEA

Heloise Nel summarised the Energy Mix Re-boot workshop with the following key points:

- Africa needs any form of energy now. There is room for addressing this requirement but it is up to the shareholders to move with speed and courage. Important factors that must be considered are affordability, bankability, regulatory framework and human capability.
- Cost curves and outcomes provided results that have far exceeded the historic expectation.
- It is not about energy provisioning alone but developing a holistic industrial strategy.
- The discussion of the day mainly focused on the following three key points:
 - The future energy mix for power generation.
 - The implications for transmission and distribution systems.
 - Implications for risk management, economic performance and evaluation.
- Globally, in 2015, developing countries invested more in renewable implementation than the developed countries.
- In South Africa, wind cost reduced by 35% and solar PV reduced by 80%. Also, in the past three years, the installed wind and solar capacity has doubled.
- Currently in South Africa, 2.5GW of installed capacity is renewable. In the past 3 years, the cost decreased by 40%. However, renewable energies are still only 3% of South Africa's total energy system.
- Energy systems are predicted to being double the size within the next 34 years.
- IRP has played a significant role in energy planning in this country. Although limitations lie in current knowledge of technology and input pricing, the speakers confirmed that technological and economical rigour was ensured in developing the IRP model.
- Technological and economic impacts of renewables are well understood but the socio-economic and environmental impacts require more understanding on how renewables are going to be influencing South Africa.
- A shift to small scale renewables will have an immense impact on grid and dispatch costs, which will ultimately shift to consumer.
- The key questions to ask with respect to risk include:
 - What are the resilience requirements in the region?
 - How will volatility be managed?
 - What costs are involved?
 - What is the role of the energy providers?