ENERGY ROUNDTABLE

Proceedings Report

science
& technology
Department:
Science and Technology
REPUBLIC OF SOUTH AFRICA

NACI
NATIONAL ADVISORY COUNCIL ON INNOVATION

Contents

Glossary

CEO	Chief Executive Officer
CSIR	Council for Scientific and Industrial Research
DST	Department of Science and Technology
GDP	Gross Domestic Product
IEA	International Energy Agency
IAEA	International Atomic Energy Agency
IEP	Integrated Energy Plan
IMF	International Monitory Fund
IRP	Integrated Resource Plan
MPRDA	Minerals and Petroleum Resources Development Act
NACI	National Advisory Council on Innovation
NCPC	National Cleaner Production Centre
NECSA	Nuclear Energy Corporation of South Africa
NNR	National Nuclear Regulator
NSI	National System of Innovation
PV	Photovoltaic
STI	Science, Technology and Innovation
UK	United Kingdom
US	United States
WWF	World Wide Fund

1. Plenary Session

1.1 WELCOME AND INTRODUCTION

Executive Director: Mr. Joel Netshitenzhe

MISTRA: Institute for Strategic Reflection

Mr. Joel Netshitenzhe welcomed the participants in the Energy Choice Round Table Discussion, indicating that the round table was meant to focus on profound matters dealing with sustainable development, the green economy, as well as the energy choices. However, it was anticipated that the discussion would examine the immediate choices that need to be made on nuclear and hydraulic fracking to ensure energy security.

The round table discussion emanated from the Mapungubwe Institute research projects, and the findings were envisaged to influence policy direction in the country. It was emphasized that the discussions on energy choices (between nuclear and hydraulic fracking) should be based on facts instead of the ideological point of view.

1.2 KEY NOTE SPEAKER

Chief Scientific Adviser: Sir Mark Walport

United Kingdom Government

The United Kingdom (UK) government chief scientist's role is to advise the UK government on all aspects of science, engineering, technology, mathematics and social sciences for all government policies. It is also to find the best science wherever it is, and bring it into government. Therefore, the chief scientist finds the right experts, which assist in providing advice. These experts are sourced across the board, from academia, in industry, within the National Academies, within the world societies and within international bodies. In addition, an eclectic interest in science is recommended for an effective chief scientist. This prevents a potential conflict of interest, or having a singular view when advising government.

Government has a broad mandate, such as caring for its citizens and the economy. Infrastructure has a great impact on the economy, especially when it does not work. Power is an important infrastructure, it transformed the ability to live on this planet, and it enabled communities to grow, and provided societies with better lives. Fossil fuels are made up of micro-organisms such as trees and our ancestors. These organisms changed the planet's atmosphere by fixing carbon dioxide through photosynthesis. Societies are now burning the fossilized trees and releasing the carbon dioxide back into the atmosphere. The released carbon dioxide is thickening the protective blanket around the planet, resulting in more heat retention and climate changes.

There are three important points to consider in climate change, energy and power choice. Firstly, the evidence is made available and dispassionately summarised. This is a good advantage for a government chief scientist because the analysis on climate change and energy, and the impact thereof is available. The challenge arises in communicating the information clearly to the citizens. Most citizens do not understand the numbers communicated, such as the planet is warming, and by 0.9 degrees centigrade from the last century. This is an enormous change in the context of climate change; however, it may look small for the citizen. Likewise, communicating that 40 gigatonne of carbon dioxide is emitted into the atmosphere each year, does not come out as a large number to a lot of people. There is no concept of how big is a gigatonne.

Secondly, reducing carbon emission is important. One way of reducing emissions is to reduce power consumption. Power consumption focuses on the power usage that requires power production. Another is decarbonising energy sources as that will reduce and mitigate the harmful carbon dioxide released into the atmosphere. The UK Space Agency and the South African National Space Agency have signed a memorandum of understanding, and this will allow for the monitoring of the universe, such as determining the age of the universe and remote monitoring. Remote monitoring can be used to monitor weather and conduct climate modelling to measure the energy balance of the planet. Thirdly, affordability of the power supply is important. The UK government's policy of reducing carbon emission is aligned with its legal obligation to reduce carbon dioxide levels by 30% by 2020 and by 80% by 2050.

On the other hand, there is no single energy-source solution; a mixture of energy sources is required to move from high carbon fuels to lower carbon fuels. All energy technologies need to be utilised, nuclear power, wind power, solar power, tidal power, hydrogen, and bio-fuels for this move to come true. Economic incentives should be utilised to decarbonise energy sources. Renewable energy sources are not as cheap as fossil fuels, and have a challenge of intermittency. The UK government has been working with the South Africa government to explore carbon trading models, that is, putting a price on carbon. This forms part of its economical mechanism for decarbonising energy sources. As both governments acknowledge that fossil fuel will not be switched overnight, therefore reducing harmful energy emission is paramount.

Furthermore, burning fossil fuel in a clean and efficient manner is essential. Exploring technologies such a carbon capture and storage through photosynthesis have the potential to assist. However, improving the efficiency of photosynthesis is an enormous challenge for governments. Although the technologies are not new per se, they have the potential to reduce the demand for energy. Smart meters can assist in the reduction of energy demand. They have the ability to measure and consume power efficiently. The UK government is rolling out smart meters to 53 million of its citizenry through the smart grid programme. In conclusion, there is a need to collaborate globally on the energy space, similar to the human genome project, and to bring the energy debate to the public.

1.3 ENERGY TECHNOLOGIES

Councillor: Mr Kevin Nassiep
National Advisory Council on Innovation (NACI)

NACI was established under the NACI Act of 1997, and its mandate is to advise the South African Government, through the Minister of Science and Technology, on all matters related to science, technology and innovation (STI). NACI's medium term priorities include, amongst others, setting an agenda for the STI landscape in order for the Department of Science and Technology (DST) to coordinate and stimulate the National System of Innovation (NSI). Secondly, advising on creating a conducive framework for STI in order to contribute to economic growth. Thirdly, monitoring and evaluating the contribution of STI in economic growth and the country's competitiveness. Lastly, positioning NACI as a premier advisory body within the country and providing rapid responses to critical matters including energy.

In terms of the rapid response system, NACI has established an Energy Rapid Response Committee team, to advise the Minister for Science and Technology on energy related matters. The Team will evaluate solutions from an STI perspective in order to address some of the immediate challenges within the energy sector. The STI lens is emphasised because there are other role-players in the energy sector. There are two overarching and important policies in the energy sector, which are key to the discussions, that is, the Integrated Energy Plan (IEP) and the Integrated Resource Plan (IRP). The IEP is a blueprint of the energy sector. It highlights the critical areas for consideration in the energy sector, such as economic growth, environmental sustainability, energy access and energy security. The IRP focuses exclusively on the electricity sector. The IRP is important for the renewable energy market in South Africa as it sets the targets. Its primary objective is to facilitate a move away from a predominantly fossil fuel based economy.

Importantly, the government has recognised the role of renewable energy in the South African energy mix, thus adjusting its outlook by putting in place a programme with a larger contribution of renewable energy. Over 4,000 megawatts of renewable energy have been contracted, with 1000 megawatts currently provided in the grid. However, the grid is outdated. It was designed around a particular type of energy and it was based on a particular supply / demand model.

South Africa needs to invest in research, development and innovation in the smart grid and smart meter technology. There is a need to ensure that the current grid can respond and handle renewable energy power, which is variable in nature. It is important that the country creates a market where consumers have more choices than they currently have. Particularly, in managing and conserving energy, which is amongst the mitigating factors for load shedding.

The country is restricted by a number of factors in moving towards this direction. Firstly, there is a lack of political will and a sectoral resistance to removing fossil fuel subsidies. The quantum fossil fuel subsidy is estimated at 540 billion dollars, as reported by the International Energy Agency (IEA) in 2013. An updated figure from the International Monitory Fund (IMF) is estimating it at 5.3 trillion dollars. The subsidy includes the cost of liquid fuels, the cost of adaptation and mitigation of climate change, amongst others. This cost is substantial relative to the cost of renewable energy subsidies, which is estimated at 120 billion dollars. The unbalanced subsidy hinders countries in creating an equitable market for renewable energy technology. Secondly, there is insufficient expertise in the smart technology landscape. The Asian, European and American markets are emerging as strong contenders in this area. However, the technology is not diffusing fast enough and the opportunities are not being created fast enough.

Renewable energy technologies have done well in South Africa. Last year, the global status report, which observes renewable energy expenditure relative to the GDPs, featured South Africa fourth. However, in 2015, South Africa dropped from the list, making space for other countries like Burundi and Kenya. Overall, this is encouraging because smaller African countries are starting to assert themselves in the renewable energy space. In South Africa, there is a general consensus that the policy programmes are not ambitious enough. The process of bidding and acquiring rights in the renewable energy space is cumbersome and expensive. However, the pricing of renewable energy has improved with wind costing approximately 5 US cent and solar energy at 7 US cents. The price has come down by 40% to 50% over the course of three bidding rounds.

The limiting factor in the renewable energy space has been the lack of the concomitant jobs. Investments are there, but jobs are not created. South African municipalities and metropolitans are also holding the renewable energy space back, because there is a longstanding dependency upon the electricity services revenue. They need to start looking at creating other value added services for revenue. Smart meters could be used as a conduit for providing other value added services. Unfortunately, there is large-scale resistance to the implementation of smart meters in the country, because they are seen as a revenue generating mechanism on the part of the municipality, with no value added to the consumer. Roof-top PV has generated a lot of interest in the country; however, municipalities are not motivated to implement the programme due to a loss of revenue. A similar situation exists with ESKOM irrespective of the ideal location for solar energy. Furthermore, renewable energy requires storage. South Africa is a pioneer in the field of energy storage, as the lithium ion technology was invented in South Africa. However, the opportunity was lost? and other lithium ion technologies are being developed and production is taking place. This will enhance energy efficiency around solar energy. There are other energy efficiency technologies currently being explored including fuel cell technology, carbon capturing and storage technology.

In conclusion, the roundtable discussion will be focusing on nuclear and shale gas technology. It is important to note that South Africa has committed itself to a nuclear build programme. Nuclear energy is expected to feature prominently in the energy mix. The IRP has allocated 9.6 gigawatt. The nuclear build programme is estimated to cost the country over 50 billion Pounds and the procurement process has started. Shale gas has a potential to be a game changer in South Africa's energy mix. However, the exploration of shale gas in the Karoo has been delayed. In addition, a carbon tax may be introduced next year and has the potential to inhibit growth. Companies like Sasol may decide to move their operations offshore. ESKOM has already indicated that it will pass the tax on to the consumer.

1.4 OPENING REMARKS

Chief Director: Ms Tshilidzi Ramuedzisi

Department of Energy

The brief given, requested a high level presentation on the integrated energy planning (IEP) process and the inter-linkages between the IEP and the integrated resource plan (IRP), as well as other policies within the Department of Energy. The IEP focuses on the entire energy sector and looks at all primary energy carriers, all secondary energy carriers, as well as the direct energy use. It is a multi-faceted policy document which seeks transcription to provide an energy sector roadmap. The IRP focuses on the electricity expansion planning by looking at the entire electricity value chain. For example, the IRP, will focus on a sector such as the mining sector: assessing how much electricity is used for process heating, for ventilation, for heating, et cetera, thereby dissecting energy end use at a very detailed level. Furthermore, the IEP focuses on testing the implications of different policies and their inter-linkages within the energy sector. For example:

- Emission reduction is a key objective of government through "a government policy", and the IEP tests the implication of introducing emission reduction technologies, while ensuring meeting the energy efficiency objectives; and
- Similarly, with the carbon tax, the IEP looks at the implications of the tax, as well as the effectiveness of other programmes that have been introduced such as the solar water heating programme.

The process for the development of the IEP therefore involves an extensive evaluation of different policies and strategies developed by various government departments; such as the new growth path, which sets targets for moving the country towards the green economy, improving jobs and industrialisation; and the national development plan. The IEP has to take into consideration the many factors affecting the energy sector (both external and internal); such as the global supply issues; cost of technology; availability of funding; and the credit rating, which is an issue currently affecting South Africa. It also takes into consideration the country's aspirations, such as economic growth, green economy, as well as its constraints. Therefore, there is no myopic view or approach when it comes to energy planning. Eight key objectives have been identified in the IEP, namely, ensuring security of supply; cost of energy; energy access; minimising emissions and other environmental impacts; diversity of supply sources to manage risks; water consumption; and energy efficiency to ensure sustained economic growth.

When evaluating energy cost, the department does this from a level-headed point of view, and not just from a capital cost viewpoint. When calculating the cost of energy, it is done for the entire lifetime of a specific technology. Therefore, one does not look at a capital cost alone or operating costs, because this fails to compare the technologies at the same basis or level. Likewise, South Africa is a water scarce country, therefore this needs to be considered when costing water energy, emissions and the environmental impact associated with different energy carriers and technologies. Similarly, the potential for job creation, and a higher localisation potential is taken into consideration. The economic cost and the financial cost of each technology is easy to quantify. However, the minute other costs are added, such as the cost associated with carbon, cost associated with water usage, sulphur dioxide, nitrogen oxides and other particulate matter, the picture changes. Coal can be considered one of the lowest total technology costs; however, once the costs of damage associated with carbon and other elements are added, coal becomes less inexpensive.

In conclusion, IRP focuses on a subset of the IEP, that is, the electricity sector. It looks at all the elements of the electricity value chain, from primary supply to end use. It provides the details of how much energy is consumed, what type of application is used for electricity, and how much electricity is used. It dissects energy end use at a very detailed level by providing detailed analyses of the system, while ensuring that the country meets its eight objectives.

2. Panel Presentations Session

2.1 LEGAL, ENVIRONMENTAL AND SOCIAL RAMIFICATIONS OF FRACKING AND NUCLEAR

Panelist: Dr. David Fig

Biowatch South Africa

The presentation is focused on raising issues on how, in a democracy, complex and controversial technologies are decided upon. What mechanisms are in place for making such decisions? Mr Kevin Nassiep raised the importance of public debate, and therefore forums like these are important. Public debate is important at both the parliamentary level and civil society. It has been disappointing in a sense that, over last 20 years, Parliament has rather rubber-stamped government policy than interrogating issues for obvious reasons. Civil society is often excluded from the public debate. When one looks, for example, at the balance of interest and forces on the nuclear build programme; looking not so much at the scientific or even the economic debate, but at who is supporting and who is not supporting the nuclear programme, it turns out that the supporters of nuclear energy are very few, mainly the presidency and the ministry or the Department of Energy as observed in public statements.

On the other hand, civil society is seemingly opposed to the nuclear programme, such as the environmental movements, the trade union movements, the faith based communities and increasingly the private sector. The portion of the private sector that has questioned the programme very strongly forms part of the energy intensive user, such as the Chambers of Commerce in South Africa. They are worried about the implications of expensive electricity. How does South Africa decide on whether the policy should go ahead or not? Is the country, basing its decisions strictly on the technology, on the economics or on its ideological stand. South Africans are being railroaded into accepting the nuclear technologies before the public debates are held, through the fear of load shedding and of energy shortages in the country. Does this imply the adoption of the technologies before the necessary steps for regulation are put in place?

The question of nuclear technology, in agreement with the former speakers, is not just a question of science and technology. It should also be open to societal values as mentioned by others, to the economics, to financial viability of the industry, and to the resilience of the South African Financial Public Finance (?). South Africa does not want to find itself in the same place that Greece and other parts of Southern Europe are. Therefore, there is a need to ensure that the safety and technological framework is of a global standard. When the International Atomic Energy Agency (IAEA) set benchmarks for the nuclear industry, South Africa had serious queries over about 14 of the 17 benchmark dimensions. This implies that South Africa needs to change its focus if it will be taking on a nuclear build programme. The legal framework is in place for nuclear, but there are a few serious gaps in the system.

Firstly, South Africa has a national regulator (National Nuclear Regulator), which is seriously underfunded and under-resourced in terms of personnel and skill. This can be picked up from its own annual reports. Therefore, how does the country take on a huge new additional burden and how can the regulator be trusted to manage it and ensure public safety? These questions are pertinent; South Africa is resourcing the National Nuclear Regulator partly through taxation and industry paying license fees. A potential conflict of interest can be observed, as the National Regulator depends on the expansion of the industry for its financial viability; and secondly, there is no easy solution, no practical solution that South Africa has for the energy crisis.

Nuclear waste disposal does not feature in a number of government policy documents. What is the country going to do with the high nuclear waste? The reactor waste of the Koeberg Nuclear Power Station has been stored in adjacent ponds for 30 odd years. What would be done when this kind of waste is multiplied by the nuclear build programme. This will place South African citizens in a vulnerable position. The pile of the level (?) waste stored in ponds next to reactors was part of the problem at the Fukushima accident.

South Africa has a history of uranium mining which, however, was dismantled. Under the apartheid system, uranium mining was done to service the weapons that were being built, and this consisted of enrichment plants, conversion plants, and fuel fabrication plants. Also, South Africa did not reach the stage of processing the uranium. The legacy of mining in Johannesburg means that the city is probably the most radioactive city in Africa. This is because the mining waste was dumped into the environment in the form of tailings or mine dumps. 1,7 million people in Johannesburg live adjacent to those mine dumps. They grow crops, use the mine dumps for various purposes, including housing, but they have never been informed of the radioactivity of the dumps or the toxicity thereof. It is a major problem, because people do not know about it and yet it is affecting their health and their livelihoods. South Africa has to evaluate the legacy of nuclear programmes when looking at taking on further nuclear commitments.

In terms of shale gas, there are uncertainties, which include whether the resource is viable and under what circumstances companies would be prepared to invest in the viability of shale gas. Sasol is amongst the oil companies that are leaving South African shale gas alone, although they had submitted bids for exploration. Similarly, Shell made a formal announcement that it had pulled its shale gas team out of South Africa on the 30th of July, and back to the Netherlands. These companies were two of the major applicants. Now they are constrained not only by the slack nature of the general oil price, but also by the question of viability of the resource. There is no infrastructure for getting that resource to where it is needed; there is no clear indication of whether it will be used for electricity or other purposes; and it is not clear who will build that infrastructure and who will pay for the externalities-associated contamination, such as the failure of agriculture in the Karoo region.

It is almost certain that very few Karoo residents will get the jobs and very few South Africans will get active jobs in the drilling, because oil companies intend to use foreign teams to do the more skilled work. A question of whether South Africa will sacrifice the Karoo in terms of ecological sacrifice for this development needs to be answered. Who will be developed, if people are not getting jobs? If the existing jobs are eroded by the closure of farms due to contamination and pollution in the area. One of the challenges for South Africa surrounding shale gas, is that there is no law governing it. The gas law only covers the distribution of gas, not the production of gas. This is found in the Minerals Act, the Minerals and Petroleum Resources Development Act (MPRDA). The Act was written in 2002 before the advent of shale gas.

The latest amendments to the Act abolished the Regulator for petroleum and gas and said that regulation should be undertaken by regional offices of the Department of Mineral Resources. This a challenge for the system, as the regulator's function is diluted to the provisional level. It means there will be competing needs of different teams for different expertise instead of building one solid team with expertise. It will also open up a race to the bottom in terms of global standard regulation. Does South Africa need a separate Act for gas and shale gas? For shale gas, there is sufficient time for a public debate to take place, while the government decides the way forward. The open discussion must also involve the people of the Karoo, who should have some kind of stake in the development; and also who need to decide how they want to take shale gas forward. They also need to be part of the decision-making body on whether South Africa (Karoo) should adopt the technology at all, or whether government should think of other ways surrounding a fossil fuel future.

2.2 ECONOMICS OF NUCLEAR ENERGY AND TECHNOLOGIES

Panelist: Mr. Tom Harris

The presentation will focus on why South Africa should consider a nuclear programme. It will tackle some of the issues facing the country, the constraints and attempts to develop a framework which can be used to assess whether nuclear energy is a viable solution for South Africa. South Africa is facing a number of challenges, such as the immediate energy shortages. Eskom is currently struggling to keep up with the demand and this has affected the economy. South Africa has slow economic growth, a challenge the World Bank and the IMF have both cited, and energy shortage is amongst other key barriers to growth. Other constraints, are that South Africa has committed itself to reduce emissions and therefore solutions to energy challenges need to take this into account. There is also a need to consider that the country has an aging generation capacity, and therefore solutions need to take into consideration what capacity is needed in the future. Finally, there is a need to take into account Eskom's current financial position.

The South African energy solution needs to be affordable, environmentally friendly and maximise the country's economic development potential. A nuclear technology solution will be evaluated through the suggested framework to see if it measures up to affordability, environmental friendliness and economic development. So, is the argument for nuclear energy driven by a question of affordability: When observing nuclear discussions, the proponents say yes, nuclear energy is affordable because the operating costs for it are extremely low. However, affordability cannot look at operating costs alone when dealing with energy solutions. The construction costs are the key determinant of the final costs. The electricity prices will be used to pay back both the construction costs and operating costs. This is where nuclear technology becomes expensive.

The IRP (update) states that the capital cost is 6,500 US dollars per kilowatt installed. Therefore, it does not make sense to invest in nuclear energy. South Africa must rather allocate the capacity that has been allocated to nuclear energy to gas technology and renewable technology. When comparing the 6,500 US dollars to recent builds in the UK, the contract concluded with a cost of about 7,900 kilowatts per unit, per kilowatt installed which is above the 6,500 kilowatts, per kilowatt mark. There were cost overruns, and this is the case with a number of constructions. For example, in a similar case, about 7,000 dollars per kilowatt was installed in the Packs plant in Hungary. Nuclear energy is not as affordable as many would like to believe or as the proponents would like to sell it. There is a need to look beyond the argument of low operating cost and consider capital costs. Taking into consideration that financing the nuclear build would be a key issue in South Africa; wind, solar and gas technology is far below the cost of nuclear energy when taking the capital cost and operation cost into consideration.

The question of construction costs is particularly relevant because construction costs cannot be easily managed or excluded, whereas the operating costs can. Nuclear technology forecasts make assumptions that the plant can last up to 30, 40, 50, 60 years. However, research shows that many nuclear plants have been retired, before this time, across the world. There is an argument that nuclear plants can be constructed rapidly. However, assessments of constructing nuclear plants reveal that there is a massive increase in the variance of projects over the last decade or over the last two decades. Since 2004, across a number of projects, the average completion rate per project is about 10 years. This implies that, for South Africa, if construction starts today, the first unit will only come online 2025. In East Asian projects, they have managed to be built quickly, but outside of Asia little success in terms of rapid timeline completion has been observed.

Asian builds have achieved this because certain safety concerns or certain safety requirements have been bypassed. South African cannot be naive and assume they will not experience similar delays, especially when assessing what has already happened with the constructions at Medupi and Kusile. Nuclear technology is advanced and it requires certain safety standards to be met. If nuclear power stations do take South Africa the average time of ten years to build, it will not help the country in reaching the targets that are being set for 2025. The second consideration an energy solution needs to meet is environmental friendliness. When assessing nuclear environmental considerations: nuclear energy is more emission friendly than our other options such as coal and gas. However, when looking at the environmental consideration beyond emissions, that is, take into consideration nuclear disaster, leakage, cost of disposing of nuclear waste, it is difficult to conclude that nuclear is more environmentally friendly than coal and gas. It has been mentioned that South Africa has not entirely figured out yet how to dispose of its nuclear waste. Thirdly, for the broader economic context, there is no doubt that nuclear power will add jobs, thus, adding value to our economy. However, given the size of the investment, could it not be invested elsewhere in terms of job creation.

Finally, South Africa needs to think about how the question of nuclear energy is aligned with the IRP. There is a need to avoid large scale, long term projects that are going to be costly for the country. There is also a need to assess how nuclear energy is pushing South Africa away from the current trends that are moving towards privatisation. Privatisation seems to be a good move for the energy sector. Furthermore, there is a need to think about the financing risk that could result from this nuclear build. Eskom has been downgraded. South Africa's bonds have been downgraded and most of the credit rating agencies view nuclear projects as credit negative. The discussions on the alternative solutions to nuclear energy need to take place. The option that makes the most sense to nuclear energy would be to invest in a more diverse portfolio of gas and renewables. In conclusion, the case for nuclear power is not clear and nuclear energy is not affordable, does not have a rapid timeline for construction, and will not solve South Africa's energy shortage in the short term. Therefore, what is the best solution for South Africa at this moment.

2.3 DEVELOPMENT OF THE GAS MARKET IN SOUTH AFRICA: MS WRENELLE STANDER

Panelist: Ms Wrenelle Stander

Sasol

The presentation will reflect on a case study, which was a successful public private partnership in South African's gas industry. The presentation also gives a brief background on Sasol. Sasol is a proudly South African company that employs over 32,000 people in 37 countries around the world. It owns a technology that is able to convert input resources into a whole range of different higher value products. South Africa is the cornerstone of Sasol's operations and produces about 8 billion litres of liquid fuels every year. This satisfies 25% of South Africa's liquid fuels demand. Sasol also produces 3.5 million tonnes of chemicals which are used locally and abroad. Sasol generates 1,000 megawatts of electricity, which takes care of 70% of its own needs. This ultimately reduces the pressure on the grid.

The development of the gas industry started 10 years ago from 50 million gigajoules to over 170 million gigajoules, through strong in-country partnerships. Sasol pioneered the gas monetisation options in Southern Africa, by taking stranded gas in Mozambique. What was important in the development of this industry was the strategic partnerships that were created. Currently, Sasol has over 400 industrial customers in South Africa within the gas industry. Gas has a whole range of applications, such as a heat source, as a chemical feedstock (gas to chemicals), as a supplementary feedstock to coal and to a liquid process (gas to liquid). There is also an emerging re-sellers' market: companies like Spring Lights Gas and Egoli Gas. Springs Lights sells to other big industrial customers, and Egoli Gas reticulates to households. The household use of gas in South Africa is still very low, so the gas market is primarily focused on industrial use. Sasol is increasingly looking at the gas to power market.

Ongoing investment along the gas value chain has enabled growth in Mozambique and in the South African markets. Currently South Africa has a gas to power facility in Sasolburg and in Ressano Garcia. The investments have been spearheaded by Sasol together with government, E Gas, and other government agencies. Sasol had to put in place a 165 kilometre pipeline between Mozambique and South Africa, one of its investments. This does not take into account the 2,500 kilometre network that currently exists in South Africa. These investments were made in order to increase the capacity of the line, as the volumes have increased quite significantly over the 10 year period. In addition, compressions have been installed along the pipeline; and Sasol has also commissioned the first loop line, and a second loop line has been approved. A third loop line would be built if demand is there.

The enabling regulatory environment and other energy related regulatory environments have allowed the industry to development. However, it is imperative that South Africa attracts or puts in place incentives for companies and governments to invest in infrastructure development in the gas industry. Gas monetisation does provide the basis for a strong and sustainable economy. In conclusion, there is going to be a need for cross border regulation (Mozambique and South Africa). Also, now that South Africa has a developed and much bigger gas market, investment and infrastructure, provision of gas in a non-discriminatory basis to customers and of course what? is needed for the promotion of competitive markets.

2.4 QUESTIONABLE NUCLEAR BUILD COMMITMENT NOT ALIGNED WITH THE IRP AND NDP:

Panelist: Ms Ellen Davies

World Wide Fund

The presentation will look into South Africa's planned nuclear build in light of the warnings made in the National Development Plan and IRP 2010 update about the prohibitive costs thereof. Placing the presentation into the context of South Africa: The current economic condition is not conducive. It is important to note that the whole world is facing similar challenges. Therefore, South Africans need not be negative about their country. Nevertheless, it does not detract from the fact that investing billions or even a trillions of Rands on nuclear energy in the current economic conditions will not make sense.

The state of our economy includes a stagnant GDP growth, a struggling manufacturing sector, and a domestic electricity shortage, amongst others. Globally, the commodity boom is coming to an end and this will have major implications for South Africa's economy. Since it has a dependence on mineral extraction, South Africa also has a high unemployment rate. In the first quarter of 2015, unemployment reached a high of 26.4, depending on how unemployment is defined; there is a possibility that the figure could be much higher. Eskom is struggling with increasing electricity tariffs and rolling blackouts. Mrs Neva Magetla from TIPS calculated the average tariff increase from 2008 to 2014 based on Eskom's historical data. It reveals that in the residential field, there has been more than a 40% electricity tariff increase since 2008. This has caused a lot of unhappiness amongst South Africans, causing social unrest in some pockets of society. Load-shedding has had massive implications on the economy together with other indicators that have constrained the fiscus. The South African economy also has a very small tax base, amongst others.

In spite of this, why does the government believe that South Africa can afford a nuclear build programme? How is South Africa going to pay for it? The National Development Plan (NDP) and the IRP 2010 (update) have warned about costs, although the warnings are worded very diplomatically. The NDP emphasises the prohibitive costs of nuclear build and the need for a thorough investigation into the financial viability thereof. It warns "poor investment decisions commandeer the State's financial resources and hinder our important investments, ultimately constraining economic growth"; and cautions that the timing or desirability of nuclear power needs to be thoroughly thought through. The IRP 2010 (update), which has not been approved by cabinet, revised some of the demand projections and assumptions. It revised the demand projections down from 454 terawatt hours to 345 to 416 terawatt hours by 2030 and, based on these revised projections, it advises that no nuclear energy will be required before 2025 or even 2035 for the lower demand scenario.

The IRP (update) advises that the nuclear decision should be delayed so as not to commit to a technology that might be redundant in the future, if the demand projections do not materialise. It warns against long range life scale investment commitment decisions and recommends flexible decision making, based on regular or even annual IRP updates. However, government seems not to be listening to these recommendations. What is the nuclear build programme going to cost South Africa; although levelised costs are important in comparing technologies as stated by the previous speakers. Capital cost is also very important because it is a hidden cost that South Africans will have to pay. Nuclear power is the second most expensive technology in the fleet (IRP 2010). The IRP (update) states that the cost per terawatt hour will be R46,841. If one of the objectives is to provide affordable electricity, nuclear power is not the solution.

Furthermore, international experience with large energy infrastructure bills and South Africa's own current experience with Medupi and Kusile, has shown that there is a potential for delays and cost overruns. For example, the EDF's flammable plant in France has risen from an initial estimation of 3 billion to 6 billion Euros and its expected operational date has been delayed for four years; Britain's Hinckley C nuclear plant which is currently under construction has increased in cost from an initial 16 billion Pounds to an estimated 34 billion Pounds today; the Medupi and Kusile plants in South Africa have also been delayed. These two plants were expected to provide the country with 9,600 megawatt of electricity by 2018. However, they will only be on line by 2021. The cost overruns at Medupi amount to a staggering

R13 billion, many have estimated the figure to be higher. So, if the expected delays and cost overruns are factored into the nuclear build programme; South Africa is expected to pay around R1,4 trillion.

This exercise was conducted by the Mail & Guardian nuclear expert, Steve Thomas, using six ERP nuclear reactors. In research conducted by Dr Bakatula from the United Arab Emirates Regulation and Supervision Bureau (presented in 2014 at the World Nuclear Association Symposium), it was found that the construction risks pose the biggest challenges for nuclear investment. The research found that a two year delay in a nuclear plant construction project, with investment at an interest rate of 10% (in North America) can add as much as 75% to overnight costs. In conclusion, the bottom line is that, irrespective of whether or not one is for nuclear technology, it is just too costly for South Africa

2.5 ENVIRONMENTAL EFFECTS OF SHALE GAS FRACKING IN THE USA, BOTSWANA & SA

Panelist: Mr Jeffrey Barbee

Alliance Earth

It is important that these types of community discussions are held, especially involving people from industry. What is important from these discussions are the outcomes that will inform the future and that the decisions from this discussion are informed by the best science. The presenter had 15 years of experience in shale and coal bed methane gas, investigating the science behind it. The presentation touched on the experiences captured from the extraction of shale and coal bed methane gas in rural Western Colorado, United State of America; contrasting this to what will happen to South Africa, if shale and coal bed methane gas exploration is implemented. It should concern South Africans that shale and coal bed methane gas, are coming to the Karoo and places like the Kalahari in Botswana, especially when taking into consideration the experiences from Western Colorado. The promises that are made to the South African people are similar to those made in Colorado; and the people that suffer the most from these developments are the poor.

There has been communication circulated, indicating that gas is better than coal for the climate. This is misinformation, as the leakages discovered in the United State by the National Oceanic and Atmospheric Administration scientists, show that between 6% and 18% of the produced gas leaks straight into the atmosphere. The shale and coal bed methane gas industry is unable to prevent these leakages because of serious defects with the process. These defects have not been well publicised, and this could be due to the association between the United States government and the big oil corporations. In 2005, the Bush Cheney Energy Law exempted hydraulic fracturing from being covered by the community right to know act, the EPA, the clean water act, and the superfund programme. The defects data, therefore, never entered the public domain due to the exemption, until recently. This was as a result of the tightening of the rules under the Obama administration. The industry-published data for the past 20 years has been found defective by every peer reviewed scientific paper.

Botswana and South Africa are situated on a huge coal bed. Southern Africa is then looked on by governments with interest for large-scale gas extraction. In Southern African countries, there is no oversight mechanism for this. New regulations that were released in South Africa in June, are absolutely inadequate in protecting communities. The regulation has omitted to include an independent authority to monitor the drill sites individually, thus ensuring that the shale gas industry does not pollute the communities. This is a serious omission from a gazetted rule that is supposed to protect South Africans. The shale gas industry will not provide this oversight unless compelled by government. Sasol is looking at 82,000 square kilometres in Botswana, and this was discovered about three years ago. However, fracking has been taking place in Botswana for eight years. In May 2015, a visit was undertaken to the Central Kalahari Game Reserve unmanned gas holes. Sasol indicated that they were not required by the current legislation in Botswana to provide any environmental management programme over their drill sites.

It is important to note that coal bed methane requires fracking and is closer to the water table. It is much more dangerous for the environment than shale gas. However, both of these gases are not well regulated. It is commended that the initiative taken by the Canadian Government in explaining the leakages of the gas out of the ground. When drilling kilometres down into the earth, with a massive drill, rocks are cracked. There is a challenge with oversight offered at drilling sites. Fracking activities in the winter in the United States of America, have created a layer of smog above the communities. The poor water quality and the escaping deadly gasses (benzene, ethylene, toluene, Xylene, and about 15% of the methane) coming out of the community's wells, gave rise to a toxic blend of endocrine disrupting chemicals. The effect of these chemicals on the human body is massive, it can change a woman's ? who is not yet conceived how?. South Africans cannot allow these types of activities to occur near their communities. Also, South Africans cannot allow the shale and coal bed methane gas companies to write regulations, especially those gazetted last month; and lastly South Africa does not need to make the same mistake as Colorado.

2.6 ECONOMICS OF RENEWABLE ENERGY (SOLAR AND WIND)

Panelist: Professor Tobias Bischof-Niemz

Council for Scientific and Industrial Research (CSIR)

The presentation will be about the study that we conducted at the CSIR Energy Centre. The study quantifies the effects of renewables that were introduced into the South African energy system in 2014. It looks beyond the levelised cost of energy comparisons, it looks at the effect of introducing renewables into the system, focusing on the measurable direct effects. The background to the study highlights the cost of development of renewables in the last three and half years. The Department of Energy has a process in place for getting Independent Power Producers (IPP) to install wind and solar PV. The first bid window was in November 2011. At this time PV was costed at R3,40 per kilowatt hour in today's money and wind at R1,40. PV is expensive, but two and a half years later (2014), PV stands at 80 cents and wind stands at 60 cents per kilowatt hour.

This is a remarkable decline, especially on the PV side. The significant cost decrease could be attributed to a combination of local learning (how to install large scale PV systems) and global learning on the PV technology. Importantly, the cost is underwritten by a power purchase agreement by both Eskom and the IPPs. Therefore, these are indisputable costs paid to the IPP. The 80 cents per kilowatt hour is what South Africans would be paying in the next 20 years for energy produced from PV. In South Africa, both wind and solar power are the cheapest new build options, and this is remarkable because South Africa is the first country globally, where solar and wind technologies break even. The average load factor of the online wind turbines is beyond the 30% average. The German and Spanish system has an averaged load factor of between 17% and 20%.

In 2014 we had a significant fleet of wind and PV products coming online and, during the year they produced more than two terawatt hours of electricity. This means that within a year 1% of the total electricity production was ramped up, to come from wind and PV. The open cycle gas turbines driven by diesel, produced 3.6 terawatt hours last year. This is miniscule compared to coal production, and is 1.5% of the total electricity generation. Diesel is the most expensive fuel, and therefore, diesel turbines should run at half a terawatt hour. The 3.6 terawatt hours shows an indication that the system is constrained. This is why Eskom spends a lot of money, purchasing diesel for the 3.6 terawatt hours. In January last year, there was almost nothing in terms of megawatts from wind and solar; by December 340 gigawatt hours a month of energy was produced, from more than 30 individual wind and PV projects. Therefore, it was in December when South Africa reached its full capacity.

When observing the South African electricity generation profile, using the average diurnal course, from January to December, what the average day looks like for every month can be observed. It provides the ability to observe that nuclear power at a detailed level, for example, in March, April and May, Koeberg had one unit out for maintenance. It shows the large stack of coal supplying the majority of the electricity needed; it also shows the OCTGs in the summer months running throughout the day. South Africa has a peak problem, it has an energy problem (this can be observed too). There is not enough energy in the system and the energy is missing the entire day. This conclusion is made because the OCTGs are running the entire day, not in the evening (the peak) as designed.

Looking at wind and PV coming into the grid, it can be observed how much PV is producing during the day, and similarly with the wind. These renewable energy sources are both producing electricity over 24 hours in a fluctuating manner. The data used is actual data provided by Eskom. The research team developed a simple methodology, which was very conservative. It was conservative in the sense that the team underestimated the value of renewables so as to ensure absolute certainty in the statements or conclusion that came out. In the methodology, an hour of the year's renewables can have one out of three effects, namely, (1) either they avoid the burning of coal, (2) they avoid burning of diesel or, (3) they prevent the un-served energy which is a customer load curtailment.

For example, on the 17th of October 2014, the system was relatively unconstrained. The diesel turbine was not running, the coal fleet was providing the entire demand. However, the team was unable to ascertain how close the system was to switching on the diesel turbines. Despite this, it is assumed that the diesel turbines would have been turned on if there was no wind and PV energy. On the 19th of June last year, at night the system was unconstrained, and this effectively saved coal. Wind energy was utilised during the night, effectively, and during the day, wind and the PV energy were used. This saved the diesel turbines as they were switched off, and would have had to run longer. Thus saving diesel fuel in these hours. The 16th of December 2014 was a bad day, as relatively high amounts of diesel were burnt that day, between nine o'clock and one o'clock. The diesel turbines were running at their maximum capacity, 2,4 gigawatts.

The following conclusions were reached by the team, 1,000 gigawatt hours from wind replaced roughly half-half coal and diesel burn; similarly PV replaced also roughly half-half coal and diesel burn. This avoided the burning of coal to produce 1,120 gigawatt hours of electricity and another 1,000 gigawatt hours of diesel. Also, the diesel fleet would have had to produce 4,6 terawatt hours without the renewables. In addition, South Africa avoided 20 gigawatt hours of the so called un-served energy, and curtailment of customer load. When placing a price tag, and this price tag comes from Eskom's financial statements, it is clear that the country saved R3.6 billion last year from using wind and solar energy. When adding another additional economic value, such as avoiding customer load shedding, the country saved R1.7 billion during 117 hours. This makes a saving of R5.3 billion in total, and when subtracting R 4.5 billion, as tariff payments to the independent power producers, the economy had a net benefit of R800 million in 2014.

3. Plenary Discussion Session: Question and Answers

A question was raised on embedding innovation into the system of production and development and the failure of protecting and developing one's technology. It was suggested that there are challenges in completely embedding science, engineering, technology and innovation into the country's national system; however, the UK government is making progress. In order to embed innovation into a system, political leadership is required. A good example in the UK is the rolling out of the smart grid and smart meters to citizens. In terms of failure to protect one's technology, there are two reasons, firstly an underestimation of the financial implications for taking a product from a prototype stage to the commercialisation stage. In the case of South Africa's Joule car, the country spent approximately R50 million or R60 million on the prototype. The prototype is working. However, an international partner like Mercedes Benz or BMW was needed for the credibility and viability of Joule.

There is also a technology valley of death, where public sector funding is available and significant enough to overcome some technical risk elements; however, the private sector is unwilling to take the risk at the stage of commercialisation. The second factor is having the ability to protect your innovation after it is developed. South Africa lost its lithium ion technology, which was developed by the CSIR, to Japan. Part of the challenge was capacity, and the language barrier. South Africa sent one lawyer from the CSIR, who walked into a room full of Japanese lawyers. The lawyers indicated that they could not speak English, and the South African lawyer needed a translator. The translator came at a hefty cost and eventually through frustrations the discussions ended and South Africa lost the technology.

A second question on cutting down wind subsidies in the UK revealed that the UK government is committed to wind technology as one of its power sources. However, it was suggested that the cutting down of subsidies was based mainly on the politics of subsidies rather than on science. The science has shown that a balance needs to be met between onshore and offshore wind. The UK has more of the offshore wind, which is more reliable, but technologically challenging because the water is highly corrosive. A third question on nuclear energy beliefs in the UK, revealed that the people's attitudes towards nuclear energy is shaped by their values rather than by the science. Analysis of the harm of nuclear technologies to human beings revealed that nuclear power has far less harm to humans than mining fossil fuels.

The nuclear disasters observed from Chernobyl, Three Mile Island and Fukushima held a relatively small amount of harm. Secondly, the safety record of nuclear provision of power is higher than fossil fuels. Its efficiency in terms of waste generation is completely transformed. Therefore, the public discourse in the nuclear field centres around the economics rather than attitudes on radiation. In conclusion, two discussions should be taking place surrounding nuclear power. Firstly, the science discussion and secondly, the values discussion. In conclusion, it was suggested that municipalities can provide Wi-Fi to households through the smart meter technology, as an alternative for revenue generation. A suggestion from the last question on the funding model for municipalities. Also, it was commented that municipalities recognise the diminishing revenue sourced from electricity.

4. Panel Discussion Session: Question and Answers

4.1 THE NUCLEAR TECHNOLOGY DISCUSSION

A request was made to clarify why different presentations on various energy options reached different conclusions on the cost of nuclear power. The panellist responded by indicating that the differences were based on the assumptions made regarding the cost. The panelists who placed nuclear technology on the higher cost based their assumptions on construction delays and cost overruns. These assumptions were based on evidence seen on other nuclear power stations built across the globe. The panelists that placed nuclear power on the lower side, included other externality costs, such as the environmental impact factors (such as costs, water usage and job creation). The nuclear technology cost came lower when the environmental impact factors were added.

In the nuclear technology discussion, a comment was raised that nuclear technology had a carbon footprint, contrary to popular belief. The footprint can be observed through the nuclear fuel value chain. It starts from mining through to milling of the mineral, the enrichment of uranium, the deconstruction or decommissioning of that reactor, and the treating of nuclear waste. In addition, the transportation of the minerals (uranium) to be enriched elsewhere. It was suggested that a distinction should be made between the successes achieved in China towards nuclear build programmes versus the rest of the world. The Chinese capacity for nuclear construction is enhanced by the fact that China has been building nuclear plants for a long time. This is not the case for South Africa, and therefore there is a huge risk for the construction, as the capacity to support this development is limited or lacking. Government has decided to build nuclear programmes to meet its low carbon trajectories. In addition, the future energy mix comprises all the various energy technologies.

A comment suggested that the difficulty and sophistication in building a nuclear plant was at 12 for South Africa, on a scale of 1 to 17. The country's capability to support the nuclear build programme was also raised, indicating that the country was battling with building coal power stations: although South Africa has been building coal power stations for a long time (Medupi and Kusile construction challenges). A request to government to consider being transparent around the costs of the nuclear build programme was made; indicating that the cost suggested in the public space was making South Africans worry and sceptical.

A number of issues were raised on South Africa's ability to manage the nuclear waste. It was indicated that nuclear waste management can be divided into the three categories, and all three are not properly managed in the country. Firstly the mining waste, which affects the water basin. The second category is the reactor waste, which has two forms; the first is the low and intermediate level waste. South Africa built a depository for it in Namaqualand without consulting the people and this waste includes the Koeberg workers' clothing and contaminated components of the power station. This waste is buried in drums in the desert and that facility was managed by the Waste Management Institute, before that it was managed by NECSA, and before that, it was the Atomic Energy Board.

The second form is the high level waste, which is the waste coming out of the reactor. A solution has not been found for this waste, it is buried in ponds around the reactor. This is a normal thing to do to cool off the spent fuel before it is moved to its final storage site. The Koeberg nuclear plant has been storing this high level waste in the ponds for decades. The South African national waste management, nuclear waste management policy has no deposit plan for high level waste, and this becomes worrisome for the upcoming nuclear build programme. It was indicated that the South African government has not taken any steps towards regulating the nuclear waste. However, it is trying to get the IAEA to look into how South Africa is managing its nuclear industry.

4.2 THE "GAS" DISCUSSION

A similar question was raised on why another panelist recommended gas and others caution against it. A response indicated that the panelists were not comparing the same types of gases. The panelist that cautioned against gas development in South Africa was speaking on shale gas; whereas the panelist that recommended gas was speaking about conventional gas. Shale gas was said to be bad for the environment citing health related issues from the methane gas leaks, and poor monitoring by the industry and government. Hydraulic fracturing for shale gas requires huge numbers of gas wells, up to thousands to drilled, thus difficult to monitor.

A comment was made that South Africa does not have a shale gas industry yet, and therefore the supporting infrastructure is not available. Shale gas development will thus come with a huge infrastructural cost, and this has not been entered into the cost for developing a shale gas industry. Also, the external costs of shale gas include the potential failure of agriculture in the Karoo. If the shale gas industry contaminates the scarce underground water in the Karoo, agriculture will be threatened; and also the dust particles that come with the development of a shale gas industry, can lead to the death of the wool and mutton markets. Sheep do not eat dusty crops or vegetation. When agriculture fails, the people that work in agriculture will lose their livelihood.

On the other hand, a conventional gas well requires far less funding and is well monitored. A comment was made that Sasol ensures that the amount of conventional gas that leaks into the atmosphere is monitored and stands at less than 0.7%. As a preventative strategy, Sasol uses steel pipelines that are covered by three coatings of HDPE. Additionally, regular cathodic protection checks are conducted, and the pipeline has a technology that monitors changes in pressure using a 24 hour control system. Also monitoring on the ground is conducted by daily, weekly and monthly patrols.

4.3 THE RENEWABLE ENERGY DISCUSSION

A comment was made that South Africa is new to the renewable energy fields, such as solar PV and wind. These two are the cheapest technologies per kilowatt hour, and the cheapest supplier options to build. This is based on actual tariffs signed by independent power producers and not assumption. However, the challenge with solar and wind energy is that they are intermittent and fluctuating. Two solutions were suggested to counter this, which are by introducing renewable energy into the system without really feeling the difference. This is what is happening in South Africa at the moment. The benefit can be felt financially but not technically. The second solution is to build a horizontal stacking of different energy supply sources, catering for a larger penetration of renewable energy into the system. In the horizontal stacking the required base load for the country does not change, but the supply sources change.

Scenarios were suggested, with 70% of energy capacity coming from both wind and PV. The remaining 30% gap, when there is no wind or sun is filled with a flexible source of energy (economically) that can be technically ramped up and down very quickly. Economically flexible means it should not be costly to run. It should be easy to shut it down without cost to the system. Gas meets both the technical and economical flexibility, as it is capital light and fuel heavy which makes it flexible from an economical perspective. Instead of coal, which is capital heavy and fuel light. However, gas is expensive at R1, 46 per kilowatt hour. It was indicated that gas and renewables as an energy mix are much cheaper than coal.

4.4 GENERAL ENERGY DISCUSSION

A comment was made that globally, there is a need to make better energy choices as the consequences of bad energy choices are affecting the global community. The Syrian conflict has a direct basis in climate change resulting from the collapse of the farming economy in the Euphrates valley. The CSIR has proven that Southern Africa is going to face twice the rate of warming as the rest of the planet. The South African government was applauded on work done in the renewable energy field. The bidding option for renewables against the dominant paradigm of a feeding tariff was hailed as an innovation. South Africa is said to be realising the renewable energy benefits and these are quantifiable.

A comment was made that the discussion has been heavily focused on the supply side of energy, with little on the demand side. It was suggested that there is a systematically limited capacity on the demand side, with local municipalities the worst culprit. The metropolitan councils seem to be well run, but the local governments are in a chaotic situation. A policy incentivising was recommended for domestic water heating driven by solar energy. It commented that Eskom has given away approximately 10 million water heaters; however, 50 million free water heaters was the number suggested that could have saved South Africa from building two power stations. It was mentioned that some Johannesburg suburbs were going off the grid, namely, Parktown, Pankhurst and Constantia. In response, it was suggested that going off the grid is not advisable for South Africa. This will not benefit the country, and staying on the grid will. A suggestion was made to incentivise the citizens to give back the excess electricity generated from their renewables to the grid, and this cannot happen if everyone leaves the grid. Secondly, the grid is interconnected spanning from east to west, therefore, people of Durban will benefit from the last sunray captured in Cape Town.

Similarly, energy efficiency was neglected in the items discussed. It was mentioned that cost is the single greatest driving force for energy efficiency. There is a need to develop a projected energy demand outlook for the next 20 to 30 years. When comparing South Africa to Australia, and this comparison was made because of the similarity in structure of the economy of the two countries, South Africa is amongst the least efficient countries in the world in terms of converting kilowatt hours into GDP; it takes approximately twice as much to convert energy into a percentage of GDP than Australia. Australian GDP per capita is four times higher than South African.

5. Closing Remarks

Dr Velaphi Msimang (Programme Director)

Mapungubwe Institute for Strategic Reflection (MISTRA)

The Programme Director thanked the panelists for helping the participants to better understand the dynamics and issues that need to be factored when considering nuclear power and shale gas; and thanked the participants for their inputs into the discussions. It was indicated that the round table discussion was an informative discussion, and did not answer all the questions that the participants had; however, it was clear from the discussion that it was not just science that influences the policy on energy.

There are many other considerations, both negative and positive. One key message that came out of the discussion is flexibility in the energy system. As a result, our planning needs to factor in uncertainties, and this means prioritising flexibility. It was also clear that the discussions could not address nuclear and hydraulic shale in isolation of renewables, and also conventional gas. The energy discourse continues, and MISTRA was open to partnering with all the various stakeholders in this area.

ANNEXURE A

Programme Agenda

ROUNDTABLE ON ENERGY CHOICE

VENUE: SHERATON HOTEL, ARCADIA, PRETORIA

PROGRAMME DIRECTOR: DR VELAPHI MSIMANG

REGISTRATION AND MORNING TEA 08H00

Agenda	Speaker	Time
Words of welcome and Introduction	Mr Joel Netshitenzhe (Executive Director, MISTRA)	08h30–08h40
Keynote Speaker	Sir Mark Walport (Chief Scientific Adviser, United Kingdom Government)	08h40–08h50
Energy Technologies	Mr Kevin Nassiep (NACI Council Member)	08h50-09h00
Q & A (40 minutes)		
Opening Remarks	Ms Tshilidzi Ramuedzisi (Chief Director: Planning, Department of Energy)	09h40–09h50
TEA BREAK		
10h00 – 12h20 **PANEL DISCUSSION** The nuclear and shale gas policy orientation and implications (including relevance to the IRP and NDP).		

Agenda	Time
Dr David Fig(Biowatch SA) - Legal, environmental and social ramifications of fracking and nuclear	10h00-10h10
Mr Tom Harris– Economics of Nuclear Energy and Technologies	10h10-10h20
Ms Wrenelle Stander(Sasol)– Development of the gas market in South Africa	10h20-10h30
Ms Ellen Davies(WWF) – Questionable nuclear build commitment, not aligned with the IRP and NDP	10h30-10h40
TEA BREAK	10h40-10h50
Mr Jeffrey Barbee(Alliance Earth) - Environmental effects of shale gas fracking in the USA, Botswana and South Africa	10h50-11h00
Dr(Professor) Tobias Bischof-Niemz (CSIR) – Economics of Renewable Energy (solar and wind)	11h00-11h10
Q&A Discussion (60 minutes)	11h10-12h10
Closing Remarks (Dr Velaphi Msimang)	12h10-12:20
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