HEINRICH BÖLL STIFTUNG
SOUTHERN AFRICA

Final Report – Findings of the African Nuclear Study

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Rationale for the study[1]

While the debate is raging internationally on whether nuclear power should form part of any country's low-carbon energy future, a few countries in Africa are taking decisive steps to invest in new nuclear energy generation. South Africa already has the only African active nuclear power station, Ghana is going ahead with development of a 700MW nuclear plant with plans to expand to 1000MW, and other countries including Kenya, Egypt, Ghana and the Democratic Republic of the Congo have research-oriented nuclear reactors. In addition, Namibia, Uganda, Nigeria, Senegal, and Niger have all expressed interest in growing nuclear power expertise within their countries.

> *"Now we have rejuvenated the whole idea to go nuclear because it was envisaged that it would be so cheap that we would not even have to price electricity. We would write in our history books that once we used to ration power in this country. It will [also] spring new industries in steel technology, welding and various robotic roles. All these are spin offs from nuclear power." - Robert Sogbadji, in charge of nuclear and alternative energy at Ghana's energy ministry (eNCA, January 2015)*

We need to understand why nuclear power is perceived by some African governments to be an attractive energy choice.

In Africa access to electricity remains extremely low, often due to a limited grid but also because of affordability. Most countries are having to make urgent choices about their energy mix, in view of desired growth taking place in the formal economy. Because of perceived scale and steady output when functional, governments are looking to nuclear to meet the needs of expected growth. Seduced by vendors' offers, attracted to the prestige of projects, believing that developed nations have benefited from early adoption, and accepting questionable arguments on climate and beneficiation, governments are leading their countries down a path of underestimated future costs and dangers. More future-focused energy solutions may be the answer to Africa's developmental needs.

This growing interest in nuclear energy generation from African governments – even in a context of global nuclear sector decline - has prompted the Heinrich Böll Foundation to commission a study that will take a closer look at nuclear energy from an African perspective. This study was undertaken in order to review the arguments that have been presented by African governments in support of nuclear power generation and the related public response. Specifically, this study has focused on the nuclear ambitions of Kenya, Nigeria and South Africa as the countries in Africa with the most advanced current plans on nuclear power investment.

The activities making up the study

1. A desktop literature review of key nuclear power and related materials in Kenya, Nigeria and South Africa.
2. Interviews and workshops with stakeholders in the three countries to better understand the context and some of the arguments each country has made with nuclear and some of the public responses to these arguments.
3. Reporting and analysis of findings in the form of a detailed narrative report (this document) and a more concise popular publication (forthcoming) setting out the research highlights and opportunities for engagement.

[1] Based on the formal terms of reference from HBF

Research questions

The research sought to answer the following questions:

- Is there a nuclear renaissance in Africa?
- What are the stated ambitions of government in relation to nuclear power?
- Are the common associated risks of nuclear power present in African deals currently underway? Are these understood by stakeholders?
- What is known about likely construction outcomes?
- What are the known costs and investment models?
- How is nuclear understood to compare with Renewable Energy (RE)?

But first, the researchers set out to take stock – of stated government ambition, of public understanding of such ambition, and of current practice in order to ultimately identify opportunities to influence imminent decision-making.

Executive Summary

This study was commissioned by the Heinrich Böll Foundation in September 2014 and a final report submitted in January 2015. The report was updated to reflect recent events, in July 2015. The primary research was conducted by independent researcher Brenda Martin and at a later stage academic analysis was provided by Dr David Fig, an African Energy scholar. Both contributed to the writing of the final report and forthcoming popular version of it.

During the primary research over 40 stakeholder interviews were conducted, 2 national workshops were held, and an extensive literature review was undertaken. This report presents a summary and overall analysis of findings and includes concrete recommendations for civil society engagement. According to the research, government representatives in all countries cite economic growth (particularly job creation) and addressing access, as key motivations for investment in nuclear power. The theory of change is: boost grid-based electricity supply and access and the economy will grow naturally. In addition, in a context of growing global awareness of the need to transition to low carbon energy solutions, nuclear power generation as a 'low carbon solution' is also a commonly stated objective.

Of the countries under review, South Africa's nuclear ambition is the largest – with plans to add 9,600 MW of nuclear power to the existing 40,000 MW generation capacity. Nigeria and Kenya both aim to add 4,000 MW of nuclear power to existing relatively low national grid capacity.

The risk of high tariffs (and related likely continued lack of access) due to common costly nuclear power investment models is not seen as an insurmountable hurdle. All 3 countries are investigating finance models and appear confident that cost is not a constraint.

It has emerged that Nigeria and South Africa's nuclear ambition and progress toward procurement is the furthest advanced, and that Kenya is making slow but steady progress toward achieving its ambition at similar scale to that of Nigeria.

All three countries have opted voluntarily to comply with International Atomic Energy Agency milestones for nuclear investment and in turn, enjoy the pro-active support of the Agency and that of global powers, some of whom are in fact reducing their own domestic nuclear power investment.

Globally, the nuclear power sector is in decline, particularly post-Fukushima. Construction delays, escalating costs, changing financial models, heightened secrecy and lack of public consultation are all long-standing features of an industry which operates in a global context where Renewable Energy is flourishing.

The unassailable desire for energy security of supply, for increased energy access and the commonly held belief that economic growth and social well-being are all contingent on reliable base load energy supply, are all powerful driving forces of ambition for centralised energy infrastructure investment in Africa today.

Views on the best technology options differ widely, but the common message from civil society is clear: energy investment decisions have to be made urgently, but on the basis of factual information which fairly considers ALL available options and with full transparency and accountability.

This study cautions against nuclear investment generally and recommends specific areas for focused anti-nuclear lobbying and advocacy.

Introduction – the Global picture

Preparing to embark on a nuclear power investment programme

In preparing the infrastructure to introduce nuclear power, there are several steps that need to be taken by governments. These can be split into what the International Atomic Energy Agency (IAEA) refers to as the "three progressive phases of development". The completion of the work at each of these phases is marked by a specific milestone at which the progress and success of the development effort can be evaluated and a decision made to move on to the next phase. These phases are:

- Phase 1: Considerations before a decision to launch a nuclear power programme is taken
- Phase 2: Preparatory work for the construction of a nuclear power plant after a policy decision has been taken
- Phase 3: Activities to implement a first nuclear power plant

We provide more information on the corresponding IAEA milestones for each phase, later on in this report.

Nuclear power investment globally, is in decline

In 1984 the non-partisan United States Office of Technology Assessment (OTA) reported that:

> *"No nuclear plant now operating or still under active construction has been ordered since 1974, and every year since then has seen a decrease in the total utility commitment to nuclear power. By the end of this decade, almost all the projects still under construction will have been completed or cancelled. Prospects for new domestic orders during the next few years are dim".*[2]

Similarly, according to the *2014 World Nuclear Industry Status Report* (WNISR), globally there continues to be a clear trend of declining share of nuclear energy in power production – most recently from 17.6% in 1996 to 10.8% in 2013.

Today there are 31 countries operating nuclear power plants in the world. A total of 388 reactors have a combined installed capacity of 333 GW. The average age of existing nuclear reactors is now 28.5 years. More than 200 reactors may face shutdown in the next two decades and over 170 units (44% of the total) have operated for 30 years or more, including 39 that have run for over 40 years[3].

Of these, the WNISR classifies 43 power stations with a new term: "long term outage", i.e., reactors that have not generated any power in the entire previous calendar year, and in the first semester of 2014. Not surprisingly, in Japan, four-fifths of the fleet have not operated since 11 March 2011, the date of the Fukushima disaster.

It can be concluded that the global nuclear industry is in decline when noting that current annual nuclear electricity generation corresponds to a level previously seen in 1999[4].

[2] Nuclear Power in an Age of Uncertainty, February 1984
[3] World Nuclear Industry Status Report, 2014
[4] World Nuclear Industry Status Report, 2014

Today, South Africa is the only country on the continent with a nuclear power station. As indicated above, aside from the 3 countries under review (South Africa, Kenya and Nigeria) Ghana, Algeria and Egypt are also actively pursuing small new nuclear power build programmes.

The associated risks

Proliferation of nuclear weapons is a general threat to global peace and security. In the literature and in public opinion within the three countries under review, the most widely recognised and respected risk is that of safety and security. In the case of South Africa, the apartheid government weapons programme ended officially in 1990. Since then South Africa has declared itself in favour of the African nuclear weapons-free zone created under the Treaty of Pelindaba. This situation could change as there are no long term guarantees that future governments with access to enrichment technology will not turn to proliferation of nuclear weapons.

South Africa's admission to the BRICS group of nations brings it closer to three key nuclear weapons states. BRICS is the acronym for an association of five major emerging national economies: Brazil, Russia, India, China, and South Africa. BRICS was formed specifically to create a new global order as a counterweight against Western dominance. BRICS members together yield considerable influence on nuclear issues, as members of the IAEA Board of Governors. Additionally, BRICS includes nuclear and defence cooperation.

Of the nuclearised BRICS partners: Russia is in a position to threaten nuclear war, India is testing nuclear-capable missiles and hinting that it may abandon its 'no first use' policy on nuclear weapons, and China's nuclear arsenal may be invoked in growing tensions in the East Asia region and beyond.

In Africa, the acquisition of nuclear energy begs the question of how countries can safeguard the stocks of enriched uranium from falling into terrorist hands. It is no coincidence that states with nuclear energy ambitions such as Nigeria and Kenya are under threat of insurgent groups such as Boko Haraam and Al-Shabaab respectively. It is therefore questionable why the leadership of these countries would seek to introduce energy technologies that compound the security challenges these countries are facing. Future leaders may deem that nuclear weapons are warranted to deter insurgency, but as in the case of apartheid South Africa, nuclear weapons could not rescue the regime.

On the continent, in many cases where nuclear ambition has moved toward a build programme, it has clearly been due to a combination of highest level leadership oversight of such investment with the president often heading up any implementing body, little or no accountability on implementing activities to parliament or the public, and secret government-to-government deals that have not borne the scrutiny of established oversight bodies. Globally today, political ambitions in developed and developing countries occur against a backdrop of worsening poverty, growing wage and inequality gaps and socio-economic upheaval is growing particularly in developing countries.

Construction timeframes, construction delays, halts

Fourteen countries are currently listed as building new nuclear power plants, i.e. 67 reactors with a total capacity of 64 GW (WNISR, 2014). The average building time of units under construction stands at 7 years. However: 8 of the 67 reactors have been listed as under construction for more than 20 years, one for 12 years; at least 49 of the 67 have encountered construction delays (months to years); for the remaining 18 reactor units, either construction began in the last 5 years or the reactors have not yet reached projected start-up dates so it is not possible to assess whether they are on schedule or not.

In Taiwan, two units which had been under construction for the past 15 years saw further construction halted in 2014. The average construction time of the last 37 units that started up in 9 countries since 2004 was 10 years (the range is between 3.8 to 36.3 years). None of the next generation or so-called Generation III or III+ has entered service as yet. Over the past few years, numerous nuclear projects have been delayed indefinitely or cancelled (WNISR, 2014).

Costs and investment

Investment costs for nuclear power plants have increased in the past ten to fifteen years from US$1,000 to around US$8,000 per installed kW. Construction cost estimates have increased in virtually all countries with build programmes currently under way.

Historically low inflation-adjusted operating costs have escalated so rapidly in some countries (France, Germany, USA, Sweden) that the average reactor's cost is barely below, or even exceeds the normal band of wholesale power prices.

The largest nuclear operator in the world (EdF) experienced an income deficit of US$2 billion in 2012 because tariffs did not cover the running costs. Ratings agencies consider nuclear construction projects generally as 'credit negative'.

Comparisons with Renewable Energy (RE)[5]

Global investment in RE totalled US$214 billion in 2013, down from a record US$300 billion in 2011, but still four times the 2004 amount. The decrease in investment was mostly due to significantly lower prices for RE technology. Globally, since 2000, the annual growth rates for wind power have averaged 25% and for Solar PV, 43%. Global nuclear electricity generation in 2012 was at its lowest level since 1999.

At the end of 2013 China's 18 GW solar installed capacity for the first time exceeded operating nuclear capacity. In 2013 Spain generated more power from wind than from any other source, outpacing nuclear for the first time. This was also the first time that wind became the largest electricity generating source over an entire year in any country. At the same time, growth rates for generation from wind power above 20% were seen in North America, Europe & Eurasia and Asia Pacific. In addition, North America more than doubled its Solar PV power generation and Asia Pacific grew by 75%.

[5] REN21, Renewables global futures report, 2013

The traditional understanding of base load electricity generation might become obsolete with increasing RE penetration into national grid systems as evidenced by rapidly growing penetration trends illustrated in the Renewable Energy Policy Network for the 21st Century (REN21) 2014 global status report[6]. As the report indicates: "In the 'spot market', several countries experience extended periods of very low or even negative RE electricity prices". Nuclear plants are the least flexible in reaction to unfavourable economic conditions and keep operating for hundreds of hours at spot prices below their average marginal operating costs. In 2013, Germany produced 56% more electricity from renewables than from nuclear.

General points - Africa's Energy context

Power generation capacity on the continent is currently estimated at 90 GW, with about 40GW of this being generated in South Africa (International Energy Agency (IEA), 2014). In its 2014 Africa Energy outlook report the IEA predicted that power generation capacity in Africa will quadruple from 2020 to 2040, giving nearly a billion people access to electricity. It indicated however, that West African oil production was set to fall more than 12% between 2020 and 2040 at a time of fast rising domestic demand for oil-based products (predicted to double during this period), squeezing the region's exports. It also forecasts that more than half a billion people, mainly in rural areas, are likely to remain without electricity in 2040.

This study has focused on the nuclear power investment ambitions of Kenya, South Africa and Nigeria. South Africa's nuclear investment ambition is by far the greatest. Kenya and Nigeria have ambitions at a much smaller scale, but at relatively higher cost when applying economies of scale.

Reports from the 3 countries under review: Kenya, South Africa and Nigeria

Summary of findings common to all 3 countries

Nuclear-related deals in all three countries are being brokered at the highest level of political leadership, with little or no public consultation and with no details of agreements provided. Policy is often re-drafted retrospectively to ratify government action e.g. to protect secrecy, to adjust the procurement process as necessary, to frame ministerial power.

All three countries have other energy supply options that are faster to implement, cheaper, safer and likely to contribute to a number of socio-economic, environmental and developmental objectives.

It is our view that the leadership of all three countries is determined to pursue nuclear power programmes and that – like in all situations where sufficient leadership will exists – the means to realise this determination will be found. Citizen engagement with the process is urgent and critical.

What governments say: common rationale for pursuing nuclear power investment

Among the common arguments government have put forward is the need to increase energy generation as African economies grow and experience an accompanying energy deficit. They argue that diversification of energy sources is important in meeting the growing

[6] REN21 Renewables 2014 Global Status Report

demands in energy and in boosting energy security. Governments claim that the unreliability of current energy sources will only be addressed with increasing base load energy production, such as can be provided by nuclear.

Now synthesised reports are provided for each country focusing on: the differentiated, expressed government rationale in support of nuclear power planning in each country, and the public response to this ambition. These summarised reports are based on a comprehensive literature review, interviews with 44 diverse (largely senior) stakeholders in the three countries under review, and research analysis. Stakeholders included government, business and industry, youth, media, academic and organised civil society representatives.

Kenya

Introduction

With a population of 43.2 million[7] and a GDP per capita of $994[8], Kenya's economy is market-based, with a few state-owned infrastructure enterprises, and a liberalised external trade system. The country is generally perceived as Eastern and Central Africa's hub for financial, communication and transportation services. Currently domestic economic prospects are seen as favourable by investors with above 5% GDP growth expected in 2014, coupled with modest external national debt. This is largely attributed to expansion in tourism, telecommunications, transport, construction and a growing recovery in agriculture and a growing local professional workforce.

The government, generally perceived as investment friendly in business literature, has enacted several regulatory reforms to simplify both foreign and local investment, with the most important of these considered the creation of an export processing zone. Compared to its neighbours, Kenya has a reasonably well-developed social and physical infrastructure. Widely known by locals in varied sectors, the Vision 2030 is Kenya's current blueprint for the future of economic growth. The long-term goals of this vision are to create a prosperous, and globally competitive nation with a high quality of life by the year 2030. To do this, it "aims to transform Kenyan industry all the while creating a clean and secure environment". The vision is separated into three different pillars: economic, social, and political governance.

Electricity supply in Kenya today

Kenya's interconnected system installed capacity is 1,697 MW which includes 808 MW hydro, 531.4 MW thermal, 205.8 geothermal, 26 MW cogeneration, 5.8 MW wind and 120 MW Isolated grid[9].

Energy demand has grown consistently at around 8% per annum for the past 5 years and in order to meet rapidly growing domestic energy needs[10], the country has to import substantial amounts of crude oil and natural gas. This might change with the discovery of potential oil reserves in the north of Kenya, but progress on exploration has been slow.

[7] World Bank, 2013
[8] World Bank, 2014
[9] Kenya Nuclear Electricity Board, March 2014 – presentation to IAEA in Seoul, Repubic of Korea
[10] Kenya Nuclear Electricity Board, March 2014

Key economic and energy data[11]	1990	2000	2012
Energy used per capita (kilograms of oil equivalent)	455	449	480
Carbon dioxide emissions per capita (metric tons)	0,2	0,3	0,3
Electricity use per capita (kilowatt hours)	125	113	155
GDP ($ billions)	8,6	12,7	40,7
GDP growth (annual %)	4,2	0,6	4,6
Military expenditures (% of GDP)	2,9	1,3	2
Paved roads (% of total)	12,8	12	7
Total external debt stocks ($ billions)	7,1	6,2	11,6
Foreign direct investment, net inflows ($ millions)	57	111	259
Net official development assistance received ($ millions)	1,2	0,5	2,7

Connectivity to the national grid in Kenya currently stands at 28%.

Kenya has an energy plan linked to projected growth in demand and related anticipated economic growth – the Least Cost Development Plan (LCDP) -- which was designed to realise the energy components of the country's development blueprint: Vision 2030. The LCDP allocates total installed capacity of 15,026 MW by 2030, with nuclear power to contribute a total of 4000 MW. This is a tenfold rise in current generation capacity and energy access is cited as the most important benefit of such an increase. Nuclear power is considered by several government, business and some civil society stakeholders as a least cost option. But on the whole, nuclear cost is not the greatest common concern. More on this below.

In order to achieve 'established middle-income' status, nuclear energy has been chosen by government as the best way to produce safe, clean, reliable and base load electricity in Kenya. Kenya has a number of other energy supply resources - wind, solar and geothermal plants and advocates for RE expansion and growth in distributed energy supply express frustration at the focus on centralised, risky and expensive nuclear power.

In September 2010, with no prior public consultation, the former Energy and Petroleum Ministry announced that Kenya would build a 1,000 MW nuclear power plant between 2017 and 2022, with further plans to have installed a total of 4,000 MW nuclear power by 2030. This additional capacity would address about 19% of Kenya's projected energy needs. The projected cost (using South Korean technology) is US$3.5 billion. Nuclear power would then become the second largest source of energy in Kenya, after hydro. Our research revealed very little public support for this ambition, but the Kenya Nuclear Electricity Board is clearly well-resourced and is moving ahead with action toward the achievement of IAEA milestones. Given the very low level of reporting on nuclear ambition during the two years prior to and during the study, it was not possible to ascertain empirically what broad public opinion currently is in Kenya. The research relied on stakeholder interviews, a thorough scan of relevant online news articles between 2012 and 2014, and published regional reports.

The Kenya Nuclear Electricity Board is in charge of spearheading the new nuclear sector in the country. Our research revealed that the Board is fully funded by national treasury. The Board claims to have held a stakeholder forum in February 2014, but of all the people interviewed in 9 energy sub-sectors in Kenya, no one was aware of this.

Poor governance and corruption have had a negative impact on growth, making it increasingly expensive to do business in Kenya. According to Transparency International's

[11] World Bank, 2014

corruption perception index, Kenya ranks 136th out of 175 countries assessed globally. Bribery and fraud has cost Kenya as much as US$1 billion a year. Kenyans, 23 percent living on less than US$1 per day, pay some 16 bribes a month— some estimate two in every three encounters with public officials. Between September 2013 and November 2014, over 150 people have been killed, and more injured in terror attacks in Kenya. Terrorist attacks or narrowly averted attacks have been reported at least bi-weekly since July 2014.

Commonly expressed public concerns around nuclear cited in on-line media, 11 stakeholder interviews and a multi-stakeholder in-country workshop attended by 12 participants from 9 sectors, mainly relate to issues of security and safety, with potential for corruption appearing as a secondary concern.

Institutions, Policy & Regulation pertaining to nuclear power plans

As in Nigeria and South Africa, the nuclear power programme in Kenya has support at the highest levels of government, with significant and comprehensive political resources allocated.

Kenya Vision 2030 is the country's development policy blueprint covering the planning timeframe between 2008 and 2030. It aims to "transform Kenya into a newly industrialised, middle income country". Energy is considered one of the key enablers of the Vision. The country's power planning allocation policy - the Least Cost Power Development Plan (LCDP) was crafted based on Vision 2030.

The following policy instruments have been drafted to support nuclear electricity generation:

- Draft Energy Bill 2014
- Draft Energy Policy 2014
- Environmental Management & Coordination Act (EMCA)

A nuclear energy policy and bill are currently being developed, with the assistance of the International Atomic Energy Agency (IAEA)[12].

A Prefeasibility Study Team was launched by government in November 2011, made up of an intergovernmental team of assessors to study the 19 infrastructure issues on the IAEA milestone list, assess Kenya's readiness for a nuclear power programme and propose a roadmap for implementation. The IAEA indicates that Kenya is nearly ready to pass Milestone 1.

Unlike other energy sources, the country would be burdened with having to establish an independent nuclear energy regulatory agency, with a clear legal mandate to protect the population from exposure to radioactivity. It would have to have institutions that could measure radioactivity in the environment, deal with hazardous waste and cleaning up of spills, and ensuring safety and evacuation plans and training.

The study has revealed that Kenya does not have adequate legislative, regulatory or institutional frameworks in place to support a nuclear power build programme at the moment. Whether Kenya has the time and resources to build a scientific establishment versed in nuclear technology, develop a technologically competent engineering sector that could build, operate and maintain nuclear facilities, find finance for fuel, cover operating costs, deal with safe waste disposal and finally decommission plants at the end of reactor lifespans – all within a competent and honest regulatory apparatus are questions that remain unanswered at this time.

[12] Kenya Nuclear Electricity Board, 2014

Nuclear ambition – stated government rationale

Government asserts that overreliance on Hydro is costly to the economy due to changing climatic conditions (particularly increased frequency of drought), and that fossil fuel import prices are growing rapidly. At the time of writing this report, global oil prices are on a significantly declining trend. In spite of evidence of global RE prices dropping substantially over the past decade, there is an often-repeated government view that domestic renewable energy resources simply cannot meet the pace of growing demand. It is unclear why, unlike in South Africa, the local price of renewable energy technology has not dropped significantly in Kenya or Nigeria over the past 5 years. Given that analysis of this reality was outside of the scope of this study, future planned research could investigate why this is the case.

Diversifying the energy mix to include nuclear power is described by government as 'necessary' in the context of growing energy demand and the need to reduce emissions in the face of climate change. Nuclear power investment is viewed as financially viable and as making economic sense, e.g., it is believed that the cost of power will finally drop to below 10 US cents/KWh[13].

The economic strength of global superpowers is pointed to as due to their willingness to commit to nuclear. There is a strongly held view within government that Kenya can learn from the mistakes of others and benefit from joining the nuclear investment movement now that the major problems are either sorted out or are well on their way to being sorted out.

Problems of waste management are seen as something to address only well into operations (at least 20 years from commissioning) and demonstrated typical nuclear build cost overruns are viewed as manageable through a watertight, non-negotiable financing model where the risk of cost overruns is not likely to be located with Kenyans.

The only problems associated with nuclear power which all parties across the pro- and anti-nuclear spectrum agree on are: the undeniable and growing risk of security and safety linked to growing incidents of terror. Even though some officials will point out that nuclear plant designs are improved and advanced to ensure that they meet the required safety standards, that current plant designs feature reliable and diverse safety systems and strong physical barriers to prevent incidents that could pose a threat to public safety. It is clear that safety and security is a daunting concern even for local supporters of nuclear power.

In summary: all government officials tasked with implementing nuclear ambition believe that nuclear power can provide reliable, stable and cost effective electricity supply to support the country to affordably address its economic and social needs – provided issues of safety and security can be sufficiently addressed. This can partially be addressed through government commitment to waging a war on terror, growing public sentiment around not supporting terrorist agendas, and partially by radically reducing corruption among government officials. Generally, wider public opinion is that these latter solutions are unlikely to be realised.

What recent progress has been made?

Kenya appears to have taken a measured approach to nuclear power ambition – only a few key institutions have been formed to plan for implementation, the IAEA requirements are being diligently addressed, international support is being drawn on, and modest human resource capacity development is happening. It is acknowledged by government that currently Kenya has inadequate local technical skills, technology and energy planning capacity. As indicated above, policy and regulation measures are not yet sufficiently established.

[13] Interview with senior government official, November 2014

It is unclear whether the necessary financial resources for a nuclear build programme are available. During the course of the study we heard contradictory views from the Kenya Nuclear Electricity Board. In our interview they spoke as if financing was no longer a challenge, but in their reports to the IAEA, the KNEB indicates "constraints in funding and financing of the nuclear power programme".

Finally, the existing electricity grid infrastructure is inadequate to support a nuclear power programme and we have found no indication of imminent actions to improve the grid.

Summary of non-government stakeholder views

There are mixed views on whether risk is acceptable or outweighs the benefits of nuclear power. Some believe that the risk is acceptable when cheap electricity tariffs can improve livelihoods and reduce suffering today. Others believe that the risks are far greater than the likely benefits and the benefits (e.g. cheap, reliable electricity) are not guaranteed.
There are many opportunities for local energy efficiency and wise use of energy that have not yet been implemented, e.g., improved, electric-powered public transport to reduce traffic and single use vehicles would reduce petroleum demand and divert new electric energy (even if nuclear) to more efficient applications; rooftop solar PV and solar water heating would stimulate the local RE industry and bring down prices (in SA the RE competitive bidding process has reduced cost by an average of 60% over 3 years).

Kenya is about to move away from REFIT and opt for competitive bidding as this leads to more rapid reduction in RE prices.

Our research did not reveal significant critical engagement by civil society in Kenya. Media coverage of nuclear ambition is very low, and many stakeholders are not paying attention to the process or pointing out the many flaws in government arguments in favour of nuclear power. Although energy access is widely agreed to be a critical priority, specific alternative energy options are not being advocated vocally. It has been our strong impression that in Kenya there appears to be a policy vacuum based on a widely held scepticism of government ability to deliver on such a large infrastructure programme. In short, it appears that advocating against nuclear ambition is considered unnecessary – because it is perceived as unlikely to be realised.

From the stakeholder workshop discussion held in November 2014 (which turned out to be more of an opportunity to inspire local civil society leaders to action), the following suggested actions emerged from the group to raise awareness and encourage public engagement to ensure good governance of the process:

- The media should grow their understanding of the issues and help share reliable facts. Longer term, this education can start at journalism school.
- Stakeholders should bring specific updates, events and milestones to the attention of the media.
- Youth should be inspired to pay attention to the choices being made today that will affect them in future.
- University courses must include emphasis on engaged and critical citizenship that looks after the best interests of the country as a whole.
- Citizens must remind politicians of the need to consider value propositions and the application of the precautionary principle; politicians must ensure that officials are accountable.
- Effective communication with government is an essential skill to master.

Consensus point: no matter what is decided, it should be on the basis of factual information, full transparency and accountability and in the best long term interest of Kenya.

South Africa

Introduction

With a population of 52.3 million[14] and a GDP per capita of $6,617.91[15], now Africa's 2nd largest economy (arguably the most established), South Africa has been widely hailed for its relatively peaceful transition to democracy in 1994. South Africa is a country rich in mineral, natural and human resources. Since democracy South Africans have seen their incomes rise by almost 30% on a flat average, in real terms[16]. In conventional economic growth terms, the SA economy grew strongly between 1994 and 2012. The poor have benefited from a more socially oriented government and a massive rollout of services and grants under the African National Congress's (ANC) tenure which has been responsible for lifting most out of the lowest living standard and income measures. Population growth has been slowing steadily by 1% each year, but also average life expectancy has declined due to the AIDS pandemic and slow initial government response.

While the end of apartheid at least opened prospects for equal opportunity regardless of race, South Africa struggles to correct the inequalities and social dysfunction created by decades of apartheid policy. Despite some ANC policies aimed at closing the poverty gap, continued intergenerational poverty, unemployment[17], income inequality[18], failure to reform land ownership, collapse of public infrastructure and uneven educational reform remain serious social problems that require both policy and funding to address.

Part of South Africa's apartheid legacy is a nuclear industry long shrouded in secrecy and extensive government support which originated in a context where apartheid SA was facing growing international condemnation for its oppressive regime. Uranium resources have been plentiful for decades and co-operation with US, UK, West German, French and Israeli nuclear expertise ensured that local nuclear technology capacity was strong. Whilst it could develop its own weapons, however, the South African nuclear industry has never been successful in being able to build its own reactors[19]. In fact, extending the industry will not create energy security and independence, but instead tie South Africa into greater dependency on its technological partners abroad.

In theory South Africa has sufficient coal resources to make it 100% energy self-reliant, but because of climate considerations, this cannot be the case. SASOL, the synfuels industry set up by the state in the 1950s and now privatised, converted coal (now gas) to liquid fuels and helped to reduce dependency on international petroleum resources which were prone to sanctions. Ostensibly the nuclear energy industry claimed to extend energy independence. However this claim is currently threadbare in view of the need to send uranium to be enriched abroad. During apartheid, the state possessed conversion, enrichment and fuel fabrication plants, but these have all been dismantled and will require extensive investment if they are to be reinstated.

The South African nuclear power industry therefore grew less out of a desire to establish energy independence in the face of global economic sanctions and justified fears of isolation, than as a cover for the weapons programme. The associated uranium enrichment

[14] 60% urbanised and with a projected 8 million new urban residents by 2030
[15] World Bank, 2013
[16] Investec, 2012. If inflation is included then the estimated income per person in South Africa has risen almost four times since 1993.
[17] Officially unemployment is at 25.5% of the population, but when including discouraged work seekers this rises to 40% (Gumede, 2013)
[18] The top decile of the population accounts for 58% of income while the bottom half accounts for less than 8% (World Bank, 2013), resulting in one of the highest global inequality levels with a Gini coefficient of 0.69.
[19] This applies to the Koeberg reactors, the failed Pebble Bed project, and to future NPP orders.

and weapons programmes acted to assert apartheid's security dominance and helped build the illusion of its indestructability.

Taken collectively, the apartheid government's nuclear programme exhibited the logic of its role as an oppressive state. Why the ANC seems to have become enchanted by the nuclear 'value chain' is thus viewed as curious by most stakeholders who clearly recall South Africa's recent past.

Within the anti-apartheid movement, anti-nuclear sentiment was widespread and the industry seen as a significant pillar and prop of the apartheid regime. Prior to democracy, the ANC was very clear: nuclear power was dangerous, always decided on in secret, and should be actively rejected. From about 1996 onward, this sentiment slowly but surely evaporated as increasingly ANC leaders began to speak of the need to 'be realistic' and to 'explore all technology options'. Deputy President Thabo Mbeki (later SA's second democratic president) included expansion of local nuclear expertise within his ambition for an African renaissance grounded in intellectual, economic and political leadership focused on continental progress.

Although canvassing support from a very different platform, today, South Africa's third democratic president – Jacob Zuma – is a firm advocate of nuclear power supply and he has made clear since 2010, that nuclear power investment in South Africa is non-negotiable and that all necessary actions should be taken to ensure realisation of a new nuclear power programme. In South Africa procurement for 9600 MW of nuclear power supply is scheduled to begin in August 2015.

Key economic and energy data[20]	1990	2000	2012
Energy used per capita (kilograms of oil equivalent)	2584	2483	2741
Carbon dioxide emissions per capita (metric tons)	9,5	8,4	9
Electricity use per capita (kilowatt hours)	4431	4681	4604
GDP ($ billions)	112	133	384
GDP growth (annual %)	-0,3	4,2	2,5
Military expenditures (% of GDP)	3,9	1,4	1,2
Paved roads (% of total)	no data	20	no data
Total external debt stocks ($ billions)	no data	25	138
Foreign direct investment, net inflows ($ millions)	-76	969	4644
Net official development assistance received ($ millions)	270	486	1067

Electricity (and energy) supply in South Africa today

With grid supplied generation capacity of about 40 000 MW, the majority (about 72%) of South Africa's energy needs are provided by coal. About one-third of the country's liquid fuel (via the Sasol coal-to-liquid process) is also derived from coal but is at least 60% more emissions intensive than conventional oil refining.

Aside from a growing middle class able to afford electrified housing and individually owned transport, since democracy, about 4 million new homes have been connected to the national grid. The 2011 Census revealed that 84.7%[21] of formal households[22] in South Africa are technically connected to the grid and can use electricity for lighting. But the significant increase in the number of households with access to electricity and energy provides a one-

[20] World Bank, 2014
[21] Up from 70.2% in 2001.
[22] The poorest of the poor living in informal housing or at no fixed/formal address are excluded here.

sided picture of access – rapidly rising electricity and fuel tariffs mean that such access is increasingly unaffordable.

Just focusing on electricity, the tariffs charged by the national utility and monopoly electricity provider, Eskom, have increased on average by about 378% between 2001 and 2011 and Municipalities add their own margins on top of these tariffs when they sell on to domestic customers. The poorest households in South Africa today spend 47.7% on food and 32% on housing, water, electricity, gas and other fuels (excluding transport)[23].

Eskom dominates the South African power sector. Currently the utility is in the midst of the worst operational crisis it has ever experienced due to the knock-on effects of delayed grid and infrastructure improvements and a history of cheap tariffs. Eskom's credit ratings have been cut to near-junk status.

South Africa has the only nuclear power station in Africa – Koeberg. It has been operational since 1984, and has installed capacity of 1,930 MW. Koeberg's two reactors currently supply about 5% of South Africa's electricity.

Institutions, Policy and Regulation pertaining to nuclear power

In South Africa, nuclear ambition enjoys comprehensive political support, even while there is significant government-commissioned advice against such ambition. Before listing the specifics of regulation and policy, some examples of this complexity are outlined.

High-level endorsement

As in the other two countries under review, Kenya and Nigeria, nuclear power planning has the highest level of political support – in particular from the President and the Minister of Energy. The clearest statement of presidential endorsement was the State of the Nation address held in parliament on 17 June 2014, just after the ANC had won a general election. In the speech, President Zuma identified energy security as a priority for enabling SA to achieve economic growth of 5% by 2019. He stated that "this situation calls for a radical transformation of the energy sector, to develop a sustainable energy mix that comprises coal, solar, wind, hydro, gas and nuclear energy."[24] Presidential support for nuclear energy is underpinned and strengthened by a range of policies and institutions.

New policies

The country's "New Growth Path" seeks a transition to a Green Economy and is specifically geared toward accelerating change within various South African economic sectors. The Department of Science and Technology (DST) launched a "Ten Year Innovation Plan" in 2008 targeting the energy sector as one of South Africa's 'five grand challenges'. Yet neither of these initiatives have been as decisive in examining South Africa's energy future as the "Integrated Resource Plan 2010" process and the publication of the country's National Development Plan, "Vision 2030". These policies are described in greater details below.

The IRP2010 process

This key electricity planning process undertook detailed supply planning to set targets for shifting the country's energy mix by 2030. Despite extensive civil society lobbying for the Department of Energy to consider a nuclear-free option and the modelling underpinning the supply mix discarding nuclear as too costly, inclusion of nuclear was treated as non-negotiable in the final plan. The revised plan ultimately endorsed the ambition of the political leadership to add 9 600MW of nuclear to the national grid. Legally, the IRP process is meant

[23] Mail & Guardian, 9 November 2012
[24] President J G Zuma, State of the Nation Address, 17 June 2015.

to be reviewed every two years, but the last update report appears to have been quashed by government.

On 21 November 2013 an IRP2010 update report (IRP2012) was released on the Department of Energy web-site and public comment invited by early February 2014. For nuclear power, the draft update suggested that nuclear investment be re-examined in 2015 on the following conditions: "if demand exceeds 270 TWh and there is no shale gas development, it might go ahead." Nuclear costs were still assumed, as a central case, at a low $5 800/kW; but a more realistic $7 000/kW as a sensitivity analysis. Utilising the decision-making approach, it suggested significantly, that "*in 2015, even if demand is high and there is no prospect of shale-gas power plant, that if nuclear costs exceed $6 500/kW, then the procurement programme should be abandoned*."

Officials have generally ignored the outcomes of the update report, claiming it was not officially released, and the parliamentary portfolio committee chairperson has been quoted in the media as saying that it will "never see the light of day". Procurement will thus proceed on the basis of a five year old IRP which conveniently called for unconditional endorsement of the 9 600MW of nuclear energy.

The National Development Commission

This high level, cross-sectoral commission was created in 2009 in the office of the president to harmonise national development strategies. The commissioners took a great interest in the nuclear question, commissioning an expert paper from the Energy Policy Institute at the University of Cape Town, which argued that adding nuclear energy capacity at present was inappropriate.

The final report of the Commission, issued in November 2011, recommended that considerable caution was necessary with regard to additional nuclear, especially on financial grounds:

> Although nuclear power does provide a low-carbon base-load alternative, South Africa needs a thorough investigation on the implications of nuclear energy, including its costs, financing options, institutional arrangements, safety, environmental costs and benefits, localisation and employment opportunities, and uranium enrichment and fuel-fabrication possibilities. While some of these issues were investigated in the IRP [update], a potential "nuclear fleet" would involve a level of investment unprecedented in South Africa. An in-depth investigation into the financial viability of nuclear energy is thus vital.[25]

Inter-ministerial sub-committees

In November 2011 an inter-ministerial committee on nuclear energy was formed. Named the National Nuclear Executive Coordination Committee (NNEECC) and located within the Presidency, the committee was initially chaired by the Deputy President Kgalema Mothlanthe.

However, due to Mothlanthe's subsequent challenge to Zuma as ANC party leader, in July 2013 President Zuma took advantage of a cabinet reshuffle and dismissed Mothlanthe as Deputy President. President Zuma then took control of the NNEECC as its new Chair.

[25] South Africa, National Planning Commission, 2011. *Vision 2030: the National Development Plan*. Pretoria: The Presidency, page 172.

In June 2014 the Presidency announced that a cabinet sub-committee on Energy Security had been established to 'oversee the development of SA's future energy mix'. This initiative replaced the NNEECC and included the following departments: Defence, Economic Development, Energy, Environmental Affairs, Finance, International Relations & Co-operation, Mineral Resources, Public Enterprises, State Security, and Trade & Industry. A nuclear energy technical committee led by various departmental Directors-General was also formed to report to the ministers on the sub-committee, as was a nuclear energy working group led by senior officials. Initially the NNEECC had determined that Eskom would be the owner/operator of the new nuclear power plants. In September 2014 it was announced in the media that Eskom would, after all, not be involved in nuclear procurement.

Now, to return to points of regulation, research and governance of nuclear power in SA.

Regulation

The establishment of the National Nuclear Regulator (NNR) in 1999 gave it clearer legal powers than had its predecessor, the Council for Nuclear Safety. The mandate of the NNR was to ensure protection of the public against radioactivity, except for that emanating from the medical sector. It therefore had oversight of all nuclear energy facilities as well as over those mines producing radioactive minerals. The problem with the institution was its reluctance to engage openly with the public, and its heavy financial reliance on fees gained from the nuclear industry itself. However, its annual reports consistently complained of state underfunding and skills shortages. It has been notoriously quiet on taking responsibility for dealing with the impacts of radioactive waste from the mining industry. Unable or unwilling to fulfil its mandate vigorously, critics have a right to question its capabilities in view of potential fourfold expansion of the industry. In 2010 it was involved into a regulatory self-assessment, and it plans an Integrated Regulatory Review for December 2016. Will this be sufficient for the NNR to meet expanded responsibilities?

An IAEA team of technical experts carried out a review of South Africa's nuclear infrastructure from 30 January to 8 February 2013 - an Integrated Nuclear Infrastructure Review Mission (INIR). The IAEA team identified strengths such as "regulatory self-assessment, environmental impact assessment, grid development and stakeholder involvement". Specific recommendations were made by the IAEA team to strengthen SA's infrastructure. Since the official release of the INIR report (date unclear) the NNR said it had rolled out an action plan functioning under the cabinet's energy security sub-committee. In February 2014 a second team of IAEA experts carried out a full scope review of SA's nuclear emergency preparedness. Outcomes from this review informed the country's revised nuclear safety action plan (not yet public).

In terms of procurement regulation, under the Electricity Regulation Act, the minister has the authority to commission new energy generation. But there would be no escaping a competitive bidding process, nor the prescripts of the Constitution, Treasury regulations and the Public Finance Management Act. Public procurement must be done "according to a system that is fair, equitable, transparent, competitive and cost-effective".

In terms of nuclear regulation specifically post-procurement, the National Nuclear Regulator (NNR) covers radioactivity in mining, industry, transport and electricity production. The electricity sector as a whole is regulated by the National Energy Regulator of SA (NERSA).

Nuclear research

The key government Institution concerned with research is the South African Nuclear Energy Corporation (which enjoys the acronym NECSA), based at Pelindaba in the North-West province. NECSA was established as a public company by the Nuclear Energy Act in 1999 and is wholly owned by the State. NECSA replaced the apartheid-era Atomic Energy Corporation, which had a hand in developing nuclear weapons, and its predecessor, the Atomic Energy Board, which dated from 1949. The main functions of NECSA are:

- to undertake and promote research and development in the field of nuclear energy and related technologies;
- to process and store nuclear material and other restricted material; and
- to co-ordinate with other organisations in matters falling within these spheres
- to serve some of the state's nucleqr institutional obligations.

NECSA and its predecessors until recently operated the Vaalputs radioactive waste-disposal facility in the Northern Cape. Vaalputs accepts only low- and intermediate-level waste, which it stores in trenches 10 metres below ground. The high-level waste from South Africa's reactors still has to be stored on site. In 2014 NECSA ceded responsibility for managing the Vaalputs site to the newly-formed National Radioactive Waste Disposal Institute.

The Nuclear sector in South Africa is directly governed by the following legislation and policies:

- Energy White Paper of 1998
- Hazardous Substances Act, No. 15 of 1973
- Nuclear Energy Act, No. 46 of 1999
- National Nuclear Regulator Act, No. 47 of 1999
- Disaster Management Act, No. 57 of 2002
- Radioactive Waste Management Policy and Strategy of 2005
- National Radioactive Waste Disposal Institute Act, No. 53 of 2008
- Nuclear Energy Policy of 2008

Internationally, South Africa is a signatory (Contracting Party) to the Treaty of Pelindaba (establishing Africa as a nuclear-weapons-free zone), the Convention on Nuclear Safety; and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

Nuclear ambition – stated government rationale

The main stated objectives driving government's nuclear ambition are:

- The future nuclear programme would significantly contribute to the country's long term base load energy security and economic development objectives, including jobs creation, skills development and industrialisation.
- To be self-sufficient in all aspects of the nuclear value chain on the continent (the entire nuclear value chain includes uranium mining, enrichment, nuclear fuel manufacture, reprocessing, and waste disposal, as well as the design, construction, operation and decommissioning of nuclear power plants).
- Localisation will result in opportunities for local industry in the manufacturing of various components that are used in the nuclear energy sector.

Public response to this ambition

Prior to 2014, public response to nuclear ambition was clearly divided along idealogical lines – those who were in favour and those who were not in favour of nuclear technology.

After commencing his second term in April 2014, President Jacob Zuma clearly ramped up his (since 2010) vocal and practical support for nuclear ambition. Given President Zuma's chequered track record of accusations of graft, self-interest and corruptability, public sentiment has swung to the extent that today a significant proportion of South African citizens are expressing lack of support for new nuclear power.

The main concern is cost (more on this below), followed by the unacceptably high levels of secrecy that have already accompanied initial agreements between government and Russia, China, France, the US, Japan and South Korea – the details of none of which have been reported to Parliament, or ratified by the Cabinet; the many mixed messages from all parties involved – whether procurement is imminent or not, whether bi-lateral agreements are binding deals or not… Public sentiment across all sectors – labour, business, civil society, academia, health – all express dismay at the pace and lack of transparency of nuclear power planning in South Africa at this time.

Several civil, legal and good governance actions are currently underway to challenge or at the very least seek clarity on the various aspects of the process thus far:

- In October 2014 *Business Day*, *Sunday Times* and the Council for the Advancement of the South African Constitution made an application under the Promotion of Access to Information Act (PAIA) requesting evidence of a record of decision to forge ahead with nuclear power plants.
- In parallel the Sunday Times submitted a PAIA application to the Presidency, Parliament and the Department of Energy for access to the framework agreement SA signed with Russia. This request was refused by the Department of Energy because"the agreements would compromise the delicate negotiations that SA was holding with other countries".
- In October the Democratic Alliance called on Energy Minister Tina Joemat-Pettersson to appear before Parliament to explain the framework agreements she had signed with Russia and France. This call has not been heeded by the Minister.
- In November 2014 the Southern African Faith Communities' Environment Institute (SAFCEI) made a PAIA application to National Treasury for information regarding the nuclear deals.

The origin of new South African nuclear power investment ambition

South Africa's mining and industrial sectors jointly consume about half the national primary electricity supplied, while the residential sector consumes about one sixth. Given South Africa's dependence on coal, the Energy sector as a whole is the country's principal air and water polluter and the major contributor to national carbon dioxide equivalent (CO_2e) emissions[26]. With all of this, it makes sense that in South Africa, effective mitigation basically requires transformation of its energy mix. Recognising the imperative, South Africa's long-term mitigation strategy calls for its carbon emissions trajectory to peak in the period 2020 to 2025 at between 500 and 550 Mt CO_2e per annum, to remain at that emissions level until 2035, and for emissions to decline to a range of between 200 and 400 Mt CO_2e per annum by 2050. This is referred to as the 'peak, plateau and decline' emissions trajectory in SA policy.

[26] Bending the Curve, Africa Geographic, 2008. See www.bendingthecurve.co.za/

In the country's 20 year electricity plan – the IRP2010 - the contribution of Coal to its electricity mix reduces to 65% of the overall electricity supply by 2030[27], nuclear increases to 20%, hydro is static at 5%, and renewables increase to 9%. This shift in the supply mix would require that 42% of all newly built capacity be Renewable energy (RE).

South African nuclear power build - cost estimates

In 2011, the South African Nuclear Energy Corporation (NECSA) estimated the overnight costs of construction at R300-billion to R400-billion. More recently the South African government has estimated a cost of R500-billion (Business Day, July 2015) but declined to provide any details of the basis for this financial estimate. Among those to make a more scientific — and more recent — guess is the University of Greenwich's professor of energy policy, Stephen Thomas. Thomas said: "I think the most relevant guide for figures for South Africa are those agreed between EdF [France] and the British government in October 2013 to build two 1.6GW reactors at Hinkley Point." Using today's exchange rate and extrapolating this to the 9.6GW, Thomas came up with a figure of R855-billion. Some local stakeholders in civil society and business interviewed, estimate a bill as high as R1.4 trillion when including the costs of finance, insurance, operation, fuel, waste disposal and final decommissioning of plants.

During 2012 Treasury estimated in its National budget review that approximately R300 billion will be needed over 17 years for the nuclear build programme and indicated Eskom as the implementing agent, but no reference was made to who would finance the investment.

How close is South Africa to nuclear procurement?

Between September and November 2014 the South African government signed bi-lateral nuclear "co-operation agreements" with Russia, France, China, USA and Japan. Some of these agreements have only recently been submitted to Cabinet, the sub-committee on Energy security, Parliament and Treasury – after extended public demand for transparency, which was initially ignored. In addition the following events have emerged:

- Highly clandestine "vendor parades" where prospective vendors showcased "what types of technology offerings could be expected from each vendor country if they were selected after a procurement process"[28] have been held since mid-October 2014. No details of the events have been provided in the public domain.
- Government speaks confidently to the outdated IRP2010 with no indication provided of what has happened to the IRP2010 2013 Update report or indeed, the country's Integrated Energy Plan which was under review at the same time as the IRP2010.
- The Department of Energy, the Department of Trade and Industry, the Department of Public Enterprises, the National Treasury, the National Nuclear Regulator (NNR), Eskom and NECSA have all undertaken visits to China, Japan, (South) Korea, Russia and the US to study their civil nuclear energy programmes.
- The Department of Energy reports that it, and other relevant departments and "stakeholders" have finalised preparation for the procurement framework.
- Government is calling on International companies to "develop connections with their local counterparts". This would ensure "that, when the [nuclear] roll-out is announced

[27] From 90% in 2010
[28] South African Nuclear Energy Corporation's Ambassador Xolisa Mabhongo, October 2014, reported in the media.

and commences, there will be vibrant partnerships between South Africans and international role-players".

- Procurement is due to proceed in August 2015.

Recommendations to SA civil society

The following recommendations for SA civil society engagement with/challenge to the decision-making process heading toward procurement are offered.

1. Bi-lateral co-operation agreements

Details of the agreements, particularly the one between Russia and South Africa given the disturbing clauses in an earlier draft agreement which was published, need to be made available in the public domain. At the very least, to Parliament, Cabinet and Treasury.

2. Constitutionality

Clarity on whether a legal procurement process will take place. There have been numerous mixed messages coming out of DoE – that procurement will still take place, that the vendor parades are a preparation for procurement process, that a procurement framework is already being designed by DoE, that a number of procurement designs are possible, depending on the vendor parades.

In a 2 October 2014 *Business Day* article, the deputy director-general for nuclear energy in the DoE, Zizamele Mbambo, said the tender for nuclear power "might not be an open tender". It could be a closed tender or a government-to-government agreement. I can confirm to you that there will be a procurement process." He continued: "Which procurement process is decided upon will depend on the models under consideration. Mr Mbambo repeatedly emphasised that nuclear procurement was not the same as any other, and that international experience showed countries made decisions based on "national interest". In SA's case, the national interest was to be energy self-sufficient and to develop the entire nuclear value chain from the mining of uranium to enrichment, to the disposal of waste[29].

Although procurement is poised to proceed, no clarity on the likely process, the budget available, or the likely financing models to be looked at has been provided by government. South Africa has no existing legal and transparent framework for nuclear procurement.

3. Economic health, costs and tariffs

With SA's debt and guarantees forecast to peak at 57.1% in 2016, there is very little room for further borrowing if the Treasury is to remain within its benchmark of 60%. The National Treasury has cautioned that: "Nuclear power would be a substantial financial commitment, and government can only make that kind of commitment after careful and thoroughgoing modelling and an affordability assessment."[30]

Government is already committed to providing R350bn debt guarantee to Eskom, SA has an unaffordable debt-to GDP ratio (currently at 46.1). At the high end of cost-estimates, the nuclear investment could double our national debt. Potential clean-up, compensation and decommissioning costs are now known (post-Fukushima) – and significant ($105 billion[31]). Clarity on long-term sovereign debt implications is critical.

South African economists have warned that the country faces "expenditure bombs" — each one of which could cause a sovereign solvency crisis in a few years' time:

- an exponential rise in the public sector wage bill,

[29] http://www.bdlive.co.za/business/energy/2014/10/02/sa-resolute-on-nuclear-build
[30] http://www.bdlive.co.za/business/energy/2014/10/02/sa-resolute-on-nuclear-build
[31] http://rt.com/news/183052-japan-fukushima-costs-study/ - August 2014

- the inexhaustible demands by state-owned firms for government funds,
- the planned trillion-rand nuclear build programme; and
- the planned national health insurance scheme.

Estimates of the cost of 9,600 MW of nuclear build in SA vary between R300 billion and R1.4 trillion. A simple average of the range of cost estimates is R881 billion; by comparison the arms deal was worth R30bn in 1999 rands (R72bn in today's money).

In the IRP update nuclear costs are still assumed, as a central case, at a low of $5,800 / kW; (with a more realistic $7,000 / kW is a sensitivity analysis); current build costs closer to $8,000/ kW, for example for Hinkley C (UK buying from France). It should be noted that these are "overnight" costs, which cover only the construction of the reactors to the point of their being switched on. These costs exclude finance, insurance, operational costs, conversion and enrichment, fuel manufacture and substitution, waste disposal and decommissioning. Taken together, build programmes in the last decade have proven that final costs are likely to be double that of the "overnight" costs.

So even ignoring potential cost over-runs, which are not uncommon, and allocations for disaster, SA would be paying more than 12 times the arms deal (or between four-and-a-half and 20 times). Treasury needs to be mandated to conduct a cost analysis based on current market realities. Government has mentioned various financing options being considered e.g. Build, Own, Operate (BOO) or vendor financing. Vendor finance models where costs are covered by the selling party are understood to eventually lead to high tariffs.

By way of recent comparison, the Russian-owned Turkish build may considered. The Turkish government has said that it will take on none of the financing costs, the project has stalled over the price of the power purchase agreement required as a necessary guarantee for Rosatom. In this case, it will be the consumer who repays the capital costs through the tariff, and who bears all the risk as well. As Department of Energy's acting director-general Wolsey Barnard put it in October 2014: "The customer will pay just as (they) will pay for renewable energy and the energy produced by Medupi and Kusile."[32]

Dealing with the current electricity supply crisis

Electricity disruption is one of SA's main present socio-economic challenges, and has been highlighted by many — including rating agencies — as a restriction to achieving higher economic growth. A strategic plan for immediate, short and medium term renewable and sustainable solutions would be a valuable use of government's time, rather than focusing on an expensive, risky megaproject which may not even be realised if the country's grid should collapse in the short term.

Nigeria

Introduction

Nigeria has a population of 168.8 million and a GDP per capita of $3,006, and in 2014 was recognized as the largest economy on the continent. Yet the country remains plagued by poverty and underdevelopment. Like many countries it has a history of ethnic and religious

[32] http://www.bdlive.co.za/business/energy/2014/10/02/sa-resolute-on-nuclear-build

tension which has often turned violent. In recent months, growing domestic fundamentalist violence and growing social criticism of the federal government have dominated news headlines.

According to Transparency International's corruption perception index, Nigeria ranks 144th out of 175 countries assessed globally.

While the Nigerian nuclear program was founded in 1976, goal-directed nuclear energy aspirations began in 2004. Since 2004 Nigeria has been guided by a federal government approved nuclear power roadmap and sought the support of the International Atomic Energy Agency to build up to 4,000 MW of nuclear capacity by 2027[33]. Nigeria's strategy for nuclear power set a target to begin construction in 2011 and start nuclear power production in 2017-2020. The Federal Government aims to start with a pilot of about 1,000 MW by 2020. The 2011 deadline was not met.

Despite chronic underdevelopment, given Nigeria's oil wealth, the high cost of nuclear power is not necessarily a constraint. The successful development of a nuclear energy programme may well be perceived by government as a matter of national pride and a means of reinforcing the country's status on the continent. We have found reliable indications of significant progress toward the achievement of Nigeria's readiness to realise its nuclear power ambition. In Nigeria, as in Kenya, public concerns around nuclear mainly relate to corruption and security.

Key economic and energy data[34]	1990	2000	2012
Energy used per capita (kilograms of oil equivalent)	738	737	721
Carbon dioxide emissions per capita (metric tons)	0,5	0,6	0,5
Electricity use per capita (kilowatt hours)	87	74	149
GDP ($ billions)	31	46	263
GDP growth (annual %)	8,2	5,4	6,5
Military expenditures (% of GDP)	0,8	0,8	0,9
Paved roads (% of total)	no data	15	no data
Total external debt stocks ($ billions)	33,4	31,6	10,1
Foreign direct investment, net inflows ($ millions)	0,6	1,1	7,1
Net official development assistance received ($ millions)	255	174	1916

Electricity supply in Nigeria today

Nigeria has a total available power capacity of about 6,852MW, but actual production peaks around 4,300MW and is frequently unreliable. Most generation is thermal based, with hydropower from three major plants accounting for 1,938.4 MW of total installed capacity (and an available capacity of 1,060 MW).

After years of mismanagement, lack of investment and maintenance neglect, the country's electricity supplier – state-owned utility the Nigerian Electricity Supply Company - failed to meet the energy needs of citizens. A privatization scheme started under the second term of democratically elected President Olusegun Obasanjo[35] with support from the World Bank. Yet today only 40% of a population of 168.8 million Nigerian citizens have access to electricity supply via the grid[36].

[33] National Program for the Deployment of Nuclear Power for Generation of Electricity
[34] World Bank, 2014
[35] Military ruler from 13 February 1976 to 1 October 1979 and democratically elected president from 29 May 1999 to 29 May 2007.
[36] Energy Commission of Nigeria, 2013

Africa's largest economy, Nigeria produces more power from privately-owned diesel generators (6,000 MW) than from the national grid. Stakeholder opinions on why the grid is so dysfunctional and underdeveloped differ widely with some citing regular sabotage by terrorists, others corruption leading to the disappearance of maintenance budgets, and yet others who believe that privatising the grid would resolve this problem rapidly.

The National Electric Power Policy of 2001 kicked off power sector reform in Nigeria, leading to several other reforms to-date. Since the advent of democratic government in Nigeria, there have been significant strides in the reform of the sector, with transaction costs of about $3 billion.

The Federal Government retains ownership of the transmission assets (management under concession) with the generation and distribution sectors fully privatised[37].

Institutions, Policy & Regulation pertaining to nuclear power plans

As in Kenya and South Africa, the nuclear power programme in Nigeria has support at the highest levels of government, with significant and comprehensive political resources allocated. The following information has been confirmed by an online copy of the IAEA presentation: "Update on the Status of Nuclear Power Infrastructure (NPI) Development in Nigeria"[38].

The Presidency, the Federal Ministries of Environment, Science & Technology and Power each oversee 6 key institutions mandated to ensure successful implementation of the nuclear programme, with a likely Special Purpose Vehicle (SPV) becoming operational further into the process –

1. Energy Commission of Nigeria,
2. Nigeria Atomic Energy Commission (reports directly to the Presidency),
3. Nigerian Nuclear Regulatory Authority,
4. National Emergency Management Agency (reports directly to the Presidency),
5. Nigerian Environmental Standards Regulation and Enforcement Agency,
6. Nigerian Electricity Regulatory Commission
7. Nuclear Power Plant Operating Organisation (pending formation).

In addition, a National Nuclear Energy Programme Implementation Committee (NEPIC) has been formed, is chaired by the CEO of the Nigeria Atomic Energy Commission and is composed of senior representatives from all of the above ministries and institutions, plus

- the Ministries of Finance and Justice,
- National Agency for Science and Engineering Infrastructure,
- National Space Research and Development Agency,
- Nigerian Geological Survey Agency,
- Nigerian Meteorogical Agency,
- Office of the National Security Advisor,
- Office of the Surveyor General of the Federation,
- Transmission Company of Nigeria,
- Power Holding Company of Nigeria,
- National Planning Commission,
- 1 representative of civil society and
- 1 representative of the Manufacturers' Association of Nigeria.

In terms of policy, the Electric Power Sector Reform Act of 2005 is the foundation of the restructured power sector in Nigeria. The Act, which evolved from the National Electric Power

[37] KPMG guide to the Nigerian Power Sector, 2013
[38] http://www.iaea.org/NuclearPower/Downloadable/Meetings/2014/2014-02-04-02-07-TM-INIG/Presentations/10_S2_Nigeria_Mallam.pdf

Policy (2001), established the basis for private companies to participate in generation, transmission and distribution of electricity.

The Nuclear Power Roadmap of 2007[39] has been the guiding framework for developing necessary policy in the areas of:

- waste,
- land,
- public information and consultation,
- training & capacity building,
- environmental assessment,
- technology and fuel cycle assessment,
- economic and technology assessment,
- technical & commercial, electric market and generation mix.

In addition, the Nigerian Investment Promotion Commission (NIPC) Act of 1995 established the NIPC as an investment promotion agency of the Federal Government.

The key regulatory agencies are: the Federal Ministry of Power, the Nigerian Electricity Regulatory Commission, the Energy Commission of Nigeria, the Rural Electrification Agency, the Presidential Task Force on Power and the Nigerian Nuclear Regulatory Authority (NNRA) which was established in 1995 but began operating in 2001. Institutionally the Nigerian Atomic Energy Commission is part of the Ministry of Science and Technology.

Nuclear ambition – stated rationale

Government's main stated motivation is to meet the nation's growing electricity demand, which it estimates will rise to almost 200,000 MW by 2030[40] through diversity of supply. Specifically,

- Nuclear will enable long-term energy security for a fast growing population with energy demands.
- Security of supply through nuclear power is essential for retaining investment and growing the economy. The Nigerian manufacturing sector is suffering from acute shortage in power supply and stakeholders report that some industries are shutting down in Nigeria due to this.
- Long term energy security through diversity of supply. "'Wisely investing' means we have to develop other energy resources in a way that will allow us to sustain a high standard of living over time".[41]
- Nuclear is safe as long as it is handled 'in a scientific manner'. The waste management issue is not raised, nor concerns of terror/security risk.
- Nuclear technology provides clean energy – particularly compelling in a country where oil spillages and gas flaring have caused serious and obvious present-day environmental pollution.
- To exploit all energy options responsibly, Nigeria needs an optimally varied energy supply mix.
- Adoption of a stable power supply from an optimal energy mix will result in the reduction of electricity tariff.

[39] Tagged the "Technical Framework" (TF) by government
[40] Energy Commission of Nigeria, 2011
[41] Mr Osaisai, head of the Atomic Energy Commission, 2009

Public response to this ambition

As in Kenya, the greatest public concerns relate to safety and security. Some stakeholders express being inured to continued terror threats, and even these acknowledge that the risk of nuclear technology (whether uranium or uranium waste) getting into the hands of terrorists would compound existing consequences of such attacks.
Linked to this is cynicism in relation to the reputation of corrupt officials who are prone to bribery, kick-backs and side-deals. Public confidence in the integrity of government is low.

A third commonly expressed skepticism relates to the capacity of the grid to cope with additional power, or indeed the ability of government to address grid improvement sufficiently to meet the IAEA milestone relating to grid capacity. Continued transmission failure due to a host of factors some within and some beyond government control is a daily reminder of the massive task required to improve the grid.

Yet the desire for energy security and reliability among Nigerians, particularly those keen to grow their businesses, is high. Here the prospect of nuclear power, even with associated risks is welcomed. So many existing energy technology options have failed, and nuclear power – at least as something that has not been tried in Nigeria before – is considered a serious prospect that deserves to be tried.

Unfortunately we did not manage to gather opinions from stakeholders within the renewable energy sector by the time this report was written, as none of these responded to repeated requests for discussions. On the whole, it was easiest to secure interviews with stakeholders within the nuclear sector – either pro- or anti-.

How has nuclear ambition emerged?

Nigeria's nuclear programme emerged tentatively in 1976 as a response to South Africa's acquisition of nuclear weapons and India's test of a nuclear device[42]. Initially nuclear power and nuclear weapons prospects were considered.

The Nigerian Uranium Mining Company was founded in 1978 as a partnership between the federal government and the French mining company Minatom to explore uranium reserves. Two nuclear research institutes were founded: the Centre for Energy Research and Development (CERD) at Obafemi Awolowo University in Ile Ife, and the Centre for Energy Research and Training (CERT) at Amadu Bello University in Zaria. These centres have specific mandates to conduct research and build indigenous nuclear expertise[43].

The Nigerian Atomic Commission has sent graduate students to Europe and North America for training in nuclear related scholarship since the 1970s and some of these students have returned to Nigeria to teach in local universities. In 1998 a third research centre the Nuclear Technology Centre was launched in Abuja and a capacity training programme continues there to-date. Federal universities have long been directed to introduce nuclear physics programmes[44].

Nigeria's first research reactor was established in 2004 at Ahmadu Bello University. The National Energy policy of 2003 explicitly calls for the development of nuclear power and exploitation of uranium resources[45].

Government has had a clearly articulated Nuclear Power Roadmap since 2007 with the Draft National Energy Master Plan of June 2007 affirming leadership support for nuclear power.

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[42] Nigeria and nuclear energy: plans and prospects. Centre for International Governance Innovation (CIGI). Canada 2010
[43] Nigerian Atomic Energy Commission, 2009
[44] Interview with senior academic, November 2014
[45] National Energy Commission, 2003

What recent progress has been made?

Significant implementation of policy objectives has been slow prior to 2012, but has significantly gathered momentum since then. The following has been reliably confirmed:

- The federal government has signed a five year Country Programme Framework (CPF) agreement with the IAEA for the development of its nuclear programme from 2012 to 2017, with six major potential areas for technical cooperation and transfer of nuclear technology: Energy planning and infrastructure development, Human health, Food & agriculture, Nuclear safety and radiation protection, Water resources and environment, Education and training.
- The IAEA has conducted an Integrated Nuclear Infrastructure Review (INIR) mission to Nigeria in February 2014 to assess progress on phase 2 of readiness.
- Phase 2 Integrated Nuclear Infrastructure Review readiness work has been completed during March 2013 and February 2014.
- Progress has been made in Education & Training, particularly technical, undergraduate and graduate programmes in Nuclear Science and Nuclear Engineering since February 2012.
- Procurement of the full scope nuclear power simulator system completed, installed and training currently under way.
- National capacity building for development of the Regulatory framework commenced in 2010.
- Two preferred sites have been earmarked - at Geregu and Itu - and have been recommended for detailed evaluation and characterization. The NNRA has completed preparation of the draft siting criteria which government says has been reviewed by 'all relevant stakeholders' and government approval is now awaited.
- Nigeria has a Nuclear Waste Management Policy and has started the development of facilities for the treatment and storage of low- and intermediate-level radioactive wastes.
- The National Atomic Energy Commission and Rosatom signed a broad framework agreement in June 2012 for the Design, Construction, Operation and Decommissioning of Nuclear Power Plant(s) in Nigeria. This agreement has been ratified by both countries and instruments of ratification exchanged.
- Details of a specific Inter-governmental agreement (IGA) are currently being negotiated between Nigeria and Russia. Elements of the IGA needs to be aligned with the procurement requirement of the milestone approach once phase 2 is complete.
- The above requires revisions in the National Action Plan and National Strategic Plan for implementation to reflect achievements as well as gaps identified by the self-evaluation exercise. The review process has been completed, but some aspects may change depending on the negotiated IGA.
- Nigeria has proposed the modality and initiated the process of creation of a SPV as the new National Power Owner/Operator Organisation.
- The preferred financing structure has been identified as through a Build Own Operate Transmit (BOOT) arrangement with advance power purchase agreements (PPA) guaranteed by the federal government (currently awaiting endorsement). These will form part of a negotiated IGA between the Nigerian government and the technical partner country.
- Implementation of some projects is being sped up to strengthen and upgrade the national electricity grid to facilitate the BOOT arrangement.
- As evidence of even stronger government commitment to the nuclear programme, a Presidential Technical Committee on the Atomic Energy Sector is being set up and evaluation of strategies for the financing of the nuclear programme by the National Economic Management Team is being undertaken.
- Nigeria has already signed agreements on nuclear energy production as follows, but it was not possible to ascertain progress toward implementation:

    - Nigeria contracted Russia to build a nuclear power plant worth $4.5 billion in 2012 and has an MoU with Rosatom to prepare a comprehensive programme of building nuclear power plants in Nigeria. Other international agreements include Iran, South Korea and India. We are not entirely clear about the status of these agreements.
    - General Electric and Siemens signed MoUs in 2012 to assist in generating 10,000MW each. Again, we do not know the status of these projects, although Siemens has withdrawn from its nuclear operations
    - Nigeria concluded plans in 2014 to procure a $6 billion nuclear plant in 2022. We are unsure whether this is a 100% commitment, or whether money has been allocated or paid.
- The INIR mission will visit Nigeria again in the 4th quarter of 2014 after the national self-evaluation report is submitted to the IAEA.
- Nigeria is currently in phase 2 the three-phase IAEA assessment framework.

According to local stakeholders and experts, significant challenges remain and in general civil society is sceptical of the chance that Nigeria's nuclear ambition will be realised.

Remaining challenges include:

1. The national electricity grid: according to the IAEA, a single plant should make up no more than 5-10% of the total installed generating capacity of a national grid. Nuclear plants run most efficiently as base-load generators and require constant demand. Reliable independent power is necessary to safely operate a nuclear power plant – an electric grid that can guarantee the supply of stable, off-site power is required to begin construction[46]. Without significant investment in the national electricity grid, nuclear power will remain a distant dream[47].
2. Site and supportive Infrastructure: transportation and physical infrastructure in Nigeria are of bad quality and this could significantly raise the cost of procurement or necessitate additional government investment before construction begins. A nuclear plant is most likely to be based near Lagos, Nigeria's main port, and port delays currently stretch up to one year. According to the roadmap produced by the NAEC, site selection was meant to be completed by 2008. According to local nuclear policy commentators, it has not yet produced its final report.
3. Security concerns: although the religiously motivated violence originates mainly in the North East of the country, terror attacks are growing in frequency and geographic distribution.
4. Financing and Electricity market reform: Nigeria has earned hundreds of billions of US dollars in oil revenues since the 1970s. If oil revenues remain stable or increase, the Nigerian government could conceivably afford the cost of nuclear power investment itself. Public reaction to this prospect may however, be negative, particularly if energy price increases are likely to follow. In addition, public confidence in the ability of government to manage large and complex projects is extremely low.
5. Human resources and technical capacity: even though Nigeria has had research and capacity building programmes in place for decades, indigenous technical capacity to design, operate and manage nuclear power plants, remains low.

Main common risks and challenges for all three countries under review

These are common to all three countries (from literature review, research and interviews):

1. Ailing or insufficient grid – to greater and lesser degrees, all countries would have to improve substantially the capacity of their national grid and related infrastructure.

[46] IAEA, 2007
[47] Centre for International Governance Innovation, 2010

2. Expensive, contingent funding – as developing countries, domestic challenges abound. Access to the necessary financing will not be easy. In addition, vendor or conditional funding - even if initially 'affordable', could end up with long-term negative national effects, e.g., high future electricity tariffs or, at the very least, some form of sovereign obligation.
3. Cost overruns – unplanned, unavoidable and serious cost overruns due to construction delays as illustrated by projects currently under way in developed countries and other large infrastructure projects in some of the countries under review.
4. Erosion of the health of democracy - the associated nature of secrecy common to the nuclear power sector lends itself to the risk of high-level, easily unaccountable political control and undisclosed geopolitical deals. Evidence of this is already playing out in preparatory stages and can be found in all three countries.
5. Inadequate consideration of alternatives – nuclear technology is complex and requires building substantial advanced capacity, the deals are usually large and expensive, and the timeframes are long term. Committing to nuclear often absorbs so many resources that it is impossible for governments to also commit similar resources and attentiveness to alternatives. Fair, considered, scrutiny of all options is threatened by a common human belief that complexity and high price trumps simplicity and affordability.
6. Clearing out the fiscus – nuclear power requires vast financial resources whether pursued at large or small scale. This can reduce the financial resources (money, aid, credit-worthiness) available for developmental needs and distributed energy options.
7. Safety and security - in regions of high security instability, nuclear technology that ends up accidentally in the hands of those with an interest in acts of terror is a serious risk.

Key differences between the nuclear ambitions of the countries under review

The three countries reviewed all differ in terms of geography, economics and democratic history. Key differences in relation to nuclear power ambition are:

1. Experience - South Africa is the only country on the continent already producing nuclear power.
2. Scale of ambition and planned pace of build - Kenya and Nigeria have a substantially lower nuclear power plant build ambition – 4,000 MW as compared to South Africa's 9,600 MW AND both Kenya and Nigeria are committed to building an initial 1,000 MW. South Africa appears to be aiming to take a decision on the procurement of multiple reactors.
3. Safety and Security - Kenya and Nigeria appear to have a greater risk in relation to safety and security, with recent upward trends in reported terror attacks and regular reports of poor policing practice. This is not as great a risk in South Africa at this point in time.
4. Ability to expand alternative options at scale – South Africa has a growing renewable energy sector and has proven its ability to transparently and successfully procure renewable energy through its Renewable Energy Independent Power Producers Procurement programme.

Analysis of research findings

1. **Elite nuclear nationalism defies logical argument**. Nuclear expansion is a highly controversial issue. Proponents in the African region are supporting the technology as it ostensibly raises national prestige, provides a steady energy source, and, they claim, has a climate dividend. Opponents point out that there are more appropriate energy technologies suitable for African development that are not a drain on the fiscus and consumers. These pose no security problems, nor do they pose potentially devastating health and environmental risks.

   The alternatives can accommodate more flexible, decentralised power solutions, which provide more jobs, and – in contrast to nuclear – help strengthen democratic and socially accountable processes. On climate, opponents note, it is important to understand that while there are no carbon emissions from reactors, the whole nuclear fuel chain taken together has highly carbon-intensive links, such as mining, transport, enrichment, reprocessing and decommissioning.

2. **Conflict societies**. The risks posed by the nuclear industry expand greatly when their host societies are embroiled in conflicts such as insurgency, terror attacks, and religious zealotry. This raises the stakes in terms of nuclear technology, whose fuel needs to be safeguarded physically at all stages in order not to become a source of terror.

   States already grappling with such security threats need to be even more vigilant, organised and better armed to deal with the risks of nuclear material going astray. This also has implications for the type of democracy which Africans are keen to develop. The alternatives to nuclear energy do not pose such problems for democratic development.

3. **Robust economies**. If the procurement of 9600 MW of new nuclear power in South Africa results in the spending of between R850 and R1400 billion rands (between US$73 and US$120 billion) for construction alone, this would have a hugely deliterious effect on the rest of the economy.
   Energy consumers are already finding that the costs of electricity have become a major burden, so the added costs of nuclear could result in broad economic recession and disinvestment. Credit agencies have been diminishing the credit status of local institutions such as the electricity utility, Eskom, making credit far more expensive.
   The scourge of corruption, a factor in all three countries, especially in regard to infrastructural spending, places an additional economic burden on citizens.

4. **Civil society**. Nigeria has a history of strong movements supporting environmental and social justice, but as yet, these have focused more on petroleum than on other parts of the energy sector. Kenyan civil society has some strengths in terms of human rights work. Since the 1980s, when South Africa installed its first reactors, a small but energetic anti-nuclear movement has been involved persistently in providing an alternative view to the proponents of nuclear energy. However, in all three cases,

there is a need for civil society to undertake much more vigorous work to popularise the alternatives to nuclear energy.

Africa also hosts a loose coalition of civil society forces challenging uranium mining, entitled the African Uranium Alliance. It is important for disparate campaigns to engage in mutual consultation and support and for previously narrow environmental concerns to be broadened to include energy equity, human rights, popular control of energy technology, decentralisation and climate justice. The economic questions affectiing people are the affordability of the technology, the opportunity cost of increased jobs in other parts of the energy sector, and the crowding out of social investment given the intensive costs of nuclear.

5. **The lessons of Fukushima**. The mammoth meltdown at the Fukushima Dai'ichi reactors in March 2011 has had a number of important impacts. Japan temporarily ceased nuclear energy production of over 50 other reactors. Germany and Switzerland announced they would phase out their nuclear industries. Italy confirmed its anti-nuclear stance in a popular referendum. Russia and China instituted more safety controls and slowed down new nuclear build. Even the French nuclear vendor Areva has entered into a phase of deep economic crisis.

   Whilst countries with extensive nuclear experience are tending to move away from further investment in nuclear, the countries in this study are – at least officially – seeking to embrace this technology more thoroughly. Part of the reason for this is the intensive lobbying of the IAEA (whose remit includes the promotion of peaceful uses of nuclear energy) and vendors of nuclear technology seeking new clients, combined with the susceptibility to these approaches of the African political elites seeking benefits of procurement from expensive prestige projects.

6. **Prospects for nuclear expansion in Africa**. Whilst governments seem bent on implementing nuclear expansion, progress has not been without difficulties. Nigeria is passing through a period of diminished oil revenues, making the affordability of nuclear problematic. In any case, institution building has been extremely tardy, and internal conflict issues have grave implications for progress on the nuclear front.
   It is not even clear whether the miniscule Nigerian electricity grid could accept large-scale nuclear power. In Kenya's case, the same slow institutional progress and the problems of insurgency also make prospects for early procurement of nuclear difficult. In the case of South Africa, society is very divided on the issue, even within different parts of government. Big business is not convinced that this is the right moment to expand nuclear. The Treasury has yet to pronounce on whether such expenditure is feasible or desirable. No doubt civil society challenges to procurement efforts will be forthcoming. Support for procurement has narrowed down to the current president Jacob Zuma's ambitions, but it should not be forgotten that his second and last term of office will end in 2018.

Across Africa, it seems that there is a margin of space and time to expand the debate on the nuclear question. Civil society and the media should utilise this for extending public education on questions of energy, public spending and democracy.

Recommendations for civil society engagement with/challenge to the decision-making process – a synthesis of research and stakeholder consultation

1. Effective (targeted, sustained, simple) public Awareness-raising campaigns focused on:
    a. **Understanding nuclear power** – how the technology works, risks, costs, governance.
    b. **A focus on the major concerns**: safety, economics and democracy. All 3 countries have reasonably engaged, educated citizens who could lobby government on the priority public concerns of safety & security, cost, transparency and accountability.
    c. **Support for shorter lead-time, more economical Renewable Energy & Energy efficiency solutions**. Anti-nuclear advocacy can benefit greatly from growing public knowledge of the increased viability of RE & EE, and the pivotal role citizens and businesses have in growing these industries through greater demand (which drives down price) and insistence on government incentives.
    d. **Linked to all of above** – provide clear arguments & alternative solutions to governments' motivations for nuclear.

2. **Legal challenge** – the governments of all three countries are pursuing nuclear power investment with little regular (or no) public engagement. At the very least, legal challenges that speak to long term sovereign obligation can be mounted as a delaying or even stalling tactic. In the case of South Africa, a significant number of viable legal challenge prospects exist.

3. **Media work** - government will be issuing press statements that most journalists will swallow wholesale unless significant work is done to alert members of the press to the problems arising from the adoption of nuclear energy. Specialised training sessions for journalists to be able to question whether nuclear is the best energy option should be undertaken. These should deal with the technology per se, but also with questions of finance, democracy and human rights.

4. **Alliance building** – a clear analysis of the forces opposed to and supporting nuclear power should be drafted, with a view to understanding how strongly the government's propositions are grounded. In the case of South Africa, it is possible to demonstrate that important sections of organized labour, the private sector, and even certain government agencies (such as the National Planning Commission) are opposed to unbridled acceptance of the expansion of nuclear energy. In principle it may be possible to isolate the proponents by identifying how few social forces are in favour. In South Africa's case, it may be shown that the propositions to expand the nuclear industry are put forward by a limited, confined group comprising the president, his entourage, and the small nuclear lobby. Opponents would gain from being able to join forces to achieve a different policy outcome.

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Annexure 1: International compliance: the International Atomic Energy Agency (IAEA) Milestones

Complying with the IAEA is voluntary, but all three countries under review have decided to follow the IAEA preparedness guidelines. The IAEA has offered all 3 countries under review extensive support to strengthen and enhance their preparedness, regulation and actions to address identified needs.

As previously indicated, the IAEA's three "phases of development" are:

- Phase 1: Considerations before a decision to launch a nuclear power programme is taken
- Phase 2: Preparatory work for the construction of a nuclear power plant after a policy decision has been taken
- Phase 3: Activities to implement a first nuclear power plant

The corresponding milestones (and relevant infrastructure issues within each) are:

- **Milestone 1:** Ready to make a knowledgeable commitment to a nuclear programme
  - National Position
  - Nuclear Safety
  - Management
  - Funding and Financing
  - Legislative Framework
  - Safeguards
  - Regulatory Framework

- **Milestone 2:** Ready to invite bids for the first nuclear power plant
  - Radiation Protection
  - Electrical Grid
  - Human Resource Development
  - Stakeholder Involvement
  - Site and Supporting Facilities
  - Environmental Protection

- **Milestone 3:** Ready to commission and operate the first nuclear power plant
  - Emergency Planning
  - Security and Physical Protection
  - Nuclear Fuel Cycle
  - Radioactive Waste Management
  - Industrial Involvement
  - Procurement

Figure 2 below, illustrates this graphically.

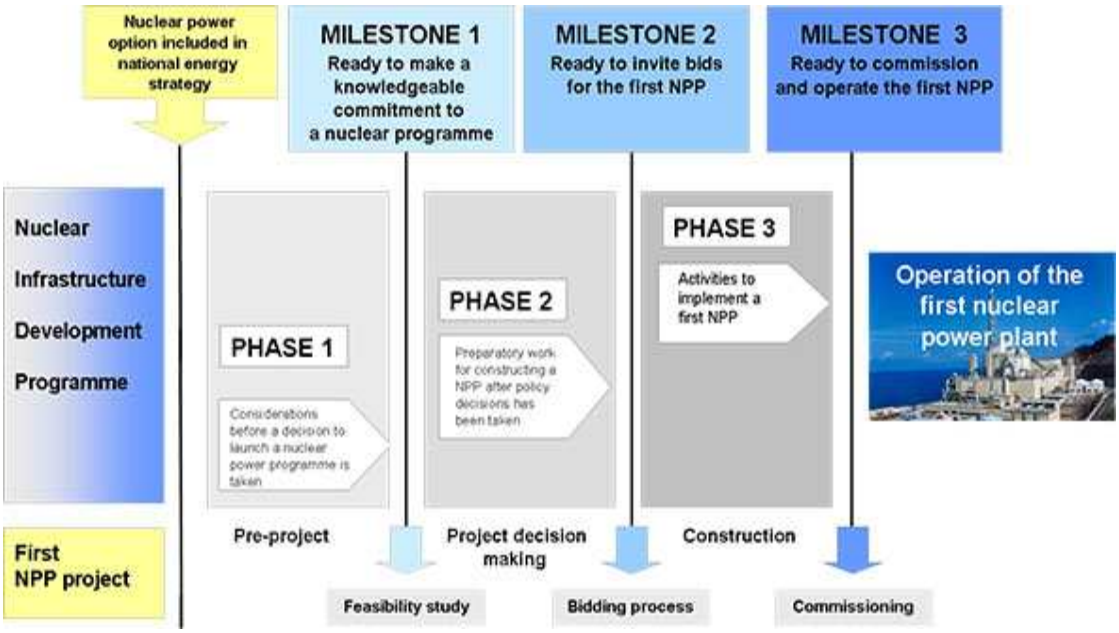

Figure 2: Nuclear power plant development timeline