

**A framework for building confidence in nuclear
power for the labour Union environment of
South Africa**

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CHAPTER ONE

INTRODUCTION

1.1 Background

Electricity demand worldwide is expected to increase significantly until 2030, to the extent that it could double from 2000 to 2030. This increase in demand is due mainly to accelerated economic growth in developing countries and increasing global population (BIROL, 2004; WORLD NUCLEAR ASSOCIATION, 2001). In order to keep pace with this growing electricity demand, it is imperative that significant attention be given to substantially increasing the world's electricity generation output.

Coal-generated power is currently the largest source of electricity generation in the world, supplying 41% of electricity worldwide (WORLD COAL INSTITUTE, 2010). However, the high emission of CO₂, *inter alia*, into the environment from coal-fired power plants is cause for concern globally. Hence the need to consider expanding other power generation technologies which have a reduced environmental impact, such as nuclear, hydro, and solar power. All factors must be considered when deciding which technology to implement to ensure the growing demand is met without introducing further environmental, safety, cost, political and unemployment problems.

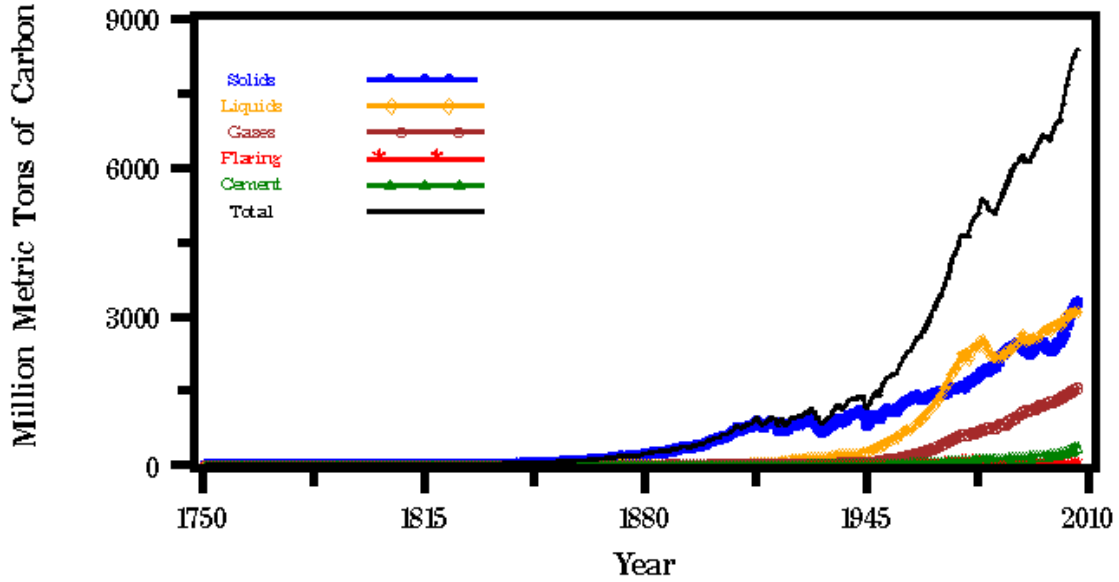
This study focused on nuclear energy and the level of acceptance of this technology by the labour unions in South Africa. In order to establish the possible reasons for the labour unions opposing nuclear power, their views on the impact of nuclear energy had to be investigated holistically. The five main areas of research which were considered in this study were: environmental impact, safety, cost, political influence, and job creation. These are elaborated on in the rest of section 1.1.

1.1.1 Environmental impact

The presence of carbon dioxide (CO₂) and other greenhouse gases in the atmosphere is a major concern because these gases form an insulated envelope around the earth, resulting in global warming. After the industrial revolution there was an increase in the production of greenhouse gases. A high percentage of CO₂ emission was from the burning of fossil fuels and a smaller portion from cement production as evident from Fig 1.1. Global warming has increased the average global temperature by approximately 0.8°C from 1880 to 2000 (NATIONAL GEOGRAPHIC NEWS, 2007), and it is expected to rise between 1.1 and 6.4°C in the 21st century (VAN VUUREN *et al.*, 2008).

The global increase of CO₂ emissions has followed an exponential curve since the industrial revolution, as depicted in Figure 1.1. Of the total CO₂ emissions between 1750 and 2007, 50% occurred in the last thirty years (CARBON DIOXIDE INFORMATION ANALYSIS CENTRE, 2010). This increase of CO₂ emissions has pressurized governments and companies to take steps to reduce their emission rates.

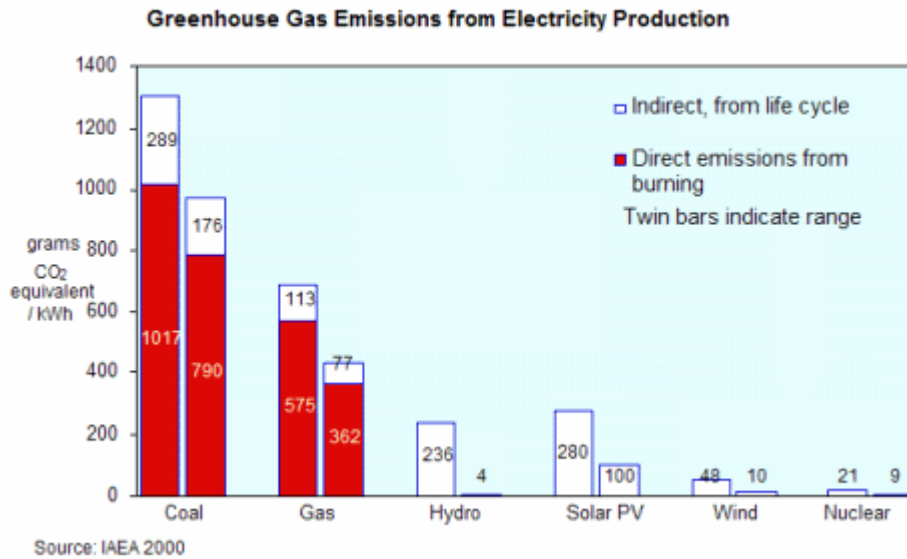
“A carbon footprint is the total amount of CO₂ and other greenhouse gases emitted over the full life cycle of a process or product. It is expressed as grams of CO₂ *equivalent* per kilowatt hour of generation” (PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY, 2006). Electricity generation technologies with a reduced carbon footprint to coal must be considered for sustainable energy solutions of the future, in order to satisfy the growing electricity demand.



Source: (Carbon Dioxide Information Analysis Centre, 2010)

Figure 1.1: Increase in CO₂ emissions from 1750 to 2007 resulting from fossil fuel burning and cement production.

Fossil fuels generate most of their CO₂ directly from electricity generation whereas nuclear energy plants have very low carbon emissions during direct operation, and indirect emissions from the nuclear fuel cycle account for the bulk of its carbon footprint. Technologies that are competitive regarding carbon emissions are nuclear power, and renewable energies such as hydro, wind, and solar power. The comparison of the greenhouse gas emissions of the different technologies is shown in Figure 1.2.



Source: WORLD NUCLEAR ASSOCIATION, 2008

Figure 1.2: Comparison of greenhouse gas emissions with different energy generation technologies

1.1.2 Safety

Safety of the public, and workers in a power plant are critical points to consider when assessing different power generation options. The level of safety can be expressed by the probability of an accident occurring, and the health hazards during normal plant operation. Workers involved in nuclear power plants, and the mining and processing of uranium are exposed to radiation. This radiation exposure must be within allowed limits to prevent any negative health effects on the workers.

The National Nuclear Regulator in South Africa (NNR) has defined radioactive waste as “material that contains or is contaminated with radionuclides at concentrations or activities greater than clearance levels as established by the NNR, and that has no use” (NATIONAL NUCLEAR REGULATOR, 2009).

Radioactive waste emits alpha, beta and gamma radiation which affects genetic cells and the exposure to this radiation must therefore be minimized. The radiation dose is measured in units of Sieverts (Sv). The maximum allowable dose for workers exposed to radiation is 100mSv over a five year period, whereas the radiation dose that can cause symptoms of radiation sickness is 1000mSv over 24 hours (NATIONAL NUCLEAR REGULATORY COMMISSION, 2009).

Table 1.1: Comparison of accident statistics in primary energy production (40% of which is electricity generation)

Fuel	Immediate fatalities: 1970-1992	Who?	Normalized to deaths per TWy* electricity
Coal	6400	workers	342
Natural gas	1200	workers & public	85
Hydro	4000	public	883
Nuclear	31	workers	8

* Basis: per million MWe operating for one year (i.e. about three times world nuclear power capacity), not including plant construction, based on historic data – which is unlikely to represent current safety levels in any of the industries concerned. The data in this column was published in 2001 but is consistent with that from 1996-7, where it is pointed out that the coal total would be about ten times greater if accidents with less than five fatalities were included.

Source: (BALL *et al.*, 1994; HIRSCHBERG, 1996)

Table 1.2: Ionizing radiation from different sources

	Typical ($\mu\text{Sv}/\text{yr}$)	Range
Natural:		
Terrestrial + house: radon	200.0	200-100 000
Terrestrial + house: gamma	600.0	100-1000
Cosmic (at sea level)	300.0	
+20 for every 100m elevation		0-500
Food, drink & body tissue	400.0	100-1000
Total	1500.0 (plus altitude adjustment)	
Artificial:		
From nuclear weapons tests	3.0	
Medical (X-ray, CT etc. average)	370.0	Up to 75 000
From nuclear energy	0.3	
From coal burning	0.1	
From household appliances	0.4	
Total	375	

Source: (WORLD NUCLEAR ASSOCIATION, 2008)

Although tables 1.1 and 1.2 show that nuclear power compares well to other technologies regarding safety, the confidence of the public has been affected by previous accidents such as the Chernobyl accident which had devastating effects. Even though the Three-Mile island accident did not result in any deaths, it also affected the confidence of the public in the safety of nuclear power. This is evident by the fact that no new nuclear power plants were built in America since the accident (STRANAHAN, 2010).

1.1.3 Cost

Cost and efficiency are major factors that are considered when choosing an energy generation technology. Coal, nuclear, and gas generated power prove to be very competitive regarding cost and efficiency (ENERGY INFORMATION ADMINISTRATION, 2009).

Table 1.3: Comparison of electricity costs with the different technologies

Estimated Levelized Cost of New Generation Resources, 2016.

Plant Type	Capacity Factor (%)	U.S. Average Levelized Costs (2008 \$/megawatthour) for Plants Entering Service in 2016				
		Levelized Capital Cost	Fixed O&M	Variable O&M (including fuel)	Transmission Investment	Total System Levelized Cost
Conventional Coal	85	69.2	3.8	23.9	3.6	100.4
Advanced Coal	85	81.2	5.3	20.4	3.6	110.5
Advanced Coal with CCS	85	92.6	6.3	26.4	3.9	129.3
Natural Gas-fired						
Conventional Combined Cycle	87	22.9	1.7	54.9	3.6	83.1
Advanced Combined Cycle	87	22.4	1.6	51.7	3.6	79.3
Advanced CC with CCS	87	43.8	2.7	63.0	3.8	113.3
Conventional Combustion Turbine	30	41.1	4.7	82.9	10.8	139.5
Advanced Combustion Turbine	30	38.5	4.1	70.0	10.8	123.5
Advanced Nuclear	90	94.9	11.7	9.4	3.0	119.0
Wind	34.4	130.5	10.4	0.0	8.4	149.3
Wind – Offshore	39.3	159.9	23.8	0.0	7.4	191.1
Solar PV	21.7	376.8	6.4	0.0	13.0	396.1
Solar Thermal	31.2	224.4	21.8	0.0	10.4	256.6
Geothermal	90	88.0	22.9	0.0	4.8	115.7
Biomass	83	73.3	9.1	24.9	3.8	111.0
Hydro	51.4	103.7	3.5	7.1	5.7	119.9

Source: Energy Information Administration, Annual Energy Outlook 2010, December 2009, DOE/EIA-0383(2009)

Nuclear power is competitive regarding cost, as is evident in Table 1.3. It has the highest capacity factor and its total levelized costs are comparable with other technologies. The main factors to consider when choosing an alternative to coal are capital cost, running costs, safety, time, the environmental impact, and job creation of the technology. Nuclear power is competitive with cost, safety, and environmental impact. Public opinion and

politics are, however, also factors which have to be considered because of their influence on whether a technology is implemented or not.

1.1.4 Political influence and job creation

South Africa has a growing economy and it experienced power cuts in 2008 due to a shortage of electricity supply. This was caused by the rate of growth of electricity demand in the country exceeding the rate of growth of electricity production capacity (VAN DER MERWE, 2009). The reason South Africa experienced this problem was two-fold (INGLESI and POURIS, 2010):

1. The government delayed the approval of a new power station which was not ready in time to prevent the electricity shortages.
2. The country's electricity demand increased significantly between 1994 and 2007 due to an increased economic growth once sanctions were lifted post apartheid, and also possibly due to the Free Basic Electricity Policy implemented in 2001.

These power cuts had a negative effect on the economy of the country, with economic growth dropping from 5.4% at the end of 2007 to 1.57% at the beginning of 2008 (INGLESI and POURIS, 2010). The power cuts also negatively affected businesses and industries (VAN DER MERWE, 2009). Eskom, South Africa's power utility, has increased the electricity rates in order to expand its electricity generation capacity (INGLESI and POURIS, 2010). These increased rates have directly affected the public and businesses. Nuclear power generation is one of the options that were considered by Eskom to ensure secure electricity supply in the future but its implementation has been delayed.

The nuclear reactor considered to be built, by the South African government, was the Pebble Bed Modular Reactor (PBMR) but the construction of this reactor was delayed due to financial constraints (POWER GEN WORLDWIDE, 2010). There was also

opposition from environmental organizations to expanding the nuclear industry in South Africa (VAN DER MERWE, 2009).

South Africa needs to increase its electricity supply to avoid any significant future power cuts such as those of 2008. Nuclear energy offers part of the solution but there are drawbacks to the technology such as long lead times, high capital costs and resistance by labour unions. The opinion of the South African labour unions on nuclear power generation is important because their members will form a pivotal component of the nuclear industry if it is expanded. It is therefore important to determine their views on nuclear energy and the reasons thereof. This forms the basis of the objective of this research.

The information obtained from the labour unions was used to develop a framework for building their confidence in nuclear power. This will hopefully help get the approval of labour unions on the implementation of nuclear energy technology in South Africa.

1.2 Research Problem

The International Atomic Energy Agency (IAEA) has required its members to work on building the confidence of the public in nuclear power. Labour unions play a critical role in the decision making process of any new government venture since, in a democratic country like South Africa, the approval of all the relevant stakeholders is necessary. The labour unions are therefore a powerful force that could sway the decision of building a nuclear power plant. Of particular significance in this regard is the power and influence wielded by COSATU on government decision making. COSATU is the largest labour union in South Africa and has a loud voice, especially since it is one of the tripartite alliance partners of the ruling party, the African National Congress (ANC).

In order for nuclear power generation to be accepted and implemented it is important to identify the reasons for any negative views expressed by the labour unions. Therefore, the research problem was defined by the lack of information available on the following:

1. the views of the different South African labour unions regarding nuclear power and the reasons for these views
2. a comparison of the views of the different unions in South Africa
3. a comparison of the views of the South African labour unions with those around the world

This information is necessary to achieve part of the requirements of the IAEA which is to improve the outlook of labour unions on nuclear energy. This forms the basis of the research problem for this investigation.

1.3 Research Objectives

Based on the research problem, the main aim of this investigation is thus two-fold:

1. To carry out interviews in an attempt to obtain an in-depth understanding of the main issues causing negative perceptions among the South African labour unions.

The specific objectives of the interviews were to test the following hypotheses:

- a. There are misunderstandings and/or misinterpretations on the facts of nuclear power amongst the unions.
 - b. The different labour unions have differing views on, and perceptions of, nuclear power.
2. Based on the results of the interviews, to suggest or recommend how these issues can be addressed in order to help increase the confidence level of the labour unions in nuclear power.

To obtain an accurate view of the labour unions in South Africa, the unions selected for the study had to represent the workforce that would be connected with the nuclear industry. The unions chosen for this study were the COSATU, NUM, and Solidarity. There are 196 registered trade unions in South Africa, as at 31 August 2010 (WORK PERFORMANCE TECHNOLOGIES, 2010), and COSATU is the largest of these, while Solidarity is the largest independent labour union in South Africa

The secondary objective of this research was to determine how the views of labour unions around the world compared to those in South Africa and the reasons for any differences. The analysis of the results of the interviews together with the findings from the literature review were intended to provide the information required to develop the framework for building confidence in nuclear energy.

Nuclear power generation offers a way to solve part of the energy supply problem in South Africa. If this technology is not implemented, electricity supply may not be able to keep up with the growing demand for electricity. It is envisaged that by achieving the

objectives of this research, the level of confidence and knowledge of the labour unions on nuclear power could be improved, thereby reducing the resistance to the technology.

1.4 *Dissertation Outline*

The findings from the literature review are detailed in Chapter two. This provided the insight on which this research was based and aided the experimental design covered in Chapter three. The five main areas of research that were chosen were environmental impact, safety, cost, political influence, and job creation. The role that each of these plays in the acceptance of nuclear power and the reasons for the lack of confidence in nuclear power in different countries was investigated in the literature review in order to draw comparisons.

It has been extensively debated whether nuclear energy is a viable part of the solution to the energy crisis in the world. The different arguments used around the world in favour of nuclear power and against it are presented in Chapter two so that the reader has an understanding of the way these arguments can sway the decision on energy generation, and how the experimental design was developed. The literature review was critical to ensuring that the results of the experiment would result in the objectives of this investigation being achieved.

Chapter three contains the description of the experimental design that was used. The data collection and analysis procedures are presented. A summary of the results from the interviews are also presented and categorized according to the hypotheses to be tested. Interviews were selected as the method for data collection and the interview design was based on the literature review.

Chapter four presents the analysis of the results from chapter three. Here, the hypotheses are evaluated to determine whether or not they were confirmed by the research. This was combined with the results of an extended literature review to draw conclusions and develop recommendations on how to overcome the negative perceptions of nuclear power amongst the South African labour unions.

Chapter five is the concluding chapter of the dissertation that presents the conclusions and recommendations of the research. The framework for building the labour Unions' confidence in nuclear power is presented in this chapter.

Details on the references used are presented in Chapter six. The references included reports and articles found on the internet, interviewee details, personal conversations, and electronic mail correspondence.

The Appendix contains the interview questions as well as the detailed responses of the six interviewees.

CHAPTER TWO

LITERATURE REVIEW: OVERVIEW OF FACTORS INFLUENCING VIEWS ON NUCLEAR ENERGY

2.1 *Intention*

The intention of this literature review was to gain an insight into:

1. previously reported views of labour unions and governments worldwide, regarding nuclear power generation, and their possible reasons for opposing or supporting this technology
2. relevant work conducted by other researchers with a view to possibly complementing such work
3. the comparison of nuclear power generation with other power generation technologies

Once collected the relevant literature was qualitatively analyzed. The findings then gave direction to the development of the experimental design for this research.

2.2 Methodology

The literature search was confined to views expressed on the impact of the various electricity generation technologies on the five categories mentioned in Chapter one, namely: environmental impact, safety, cost, political influence, and job creation. The data was collected mainly by making use of the internet with the following methodology:

1. Searches were conducted for the views of labour unions and governments on the five research areas and relevant articles were chosen
2. All documented relevant research that was found was reviewed
3. Articles comparing nuclear energy with other energy generation technologies, in the five research areas, were reviewed and the most relevant ones chosen for this study.

The findings of the literature search, categorized according to the five areas of research, are detailed in sections 2.3 to 2.7.

2.3 Literature related to environmental impact

Electricity generation around the world has largely depended on coal which has been the main contributor to the increase in CO₂ emissions. Approximately 25% of the increase in the greenhouse effect, which results from human activity, is contributed by coal generated power. The rate of growth of electricity demand around the world is expected to increase rapidly from 2005 to 2030, most of this being in the developing world (WORLD NUCLEAR ASSOCIATION, 2001). Coal also releases toxic and radioactive heavy metals into the environment through the ash produced.

Nuclear energy is able to supply base-load electricity, just as coal can, but without emitting the same harmful substances that coal does. The waste from a nuclear power plant is kept contained for many years and thus far, there have been no incidents of unsafe radioactivity release from nuclear waste storage facilities (WORLD NUCLEAR ASSOCIATION, 2001).

Patrick Moore, an environmentalist, expresses the changes in his views on nuclear power, throughout his career, in the article “*Nuclear Re-think*” (MOORE, 2004). He writes about his initial negative views on nuclear power due to the perceived safety risks, and the change of these views once he had learned more about nuclear power. The reduced environmental impact of nuclear energy, compared to other power generation technologies, should sway decisions in favour of nuclear, according to Moore.

Moore believes that solar and wind power should also form part of the solution to bridge the deficit between electricity demand and supply but renewable energy alone cannot supply a base-load. He believes that nuclear has to be part of the solution to the electricity supply problem to ensure the base-load requirement is met. The added benefits from the use of nuclear energy for hydrogen production and water desalination have made Moore even more positive toward nuclear power.

Even though there is a strong argument in favour of nuclear energy being environmentally friendly, the residents of Cape Town, South Africa, have protested against the building of a nuclear power plant in their area (GOSLING, 2009). The mayor of the area was attacked for allegedly supporting nuclear power which he later denied. The article showed that the public in Cape Town is very aware of the heritage and beauty of their surroundings. They value this and want to preserve it and they feel that a nuclear power plant will destroy what they have (GOSLING, 2009).

There are many anti-nuclear organizations that believe nuclear energy is releasing very dangerous radioactive waste into the environment and they do not support its use for the intention of reduced carbon emissions. One of these organizations is the Coalition Against Nuclear Energy (CANE) and it believes that the nuclear industry does not have any regard for the regulations in place to protect workers and the public (COALITION AGAINST NUCLEAR ENERGY, 2008).

The main reason why power generation capacity has to be sized for peak power demand is that the power produced from power plants cannot be stored to supply energy for a sufficiently long time. In order to meet peak demand requirements, it has therefore been necessary to use plants, such as coal and nuclear plants, which can supply a large amount of continuous and uninterrupted power. Renewable energy sources have not been able to provide a continuous energy supply for base-load power without the back-up of another energy source, like coal or nuclear. Although nuclear energy can supply “clean” power, it is not easily accepted by environmental groups due to their discomfort with the waste generated by nuclear plants. This provides major obstacles for the nuclear industry globally.

2.4 Literature related to safety

The safety of nuclear power has been debated ever since the accidents at Chernobyl and Three-Mile Island. America has not built any new nuclear power plants since the Three-Mile Island accident (STRANAHAN, 2010) which implies a lack of confidence in the safety of the technology. American companies such as Westinghouse have developed designs for new nuclear plants which are being built in other countries like China, but no new plants have been completed in America in the last thirty years (STRANAHAN, 2010).

According to Stranahan, an experienced journalist in environmental and energy issues, the biggest difference between the old reactor designs and the new designs is the reduced human requirement under accident conditions in the latter (STRANAHAN, 2010). There are currently many different reactor designs in America and one of the proposals is that the new reactor designs be standardized to make the licensing and regulation process simpler and more effective, and to improve implementation times of nuclear plants. The Nuclear Regulatory Commission (NRC) sees the lack of experience on the running of newer reactor designs as a possible safety risk compared to existing designs (STRANAHAN, 2010).

The threat of terrorism has also had an effect on the perceived safety of nuclear power. Following the terrorist attack on America on September the 11th 2001, questions were raised on the consequences of such an attack on nuclear power plants. This initiated changes to the safety requirements of these plants which stipulate that, even under extreme circumstances such as terrorist attacks and natural disasters, a catastrophic accident would not occur. Even though these regulations are in place, Stranahan still states that these containments will not be able to tolerate a severe earthquake. This shows that no matter how safe the designs of nuclear power plants become, there will always be fears of the risks associated with it.

There is a fear that countries which use nuclear energy for electricity production could also produce nuclear weapons. Africa has become a nuclear weapon-free zone, as declared by the “African Nuclear-Weapon-Free Zone” treaty in place (MAHDY, 2009). This treaty serves to prevent any African country from using uranium for nuclear weapons. Since Africa is a uranium-rich continent, this is an important agreement to prevent the proliferation of nuclear weapons. This treaty should provide some assurance to those that fear the abuse of nuclear power plants for the production of weapons.

Other countries have followed suit to assure the world that they would not allow the development of nuclear weapons (MAHDY, 2009). Mahdy reported the views of the country leaders as well as nuclear organizations and presented the facts on treaties signed. This article was free of any personal views of the reporter and it suggests that the world is moving toward using nuclear energy for constructive purposes only.

The Nuclear Energy Institute (NEI) has released the performance data of the American nuclear plants for 2009. This data revealed that the safety performance of these reactors has consistently been excellent and continually improving. The American nuclear industry is therefore one of the safest industries to work in (NUCLEAR ENERGY INSTITUTE, 2009).

The views of the director general, of the Organization for Economic Co-operation and Development (OECD) Nuclear Energy Agency (NEA), on the safety of nuclear power regarding radioactivity have been published (ECHAVARRI, 2006). The director general mentions that the actual radiation doses of nuclear power are much lower than the allowed limits and that the level of radiation the workers and public are exposed to have significantly reduced over the years. He also discusses the safety of nuclear power compared to other technologies. Although the article is factual, it is favoured toward nuclear energy since it is written by the director of the OECD NEA.

Australia has been involved in uranium mining more than nuclear power production. Opposition movements in Australia have been active for decades and their main reasons

for opposition were their perceived safety risks of nuclear power (MARTIN, 2007). Australian trade unions have opposed nuclear power since the 1970's and this opposition was strongest amongst the union members and not the management. Martin discusses the view that only those people who are in powerful positions are able to make decisions on nuclear power, which is why it has less support with union members and the public. Martin argues many points that are based on his personal opinion or hearsay rather than fact and this could incorrectly sway the views of the readers of this article.

Eskom, South Africa's power utility, has plans to increase its power generation capacity until 2025 in order to meet the growing demand (WORLD NUCLEAR ASSOCIATION, 2010a). The only nuclear power plant built in South Africa (Koeberg) was built in the Western Cape due to the long distances coal or electricity would have to be transported in order to supply power from coal-rich areas. The plans to build new nuclear power plants in South Africa were delayed in 2008 due to financial constraints. The WNA article also states that South Africa is the only country to have developed nuclear weapons and voluntarily given them up which shows a commitment to the safe use of nuclear power.

Safety of nuclear power is a global concern and the possibility of an accident at a nuclear plant or the proliferation of nuclear weapons has made many groups of people nervous. Since the Chernobyl and Three-mile island accidents, there have been changes made to reactor designs to improve safety. There has been a global commitment shown to eradicate the proliferation of nuclear weapons, as is demonstrated by the signing of treaties by many countries. There is still work to be done to change the perception amongst many, labour unions included, that nuclear power is dangerous.

2.5 Literature related to cost

The cost of an electricity generation technology is an important factor for investors to consider but it is also important for governments to ensure that the price of electricity to the public is kept low. According to Professor Steve Thomas, of the University of Greenwich, the price paid by the consumer would be high if the correct decisions are not made in choosing an electricity generation technology (THOMAS, 2007). He says that this high price would be independent of the investor, being the private sector or government. Coal and gas powered plants are the more logical choices regarding cost, according to Thomas, while nuclear plants do not have enough guarantees on construction costs, and time and regulatory costs.

A review was carried out on many of Thomas's published articles. His negativity toward nuclear power is evident and he does not see it as a viable option. He mentions the negative aspects of coal and gas power but he does not mention the positive aspects of nuclear energy. He also states that the efficiencies of complex plants, like nuclear and advanced coal plants, may not be what is claimed and may lead to higher than expected electricity prices. These claims by Thomas are not backed up by references, implying that they are his personal views. Thomas's articles were found to be unreliable for this reason.

The OECD countries have almost 25% of their energy supplied from nuclear power (ECHAVARRI, 2006). The director general of the OECD Nuclear Energy agency (NEA), Echavarri, believes that the cost benefits of nuclear power have enabled the implementation of the technology in the OECD countries. The lower cost of uranium, the increased stability of uranium supply compared to fossil fuels, and the abundance of it, make the cost of nuclear fuel significantly lower than fossil fuel. There is also a lower risk of significant price fluctuations with uranium due to the wide geographical distribution of it in the world.

According to Echavarri, nuclear power plants have made strides to improve their designs to make them more efficient, safer, and achieve better fuel utilizations which make them

more cost-competitive. The increasing costs of fossil fuels and the introduction of carbon taxes make nuclear power even more cost-competitive than fossil fuel generated power. These views are in contrast to those of Thomas.

As discussed in Chapter one, the cost of nuclear energy is very competitive with alternative energy generation technologies. These costs seem to, however, be questioned by those that are anti-nuclear.

2.6 Literature related to political influence on the choice of energy generation technology

Governments are responsible for making decisions for their countries that affect their future. These decisions should be based on the best interest of the country, but unfortunately corruption has affected these decisions in some countries. One such example of a government that has a history of corruption is the Indonesian government which has attempted to implement nuclear power in the country (TANTER *et al.*, 2009).

Indonesia has a fairly young democratic government and the country has had plans to build nuclear power plants for many years. The government has planned to build four 1000MW plants in Java but there is concern that the government may be influenced by corruption rather than just the best interest of the country. Over the years, politicians appear to have based their publicized views regarding nuclear power on winning the favour of the public. During the Indonesian presidential elections, none of the candidates gave any opinion on nuclear power for fear of losing votes. The Indonesian president stated that nuclear power will not be supported by his government while other alternatives are available. This occurred after an Islamic organization in Indonesia condemned the technology (TANTER *et al.*, 2009).

The decision to build nuclear power plants in Indonesia is still pending due to the perceived safety and financial risks. The safety of the proposed nuclear power plants in Indonesia has been questioned due to the seismic activity in the Muria Peninsula of Java. According to Tanter *et al.*, the Indonesian government has remained adamant that the chosen site is the best for the nuclear plants, however, experts believe that it is not seismically stable. A re-assessment of the site is required and this will contribute to Indonesia missing its target of having the first planned plant running by 2016. The article shows a lack of confidence in the Indonesian government and its ability to make decisions without corruption affecting it. It also demonstrates that the Indonesian public does not have faith in the decisions its government makes (TANTER *et al.*, 2009).

In a BBC news article (WHEELER, 2007), Brian Wheeler states that “anti-nuclear campaigners like to portray the government as being in the pocket of the nuclear industry”. The article discusses stories of pro-nuclear lobbyists paying government members money or doing them favours, with the intention of winning their support. The lobbyists deny these accusations as they claim that all payments are declared and justifiable. According to Greenpeace, the lobbyists spend a lot of time and effort convincing the government members to support nuclear power. Wheeler also mentions that the support, or otherwise, of labour unions can greatly influence the implementation of nuclear power.

European governments appear to be split regarding their stance on nuclear power (GURRIARAN, 2008). Britain and France still plan to build more nuclear power plants, according to Gurriaran, and Germany and Spain would prefer to move away from nuclear power because of their lack of confidence in its safety. The Spanish government prefers renewable energy sources due to concerns over the disposal of radioactive waste.

Nuclear power plans in Poland have changed over the years (KULCZYNSKI, 2010). The Zarnowiec power plant was planned to be built since the 1980's. After the Chernobyl disaster, the safety of the design was improved. The building of this plant was then delayed due to safety concerns. However, these plans were recently re-initiated due to the rising energy demands in Poland, and increasing pressure to reduce carbon emissions. Poland's power is supplied mainly by coal so until the year 2020 they will be charged reduced carbon taxes by the European Union (EU) but these rates will increase thereafter.

It is therefore critical that Poland introduces other power generation technologies that have reduced CO₂ emissions and are able to meet growing energy demands. Nuclear power is being considered for this but the Polish government has not previously followed through with their nuclear plans (KULCZYNSKI, 2010). The current government has other pressures, however, which have made it more likely to implement the nuclear plans.

Governments around the world have to make decisions regarding energy generation, as the shortage of electricity supply is a common global problem. There are different pressures from environmental groups, anti-nuclear organizations, the public, and the different energy generation sectors but the government needs to make the correct decisions for their countries at the correct times. Economic growth and sustainable development is what every government needs to achieve.

2.7 Literature related to labour Unions' views on job creation prospects of energy generation technologies

Labour unions will always be concerned with employment for their members. Their duty is to ensure their members' jobs are secure and that the conditions under which they work are fair and safe.

American labour unions have a positive outlook on job creation from nuclear power (BOGARDUS, 2010). They believe that the jobs created by the nuclear industry will mostly be union jobs and this will allow labour union membership to grow. According to Bogardus, the NEI estimates that 80% of workers in the nuclear industry belong to labour unions. Nuclear jobs are also seen as being in line with combating climate change. Environmentalists disagree with labour on this point but the American labour unions would like more nuclear power plants to be built to create jobs, increase membership and grow the economy (BOGARDUS, 2010).

Labour unions in the UK have been lobbying to get more nuclear power plants built, and the decision to build a new generation of nuclear power plants, with improved safety features, has been well received by the unions (ROWELL, 2006). They are in favour of building more nuclear power plants because it will lead to increased job creation. There is some controversy involved with the UK labour unions favouring nuclear power plants because of the suspicion that the nuclear industry is paying toward the labour union's expenses. This has made it appear as though the nuclear industry is using money to persuade UK labour union management to be in favour of nuclear power (ROWELL, 2006).

South Africa has 79% of the installed electricity capacity in the Southern African Power Pool (SAPP). Electricity supply capacity in South Africa is therefore critical for Africa's electricity supply and thus growth and development. The SAPP countries can supply each other with electricity when required. Since South Africa has the largest installed capacity, it is more likely that the other SAPP countries will require power from South Africa

instead of South Africa relying on the others. If South Africa's power supply is insufficient to support it, not only will the economic growth of South Africa be affected but the economic growth of the SAPP countries will also be affected. This will ultimately affect the unemployment rate of the continent.

Labour unions in other countries seem to be in favour of nuclear energy because they believe that there will be more jobs created. The research had to determine whether the South African labour unions had the same view.

2.8 Conclusion

Different views on nuclear power were presented in the literature review. Labour unions and governments around the world have differing opinions on the technology for various reasons. The main reasons that nuclear power is supported or opposed were found to be environmental impact, safety, cost, political influence and job creation. These five categories formed the basis for the experimental design of this study.

CHAPTER THREE

EXPERIMENTAL WORK

3.1 *Experimental design*

3.1.1 Basis

The intention of this research was to determine the reasons the South African labour unions could lack confidence in nuclear power and to then develop a strategy to build this confidence. The approach was thus qualitative. The literature review provided the initial direction for this research by revealing the five main areas of concern for labour unions, globally, with regard to nuclear power. In order to establish the views of the labour unions, interviews were conducted with selected members of representative labour unions.

The interviews were directed at three South African labour organizations, namely, COSATU, NUM and Solidarity. The reason for selecting these unions was that they formed a good representation of the labour unions involved with nuclear power in the country. COSATU is a powerful federation of many unions and it is very influential with government, and the country's workforce. NUM is an affiliate of COSATU and is vital to their energy policy development. Solidarity is the largest independent labour union in South Africa. These three organizations were regarded as being able to provide enough information from which to draw meaningful conclusions.

3.1.2 Methodology of data collection

Data was collected through in-depth, rather than structured, interviews with members of the labour unions who were their specialists on energy matters. Since there are only a few of these specialists in each union, only a small sample size could be used in this investigation.

In-depth interviews were used because interviewees are allowed to discuss their views and give more details on their opinions, whereas structured interviews would have compartmentalized the responses of the interviewees and may not have provided an accurate representation of their views. The results of the interviews were recorded and the details are presented in Appendix 2. The summarized results follow in section 3.4 of this chapter.

The questions for the interviews were based on the five areas of research and the methodology used to develop them is elaborated on below. The actual questions used are available in Appendix 1.

3.1.2.1 Environmental impact

One of the arguments in favour of nuclear power is its reduced carbon emissions compared to fossil fuel plants but the literature review revealed that there are many organizations, including labour unions, which disagree with this argument. This highlighted the need to verify whether the South African labour union members agreed with this fact. If they did, they were questioned further on whether they thought this was a good reason to make nuclear energy part of the solution to the energy crisis.

3.1.2.2 Safety

The interviews were aimed at determining whether the interviewees believed that the current safety regulations and licensing process ensured the safety of the public and employees of a nuclear power plant.

The interviewees were also questioned on whether they felt confident that a disaster like Chernobyl would not occur again. This was asked in order to bring in an element of repeatability in the questions so as to portray consistencies, or the lack thereof, in the responses.

3.1.2.3 Cost

The capital cost and time required to build a nuclear power plant are significant when compared to other technologies (Table 1.3). The collected data had to reveal whether the labour unions were of the opinion that the South African government should invest in nuclear power and whether the long term benefits would be worth the initial capital investment.

The running costs of a nuclear power plant are comparatively low which makes the total cost of the electricity produced very competitive (Table 1.3). The interviewees were therefore questioned on whether or not they thought the price of electricity would increase if nuclear energy was implemented.

3.1.2.4 Political influence

According to the literature review, some labour unions and anti-nuclear organizations believe that corruption could play a role in the decisions of government to build nuclear power plants. The data collected from the interviews had to reveal whether the South African labour unions had confidence in their government to make the correct decisions for the country without allowing personal gain to be an issue.

3.1.2.5 Job creation

The interviews had to reveal whether the South African labour unions believed that more jobs could be created with nuclear power or that nuclear plants could replace coal plants and result in job losses.

3.2 Data collection procedure

1. An in-depth interview questionnaire was developed with 14 initial questions covering all five areas of research
2. The contact details of the six interviewees was obtained
3. These interviewees were then contacted and an interview appointment was set for each one indicating the intention of the interview
4. During the first contact, each interviewee was briefed on the topic being researched
5. The interviewees were then contacted telephonically for the conduction of the interview, during which the responses to the questions were typed live on computer
6. For the first interview (which was with Interviewee 4), 14 questions were posed and the responses recorded. From that interview it became evident that further questions were required. Four more questions were added and these were implemented on the second interview and beyond.
7. Once collected, the data was then analyzed and summarized. This summary is presented in section 3.4.

3.3 Data analysis

The collected data was split according to hypothesis for the analysis. An extended literature review was used to verify the views of the interviewees. This was followed by a discussion of the findings which is detailed in chapter four.

3.3.1 Hypothesis 1: There are misunderstandings and/or misinterpretations on the facts of nuclear power amongst the labour unions

Research was done to determine whether the views of the interviewees were justified and true. All those views that were not able to be backed up by literature or that were proven false by literature were discussed in detail in chapter four. This enabled the development of valid recommendations.

3.3.2 Hypothesis 2: The different labour unions have differing views on and perceptions of nuclear power

The difference in views between labour unions was grouped according to the five main categories of the investigation. Reasons for the difference in views between the unions were researched and this aided the formulation of the recommendations.

3.4 Results

3.4.1 Hypothesis 1: There are misunderstandings and/or misinterpretations on the facts of nuclear power amongst the labour Unions

Table 3.1: Summary of all possible misunderstandings and/or misinterpretations on nuclear power amongst the labour unions

Labour union	Misunderstandings on each category
	Environmental impact
Solidarity	<p><u>Interviewee 4:</u></p> <ul style="list-style-type: none"> It is difficult to store renewable energy – if you generate it with solar, you need to use it immediately and you need a base load back-up
COSATU	<p><u>Interviewee 3:</u></p> <ul style="list-style-type: none"> If renewable energy is invested in further and if more research is done on it then it could supply the base-load power. The nuclear fuel cycle is not environmentally friendly – there are carbon emissions through most of the cycle. Nuclear energy will not result in a reduced carbon footprint for the country.
NUM	<p><u>Interviewee 5:</u></p> <ul style="list-style-type: none"> The nuclear fuel cycle is also energy-intensive – the processing, transporting etc is quite energy-intensive. <p><u>Interviewee 6:</u></p> <ul style="list-style-type: none"> With some development, renewable energy could supply the base load power and we should invest in such development.
	Safety
COSATU	<p><u>Interviewee 3:</u></p> <ul style="list-style-type: none"> The current safety regulations insufficient to prevent a disaster like Chernobyl.

Labour union	Misunderstandings on each category
	Cost
COSATU	<p><u>Interviewee 3:</u></p> <ul style="list-style-type: none"> ▪ Nuclear energy would increase the cost of electricity to the public. The nuclear industry admits that the running and capital costs are high because of the kind of technology used. That is why they require subsidies.
NUM	<p><u>Interviewee 5:</u></p> <ul style="list-style-type: none"> ▪ The PBMR has failed in other countries (Germany and Australia) before it was explored by South Africa and we should have learned from this. <p><u>Interviewee 5 & 6:</u></p> <ul style="list-style-type: none"> ▪ Nuclear energy is more expensive than other technologies so the price paid by consumers will go up if nuclear power is expanded. ▪ The capital and running costs of nuclear energy are high.
	Political influence
COSATU	<p><u>Interviewee 3:</u></p> <ul style="list-style-type: none"> ▪ The government seems to have fallen into the trap of nuclear lobbyists that have convinced government that nuclear energy is clean.
	Job creation
Solidarity	<p><u>Interviewee 2:</u></p> <ul style="list-style-type: none"> ▪ Renewable energy technologies will not create more jobs than nuclear energy and job creation is not a good reason to choose it instead of nuclear power.
NUM	<p><u>Interviewee 5 & 6:</u></p> <ul style="list-style-type: none"> ▪ If other energy sectors are neglected in order to expand nuclear, there will be a loss of jobs in those sectors. ▪ There is a very high skill level required in nuclear and this skill is not available in South Africa which means that human resources would have to be imported. It would also mean that fewer jobs will be created compared to other power generation technologies.

3.4.2 Hypothesis 2: The different labour Unions have differing views on and perceptions of nuclear power

Table 3.2: Comparison of the summary of views of the different labour unions on nuclear power

Labour union	Views on each category
	Environmental impact
Solidarity	<p><u>Interviewee 1:</u></p> <ul style="list-style-type: none"> ▪ The entire nuclear life cycle is more environmentally friendly than the life cycle of coal and it is irrelevant whether global warming is true or not – if we can improve the quality of our air and reduce climate change we should. ▪ Wind and solar power must be used where feasible and should be used in combination with nuclear – it cannot be used alone and if there is a choice between combining with coal or nuclear, they should be combined with nuclear. ▪ With nuclear power there is a small amount of controlled waste whereas with coal, the waste is sent directly into the air without any control. <p><u>Interviewee 2:</u></p> <ul style="list-style-type: none"> ▪ The problem in our country is that people burn coal at home and that negatively affects the environment <p><u>Interviewee 1, 2 & 4:</u></p> <ul style="list-style-type: none"> ▪ Nuclear power will definitely reduce South Africa’s carbon emissions and ensure that the energy produced is cleaner. ▪ A nuclear plant would have a lower impact on the environment compared to renewables because of the smaller plant size required. ▪ The base-load can either be supplied by coal or nuclear and coal is dirty so we prefer nuclear.
COSATU	<p><u>Interviewee 3:</u></p> <ul style="list-style-type: none"> ▪ Renewables need more attention and investment. If the government looks into renewables more seriously, it may be able to expand and supply the base-load

Labour union	Views on each category
	<p>power.</p> <ul style="list-style-type: none"> ▪ Improving our energy efficiency will go a long way to reducing our carbon footprint – we will need to produce less power and we will therefore generate less emissions. Businesses should get more efficient and use co-generation but they should also invest in technologies that are reducing carbon emissions from the existing coal plants as well. ▪ The whole cycle of nuclear is not environmentally friendly. The mining of uranium contributes to carbon emissions and COSATU does not believe that nuclear is better for the environment than coal generated power
NUM	<p><u>Interviewee 5:</u></p> <ul style="list-style-type: none"> ▪ We need to improve our energy efficiency and concentrate more on renewable energy. ▪ Nuclear is not a green technology and does not have reduced carbon emissions compared to other technologies – these are untrue claims by the nuclear industry. Every part of the nuclear fuel cycle produces emissions, it is only the actual fission process that does not. ▪ The radiation emitted from the entire nuclear process (mining to waste disposal) is too high and more needs to be done to reduce these emissions. ▪ The exposure of workers to radiation is the biggest problem. The radiation exposure in uranium mining does not have enough precautions in South Africa right now. ▪ Our water sources are being contaminated by uranium and gold mining. <p><u>Interviewee 6:</u></p> <ul style="list-style-type: none"> ▪ We have such a small quantity of uranium but there have been so many issues with it – Pelindaba and PBMR were closed down – not sure this has been properly done – if it was done properly then there should not have been waste missing from NECSA. The control on any nuclear related material is not done well. ▪ Nuclear is not an automatic solution to displace carbon because although it is

Labour union	Views on each category
	<p>carbon neutral, its environmental hazards are far worse – there is no point in displacing carbon and creating far more dangerous nuclear waste.</p> <ul style="list-style-type: none"> ▪ We should rather stick with coal because we're more comfortable with the waste created by coal. I would rather go with waste that's bad than waste that's worse so I would rather displace nuclear with coal. ▪ Nuclear is not renewable. With some development renewables could supply the base-load power and we should invest in such development.
	Safety
Solidarity	<p><u>Interviewee 1:</u></p> <ul style="list-style-type: none"> ▪ The reactors of the old design in Russia are the only ones with safety issues. There are still some existing plants like this without strong containment buildings which could be a risk. One would expect that they have learnt their lesson and would not let inexperienced people handle the reactor again. ▪ 3-mile Island was actually a success story but it stopped the building of nuclear plants in the USA – it showed that a nuclear plant can be safe even under an accident condition. ▪ Lessons have been learnt from previous accidents and if the regulations are abided by it is very unlikely that another major accident will occur – this small risk should not hold back progress. ▪ Coal mining has the added risk of explosion with the added gases. <p><u>Interviewee 2:</u></p> <ul style="list-style-type: none"> ▪ The clean energy generated by nuclear mitigates the minute risk of a possible accident occurring. ▪ Koeberg's history has shown that their safety regulations work. <p><u>Interviewee 4:</u></p> <ul style="list-style-type: none"> ▪ The safety risks with nuclear are better than the contamination issues with coal. <p><u>Interviewee 1, 2 & 4:</u></p> <ul style="list-style-type: none"> ▪ Uranium and coal mining are both equally dangerous and there are no additional problems with mining uranium.

Labour union	Views on each category
	<ul style="list-style-type: none"> ▪ Nuclear energy has many regulations in place that should ensure the safety of the public and the workers in the plant – it is a lot more regulated than coal. If these regulations are correctly enforced, there should be no safety issues with nuclear. ▪ We have the local experience to ensure the safety of the public and workers in the nuclear industry. The nuclear industry is under more intense scrutiny than coal, their regulations are stricter, and they abide by their regulations better.
COSATU	<p><u>Interviewee 3:</u></p> <ul style="list-style-type: none"> ▪ There have already been tragic accidents with nuclear and there is no guarantee that such accidents cannot re-occur. If an accident does occur it will be catastrophic. ▪ The workers in the industry will be exposed to radiation and this will have irreversible long-term effects. ▪ There is no proof to show that the exposure at Koeberg is currently within acceptable levels. The workers are not sent for regular check-ups. ▪ The current safety regulations are not sufficient ▪ Uranium and coal mining are both equally dangerous.
NUM	<p><u>Interviewee 5:</u></p> <ul style="list-style-type: none"> ▪ The current safety regulations in South Africa are sufficient. ▪ There was an accident in Koeberg where 91 workers were exposed to higher levels of radiation than allowed – this means that we still have issues with safety. ▪ Abiding by the regulations does delay the process of building nuclear power plants but it is very necessary. ▪ The choice of waste disposal sites in South Africa are currently the poorer areas and these communities are being taken advantage of. ▪ Uranium and coal mining are both equally dangerous. ▪ More work needs to be done to improve the safety of uranium mining and the safer disposal of nuclear waste. ▪ There has always been secrecy regarding what happens at Koeberg – information is not made available on enquiry.

Labour union	Views on each category
	<p data-bbox="367 310 542 338"><u>Interviewee 6:</u></p> <ul style="list-style-type: none"> <li data-bbox="367 363 1412 562">▪ Aging plants are being used and there are life extensions done on old plants. There is also growth of nuclear reactors in countries that don't seem to have good safety records – especially in eastern countries – they have far too many incidents and I think an accident like Chernobyl would happen again. <li data-bbox="367 583 1412 667">▪ The NNR has really developed its capability in the last few years – technically they have really improved and are doing a good job. <li data-bbox="367 688 1412 940">▪ The problem is that we would probably use light water reactor technology that is foreign and may not be able to be transplanted exactly into SA – the level of radiation to workers and the public may not have been taken care of yet but that is fine because it would have been pre-mature. The regulator has sufficient capability to ensure it if it happens. <li data-bbox="367 961 1412 1161">▪ Right now if the mining of uranium is done by companies with a good safety record and I don't think there is a problem with uranium mining because I am happy with the way the licensing regime is working – I know how it works and I'm fairly comfortable with it. <li data-bbox="367 1182 1412 1266">▪ There would be more impact on people with uranium mining than coal because coal is a more mature industry.
	Cost
Solidarity	<p data-bbox="367 1356 558 1383"><u>Interviewee 2:</u></p> <ul style="list-style-type: none"> <li data-bbox="367 1409 1377 1493">▪ The Medupi coal plant is costing R100billion so there shouldn't be an issue of cost with nuclear plants. <li data-bbox="367 1514 1377 1650">▪ A lot more capacity is required to build renewable energy plants compared to coal or nuclear. There are also more transmission lines required which adds to the costs. <li data-bbox="367 1671 1377 1871">▪ The price paid for electricity could increase but the current price increases should be sufficient and there should actually be a significant surplus. If the money is used correctly, there should be no impact on cost by nuclear. If the electricity price goes up it will be because of Eskom and not because nuclear

Labour union	Views on each category
	<p>requires it. There should be a huge surplus of money to build new plants in the future after all the price increases by Eskom.</p> <p><u>Interviewee 4:</u></p> <ul style="list-style-type: none"> ▪ Carbon scale will have to be abided by internationally and the tax will have to be paid. <p><u>Interviewee 1, 2 & 4:</u></p> <ul style="list-style-type: none"> ▪ The best technology for the government to invest in currently is nuclear power. ▪ Although the capital costs of nuclear power are higher than coal, the running costs are lower and so the expansion of the nuclear industry should not affect the electricity price paid by consumers.
COSATU	<p><u>Interviewee 3:</u></p> <ul style="list-style-type: none"> ▪ The price for electricity paid by consumers will rise if nuclear power is expanded because the cost of building nuclear power plants and the running costs are very high. ▪ The government will have to provide subsidies because the costs are so high and this money can be put to better use to expand the renewable energy sector ▪ If nuclear power is implemented then resources will have to be taken from other priority areas to subsidize it. Even residential consumers will be paying in that case. ▪ Energy efficiency will help reduce the cost of electricity. ▪ The money that was spent on the PBMR project could have been used to create other jobs in the country in other sectors. ▪ There won't be any need to build the coal stations planned if we improve our efficiency – it is not being used efficiently currently.
NUM	<p><u>Interviewee 5:</u></p> <ul style="list-style-type: none"> ▪ Nuclear should not form part of the energy mix in South Africa now because we need the economy to grow more before we can afford to expand nuclear ▪ South Africa should wait for a proven nuclear plant that sticks to its budget and timeline so that we can have a good idea of what we're investing in at the

Labour union	Views on each category
	<p>beginning. Nuclear projects always exceed their initial budgets and timelines.</p> <ul style="list-style-type: none"> ▪ The nuclear industry requires massive subsidies from the government – we could be using that money for other things. ▪ Nuclear plants always exceed their budgets and timelines. <p><u>Interviewee 6:</u></p> <ul style="list-style-type: none"> ▪ Nuclear technology is more expensive – there are higher capital costs and the operating costs also seem to be higher. ▪ Generic studies show cross-comparisons between countries and I'm not sure that SA can compete with USA and France to deliver the same electricity prices – we will not be able to run those efficiencies to keep the costs low.
	Political influence
Solidarity	<ul style="list-style-type: none"> ▪ In South Africa we may have issues getting the correct people in the correct positions to ensure all the regulations are abided by. ▪ There are anti-nuclear groups but no pro-nuclear groups – the government needs groups on both sides to make an informed decision. <p><u>Interviewee 2:</u></p> <ul style="list-style-type: none"> ▪ The South African government would rather pay five times more money to employ foreigners compared to employing a white South African male because of political reasons. Other labour unions influence these actions. ▪ The other labour unions do not support nuclear power because the demographic of the nuclear experts in South Africa do not suit the political agenda of the other unions. ▪ The designate groups are in small numbers – they are wanted by the government and the labour unions but they are not coming through and this is holding back progress on nuclear. ▪ The government has indicated that they want to expand South Africa's nuclear industry but they have not followed through with these plans, which disappoints Solidarity. Their reasons for not expanding the industry seem to be driven by the views of the other labour unions.

Labour union	Views on each category
	<p><u>Interviewee 1, 2 & 4:</u></p> <ul style="list-style-type: none"> ▪ Corruption is an issue in South Africa but it is not likely to affect the design and safety of the nuclear plants. It is more likely to come into play when awarding tenders for construction.
COSATU	<p><u>Interviewee 3:</u></p> <ul style="list-style-type: none"> ▪ The South African government has made efforts to eradicate corruption but there is still work to be done. ▪ The government has not changed its plans to include nuclear power in the energy plan for the country and this is against COSATU's wishes. ▪ The government wants to expand nuclear energy in South Africa just because it is being done elsewhere in the world and because they are viewing the situation from the point of view of businesses. ▪ We should not import technologies but we should develop them ourselves.
NUM	<p><u>Interviewee 5:</u></p> <ul style="list-style-type: none"> ▪ The current government inherited corruption from the apartheid government and their initial focus was not on fighting corruption but they have shown a commitment to fighting corruption. ▪ The nuclear industry has publicized their views a lot more than the renewable energy industry and that could be the reason that it is being considered by the government more. ▪ Politics is involved in choosing the locations for nuclear waste dumping sites. It is the poorer areas that are chosen and these communities are taken advantage of. <p><u>Interviewee 6:</u></p> <ul style="list-style-type: none"> ▪ The nuclear industry is held in the hands of white people – it is very difficult to get black acceptance of the whole process. Black people will not be able to participate in the industry. ▪ I'm not comfortable with SA being involved with the processing of uranium – I don't want us to ever be involved because there is very little possibility for black involvement.

Labour union	Views on each category
	<ul style="list-style-type: none"> ▪ White jobs will be created instead of black jobs. There is not enough transformation of the industry. Amongst the unions, there are generally statements like “this is a white industry so why should we be involved”. If there are programs around with social responsibility – they will have an impact. ▪ I've been very impressed in the way the energy minister has been running the department.
	Job creation
Solidarity	<p><u>Interviewee 1, 2 & 4:</u></p> <ul style="list-style-type: none"> ▪ Most of the jobs created by the nuclear industry will be for skilled people and there may not be many unskilled jobs created. However, this should not stop the expansion of the industry because nuclear power will ensure security of our base load power and we should not hold back scientific advancements for labour. Unskilled jobs will be created but not as much as with fossil fuel plants ▪ Nuclear energy will create more jobs but the net gain in jobs will be small and may not have a significant impact on the unemployment rate of the country. There can only be a net gain in jobs even though it will not be large. <p><u>Interviewee 1 & 2:</u></p> <ul style="list-style-type: none"> ▪ Coal will not be replaced by nuclear in the near future as the main source of energy generation so there will be no loss of jobs in the coal industry if nuclear is expanded. There is a large industry for coal internationally so it will get mined as long as it is available and it will take years before there is a reduction of jobs in the industry. <p><u>Interviewee 2:</u></p> <ul style="list-style-type: none"> ▪ The lack of action by the government to expand nuclear power has caused South Africa to lose many good scientists and engineers. The retrenchments from PBMR caused some of the employees to leave the country and it is not likely that they will return. <p><u>Interviewee 4:</u></p> <ul style="list-style-type: none"> ▪ The PBMR would have been the first of its kind in the world. The current

Labour union	Views on each category
	<p>nuclear reactor types would not create many jobs – their major purpose would be energy generation. We could create a whole new industry if we used the PBMR – in the engineering and manufacturing fields. The PBMR would create the industry in South Africa for downstream manufacturing – we will be the original manufacturer for the rest of the world – it would be under our license and we could sell it.</p>
COSATU	<p><u>Interviewee 3:</u></p> <ul style="list-style-type: none"> ▪ Nuclear will not create jobs in the scale of the unemployment rate of the country and it could actually take away jobs that currently exist. ▪ Jobs were lost in PBMR so nuclear has not demonstrated that it will improve unemployment in the country but rather that it will make it worse. ▪ Renewable energy technologies will result in the creation of direct jobs which is always welcome by COSATU.
NUM	<p><u>Interviewee 5:</u></p> <ul style="list-style-type: none"> ▪ There is no evidence from previous nuclear plants of significant job creation and most of the jobs that would be created require skills that we do not have in South Africa. ▪ There will be no decent long term jobs created by nuclear. ▪ Investors do not look at job creation – they are only concerned with a high return on investment. <p><u>Interviewee 6:</u></p> <ul style="list-style-type: none"> ▪ Coal creates significantly more jobs than nuclear – nuclear requires highly skilled labour and very few jobs are created. I'm not sure if we'll have the capability and resources to develop a labour force to sustain a nuclear industry in SA. We will have to import labour and we are opposed to that. The nuclear industry will displace jobs ultimately because it will eventually replace coal. ▪ Renewables provide more jobs than nuclear and coal – nuclear creates the least jobs.

CHAPTER FOUR

RESULTS ANALYSIS

4.1 Analysis of views relevant to hypothesis 1: There are misunderstandings and/or misinterpretations on the facts of nuclear power amongst the labour unions

An extended literature review has revealed a few misunderstandings and misinterpretations in the opinions expressed by some of the interviewees. These are discussed below for each of the five areas of research. The recommendations to rectify these misunderstandings are discussed in Chapter five.

4.1.1 Environmental impact

4.1.1.1 Renewable energy generation technologies

One of the Solidarity interviewees (Interviewee 4) stated that solar energy had to be utilized immediately due to the difficulties with storing it (Table 3.1). According to the extended literature review, work has been done to improve the storage capacity of energy generated by renewable energy sources. This technology can also be applied to base-load supplying plants, like coal and nuclear (MULLIKEN, 2010). The ability to store sufficient power would enable power plants to run at their full capacity for a longer time and will thus reduce the power supply risks at peak demand periods. However, there is still progress to be made with this technology before it can significantly impact power supply.

Hydro-electric power has the highest installed capacity internationally compared to all the other renewable technologies. Pumped storage dams are used with some renewable energy technologies so that their power is more available. With pumped storage dams,

the excess energy from renewable energy, during off-peak periods, is used to pump water up into a storage dam and then during peak periods, this water is allowed to fall and is used for hydro-electric power generation (WORLD NUCLEAR ASSOCIATION, 2010b).

There is thus a possible misunderstanding with Interviewee 4 regarding the issue of solar energy storage capacity. However, the interviewee could have been referring to the current small storage capacity of solar energy plants which does not allow them to supply the base-load power.

Interviewee 3 from COSATU and Interviewee 6 from NUM were of the opinion that renewable energy storage capacity should be researched further to enable it to provide the base-load power (Table 3.1). No evidence was found in the extended literature review that it would be practically possible for renewable energy alone to supply the base-load power. Moreover, such a venture could require major investment and time in research without any guarantees of achieving these objectives and this may not be practical for South Africa at the moment.

4.1.1.2 CO₂ emissions

The claim by Interviewee 5 from NUM and Interviewee 3 from COSATU that the nuclear energy industry emits CO₂, and that this is mostly from the mining and processing of uranium, is valid (PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY, 2006). The CO₂ emission rate is dependent on the level of uranium in the ore mined; a lower concentration of uranium results in a higher cost and CO₂ emission rate in the uranium extraction process (PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY, 2006).

There is still uncertainty as to the amount of high-grade and low-grade uranium ore available in the earth. This uncertainty makes it difficult to accurately predict changes in CO₂ emissions in the future. Part of this problem can be alleviated by the use of fast breeder reactors which would extend the life of the available uranium. However, there are

not currently many of these reactors operational in the world (PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY, 2006).

Despite the above-mentioned, it is significant to note that the comparative CO₂ emissions reflect positively on nuclear power. Nuclear power's carbon footprint is ~ 5 gCO₂eq/kWh, which is lower than most of the other technologies: coal > 1000 gCO₂eq/kWh; gas ~ 500 gCO₂eq/kWh; solar 35-58 gCO₂eq/kWh; hydro power 5-30 gCO₂eq/kWh; wind ~ 5 gCO₂eq/kWh (PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY, 2006). This shows that even though nuclear energy emits CO₂, the net effect of nuclear energy would be a reduced carbon footprint for the country if it is chosen to be expanded.

There seems to be a possible lack of understanding with some union members regarding the impact of nuclear power on the total CO₂ emissions which is probably due to their lack of trust in the numbers reported for these emissions. This lack of trust is evident by the response, of Interviewee 5 from NUM, to Question 10 of the interview: "That is some nonsense that has been made up by the nuclear industry" (Table A.6).

4.1.2 Safety

The COSATU interviewee (Interviewee 3) said that the current safety regulations are not adequate to prevent a disaster like Chernobyl from re-occurring. However, safety regulations and reactor designs have improved internationally since the Chernobyl disaster. With the correct implementation of the current safety regulations, it is highly improbable that such a catastrophic disaster will re-occur. A probabilistic risk assessment shows that the probability of a nuclear accident resulting in more than 2000 fatalities is "1 in 1million-years" (NUCLEAR ENERGY AGENCY, 2010). This implies that Interviewee 3 is possibly unaware of the current safety regulations.

4.1.3 Cost

All the COSATU and NUM interviewees were of the view that nuclear power is expensive and would increase the price of electricity to the public. This is not true as the

cost of nuclear power is very competitive compared to other technologies (Table 1.3). The electricity price averaged over a few years is similar in both nuclear and coal plants because, although the construction costs of nuclear plants are higher, the running costs are lower than coal (KEMM, 2007). The electricity price in South Africa is controlled by Eskom so the price may increase due to decisions made by Eskom but not directly resulting from nuclear power itself.

Electricity price is a sensitive issue for the labour unions since 33% of households in South Africa do not have access to electricity and those that do spend up to a quarter of their salary on it (WORLD BUSINESS COUNCIL FOR SUSTAINABLE DEVELOPMENT, 2008). It is therefore understandable that there is concern around the price of electricity. However, more needs to be done by the nuclear industry to convince the Unions of the competitive cost of nuclear power.

The capital investment in the PBMR project by the South African government was raised by some COSATU and NUM interviewees. Interviewee 5 from NUM was of the opinion that the pebble bed technology did not succeed in other countries (Germany and Australia were mentioned) and would therefore be a waste of time and money for South Africa.

The pebble bed technology was first successfully proven in Germany with the Arbeitsgemeinschaft Versuchsreaktor (AVR) reactor. Thereafter the Thorium High-Temperature Reactor (THTR) was constructed in Germany but it was shutdown after the Chernobyl accident due to fears amongst the anti-nuclear organizations (MULDER, 2010). There is no history of pebble bed reactors in Australia. This disproves the claim by Interviewee 5 since the PBMR did not fail in Germany and Australia so this is not a good reason to hold back investment in the PBMR.

4.1.4 Political influence

The COSATU interviewee (Interviewee 3) stated that the South African government has been influenced by nuclear lobbyists which made them believe that nuclear power is

“clean”. As discussed earlier, nuclear power has a lower carbon footprint than coal, and some renewable technologies. Therefore the suggestion that the government is being misled by lobbyists is unjustified.

4.1.5 Job creation

Interviewee 2 from Solidarity stated that there would not be increased job creation with renewable energy technologies compared to nuclear power. The fact, however, is that more direct jobs are created by the renewable energy industry compared to the coal or nuclear industries (MILLOY, 2007). This indicates a possible misunderstanding amongst Solidarity regarding job creation in the renewable energy industry.

The NUM interviewees were under the impression that the preferential expansion of certain energy sectors would result in job losses in those that are not expanded. According to the extended literature review, South Africa has large coal reserves and this will ensure that the coal industry will create jobs for a significant time in the future (KEMM, 2007). South Africa is the fifth largest coal producing country in the world so the coal industry is not likely to lose jobs even if other power generation technologies are expanded (RESEARCH CHANNEL AFRICA, 2007).

4.2 Analysis of responses relevant to hypothesis 2: The different labour unions have differing views on and perceptions of nuclear power

It was generally found that the Solidarity Union was in favour of the expansion of the nuclear energy industry in South Africa while COSATU and NUM were firmly against it. Solidarity is the largest independent labour union in South Africa, while COSATU has many affiliates, NUM being one of them, and they stand together in their views on nuclear power.

The differing views between the unions on each of the five areas of research are discussed below.

4.2.1 Environmental impact

4.2.1.1 CO₂ emissions

Interviewee 2 from Solidarity raised the issue of burning coal at home which contributes to carbon emissions in the country. According to the extended literature review, coal is used in low-income households in South Africa for heat energy. It is estimated that the domestic coal use in the country amounts to 3% of the total consumption and there are 950,000 households using it (BALMER, 2007). The burning of this coal contributes to air pollution in the area it is burned, as well as respiratory diseases. According to Balmer, these diseases cost the South African government R1.2billion per year. The burning of coal at home can only be reduced if affordable electricity is made available to all South Africans (BALMER, 2007). Nuclear energy can contribute to the reduced price of electricity to the country to alleviate this problem.

The Solidarity interviewees believed that nuclear energy would reduce the carbon emissions in South Africa compared to coal. In contrast, Interviewees 3 and 5, from

COSATU and NUM respectively, did not agree with this because of their distrust in the reported carbon emissions.

4.2.1.2 Nuclear waste disposal

Interviewee 6 from NUM said that nuclear energy is carbon neutral which contrasted to the views of the other NUM and COSATU interviewees. This was, however, not seen as a favourable aspect for Interviewee 6 who believed that carbon emissions are less dangerous and hazardous to the environment than nuclear waste. They were of the opinion that nuclear waste is not currently safely disposed of in South Africa. Missing waste from the National Energy Corporation of South Africa (NECSA) was mentioned as one of the reasons why waste disposal cannot be regarded as safe. For this reason, coal power generation is actually preferred over nuclear power generation for Interviewee 6 who would rather replace existing nuclear plants with coal plants.

Interviewee 1 from Solidarity did not agree with an argument they have heard used by some groups regarding nuclear power: the worst possible accident with coal is not as bad as with nuclear and even though coal emits harmful substances into the environment, we know coal technology better so we prefer it. This is a similar argument used by Interviewee 6, discussed above, and therefore Interviewee 1 and 6 are in disagreement on this viewpoint.

Interviewee 5 from NUM expressed concern around water contamination resulting from gold and uranium mining. This contamination risk is definitely a concern for the country. The contaminated water started leaking out of old abandoned gold mines in and around Gauteng and it is contaminated with uranium and other heavy metals. This water can affect the foundations of buildings and contaminate water sources (HURD, 2010). Hurd states that the South African government is looking at solutions to the problem.

According to Dr. A. Turton and Dr. R. Doyle, the uranium in the contaminated water can be extracted and research into these extraction methods is currently underway (TURTON, 2010). There is a process that can extract uranium from the acid mine drainage (AMD) to

the extent that it is no longer detectable. This extracted uranium can be used to produce nuclear fuel but this has not yet been done (DOYLE, 2010). According to Dr Doyle, the government has not yet made a decision on dealing with the AMD.

Urgent action needs to be taken to ensure the safety of the public from the radiation in the contaminated water seeping out of mines. There are many sites in the country where AMD is exposing people to higher levels of radiation than the stipulated allowed limits (LIEFFERINK, 2010). This AMD originally started from old gold mines but it is also leaking out of mines currently in operation. Coal mines also result in the release of AMD and the exposure here is actually worse than gold mines since these are open cast mines (LIEFFERINK, 2010). The radiation release from these mines does not directly result from the nuclear industry but rather from the mining industry at large. There is therefore a possible misunderstanding on this issue with Interviewee 5 because it was implied that this contamination results from uranium mining and therefore from the nuclear industry. It is important that the unions are made aware of the root causes and solution plans in place for this problem.

In contrast to the views of the NUM and COSATU interviewees, the Solidarity interviewees believed that nuclear energy releases a small amount of waste which is well-controlled. This is preferred by Solidarity over coal plants where the waste is released directly into the atmosphere.

4.2.1.3 Energy efficiency

The NUM and COSATU interviewees were of the opinion that improving energy efficiency is critical to South Africa reducing its required energy supply capacity. This will reduce the environmental impact of energy generation and the South African government has a strategy to improving energy efficiency.

South Africa's energy efficiency strategy is driven by the goal to improve energy efficiency by 14% by 2014 (DEPARTMENT OF MINERALS AND ENERGY, 2004). The comparatively cheap price of electricity in South Africa in previous years has

resulted in low energy efficiency, and this needs to be improved in order to meet the growing energy demand. The energy efficiency strategy includes Eskom's strategy to reduce electricity demand and these combined efforts should reduce the new electricity generation capacity required.

According to a report by Worldwatch, energy efficiency is the key to job creation and meeting increasing energy demand (SONG, 2007). In the USA, increasing energy efficiency is estimated to have met fifty percent of the increase in energy demand since 1980. As discussed earlier, the South African government has a strategy to improve the energy efficiency of the country so the interviewees' suggestions should materialize.

4.2.2 Safety

4.2.2.1 Nuclear accidents

Interviewee 1 from Solidarity raised concerns around safety issues with the existing RBMK reactors (Table 3.2). They felt that these posed a possible safety risk globally. Post the Chernobyl accident, there were changes made to the design of the other existing RBMK reactors in Russia to improve safety. There are eleven of these reactors still existing, the last of which will run until 2026. These reactors do not have containment buildings but they do have radiation shields (WORLD NUCLEAR ASSOCIATION, 2010c).

There is validity in the concerns of Interviewee 1 from Solidarity regarding the RBMK reactors but work has been done to mitigate the safety risks. Interviewee 1 also believed that there is insufficient knowledge on the Chernobyl accident and the reasons for it, which has caused fear in other labour unions.

There was concern expressed by Interviewee 6 regarding the safety of running older nuclear plants, and the extension of the life span of these plants (Table 3.2). The technical

evidence that supports these actions should be made more available for a better understanding and acceptance when these decisions are made.

4.2.2.2 Radiation exposure

Interviewee 3 from COSATU raised a concern that the workers at Koeberg are not sent for regular check-ups. This could not be verified by contacting Koeberg directly. Interviewee 5 from NUM mentioned the “secrecy” surrounding information from the Koeberg plant. Attempts were made to find information on the regulations in place to limit the radiation exposure of the workers at Koeberg, and the actual radiation dose figures. It was very difficult to get hold of this information and a special request must be made to the station manager in writing. Even with this request, only limited information would be disclosed and this would not include the actual radiation doses of the workers.

It was found that there is much secrecy surrounding nuclear information, particularly the actual radiation doses that radiation workers are exposed to. This lack of transparency of safety information creates distrust of the unions in nuclear power. Information on radiation doses was found in Eskom’s annual report and this showed that the dose to the public is well below the regulatory requirements. The doses achieved by Eskom have been $<0.005\text{mSv}$ for the last three years and the allowed limit stipulated by the NNR is $<1\text{mSv}$ per year (ESKOM, 2010b). The information on the radiation doses of the workers was not stipulated per worker in the report but rather as a collective number so it cannot be compared to the regulatory limits set by the NNR.

Interviewee 3 from COSATU did not believe that the current safety regulations are sufficient whereas both the NUM interviewees thought that they were. However, they all agreed that nuclear waste is not currently being safely disposed of in South Africa. There was a level of inconsistency in the responses from the NUM interviewees because although they believed that the current safety regulations are sufficient, they did not think that waste disposal was well-managed and they believed that it is probable for an accident like Chernobyl to re-occur. This implies a lack of confidence in the enforcing of the regulations. As mentioned in Chapter two, there have been no incidents of unsafe

radioactivity release from nuclear waste storage facilities (WORLD NUCLEAR ASSOCIATION, 2001).

The safety of uranium mines regarding radiation exposure was believed to be a risk according to Interviewee 5 from NUM. The International Commission for Radiological Protection (ICRP) has developed standards for the protection of the public and radiation workers. According to a report by the World Nuclear Association (WNA), “the weight of scientific evidence does not indicate any cancer risk or immediate effects at doses below about 50 millisievert (mSv) per year” (WORLD NUCLEAR ASSOCIATION, 2009).

The radiation levels prescribed by the ICRP are 1mSv/year for the public and 20mSv/year averaged over five years for radiation workers. South Africa’s NNR has the same stipulation for radiation doses to radiation workers (NATIONAL NUCLEAR REGULATORY, 2009). The report by the WNA (WORLD NUCLEAR ASSOCIATION, 2009) indicates that these limits are currently easily achieved in the uranium mining industry, with the maximum dose recorded at being half of the limit and the average dose being ten percent of the limit.

In the early years of uranium mining (in the 1940’s and 1950’s), the levels of radiation were much higher (750mSv/year in mines in East Germany) than the current allowable limits and this elevated exposure resulted in many cases of lung cancer (WORLD NUCLEAR ASSOCIATION, 2009). The report by the WNA does not detail the statistics for each country involved with uranium mining. If the regulations prescribed by the ICRP are abided by, the radiation exposure in uranium mining should not result in any adverse health effects for radiation workers or the public. The NNR in South Africa is accountable for ensuring that these regulations are abided by.

4.2.2.3 Mining safety

The general opinion of all the labour unions was that all mining is always dangerous. Some interviewees believed that uranium mining could be more dangerous because of the greater depth of the mines. However, there was the general consensus that it is not a fair

comparison between uranium and coal mining because of the large difference in proportions of each in South Africa.

Mining fatalities in South Africa have reduced by 26% in the first nine months of 2010 compared with the first nine months of 2009 (PRINSLOO, 2010). Gold mining was found to be the most dangerous because these mines are deeper than other mines. The number of mining accidents reduced by 31% from the first nine months of 2009 to the same period in 2010. These statistics show that there is a commitment to improving the safety of South African mines and that this commitment is resulting in a real reduction of accidents.

Interviewee 6 from NUM indicated confidence in the regulations in uranium mining and the enforcing of it. It was also highlighted that if the regulations are not abided by, uranium mining would be very dangerous. Interviewee 6 also felt that the greater experience in coal mining could work to the advantage of coal regarding safety.

4.2.3 Cost

The general view on cost was that an expansion of nuclear power would either keep the electricity price the same or increase it. The Solidarity interviewees were of the opinion that no further price increases would be necessary in South Africa with an expansion of nuclear energy, while the NUM and COSATU interviewees believed that the electricity price would be likely to increase. Interviewee 6 of NUM was of the opinion that South Africa could not compete with countries like France and the USA regarding nuclear plant efficiencies and therefore with lower efficiencies there would be higher electricity prices.

4.2.3.1 Renewable energy

One of the Solidarity interviewees (Interviewee 1) mentioned that a larger plant capacity is required in a renewable energy plant to generate the same amount of electricity as a coal or nuclear plant, and longer transmission lines would also be required (Table 3.2).

This claim has been supported by a report (KEMM, 2007), which clarifies the limits on the harnessing capability of renewable energy.

Kemm states that with solar power, there is only a certain amount of energy striking the ground and this cannot be increased by any means. Thus in order to maximize the generation of electricity, the best locations in South Africa for solar plants are in the remote areas with the least cloud cover and therefore the maximum amount of sunlight reaching the ground. Due to the location of these sites compared to the major energy users in the country, very long transmission lines would be required to get the energy from the point of harnessing it to the end user. There would therefore be increased transmission costs involved compared to coal and nuclear plants. The energy generation of these plants would depend on the climate changes in the area so they could not be predictable or reliable in the long term.

Interviewee 3 from COSATU and interviewee 6 of NUM were both of the opinion that greater investment should be made in the renewable energy sector to grow the technology and thus enable it to supply the base-load power for South Africa. It is questionable whether there is enough value to be gained from a major investment in renewable energy over other technologies. Renewable energy is more suited to supply smaller communities rather than supplying the base-load requirement for the country.

4.2.3.2 Coal plants versus nuclear plants

Interviewee 2 from Solidarity made the comment that the Medupi coal plant is costing a lot more than the planned cost of the PBMR plant hence there should be no issues with the latter. The PBMR plant was planned to have a capacity of ~ 165 MWe for a total cost of ~ R40billion. The latest cost estimation for the Medupi plant is ~ R142billion (YELLAND, 2009) and its power output will be 4200 MWe. This translates to R242mill/MWe for the PBMR plant and R34mill/MWe for the Medupi plant.

This simple cost comparison is not accurate due to the fact that the PBMR cost would reduce with more plants being built. The estimated R40billion includes the cost of design

development but once this is finalized, subsequent plants will be cheaper. Interviewee 2 directly compared the costs of the Medupi and PBMR plants but this is not a fair comparison as the power outputs must be considered. When this is done, the capital cost of the Medupi plant is found to be significantly cheaper. As discussed previously, the lower running costs of nuclear plants still makes the cost very competitive.

Interviewee 5 from NUM made the comment that nuclear projects always exceed their initial time and cost estimates. The extended literature review revealed that the Medupi plant was initially planned to have a ten year implementation period with an initial investment of R100billion (ESKOM, 2010a). The Medupi plant has run over its initial budget and timeline. The latest cost estimation is ~ R142billion (YELLAND, 2009). The initial date for the plant to be fully commissioned was 2015 but since the inclusion of flue gas desulphurization, the plant is now planned to be complete in 2018 (ESKOM, 2010b). This demonstrates that the exceeding of budgets and timelines is not exclusively a problem with nuclear plants.

Just over \$3billion of the money required for Medupi was funded via a loan from the World Bank. This loan has not been well accepted by many people. Interviewee 3 from COSATU expressed concern about secrecy surrounding the loan from the World Bank. It was their opinion that the use of the borrowed money was not well publicized. The World Bank loan was made up of the \$3.05billion dollar loan for Medupi, and a loan of \$260million and \$485million for wind and solar, and “low carbon energy efficiency components”, respectively (MAIL & GUARDIAN ONLINE, 2010).

The general view of the NUM and COSATU interviewees was that nuclear power is more expensive than coal power and it would increase the price of electricity. Beside the cost comparison shown in Chapter one (Table 1.3), other factors affecting cost in South Africa that should be considered are: (1) The implementation of carbon taxes which would make nuclear plants even more cost competitive with coal plants because of their lower carbon emissions (PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY, 2006); (2) The transport costs of coal which are much higher than

uranium (KEMM, 2007), and this was part of the motivation to build the initial Koeberg plant in the Western Cape.

Overall there is a positive view on the cost of nuclear power by Solidarity while COSATU and NUM have a negative view and believe that nuclear power will not be a good investment for South Africa.

4.2.4 Political influence

The Solidarity interviewees believed that the reason the government has not expanded the nuclear industry is because of pressure from opposing labour unions. It was their view that the other unions do not support nuclear power because they believe the industry is dominated by white people. Interviewee 2 from Solidarity was of the view that the government would prefer to employ foreign labour at a higher price rather than white South Africans for fear of political pressure from the opposing unions.

Interviewee 6 of NUM seemed to confirm the issues raised by Interviewee 2 from Solidarity, discussed above, because the interviewee believed that the nuclear industry is dominated by white people and will therefore mostly result in White job creation. There was also the opinion that the nuclear industry could eventually replace the coal industry which would result in the replacements of Black jobs with White jobs. This is not supported by NUM and COSATU because they are in support of further Black job creation. This racial tension is currently providing a barrier to the expansion of nuclear power in South Africa.

There was a general consensus that although corruption is a problem faced in South Africa, the government has shown an intention to combating it. The interviewees seem to have confidence in the South African government but Solidarity has been upset with some of the political decisions made regarding nuclear power. It was generally believed that if corruption played a role in the expansion of nuclear power, it would only affect the awarding of the construction contracts and not the safety of the plants.

4.2.5 Job creation

The general consensus amongst the interviewees was that the expansion of nuclear power will not result in significant job creation, however, some interviewees were of the opinion that nuclear energy would actually increase the unemployment rate. The reasons that the NUM and COSATU interviewees did not support nuclear power was because they believed that it creates fewer direct jobs than fossil fuels and renewable technologies, and they thought that it would create foreign jobs rather than local jobs. These views contrast to those of other unions in the world which were discussed in the initial literature review of Chapter two.

Research done by Greenpeace has shown that renewable energy technologies will create more jobs than coal and nuclear power (GREENPEACE, 2010). According to this research, if renewable energy was expanded instead of fossil fuel and nuclear power, 2.1 million jobs would be created as opposed to 650,000 jobs if energy plans continued with fossil fuels and nuclear energy. This job creation would make up for the approximate 394,000 jobs that would be lost in the fossil fuel and nuclear industries.

In an article by Fox News, a report by the University of California (Berkley) is discussed. The research done by Berkley shows that about 240,000 jobs will be created by renewable energy in America by 2020 compared with 75,000 jobs if just fossil fuels are expanded (MILLOY, 2007). The Fox News article also states that the jobs created by a growing economy are far greater than those created by the energy industry. Dr. Tom Wigley (National Center for Atmospheric Research) expresses his disagreement with employing more people to produce a unit of power because he believes it is less productive.

The extended literature review has shown that there is greater job creation from renewable energy compared to fossil fuels and nuclear energy, which validates the views of the NUM and COSATU interviewees. Employing more people to produce a unit of power would ultimately result in higher running costs of energy generation.

The Solidarity interviewees were bitterly disappointed with the closing down of the PBMR project in South Africa. It has resulted in job losses for highly qualified individuals and Solidarity believes that some of the retrenched employees will be lost from South Africa permanently due to better opportunities in other countries. Solidarity is supportive of advancing with science and technology and do not want to condone exclusively driving the labour agenda. NUM and COSATU are more concerned with job creation rather than progressing with science and technology.

The United Kingdom's (UK) coal-producing capacity was down-sized by Margaret Thatcher and this made the UK dependent on importing coal from other countries to sustain its coal requirements. This downsizing of the coal mining industry in the UK caused major disputes between trade unions and government but this did not stop the closing of mines (SCOTT, 2009). This demonstrates that a government can ultimately enforce a decision that may be against trade unions. South Africa has recently announced its new power generation plan for the next 25 years. This plan includes nuclear (14%) and renewable technologies (16%) (SABC news, 2010) and COSATU and NUM do not agree with this plan. They believe that their opposition to the expansion of nuclear could slow down, if not prevent it.

The increased job creation of renewable energy is portrayed positively by those that support these technologies. With improved energy security, economies will grow faster and more jobs will be created by the healthier economies. It costs governments more to employ more people to do the same job and it is therefore more economically viable to implement technologies that require less people per unit of power produced.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 *Conclusions*

1. The results of the interviews clearly indicated that some union members expressed serious reservations regarding nuclear power and some of them were simply anti-nuclear, despite the reasons for their concerns.
2. Hypothesis 1 was proven true but not to the extent initially anticipated. There were only a few misunderstanding and misinterpretations amongst the interviewees and overall they were very knowledgeable on energy matters. More than a lack of knowledge, there was a lack of trust and confidence in the nuclear industry
3. Hypothesis 2 was proven true as the Solidarity Union had a vastly contrasting view to NUM and COSATU: Solidarity was strongly in favour of nuclear power while NUM and COSATU were against it.
4. There were a number of reasons why the NUM and COSATU interviewees opposed nuclear power:
 - a. Race was one of the issues which affected the labour unions' views. There was resistance shown by the NUM interviewees because they believed the expansion of nuclear power will ultimately result in the diminishing of the coal industry, thereby taking away current Black jobs and creating foreign or White jobs, on the basis of a higher skill level in the nuclear industry.
 - b. The secrecy of the nuclear industry regarding safety information introduces discomfort and distrust in the labour unions. This safety

information is restricted and not publicized or attainable even when requested, which gives the unions the impression that the industry has something to hide.

- c. They did not believe that nuclear energy would reduce the country's carbon emissions. They are of the opinion that the entire fuel cycle is negative to the environment and therefore nuclear will not result in a net reduction of carbon emissions for the country. The carbon emissions of the nuclear fuel cycle have been measured and it is a fact that these emissions are low compared to all other power generation technologies (Figure 1.2). NUM and COSATU did not seem to trust these published figures.
 - d. They were less concerned on the issue of carbon emissions than the other safety risks of nuclear energy, such as radiation exposure and the possibility of accidents. The reason for the concern around safety issues was distrust in the nuclear industry, partly due to its lack of transparency. The safety risks resulting from acid mine drainage are also perceived to be linked to the nuclear industry because of the elevated uranium levels. There are some possible misunderstandings regarding safety but the biggest issue appears to be the lack of trust in the industry.
5. The interviewees were all of the opinion that the nuclear industry will create more skilled jobs than unskilled jobs and there will be no major job creation from the industry. Some interviewees believed that unemployment will eventually rise if nuclear energy is expanded.
 6. The objectives of the research that were mentioned in Chapter one were achieved:
 - a. An understanding of the labour unions opinions on energy generation in South Africa was obtained.
 - b. Recommendations on building the confidence of the labour Unions in nuclear power have been formulated and are presented in section 5.2.

5.2 *Framework for building the labour Unions' confidence in nuclear power*

From the results and conclusions of this research, it is evident that the expansion of the nuclear energy industry in South Africa can be realized if all relevant stakeholders take heed of the current obstacles facing the industry and embark on a process of overcoming them. Against this background, it is envisaged that the framework proposed below is given the importance it deserves.

5.2.1 Formation of a Forum

There is a need for the creation of a fully represented forum (represented by all stakeholders), which would chart the way forward into making nuclear power generation a much valued and accepted source of energy. In order for this forum to have the necessary influence, it should be driven by a champion organization.

Eskom could fulfill the role of the champion organization since it has a vested interest in the expansion of nuclear power and is the major power utility in the country.

5.2.2 Proposed Composition of the Forum

It is important that such a forum is well-represented by government, all the major labour unions, the NNR, NECSA, Eskom, the Nuclear Industry Association of South Africa (NIASA), universities involved in nuclear research and relevant environmental organisations.

Government representation would form a critical part of the forum because they must ensure the best interests of the country. Their role will be to make the correct decisions for a stronger economy, reduced unemployment and reduced carbon footprint. The government representation must ensure that the long-term vision for the country is

fulfilled and by discussing this vision with the forum, it is more likely that they would get the buy-in of the members in the forum.

5.2.3 Role and Functions of the Forum

Emanating from the results of this research, the role and functions of the forum would be to ensure adherence by its members, at all times, to the following:

- 5.2.3.1 Any incident in the nuclear industry is promptly, factually and transparently reported to the forum and public. These reports should clearly outline the nature of the incident, the possible causes, and preventative and corrective action that would be taken. The forum must then be given the opportunity to make submissions of their inputs on the planned action and these submissions must be given the consideration and recognition they deserve.
- 5.2.3.2 The nuclear industry needs to be properly represented by all races in the country and a much greater commitment to black economic empowerment, and skills development needs to be demonstrated. In this regard, much can be done by organizations such as NIASA in showing a commitment to balancing their racial representation.
- 5.2.3.3 The lack of trust and confidence in the nuclear industry by the labour unions needs to be taken with the seriousness it deserves, by role players such as Eskom, NECSA and the NNR. All facts and figures on the actual radiation doses workers are exposed to and all performance data should be readily and transparently disseminated. This would help build the trust of the unions in the nuclear industry and rectify any misunderstandings that exist.
- 5.2.3.4 The growth in the economy resulting from a more stable electricity supply will ultimately lead to job creation, but these jobs demand more skills as an

economy progresses. In this regard, the nuclear industry should work together with the government to ensure adequate funding.

5.2.3.5 The labour unions must use the forum as a platform on which to raise their concerns about nuclear power. They should also be open to discussion about their concerns so that the long and short-term interests of their members are looked after.

5.2.3.6 All the members of the forum should work together in a professional manner. A code of conduct should be drawn up in which all members are afforded an equal opportunities to express their views and concerns. All concerns raised must be dealt with in a fair and constitutional way.

5.2.3.7 The media will also have a part to play in the forum and they must be notified of decisions made so that the public is kept aware of the forum's progress. There should be equal opportunity for all parties of the forum to be represented in the media.

5.3 Recommendations

- 5.3.1 Further research should be done with the objective of helping improve the public relations aspect of the nuclear industry. An important outcome of the proposed research would be the creation of a better working relationship between the nuclear industry and the labour unions. The public relations department of Eskom could undertake such research by virtue of its vested interest in nuclear power.
- 5.3.2 The framework proposed in section 5.2 should be given serious consideration and should be regarded as a good starting point for the way forward.

Unless a concerted effort is made by all relevant role players to address the concerns of the labour unions with commitment and sincerity, the objective of making nuclear energy a more accepted option in South Africa, cannot be realized. It is envisaged that the findings of this research together with the proposed framework would serve as a good starting point to embark on the process of achieving this objective through further research and implementation of the recommendations of this and other research.

CHAPTER SIX

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6.2 Interviewees

Interviewee 1:

Union	– Solidarity
Position	– Researcher
Highest qualification	– BA degree
Age range	– 20 to 30

Interviewee 2:

Union	– Solidarity
Position	– Senior organizer
Highest qualification	– MSc degree
Age range	– 30 to 40

Interviewee 3:

Union	– COSATU
Position	– Policy co-ordinator
Highest qualification	– MSc degree
Age range	– 40 to 50

Interviewee 4:

Union	– Solidarity
Position	– Retired deputy general secretary
Highest qualification	– Matric
Age range	– 50 to 60

Interviewee 5:

Union	– NUM
Position	– Researcher
Highest qualification	– Matric
Age range	– 20 to 30

Interviewee 6:

Union	– NUM
Position	– Chairperson of PBMR branch
Highest qualification	– MBA degree
Age range	– 20 to 30

APPENDIX 1: INTERVIEW QUESTIONS

Table A.1: Interview questions

<p>Questions 1: The nuclear fuel cycle: Uranium is mined and then processed into fuel before it is transported to a nuclear power plant where it is used to produce electricity. The spent fuel is then sent into short-term, intermediate and then long-term storage where it is managed to limit the release of radioactivity.</p> <p>What do you think of this cycle? Why</p>
<p>Question 2: Suppose nuclear power was expanded in South Africa, do you think this will create more jobs and reduce unemployment in the country? Why?</p>
<p>Question 3: Do you think there will be jobs for skilled and unskilled labour with an expansion of nuclear power? Why?</p>
<p>Question 4: In order to build a nuclear power plant there is a very rigorous licensing process with very strict safety regulations that ensure safety even under accident conditions.</p> <p>Do you believe that this process is sufficient to ensure the safety of the public and the workers in the plant? Why?</p>
<p>Question 5: How do you think the safety of uranium mining compares to coal mining? Why?</p>
<p>Question 6: Do you believe that the waste from nuclear power plants is safely disposed of? Why?</p>
<p>Question 7: Do you feel confident that a disaster like Chernobyl will not re-occur?</p>
<p>Question 8: The South African government has shown a commitment to eradicating corruption. Do you agree with this statement? Why?</p>
<p>Question 9: Do you trust the government to make a decision on implementation of nuclear power based on the interest of the country as a whole without allowing any personal gain to be involved? Why?</p>
<p>Question 10: One of the benefits of nuclear power that has been used to promote it, is the fact that carbon emissions are much lower than other power production technologies.</p>

Do you agree that nuclear technology would reduce our carbon footprint? Why?
<u>Question 11:</u> Do you think that it would be better for the environment to use renewable energy technologies like hydro or wind power, or do you think nuclear energy will be a viable option regarding the environment? Why?
<u>Question 12:</u> There are many organizations involved in the licensing process and the building and running of nuclear plants. What is your view on these organizations like NNR, NECSA and Eskom? Why?
<u>Question 13:</u> The current proposed energy plan includes nuclear energy. Do you agree with this plan? How do you think it should change?
<u>Question 14:</u> Do you think that it is financially worth while for the government to invest in nuclear power? Why?
<u>Question 15:</u> If a nuclear power plant is built, how do you think the price paid by the public for electricity would change? Why?
<u>Question 16:</u> Has your union made your views on nuclear power public? Does rhe government know your views?
<u>Question 17:</u> Do you think other unions have different views to yours? Why?
<u>Question 18:</u> Do you think that if the labour unions do not support nuclear energy, it will stop the implementation of it?

APPENDIX 2: INTERVIEW RESULTS

Table A.2: Interview results for interviewee 1

Age	20-30	x	30-40		40-50		50-60	
Sex	Male	x	Female					
Race	White	x	Black		Indian		Coloured	
Union	Solidarity							
Position in union	Researcher at the research institute focusing on political and economic issues							
Highest qualification	BA with PPE (politics, philosophy, economics)							
Years of experience	3 years							
<p>Question 1: In terms of safety - I'm under the impression it's quite safe. At Koeberg, they are storing the high level waste in the containment. There's enough space to store the high level waste for the entire life of the station. The lower and intermediate level waste they store at Vaalputs – the waste they store there is less radioactive than the soil in the area – it is actually making the situation better. The high level waste could be re-processed to produce fuel again – not really waste if someone is willing to process it.</p> <p>The reactor at Chernobyl did not have a containment building because the crane they used was too high and they couldn't build a containment around it – we and most of the world will not do that again – the reactors of the old design in Russia are the only ones with safety issues. The possibility for accidents is very low – there's risk is involved in anything so we shouldn't be afraid of nuclear.</p> <p>The mining is probably where there is some concern – SA has not had any major issues but there are other places where the safety of the uranium mining process has been a problem.</p> <p>Uranium ore is not a concentrated product so exposure is easier – personally people are not as careful with it – accidental exposure is most likely due to the fact that people would not realize the threat</p>								
<p>Question 2: Yes, because of the direct jobs involved – not too many though, not as much as coal. At least in the near future we are not going to replace coal with nuclear so coal will not lose jobs. Can only be a net gain in jobs even though it will not be large. Whatever we do with our coal in the country, it will get mined even if we don't use it for power – will get exported. In terms of</p>								

how environmentally friendly nuclear is – it is much better than coal.

In the broad sense – electricity shortage is less likely than just with coal. Electricity supply ensures more job creation – but you could also argue that if we had enough coal we could manage.

Question 3: Yes, mostly skilled. Unskilled as well – not as much as fossil fuel but it will still happen. Just because there is currently a lot of unskilled labour, we can't not use technology that requires skills because unskilled labour will not get jobs. Not a valid argument to me – doesn't mean you shouldn't try to create jobs for them but you shouldn't stop a technology for it.

Question 4: Yes, both locally and internationally. Locally, we have the experience – have done it before. Such stringent regulations in place – so many agencies and people that scrutinize the process – cannot get away with cutting corners. We've seen this in coal mining where procedures were not followed completely – more intense scrutiny in nuclear that will prevent this

Question 5: Direct safety of workers – many more accidents in coal mines. Partly because of where they are mining – in the coal mines there are added gases with a higher explosion risk. There are many more coal mines so a direct comparison is not fair – they are comparable with safety. In 1 you have some hazards that you don't have in the others – uranium mines are deeper than coal mines. Uranium is a by-product of other mining processes like gold – not really an issue of mining for uranium specifically – it is not a direct choice whereas it is with coal. You have to intend on mining for coal unlike uranium

Question 6: Yes but we shouldn't be complacent about it – still have to check and make sure that as far as we are aware, there's no problem with the process followed. In terms of the waste disposal process in nuclear versus fossil fuel power plants – quite different because in nuclear there is a small amount of waste and you can control where it goes but with fossil fuels it just goes into the air and there's no control – it affects everything.

Question 7: Not necessarily in the plants of that design still operating in Russia. There are still some plants like that without strong containment buildings that could be a risk. One would expect that they have learnt their lesson and would not let inexperienced people handle the reactor. None of those types are being built anymore. 3-mile island and the case in Japan – well-contained – no safety issues for people outside. Quite surprising that 3mile island stopped the building of new plants in the US – it was actually a success story that showed it can be safe even though something went wrong.

Question 8: If you take the verb 'has shown' – if it means the same as 'has said' or 'has written down' then YES, but if you say 'has done so' then NO. Some government members will say they are committed to it and they mean it but their actions do not reflect this. The people who say it probably are honest when they say they want to stop corruption but we haven't seen much happening on doing it.

Question 9: I think in practical terms it would be a mixture of both unfortunately – most things that need approval from government happen partly and hopefully mostly because it's in the interest of the country but personal gain can also play a part. Unfortunately the sense you get is that whenever a lot of money is involved, someone will have to get something personally before it goes through.

I think you have to have the proper procedures in place and can't be complacent – must ensure they're being followed. When they're not followed, it must be followed up. In terms of the rules that exist – they are good but with the enforcement of the rules – there are attempts to enforce them but in the end it may not happen – must be done in a timely manner. Can't do it after the power station is built – must know about it at the right time – like the arms deal – was discovered too late.

Question 10: Yes, we definitely agree with that. It's self-evident really – you are not emitting a massive amount of fossil fuel waste into the atmosphere every day. Koeberg is almost the same as a big coal station – if you could replace a big coal station with a nuclear station – will reduce the contribution to pollution – not only reduced CO₂ but also the ash and other pollutants – it's a very long list of pollutants. We won't replace all of them but we should avoid building new ones – they also require water in coal mining. All that will reduce carbon emissions. On a personal note – it is immaterial whether global warming is true – if we can improve the quality of the air and water and reduce climate change we should do it. The smog when you're flying over Joburg is evident that our pollution levels are too high!

Question 11: Not chosen over nuclear but should be used in combination with nuclear. Hydro – we don't have more capacity for this in SA, we can import it but within our own borders we don't have more capacity. In terms of wind and solar – should not be neglected – where it is feasible, it should be done. People sometimes forget that to make solar or wind power viable as a base load power, you need a lot more built to make it feasible or you need a few plants in different areas. Also need more transmission lines – adds to the cost and complexity of the system. Could follow

the pump storage route but will need a massive dam built. A dam has quite a big impact – has to be added into the calculations. Don't want to go that route but you want to use the cleaner energies and using them in combo with nuclear is a better option than using coal-fired power in combo instead – can adjust the output a lot faster with nuclear. Can't really vary the output of coal reactors as quickly – better to use nuclear in combo because of the faster reaction time which is more efficient. Can't choose one clean technology or the other – it's about the type of combination you choose.

Question 12: We have a lot of members in NECSA so my view should be positive – a lot of members in Eskom which we all know about. NERSA – we're not so comfortable with their role. They seem to have a lot of capacity constraints. They do not have the resources to perform their function adequately. As an example, the municipal tariff increases – the processes followed have not been according to procedure – they don't seem to have the capacity to deal with all the municipalities. Don't have time to look at all the recommendations. They changed their mind twice this year and when certain municipalities did not want to agree, the results were very inconclusive – if this will happen with nuclear, it would not be good.

No issues with NECSA and NNR

Don't want NERSA to have a role to play in nuclear if their capacity does not improve

Question 13: Not that familiar with the plan – not sure if the last one I saw is the most recent.

Am happy with nuclear being included - if it's not, that's a problem!

Big disappointment for us when the PBMR project started to unravel earlier in the year. If the other plans do not materialize – will be an even greater tragedy.

Part of the reason why the plans have been stalled (very little progress has been made) – some people have a bad reaction to the technology regarding safety and they also have extreme paranoia. Some people say that even though the size of the risk of the problem is small, the conceivable consequences are what you should look at – that argument should not be used. They say: We know coal is emitting harmful substances but we know it and the worst accident with a coal plant is not as bad as nuclear – I do not agree with this argument.

Question 14: If there was no alternative – I have to pay tax – so if I had a choice on the technology it would be used on like coal or solar or wind or nuclear – I would choose nuclear in SA at the moment. If the extra option was on the table for private sector funding then that would be the best – doesn't look like there are good chances of that now. Would have to at least be

partly financed by government – best place for this investment would be nuclear rather than anything else

Question 15: It might – especially if the financing model stays as it is – if they want to repay within a few years. If you look at the figures and once the loans etc are paid off, if electricity tariffs increase after that – there should be a huge surplus to build new plants in the future. I don't think more price increases will be necessary – current price increases should be sufficient. If the tariffs stay at that level and just increase with inflation – will quickly give a large accumulation of profit to Eskom – could include building of nuclear power plants. Don't think Eskom would agree that they would have a massive surplus. Don't know where they plan for that money to go but it should go to new power plant building. No significant impact on cost by nuclear should happen – if the money goes where it should.

Question 116: With Eskom and NERSA we have expressed our support but not at the executive government level yet.

I think NUM and COSATU are not as positive about it as us – I'm not sure what their reasons are – it could be a concern around jobs with the whole fossil fuel supply chain but our view is that this will not be an issue – if we don't want it, another country will. It will take years before an impact is seen here to reduce jobs.

Question 17: I think part of it is also the environmental issue that mining uranium and refining it will contaminate the country with radiation – could be insufficient knowledge of the facts. Most people I spoke to about Chernobyl they think it is the equivalent to an atomic bomb going off – the half-life of the products in a bomb is probably lower so maybe that would have been better. It is extremely unlikely that there would be major contamination from Koeberg – don't think the distinction between Chernobyl and another proper reactor – not widespread knowledge on it.

Question 18:

Table A.3: Interview results for interviewee 2

Age	20-30		30-40	x	40-50		50-60	
Sex	Male	x	Female					
Race	White	x	Black		Indian		Coloured	
Union	Solidarity							
Position in union	Senior organizer							
Highest qualification	MSc in labour law and employment relations							
Years of experience	Solidarity - 2 years and before at the public servants association for 12 years - was a labour relations officer - still focused on collective bargaining							
<p>Question 1: Solidarity is quite in favour of nuclear power. It is a trade union that deals with qualified technical and professional workers – we differ vastly from the other trade unions. It is our contention that the science behind nuclear makes total sense. We believe that the mining of uranium and all the products and the process of generating electricity does not cause the problems that people perceive – there are no additional problems with mining uranium as mining coal – mining is mining. If we move to nuclear it will not harm coal mining because there is an extensive market for coal – it will not replace coal as the main source of energy. There is a possible threat that could take place with nuclear in terms of an accident but versus the pollutants that coal releases – we believe it is a fair trade and worth the risk. We believe it makes business sense to go with nuclear. We want to support moving forward with science rather than just driving labour. Nuclear is a lot more regulated than coal</p>								
<p>Question 2: Unfortunately I don't think so – the mining side will be labour intensive. I just went through the retention of 900 employees at PBMR – extremely highly qualified individuals that worked on the project for 10 years. We think there is a political agenda on this – the minister says that she wanted to close PBMR and produce a new kind of talent – we know what this means, she wants the designate groups. Unfortunately the designate groups are in small numbers – these are wanted but they are not coming through. Our projects will probably be run by Westinghouse – very few jobs in the higher levels but in the mining sector there will be.</p>								
<p>Question 3: More jobs for skilled labour. PBMR did not have mining but they had 900 employees – not significant job creation but if the plant was built there might have been more jobs created with mining but the initial 900 might have reduced because not as many technical skills would</p>								

have been required.

Question 4: I believe the correct protocols are in place – just have to look at Koeberg – its operation has just been extended by 15 years I think. It has had no major incidents. Everything is regulated. We believe if we have the right people in place we will sufficiently stop these risks – can't be 100% sure but if we have everything in place, we can mitigate these risks – it must just be in place. We need the right knowledgeable people in place – may be an issue in our country with getting the right people in the right positions.

One must accept in terms of labour – if you choose a career in a risky environment you must understand the risks – there is a premium salary paid for a risky job – if you look at NECSA – they earn 20-30% more for their scientific qualification because of the risk they are exposed to – they are compensated for it. NECSA have sport days etc to help their employees relax – the majority of the males that work there are sterile but they accept it because they chose it. The problem is at the bottom level where they work for just a job and not for a career – but we do not condone the irresponsible the lack of control with not adhering to health and safety standards – we will intervene then. We will not require the employer to guarantee zero levels of radiation because that is impossible – there will be exposure but it must be controlled

Question 5: Similar risks in both minings – differences with the refining but not with the physical mining

Question 6: I went to NTP NECSA recently and went into their workshop where they were building stainless steel containers for disposing of nuclear waste from Pelindaba – they are placing the certified concrete container in a stainless steel container even though it is not necessary so there are extra precautions taken. Koeberg has quite a good track record about this. Hopefully we do not accept waste from other countries – if that happens we will react as Solidarity.

Question 7: (Laughter). It might happen – I won't say I it won't. I think if we follow regulations to the book and have competent people working on it – it shouldn't happen. The regulations have improved over the years as the knowledge has improved. An accident may still happen with all the regulations in place and it could be big if it happens. We still feel that the clean energy we get mitigates this minute risk as opposed to the use of coal

Question 8: There's a declaration of intent – not necessarily a declaration of action. If the head of police could be corrupt then anyone could be – that makes me not believe it

Question 9: We always say you deserve the government you elect. The elected government has made a decision to pull the plug on certain nuclear projects with the intention of building other nuclear plants. They mentioned those intentions at the beginning of September. For them to embark on a process of building a new reactor – they will have to pay for international resources and designs and it will cost a lot more. Instead of using local resources which cost less and have the right expertise like at PBMR and now we have lost that – the ex-PBMR employees will not easily and readily fall for another offer from government and they have now even moved to other parts of the world. Those employees were highly qualified and competent and have now been lost. The government has a statement of intent and not action.

Of course there could be corruption – if you look at PBMR an amt of about R2bill was lost due to placing a construction order too early. Corruption in SA is quite rife. There is a huge amt of space for corruption on procurement – not necessarily on the design side. The cost of the graphite on the PBMR – was R100mill so there's a lot of money involved. Other examples have shown that tender fraud is a huge problem – name recognition etc. is used to award contracts. You find that people who get the tender may not have applied for it but other people apply and then give the contract to someone else - some people view it as business and not corruption

Question 10: We would definitely reduce – it depends how much electricity consumption it replaces – it will always mean less coal burnt. When it gets to 15-20% and more of our capacity it will have a significant impact on reduction of CO₂ emissions. The problem in our country is that people burn coal at home. If you look at the PBMR, it didn't need to be near water it could've been built in Johannesburg – less strain on resources available. If we could expand nuclear and use less resources we would be 100% behind it

Question 11: Our belief is that renewables do not give the same yield – nuclear gives a much higher yield so we believe it makes more sense to invest in it – less impact on environment because the size of the plants is smaller. I don't think renewables will create more jobs than nuclear – smaller companies will be involved. Cell networks have put up lots of towers and they have contracted out the running of the towers to very small groups – only about 5 people. It won't create vast employment. Not a good reason to choose it over nuclear

Question 12: NECSA has been to a large extent getting smaller over the past few years. Have moved more to a regulatory function – government funding to them has dropped. NNR is the regulatory body and they are statutory – they are not from the business oriented environment –

have problems with time frames and carrying out work – they probably need to be jacked up. I believe Eskom is not really interested in nuclear – more interested in coal. Although they are in charge of this process – I don't think they will look at nuclear. Coal plants are more labour intensive – they prefer that. They have a large labour contingent in mining – mining union operating within the electrical sector

Question 13: It should intensify and use local knowledge – it should not utilize or rely so heavily on outside knowledge. Our own scientists and engineers should be used. All of the resources should be localized – the government would rather pay 5 times more to employ outsiders than a white SA male for political reasons – because of the views of the other unions. The tail wags the dog.

Question 14: Not SA private sector – they do not have the financial depth here especially with the exchange rate. If there is investment it would be from overseas – North Korea, North Africa, USA and Germany have shown interest in investment in nuclear. This type of agreement also involves the government so these processes take years. I don't think we have other funding except the government and they have other priorities. I would be happy if they did invest in it – especially for the green issues

Question 15: If you look at Medupi, it is costing R100bill – PBMR would have cost a total of R40bill (R10bill to date and a further R30bill) – R60bill less than Medupi so what is the problem? We don't think it will increase the costs – a coal plant will have to continuously use a lot of coal – running expenses will be lower with nuclear. Costs will go up but not because the technology is more expensive – Eskom will hike up the costs anyway.

Question 16: We made a statement a few months ago regarding nuclear. Between November and Feb we explained our total view.

Question 17: They do not agree with nuclear – probably because of job creation – they are socialist in nature and concentrating on the lower end of the job market. The demographic of the scientific nuclear people in SA does not fit their political agenda – they view it to be racially driven.

Question 18: It seems at this stage that the unions are disagreeing with government on a lot of things but it doesn't stop government from doing what it intends – it will delay government but eventually government will take a decision that suits it. The unions cannot indefinitely use industrial action to make a political point at the expense of their members – they cannot stop things

from happening. You need to know your limitations as a union.

General comment:

We are quite disgusted and unhappy about the process the government has taken regarding nuclear after signing the Copenhagen agreement that Zuma signed – the government decides to retrench the top-notch scientists that were precisely what the agreement mentioned – they could have decided to go with another Koeberg but they didn't. We are losing our great minds to overseas because other countries need their resources – we've lost them for good so we are extremely dissatisfied with that. They could have taken a year or 2 to make a decision and paid them because they are not going to come back because it is eventually working toward your own security – they will look for that security elsewhere because of the risk to their own financial security

Table A.4: Interview results for interviewee 3

Age	20-30		30-40		40-50	x	50-60	
Sex	Male	x	Female					
Race	White		Black	x	Indian		Coloured	
Union	COSATU federation							
Position in union			Policy co-ordinator					
Highest qualification		MSc in governance						
Years of experience					More than 10 years. Previously with another union for 3 years			
<p>Question 1: I'm not an engineer or a nuclear physicist. I may not understand some of the things. From where COSATU stands we do not regard nuclear energy as clean when you consider the whole cycle – because of costs. The mining of uranium has carbon emissions involved. Other studies that have been done by environmental activists have shown that it gets difficult to mine the uranium. We are being told that coal will get more expensive and will use more energy. There's no way that the whole life cycle is clean. The best way to go would be renewables. We can't just move away from coal overnight though – it is a process. We need to look at technologies that can make the coal process cleaner – there are these interventions going on. Ultimately we must move toward renewables. We also don't believe that interventions of the energy sector must be de-linked from the industrial policy. We should not seem to be importing technologies, we should develop them ourselves</p>								
<p>Question 2: The minister of public enterprises announced last week that they are disinvesting in the PBMR project. Instead of creating jobs, we don't believe nuclear energy will create jobs in the scale of the unemployment rate of the country. It is capital intensive and very expensive. It is therefore creating fewer jobs because it is capital intensive. A lot of money was spent in PBMR – about R9bill and it would need an additional R30bill to continue with the project. Now it has collapsed and those jobs have been lost – it is a lesson we must learn form this whole debacle. That money could have been used to create jobs in other areas – or for education. It could have been used to employ more educators and for more equipment in the public health sector – could have addressed things that workers have been complaining about.</p>								
<p>Question 3: Already answered.</p>								

Question 4: No. We don't think so because recently we had a discussion with one of the workers that has been working at Koeberg for some time. He indicated that workers at Koeberg have never been taken for check-ups – no regular check-ups. The effects of radiation are very severe even though the nuclear industry would refute this. If there are alternatives, why don't we start now instead of expanding nuclear as a share of the energy mix of the country? There is no evidence to prove that the workers are not affected because no tests are done on them

Question 5: Mining is mining – fatalities can happen in both instances and both are a concern. Mining is very dangerous and as mines get deeper there is even more danger of death. Neither is better

Question 6: No.

Question 7: Not at all. It is unfortunate when such disasters happen – many people get affected. The economic impact as mentioned before must be taken into account. I do not think it is safe enough to prevent a disaster

Question 8: It has, there is commitment. Obviously we would want to see more happening – we have recently supported minister Tokyo Sexwale who is taking drastic steps to eradicate corruption in the construction industry – especially with the RDP houses. Unfortunately the public views it as acceptance if nothing is done. Fighting corruption is one of the key focuses of the ANC 2009 elections manifesto – 1 of the 5 priorities.

Question 9: Unfortunately I have mixed feelings as far as that. When it comes to PBMR – we have been very consistent together with other organizations like the SA council of churches – government wanted to privatize Eskom earlier and they didn't want to support Eskom in the electricity industry. In this instance it would be very possible that government would listen to business interest. Nuclear energy became unpopular after the disasters but since the climate change issues it has come up again. We have been opposing the expansion of the industry. We have policy and the government is sticking to it with nuclear – not learning from mistakes of PBMR. They seem to have fallen into the trap by the nuclear lobbyists that say it is clean and the way of the future. We've been told that other countries are going the nuclear way and therefore we should too or we'll be swimming against the tide. We've seen this soon after 1994 elections – government opened the economy to international companies and jobs were lost particularly in the textile industry because of importing expanding.

Question 10: If you look at the whole life cycle it will not reduce the carbon footprint.

Question 11: Government is saying renewables can't provide the base load power and that is why they are opting for nuclear but we should conduct research and look at how other countries have succeeded in implementing renewables in their countries. We believe we haven't done the work in that area to get renewables to provide the base load. Businesses need the base load but if you implement nuclear then you must take resources like indicated earlier from other priority areas to subsidize it. Even residential consumers will be paying in that case. There are other ways over renewables – experts in the energy field will tell you that there are other things to be done to use energy more efficiently. Eskom has indicated that they have saved massively through using energy more efficiently. We are willing to use our own infrastructure to reduce the usage. There won't be any need to build the coal stations planned if we improve our efficiency – it is not being used efficiently. Businesses should get more efficient and use co-generation but also investing in technologies that are reducing carbon emissions from the existing coal plants as well. Expand renewables massively and in the process we must create jobs – there will be direct jobs from renewables. Given the high levels of unemployment especially with young people, any intervention that will create decent jobs are welcome

Question 12: NECSA and NNR - we don't have much of a problem with them but there is a lot of secrecy involved with nuclear energy. I have not really seen NNR doing what NERSA normally does when it is consulting on an Eskom application – we need that level of participation. These regulators will eventually succumb to pressures in the industry – it has happened with Eskom with the proposed tariff increases. There is a problem there. Secrecy – Eskom got a loan from the world bank and we called for Eskom to make the conditions of the loan public – obviously you would be suspicious particularly if you are not directly involved. The loan was used for coal fired power stations but they said part of it would be used for renewables but there are no details.

Question 13: No I do not agree with the plan including nuclear

Question 14: No

Question 15: No we don't think it would come down – nuclear power is expensive. External costs – will be coal for fossil fuels. Nuclear energy would increase the cost to the public. Nuclear industry admits that the running costs are high because of the kind of technology used. That is why they are asking for subsidies. Both the running and capital costs are high

Question 16: Yes. In 1999 we had our inaugural central committee like the ANC one in Durban now. That conference – we stated that nuclear must not be part of the energy mix. We have together with other organizations, said that PBMR must be abandoned. When government was developing the nuclear energy policy in 2008, we made a submission to government to say that we do not support nuclear.

Question 17: COSATU unions have 1 position but there are discussions with other unions. NUM is our biggest affiliate with energy. The policy structures in unions are national policies. The COSATU position is informed by the affiliate position. Our views are the same – COSATU and its affiliates.

Question 18: There are many policies that government has implemented despite our objections – we were opposed to inflation targeting. But we think we can provide some speed bumps in the process – our banks have not been affected by the economic crisis but we were not given any credit for that. If we are not opposed to privatization we would probably have it now. Even minister Barbara Hogan made an announcement about PBMR – we have skilled people that can work in the nuclear industry. She is cautious – she did not say we are expanding, she just said if there is a need to expand we have the skills.

Table A.5: Interview results for interviewee 4

Age	20-30		30-40		40-50		50-60	x
Sex	Male	x	Female					
Race	White	x	Black		Indian		Coloured	
Union	Solidarity							
Position in union	Deputy general secretary (retired)							
Highest qualification	Matric							
Years of experience	25 years of organizing							
Question 1: Think it's managed fairly well – as well as it can be								
Question 2: Depends on the type of nuclear facility. If the PBMR was looked at, it is cutting edge technology – the first in the world. If it was viable for the rest of the world – it would create manufacturing jobs that would be a tremendous benefit. The current nuclear reactor types would not create that many jobs – their major purpose would be energy generation. We can create a whole new industry based on PBMR in the engineering and manufacturing fields. Casting of the reactor will be something that could be done in a specific country. The PBMR would create the industry here for downstream manufacturing – we will be the OEM for the rest of the world – it would be under our license. If we could refine the technology, it is small enough to be placed anywhere.								
Question 3: Not much for unskilled labour – only in the construction phase on a temporary basis. Will mostly be highly skilled								
Question 4: Yes. The safety issues are much better than the contamination issues with other technologies. The reason I would support nuclear is because the base load can either be produced by coal or nuclear and coal is dirty. We cannot do hydro. Clean energy cannot be used for the base load – only as a top-up								
Question 5: Mines both have their risks – should be similar with safety. Uranium mines are much deeper but there are risks on both sides								
Question 6: As much as I know it is as safe as it could be. I've seen the Koeberg storage and they have assured me that it can be stored for many decades. Apparently the later stages of storage are safe – so I've been told								

Question 7: We had a bit of a study on that and saw that both Chernobyl and 3 mile island had very old technology and the safety precautions were not taken. Apparently in modern nuclear reactors those accidents would not be possible – as far as I can gather from the people working in the nuclear industry. We visited Pelindaba and Koeberg and the nuclear plants there seem safe. Saw the water cooling system with the sea water and how the water will not be contaminated.

Question 8: It is a political statement and one would say there is an intention to do it. I'm not sure if it is actually being done or to what extent. I know the intention is there.

Question 9: I think they will – there is major pressure from environmental groups. Carbon scale will have to be abided by internationally – the tax that will have to be paid. There is no other way to create a base load. There is a lot of political pressure from NUM to persuade them not to go that route. NUM is against it because they do not believe it is safe – cancer etc. It would be the environmental argument that will persuade the government and we would have to double the energy generation in the next few years. They built 2 new coal plants but that is not sufficient for the need for energy. There may be some personal gain involved but we need a strong pro-nuclear lobby group – we have anti-nuclear groups but no pro-nuclear. Government will need groups on both sides

Question 10: Yes

Question 11: We will have to use it but it will only be used for top-ups and not for a base load. Difficult to store the energy – if you generate it with solar, you need to use it immediately but you need a base load back-up

Question 12: Don't know much about the others (only Eskom). View on Eskom – the skills are there if it is properly managed they will probably be able to run more nuclear plants

Question 13: I agree with it. Happy with nuclear

Question 14: Government would be the only institution that has the money to do it because the ROI for manufacturing industry in private is too long - they want a quicker ROI. Government is the only one that has the capacity for this – happy that my tax money will be used for it because we need the energy

Question 15: In the long term it will change – initially it will cost a lot to build it but the running costs are lower so over a period of time it will reduce compared to only coal – price of coal will escalate and coal will be scarcer.

Table A.6: Interview results for interviewee 5

Age	20-30	x	30-40		40-50		50-60	
Sex	Male	x	Female					
Race	White		Black	x	Indian		Coloured	
Union	NUM							
Position in union	Researcher in the parliamentary office							
Highest qualification	No formal qualifications but always worked in the energy sector with a specific interest in sustainable energy. Have matric							
Years of experience	NUM - 2 years. NGO's and a consultancy company on energy. I was a project manager - managing and co-coordinating campaigns and projects.							
Question 1: I think SA has quite a solid background in mining but uranium mining is another story but I think there are challenges regarding health and safety that must be addressed. I don't think we are processing uranium at the moment. There is a need to improve this skill in SA. The biggest problem is the exposure of workers to radiation – I don't think much caution is taken in SA at the moment. Gold mining has challenges with health – SA mines are particularly dangerous and there needs to be more investment regarding safety. We need to invest in better safety measures								
Question 2: No. For us as a union we are anti-nuclear. We think that any other applications from nuclear we support – we do not support nuclear. There is no evidence of job creation – there is only failure after failure of nuclear projects. The projects keep exceeding their budgets and time frames – resources that could be invested elsewhere. We do not see it as a contributor to the economy – we see it as a wasteful venture – like with PBMR. If there is a neglect of other energy sectors then it will mean a loss of jobs in that sector. Nuclear is a highly technical field which requires scientists which we do not have in SA at the moment. We would have to import the work-force that will work there. Fewer people will be employed because of the high level of skill required								
Question 3: With nuclear I don't think there will be jobs – there might be in construction (like the world cup) but no long term jobs. Decent jobs cannot be created from it.								
Question 4: I think it is an important exercise to check safety and to ensure that the workers and the community are safe no matter what happens in the plant. I think the regulations are sufficient								

at the moment. The EIA processes do slow down the process. Nuclear has checks and balances which are important and sufficient in SA at the moment.

Question 5: Based on the stats that we've seen amongst all the mining – coal is doing quite well with accidents and mortality – I'm not sure about the health risks. I wouldn't compare the 2 – we don't have much experience with uranium and the indications are that it is not easy. The community can be affected by mining uranium and water sources can be contaminated – there is the problem in Gauteng with the water being contaminated with gold mining. Need proper safety measures. I wouldn't compare them

Question 6: There's a piece of legislation in place which established the institute that is supposed to take care of all types of waste. I don't believe it is safely disposed of currently. Koeberg has the high level waste stored on site and it will take thousands of years to make it safe. There can't be any measures you can take to ensure that it is safe. In the USA – the project for high level storage is important. There is no feasible site to store high level waste. My problem with the legislation at the moment is that in the northern cape there was a spillage and the workers had to clean it up without any safety gear. There was an accident in Koeberg where 91 workers were exposed to higher levels of radiation. That means that we are not yet there in terms of ensuring safety. Radioactive waste management in SA is not as safe as it should be – I think the government must just oversee what is happening. We cannot have government taking care of business waste. All countries have a problem with nuclear waste. If a super power like the US has not yet found a solution then there's a problem there. With all their resources they have not yet found a suitable site.

People that live in the northern cape are generally poor – low level waste disposal sites. The choice of the northern cape is simply political, not scientific. That is my problem at the moment – poorer communities are being taken advantage of. The waste producer should find another site that would not affect people. There must be continuous observation of the waste. There are quite a few unpopulated areas but it shouldn't be in a place with active biodiversity and communities – not sure what that means but the best way of managing it would be to not produce it.

Question 7: I don't know – I'm not sure. It will be difficult for me to trust nuclear for many reasons but I think it is possible to have another accident like that especially if the technology has failed in other countries – PBMR was tried in Germany and Australia and it failed and only after we spent over R10bill we abandoned it. We need to think about other technologies.

Koeberg is done and there were no national conferences with that decision – there has always been secrecy about what happens there – you can't get any info about emissions, you will just get PR. I don't want another Koeberg – the problems we have with waste are from it.

Question 8: I think it will be in the interest of SA to combat corruption. It is something that should be on the top of the list and I think it is. It's complicated – the government inherited corruption from apartheid and you needed a stronger administration to ensure it did not continue but the focus was not necessarily on corruption. I think the new administration means business.

Question 9: (Laughter). The energy sector in SA is highly congested. You have ignorant people and you can expect anything to happen. Thinking in terms of NUM, COSATU and the ANC – there should be more expansion on renewables to fight climate change. Climate change is used as a scapegoat for nuclear. The nuclear industry is publicizing their views a lot more than renewables which could contribute to nuclear expanding more in SA.

Question 10: That is some nonsense that has been made up by the nuclear industry. The fuel cycle of nuclear is also energy intensive – the processing, transporting etc is quite energy intensive. It is only the fusion that doesn't produce any emissions. We should focus more on energy efficiency and specifically on renewables. I'm not saying nuclear will never form part of the energy mix but if we look at the cost I don't think we should take it now – maybe later when the economy grows more. Nuclear will not save us from the worst effects of climate change – improving energy efficiency is what we need to do.

Question 11: Nuclear should be part of the energy mix later – we should wait for a proven plant to be built and running and then we can look at that – we will then know the total costs and timelines once it is complete. Sometimes it costs 90% more than the initial budget and it takes 10 times the time frame – we shouldn't be wasting time on this now. Nuclear is capital intensive. Investors see it as a potential to make money but not to empower the nation – decent jobs is the last thing they look at.

Question 12: NECSA and Eskom are yet to be transparent – Eskom conducts itself as an independent company – if it wants to increase tariffs it does. It is a state-owned company and government should hold Eskom responsible.

NECSA is similar to Eskom – I don't know if they consider the national objectives. I just know that they are government controlled but we don't know exactly what goes on there.

NNR – I'm yet to see labour actually driving the agenda at NNR regarding safety etc. An

incident happened in August in Koeberg where the 91 workers were exposed to high levels of radiation – NNR is supposed to communicate with the nation and that has not happened to an extent that makes us comfortable. It is still a weak institution.

Question 13: Nuclear energy takes a bigger chunk – dominant technology of the future. We can't have 1 technology being dominant with unclear reasons. There should be investments in all technologies available to us. I don't agree with the plan at the moment.

Question 14:

Question 15: I think it will change – it would mean that it would be more expensive. Nuclear is expensive and it will affect the price because any investors would want a good return – it will change our perception of what expensive is. People already can't afford the electricity prices.

Question 16: NUM is in a process to develop its policy which will inform our choices for energy in the future. I think soon we will have a workshop where we will discuss it and then we will put together a policy.

Question 17: They might have different views to ours – I do not know – NUMSA may have different views but I think in terms of understanding the issues we are on the same page.

Question 18: Partly yes – but I think the energy subject requires national consensus. You need everyone to discuss and decide the way forward. It should be a subject that involves everyone. Energy is central to economic development. If all labour unions decide to be anti nuclear – the nuclear project might be smashed in SA.

Table A.7: Interview results for interviewee 6:

Age	20-30	x	30-40		40-50		50-60	
Sex	Male		Female	x				
Race	White		Black		Indian	x	Coloured	
Union	NUM							
Position in union				Chairperson of PBMR branch				
Highest qualification				MBA				
Years of experience				10yrs - 1yr at NUM				
<p>Question 1: My first issue from a political point of view is that we continue to sell uranium as a resource rather than develop it as a commodity for energy. There are too many mineral rights given to other countries. We had capability in terms of the processes to enrich uranium which we have lost – it is held in the hands of white people – it is very difficult to get black acceptance of the whole process. We won't be able to participate in the industry – political.</p> <p>From a scientific point of view I have problems – it seems to cause a lot of environmental issues in the process. I'm not in support of SA having that sort of capability – I'm not sure if we can control the impact because of the waste that is generated in the process. I'm not comfortable with SA being involved with the processing of it – I don't want us to ever be involved because there is very little possibility for black involvement. I'm not sure if we should engage in it – we should not be investing in it. COSATU has a position on nuclear which I agree with. We have such a small quantity of uranium but there have been so many issues with it – Pelindaba and PBMR were closed down – not sure this has been properly done – if it was done properly then why was there waste missing from NECSA? The control on any nuclear related material is not well-controlled. I'm anti-nuclear – I don't think SA is ready but I'm anti it anyway. That is the position of NUM and COSATU.</p>								
<p>Question 2: Not at all – the reason I say that is that close to 90% of SA's energy needs is supplied by coal. Coal creates significantly more jobs than nuclear – nuclear requires highly skilled labour and very few jobs are created. I'm not sure if we'll have the capability and resources to develop a labour force to sustain a nuclear industry. The nuclear industry will displace jobs ultimately because it will replace coal eventually. I don't oppose renewables because it provides more jobs than nuclear – nuclear creates the least jobs. In the initial building of plants we will replace SA jobs with foreign jobs – we will be importing labour and we are</p>								

opposed to that. Renewables create more jobs than coal as well – with all things equal. White jobs will be created instead of black jobs. From the concept stage throughout the process it looks like there will be no short-term or long-term transformation. There is not enough transformation of the industry. Amongst the unions, there are generally statements like “this is a white industry so why should we be involved”. If there are programs around with social responsibility – they will have an impact. Even we were very surprised with the respondents on the IRP2 in terms of inputs – opposing nuclear

Question 3: Already answered

Question 4: To be honest I think the NNR has really developed its capability in the last few years – technically they have really improved and are doing a good job. They are currently facing challenges to take care of everything they need to. In terms of licensing – with the control of radon at Koeberg – I'm not sure that we really have sufficient time for a new build program. The new build will come on in 10-12 yrs – NECSA has a license for research and development – lab-scale and different licensing to Koeberg. The problem we have is that we would probably use light water reactor technology that is foreign and may not be able to be transplanted exactly into SA – the level of radiation to workers and the public – not sure that these issues have been taken care of yet but that's fine because it would have been pre-mature. The regulator has sufficient capability to ensure it if it happens.

Question 5: I think that right now if the mining of uranium is done by companies with a good safety record then I don't think there is a problem with uranium mining because I am happy with the way the licensing regime is working – I know how it works and I'm fairly comfortable with it. The hazards are greater with uranium if it is mismanaged. It's difficult to compare coal and uranium because there is ambiguous reporting of injuries in gold mining where uranium is a by-product – it is currently not acceptable. There would be more impact on people with uranium mining than coal. Coal is a more mature industry.

Question 6: Look, we've recently had uranium waste in Gauteng where uranium waste from Necsa went missing – under those circumstances can we say that our waste is being properly managed? – I'm not sure. I don't have a high confidence in it right now.

Question 7: No not at all. Generally I don't feel confident that it cannot happen in the world as a whole. I think it's simply because we're operating under different circumstances – aging plants and we keep doing life extensions on old plants. There are also growth of nuclear reactors in

countries that don't seem to have good safety records – especially in eastern countries – I don't feel confident that they won't end up like Russia. They have far too many incidents and I think an accident like Chernobyl would happen again.

Question 8: Yes I do – they have.

Question 9: No I think they would make decisions based on the country because this is such a contentious issue that they have to be careful. The energy minister – I've been very impressed in the way she's been running the department.

Question 10: I don't agree that nuclear is an automatic solution to displace carbon because although it is carbon neutral, its environmental hazards are far worse – what's the point of displacing carbon and creating far more dangerous nuclear waste. I'd rather stick with coal because I'm more comfortable with the waste created by coal. I'd rather go with waste that's bad than waste that's worse.

Question 11: Absolutely! Nuclear is not renewable. I think with some development renewables could supply the base-load power and we should invest in such development.

Question 12: NNR – I think they do their jobs – they are independent and have shown it. They have built capability – I have a lot of respect for them. I've had a lot of dealings with Eskom and they really challenged all assumptions in terms of the PBMR. I have found the interaction with Eskom to be very good – they did a better job of leading the PBMR project than PBMR. If Eskom was not involved, the PBMR project would have been in trouble – Eskom was the customer but they had to approve the specifications. I found their technical reviews to be very good. These institutions make the right decisions.

Question 13: I don't agree – I don't support it in the energy mix. I would rather displace nuclear with coal.

Question 14: No not at all – because it's more expensive.

Question 15: Yes definitely. The technology is more expensive – higher capital costs and the operating costs seem to be higher. Generic studies show cross-comparisons between countries and I'm not sure that SA can compete with USA and France to deliver the same prices – we won't be able to run those efficiencies to keep the costs low. Capital investment is much higher.

Question 16: Yes – officially. We participate in energy talks with govt. We lead COSATU – our views are NO to nuclear and it is very public.

Question 17: Maybe NUMSA has different views but when it comes to conferences – the

delegates have spoken consistently. COSATU general is in unison with the views on nuclear. It will be very difficult to move the general membership away from these views.

Question 18: I think it can stop the implementation – I know that in some of the meetings we've been having – it's a very political issue that there's such a strong anti-nuclear group in SA. I think the plans can be changed along the way.

ABSTRACT

The intention of this research was to uncover the reasons for the perceived lack of confidence in nuclear power by the labour unions, and hence to propose a framework for building the unions' confidence in nuclear energy.

A literature review of the views of labour unions, globally, on nuclear power was conducted. This provided the insight to design the experiment for this study. The literature review revealed that there were five major reasons causing labour unions to oppose nuclear power: environmental impact, safety, cost, political influence and job creation. The research was then categorized on the basis of these reasons.

The labour unions selected for this research were Solidarity, Confederation of South African Trade Unions (COSATU) and National Union of Mineworkers (NUM). Questions were prepared on each of the five categories and in-depth interviews were telephonically conducted. The responses to these interviews were analyzed to establish the best way forward for building greater labour union confidence in the nuclear industry in South Africa.

The results of the interviews showed that Solidarity was in favour of nuclear power, while COSATU and NUM were against it for the following reasons:

1. They believed that the industry would not create a significant number of jobs, and may even lead to job losses.
2. They had the perception that the nuclear industry was dominated by white people and that the expansion of the industry would ultimately result in the creation of White jobs at the expense of Black jobs.
3. They were of the opinion that the nuclear industry harbored certain secrets which resulted in their distrust of it.

These findings were then used to develop recommendations for building the confidence of the unions in nuclear power.

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LIST OF ACRONYMS AND ABBREVIATIONS

AMD	–	Acid Mine Drainage
ANC	–	African National Congress
AVR	–	Arbeitsgemeinschaft Versuchsreaktor
CANE	–	Coalition Against Nuclear Energy
CO ₂	–	Carbon dioxide
COSATU	–	Confederation of South African Trade Unions
EU	–	European Union
HTR	–	High Temperature Reactor
IAEA	–	International Atomic Energy Agency
ICRP	–	International Commission for Radiological Protection
mSv	–	Millisievert – a unit of measurement of radiation dose
NEA	–	Nuclear Energy Agency
NECSA	–	National Energy Corporation of South Africa
NEI	–	Nuclear Energy Institute
NIASA	–	Nuclear Industry Association of South Africa
NNR	–	National Nuclear Regulator
NRC	–	Nuclear Regulatory Commission
NUM	–	National Union of Mineworkers
OECD	–	Organization for Economic Co-operation and Development
PBMR	–	Pebble Bed Modular Reactor
SA	–	South Africa
SABC	–	South African Broadcasting Corporation

SAJS	–	South African Journal of Science
SAPP	–	Southern African Power Pool
THTR	–	Thorium High-Temperature Reactor
UK	–	United Kingdom
USA	–	United States of America
WNA	–	World Nuclear Association

EXPLANATION OF TERMS

Carbon tax	:	Tax that is charged for carbon emissions.
Carbon footprint	:	“The total amount of CO ₂ and other greenhouse gases emitted over the full life cycle of a process or product. It is expressed as gCO ₂ eq/kWh” (PARLIAMENTARY OFFICE OF SCIENCE AND TECHNOLOGY, 2006)
Radiation dose	:	The radiation dose is the amount of radiation that people are exposed to. It is expressed in units of Sieverts (Sv).
Radioactive waste	:	“Material that contains or is contaminated with radionuclides at concentrations or activities greater than clearance levels as established by the National Nuclear Regulator (NNR), and that has no use (NATIONAL NUCLEAR REGULATOR, 2009).
Eskom	:	South Africa’s power utility.