Discussion Paper on the Dynamics of Nuclear Energy in South Africa

Summary Report

17 February 2017

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Introduction

This report provides a summary of the full Discussion Paper, and aims to provide the Boards of the Soul City Institute of Justice (SCIJ) with a succinct, evidence based summary report on the viability of investing in nuclear energy in South Africa, taking into account the principles that underpin the SCIJ's Investment Charter. It is recommended that the summary report be read in conjunction with the full Discussion Paper for reference to a more complete set of facts, analysis and references.

The planned nuclear build programme for South Africa is multi-faceted and an investment decision is not as clear-cut as it may seem. *"We see clear winners for the next 25 years – natural gas but especially wind and solar – replacing the champion of the previous 25 years, coal, but there is no single story about the future of global energy: in practice, government policies will determine where we go from here."* (WEO, 2016: Dr Fatih Birol, Executive Director of the International Energy Agency)

Understanding the place of nuclear energy in South Africa's future energy mix is critical to investment decisions, noting that it will take, at a minimum, ten years to commission and build new nuclear capacity in the country. Access to reliable and safe energy supply is crucial for socio-economic development as South Africa's recent energy crisis demonstrated. The proposed nuclear build programme is intended as an integral component to ensuring the country's future energy security, in turn deemed necessary to enabling economic growth and social development in the country.

With the Investment Charter in mind, socially responsible (environmental, social and governance) investment principles are critical when considering the provision of public goods and services, as is the case in the nuclear energy build programme. SCIJ has to be sure that an investment decision regarding this project is made on evidence of the economic, political, technical and environmental sustainability of the project.

This OneWorld Sustainable Investments Discussion Paper' approach has been to provide the necessary analytical framework which SCIJ can use to weigh up this decision. It was informed by desktop review as well as interviews with an extensive and cross-cutting range of experts from all fields of the energy sector.

An understanding of the primary components of analysis of South Africa's current energy situation, further informed by relevant global energy trends, frames the assessment of the need for and viability of potential nuclear investments in this country.

Critical questions for framing the assessment are:

- What should South Africa's energy future look like, given the geography, socio economic environment, affordability and politics of the country?
- What comprises a feasible energy mix to secure energy for the country, taking account of uncertain economic growth and affordability?
- What are the political priorities and forces at play?
- What can the consumer and national fiscus afford?
- Is nuclear a viable option to supplement coal for baseload power?
- Is South Africa following global nuclear trends and can it afford to do so?
- Does the country have nuclear expertise, and a history and credible track record of operating nuclear power plants?

Global Energy Trends and the implications for South Africa

A globally primary driving force affecting the energy development is the commitment to action on climate change. Underpinning this is the international scientific community and most world leaders' recognition of the need to reduce carbon dioxide (CO_2e) emissions, to minimise as far as possible the impacts of climate change and variability on the world's population.

Globally, the Paris Agreement (PA) 2016 was a game changer for the energy sector – and potentially for future climate change. The PA was a global agreement by 187 countries aimed at reducing the carbon dioxide (CO_2) emissions destabilising the world's climate, and supporting poorer countries affected by climate change. 2016 also saw the renewal of global commitments to sustainable development with the adoption of the Sustainable Development Goals (SDGs) otherwise known as Agenda 2030.

Simultaneously, energy security remains of paramount concern for industrialised and emerging economies, while developing economies seek sufficient energy capacity to fuel much-needed development. Energy security refers to a country's ability to generate consistent and reliable power, at least cost to the country. Parallel changes affecting the energy sector are population growth and urbanisation, impacting energy demand and supply patterns. With change of this magnitude, come winners and losers, manifesting in various ways such as protectionism and opportunism, with emergent coalitions contributing to shaping trends.

As has historically been the case, energy security, at least cost, are still the primary criteria for many in determining energy investment decisions. This is not a straightforward task. Energy demand varies cyclically throughout the day, typically reaching a peak during the early evening, and dropping back down during late night and early morning, however always remaining at a certain base level. Energy security therefore requires meeting minimum demand levels (called base load power), as well as meeting as near as possible to 100% of demand when it is needed most (called peak power demand).

Resource sustainability has significantly altered coal's role in energy security. Globally baseload power is generated from one of three sources: coal, nuclear and hydropower, all able to provide a reliable and consistent energy supply. Coal, a high CO_2 emitting fossil fuel, is widely used, including in South Africa, to generate reliable electricity supply, albeit unsustainably. Global best practice is to secure minimum demand power at least cost, Achieving least cost alone is not enough - reliability of supply is paramount. However, a different approach is becoming more apparent in securing peak load power; natural gas is frequently used to meet surges in demand cycle patterns. Simultaneously, arguments are emerging for renewable energy to contribute to base load power. Thus, the energy mix of countries around the world is changing.

These significant changes also challenge the continued existence of the ubiquitous model of State-owned, monopoly utilities, which control a nation's generation, transmission and distribution of power – and South Africa has one of the world's largest monopolistic utilities. The changes, combined with more recent global trends to reduce C_02, have led to a requirement for increased flexibility in a country's energy mix.

Renewable energy technologies are able to provide more flexibility, not least because these power plants can be turned on and off relatively quickly, as demand cycles fluctuate. This directly contrasts to coal and nuclear where shut downs are not cost effective (it is expensive not to run such large scale, complex plants as continuous power sales contribute substantially

to their viability). Nuclear also has associated safety risks as shut downs have to be very carefully managed to avoid an accident that could cost numerous lives.

The CO2 driver has seen the focus on clean energy resources intensify, particularly renewables such as solar, wind, biomass and geothermal generated power. Although progress has been significant, the way forward is not clear cut and some governments (e.g. South Africa) are using the uncertainties surrounding alternative solutions to protect state owned power monopolies. Eskom, South Africa's largest state owned entity (SOE) is no exception. It employs 43,000 people where the number of people typically depending on one income is five.

These monopoly utilities, supported by a few global energy experts, argue that renewable sources of energy are intermittent because, for instance, the sun does not shine continuously, while technology solutions to mitigate this risk, such as storage, are still under development. The addition of renewable energy capacity into a country's energy mix introduces a very significant change to the stability of the grid – a network that can deliver power consistently, including at times when there are sudden changes in supply or demand. The intermittency of renewables is thus often cited as a risk to energy security with many countries choosing to include renewables in their energy mix, but not as baseload power.

Many South African and international experts disagree, arguing that smarter decisions around an appropriate energy mix significantly change the game. These options include backup solutions for when the wind does not blow (such as gas), and the acceleration of innovative technology solutions that facilitate storage, decentralised utilisation, and alternative grid management options. A few countries that are moving to 100% renewables, some without neighbours they can purchase power from in an emergency, demonstrate the validity of these arguments. Disruptive innovation breakthroughs (i.e. technologies superior to those currently in use, which as they come down in costs, disrupt existing markets) that are able to harvest power in cloudy conditions, for example, and also store it, are accelerating and at rapidly reducing cost (Seba, 2016). Global energy actors can no longer assume the same technology conditions in situations where disruptive innovation is fast becoming the order of the day.

Moreover, a reliable investment climate for RE has emerged, altering the investment profile of the energy sector. Since 2004, Europe and China have experienced the most reliable and steady growth in RE (UNEP, 2015), with China overtaking Europe in 2015. RE prices have decreased significantly, making the economic case for renewables as attractive for their C02 reduction, thereby greatly enhancing the business case for renewables.

The rapidly progressing renewable sector has also resulted in accelerating the trend toward diversifying energy generation from being wholly state owned to include private sector investments through globally increasing Independent Power Producers (IPP). IPPs generate both large and small scale power with national power utilities the main buyer. Energy tariffs are being driven down in energy markets that have become more competitive. This is also achieving economies of scale in the renewables sector and the costs of wind and solar investments are reducing substantially. For instance, wind has over the last year, become the cheapest electricity option in South Africa, and elsewhere, at around 0.62 ZAR cents per kWh. Also, over the past ten years, solar costs have dropped by 90% and are still coming down, with experts estimating that solar could cost as little as 0,05 US cents within seven years (Seba, 2016). Larger scale public power generation investments (i.e. power supplied by Eskom) cost nations and consumers much more, with coal costing South Africa around 1.00 ZAR per kWh, while nuclear is forecast by experts to cost between 1.50 and 1.70 ZAR per kWh. Consequently,

the IPP model therefore threatens the future of power utilities globally, and renewable energy is thus even more unpopular to utilities such as Eskom.

A simultaneous, more tentative and nuanced trend is evident in the global rise of nuclear power. Nuclear, alongside hydroelectric power (HEP), is the only recognised alternative to coal for secure, reliable baseload power, with the advantage of being able to provide large amounts of energy around the clock while seeming not to produce carbon emissions, thus meeting energy and climate security needs.

However, the safety issues surrounding nuclear power are extremely concerning. The Fukushima nuclear accident of 2011 in Japan (Case study 1) illustrates the catastrophic consequences when a nuclear reactor is breached and radiation is released into the atmosphere, contaminating water, soil and food, sometimes for decades. The costs in human health are immense, and whilst these accidents are relatively rare, they cannot be ignored.

Nuclear has nonetheless been making a selective comeback since the Fukushima accident, coinciding with CO2 reduction requirements, although producing energy from a nuclear reactor relies on a steady supply of uranium, supplied through mining operations in the emissions intensive extractive sector. Notwithstanding, analysis of a nuclear plant's lifecycle, including inputs and outputs, supports the argument that nuclear power is a relatively low carbon technology (OECD NEA, 2015).

China seems to be at the forefront of domestic nuclear energy expansion and is set to become the world's biggest nuclear energy provider by 2030. China's biggest driver is to limit the currently significant impacts of local air pollution. By 2030, officials expect nuclear to account for around 10% of China's electricity generation. This would be the equivalent of around 150 gigawatts of generating capacity by 2030, accounting for one third of the current global capacity (adapted from Buckley C., 21 November 2015 and the World Energy Council (WEC)).

China is also exporting nuclear technology, although a safety and cost-effective track record has still to be demonstrated. Partnerships are being established with older technology players, such as French-owned Areva which, supported by Chinese finance, is building a nuclear plant at Hinkley Point in England. Nuclear power is also a strategic priority for South Korea. Other growth nodes are in Asia, and Eastern Europe, driven by Russia. However, this trend is not presently evident in the USA and Western Europe. Germany, which until 2011 obtained a quarter of its electricity from nuclear energy, using 17 reactors, has embarked on a 100% decommissioning programme. Following Fukushima, Germany immediately shut down eight reactors, phasing out the remaining reactors over the coming decade.

Another issue is the cost of nuclear build and of nuclear energy itself. UK taxpayers may have to bear a long-term burden caused by the government's debt guarantee for the Hinkley Point project. One report estimates that future top-up payments "have increased from £6.1bn in October 2013 when the strike price was agreed, to £29.7bn in March 2016" (NAO, 13 July, 2016), an increase of over 400% in only 3 years. Furthermore, nowhere globally has a nuclear operation been fully decommissioned (including decommissioning nuclear waste). This creates a significant gap in the understanding of the full costs of nuclear across the lifecycle, and the long-term waste management capabilities that are required.

Only a few countries are currently positioned to export nuclear technologies, as few can build nuclear programmes without external technology supply. The main technology exporters are Russia, France, South Korea, USA, Japan and China. Japan, France and the US have seen

declines in their business and technologies. Russia is cited by many global power analysts as being the most reliable and robust in present terms (Yelland C., pers. comm., 19 January, 2017 and Joubert, P., pers. comm, 16 January, 2017).

In South Africa, it is evident that the political powers have prioritised a nuclear build programme and that relevant state organs have been set up to enable and drive this priority as a matter of urgency. While including nuclear in South Africa's energy mix is likely to justify Eskom's existence in its current format, the timing of the proposed nuclear build programme is contradictory, immediately raising questions as to the motivation behind this investment decision. Firstly, this decision has come at a time when energy demand is at an all-time low, coupled with new power generation having come on stream (two new coal fired power stations and a wide range of RE IPPs). Secondly, and perhaps more importantly, the programme is being unnecessarily accelerated by Eskom, who has commenced a procurement process now despite the provisions of the new, Draft Integrated Resource Plan (IRP) 2016 which clearly indicates that South Africa can delay its nuclear build programme to 2037. This argument is made in accordance with economic growth projections as well as the requirements to roll out the programme to shut down South Africa's older fleet of power plants (mainly coal, along with the Koeberg nuclear plant), in stages, but by 2045.

Eskom puts a strong, but possibly flawed argument that the programme needs to be brought forward to 2025, arguing it is better for the economy. The utility would rather not continue to bring power from the country's Renewable Energy Independent Power Producer Procurement Programme (RE IPPPP) on-line (an incentive programme that is internationally acclaimed as hugely successful). In addition to citing RE as expensive to connect to the grid, and at risk to reliable power supply, Eskom, argues the economy will return to the steady growth levels of 3,5%, experienced between 1980 and 2007 - called aspirational growth by Eskom. However, three key considerations suggest otherwise: i) this sort of growth has not been experienced for many years; ii) the economic future of South Africa's economy is extremely uncertain and iii) future global energy demands are on a downward trend, largely because of the drive to reduce emissions and increases in energy efficiencies.

Eskom has however identified strategies for mitigating the risks associated with being wrong footed on growth forecasts, thus tying up large amounts of capital in a long-term programme that the country may not need: The utility believes it can play a significant role in stimulating economic growth through improving energy security and costs, and attracting investors to the country. It further believes it can sell surplus power to South Africa's neighbours, even though the grid infrastructure required to facilitate this outside of South Africa is very weak.

As indicated, a massive-scale investment in the planned nuclear-build programme in South Africa will lock the country into relatively expensive energy tariffs which may be unaffordable for many, while also locking up large amounts of capital over a long period of time. This comes when flexible solutions are needed most and presents the country and investors with an enormous risk of stranded assets (assets that are operational but no longer economically viable or needed and therefore not in use) as the energy landscape is already undergoing significant change, with all signs of this accelerating rapidly.

Whatever the drivers, nuclear is relatively expensive for a country like South Africa where the triple challenges of poverty, employment and equality continue to be the main focus; ultimately, the consumer will bear the brunt of the country's energy choices.

Situational analysis – South Africa

Recent developments in the global energy sector and the long-term planning process (explained in detail below, in the section on the Draft IRP 2016) are the two main factors affecting the energy situation in South Africa. The country has put forward global commitments (voluntary but measurable) to reduce CO2 emissions. This, along with the water threats associated with coal (water is required for coal mining as well as in coal-fired power stations), has brought current and past levels of burning coal into sharp focus.

South Africa is a recent investor in wind and solar energy, and is presently benefitting from the recent, sharp decline in the costs of RE. Energy insecurity is also a feature of the country's recent history. In spite of Eskom's arguments that RE is too risky, South Africa's bouts of load shedding have strengthened the case for RE. These developments in South Africa's energy sector have also come at a time of declining energy demand and in the face of serious questions as to the financial and strategic viability of Eskom. These arise with economic stagnation, with uncertainty as to future growth trajectories, or the best energy mix going forward.

South Africa has a robust and extensive electricity transmission and distribution infrastructure, or national grid. Most electricity is supplied from centralised energy generation, or sale of electric power capacity, mostly from coal, at around 85% of total generation capacity. Since the recent inclusion of electricity supply into the grid by RE IPPs, the share of coal-generated electricity has dropped, and hence that sales from Eskom-generated power, have declined. This poses a threat to the viability of the monopoly utility.

South Africa's primary energy drivers

Primary energy drivers in South Africa include the costs and availability of different types of energy (for example RE versus coal), as well as policy, politics, institutional arrangements and governance, and international agreements already made regarding nuclear build supply.

The last 20 years have transformed South Africa's energy sector. The democratic government has pursued a policy of providing universal access to energy, and has achieved 92% delivery. However, due to a combination of factors including poor planning and institutional mistakes, demand overtook generation capacity during two periods (2007-08 and 2014-15), resulting in costly rolling energy blackouts across the country. Additional coal-fired power stations, Medupi and Kusile, were commissioned, but building costs have continuously overrun budgets at a time when the economy – and demand for energy – has slowed. Simultaneously, RE costs have dropped and are now cheaper than coal and nuclear.

Various policies within the regulatory framework govern energy decisions and the investment environment. The *National Development Plan (NDP) (2013)* emphasises the need for energy security and enabling energy infrastructure, suggests a shift from centralised supply with inclusion of off-grid solutions such as private rooftop solar installations and promotes the diversification of power sources and ownership with a target for 20,000 MW of RE by 2030.

The Draft Integrated Resource Plan (IRP) 2016

The IRP is a component of the Integrated Energy Plan (IEP), a long-term planning document. The IRP focusses on electricity specifically whilst the IEP relates to future energy planning in general. The Department of Energy (DoE) is the IRP custodian, supported by Eskom for its development (specifically to model energy scenarios) and was intended to be updated annually. The current draft of the IRP (Draft IRP 2016) was launched for public comment in December 2016, and has come under scrutiny partly because of its emphasis on a new nuclear programme and the related constraints placed on the RE IPPPP. A Draft IRP 2013, published

by DoE but never approved by Cabinet, recommended a reduced and delayed nuclear new-build, compared with the 2011 draft. The Draft IRP 2016 has critical implications for the energy planning process and for nuclear and RE targets. An assessment of Draft IRP 2016 demonstrates Eskom's considerable influence over energy decision making in South Africa, despite the fact that it has an obvious conflict of interest, since it is both a key player in the field and has much to gain or lose from any adopted Plan. Furthermore, the DoE ignored recommendations regarding scenarios made by a Working Group set up by the Energy Minister to review Draft IRP 2016. Furthermore, according the Working Group established under the Ministerial Advisory Council for Energy (MACE), the energy models used for Draft IRP 2016 (the assumptions, arising from Eskom) are characterised by a lack of transparency and misuse of available and reliable data (e.g. load factors, costs of renewable energy, etc.).

Importantly, running the model to establish the least-cost case for electricity provision to 2050 (as opposed to the policy constrained scenario, as imposed by DoE and Eskom), tells South Africa to **increase** its build of wind and solar photovoltaic capability, supplemented by gas. Under this scenario, the model makes zero provision for nuclear technology, which neither the national fiscus nor Eskom's balance sheet can support. The costs of trade-offs necessary for a nuclear build programme, such as reduced social spending on public health and food security, can only be borne by the public and taxpayers (on a small tax base). Such trade-offs are unlikely to enhance social inclusion or increase employment in the country.

It is becoming increasingly clear that an expensive and large-scale nuclear agenda now dominates the political and institutional energy discourse, which constrains the development of RE, despite evidence of its success and diminishing costs. An "either/or" situation is emerging (suggesting that RE is getting in the way of nuclear decisions), with the nuclear agenda showing potential of derailing the substantial progress made in RE.

The nuclear agenda is evident in the political actions, approach and structure of the primary actors and decision makers in the public energy sector: the DoE, Eskom and the President. It is important to note that changes in the political landscape in South Africa in the last few years have had an institutional impact on the energy sector. *A political economy approach therefore underpins this analysis, with the emphasis on decision making capacities and on the nuclear agenda visible in each institution.*

Evidence from various quarters points towards the existence of large-scale corruption (termed grand corruption) surrounding the nuclear programme, involving state actors (the DoE, State President and Eskom, international finance and other countries (e.g. Russia). This evidence cannot be ignored, and is a view expressed by an overwhelming number of credible actors.

The Department of Energy (DoE)

The structure and organisation of the DoE seems to support the drive to realise RE targets, and has built strong capacities in electricity, energy planning and clean (renewable) energy. The Energy Minister, Ms Tina Joemat-Pettersson, also plays a role in the planning process. In office since 2014, she states that RE is on the country's energy agenda and that the nuclear procurement process will be above-board and transparent. However, there have been substantial delays in recent rounds of the RE IPPP, alongside which the nuclear procurement process has been under development. Both these processes took place ahead of the finalisation of the Draft IRP 2016, suggesting a foregone political conclusion. Furthermore, the Minister's close relationship with President Zuma, who is known to be engaged in entrepreneurial activities (well documented in the October 2016 State of Capture (SoC) Report published by the Office of the Public Protector), is widely acknowledged. It has also been recognised that the Minister supports the proposed nuclear deal, which is strongly backed by the President.

Within DoE, the Director General (DG) is known to support the nuclear programme and a Chief Operating Officer has been situated between the DG and the Deputy Director Generals (DDGs), purportedly to facilitate the acceleration of nuclear decisions and the delay of others. This is the understanding of many, including National Treasury's State Owned Enterprise unit.

Eskom

Apart from Eskom's functioning in the current context, it should be noted that the utility has been suffering from high levels of indebtedness, delayed build programmes at significant overrun cost, and ongoing delays to its transition to cost-reflective tariffs. For these reasons the international credit rating agency, Standard & Poor's, downgraded Eskom's rating to level BB in November 2016 and kept its outlook negative.

RE generation in this country is mostly independent of Eskom (based on IPPs and technology such as rooftop solar installations). Eskom states that it supports the integration of RE into the grid thus facilitating IPPs to sell power into the grid but is unwilling to do so at its own cost (calculated in terms of loss of its own revenue, and threat to the country's baseload generation capacity, on which it depends financially). It is clear therefore that Eskom cannot hold a neutral standpoint towards RE. Many of South Africa's coal-fired power stations will reach their end of lifecycle and will need to be shut down well before 2050. It is evident from the preferred scenario of the Draft IRP 2016 that Eskom sees the proposed nuclear build programme as replacing a significant component of this baseload capacity, thus also protecting the utility's future and monopolistic status.

However, many experts are examining the need for significant investment in baseload capacity, specifically questioning how much power is really needed given national economy changes and electricity usage. Electricity demand is below 2007 levels and as at 2015, actual energy usage was well below the forecasts of IRP2010, even at the lowest growth/demand scenario. This is among the evidence that strongly suggests that a realistic assessment of future requirements is needed; less demand means less power than previously planned.

Eskom is also tainted by the lack of transparency surrounding the nuclear build programme. According to the SoC Report (in which Eskom is cited on 207 out of 355 pages), Mr Molefe used internal relationships to promote certain agendas and contracts, including development of a nuclear programme. The SoC report is explicit about the extent of corruption in the utility, implicating senior management and procurement. Mr Molefe's successor at Eskom, Mr Koko, is widely recognised by energy experts as following closely in his footsteps in promoting a nuclear build programme, delaying RE, and in a lack of transparent flows of information. National Treasury support this view and find themselves in a position of no longer being able to obtain reliable information from Eskom, as confirmed by an interview with NT.

How much electricity will South Africa really need?

Even if demand picks up again (as Eskom assumes), the country will still need substantially less than predicted in both IRP 2010 and the 2013 update; even if demand growth reached 3% per annum, a figure seen as ambitious by most economists, this would require installed capacity of not more than 50MW by 2030. If demand growth reached 1% per annum, demand for installed capacity would only reach 38MW by 2030. With a good practice reserve margin of 20% in place, this creates a system requirement for 45MW, about what the country has today. Eskom's existing installed capacity is around 45GW, although not all available due to unplanned breakages and losses (Eskom at times shuts down plants for planned maintenance purposes). Furthermore, some of Eskom's plants are nearing the end of their lifecycle and a

total of around 10GW will possibly need to be decommissioned before 2030. Assuming a scenario where around half of the older power stations will be replaced before 2030 (i.e. 5GW), and discount the 7GW of Eskom plant that is, on average, broken, then total new power generation capacity needed by 2030 will be between 12GW and 27GW, corresponding to electricity demand of 1% or 3% per annum respectively. Given recent demand trends, the lower figure is more realistic (adapted from Eberhard, 2016)

Three primary drivers appear to be behind Eskom's apparent increasing distance from RE:

i. the alleged corruption behind the intended nuclear build programme;
ii. the need to protect Eskom's future through securing baseload capacity to replace coal;
iii. the threat an increasing amount of power generated from IPPs places on the utility's ability to monopolise generation capacity. (Eskom has traditionally been able to eliminate competitive alternative generation capacity in the private sector through its ability to control connectivity to the grid, despite regulatory policy to the contrary.)

An examination of the nuclear procurement process so far is instructive. Mr Koko released the Request for Information (RfI) for the proposed nuclear build in mid-December 2016, effectively launching the nuclear procurement process earlier than required in the Draft IRP, 2016. This immediately followed a surprise move that saw the DoE giving the nuclear procurement process to Eskom through a new Section 34 court Determination. This confirms Eskom as the procurer, owner and operator of any new nuclear reactors to be built in South Africa, whereas previously, the DoE was the designated and mandated procurer of nuclear capability, flowing from the fact that Eskom was not considered to be in a financial position to procure new nuclear capacity. The new 2016 determination is based on the outdated IRP (2010). It points out that the nuclear programme will target connection to the grid, as outlined in the IRP 2010-2030 or the updated version. The determination was gazetted just as the roadshows for the public consultation on the Draft IRP 2016 were supposedly drawing to a close (although they were subsequently extended till March). Nonetheless, the Determination was signed by the Minister for Energy on 5 December 2016, just ahead of the public consultation process. The new Determination was however only revealed at the nuclear court hearing on the 13th December 2016, causing the case to be adjourned to the 22 February 2017.

The ongoing Nuclear Court Case

In October 2015, two civil society organisations brought a case against the President and the Minister of Energy. The case challenges the lawfulness of the Government's nuclear, energy decisions, raising explicit concerns that the procurement is being geared toward a deal with Russia. In adjourning the case after the announcement of the surprise Section 34 Determination, the Court ordered the Minister of Energy to pay the applicants' costs on a punitive scale, including the costs of four members of counsel.

In parallel, key actors, such as National Treasury and big business in South Africa, are concerned as to the viability of Eskom, noting forecasts for a weakening balance sheet going forward, as energy sales are expected to continue to drop. The utility's balance sheet is likely to weaken further as the utility loses assets with the closure of all Eskom's older coal-fired power plants and the Koeberg nuclear plant between 2025 and 2043. Many experts consider Eskom unable to provide a coherent, affordable strategy for the future.

The President of South Africa

With the publication of the SoC Report, Mr Zuma's political agenda became highly visible, with credible allegations as to the nature of his state-manipulated transactions. The Report documents his corrupt relationship with the Gupta family; and Mr Zuma's maneuvering with

regard to his Ministers of Finance has been clearly related to promulgation of his own agenda. Mr Zuma's numerous cabinet reshuffles have been attributed to his routinely putting his own political interests ahead of service delivery (Business Day, 1 February, 2017). The same newspaper published a political commentary on Mr Zuma's attack on the NT at the ANC lekgotla (January 2017), for frustrating the economic transformation agenda by not availing funds for certain projects. The article states that "Gordhan and the Treasury are seen as a stumbling block to implementing projects favoured by the president, including the nuclear-build programme" (Marrian, N., 2 February, 2017).

The international agreement with Russia

An important facet of the political discussion, is an international agreement with Russia on the supply of nuclear plants - a central component of the court case against the Minister of Energy. In 2014, the DoE signed an intergovernmental agreement with Russian Nuclear entity, Rosatom State Atomic Energy Corporation, in an internationally binding agreement, to buy a fleet of nuclear reactors from Russia in a $50bn strategic partnership. (One reactor costs around $5bn, with eight reactors expected by 2035.) The nuclear agreement was followed by the signing by South Africa (represented by the DoE) and Russia (represented by Rosatom), of two memoranda of understanding (MoUs) on nuclear power. These MoUs called for projects to educate South Africans towards public acceptance of nuclear power, and include programmes for training specialists in South Africa's nuclear industry.

This scenario raises tension between, on one hand, domestic procurement law that necessitates a transparent and thorough procurement process for an infrastructure build programme of this nature, and on the other, international law. This situation leaves South Africa open to legal risks and potentially substantial costs (discussed further in section D of the main report, and later in this Summary). However, under the procurement process, which Eskom is currently driving, recently announcing that the launch of the Request for Proposals (RfP) is expected in July 2017, it is likely that Russia will legitimately win the bid, given their current status as the primary supplier of global nuclear technology.

Again, it is evident that the political powers have prioritised a nuclear build programme and that relevant state organs have been set up to enable and drive this priority. It is probable that the main driver is corruption, with much personal financial gain to be made by the political participants. Corruption experts share the view that the scale is that of "grand corruption" as outlined in the Political Risks section below).

However, there are also technical and strategic arguments that support the nuclear programme expressed by some global power experts, economists and energy analysts, who are apparently independent of the political agenda. These are discussed in in the section below.

Global interests that impact on South Africa's energy decisions

Two global interests that impact on South Africa's energy mix are: international climate change agreements, and the international investment landscape – with the availability of international finance. South Africa has committed to reducing its CO2 emissions in several policy documents, most recently in its Nationally Determined Contribution (NDC) to the PA (NDC, 2015). This document pledges to peak national emissions by 2025, after which they will plateau for a decade, approximately, and thereafter decline, in absolute terms. This means that South Africa is committed to reducing its dependence on coal, in order to achieve this aim.

South Africa is a significant destination for international energy investment. This has been evident in the RE investments into South Africa, most of which have relied on imported technologies. Similar is likely to be true of the nuclear build programme, should this proceed,

as the technological solutions will need to be imported. Finance for a nuclear build programme is also likely to come from international sources, such as the BRICS Bank and the Russians have purportedly suggested that they could enable a 'build now, pay later' solution for South Africa, meaning that they will secure the programme Capex, recovering the costs of investment from the consumer in the future (through electricity tariffs).

Most informants interviewed for this report believe that raising finance for the proposed nuclear build programme will not be difficult, and suggest it will be a blend of debt and equity finance, through a mix of project finance, country to country finance, and commercial and government debt, including from the BRICS development bank (BRICS countries being Brazil, Russia, India, China and South Africa). The latter option is supported by the fact that nuclear trends feature in most of the major BRICS economies.

Commercial banks in South Africa are not expected to invest in nuclear, due to the programme's magnitude, and the corruption risks highlighted by the SoC Report (Standard Bank, ABSA, Chris Yelland, ACED, pers. comms, December 2016 and January 2017).

Investment costs and the risks of different energy options

Cost and risk are the primary criteria determining the energy mix in most countries, including South Africa. National Treasury, an important Eskom shareholder, takes the view that energy investment choices in SA should be made on the basis of the least cost option that does the job properly (NT, Yelland, pers. comms., January 2017). "Properly" includes securing baseload power, with NT viewing energy security as critical to the economy's stability and growth.

As discussed, nuclear is not the cheapest form of power available to the country, especially with the cost of renewables having declined rapidly. Furthermore, NT, according to Draft IRP 2016, expects an 8% return on public energy investments. Moreover, it is expected that because Eskom is 100% state owned, the shareholder (the State) will have to take the risk and provide the guarantees. This is the jurisdiction of NT, who in an interview in December 2016, stated that *they are reluctant to put up any more guarantees for Eskom or to provide the entity with further financial bailouts.*

The need for more flexibility in South Africa's energy mix going forward is an increasingly critical factor determining energy investments in the future. As discussed, an "either or" situation exists, with Eskom and some other experts and institutions arguing that RE cannot provide baseload power and that they are suffering from a reduction in coal sales, displaced by the coming online of renewables. They further argue that this raises the cost of the otherwise much cheaper RE technology.

Nuclear is both expensive and inflexible - indications are that nuclear will be an expensive option for South Africa, and the country is not showing signs of being able to afford this expense. *Some experts say that only economies that have steady growth rates of five percent or more, can afford nuclear* (WWF, pers. comms, February 2017).

With this, investors expect major baseload investments such as nuclear (and coal) plants to run all the time in order to validate the cost of investment, particularly the high, upfront capital costs (capex). This locks countries into long-term solutions based on tariffs that are determined upfront, creating an inflexible cost base, as seen in Hinkley Point (see Case study 2: main report). With South Africa's uncertain economic future, *many experts consider long-term energy solutions – such as nuclear build – to be too costly. This suggests that the precautionary principle be applied.*

For baseload provision, hydro-power is not an option within South Africa but is available to import from the region. Generating further coal power places the country at even greater risk to national water security. *However, RE provides cheaper options to nuclear, and many experts suggest that these should be explored, along with a more flexible energy system.*

South Africa's ability to build large scale energy infrastructure within budget and on time is questionable. With the possible exceptions of China and Korea, the world has a track record of significant delays and overrun costs in building nuclear. A three-year delay constructing Medupi with substantial overrun costs, has already been experienced, suggesting a much higher tariff than published by Eskom. Notably, South Africa has significant experience of building coal fleets, suggesting that these overruns are even more likely to occur with nuclear build, of which the country knows substantially less.

Lastly, inevitable changes in the power sector, in particularly through the breakthroughs of disruptive technologies, would facilitate the introduction of greater flexibility into South Africa's energy mix, at much lower cost. This will be extremely welcome in a country facing as much economic and political uncertainty such as South Africa.

Socio-economic context and implications for the energy sector

From a socio-economic perspective, South Africa continues to face the triple challenges of poverty, unemployment and inequality - women and children being the most vulnerable to health and security risks. Ever-rising electricity costs can easily become unaffordable for the poor. With universal access to affordable electricity being one of the government's main priorities, the country can ill afford to make electricity even more expensive. On the other hand, the energy sector has potential to improve conditions of poverty, inequality and unemployment, as proved by several studies, including by the DoE. The DoE has estimated that around 25,000 job years (full time employment opportunity for one person for a year) have been created since the start of the IPP programme in 2013; with a commensurate increase in local manufacturing content of R30 billion (DoE, 23 August, 2013). However, this progress is threatened by the delay in Eskom's signing of power purchase agreements with IPPs.

Despite the fact that South Africa has one of the most well developed energy sectors in the region, the structure of its consumer base and thus its overall energy demand is currently compromised by rising unemployment, and persisting poverty and inequality. These challenges are in turn exacerbated by low economic growth projections for the medium term. Therefore, it is important that *prospects for future energy demand and decisions about new baseload generation capacity are modelled in the context of South Africa's socioeconomic challenges, in order to ensure the sustainability of new infrastructure investments.*

History of nuclear energy in South Africa

South Africa's experience in nuclear power dates back to 1948, when it established the Atomic Energy Board (later the Atomic Energy Corporation) to oversee development of the uranium mining and trade industry. It demonstrates a lengthy process and also speaks to South Africa's international relations, which diplomatically and economically are linked to the country's nuclear energy relationships. It is evident that Russia is a significant partner and that there has been a shift away from relations with France, the USA and the UK.

South Africa has an interesting history of nuclear, starting with nuclear weapons before transitioning to energy and dating back to as early as 1948. In earlier years, the country pursued a nuclear weapons programme (as a deterrent to what was perceived as a Soviet threat in southern Africa). The programme was so successful that in 1976, the Soviet Government became sufficiently alarmed that it sought US cooperation to end the programme, resulting in

the termination of the nuclear weapons programme in 1990: South Africa then became a champion of non-proliferation efforts. In the subsequent years South Africa became a recognised producer and exporter of nuclear technologies and materials and in 1999: Russia's President Yeltsin and South Africa's President Mandela established a Declaration on Principles (of partnership). This was revisited in 2006 with a recommitment by the countries. Other cooperation agreements were also signed, including with the US in 2009. In 2013, the Putin-Zuma Joint Declaration of March 2013 effectively upgraded the 2006 strategic partnership to a "comprehensive strategic partnership".

Current nuclear skills and capacity in South Africa include highly skilled employees such as design engineers. As at 2017, South Africa operates two nuclear power reactors (Koeberg 1 and 2, in the Western Cape), producing 1800MWe, or 5% of the country's energy supply. Koeberg has a strong safety track record, although designs for and implementation of waste management infrastructure is lagging, with the nuclear fuel ponds allegedly holding three times the amount of waste that they were originally designed for. According to President Zuma, the country expects to build 9,600MW of nuclear generation capacity by 2030, with the intention to take a fleet approach, building multiple plants at once rather than ordering one reactor at a time. Several international companies have expressed interest in investing in this programme (Areva, China General Nuclear Power Group, EDF, Rosatom, Toshiba, Westinghouse and KEPCO).

More recent developments show that the call for a nuclear programme has accelerated. In 2010, Cabinet approved the DoE Integrated Resource Plan (IRP 2010-2030) which is still the official plan and provides for, inter alia, 9,600 MWe of nuclear for SA's future energy mix. In 2013, the DoE revised IRP 2010-2030, discarding the importance of nuclear, but then failed to take this through cabinet. In 2014, the DoE signed an intergovernmental agreement with Russian Nuclear entity, Rosatom, an internationally binding agreement to buy a fleet of nuclear reactors. This was immediately followed (in 2015) by SA (DoE) and Russia (Rosatom) signing 2 memoranda of understanding on nuclear power. This gave rise to SAFCEI and ELA launching a court application in 2015 in an effort to stop the nuclear programme. In the midst of this, the DoE published the aforementioned nuclear determination allowing Eskom, and therefore the state, to legally proceed with 9.6GWe nuclear build. In October 2016, SAFCEI/ELA note Cabinet's statement that it will delay the nuclear requests for proposals (RfP), until the energy plan (IEP) and its subset, electricity plan (IRP) have been completed, welcoming this as a step toward good governance.

During the last quarter of 2016, Minister Tina Joemat-Pettersson gazetted the Draft IRP 2016, as an update and revision of IRP 2010-2030, During the related public consultations in December 2016, Mr Koko (acting CEO Eskom), announced the intention to launch the nuclear RfP following the Government gazette nuclear determination.

Risks and potential for nuclear energy investors in South Africa

There is much uncertainty regarding nuclear energy, and related factors: South Africa's economic future, the related demand for energy and the country's ability to afford expensive, if reliable energy; uncertainty as to a 'good practice' model for the future of the power sector, and the viability of technologies that could enable a cheaper, more flexible alternative to the lock ins created by nuclear build. There is also uncertainty for future generations left with plants to decommission, nuclear waste and uncertainty around the success rates of other large-scale nuclear build programmes taking place in countries such as China. In the case of the latter, as well as some of the other uncertainties, it is just too soon to tell.

However, some risks regarding the nuclear build programme can be assessed with certainty, including political, financial, socio-economic, environmental, safety and security, and legal risks. There are also identified opportunities, discussed briefly after the evaluation of the risks.

Measuring risk
The level of risk is measured as the probability of the event occurring, multiplied by the level of impact the event is expected to have.

Risk = Probability x Impact

Political risk is deemed the biggest risk for SCI. Allegations of corruption have dogged the nuclear proposal deal from the start and evidence points to a large-scale systemic corruption, and, in fact, grand corruption (as defined by Transparency International - the abuse of high-level power that benefits the few at the expense of many, and causes serious and widespread harm to individuals and society, and that often goes unpunished) (TI, 21 September, 2016 and pers. comm., H van Vuuren, economic corruption expert, Institute for Justice and Reconciliation, January 2017). This is witnessed by the manner in which the nuclear build programme and related policies have evolved, with manipulation of facts to push toward large-scale procurement (see the IRP process, discussed earlier) and accelerate the process; the complicated technical nature, confusing officials and the public alike, and related security issues, allowing politicians to create a veil of secrecy, supposedly in the interests of national security (interview with Hennie van Vuuren, Economic corruption expert, Institute for Justice and Reconciliation, January 2017). In addition, a political dependency is created through the Russian agreement, which for example stipulates that if South Africa wishes to sub-contract part of the build programme, it must get Russia's approval. TI also supports the view that there are many parallels with the case of South Africa's arms deal, only this deal is potentially much bigger. South Africa would be buying large-scale technology it does not need, while promising the economy jobs and socio-economic spin offs that are beneficial, and will be financed through the international finance system. The evidence for grand corruption is apparent in the following (and explained in detail in Section D of the full report):

1) *Evidence and process surrounding the nuclear court case brought by SAFCEI/ELA against DoE*: For example, the minister repeatedly delayed providing information called for ahead of the court case, often ignoring set dates and calls for information.
2) *Contradictory statements from Government*, for example "South Africa needs an alternative plan – 'Plan B' – should nuclear energy prove too expensive, sufficient financing be unavailable or timelines too tight" (National Development Plan); *versus* "South Africa's nuclear power plant planning process is at an advanced stage and the multi-billion-dollar procurement process should be completed by the end of this financial year" (President Jacob Zuma, 11 August 2015). With this, the Draft IRP 2016 states that the nuclear build programme would be delayed to 2037, and simultaneously, Eskom, one of the two IRP authors, is accelerating the programme to 2025.
3) *The presence of corruption in the SOE (Eskom),* for example Eskom is responsible both for energy planning (IRP) modelling *and* for the procuring, owning and operating the

Why is grand corruption a significant risk for SCI?

Soul City is a renowned NGO with a sustained and robust track record for promoting social justice. ***The probability and impact of this risk being realised are both high***; Soul City's reputation surrounding its core business could be severely compromised, while participating in a programme associated with grand corruption is against the principles of ethical investment embedded in the SCI Investment Charter.

nuclear build programme. Furthermore, the SOE's recently departed CEO, Mr Molefe has a long history of allegations of corruption, including allegations while at Eskom; and finally, Eskom is seriously implicated in the SoC Report.

Financial risks are a further, critical consideration for SCI:

i) The inflexible nature of large scale nuclear build programmes means that investors are locked into agreements and prices before the plant has begun to be built. This means for example that if RE becomes a baseload energy option, it would be difficult or impossible, to downsize the use of nuclear and upscale the use of RE, unless the demand for energy increased substantially. Furthermore, *the risk of cost overrun is high and is likely to reduce the return on investment.*

ii) South Africa could be left with stranded nuclear assets because of over investment in generation capacity for which there is inadequate demand. Stranded assets are not likely to yield any returns on investment and this is a risk for the country and all investors in a nuclear build programme for which there is insufficient demand.

Socio economic risks are likely to negatively impact SCI's reputation. There is a 94% chance that South Africa's electricity price will be greater with a commitment to nuclear power, by 2030, with a 20% chance that the price will be at least 10% higher (ERC, 2015). Under their worst-case scenario for nuclear, the ERC model forecasts 75,000 jobs will be at risk, with consumers being hit directly both by high electricity prices and overall decreased economic growth (ERC, 2015). Eskom also cites job loss as a risk to nuclear (coal employs far more unskilled labour than nuclear), but notes the trade-off for C02 reductions. National Treasury has made it clear that the nuclear programme is not viable and that unless South Africa can guarantee 70% local finance, the programme is unaffordable. The trade-off costs for socioeconomic programmes are likely to be significant, as the national fiscus does not have these sorts of reserves or capacity. Should the Russians do as they promise, which is to finance the upfront capex, they will recoup from the future consumer and the country would still have to produce adequate finance for operational expenditure (opex).

Environmental, safety and security risks are also evident and much discussed, with three types of associated risk identified:

i) Nuclear waste management risks in the medium and long-terms
ii) The risk of a nuclear accident and disaster
iii) Risks to national security.

Management of nuclear waste has posed problems for the industry for decades. The associated risks of disasters have a long lifespan. Typically, plants are designed for five years of waste management, with the expectation that the next phase will be designed during the five-year period and the plant upgraded accordingly. It is evident however that this has not been the case at Koeberg, which nonetheless has high ratings for safety. Koeberg's nuclear waste ponds as a result carry around three times the waste they were designed for, heightening the impact of a potential accident or disaster. While disasters of the magnitude of Fukushima, are relatively few, when they happen, the consequences are immense and long lasting, experienced in direct financial costs, socio-economic costs, loss of life at scale, long-term health and environment consequences and massive cost to infrastructure. Acts of terrorism are another potential risk, not least because of porous borders and known terrorism training that takes place in the country (ISS, 2014, British Peacekeeping Force, 2014, USA Government, 2016). A nuclear plant is a recognised target, potentially triggering a large scale nuclear disaster.

A key consideration is whether South Africa has the discipline to mitigate all three risks. The country has a poor track record in managing long-term environmental risks; noting the prominent example of the mining industry's failure to manage acid mine drainage. This large-scale problem threatens the country's already scarce water resources and the problem has become so big that it is now considered too expensive to resolve.

Specifically, for SCI, the risks are both financial and reputational in nature. An analysis of probability and impact for each type of risk identified shows:

i) Waste management risks: High probability, low impact
ii) Risk of a nuclear disaster: Low probability, high impact
iii) Risks to national security: Low probability, high impact

Legal risks considered are twofold:

- **South Africa's domestic regulatory environment is at odds with international law** (the Russian agreement). Given the continued robustness of South Africa's legal and court system, there is a strong possibility that the nuclear build programme will be challenged by protracted legal processes and court cases.
- **International vendors are experts at protecting their interests contractually.** Financial flows are likely to be available from signing the deal and then commissioning plants. Should the country subsequently decide not to proceed, because the power is no longer needed, or for reasons of affordability, contractual obligations could be challenged at a much later stage of the process than where the country is today.

The specific risks for SCI are as follows:

i) Protracted court cases may raise SCI's visibility as an investor in the nuclear build programme, potentially damaging its reputation. It is also likely that there will be associated financial implications. ***High probability, medium impact***
ii) Russia (and other international vendors) are experienced and well versed at entering into these contracts, experience that is low in South Africa (with experience only from a relatively small nuclear plant, commissioned and built before the current political regime). Furthermore, the likelihood that SA would decide, under future political leadership, that the planned level of nuclear capacity is not needed, is strong. ***Medium probability, high impact***

The potential for nuclear investment for SCI

Although a full examination of a possible investment plan for SCI is beyond the scope of this report, there are a few considerations worth highlighting.

The nuclear build programme is likely to follow a similar route in terms of BBBEE requirements as the recent new coal fired generation capacity did, which required a 51% BBBEE shareholding structure. This immediately presents an opportunity for SCI, who could co-invest in the BBBEE component. Should the nuclear build programme proceed, the investment itself is potentially attractive in that the programme is large scale and long-term. The reactors are likely to be built in pairs, and not in parallel, meaning that it could take a few decades to complete the build programme, with potential returns on investment each time another module of the build programme is commissioned. Assuming the entire build programme is realised, which would mean that the financial guarantees are in place, the

possibility of a sustainable and longer term revenue stream for the investor is strong, provided that energy demand grows and stabilises and the electricity does not become unaffordable.

Given the financial rewards at stake, the involvement of political players and state institutions in the process, the possibility that the primary BBBEE investor has already been identified is very strong. While this would not necessarily mean that there is no room for a smaller investor such as SCI, its involvement could be viewed by political actors as an opportunity to legitimise the investment structure and players. SCI would therefore need to conduct an extremely thorough due diligence of the investment structure and players, under circumstances that are likely to be difficult and not fully transparent. The reputational and financial risks for SCI are considered to be significant, with high probability of these risks occurring.

It is possible however that events could play out differently in the future: the feasibility and technology evaluation studies that have been called for, could be produced by neutral experts, validating the technology choice, energy demand scenarios and the viability of the programme. A more accurate analysis of future demand scenarios (and the need for nuclear, as well as affordability) may be forthcoming. Noting that to date, these studies do not exist and many of the country's energy experts are not in support of the nuclear build programme, although there are voices, globally and locally that promote the nuclear solution as part of the country's future energy mix. Should these studies be produced, credibly validating nuclear investments, the energy programme would become decoupled from the political agenda, creating a much more attractive and less risky investment environment that is founded on solid rationale and National Treasury, civil society and energy experts support.

In conclusion, the risks appear to outweigh the opportunities for SCI by a significant margin. Much is at stake for a few players in an uncertain and fraught political environment in South Africa. A massive infrastructure programme of this nature, that is clearly located within the global energy environment and politics - also uncertain, changeable and politically fraught - is unavoidably a politically driven programme. Thus the key question for SCI is, *is it worth risking the robust reputation of a highly credible organisation, under the circumstances outlined in this document?*

Recommendations

Recommendations to the SCI as the sole shareholder of the SCBBEC, are framed by the information outlined throughout this discussion, and in particular the risks outlined above. The prevailing atmosphere of uncertainty in global and local energy politics and economics is an overarching consideration. Furthermore, note is taken of the investment strategy of the company in relation to potential for its investments in the energy and nuclear sector; whatever the technology, energy investments are critical to South Africa's long-term development. This is both true for securing South Africa's socio-economic future, to which a secure energy environment is integral, and is articulated in the SCBBEC Investment Charter.

The nuclear build programme, at face value, ignoring the political and cost-related/affordability discussion outlined above, may appear to present a sound opportunity for SCI to acquire a sustainable source of funding. As a BBBEE shareholder and SCI is well positioned to play a role in the programme. As indicated, SCI is likely to be an attractive shareholder given its robust reputation and legitimacy.

Two pathways are available to SCI. The first, preferred in terms of the evidence outlined in this paper, is to completely and permanently close the door on investing SCI's finances and reputation in South Africa's nuclear build programme. The second pathway, is to take note of

the possible uncertainties in how the future could play out, and to track the opportunity closely, with a view to possible investment, should there be a change in the politically driven and therefore skewed agenda.

The preferred (first) option is recommended on the basis that the stakes are high, the political links are strong, and South Africa can ill afford to enter another Arms Deal-like scenario, with a nuclear build programme being set by all accounts to be on an even greater scale.

The second pathway is that the critics are wrong and there is the possibility that South Africa requires a large-scale energy infrastructure investment programme, where nuclear is the only option. Were this to be proven beyond reasonable doubt (not the case today), then the energy programme could become decoupled from the political agenda. Of course, this would not necessarily mean that grand corruption is no longer at play. A legitimised energy programme of this scale is likely to feed into the vested interests of the political players in the process.

Applying '**the precautionary principle'** is therefore highly recommended for SCI, should the organisation choose to pursue the alternative pathway of a nuclear investment option. The precautionary principle is widely applied in the global financial environment when dealing with risk. It states that when there is an apparent but not yet scientifically proven threat to society or to the environment, scientific uncertainty should not prevent prudent actions to prevent potentially large damage. Thus the precautionary approach is applied in order to protect society and the environment. Fundamentally, where there are potentially grave or irreversible threats, lack of full scientific consensus should not be used as a reason for postponing cost-effective action. This principle is often found in relevant legal treaties and early law, for example in Justinian's statement in 527 AD, that "the maxims of law are to live honestly, to cause no harm to others, and to give everyone his due" (Thomas, 1975).

Should SCI choose to pursue this opportunity, it would greatly benefit from proceeding with caution. This approach requires close scrutiny of the nuclear procurement process, paying attention to the relevant aspects of politics, socio economics and energy economics, locally and globally. At a subsequent, although later stage, it would require a thorough due diligence of the unfolding investment and financing structure proposed for the programme, the investors and the preferred Vendor, and thus the technology supplier and the contractual arrangements. At each stage, a detailed risk assessment would be critical, accompanied by a cost benefit analysis that is done in consideration of the precautionary principle.

The pursuit of the nuclear investment opportunity is likely to be expensive and difficult for SCI. This is a fraught pathway, with many obstacles to resolve before signature is put to any agreement, of either intent or full commitment.