A Regulatory Assessment of the Build-Own-Operate model for New Nuclear Build in South Africa

MASTERS OF SCIENCE IN NUCLEAR POWER
MINI-DISSERTATION

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RESEARCH REPORT

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Abstract

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Title	A Regulatory Assessment of the Build-Own-Operate model for New Nuclear Build in South Africa

Governments pursue New Nuclear Build (NNB) projects for different strategic reasons. Many countries are not able to devise a funding model for the excessive costs of a NNB project nor do they have the local skills to construct, operate and maintain a NPP.

South Africa's Integrated Resource Plan 2016 indicates that the base case scenario includes a target date of 2037 for the first unit of a NNB programme. This date moves to 2026 when the carbon budget is included in the forecast. The National Nuclear Regulator (NNR) has limited experience in licensing NNB programs as the country's only other commercially operating nuclear power plant was completed in 1984.

The Build-Own-Operate (BOO) model is being promoted by Russia as an option to finance, design, supply most of the equipment for, construct and operate, a NPP. The first of this model is being executed at Akkuyu in Turkey.

South Africa and specifically the NNR will face many challenges should it pursue the Build-Own-Operate model for its New Nuclear Build programme, given this model's novel and complex demands.

This study has concluded that the Nuclear Energy Policy does not support an entity other than Eskom (the South African electricity utility) from owning and operating any new NPP in South Africa. The NNR does not presently have the resources to be able to service a NBB program but should be able to adapt to the increased demands of a NNB programme.

The minister responsible for the promotion of nuclear energy also provides oversight of the NNR. This conflict of interest does not appear to have affected NNR decisions thus far; however, a NNB

programme will exert undue pressure on all stakeholders which could change the relationship between the NNR and its minister. The National Nuclear Regulator Act (NNRA) needs to be enhanced to change this reporting structure while also enhancing the independence of the NNR.

Should the Hinkley Point C model be followed in South Africa, the appointment of a design authority within the licensee which effectively creates an additional layer of verification should warrant strong consideration for the South African NNB model.

The Akkuyu BOO model challenges the principles of the Intelligent Customer concept. Should the Akkuyu BOO model be followed, the NNR would require the licensee to show that independent verification is in place. Roles and responsibilities should be clearly described and understood by all stakeholders. The onus remains with the licensee to prove Intelligent Customer capability.

List of abbreviations

AE	Architect Engineer
AGR	Advanced Gas-cooled Reactor
APC	Akkuyu Nükleer Güç Santrali Elektrik Üretim Akkuyu Project Company
BOO	Build-Own-Operate
BOOT	Build-Own-Operate-Transfer
CGN	China General Nuclear Corporation
CLB	Current Licensing Basis
CNNC	China National Nuclear Corporation
CNS	Convention on Nuclear Safety
DIN	Division Ingénierie Nucléaire
DME	Department of Minerals and Energy
DoE	Department of Energy
DPE	Department of Public Enterprises
EDF	Electricite de France
EPR	European Pressurised Reactor
FOAK	First of a Kind
GOR	General Operating Rules
HPC	Hinkley Point C
IAEA	International Atomic Energy Agency
IC	Intelligent Customer
IMS	Integrated Management System
KNPS	Koeberg Nuclear Power Station
Mwe	Mega Watts electrical
MWh	Mega Watt hour
NEA	Nuclear Energy Act
NIL	Nuclear Installation Licences
NISL	Nuclear Installation Site Licences
NNB	New Nuclear Build
NNR	National Nuclear Regulator
NNRA	National Nuclear Regulator Act
NPP	Nuclear Power Plant
Nuclear	Nuclear Power Station
OECD	Organisation for Economic Co-operation and Development
ONR	Office for Nuclear Regulation
PWR	Pressurised Water Reactor
QMS	Quality Management System
RFI	Request For Information
SA	South Africa
SAR	Safety Analysis Report
SMS	Safety Management System
TAEK	Turkiye Atom Enerjisi Kurumu, Turkish Energy Authority
TSO	Technical Support Organisation

UK	United Kingdom

1. Introduction

1.1 Background to the problem

Entities embarking on infrastructure type projects are innately aware of the principle of the project management triangle, viz. cost, time and scope that needs to be managed to ensure that the project meets the specified quality requirements.

When that project management triangle applies to New Nuclear Build (NNB) projects, the quality aspect is inevitably linked to nuclear safety. As the Fukushima and Chernobyl nuclear accidents have shown, the impact a nuclear power plant (NPP) can have on the safety of people, property and the environment can be severe. In most countries, the nuclear regulator is established by the local government to enforce nuclear safety standards and regulations during all phases of the NPP.

NNB projects can incur billions of dollars of construction related costs over several years without getting a return on investment. Additional unplanned costs are often incurred due to risks that have not been adequately mitigated. NNB projects face many risks; these risks include the regulatory risk that may be encountered by an entity embarking on a NNB project.

Governments pursue NNB projects for different strategic reasons. Especially for developing countries, the strategic intent may include access to electrical energy. This access then either supports a growing economy or allows the economy to be stimulated and hopefully put the country on a growth trajectory. Many countries are not able to devise a funding model for the excessive costs of a NNB project nor do they have the local skills to construct, operate and maintain a NPP. In addition, when there is an absence of a local nuclear support industry and, significantly, a nuclear regulator, the challenges to establish a NPP appear insurmountable.

Build-Own-Operate (BOO) may be a relatively novel concept in the NNB industry but not to industry as a whole. In a scenario where the government is the client, BOO refers to a model where a private entity funds, designs, procures all equipment and material, and then constructs. The same entity then operates the facility as the operating licensee. The income generated (or part thereof) from the operation of that facility would be for the entity's benefit. This allows the entity to recover its investment.

South Africa only has one Nuclear Power Station (NPS), Koeberg Nuclear Power Station (KNPS). The power station was commissioned in 1984 and uses Pressurized Water Reactor (PWR) technology

that was based on a Westinghouse design and built by the French company, Framatome (Arcuss Gibb (Pty) Ltd , 2011). The local utility, Eskom, operates the NPS. The local regulator, the National Nuclear Regulator (NNR) therefore has limited experience in licensing and regulating NNB programmes. Additionally, the resources that were involved in the construction of KNPS are not likely to be involved in the NNB, given the time-delay since the construction of KNPS.

There is a possibility that the technology deployed for the proposed NNB programme in South Africa may not yet have been successfully commissioned elsewhere in the world. The new technology may place further strain on the NNR and SA's limited skilled resources.

1.2 Hypothesis

South Africa and specifically the NNR will face many challenges should it pursue the Build-Own-Operate model for its New Nuclear Build programme, given this model's novel and complex demands.

The immediate questions that emanate from the hypothesis:

1. What are the key elements that distinguish BOO from other NNB programmes and what are the comparative tariff models that make these options financially viable?
2. What are the nuclear licensing and regulatory requirements for NNB?
3. What regulatory frameworks are in place for the different models in the host countries?
4. What are the different nuclear liability scenarios?
5. From a resource perspective, how will the nuclear regulator adapt to the increased and complex demands of a nuclear new build programme?
6. Are these countries signatories to Convention on Nuclear Safety (CNS) and Non-Proliferation Treaty (NPT)? What do CNS and NPT specifically say about these 'arrangements'?
   Would South Africa be abdicating its responsibility by accepting any of the BOO models?
7. Is BOO suitable for the 'Intelligent Customer'? How is the implementation of RD-0034 (and other similar requirements) affected by the two models?
8. Akkuyu is Rosatom's shop-front; HPC is EDF joint venture's shop-front;
   When considering the constraints in terms of nuclear skills internationally, is the BOO model repeatable in multiple countries at the same time? What is the regulatory impact?

9. Considering that politics play such a pivotal role in the initial approval of a nuclear programme, what sort of pressure could this put on the regulator in terms of supporting a NNB construction programme?
10. Do the benefits of BOO outweigh its disadvantages? Is BOO suitable for South Africa, given its specific conditions.

1.3 How can the hypothesis be tested

A desktop study will be conducted to provide answers to the research questions to gain greater insight about the hypothesis. The ideal nuclear regulator will be discussed as per the International Atomic Energy Agency's (IAEA) recommendations, specifically in relation to the new nuclear build programme. The South African nuclear regulator will then be assessed in reference to the ideal nuclear regulator and a potential new nuclear build programme.

Two specific new build programmes will then be analysed as examples of countries with an existing nuclear industry versus a nuclear newcomer country. These two cases are chosen as versions of the build own operate model (as defined later in the mini-dissertation) with differences and similarities to South Africa being highlighted.

Interviews are then conducted with experienced stakeholders to provide a subjective view of the research questions.

1.4 Research Scope and Limitations

The study will consider two new nuclear build programmes in the UK and Turkey respectively for reasons related to the build own operate model. While considering these specific programmes, the common thread will be the differences and similarities to South Africa and the NNR. The study does not seek to determine which is the best model to apply to South Africa and so does not do a detailed evaluation of the various models available but rather seek to understand the challenges that South Africa and particularly the NNR may encounter with applying the BOO model.

1.5 Structure of mini-dissertation

Chapter Two will present the literature survey of concepts and terminology that is used in the hypothesis. Existing sources will be used to clarify the research questions and provide greater understanding of the topic.

Chapter Three will provide insight into the IAEA's recommendations about the role the nuclear regulator fulfils within the country's nuclear industry. The differences between countries with existing nuclear power plants and a mature regulator are discussed in relation to a country that is considering a NNB programme for the first time.

Chapter Four focuses on South Africa's NNR and how it compares to the ideal nuclear regulator of the IAEA as discussed in Chapter Three. Further, an assessment of the NNR's plans for the country's potential new nuclear build programme is made.

Two NNB programmes are then discussed in Chapters Five and Six. Chapter Fives discusses Hinkley Point C in the UK as an example of a country with an existing nuclear industry and a mature regulator. Chapter Six considers the new nuclear build programme in Turkey as an example of a country with no commercially run nuclear power plants and an inexperienced nuclear regulator.

Chapter Seven provides a summary and analysis of interviews conducted by the author to consider the views of individuals in relation to the research questions. The individuals include experienced KNPS employees who have interacted with the NNR, individuals who are involved in South Africa's NNB programme and a NNR representative.

Chapter Eight concludes by assessing the validity of the hypothesis by reflecting on the research questions and provides recommendations regarding the challenges that were identified in the mini-dissertation.

2 Literature Review

2.1 What is the definition of Build-Own-Operate?

The Build-Own-Operate (BOO) concept is not unique to the nuclear power plant industry. Typically, governments across the world have used public private partnerships to finance, design and construct infrastructure type projects.

BOO refers specifically to the model where a private entity finances, designs, constructs and operates a project that would otherwise have been the responsibility of the client. In this study the client is the government. The BOO entity would only recover its investment from the sales of the product that is being produced by the completed project. The development phase might take several years for large infrastructure projects before any income is generated by the project. Depending on the specific nature of the BOO model, the BOO entity typically bears most, if not all, of the initial financial risk associated with the developmental phase of the project.

Governments therefore find the BOO model attractive as it does not have to fund, finance or carry the risk associated with the developmental phase of the project. The BOO entity recoups its investment by some form of concession from the government. This concession could be some form of tax benefit, preferential purchase agreements etc., thereby allowing the government to indirectly invest in the project.

There are different versions of BOO that will be considered as part of this study. The differences stem from the existing nuclear infrastructure capability that exists in a country. Certain countries have very limited nuclear capability as the availability and abundance of other forms of energy may not have necessitated it. This is typically what has happened in Turkey – Akkuyu – where there are limited local energy sources and a reliance on gas that is imported from Russia. Rosatom State Corporation (hereafter referred to as Rosatom), the Russian nuclear construction company, defines BOO as:

Build-own-operate – under this scheme, the company, which builds the NPP, also is the owner of the NPP, responsible for its operation and power sales, as well as attracting investments for the NPP construction (IAEA, 2013a).

Another Rosatom presentation describes the type of “solution” that would be offered to “newcomer countries” (Sokolov, 2013):

- *Rosatom Offers Complete Solution for Nuclear Power Programme*, as shown in Figure 1.

- The BOO solution is further detailed in the *Russian Integrated offer,* as shown in Figure 2, which essentially describes the IAEA's *Milestones in the Development of a National Infrastructure for Nuclear Power* (IAEA, 2007c).

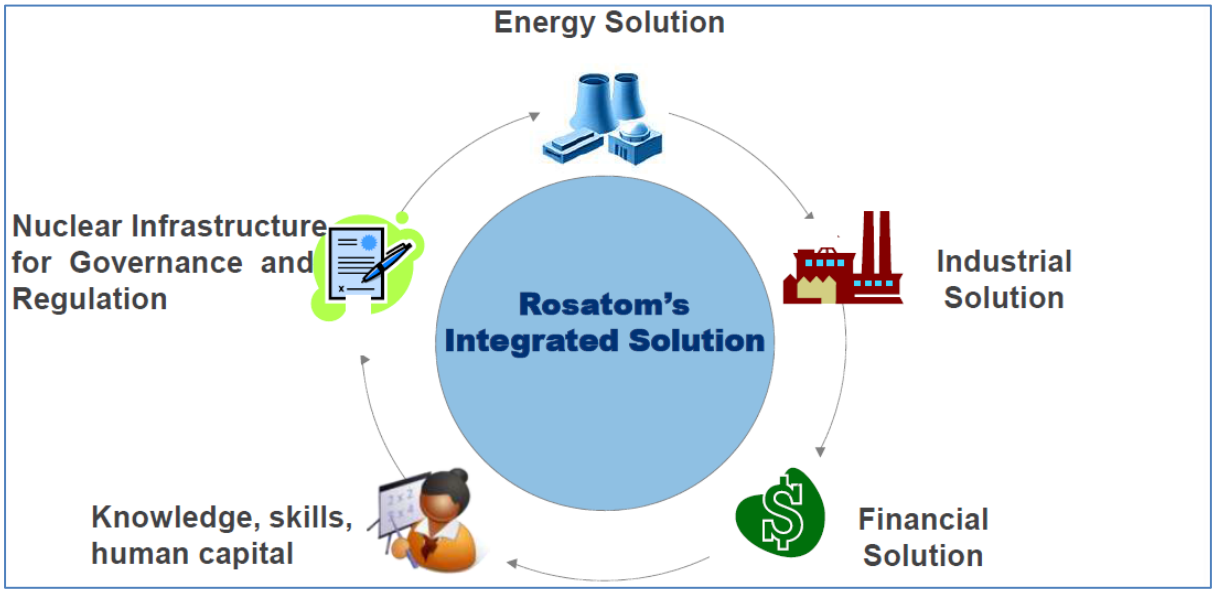

Figure 1 Rosatom's complete solution for Nuclear Power Programme (Sokolov, 2013)

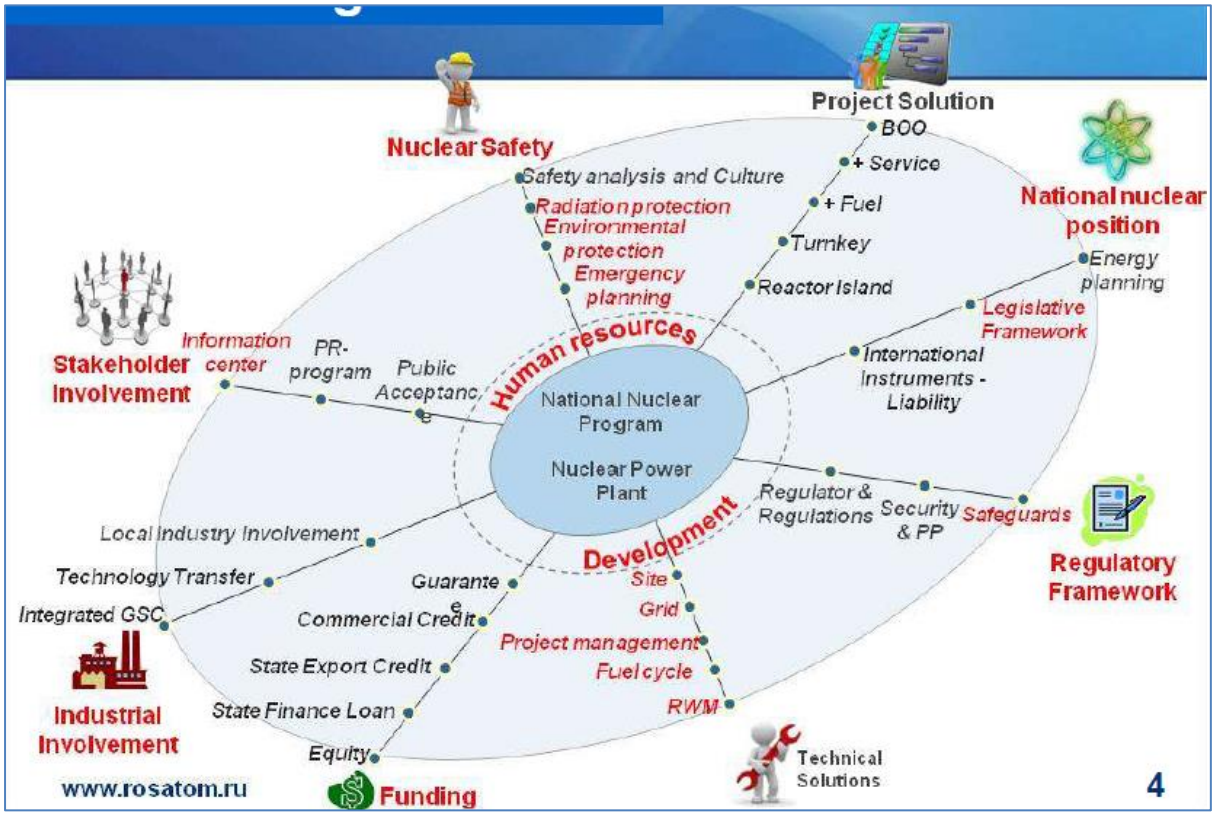

Figure 2 Russian Integrated offer (Sokolov, 2013)

Figure 1 depicts a typical BOO solution that provides finance, skills and resources, nuclear infrastructure for governance (which includes the development of nuclear regulations and regulatory functions) and even industrialisation as part of its integrated solution.

Rosatom's BOO model appears to be suited to countries with no nuclear power stations and negligible nuclear infrastructure. The fact that the supplier also offers Regulatory Framework "support" might raise concern in terms of the independence between the vendor and the regulator. It will be established later in the main body of this study whether there is adequate legislation in place to ensure the independence of the regulator as prescribed in the IAEA's *Milestones in the Development of* a National Infrastructure for Nuclear Power for the Turkish NNB project.

Figure 2 raises another interesting point. This diagram was part of a presentation at the *Nuclear Power Asia conference in 2013* (Nuclear Power Asia, 2013) which was attended by several nuclear vendors marketing nuclear power to newcomer countries and countries with existing nuclear infrastructure. The lack of competent human resources is often one of the obstacles a newcomer country faces (IAEA, 2007c). The diagram is centred on *Human resources* and *Development* with *Nuclear Safety* but one of the tentacles of the *Nuclear Power Program* for a *Nuclear Power Plant as opposed to it being a central focus area*. Section 2.2 will provide detail around the extensive safety requirements that is required of a nuclear programme and fundamentally implies that safety should be the central theme of nuclear programmes. However, as a newcomer country with likely financial constraints, energy constraints, lack of competent nuclear human resources and very likely a need for the economic development that is associated with a nuclear programme, nuclear safety might not necessarily be considered their primary focus.

Even though it may have been unintentional, Figure 2 does not necessarily depict nuclear safety as the primary focus. It should be noted that whileFigure 2 may give the impression that safety is not a primary focus, this cannot be considered as fact.

2.1.1 Financing models for generation plant projects

Before we refer to how BOO applies to the NNB industry, it would be prudent to first briefly describe the traditional models of financing a project of this magnitude. The focus will be on recently financed generation projects in South Africa and how this compares to the manner in which NNB is being financed at some presently active NNB construction sites. As a more in-depth analysis (via in-

dividual chapters) will be provided for HPC and Akkuyu, their respective finance models will be discussed during their respective chapters.

Corporate finance means that the project will be financed, typically by a loan where *lenders rely on the overall creditworthiness of the enterprise financing a new project to provide them security* (Jechoutek & Lamech, 1995). This implies that equity is being raised against the assets of the company. The developer company has to cater for all risks associated with the project. An example of this is Electricite de France (EdF) who is trying to complete the Flamanville 3 project (which is over budget and at least four years late). The cost overruns and delays in completion are exerting financial pressure on EdF as the primary developer who has had to absorb the additional costs.

The corporate finance model also appears to be used to finance the construction of South Africa's Medupi and Kusile coal-fired power stations. Medupi, for example, is financed via Eskom loans (various global financial institutions which the South African government has guaranteed), Eskom's capital reserves, Eskom's bond programmes and governmental loans.

Both these projects have been plagued by typical construction risks such as labour unrest and scope creep. *Thus the massive cost and time overruns at Eskom's Medupi and Kusile power stations are expected* to (sic) *further strain Eskom's financial resources, and place upward pressure on Eskom's electricity price trajectory in the years ahead* (Yelland, 2016). As Eskom seeks to recover its costs via the electricity tariffs, Yelland (2016) suggests that the South African public might also contribute towards the costs associated with delays at Medupi and Kusile power stations.

2.1.2 Financing models for selected active NNB construction sites

The traditional models for financing projects like NNB have left stakeholders wary of following in the same footsteps. Financial institutions that may have traditionally been stakeholders in NNB projects, have chosen a cautionary route as illustrated by George Borovas, a partner at Shearman & Sterling LLP (World Nuclear News, 2014) whose company *is advising on the world's largest nuclear arbitration dispute - concerning Finnish utility Teollisuuden Voima Oyj over construction delays and budget overruns at the Olkiluoto 3 nuclear power plant in Finland: "Unfortunately most of them, the World Bank and the International Finance Corporation have written and unwritten policies against lending into nuclear.*" And further: *"We are starting to see the emergence of certain issues, like the requirement for vendor financing – so vendors are being asked to put equity into these projects, which is not a natural place for them to be because they don't think of themselves as project developers…"*

Vendor financing has thus been the more preferred model for financing NNB projects as it transfers some of the risks associated with typical large infrastructure projects to the vendor.

Dr Nadira Barkatullah, at the time the *director of economic regulation at the Regulation and Supervision Bureau of the United Arab Emirates*, said: *Vendor financing can take one of three forms: a loan (or debt), such as the 30-year interstate loan of €13 billion ($17 billion) provided by Rosatom for Hungary's new Paks units; equity, such as the Hinkley Point C project, in which Areva, EDF, China General Nuclear and China National Nuclear Corporation each have a stake; and the build-own-operate scheme for the Akkuyu project, in which Rosatom and the Republic of Turkey are the main stakeholders* (World Nuclear News, 2014a).This study will analyse more of the overall aspects of the Hinkley Point C (HPC) and Akkuyu projects in the main body as examples of BOO models. It is acknowledged that HPC might not be considered a BOO model in terms of the definitions that have been applied thus far but its inclusion will be justified later (section 5) in the study.

In Belarus a preliminary turnkey project for the construction of 2 x 1200MWe (491) reactors at Ostrovets was realised with a subsidiary of Rosatom, Atomstroyexport. Further, an effective interstate loan with Russian state-owned banks was concluded in 2012 to provide the financing for the project with the completion of the units expected in 2018 and 2020 respectively (World Nuclear Association, 2017a).

Barakah NPS is an active construction site in the United Arab Emirates where 4 x 1400MWe units are planned. Direct loans ($16.2bn from the Abu Dhabi government, $2.5 billion from the Export-Import Bank of Korea and $250m from National Bank of Abu Dhabi, First Gulf Bank, HSBC and Standard Chartered) have been secured in addition to equity commitments from Enec and Kepco to the value of $4.7bn to finance the project. Kepco has been contracted as the mains supplier for the nuclear island. (NUCNET, 2016b)

A joint venture company, Teollisuuden Voima Oyj (TVO), was formed between Finnish utility companies and several Finnish industrial customers who form the shareholders of the company to fund Olkiluoto 3 (1600MWe). Funding for Olkiluoto 3 was provided by equity from the shareholders in addition to loans taken out by TVO. The shareholders purchase energy at cost from TVO and either uses the energy in their own facilities or sells it to other customers. Significantly, no dividends are

payable to shareholders, otherwise known as the Mankala principle. Areva is the main contractor for the nuclear island while Siemens is subcontracted for the turbine island. (Vehmas, 2010)

2.1.3 Benefits of the BOO model for NNB?

Large scale generation that is able to cater for base load includes coal fired power stations and hydro powered stations. Gas becomes an option for base load if economically viable sources are available. Considering the amount of coal required to provide the energy requirements for a country, this option tends to be more financially viable if the country has its own coal sources. In addition, the increasing costs related to carbon emissions (Groscurth, 2009), environmental considerations and comparative construction costs make coal-fired generation arguably as intricate as the nuclear option.

Hydro becomes a more viable option if the country is geographically positioned to have consistent hydro supply (precipitation) throughout the year. Solar and wind generation technology has not made sufficient technological advances as yet to be considered for power generation with a load factor that is comparable to nuclear or coal fired power stations (DoE, 2013).

Stein (2013) provides data that indicates, while also acknowledging that nuclear has the highest overnight capital cost, why nuclear is such a popular choice in relation to other base load options (Stein, 2013):

- Nuclear options have the lowest fuel cost
- Nuclear has the lowest variable operational and maintenance costs
- Lowest carbon emissions in relation to coal or gas fired power stations
- Nuclear has amongst the highest capacity factors

In addition, nuclear fuel and nuclear fuel products are more economical to import compared to coal due to its significantly smaller volume. The lifespan of nuclear power stations is significantly longer than, for example photovoltaic plant, concentrated solar plants and gas power plants. Nuclear power stations across the globe are applying for plant life extensions as the conservatism that was applied with the original design is now enabling longer plant operation with refurbishment programmes supporting this goal (IAEA, 2015). Several nuclear power stations currently have licenses to operate for 60 years.

It has already been established that there are short term financial benefits to BOO models as the local utility or government does not have to provide the upfront capital to implement the NNB project. Risk allocation is based on the principle that risk should be allocated, by contract or otherwise, to the party that is best able to mitigate or control such risk. Ideally, risk allocation needs to be shared amongst the contracting parties. Figure 3 refers to a Build-Operate-Transfer model but can equally be applied to a BOO model. It shows that the only risk that is borne by the client is the political risk associated with the project. Project, financial, construction and performance risk is borne by the project and hence the BOO entity.

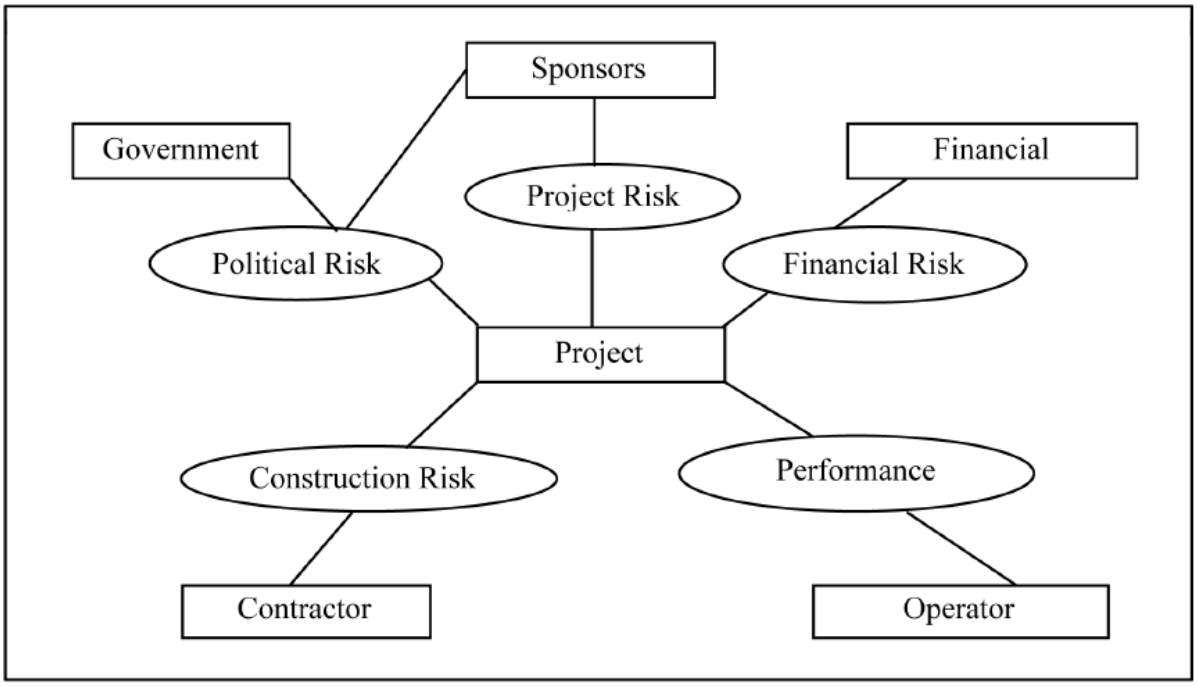

Figure 3 Risk Allocation between Project and Government (Markom, 2012)

When a contract is issued for the construction and operation of a facility, the contractor will have the operation of the asset in mind during construction. Atiyas (edam, unknown) argues that there are interdependencies between the construction and operation of the facility which could add to the increased efficiency levels. *To the extent that what is done during construction may affect the cost of operations or maintenance, the private firm will have incentives to minimize the total cost of the bundle, an incentive which is absent when the activities are not bundled* (edam, unknown) . The facility will be constructed in a manner that minimises the operational burden. However, there will also be an additional incentive to complete construction earlier in order to start generating income. When time and cost are driven primarily, often quality tends to suffer (as per the project management triangle). In this case the client – the government – needs to ensure that quality requirements are adhered to for the duration of the project construction phase.

In addition to the financial benefits and inherent project risks, countries may choose the BOO option due to its concern over its capability to independently meet the requirements by the IAEA to show that it has:

- *Comprehensively recognized and identified the national commitments and obligations associated with the introduction of nuclear power;*
- *Established and adequately prepared the entire national infrastructure needed to begin the construction of a nuclear power plant;*
- *Established all the necessary competences and capabilities to be able to regulate and operate a nuclear power plant safely, securely and economically over its lifetime, and to be able to regulate and manage the ensuing radioactive waste.*
  (IAEA, 2007c)

Furthermore, an existing energy shortfall in a country, together with the above mentioned factors may make the BOO model attractive to governments who are pursuing NNB as a newcomer country.

Other countries may have existing nuclear infrastructure but, due to economic reasons that include cheaper alternative energy sources (amongst others), the ownership and operation of nuclear power stations in that country may have changed hands, and not necessarily to another local operator. By example, in 2009 EDF Energy concluded the acquisition of British Energy for £12.5 billion (World Nuclear Association, 2016). British Energy owned and operated seven twin-unit Advanced Gas-cooled Reactor (AGR) stations and one Pressurised Water Reactor (PWR); significantly, they were also in possession of prime sites that were earmarked for nuclear new build. The acquisition put EDF Energy in an ideal position for the eventual decision by the English government to start the nuclear new build process. Hinkley Point C is a new build project where a joint venture between French and Chinese companies will finance, build and operate the NPS (CHUANG F, et al., 2014). The sharing of the equity is detailed in Figure 4 with the long term relationship between the EDF Group and China General Nuclear Corporation (CGN), and the EDF Group and China National Nuclear Corporation (CNNC) being emphasised. (Reminder: the author acknowledges that HPC may not be an accurate depiction of a BOO model.)

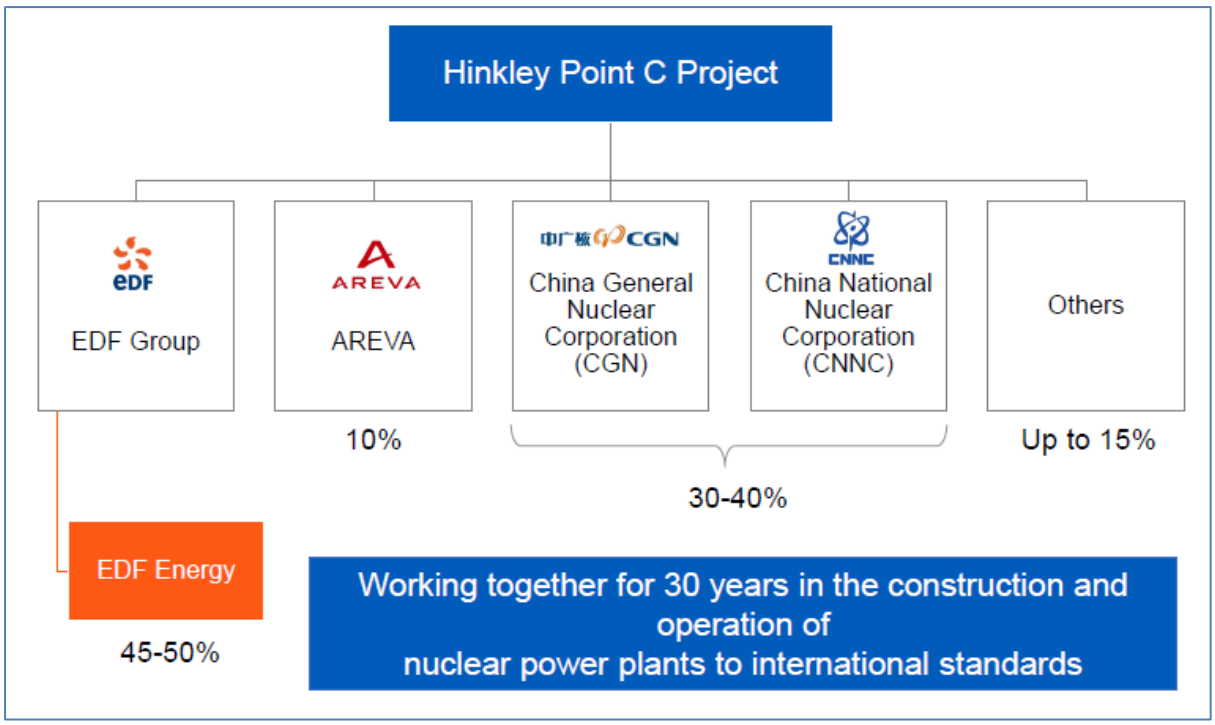

Figure 4 Equity Sharing for Hinkley Point C (CHUANG F, et al., 2014)

2.1.4 Definition of BOO

BOO was defined earlier in this study as:

Build-own-operate – under this scheme, the company, which builds the NPP, also is the owner of the NPP, responsible for its operation and power sales, as well as attracting investments for the NPP construction (Akkuyu NGS AS, 2013a).

This definition is of course not different to a utility (like Eskom) building and operating the NPP. The key difference, for the purposes of this study, is when the operating licensee also has a direct relationship to the primary equipment vendor via a parent company. For this study specifically, the focus will be on the primary vendor that supplies the bulk of the equipment of the nuclear island.

For the purposes of this study, the following list of criteria will be attributed to the BOO model:

- An entity, other than the local government or local utility, provides the funding for the building of the NPS. We will name this entity the BOO entity.
- The BOO entity is accountable for all the designs for the NPS.
- The BOO entity is accountable as the primary supplier of all equipment. The BOO entity could have a subsidiary that manufactures some of the equipment.
- This BOO entity is accountable for the construction of the NPS.

- Once the NPP is commissioned, the BOO entity (or subsidiary thereof) operates the NPS.
- The BOO entity recoups its investment by benefitting wholly (or from the majority of) the revenue linked to the sale of the energy produced by the NPS.
- The BOO entity is responsible for the eventual decommissioning of the NPS once the end of its lifespan is reached.

It should be noted that there is no singular definition of the BOO model, especially pertaining to the involvement of the nuclear regulator. Depending on the existence of an experienced nuclear regulator in the country, the BOO entity could provide regulatory support to establish a regulatory framework along while supporting the development of the regulator. When there is existing nuclear infrastructure with an experienced regulator, the need for direct regulatory support is minimised, and ideally, eliminated.

Even though many NPS projects start out via intergovernmental agreements, the specific involvement of the government in nuclear regulation also becomes crucial when the independence of the regulator is considered. Hence, the political environment will have a significant bearing on the way the nuclear regulator is allowed to operate and oversee the construction of a NPS.

This implies that there cannot be an ideal implementation model for BOO that will fit every country as the environment will dictate the attributes of the BOO model specifically pertaining to the nuclear regulator.

2.1.5 Challenges of BOO

BOO entities in the NNB industry have to invest significant amounts of money for several years before being in a position to receive a return on their investment. Why are they so keen on doing it?

BOO entities recover most of their investment from the sales of the energy that is being sold. The rate and volume at which the energy is being sold might have been one of the conditions for the deal to be finalised.

A BOO deal has been concluded between Russia and Turkey for a 4-unit NPS at Akkuyu in Turkey. They have agreed that 70% of the energy produced by the first two units and 30% of the remaining two units would be purchased by the Turkish Electricity Trade and Contract Corporation for a 15 year period for a specific tariff. The specific rate is considered *economically advantageous to Turkey* (Edam , 2011).

Hinkley Point C's power purchase agreement has a 35 year agreement for a strike price (2012 prices) that is *double the wholesale market price for electricity that prevailed in 2013* (Thomas, 2016).

BOO entities may attach value to factors other than only the direct financial cost of the project. Strategically, state-owned nuclear energy companies offer financially advantageous deals to countries to *gain politically from the leverage stemming from the establishment of an international nuclear energy company* (Heffron JA, 2014). This is the case with Russia in Turkey and Korea in the United Arab Emirates (Barakah NPS) where the Akkuyu and Barakah projects are amongst the first ventures outside their respective borders. (Rosatom is already active in construction Belarus (Schneider, et al., 2016) but this country was closely linked to Russia in the days of the Soviet Union implying a strong common political history.) These opportunities allow Russia (World Nuclear Association, 2017) and Korea (World Nuclear Association, 2017) to meet their respective political and economic objectives to export NNB to other countries.

An illustration of the political pitfalls associated with these deals was depicted during December 2015 when a Turkish fighter jet shot down a Russian aircraft near the Syria-Turkey border inside Turkish airspace. In response Rosatom suspended work on the Akkuyu project (Kramer, 2015) and only agreed to resume work several months later after talks between Russian President Vladimir Putin and his Turkish counterpart Recep Tayyip Erdogan (Sputnik, 2016).

As nuclear newcomer countries would typically not have a need for a nuclear regulator (prior to considering a nuclear programme), one of the first steps for a nuclear programme is the establishment of a competent and independent regulator. As expected, there would be a lack of available competent resources available from within Turkey to fulfil this role. The need for an independent regulator is discussed later in the study.

Rosatom offers assistance to newcomer countries' regulators (Figure 2) as part of its BOO offering. In Turkey's case, the support offered to TAEK to ensure that it becomes more skilled in regulatory affairs may raise questions about the independence of TAEK. Consequently, concerns are raised regarding the level of oversight by the regulator and the impact on nuclear safety that this situation may provide.

2.2 What are the IAEA requirements for a NNB project

The International Atomic Energy Agency (IAEA) forms part of the United Nations. *The IAEA is the world's centre for cooperation in the nuclear field and seeks to promote the safe, secure and peaceful use of nuclear technologies* (IAEA, 2017a). Part of its mission is to develop *nuclear safety standards, promotes the achievement and maintenance of high levels of safety in applications of nuclear energy, as well as the protection of human health and the environment against ionizing radiation* (IAEA, 2017a).

The Convention on Nuclear Safety (IAEA, 1994) reaffirms that the *responsibility for nuclear safety rests with the State having jurisdiction over a nuclear installation.* South Africa has ratified the Convention on Nuclear Safety in 1994 (IAEA, 2016).
Notwithstanding a country's use of BOO, *the ownership of the responsibility for implementation of a nuclear power programme rests with the country and its organizations and cannot be subcontracted or avoided* (IAEA, 2007c).

Article 5 of the *International Law Commission* on State Responsibility states further that:
The conduct of a person or entity which is not an organ of the State under article 4 but which is empowered by the law of that State to exercise elements of the governmental authority shall be considered an act of the State under international law, provided the person or entity is acting in that capacity in the particular instance.
The implication is that should a foreign BOO operator be involved in an accident that results in nuclear damage, the Installation State cannot abdicate its responsibility for nuclear safety by claiming that the BOO operator is from another country. This implies that if Rosatom is employed by SA as BOO and they cause a nuclear accident, then SA is responsible and liable for damages.

2.3 Nuclear Liability

As shown in the Chernobyl nuclear accident in 1986, nuclear damage is not limited to the country's borders.

All States that engage in nuclear related activities have concluded that general tort law is not an appropriate instrument for providing a liability regime adequate to the specifics of nuclear risks, and they have enacted special nuclear liability legislation.

And further:

International nuclear liability conventions are necessary in order to facilitate the bringing of actions and the enforcement of judgements without hindrance by national legal systems. (IAEA, 2003a)

Nuclear liability broadly refers to the responsibility that the operator or licensee should accept in the event of a nuclear accident that results in "nuclear damage" as defined in the revised Vienna Convention (IAEA, 1998b).

The nuclear conventions that have been concluded at a worldwide level include:

a) The 1963 *Vienna Convention on Civil Liability for Nuclear Damage* (IAEA, 1996), revised in 1997 *(the Vienna Convention):* 40 Contracting Parties (IAEA, 2014)to the 1963 *Vienna Convention* (as of 24 January 2014); the 1997 Protocol revising it, not yet in force.

b) The 1997 *Convention on Supplementary Compensation for Nuclear Damage* (IAEA, 1998a).

c) The 1988 *Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention* (IAEA, 1992): 22 Contracting Parties (as of 30 April 2014) (IAEA, 2014).

2.3.1 Vienna Convention on Civil Liability for Nuclear Damage

This convention is based on the following principles (IAEA, 2007b), with potential impact on the BOO operator:

a) *"absolute" liability, i.e. liability without fault;*
often referred to as "strict liability" this means that the BOO operator is held liable, regardless of fault.

b) *exclusive liability of the operator of the nuclear installation;*
this means that even if any item or equipment that is supplied from the operator's suppliers, and that item or equipment is found to be the cause of the nuclear damage, the victim can sue the operator for any physical damage or injury as only the operator can be held liable. It should be mentioned that this applies especially to the transport of nuclear fuel where the

operator is held liable even though it may not be in his possession, within the borders of the Installation State or on the premises of the NPS.

c) *limitation of liability in amount and/or limitation of liability cover by insurance or other financial security;*

this is especially beneficial to BOO operators as unlimited liability will deter investors from NNB projects.

d) *limitation of liability in time.*

The limitation in time puts a 10 year limit on claims related to a physical injury even though the effects of contamination to radioactive material could only present itself later. This could be viewed as beneficial to potential BOO operators. The ten year period can be extended by the Installation State.

The following specific clauses could impact the BOO models.

Article II: 3 (a) Where nuclear damage engages the liability of more than one operator, the operators involved shall, in so far as the damage attributable to each operator is not reasonably separable, be jointly and severally liable.

In the event that a joint venture BOO model is employed with multiple operators, , all operators in the joint venture shall be liable.

2.3.2 Convention on Supplementary Compensation for Nuclear Damage

The Chernobyl incident highlighted the need for supplementary compensation from the Installation State, especially victims of the trans-boundary effects of contamination.

While the Organisation for Economic Co-operation and Development[1] (OECD) countries signed up for the 1963 *Brussels Convention* to allow for a similar need, non-OECD countries did not have a similar instrument that all States could agree to.

The Brussels Convention indicated that *not only is the Installation State obliged to provide public funds up to a certain amount in order to cover damage in excess of the operator's liability limit, but a "third layer" of compensation is envisaged, whereby all the Contracting Parties, in a spirit of mutual solidarity, are obliged to provide public funds up to an additional amount in order to cover damage in excess of the first two layers of compensation* (IAEA, 2007b).

Contracting Parties to the Brussels Convention would thus assist the Installation State where the nuclear incident occurred, with both local and trans boundary claims. However, Convention on Sup-

[1] The OECD is a regional European agreement with several non-European members

plementary Compensation for Nuclear Damage indicates *that the international funds should be used, in part, to compensate trans boundary damage only and, in part, to compensate damage suffered both inside and outside the territory of the Installation State* (IAEA, 2007b).

It would appear that the two conventions mentioned above are similar considering that local and trans boundary claims are still considered. However, the Convention on Supplementary Compensation for Nuclear Damage appears to have more emphasis on international funds being used for trans boundary claims instead of not differentiating between local and trans boundary claims as appears to be the case for the Brussels Convention.

2.3.3 Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention

Similar to the 1963 Vienna Convention (being used by non-OECD countries), OECD countries were using the 1960 Paris Convention as their instrument to cater for civil liability in the event of nuclear damage. With the possibility of Contracting Parties being contracted to either convention exclusively, a mechanism was required to link the Vienna and Paris Conventions. The Joint Protocol is meant to serve this purpose (IAEA, 20014)

South Africa is not a Contracting Party to the Vienna Convention and the Convention on Supplementary Compensation for Nuclear Damage, and by implication the Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention.

3 The IAEA's perspective of the nuclear regulator

The IAEA has clear guidelines on the nuclear regulator, specifically regarding its independence. This chapter capture some of the key guidelines that the IAEA recommends and the implications if those guidelines are not followed.

There are two scenarios that will be considered in this study:

1. "Newcomer countries": this option is chosen as the Russian-Turkish version of BOO appears suited to countries without a significant nuclear background.
2. Countries with at least one existing NPS: conversely, this option is chosen to illustrate the different regulatory challenges that a country with existing nuclear infrastructure may present.

These two choices have specifically been chosen as the BOO models that are being considered appear to be suited to one of these choices. Rosatom offers the Integrated Offer including the regulatory support while HPC shows a scenario with existing regulatory infrastructure and negligible need for similar regulatory support.

The IAEA's *Handbook on Nuclear Law* (IAEA, 2003a) states that:
A fundamental element of an acceptable national framework for the development of nuclear energy is the creation or maintenance of a regulatory body (or regulatory bodies) with the legal powers and technical competence necessary in order to ensure that operators of nuclear facilities and users of nuclear material and ionizing radiation operate and use them safely and securely.

An IAEA brochure, *Considerations to Launch a Nuclear Power Programme* (IAEA, 2007a), is a document that provides high level considerations should a country decide to embark on a NNB project. Detail is provided in the IAEA's *INSAG-26, Licensing the First Nuclear Power Plant* (IAEA, 2012). The IAEA has recommended several steps before a NNB project can be undertaken. The IAEA's *Milestones in the Development of a National Infrastructure for Nuclear Power* (IAEA, 2007c), describes and prioritises the steps for a country that is considering NNB project.

Significant differences are expected between countries that are embarking on its first NNB and those that have at least one existing, licensed Nuclear Power Plant. In the latter case, it is expected that a regulatory framework already exists with a regulator that has the necessary powers and competencies to license and regulate the Nuclear Power Plant. Consequently, the BOO offerings and associated challenges will be different.

3.1 Newcomer countries

In relation to regulatory, and by extension legal requirements, the newcomer country should consider the following before a decision is taken to start a NPP:

- *Develop a comprehensive nuclear legal framework covering all aspects of the peaceful uses of nuclear energy, i.e. safety, security, safeguards, and liability, in addition to the commercial aspects related to the use of nuclear material.*
- *Establish and maintain an effective regulatory system.*
  (IAEA, 2007a)

Before an entity can construct, the the entity should apply for a construction licence and the regulator must assess the application before the issue of the licence. This implies that the regulator should be competent prior to construction in order to assess a construction licence application. There would be a very limited pool of local resources with operational experience to provide the core skills that are inherent to the required competence. Attaining operational experience takes time which might not be available when evaluating a construction licence application.

The *owner/operator must achieve the competence necessary to operate, maintain and establish full responsibility for the NPP* (IAEA, 2007a).
For a newcomer country technical competence in terms of local human resources could pose the biggest challenge for a country without significant nuclear infrastructure. Hence, *much of this specialized training and experience can be included as part of the contract with the supplier of the NPP technology* (IAEA, 2007a).

In terms of the regulator's human resources development:
Assistance to the nuclear safety regulator in developing the human resources capable of regulating and overseeing the safety of the plant and achieving an effective, competent and independent nuclear safety regulatory organization may be provided by the regulatory body in the country of origin of the supplier or other regulatory bodies, and complemented by the IAEA and other international organizations (IAEA, 2007a).

This statement means that the BOO's country of origin's regulator may be one of the parties assisting the newcomer country's regulator. Assuming that the technology is not FOAK, this statement is justified as the vendor country's regulator would have operational experience in the approval of a NNB programme using the same or similar technology in its own country.

This statement also requires that the assisting regulator is fully competent and independent from the BOO. Considering the frequency of intergovernmental agreements to secure NNB projects and the fact that the regulator ultimately reports to a leg of government, the regulator's impartiality might be called into question as its government might have been instrumental in securing the NNB project for the BOO. The IAEA's (amongst other international organisations) continued involvement does appear to address the concern of lack of impartiality on the part of the BOO's country of origin's regulator by providing another layer of independent assistance. Further, the IAEA recommends the use of a technical support organisation (TSO) who could act as an external consultant to provide technical expertise about the technology being implemented (amongst other services). However, the IAEA cautions:

When such external advice or assistance is provided (e.g. by a dedicated support organization, by universities, by scientific institutes or by consultants), arrangements should be made to ensure that those providing it are effectively independent of the operator or licensee. (IAEA, 2003a)

This is an important consideration for the regulator as the TSO would often have gained its technical knowledge and experience through an existing or prior relationship with the operator. The challenge is to implement practical and effective mechanisms to ensure the independence from the BOO operator.

In preparation for the construction of a NPP, the local regulator would thus be better prepared to (IAEA, 2007a):

- *Enact all the elements of the comprehensive legal framework mentioned above;*
- *Establish and ensure the competence of the regulatory body to develop a licensing system and to monitor and supervise compliance with safety standards and security guidelines consistent with IAEA standards;*
- *Decide upon the financial and operational modalities for the ownership and implementation of an NPP (government, private sector and/or foreign ownership);*

  The last bullet is not directly related to regulatory issues but is relevant as the BOO model implies an owner that may not be considered 'public' but rather private with possible foreign ownership.

Depending on the political environment in the country, the establishment of a legal framework for the NNB program and the subsequent operation of the NPP could be a time consuming exer-

cise that requires assistance from mature nuclear countries. However, it could also happen fairly expediently if the political environment is more 'aligned' to the specific country's head of state.

3.2 Countries with at least one existing NPS

For countries with at least one existing NPS the nuclear legal and regulatory infrastructure would already be in place if one assumes that the country is a member state of the IAEA. The regulator would have met most, if not all of the characteristics of a mature regulator as described in the IAEA's INSAG-26 (IAEA, 2012). Amongst those characteristics would be strong sense of independence, necessary competencies and consequently have a much lesser reliance on the BOO's country of origin's regulator. There would still be a need for interaction between the two regulators; however, it would be on a more equal footing between two mature regulators. The need for the interaction stems from the fact that the BOO's country of origin's regulator would already have overseen the construction of the same or similar technology in their homeland (Sari, 2016). This assumes that the nuclear technology being employed would not be a first of a kind (FOAK). These types of projects have a notoriously difficult and lengthy path to follow considering the lack of technology specific operating experience and may defeat one of the primary reasons for choosing a BOO model, i.e. the need for expediency due to the country's energy requirement. Additionally, the BOO would be relied upon to bring in expertise and train and develop local resources but if it is FOAK, the benefit is diminished as the BOO entity itself will still be developing its own expertise – depending on the extent to which the technology is a FOAK.

Some technical competence and expertise would already be available in a country with even a single licensed NPS. The technically competent staff would be experienced in the nuclear technology that they have been operating at the existing NPS; however, there will be a gap if the new nuclear supplier is using a different or updated technology. The mature nuclear operating experience would enable the operators to bridge the gap much quicker compared to new operators from newcomer countries. The major challenge would be the number of technically competent staff that is available to operate an additional NPS. This could very likely result in some reliance on the nuclear vendor for technical skills, at least in the short to medium term, as the local operator recruits and trains locals to help operate the new NPS. Considering that construction generally takes 11-20 years (IAEA, 2011) – there are examples of shorter and longer construction periods – from the time the government decides to pursue a nuclear programme to commissioning a NPS, the local operator would have an opportunity to address the skills shortage by also using the vendor's contractual obligation (as for newcomer countries) to train local staff.

Similarly, the regulator would be faced with a resource problem. Since the regulator is already involved in basic design approvals, years before construction starts, the regulator may not have as much time as the local NPS operator to bridge the skills gap. As long as the regulator avoids the common newcomer country mistake in lack of application *in establishing a human resources development plan and a training programme to ensure the required competencies in the regulatory body in a timely fashion* (IAEA, 2012), this problem may not be insurmountable.

3.3 Chapter Summary

This chapter has highlighted the differences between an existing, mature nuclear regulator in relation to a nuclear regulator that is required as a prerequisite for the country's first NNB programme.

Depending on the political environment in the country, the establishment of a legal framework for the NNB program and the subsequent operation of the NPP could be a time consuming exercise that requires assistance from mature nuclear countries. However, it could also happen fairly expediently if the political environment is more 'aligned' to the specific country's head of state.

The need for a competent regulator cannot be over-emphasised. Expectedly, a newcomer country will struggle in this regard. The IAEA recommends that the NNB contract should cater for skills development for the NPP's employees. It does not specifically refer to how or if the contract should cater for skills development for the nuclear regulator. It does refer to the vendor country's regulator that could assist the host country's regular considering that the same or similar technology would have been implemented already in the vendor country. The use of a TSO would further assist in bridging the skills gap within the regulator.

A country with a mature nuclear regulator is in a very different situation. The level of assistance required would clearly be significantly lesser. It would very likely require technical assistance to familiarise itself with the new technology but this is expected to happen more expediently based on the existing nuclear operational regulatory experience.

4 Regulatory models/structures/requirements

The National Nuclear Regulator Act, 1999 provides for the establishment and functioning of the National Nuclear Regulator (NNR). The NNRA allows for the establishment of a *juristic person to be known as the National Nuclear Regulator.* One of the NNR's primary objects is to *provide for the protection of persons, property and the environment against nuclear damage, through the establishment of safety standards and regulatory practices* (DME, 1999a).

4.1 The role of the regulator

The role of a regulator is described by the US Nuclear Regulatory Commission's depiction in Figure 5. The regulator has several areas of focus relating to a nuclear power plant:

1. The development of regulations and guidance for applicants
2. Licensing for the different phases of a NPP, including decommissioning of the NPP
3. Oversight of the NPP to ensure compliance
4. Assessing operational experience and events at NPP
5. Activities to support decisions, including research, obtaining independent reviews, conducting hearings with parties/stakeholder to clarify decisions

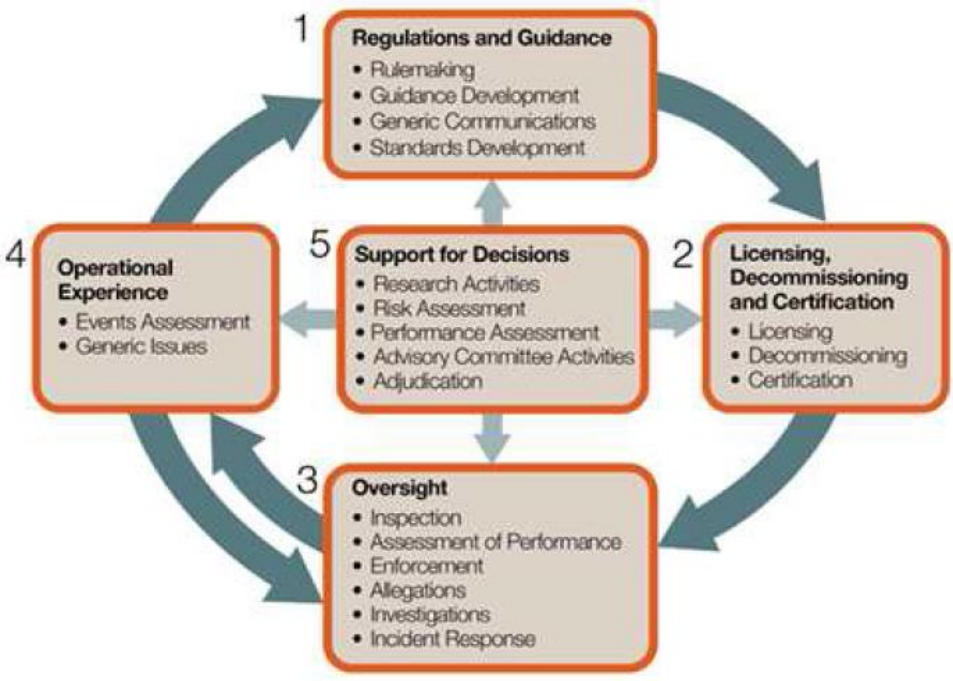

Figure 5 Roles of the Regulator (NRC, n.d.)

4.2 Existing Nuclear legislation and policies in South Africa

The legislative framework in South Africa that governs the nuclear industry is (amongst others) tabulated in Table 1.

National Nuclear Regulator Act, 1999	Provides for the establishment of the National Nuclear Regulator as the regulatory authority for the safety of nuclear installations (DME, 1999a).
Nuclear Energy Act, 1999	Provides for the establishment of the South African Nuclear Energy Corporation Limited (NECSA). Amongst other activities, NECSA promotes research and development in the nuclear energy field, regulates the acquisition and possession of nuclear fuel, transportation of fuel (DME, 1999b).
Hazardous Substances Act, 1973	*To provide for the control of substances which may cause injury or ill-health to or death of human beings by reason of their toxic, corrosive, irritant, strongly sensitizing or flammable nature or the generation of pressure thereby in certain circumstances, and for the control of certain electronic products; to provide for the division of such substances or products into groups in relation to the degree of danger; to provide for the prohibition and control of the importation, manufacture, sale, use, operation, application, modification, disposal or dumping of such substances and products; and to provide for matters connected therewith.* (Government Gazette, 1973)
National Disaster Management Act, 2002	*To provide for an integrated and co-ordinated disaster management policy that focuses on preventing or reducing the risk of disasters, mitigating the severity of disasters, emergency preparedness, rapid and effective response to disasters and post-disaster recovery; the establishment of national, provincial and municipal disaster management centres; disaster management volunteers; and matters incidental thereto.* (Government Gazette, 2002)
National Radioactive Waste Disposal Institute Act, 2008	*To provide for the establishment of a National Radioactive Waste Disposal Institute in order to manage radioactive waste disposal on a national basis; to provide for its functions and for the manner in which it is to be managed; to regulate its staff matters; and to provide for matters connected therewith.* (Government Gazette, 2009)
No. R388 Safety Standards and Regulatory Practices, 2006	Defines, amongst others: • the principal radiation protection and nuclear safety requirements, • the requirements applicable to regulated actions, • decommissioning requirements, • requirements for accidents, incidents and emergencies
No. R927 The Regulations on Licensing of Sites for Nuclear Installations, 2011	Establishes requirements for applications for nuclear installation site licences for siting

Table 1 Legislative and Regulatory framework for the South African Nuclear Industry

The Nuclear Energy Policy (2008) details the government's vision for nuclear energy. Section 12.3 regarding a *National Nuclear Power Generation Organisation*, stipulates (DME, 2008):
Eskom shall be the main owner and operator of nuclear power plants in South Africa. Ownership of nuclear power plants may also take the form of Public Private Partnerships with Eskom retaining the controlling shareholding as the Public sector player.
Ownership is an important consideration relating to BOO attributes. The entity that funds and builds the NPP would want ownership as well to create maximum benefit from its investment. Significantly, this means that the Nuclear Energy Policy would have to be amended to cater for a BOO entity to be able to operate a NPS in South Africa.

The National Nuclear Regulatory Act, on the other hand does not specifically preclude a BOO entity from applying for a nuclear license. Section 21(1) of the NNRA states that:

Any person wishing to site, construct, operate, decontaminate or decommission a nuclear installation… (DME, 1999a).

Section 12.5 of the Nuclear Energy Policy states:

To fulfil Government's intent of developing a national capacity to supply nuclear equipment and nuclear reactors, a national nuclear architectural engineering, component manufacturing and construction capability will be established. This will include the ability to design, manufacture, market, commercialise, sell and export nuclear energy systems & services. Private sector participation will be encouraged.

It is the government's intent to create a nuclear industry in South Africa and be self-sufficient in order to export nuclear energy systems, particularly into Africa. A nuclear program such as this presents high risk but may also offer high reward.

It is important to note that some BOO principles do not fully support the Nuclear Energy Policy Objectives, for example:

- *The policy objective to become a supplier of nuclear services (nuclear vendor) will require that South Africa develops or obtains its own intellectual Property Rights. This will need to be specifically negotiated as part of the procurement and will typically not be included in a BOO deal.*

The IAEA's Mission Report on the Integrated Nuclear Infrastructure Review (INIR) evaluated the *development status of the 19 infrastructure issues described in the Development of a National Infrastructure for Nuclear Power, IAEA Nuclear Energy Series No. NG-G-3.1* (IAEA, 2013b). The report then recommended and suggested actions that would address areas for further improvement, including the regulatory framework. This was in addition to the NNR's Self-Assessment of its regulatory framework. Some points from the INIR report regarding the regulatory framework include (IAEA, 2013b):

- Nuclear security is *not explicitly addressed in either* the NNRA or the NEA.
- The Minister of DoE makes regulations, not the NNR.
  The NNR should ideally *have the legal authority, technical competence and resources to fulfil the statutory obligations, ready to licence and inspect the construction of the NPP against a clearly defined set of regulations and licensing framework. Its regulatory decisions should be free from undue political and economic influence*.
- The NNR issues requirements documents, licensing guides and licensing documents.

4.3 Nuclear Skills in South Africa

The NNB programme in South Africa has been a 'stop-start' affair. In 2006 the South African government *announced that it was considering building an additional conventional nuclear plant* (Cilliers, 2016). This was part of a broader plan by Eskom to increase generation capacity to 80GWe by 2025. In 2008, Eskom was considering bids from Areva and Westinghouse but eventually stopped the process due to a lack of finance (Cilliers, 2016). In 2011 the government's Integrated Resource Plan was revised and approved by government which included 9.6GW of nuclear capacity by 2030 (Cilliers, 2016). In November 2016, the 2016 IRP was released which showed that the first new nuclear reactor of 1359MW would be online in 2037 for the base case scenario. An alternative scenario also showed an earlier commissioning date of 2026 should the *carbon budget* be considered (DoE, 2016).

Significantly, the NNR is facing a financial constraint that already challenges it in fulfilling its duties towards existing nuclear facilities. The NNR stressed that it would *continue to reduce its activities and operate at a bare minimum in line with the available financial resources* (NNR, 2015). In response to the IAEA Mission Report on the Integrated Nuclear Infrastructure Review in 2013 (IAEA, 2013b) of South Africa, the NNR indicated that plans were in place to recruit 30-35 additional staff in lieu of the NNB programme. However, the NNR's government grant was decreased by 23% while their broader financial constraints prevent it from appointing sufficient resources for a NNB pro-

gramme (NNR, 2015). One of the NNR's primary income sources is licensing fees; however, without new applications for NNB and its associated fees, appointing additional resources becomes challenging.

The uncertainty since 2006 would have made resource planning for the NNR a challenging task as certainty regarding the actual commitment to NNB from government remains elusive. This is not uncommon for NNB programmes across the world. The NNR needs to appoint resources for the proposed NNB program; however, the government's commitment to the programme is outstanding (hitherto) making the appointment of additional resources a financial risk. These resources could be redundant in the short term which is not affordable to an already financially constrained entity. Uncertainty in the NNB strategy, evidenced by the delays and changes announced by government, challenges the NNR's (and other stakeholders) ability to properly prepare its resources.

In terms of the broader nuclear industry in South Africa, nuclear skills are limited. There is one commercially operating nuclear power station in Cape Town (Koeberg Nuclear Power Station) and one research reactor in Pelindaba. This should be compared to eight commercially operating nuclear power stations in the UK (not to mention several older nuclear power stations that still need to be decommissioned and numerous other active nuclear installations) to gain relative perspective about the availability of nuclear skills in South Africa. This means that when the NNR starts to recruit staff for the proposed NNB programme local human resources with operational experience might prove hard to acquire. At the same time, with more NNB programmes across the globe, and with the relatively weaker South African currency, the ability of the NNR to retain its human resources will be crucial for any South African NNB programme.

It should be highlighted that recruiting staff with nuclear operational experience could also be detrimental to the NNR fulfilling its primary mandate. The experienced staff with operational experience might be inclined to 'get the job done' at the expense (unintentionally) of meeting the primary mandate of the NNR. Conversely, recruiting staff with the necessary academic qualifications allows the NNR to be more principled and steadfast about its objects as defined in the NNRA.

When the NNR eventually is allowed to recruit staff, it is more likely that most of the newly recruited staff would be inexperienced. Ideally, the NNR would want to structure their development by allowing them to work with experienced staff on existing nuclear installations before the potentially high

volume of work of a NNB programme. This could be considered an easier learning environment as opposed to the pressure of delivering for a NNB programme.

The NNR further stresses its concern that it may not be *prepared to handle new and emerging issues that will come with a NNB, especially if it entails new technology* (NNR, 2015). Considering that some BOO entities might be able to provide "regulatory support" the NNR would be able to obtain additional financial resources via licensing fees. The NNR may not want to accept direct assistance from the BOO entity as this may challenge its independence however, it may specify that the licensing fee should cater for learning opportunities with a regulator that has already overseen the successful implementation of the technology that will be commissioned in South Africa (or similar). The partner regulator should be chosen by the NNR to avoid any conflict of interest.

This risk of staff retention, the challenges associated with recruiting experienced staff and the ability to handle new and emerging issues make the use of a TSO unavoidable in the short to medium term. The paper, "Regulatory Body Core Competencies: When should a regulator contract a TSO?" (Wieland, et al., 2008) discusses the advantages and disadvantages of contracting a TSO. A NNB is an obvious example when a TSO will be beneficial, particularly in the medium term. However, in order to meet the Nuclear Policy objective, the intent would be to develop the regulator resources to become self-sufficient in the long term. A human resource development plan could cater for the transfer of knowledge from the TSO to the NNR to ensure that the reliance on the TSO is gradually decreased.

4.4 Regulatory Independence

South Africa ratified the Convention on Nuclear Safety in 1994. Article 8.2 (IAEA, 1994)of the convention reads:

Each Contracting Party shall take the appropriate steps to ensure an effective separation between the functions of the regulatory body and those of any other body or organization concerned with the promotion or utilization of nuclear energy.

The IAEA's INIR recommends (IAEA, 2013b):

South Africa should complete the process of revising its legislative framework to address the independence of the regulatory body, nuclear security and civil liability for nuclear damage.

The National Nuclear Regulator (NNR) reports to the Minister of Energy (previously Minister of Minerals and Energy) who is also the promoter of nuclear energy as indicated in the Nuclear Energy policy under Nuclear Energy Policy Objectives (DME, 2008)

Through this Policy Government aims to achieve the following objectives:

- *Promotion of nuclear energy as an important electricity supply option through the establishment of a national industrial capability for the design, manufacture and construction of nuclear energy systems;*

The separation of the regulator from the promoter of nuclear energy thus casts doubt over the independence on the regulator. The Board of Directors of the NNR is appointed by the Minister of DoE while representatives of DoE and the Department of Environmental Affairs serve on the said board. Other members of the board include representatives of labour, business and affected communities. The IAEA's Mission Report on the Integrated Nuclear Infrastructure Review (INIR) (IAEA, 2013b) of South Africa noted:

Considering that the Minister of Energy is also in charge of the promotion of nuclear energy and, given the structure, the designation of the Board members and the process to approve the NNR's budget, the INIR team is of the view that there is no adequate separation between the regulatory functions and the promotional activities, thus calling into question the effective independence of the NNR.

In the event that regulator report to an organisation(like a governmental ministry) that is also the promoter of nuclear energy, the IAEA recommends that certain administrative measures should be put in place, including (IAEA, 2003a):

- The regulator should not need the approval of another organisation before it can release a safety related decision.
- The appeals process for disputes regarding regulator judgements should not *give the appearance that regulatory judgements are subject to a reversal for extraneous reasons.* After following due escalation processes and the affected parties still feel aggrieved, a judicial route must still be available to resolve disputes.
- The technical capabilities of regulator should be sound; the use of a TSO is advised but cannot be in entirely reliant on a 3rd party's analysis and decision.
- The finances of the regulator must be predictable, reliable and adequate;
- The regulator should have competent leadership by way of suitable qualifications in a relevant discipline; if not, the leadership might be seen as political appointments and, by impli-

cation, receptive to undue influence by politicians.
(IAEA, 2003a)

The NNR's *The South African 6th National Report on Conventional for Nuclear Safety* (NNR, 2013) shows that it is aware of the concern regarding its independence and stresses that its independence is de facto based on:

- The NNR is accountable to parliament but operates independently to *carry out mandate without due influence.*
- The NNR 's independence is entrenched de jure as per NNRA
- The NNR reports to DoE while Eskom reports to Department of Public Enterprises (DPE).
- The existence of a comprehensive appeals process
- In the event that Minister of DoE rejects a recommendation from board of NNR, the parties will *endeavour to resolve their disagreement*; if still unresolved, minister makes final decision. Thus far, there have been no such incidents.

However, in a later NNR document relating to its strategic plan for 2016-2021, and in response to the INIR assessment in 2013 regarding its accountability to the Department of Energy who is also the promoter of nuclear energy, the NNR acknowledges (NNR, 2015):
This has been a continuing point of discomfort in South Africa's reporting pursuant to the Convention on Nuclear Safety as the view is that the Regulator is independent de jure but not de facto.
The NNR further acknowledges that it needs to report to a government entity but stresses that *an optimum arrangement should be found.* The details of that optimum arrangement is not discussed in the said document but moving the NNR to another ministry should at least be considered to counter the perception that the independence may be less than optimum.

Regarding NNB, the NNR is concerned that *the Regulator may be faced with a situation where a licensing approach that is divergent from current nuclear safety focused practices may be forced on it, in the interests of expediting a new build programme* (NNR, 2015). This statement may allude to political pressure due to the fact that the NNR reports to the same ministry that also promotes nuclear energy.

In the context of BOO, the regulator's independence might be challenged if one considers the attributes of BOO in some countries where the BOO entity might also provide financial support to the nuclear regulator.

4.5 Licensing

Section 20 (1) of the National Nuclear Regulatory Act No 47 of 1999 (NNRA) states (Republic of South Africa , 1999):

No person may site, construct, operate, decontaminate or decommission a nuclear installation, except under the authority of a nuclear installation licence.

Eskom has already applied to the NNR for two Nuclear Installation Site Licences (NISL) in March 2016 after acquiring the properties a few years earlier. *Both applications mentioned the applicant's intention to construct and operate multiple nuclear installations (power reactors) and associated auxillary nuclear installations of a plant type and technology not yet identified* (NNR, 2016).

Significantly, Eskom did not apply for a licence to construct and operate; it merely stated its intention which implies a *Multi-stage* (NNR, 2012) licensing strategy is being pursued by its shareholder (Department of Public Enterprises). The NNRA, Section 25, *prohibits the transfer of any nuclear authorisation issued* by NNR. This means that the holder of the site license, Eskom, cannot transfer their authorisation. In order for a BOO entity to be allowed to apply for a NIL to construct or construct and operate, the NISL licence holder would first have to surrender that authorisation back to the NNR. The BOO entity will then have to apply for NISL before any NIL application is made.

In order to apply for construct and/or operate licenses, the NNR would have required details of plant type and technology which Eskom does not have at this stage. The NNR's position paper PP-009 notes (NNR, 2012):

The NISL (Nuclear Installation Site Licence) would typically consider enveloping characteristics of all the nuclear installations contemplated to be constructed on the site while a NIL (Nuclear Installation Licence) to site, construct and/or operate would be for a specific nuclear installation or reactor design at a specific site.

Eskom had only issued a request for information (RFI) in December 2016 (Eskom, 2016) to potential suppliers and would thus not be in a position to know exactly what plant type and technology will be used. If a BOO entity were chosen to construct and operate, the said entity would still have to apply for the individual licenses from the NNR. The different authorisations or licenses that a BOO entity

would apply for would each have their own safety case. A safety case covers the full technical safety basis that details how all identified safety issues identified during the safety case review are adequately mitigated. Details are provided in Figure 6.

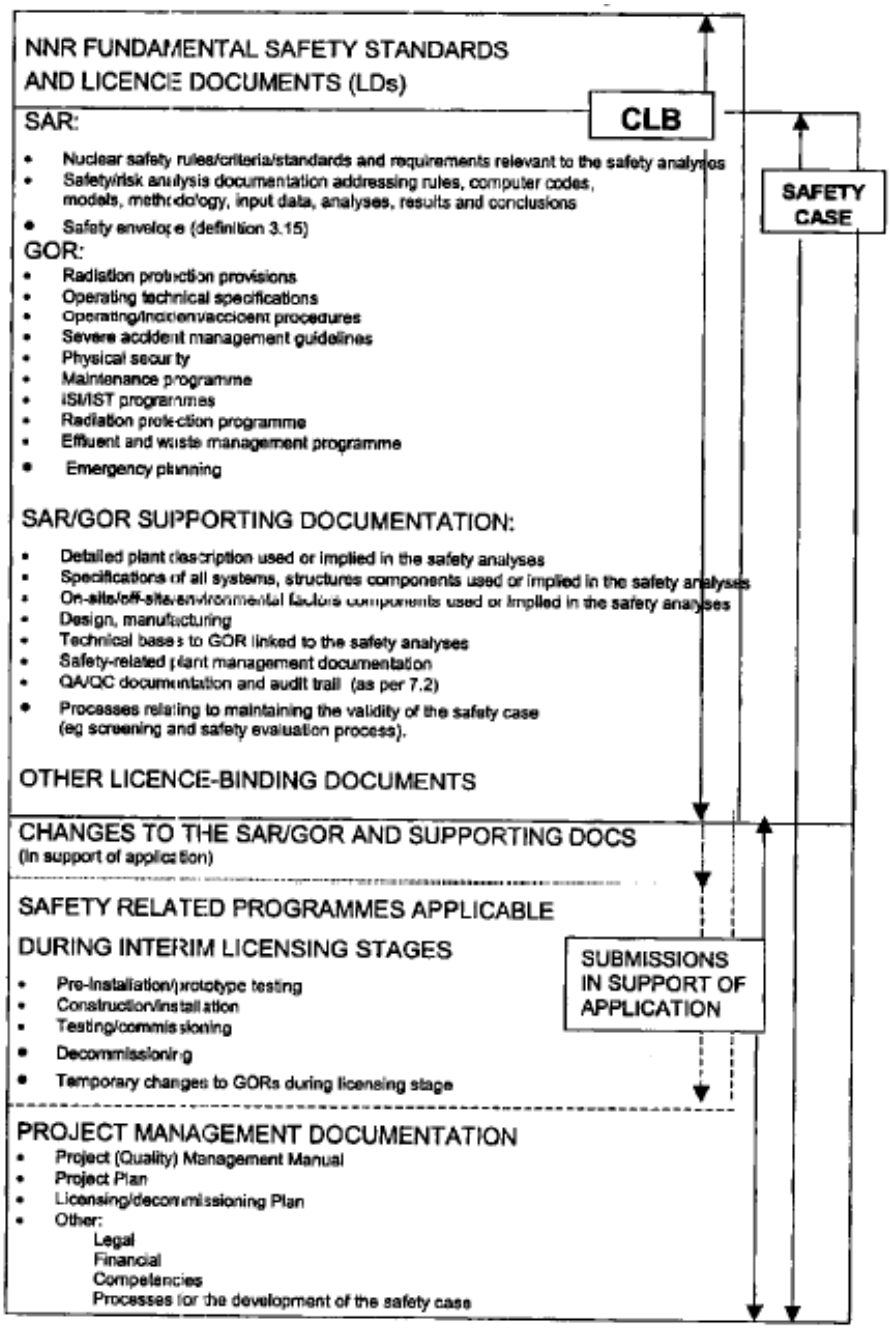

Figure 6 Licensing Documentation Hierarchy (NNR, 2002a)

Assuming a multi-stage licence strategy is employed the list of specific authorisations or licenses that the BOO would apply for includes:

- Nuclear Site Licence to be allowed to site a nuclear installation.

- NIL to design which details the *conditions for regulatory engagement during the design process*; this is followed by the Design Assessment Process where the *NNR performs an assessment of the safety case for the Reference Design of a nuclear installation and issues a Safety Evaluation Report* (NNR, 2009).
- Authorisation to Manufacture (components of a nuclear installation) which may be issued prior to the assessment and acceptance of the safety case to construct by the NNR to cater for long lead items (NNR, 2011)
- NIL to construct a nuclear installation which, once *the decision is taken to grant a Nuclear Installation Licence, the NNR may impose specific conditions related to the respective stage such as mandatory hold and/or witness points* (NNR, 2012).
- NIL to operate a nuclear installation whose safety case should *consider the results of the commissioning testing and should address all outstanding issues* (NNR, 2012).

The BOO entity might prefer to apply for a combined NIL to construct and operate as it would avoid the compilation of different safety cases for the individual licenses. The multi-stage approach is intended to reduce the lead times by allowing work to continue at an earlier stage instead of waiting until the entire safety case is complete.The need for public hearings (which can be time consuming and challenging) on a site with a NISL will be determined by the Board of the NNR on a case by case basis (NNR, 2012).

As the criteria for public hearings are not specified in PP-009 one would assume that as the BOO entity is not known at the time of the NISL application (along with the technology that will be used), the NNR might insist on public hearings to ensure greater public participation and mitigate any perceptions of trying to keep information from the public. As a NIL cannot be transferred, the combined NIL would further ensure that the BOO entity that constructed the NPP also operates the NPP. This allows the BOO to recover its investment in the NPP.

4.6 RD-0034 and the Intelligent Customer

One of the conditions for the issuance of a NIL by the NNR is that the applicant is required to meet the requirements of PP-0012, the NNR's position paper on *Nuclear Manufacturing of Components for Nuclear Installations* (NNR, 2011). PP-0012 should be read in conjunction with RD-0034, the NNR's RD-0034, a requirements document for *Quality and Safety Management Requirements for Nuclear Installations*, can affect any potential BOO entity significantly if not fully understood.

RD-0034 describes different levels of suppliers (NNR, 2008):

- Level 1 suppliers have a *direct influence on the safety performance of the nuclear installation*.
- Level 2 suppliers' products are *important to nuclear safety*.
- Level 3 suppliers' products are not directly related to nuclear safety; Level 3 suppliers are not discussed further in RD-0034.

The BOO entity will have to meet the requirements of a level 1 supplier as it has a direct influence on the safety performance of the nuclear installation. The BOO entity should then ensure that its Level 1 and 2 suppliers (and their sub-suppliers) use quality management systems (QMS) that are compliant with the ISO9000:2000 Series (including ISO 9001:2000) or any internationally accepted quality management system (NNR, 2008). Additionally, for Level 1 suppliers only, a *Safety Management System* (SMS) as part of an *Integrated Management System* (IMS) is required. More specifically, level 1 suppliers are required to have a nuclear safety culture program. The IMS is described as:
A single coherent management system in which all the organizational processes are integrated to enable the organization's goals, strategies, plans and objectives to be achieved.

RD-0034, section 7.2 (13) lists the fundamental aspects that form the IMS. The first aspect demands that safety should be the primary focus of any IMS. However, as discussed earlier regarding Figure 2, Rosatom depicts Human Resources and Development as their central theme as part of their Integrated Offer, rather than safety or more specifically, nuclear safety. While this is not necessarily evidence that Rosatom does not consider Nuclear safety as its primary focus, it is an aspect that requires consideration.

Level 1 suppliers will also include *Safety Culture* aspects into their IMS. RD-0034, section 7.2 (17) states that the licensee – the BOO entity - should monitor its Level 1 supplier to ensure that Safety Culture is indeed part of their IMS. RD-0034, section 10.4.2 (91) states that Level 1 suppliers' *qualification /certification must be traceable*.

A BOO entity will typically not manufacture all components that form the nuclear island (typically Level 1) or turbine island (typically Level 2 or 3). Some components will be sourced from their suppliers who also need to meet the requirements of a Level 1 supplier or Level 2 supplier, as appropriate. If, for example, the BOO entity's suppliers are not ISO9000:2000 series compliant, it will have to

change its supplier or assist its suppliers to become compliant. The onus is on the BOO entity to prove to the regulator that its suppliers meet RD-0034's requirements.

A BOO contract of this magnitude would typically have a local supplier development and localisation component. When Eskom was seeking prospective suppliers to inspect the reactor pressure vessel heads at Koeberg in 2016, it required potential service providers to target 40% of the contract value for local content and further *encouraged* to source 60% of the *local content from within the borders* of South Africa (Eskom, 2016). A similar requirement, although far more comprehensive, would be imposed on the BOO entity and this would inevitably include Level 1 and 2 suppliers development. With the relatively small nuclear industry in South Africa, the volume of accredited suppliers would be limited. The BOO entity would thus have the task of finding suppliers that might not yet be accredited and support them to become accredited in order to meet the supplier development and localization criteria.

4.6.1 Intelligent Customer challenges related to BOO

As shown below, BOO challenges the Intelligent Customer principles.

The IAEA elaborates on what an intelligent customer's roles and responsibilities are:
'As an intelligent customer, in the context of nuclear safety, the management of the facility should know what is required, should fully understand the need for a contractor's services, should specify requirements, should supervise the work and should technically review the output before, during and after implementation. The concept of intelligent customer relates to the attributes of an organisation rather than the capabilities of individual post holders'. (ONR, 2016c)

The UK's Office for Nuclear Regulation (ONR) states that the functions of the Intelligent Customer should include (ONR, 2016b):

- Understanding *the safety basis on which the Licensee operates.*
- Knowing what the safety case should entail.
- Recognising the strengths and weakness of the safety case and how these will evolve over time.
- Identifying discrepancies between the safety case and reality of the facility.

PP-0012 defines the "Intelligent Customer" as *the capability of the organization to have a clear understanding and knowledge of the component or service being supplied*. And further:

The applicant (in this study, the BOO is the applicant for the NIL) *must have oversight over all activities that have the potential to impact nuclear safety and all organizations in the supply chain have to maintain intelligent customer capability. The applicant will have to ensure that all suppliers of components and services implement systems and processes ensuring compliance to the NNR requirements.*

This raises the questions:

1. Who will act as the Intelligent Customer when the client and the supplier have common commercial interests? What measures should be put in place to ensure that potentially common interests do not affect the Intelligent Customer capability?
2. Who will perform oversight of the applicant if the applicant is a BOO entity?

The 2nd sentence of the quoted PP-0012 paragraph above states that the applicant will ensure that all suppliers of components and services will comply with NNR requirements. The applicant will then have to prove to the regulator that its suppliers have met the NNR requirements. RD-0034 (section 7.1 (4)) requires that the licensee *implement oversight measures for these activities to retain intelligent customer capabilities*. This could be achieved by performing regular audits on its primary supplier and its sub-suppliers as required by RD-0034, section 11.1.1 (117). However, the licensee, in this case the BOO entity, will have a vested interest to ensure that its suppliers meet NNR requirements. In the case of a BOO entity being the license holder, conflicts of interest may arise with the BOO entity's ability to exercise the intelligent customer role and functions when the BOO entity is also responsible for wide ranging responsibilities for construction of nuclear components, safety studies, involvement/support for the nuclear regulator and supplier localisation efforts. The intelligent customer relies on there being a defined client and a separate supplier. In the case of BOO, this distinction is diminished.

While the NNR (with the assistance of a TSO) would ensure that all relevant requirements of PP-0012, RD-0034 etc. are met, is this sufficient to satisfy the requirements for the duties of the Installation State when a BOO entity is involved? If the BOO entity were the intelligent customer, what role does Eskom, as a representative of government, play in ensuring that the government is not abdicating its responsibility as the Installation State? The NNR would need to consider implementing specific procedures to ensure that the intelligent customer principle remains effective.

The possibility of Eskom having an oversight role over a BOO operator may result in some conflict of interest as the BOO entity will also effectively become Eskom's competitor once the NNB enters commercial operation. It would also require Eskom to acquire significant skills to manage the BOO entity, which nullifies to some extent the intent of partnering with a BOO.

4.7 Chapter Summary

The Nuclear Energy Policy of 2008 stipulates the objectives of South Africa regarding the nuclear industry. These objectives appear to be in conflict with the principles of BOO as the country envisages becoming self-sufficient in the nuclear new-build environment. South Africa presents limited potential for NNB programmes within its borders. The export opportunities, especially within the African continent, make this intent significant in terms of the viability of BOO for South Africa.

The NNR's challenges relating to this study include:

- The NNR has financial constraints that affect its capability to perform its regulatory function over existing nuclear installations. Even though the NNR identified that it needed to appoint additional employees in anticipation of a NNB programme, it has not been able to do so to the extent that is required. In addition, the lack of local experienced resources might prove an additional challenge.
- The Minister of DoE makes regulations, not the NNR. The NNR issues requirements documents, licensing guides and licensing documents.
- The regulatory framework is based on the NNRA and NEA. It needs to be enhanced to cater for the independence of the regulator (amongst others).
- The timing of upskilling the regulator and implementing the necessary regulatory changes is affected by the political indecision to the NNB programme. Too early can lead to unnecessary costs while leaving it too late may lave the NNR vulnerable.
- The NNR is aware of the possible implications of reporting to the same ministry that is also promoting nuclear energy. It grasps the fact that it might be exposed to undue pressure – possibly political - to diverge from safety principles in order to expedite the NNB programme.

Eskom has only applied for a NISL. Eskom did not apply for a licence to construct and operate which implies a multi-stage licensing strategy is being pursued. The NNRA, Section 25, *prohibits the transfer of any nuclear authorisation issued* by NNR. This means that the holder of the site license, Eskom, cannot transfer their authorisation. In order for a BOO entity to be allowed to apply for a NIL to con-

struct or construct and operate, the NISL licence holder would first have to surrender that authorisation back to the NNR. The BOO entity will then have to apply for NISL before any NIL application is made.

The requirements of RD-0034 and PP-0012 should not be an insurmountable challenge for a NNB BOO entity.

The option to use Eskom as an extension of government to assist with the oversight of the BOO operator should be avoided as the impartiality of Eskom could be challenged by the BOO operator.

5 Hinkley Point C

Hinkley Point C is the first NNB project in the UK since 1995 (EDF Energy, n.d.). A joint venture led by EDF will use European pressurized reactor (EPR) technology to construct 2 x 1630MW reactors in Somerset in the south of England. The NPP will eventually supply 7% of the UK's energy needs when the decommissioning of carbon-based power stations is included in the energy forecast.

The author would like to remind the reader of the definition of BOO that is being applied: the definition of BOO will be defined where a vendor (likely formed as a joint venture) sources the financing, is responsible for the engineering, procurement, construction and eventual operation of the NPS. The licensee also has a direct relationship to the primary equipment vendor (who will supply all equipment for the nuclear island) via a parent company.

It will be shown later in this chapter that the construct and operate licensee for HPC is NNB GenCo, a subsidiary of EDF Energy. EDF Energy is a subsidiary of EDF SA while EDF SA has acquired a majority shareholding in AREVA NP, the supplier that is likely to supply the majority of components for the nuclear island at HPC. It is acknowledged that NNB GenCo is technically a separate entity to AREVA NP; however, there is a relationship via EDF SA that draws the comparison to BOO.

This chapter will briefly describe the financial model that made the HPC venture financially viable followed by the Conventions that the UK has entered into law that is applicable to the licensee of HPC.

The regulatory issues will be expanded by also illustrating how EDF SA became involved in the running of nuclear power stations in the UK via its subsidiary, EDF Energy. This position then allowed for the creation of a subsidiary of EDF Energy, NNB GenCo, who now holds the license to construct and operate HPC. Emphasis is put on the indirect relationship between NNB GenCo and AREVA NP via EDF Energy and EDF SA that suggests that the Intelligent Customer capability of the build and operate licensee could be compromised. This is followed by steps that are put in place by the local regulator that appears to address the matter.

Hitherto[2], the EPR technology that is proposed at HPC has not been commissioned anywhere in the world. The quality related delays at the other ongoing EPR construction projects are briefly discussed to illustrate how the Intelligent Customer capabilities may be compromised when some of the quali-

[2] 3 April 2017

ty issues are allegedly borne from one of AREVA NP's forging plants. Finally, the ONR's possible employee resource capabilities are discussed in comparison to the NNR that suggests why the former regulator is in a more advantageous position for NNB..

5.1 Finance Model

The UK relies on the private sector to finance and provide infrastructure. The energy sector is almost entirely privately financed (M Coelho, 2014). The British government finally made the decision to support the £18bn NNB project in September 2016 (Gosden, 2016).

Hinkley Point C is a new build project where a joint venture between French and Chinese companies will finance, build and operate the NPP (CHUANG F, et al., 2014). The proposed sharing of the equity is detailed in Figure 4 with the long term relationship between the EDF Group and China General Nuclear Corporation (CGN), and the EDF Group and China National Nuclear Corporation (CNNC) being emphasised.

The eventual decision by the government to approve the NNB project entails the Chinese group financing one third of the project while EDF's will not be allowed (by the UK government) to sell its controlling share (Gosden, 2016) - at least 51%. The balance of the investment will be sold by EDF to other parties.

HPC's investors' return on investment is based on a 35 year contract for a strike price of £92.5/MWh (2012 prices). If the wholesale price falls below the strike price, the difference will be paid back to consumers via the Secretary of State. Conversely, a top up payment will be due to HPC from consumers (World Nuclear News, 2014b).

As the completion of HPC is as yet unknown the strike price is increased proportionally to cater for inflation linked to the Consumer Price Index. The long term contract is a contract for difference type contract which is linked to the proposed Sizewell C NNB which also involves NNB GenCo. Should Sizewell C be given the final go ahead, the strike price for HPC drops to £89.5/MWh with Sizewell C contributing £3/MWh to HPC. The linked deal is based on the premise that the more units EDF Energy builds the lower the unit cost.

Significantly, the credit guarantee for NNB GenCo's financing is provided by the UK treasury under the UK Guarantees scheme (European Commission, 2013).

5.2 IAEA/NEA Conventions

The UK is a contracting state to the Paris Convention of 1960 and the Brussels Supplementary Convention of 1963 (NEA, 2017).

The *Nuclear Installations Order 2016* entered the 2004 Protocols to the Paris Convention and Brussels Supplementary Convention into English Law. This ensures that *higher levels of compensation will be available to a wider group of victims for broader categories of danger* (Shearman & Sterling, 2016).

The Order, supported by the Paris/Brussels Conventions, caters for three tiers of funds:

- *1st tier: operator liability funds, €700 million;*
- *2nd tier: state (host country) liability funds, €500 million*
- *3rd tier: joint funds from contracting parties to the Brussels Convention, €300 million.*

Even though the Brussels Convention allows the UK to make an operator's liability unlimited, the UK has chosen to limit the liability amount. Insurance companies generally calculate the periodic premiums based on the likely amount that would be paid by the insurance company. Unlimited operator liability would have made it difficult to find private entities that are willing to enter into the NPP market as the cost of insurance would have been difficult to quantify.

By extension, the BOO models would have been financially challenging due to the unknown operator liability costs related to this Convention. This implies that the Installation State now becomes accountable for costs associated with nuclear damage that is in excess of the limited liability amount.

From a South African perspective, a limited nuclear liability scenario is also relevant at $322.4m (NEA, 2011). The South African government would have to be cognisant of the fact that it would ultimately be financially accountable for a BOO that is fundamentally a non-South African entity.

The Minister of DoE is ultimately responsible for setting the limits for financial security and liability as detailed in Chapter 4 of the NNRA (DME, 1999a). Significantly, the NNR is not involved in the setting of the limit for nuclear liability.

5.3 Regulatory Issues

The nuclear regulator in the UK is the Office for Nuclear Regulation (ONR). The ONR regulates 37 licensed nuclear sites in the UK which includes existing NPPs, fuel cycle facilities, waste management and decommissioning sites and the defence nuclear sector (ONR, 2016a).

As expected, the ONR's regulatory focus has included the following prioritised areas (ONR, 2015):

- The NNB programme's safety cases and associated licensing applications.
- The regulation of the existing NPPs.

As stated earlier, EDF Energy acquired British Energy in 2009 which owned and operated seven twin-unit Advanced Gas-cooled Reactor (AGR) stations and one Pressurised Water Reactor (PWR). These nuclear power stations are the only ones still in operation in the UK. Significantly, EDF Energy is also in possession of prime sites that were earmarked for nuclear new build. These sites include Hinkley Point C and Sizewell. The extent of ONR's nuclear regulation in the UK is illustrated in Figure 7.

As much as the ONR acknowledges that commercial reasons have forced licensees to outsource many functions, it emphasises that the licensee cannot delegate the responsibility for safe operation of any nuclear facility. This is in line with IAEA principles. The licensee for the existing operating NPPs in the UK is EDF Energy. EDF Energy is also the licensee for gas and coal fired power stations across the UK.

The licence holder to install and operate a twin EPR nuclear power reactor at HPC is the NNB Generation Company Ltd (NNB GenCo). NNB GenCo's parent company is EDF Energy and *will be supported by Electricité de France SA (EDF SA) including EDF's nuclear engineering division (Division Ingénierie Nucléaire or 'DIN'), in particular as Responsible Designer (RD) and Architect Engineer (AE)* (NNB GenCo, 2011).

The ONR has stipulated that the licensee should assume the role of the 'Intelligent Customer'. There is not a public company - like Eskom in South Africa - that is operating another operating NPP in the UK. ONR is the only body that performs the oversight role over the licensee, EDF Energy.

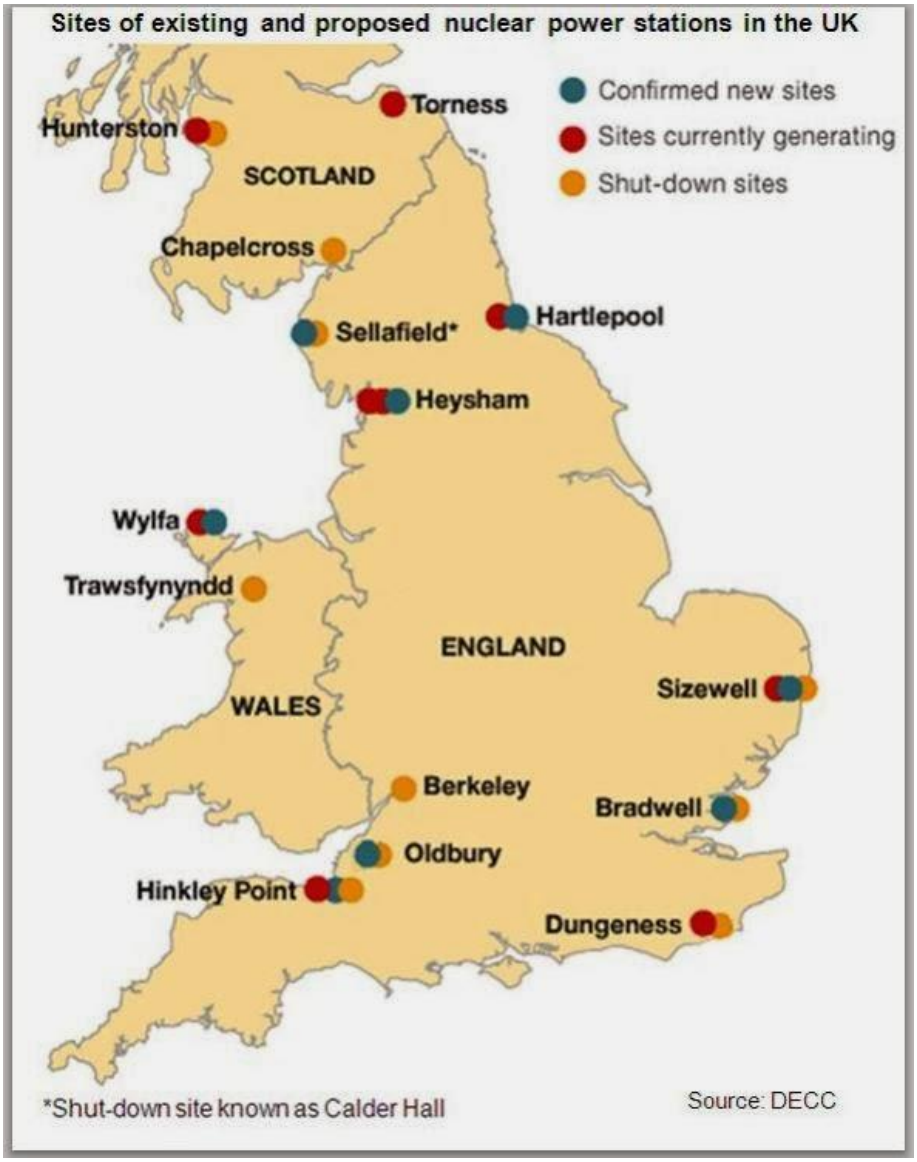

Figure 7 Sites of Existing and Proposed Nuclear Power Stations in the UK (Black, 2009)

Whereas the group of NPPs that EDF Energy acquired in the UK were already in existence, the proposed HPC NPP is of course new. In the former case EDF Energy is ultimately responsible for maintenance and operating existing NPPs with plant, many that were not from French origin (Table 2).

Reactors are typically of British origin - General Electric Company, CA Parsons & Co (Industcards, 2017). If parts of the plant need to be replaced, the plant is more likely to be replaced by a supplier that does not necessarily have strong ties to EDF Energy or EDF SA. However, a number of components for Sizewell B were sourced from the French company, Le Creusot (World Nuclear News, 2016). Details of how components forged at Le Creusot affected several NPP are discussed later in this chapter.

EDF Energy, as the licensee, is expected to be an intelligent customer and so has to demonstrate a level of diligence in ensuring that its suppliers are delivering components that meets the quality specifications that are required. ONR's job of monitoring and oversight would have been made easier by the licensee's diligence to quality of its suppliers. However, with HPC being a NNB project, this would present EDF Energy with the opportunity to use more of its own suppliers (subsidiaries). For example, the EPR reactor that will be used at HPC has been designed and developed by AREVA NP and EDF SA in France, and Siemens in Germany.

In HPC supply chain literature it is noted that NNB GenCo, at its discretion, will contractually enable itself to approve the sub-contractors of Tier 1 suppliers to demonstrate they are an Intelligent Customer. It is estimated that 180 Tier 1 contracts will be concluded where Tier 1 is similar to Level 1 and 2 suppliers as defined in RD-0034 (4.6).

Power Station	*Owner*	*Operator*	*Reactor Type*	*Electrical Output per Unit (MW)*	*First Power Generation*
Dungeness B (two reactors)	EDF Energy	EDF Energy Nuclear Generation Ltd (NGL)	AGR	520	1983
Hartlepool (two reactors)	EDF Energy	EDF Energy Nuclear Generation Ltd (NGL)	AGR	595	1983
Heysham 1 (two reactors)	EDF Energy	EDF Energy Nuclear Generation Ltd (NGL)	AGR	585	1983
Heysham 2 (two reactors)	EDF Energy	EDF Energy Nuclear Generation Ltd (NGL)	AGR	615	1988
Hunterston B (two reactors)	EDF Energy	EDF Energy Nuclear Generation Ltd (NGL)	AGR	430	1976
Hinkley B (two reactors)	EDF Energy	EDF Energy Nuclear Generation Ltd (NGL)	AGR	430	1976
Torness (two reactors)	EDF Energy	EDF Energy Nuclear Generation Ltd (NGL)	AGR	600	1988
Sizewell B (single reactor)	EDF Energy	EDF Energy Nuclear Generation Ltd (NGL)	PWR	1188	1995

Table 2 UK operating (power producing) reactors (ONR, 2016a)

The sale of AREVA's reactor business, AREVA NP, to EDF SA was concluded in November 2016 (AREVA, 2016a). In an AREVA press release, dated 29 September 2016, 2 weeks after the British government made its decision to support HPC officially, AREVA announced that it had *won several subcontracts to the value of 5 billion euros* (AREVA, 2016b).Further, the scope of these subcontracts in-

cludes *the delivery of two nuclear steam supply systems*, i.e. the components of the nuclear island like the reactor pressure vessel and steam generators.

As part of the ONR's oversight role over NNB GenCo, the ONR needs to ensure that the licensee complies with the Intelligent Customer principle. The fact that the licensee has vested commercial interests in one of its nuclear sub-contractors could create some concerns with the regulator over the licensee's will to diligently perform the Intelligent Customer role for all its suppliers in a consistent manner.

In a written representation by the ONR to the Planning Inspectorate about the nuclear site licence application in 2012 for HPC (prior EDF's acquisition of AREVA NP in2016) the ONR made the following general statements regarding the licensee's intelligent customer capability (ONR, 2012):

- *ONR requires that the licensee is fully in control of activities on its site, understands the nuclear safety implications of its activities and how to control them, and is an intelligent customer for any work it commissions externally.*
- *At the point of licensing, ONR will require assurance that NNB GenCo can demonstrate control of all activities that affect safety on the Hinkley Point C site, and that it has a robust intelligent customer capability that can secure appropriate oversight of activities carried out on its behalf.*

The ONR has acknowledged the need to highlight the importance of the intelligent customer principle given the complexities of the NNB supplier relationships and possible conflict of interest.

In a later ONR progress report about organisational capability in 2014 (ONR, 2014), the ONR further indicates its confidence in the licensee's Intelligent Customer capability with the following selected phrases:

- *NNB GenCo has established a clear approach for ensuring staff are aware of IC* (Intelligent Customer) *expectations and those with key explicit IC roles are adequately competent and are aware of their responsibilities.*
- *I consider that NNB GenCo appears to have developed an extensive set of procedures to enable it to adequately discharge its IC role. To date the effectiveness of these procedures have not been fully tested;* (sic) *the main areas that have been related to the design and safety case development.*

Significant quality related issues have been identified at Le Creusot which is used by Areva, HPC primary nuclear island contractor. NNB GenCo capability (and independence) as an intelligent customer will be tested to ensure similar incidents will not occur.

5.4 Other EPR projects

There are no other commercially operated EPR units in the world. There are 4 other EPR projects currently under construction, Olkiluoto 3 (Finland), Flamanville 3 (France) and two projects at the new Taishan NPP (China). All EPR projects are behind schedule and the former two are significantly over budget. Budgetary information is not readily available for the Chinese units. However, the ONR stated in 2014 (ONR, 2014):

I judge that NNB GenCo has established appropriate project management arrangements; incorporating learning from Flamanville 3 and other nuclear and major construction projects. It has developed a suitable IMS that supports intended PM arrangements for each phase of project.

Construction at Olkiluoto has been ongoing since 2005 with an initial planned date of going online in 2009. The latest estimate puts the completion date at 2018 (World Nuclear News, 2014c). The Finnish utility, TVO, and AREVA are currently in litigation with both parties making multi-billion Euro claims against the other for project delays due to quality issues. When EDF SA acquired the majority shareholding in AREVA NP in 2016, the Olkiluoto project was specifically excluded from the acquisition as it would have implied that EDF SA would have to take on the loss-making venture that was already running into several billion Euros (NUCNET, 2016).

Construction at Flamanville has been ongoing since 2007. The latest estimate for completion is 2018 while the costs have escalated from an initial €3.3 billion to €10.5 billion (Global Research, 2016). Quality issues (related to carbon content and toughness) were detected with the steel used for the forging of the reactor vessel components at Le Creusot. This has contributed to Flamanville not being able to attain the necessary certification from the French regulator to allow for further construction to continue (Watt-Logic, 2016). Components at 18 different EDF NPPs in France were traced back to being forged at Le Creusot. The quality issues were significant enough to halt operations briefly; the affected components were scheduled for tests to determine the extent of the possible quality issues (Global Research, 2016).

The need for Flamanville to be operational is not just important to its developers. HPC's *UK Credit Guarantee will lapse if Flamanville isn't operational by the end of 2020* (Watt-Logic, 2016). The date

for the expiry of the credit guarantee was needed to provide confidence that the FOAK EPR technology could be operated successfully (European Commission, 2014). The UK offered investors bonds to provide the finance guarantees for the construction costs of HPC. *Under the terms of agreement for the plant's construction accepted by the European Commission, this would render the UK government unable to extend promised credit guarantees to HPC's financial backers* (Global Research, 2016). Further, The HPC project will only be allowed to draw on debt to construct while the credit guarantees are in place. Unless the HPC project can secure alternative credit guarantees at that time, the project will not be able to draw on further debt to continue construction.

Le Creusot forgings were also used for the Chinese reactors at Taishan where construction started in 2009. Despite the results of the aforementioned tests being outstanding, the Chinese have decided to continue with construction with claims[3] (Factwire News Agency, 2016) that the concrete encasings for the two reactors have been sealed making replacement unlikely. The state-owned major nuclear construction companies in China report to a higher level in government than the Chinese nuclear regulator. In addition to significant concerns about the independence of the regulator (Zhou, et al., 2011), this is perhaps not surprising. The initial planned completion date was 2013. The Chinese have indicated that completion is expected in 2018 and will be the first commercially operated EPR units in the world (Factwire News Agency, 2016).

Components that were forged at Le Creusot also found its way to Sizewell B NPP. The ONR requested (and later satisfied itself) that EDF Energy prove that these components were not affected by the same quality issues (ONR, 2016e).

In summary, the ONR has the following challenges with HPC:

- ONR will provide a regulatory function for a NNB project that is using nuclear technology that has yet to prove itself, especially with a Western regulator.
- The main supplier to EDF Energy, AREVA NP, has quality issues at, at least, one manufacturing facilities that are significant enough to have halted operations at 18 French NPPs and delayed Flamanville NNB project from being certified by the French regulator.
- The licensee, NNB GenCo, has a vested interest in one of its major suppliers which raises a conflict of interest and challenges its role as an Intelligent Customer.
- The Chinese partner in the joint venture has not had experience dealing with non-Chinese nuclear regulators.

[3] Independent press articles about Taishan are proving difficult to come by

5.5 Intelligent Customer challenges

A presentation by EDF in 2014 at a meeting between EDF Nuclear Engineering Department and IAEA on Design Authority discussed organisational structure that could address the close relationship between NNB GenCo and Areva. The relationship is illustrated in Figure 8 and Figure 10.

The IAEA defined the Design Authority as having the following duties (IAEA, 2003b):

- review, verify and approve (or reject) design changes to the plant
- responsible for design configuration control
- control necessary interfaces with responsible designers or other suppliers engaged in design
- ensure that the necessary engineering and scientific skills and knowledge are maintained, including any research programmes

EDF Energy adopted the INSAG-19 (IAEA, 2003b) model for NNB GenCo. NNB GenCo has created a Design Authority role within NNB GenCo whose scope is defined in detail in INSAG-19 but includes (EDF, 2014):

- To act as the Intelligent Customer for the design and safety case

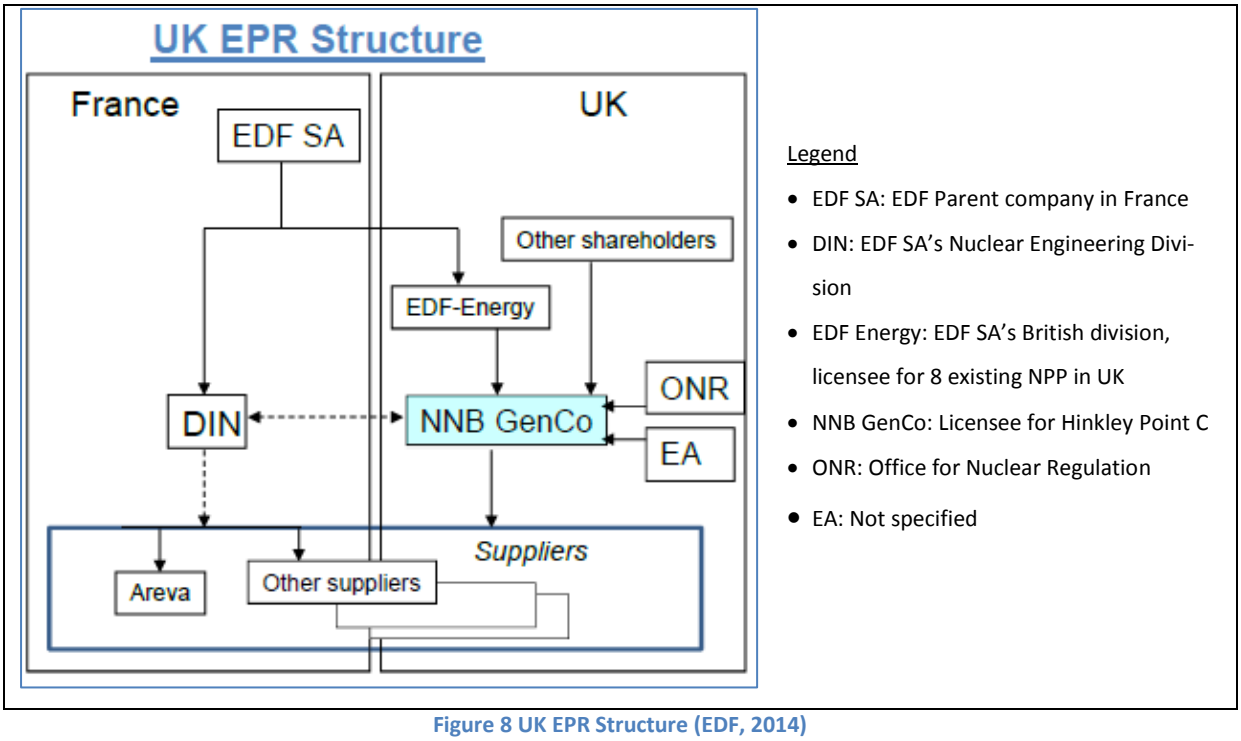

Figure 8 UK EPR Structure (EDF, 2014)

The model in Figure 8 is different from the model employed in France. There, DIN and the Operators (or licensees) are on equal reporting level, reporting to EDF SA. The Design Authority remains within

DIN; the French regulator, ASN, performs the regulatory oversight over DIN and the nuclear operator as one entity as shown in Figure 9.

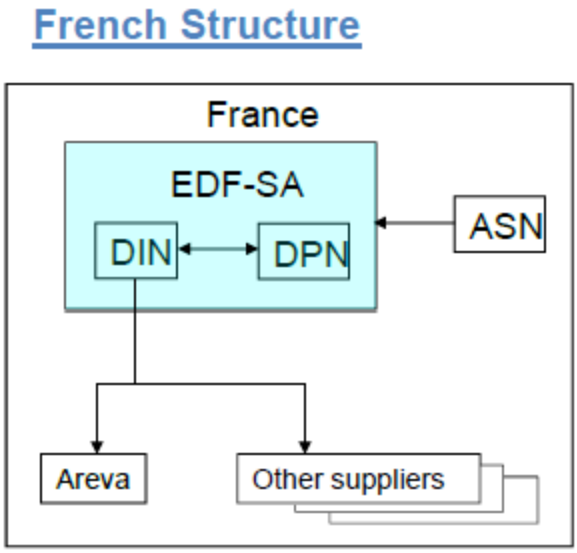

Figure 9 French Structure

As Figure 10 illustrates, the Design Authority role is performed by the licensee, NNB GenCo. DIN plays an overall Responsible Designer role with both parties interacting with the individual Responsible Designer (e.g. Areva). The IAEA defines the Responsible Designer as external and separate (likely) from the Design Authority, but assigned to a particular part of the system (IAEA, 2003b). There might be a Responsible Designer for the Nuclear Plant, Steam Generator or Electrical System. The Design Authority is then *frequently the only organization that has an overview of the design as a whole and the impact of operation on the design* (IAEA, 2003b). In this way, the Intelligent Customer responsibility, as prescribed by ONR, remains with the licensee. When the BOO entity is both the Design Authority and the Responsible Designer, the objectivity of the Design Authority becomes a concern.

By changing the relationship structure for HPC, by removing DIN from the same level as the licensee, there is an implied acknowledgement that the close relationship between EDF SA and AREVA could create concerns with the ONR in terms of the licensee's Intelligent Customer capability. Note that this structure was proposed in 2014 when EDF SA had not yet acquired AREVA NP (2016). With the acquisition of AREVA NP further consideration may be required by the ONR to ensure that the licensee is able to perform the Intelligent Customer role.

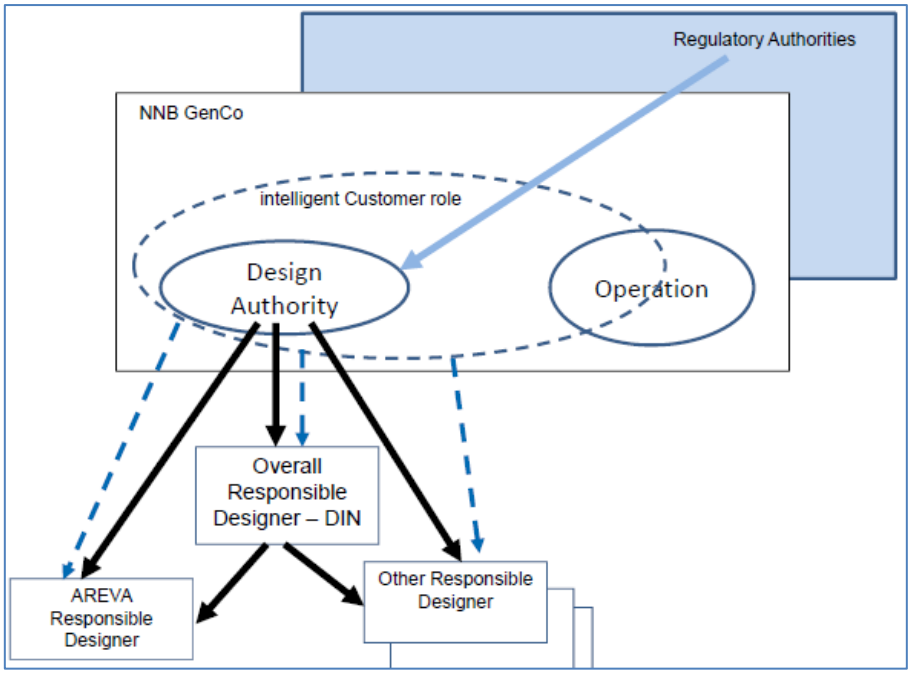

Figure 10 Relationship between the Design Authority and other entities (EDF, 2014)

5.6 ONR resources

The ONR is faced with several resource challenges on several fronts in the UK. Despite the decrease in resources due to natural attrition (resignations and retirement) the ONR *plans to increase their frontline resources by 9-10% per year between 2015/16 and 2019/20* (ONR, 2016d). Putting this into context, as of February 2016, the technical team comprised of 362 members of staff (ONR, 2016f).

Regarding HPC specifically the ONR resources have to deal with:

- Limited experience in assessing new EPR technology.
- The ONR has not been involved in NNB since 1995. More specifically, the ONR has not been involved in the start of construction of NNB since 1991. Operational experience will be lacking as the majority of regulatory staff that were involved would have retired.

In addition, excluding HPC, the ONR is involved in:

- Continued clean-up of nuclear legacy which involves sites that were built between the 1940s to 1970s like research sites, nuclear weapon material production facilities, Magnox NPPs, nuclear fuel reprocessing facilities and fuel fabrication plants (Nuclear Decommissioning Authority, 2016)
- Potential plant life extension applications from first generation NPPs (ONR, 2016d).

- Nuclear site licenses for Wylfa Newydd in Anglesey, Moorside in Cumbria and Bradwell in Essex (ONR, 2016d).

The nuclear industry in the UK is mature enough for the ONR to be able to find the additional 9-10% of staff every year. In 2013 it was estimated that there were 44000 employees working for 200 companies (World Nuclear News, 2013) in the UK. With NPPs being decommissioned, valuable employee resources with practical operating experience become available that can serve to balance the ONR resources between experienced staff and newly graduated recruits.

As a comparison to the NNR, the ONR is in a significantly better position in the short term in terms of the availability of skilled resources. As mentioned in an earlier chapter, the nuclear community in South Africa is comparatively small. The NNR might not have the luxury to select former NPP employees with extensive operational experience and is more likely to recruit a competent TSO in conjunction with younger employees with limited operational experience. In the short term, there are likely to be challenges as the NNR strives to develop these employees while facing pressure to expedite the NNB programme. However, considering the timeframes for NNB construction programmes, the NNR will need younger employees that can learn from the TSO. These employees will eventually form the core competence of the NNR and will provide the potential for greater continuity for the duration of the 9.6GW programme.

5.7 Chapter Summary

NNB GenCo (HPC's construct and operate licensee) is a subsidiary of EDF Energy while EDF Energy is a subsidiary of EDF SA. EDF SA has just recently acquired the majority shareholding in AREVA NP, the nuclear manufacturing division of AREVA. AREVA NP will be the primary supplier for the components of the nuclear island. Even though NNB GenCo is not directly linked to AREVA NP, there is a commercial link via EDF SA.

HPC's investors' return on investment is based on a 35 year contract for a strike price of £92.5/MWh (2012 prices). The long term contract is a contract for difference type contract which is linked to the proposed Sizewell C NNB which also involves NNB GenCo. Should Sizewell C be given the final go ahead, the strike price for HPC drops to £89.5/MWh with Sizewell C contributing £3/MWh to HPC.

The Nuclear Installations Order 2016 caters for three tier funds:

- 1st tier: operator liability funds, €700 million;

- 2nd tier: state (host country) liability funds, €500 million
- 3rd tier: joint funds from contracting parties to the Brussels Convention, €300 million.

Even though the Brussels Convention allows the UK to make an operator's liability unlimited, the UK has chosen to limit the liability amount.

Notwithstanding the fact that EDF SA has a successful structure operating in France of how the operator licensees (in conjunction with DIN) deal with the French nuclear regulator, the model was adjusted for the UK. The Design Authority role is part of NNB GenCo while DIN now sits outside the licensee structure. The re-arrangement suggests implied acknowledgement that the Intelligent Customer capability is not ideal with the introduction of an additional layer of review before the licensee reviews documentation from the vendors' Responsible Designers.

There are 4 other EPR projects at different levels of construction with acknowledged extensive delays at 2 of the sites. Obtaining detailed information about the 2 proposed reactors at Taishan has proven to be difficult. As yet, the EPR technology has not yet been commissioned anywhere. Significant quality issues at the forging facility used for Flamanville have created concern for HPC. One of HPC's financial instruments (credit guarantees that lapse) is conditionally linked to Flamanville 3 being commissioned by 31 December 2020. The condition was put in place to address the concern that a FOAK technology will be used for HPC. This places significant commercial pressure on the quality issues to be resolved expediently. As HPC is considered the shop-front for EDF SA, any perceived reasons for concern cannot be afforded. This has put the Intelligent Customer capability of NNB GenCo in focus as the broader commercial implications for EDF SA are significant.

The UK has effectively outsourced the ownership and operation of its NPPs. ED Energy has been operating all the active NPPs in the UK since 2009. The local regulator, the ONR, is a mature regulator which decades of experience regulating a mature nuclear industry. The fact that EPR technology has not been commissioned anywhere but is being regulated by an experienced nuclear regulator should give the public confidence in its decisions. The pool of nuclear skills in the UK is vast enough to make increasing resources easily achievable in relation to the NNR.

6 Akkuyu

Even though Turkey does not have any commercially operating NPPs, its interest in nuclear power started in the 1950s with the establishment of the Turkish Atomic Energy Commission in 1957 which was responsible for overseeing nuclear research and civil nuclear power development. This was followed by a research reactor that was commissioned in 1961. Several attempts have been made to start a nuclear programme with the latest agreement being the 6th attempt. Reasons that contributed to the delays included military coups, significant changes in government, lack of suitable funding models and intergovernmental politics (Jewell & Ates, 2015).

This chapter will briefly describe the financial model that supported the Akkuyu NNB programme followed by the applicable Conventions that the Akkuyu NPS licensee is subjected to in Turkey. A more detailed discussion of the regulatory landscape and the apparent levels of nuclear regulatory independence is then provided which ultimately supported the BOO model applied in Turkey. Other projects using the same or similar technology are briefly discussed to provide some background about the specific technology choice. Considering the lack of other NPPs in Turkey, the resources within the nuclear regulator are discussed and how it is preparing for its NNB that extends beyond the Akkuyu NNB.

6.1 Financial Model

The Russian nuclear manufacturer, Rosatom, will provide 4 x VVER-1200 units under a BOO agreement that entails Russia funding and retaining majority ownership of the NPP. The VVER-1200 technology has not specifically been commissioned elsewhere, hitherto[4], but earlier versions of the VVER technology have been operational for several decades in Russia. As the Turkey has no other commercially run NPP, Russia will provide the human resources to operate the NPP. The Russian Party has established the project company, Akkuyu Nükleer Güç Santrali Elektrik Üretim (APC: Akkuyu Project Company) in 2011 as a subsidiary of Rosatom to construct, operate and decommission the NPS.

According to the intergovernmental agreement, the Russian Party will always retain at least 51% of the ownership of the project company. The Turkish Party will have the final say regarding the distribution of the remainder of the shares in APC (edam, 2011).

[4] 3 April 2017

The land for 2 nuclear power station sites was identified in the 1970s at Akkuyu and Sinop. Russian companies will be involved at Akkuyu while Japanese companies will play a similar role at Sinop. The Turkish and Russian heads of state signed an intergovernmental agreement in May 2010 for the Akkuyu nuclear power plant which is estimated to cost US $20 billion. This was followed by separate ratifications by the Turkish and Russian parliaments later that year. Rosatom, through its subsidiaries, will start off by financing 100% of the project costs to build, own, operate and decommission the plant. Up to 49% of the shares will be available to non-Russian parties at a later stage (World Nuclear Association, 2017).

The investment will be recovered via a 15 year power purchase agreement where the Turkish Electricity Trade & Contract Corporation (TETAS) will purchase 70% of energy produced by Akkuyu's unit 1 and 2 and 30% of unit 3 and 4 after the commencement of commercial operation. The agreed price for each energy unit will be at a weighted average price of 12.35 US cents per kWh which *appears to be economically advantageous to Turkey (in the sense that the agreed upon average purchase price can be expected to be considerably lower than endues electricity prices by that time)* (Edam , 2011). After the 15 year power purchase agreement, the project company will transfer 15% of its profits to the Turkish Treasury (Edam , 2011).

Construction is expected to start in 2018 while in August 2016 the government indicated that the project was deemed a strategic investment which allows for favourable tax treatment (World Nuclear Association, 2017).

6.2 IAEA/NEA Conventions

The Paris Convention (1960) and Joint Protocol were ratified by Turkey in 1961 and 2006 respectively. It is a signatory to the 2004 Protocol to Amend the Paris Convention but has not ratified it; however portions of it have been entered into force by Turkish law (Atiyas, 2015). Article 5.5 of the Nuclear Law (Law No. 5710) states:

In case of an accident in the course of transport of radioactive material or radioactive waste or at the nuclear power plant, the 1960 Paris Convention on Nuclear Third Party Liability, its additional amendments and other national and international liability provisions shall apply. (Atiyas, 2015)

This means that a minimum of 700 million Euros is set as the operator's liability but also that the upper limit has not been established. The Brussels Convention allows Turkey to make an operator's

liability unlimited; however Turkey is not a signatory to this convention. It is believed that negotiations have taken place between Turkey and Russia to determine a cap for the upper limit (Edam , 2011). An unlimited liability presents a risk for the investor and it is assumed that an agreements has been reached on a liability cap, however this cannot be confirmed. As shown later in Figure 11, a Nuclear Liability law has been retrospectively drafted which would have been influenced by the BOO entity (or licensee) to take into consideration its financial risks.

Turkey has not yet ratified the Joint Convention on Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. However, Russia has taken the responsibility for the removal of all spent fuel and waste management.

6.3 Regulatory Issues

An unstable political environment challenges the partnership between BOO entity and the government more so than in the case of other NNB approaches. BOO in itself affects the political landscape due to the need for agreements at government level involving matters such as nuclear liability and long term cost impact on the economy.

In 2015, the World Bank's Worldwide Governance Indicators ranked Turkey 21st (out of 211 ranked countries) for the most politically unstable countries in the world (World Bank, 2017). By comparison, Syria is ranked 1st, South Africa 82nd and Greenland 211th. Perhaps unsurprisingly then, the proposed Turkish nuclear programme has been plagued by politically linked delays on a regular basis. Two examples of how politics have influenced progress will be described below to illustrate the uncertain path ahead for Turkiye Atom Enerjisi Kurumu (Turkish Atomic Energy Authority – TAEK).

During the third attempt to start the nuclear programme during the 1980s, the TAEC was abolished and TAEK was created. TAEK reports directly to the prime minister. This was also the period when the Build-Own-Transfer (BOT) concept was touted which is similar to the BOO. The BOT entity builds the NPP, recoup its investment by operating the NPP for predetermined period and gradually transfer the NPP to the Turkish government. Negotiations appeared to have progressed sufficiently for the appointment of three separate vendors. However, there was suspicion that Turkey was using the civil nuclear programme to support a nuclear weapons programme apparently due to its relationship with Pakistan. This ultimately contributed to the withdrawal of the chosen vendors (Jewell & Ates, 2015).

Considering that the intergovernmental agreement between Turkey and Russia was signed in 2010, the 2nd scenario was as recent as 2015-2016. When a Russian aircraft invaded Turkish controlled air-space in Syria during November 2015 the Turkish shot down the said aircraft. Russia's response was to halt work on the Akkuyu project which was only restarted after the respective heads of state agreed to continue work on the project in August 2016 (Sachkov, 2016). Concurrently, there was a failed coup d'état in Turkey to add further complexity to the political landscape. With the ongoing conflict in Syria and Turkey and Russia differing on how to best deal with the crisis, the potential for similar disruptions remain high.

TAEK has identified the following high level challenges and implemented solutions for these chal-lenges (Figure 11):

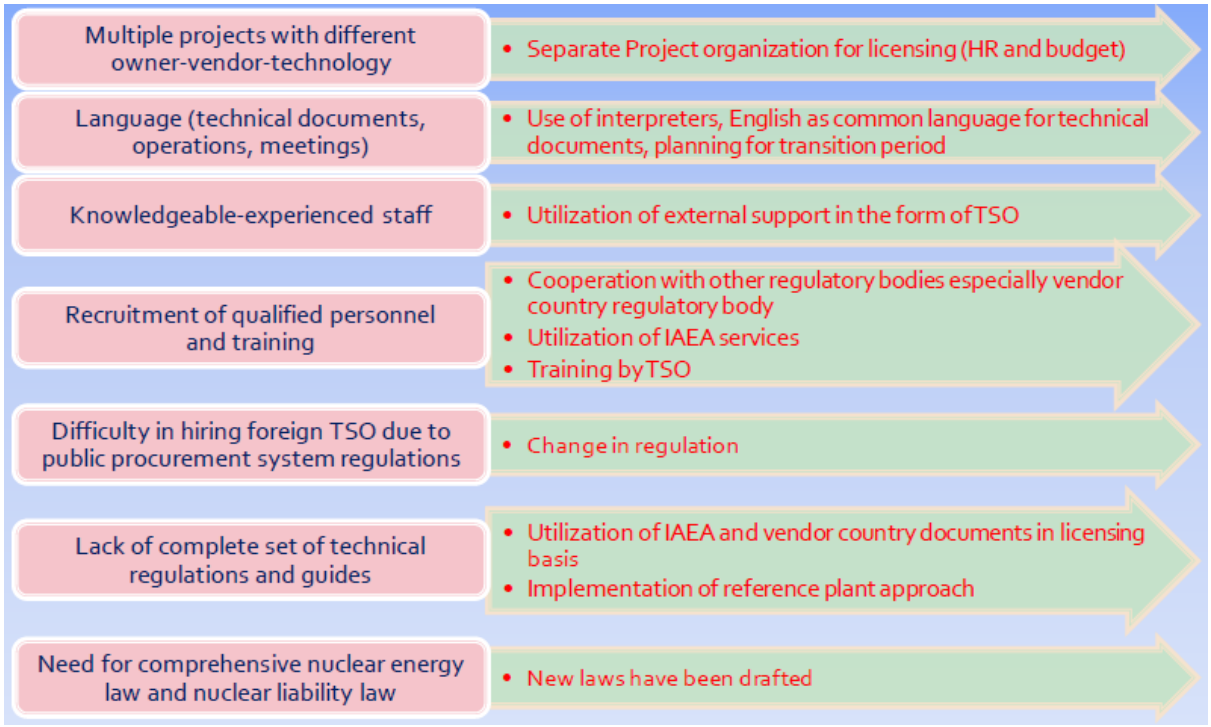

Figure 11 TAEK's Challenges and Implemented Solutions (TAEK, 2016)

The only commercially operating VVER-1200 unit is the Novovoronezh 6 unit which entered into commercial operation in February 2017 (World Nuclear News, 2017). However, the proposed units for Akkuyu are not exactly the same as the unit at Novovoronezh II. Akkuyu will use the VVER-1200/491 design while Novovoronezh II uses the VVER-1200/392M design. The differences are due to the independence of two of Rosatom's subsidiary design organisations, JSC SPb Atomener-goproekt (Saint Petersburg) (491) and JSC Atomenergoproekt (Moscow) (392M). The 392M design is based on the use of a number of passive safety systems while the 491 design is based on the applica-tion of active safety systems (IAEA, 2017). The only other site where the 491 design is relatively ad-

vanced in construction, is Leningrad-2. Construction started in October 2008 with commercial operation planned for early 2018 (Korobeinikov, 2016). Limited technical experience is therefore available for the Akkuyu design and can be considered first of a kind, given that there are no commercially operating VVER-1200/491 designs. This presents the inexperienced Turkish regulator with a significant challenge.

The regulator would require extensive support to meet this challenge. This support could entail intensive exposure to the Russian Nuclear Regulatory Authority, Rostekhnadzor, who has overseen the initial phases of construction of Leningrad-2 in addition to the appointment of an experienced TSO as indicated in Figure 11. As part of the interdepartmental agreement between Rostekhnadzor and TAEK, Rostekhnadzor appears to have facilitated training session for TAEK specialists by JSC Atomenergoproekt (Atomenergoproekt, 2014).

TAEK would require access to technical information about the technology over which they will perform oversight. The regulator should ideally access the information via the licensee with limited direct interaction with the nuclear vendor. When the regulator interacts with the vendor it should preferably be facilitated by the licensee or vendor regulator (in this case, Rostekhnadzor). Of course with this particular model of BOO, the licensee and nuclear vendor are fundamentally the same entity. This situation could ultimately increase the reliance of the regulator on the nuclear vendor which could potentially compromise TAEK's impartiality. There could thus be a situation that necessitates that the host regulator (in this case, TAEK) has additional reliance on the vendor regulator to reduce its direct dependence on the vendor. The source (Atomenergoproekt, 2014) that highlights the training of TAEK specialists by JSC Atomenergoproekt implies that it could have been facilitated by Rostekhnadzor but does not specifically say so.

The regulator's primary function is to ensure the protection of people, property and the environment from nuclear damage. When there is an over reliance on the vendor for technical information due to the regulator's inexperience, its ability to ask the right questions could also be compromised as the company that taught them, i.e. the "experts", "must surely know what they are doing".

As per the intergovernmental agreement, TAEK is also working *with Rosatom to assist with the drafting of Turkey's updated regulatory framework* (Stein, 2016). With Akkuyu being viewed as the marketing vehicle for Russian nuclear technology, there would be significant political and commercial pressures to ensure that Akkuyu NPS is completed within budget and within projected timelines.

When financial and time pressures become the primary drivers of a project, quality is often compromised. More significantly, when quality is compromised, safety of the people and the plant could be compromised. There is a risk that *private interests are put above those of the general public* (Stein, 2016). As a Rosatom BOO NPP has not yet been commissioned and operated commercially for any extended period of time, there is no evidence to support this claim of inferior quality that could lead to safety related incidents.

Nuclear energy laws are required to *provide a legal framework for conducting activities related to nuclear energy and ionizing radiation in a manner which adequately protects individuals, property and the environment* (IAEA, 2003a). Two pieces of legislation are in place in Turkey:

1. Law on the Construction and Operation of Nuclear Power Plants and Energy Sale (Law No. 5710), otherwise referred to as the "Nuclear Law"
2. Law on the Turkish Atomic Energy Authority (Law No. 2690), otherwise referred to as the "TAEK Law"

The Nuclear Law addresses rules and procedures related to the selection of companies that will build nuclear power plants; it does not address issues of nuclear safety. It also does not mention financial arrangements that should be made for decommissioning nor anything about final storage of nuclear waste (Atiyas, 2015). The intergovernmental agreement for Akkuyu indicates that Russia will take back all spent fuel which appears to absolve Turkey of such responsibility.

TAEK is also involved in research and developmental activities related to nuclear energy which is contrary to the principle that the regulator should not be promoting nuclear energy as well (Atiyas, 2015). This was also one of the IAEA recommendations as part of their INIR mission that Turkey should (Tanis, 2015):
Establish a regulatory body without promotional responsibilities and independent from entities having responsibilities or interests that could unduly influence its decision making.
TAEK's mission however,
To be a pioneer in ensuring that our country benefits from nuclear technology and to perform the regulatory and supervisory activities in nuclear field (TAEK, 2015),
suggests that the promotion of nuclear energy remains part of its mission.

The TAEK Law is not comprehensive in terms of *measures that would ensure transparency* (Stein, 2016). Transparency by the regulator allows for public participation and supports its independence from political interference.

As the Nuclear Law and the TAEK Law is not comprehensive, the Turkish government issued a decree in 2012 that elevates IAEA regulations in cases where Turkish legislation is vague or does not address a specific issue (Stein, 2016).

6.4 Other VVER-1200 projects

As mentioned earlier, the first two sites where VVER0-1200 units will be or is being used is Leningrad-2 and Novovoronezh II, respectively. There are two more units that are under construction in the Kaliningrad Region. The specific VVER-1200 type that will be used at Akkuyu is still under construction at Leningrad-2 with a planned commissioning date of 2018. The commissioning dates for Lengingrad-2 and Novovoronezh 6 were delayed in 2015 by the Russian ministry of economic development due to the then energy surplus (World Nuclear News, 2015).

The VVER-1200 evolved from the VVER-1000 which was developed during the 1970s with the oldest one commissioned in 1980 at Novovoronezh I. Even though not all exactly the same, there are 31 units in operation (in Russia, Ukraine, Bulgaria, Czech Republic, China, India and Iran) and have amassed about 500 reactor-years of operation (Rosatom, n.d.).

6.5 Regulatory independence

Significantly, Figure 11 stems from a document that is titled, "Managing the Licensing Process during the Transition to an Independent Regulatory Body" (TAEK, 2016). Independence refers to the independence from influence from governmental authorities and those involved in the commercial and political interests in Akkuyu. Some of these interrelationships are discussed below.

TAEK reports directly to the prime minister with its president directly appointed by the prime minister. The Atomic Energy Commission (AEC) *plays an important role in the licensing procedure: for example cancellation of licenses is an AEC decision* (Atiyas, 2015). While AEC is chaired by the president of TAEK, the three vice presidents' positions are filled by members that are also part of different governmental ministries. TAEK's organisational chart is shown in Figure 12.
The prime minister chairs the AEC meetings when he *deems necessary* (Atiyas, 2015). TAEK's independence is seriously compromised while the body responsible for nuclear licence cancellations is clearly not independent from government. TAEK's ability to independently issue a construct and op-

erate licence is compromised as the parties involved in the intergovernmental agreement are also involved in the licensing process.

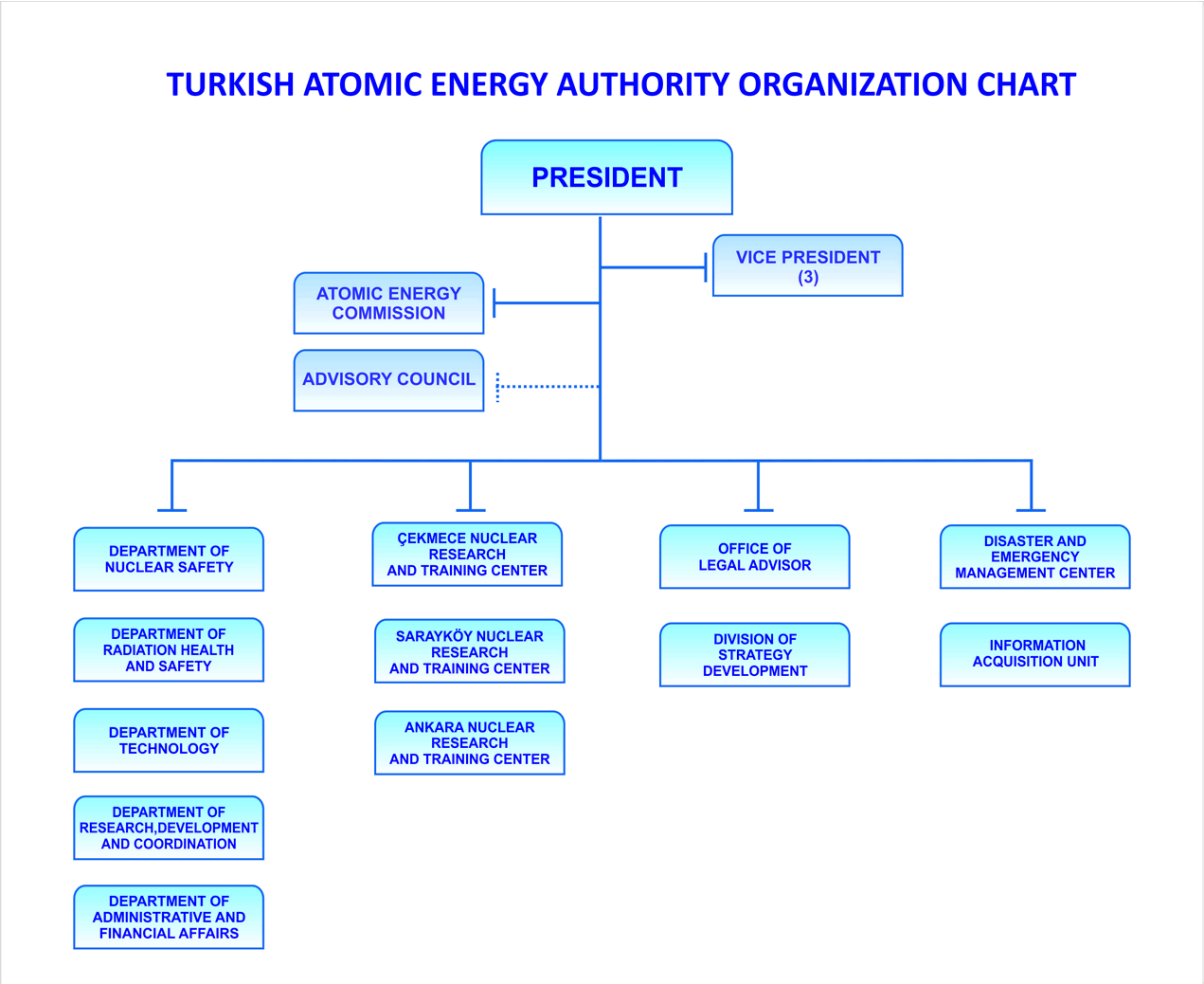

Figure 12TAEK's Organisational Chart

Significantly, the public perception of the independence of the nuclear regulator is not aided by the common theme in the following assessments:

Both the Akkuyu and Sinop reactors need construction and operating licenses from the Turkish Atomic Energy Authority, which lacks independence and is prone to conflicting political interests posed by the prime minister's office. (Power Magazine, 2014)

And perhaps best summarised (Stein, 2014):

First, the regulator's commercial interest in the project could prompt TAEK to elevate financing over safety when selecting a reactor. Second, once exclusive bilateral negotiations begin, the commercial side of TAEK has an incentive to hasten the start of the project, rather than simply focus on the technical side of the negotiations. Third, once concrete starts to be poured, TAEK has an incentive to make sure that the project is finished on time, whilst at the same time conducting safety inspec-

tions. And finally, the close ties between the Prime Ministry and TAEK could subject the regulator to undo (sic) *political pressure to ensure that projects are completed on time.*

6.6 TAEK Resources

TAEK has not been involved in the regulatory activities of a NNB programme of this magnitude. It has limited options to source employees with operational experience from within Turkey. Part of the intergovernmental agreement caters for human resources development which involves sending hundreds of Turkish students to Russia for different levels of studies and training (Sari, 2016) in fields that include nuclear engineering and science education. The students will mostly be used during construction and later operation of the NPP but some will also be used at the nuclear regulator. As shown in Figure 11, training activities will also include cooperation with other regulators, utilisation of IAEA services and training activities facilitated by TSOs.

As the VVER-1200 (491) still has not been commissioned successfully anywhere else, the available knowledge base will be based on the initial progress made at Lengingrad-2 or similar technology. Similar technology could include older versions of the VVER reactors which have been in operation for decades or the VVER-1200 (392M) version which was recently successfully commissioned at Novovoronezh 6. Once again, TSOs who have acquired knowledge and experience working on VVER systems should be used to fulfil specific regulatory activities while at the same time transferring that knowledge to ultimately enable the regulator to become self-sufficient.

6.7 Chapter Summary

The nuclear regulatory framework in Turkey is not comprehensive and needs to be supplemented with IAEA standards.

The intergovernmental agreement covers various facets including the work between TAEK and Rosatom to draft Turkey's updated regulatory framework. There is clearly a risk that private interests could be put above those of the general public. It is certainly not ideal that the vendor (and also the licensee) is assisting the country's nuclear regulator in this manner as this may lead to undue influence, especially given the regulator lack of experience.

TAEK reports directly to the prime minister. The commission in charge of issuance of nuclear licenses is comprised of members who also form part of government. The prime minister chairs this commis-

sion when deemed necessary. The prime minister was influential in concluding the intergovernmental agreement between the Turkey and Russia. Any perception about the compromised independence of TAEK appears well founded.

With Akkuyu being viewed as the marketing vehicle for Russian nuclear technology, there would be significant political and commercial pressures to ensure that Akkuyu NPS is completed within budget and within projected timelines. When financial and time pressures become the primary drivers of a project, inevitably, quality is often compromised. More significantly, when quality is compromised, along with an inexperienced nuclear regulator that also promotes nuclear energy, safety of the people and the plant could be compromised.

An inexperienced regulator in combination with a first of a kind design could be described as one of the most critical challenges facing the regulator.

7 Discussion on Interviews

Thus far, available literature has been used to obtain answers to the research questions posed in this dissertation. This chapter reports on findings from interviews with key local individuals with extensive operational, licensing, regulatory and project management experience in the South African nuclear industry.

A local perspective on the research questions can provide valuable insight and a good opportunity for comparison to some of the findings obtained thus far from the foreign case studies reported on in this dissertation. Some interviewees are involved at a senior level in South Africa's new nuclear build programme and have intimate knowledge of some aspects of the NNB program. Given the sensitivity of some of the nuclear procurement and licensing aspects, interviewees were given the option of confidentiality in order to allow free flow of information. However, their broader functions will be used to differentiate between interviewees.

The questions were provided to each interviewee beforehand to allow some preparation. Not everybody that was asked to participate felt that they would be able to make meaningful contribution, so opted not to participate. When interviews were conducted, it was agreed that the author would note all answers during the interview. Afterwards, the questions and answers were sent back to the interviewees for review to ensure greater accuracy.

In section 1.2 the hypothesis was analysed by asking questions that could provide clarity about the validity of the hypothesis. Some of these questions were answered in the Literature Review while others needed further research. These questions formed the basis of the interview questions to allow the author to compare the interviewees' views versus the research findings of this study.

Interviewees include the following:

1. Koeberg Nuclear Power Station: Licensing department – experience in regular interaction with NNR on licensing and regulatory matters
2. Koeberg Nuclear Power Station: Client Office – involved in new nuclear build and previous involvement in the Pebble Bed Modular Reactor (PBMR) project. The PBMR project was a FOAK technology that South Africa was developing but effectively abandoned in 2010 after Westinghouse withdrew from the project (Hogan, 2010).
3. Koeberg Nuclear Power Station: previously involved in Pebble Bed Modular Reactor interactions with NNR regarding licensing issues.

4. Eskom Group Capital: Licensing - provides insight from current projects that require NNR oversight and approval.
5. Eskom Group Capital: New Nuclear Build Project Management – provides insight from overall risks associated with NNB.
6. Eskom Group Capital: Project Management – provides insight from existing projects that require NNR oversight and approval.
7. Eskom Group Capital: Contracts – provides insight from existing projects that require NNR oversight and approval.
8. NNR representative - however, the said representative declined to permit the interview to be considered in this mini-dissertation.

This chapter will list every question and discuss the answers from interviewees. The complete questionnaire per interviewee is provided in the Appendix. A brief context is created for the interview to explain the meaning of BOO as the author has interpreted it. The two case studies, Akkuyu and HPC, are mentioned and reasons for their consideration are provided.

7.1 Interview Question 1

A major factor in NNB projects is the lack of skills and resources, particular at an early stage in the project. How does/should the NNR deal with this and what steps have already been taken to ensure adequate regulatory skills and resources?
How could the nature of the NNB contract, i.e BOO or otherwise affect the NNR skills and resources strategy?

7.1.1 Question 1 answers

The consensus amongst all interviewees is that the only type of support the regulator should get from the licensee is the application or licensing fee at the time of the application for NIL to construct or construct and operate. Ideally, the NNR should not deal directly with the vendor but should rather deal with the licensee. The licensee representative should rather facilitate interactions between the vendor and the NNR.

The NNR has active affiliations with other regulatory bodies that gives it access to resources and operational experience that could assist with training interventions. The appointment of a TSO is likely to happen to provide short to medium term technical resources and training. However, the core of

the skills needs to be with permanent staff within the NNR with the TSO also tasked with skills transfer.

Interviewees were informed of the NNR Strategic Report 2016-2021 statement that NNR services to existing installations would be challenged as the NNR would not be able to recruit additional staff for the NNB. Most interviewees agreed that the timing of that report was prior to the NNR receiving the application for the NISL and fees associated with the Steam Generator Replacement project at KNPS.

The licensing fees associated with NISL and the SGR are being used to recruit additional permanent resources. The timing of these staff appointments is ideal as it allows time for the new recruits to be phased in without the pressure of a NNB programme. The work on the current NISL applications comes to an end at a time that is very likely close to the time when the NIL for construct or construct and operate will be received. Even if the NIL is delayed, the bulk of the new staff will not be redundant as natural attrition at the NNR will create vacancies. Any additional staff can only be appointed if the government increases its grant to the NNR.

7.1.2 Question 1 analysis

The research findings suggested that the appointment of permanent resources for the NNB programme would be challenging. The appointment of a TSO seemed necessary but this also required additional financial resources that were not available.

Additional financial resources became available with the NISL and SGR related licensing fees. This allowed the NNR to appoint additional staff balanced by an experienced TSO. Its affiliations with other regulatory bodies allow it access to a network of knowledge and operational experience. Interestingly, none of the interviewees mentioned the IAEA as a support mechanism.

7.2 Interview Question 2

The nature of the contract may impact stakeholders such as the NNR.
Is there any intention for a BOO contract to include nuclear regulatory services? How will/should the NNR influence the nature of the contract?

7.2.1 Question 2 answers

There was overall consensus that the NNR is an independent entity and should not influence the contract as this could compromise its independence. Importantly, the regulator must be seen to be

independent. The licensing fee can be structured to cater for fixed plus variable costs in order to allow for a base team of resources for NNB and to allow for an increase of resources depending on the variability of the workload.

The NNR will engage with applicants in accordance with the defined regulatory processes and all applicants would be treated in the same way. The NNR will expect access to relevant information from the licensee who in turn might have to access information from the vendor; however, the licensee should be the only access point for the NNR.

7.2.2 Question 2 analysis

The research showed that the Russian BOO model had regulatory support as one of the tentacles of its support system. Further, the Russian vendor was assisting TAEK in setting up the licensing framework. This leads to a situation where the TAEK's regulatory independence appears seriously compromised.

The only direct support that the NNR should rely on is the associated licensing fees for the different phases of the project. The NNR's contact should be the licensee and any interaction with the vendor should be facilitated by the licensee. The NNR should not influence the BOO contractual agreement other than informing the licensee of the expected licensing fees.

7.3 Interview Question 3

If the primary contractor has vested interests in its sub-suppliers (e.g. EDF using Areva NP at HPC), how is 'Intelligent Customer' concept executed without some conflict of interest clouding the independence between the 2 parties?
The nuclear regulatory environment relies on an 'Intelligent Customer' concept. To what extent could the contract detract from this concept?

7.3.1 Question 3 answers

The general consensus amongst the interviewees is that this is not a significant issue, especially not for the HPC model. Even if the licensee and vendor are effectively the same entity, the BOO entity will need to show that independent review is a feature within the BOO entity. The BOO entity should

be able to prove that the independent review functionality is removed from the direct project environment to avoid or minimise possible conflict of interest.

Any big company has different departments/divisions but with different stakeholders. There are different entities reporting to parent company (EDF SA) but only EDF Energy (via NNB GenCo) needs to demonstrate Intelligent Customer capability.

Even though Areva NP and EDF Energy report to same parent company, ultimately both entities want to produce an acceptable product for the benefit of the parent company; hence both parties are working towards the same goal and can benefit the project. Ultimately, NIL to construct licensee needs to be accountable to the regulator.

Some of the interviewees believed that the Russian BOO model defeats the purpose of Intelligent Customer. This interviewee suggested that the onus could, in this case, fall on the regulator to perform the role of the Intelligent Customer

7.3.2 Question 3 analysis

Some interviewees believed that the Intelligent Customer principle cannot be applied to the Russian BOO model. Others believed that as long as an independent review functionality is built into the licensee structure, the model could be feasible. The operator is bound by rules and there will be separation of duties. Roles and responsibilities should be clearly described and understood by all stakeholders. The onus remains on the licensee to prove Intelligent Customer capability.

The HPC model of an almost dual independent review function, one within the licensee (design authority) and the other between the licensee and the vendors is a model that the ONR found acceptable.

The suggestion that the regulator should perform the Intelligent Customer role has some unintended implications when one considers that the oversight role at the regulator now becomes clouded with licensee responsibilities. The roles of effective promoter and regulator in the same organisation should be avoided.

7.4 Interview Question 4

Should Eskom play an oversight role of BOO operator? What are the implications if Eskom plays this role?

7.4.1 Question 4 answers

The purpose of Question 4 considers whether Eskom should play an oversight role considering that the NNR might be under resourced.

There was general consensus that Eskom should not play any role in the oversight of another licensee. If Eskom were in effect assisting the regulator, this could compromise the relationship between the regulator and Eskom when Eskom specific issues need to be regulated. Significantly, the independence of the regulator would be jeopardised.

If government insisted that Eskom play an advisory role, then it could be considered as government is Eskom's shareholder. There would more likely be a peer interest rather than an oversight interest in another NPP in South Africa.

7.4.2 Question 4 analysis

It is not advisable for Eskom to be employed in an oversight capacity due to possible conflicts of interest in the environment of future competing power stations.

The need which was borne out of lack of sufficient skills at the NNR is effectively addressed by the appointment of a competent TSO in addition to the appointment of permanent resources. The permanent resources will form the core of the NNR for future NNB programmes.

7.5 Interview Question 5

What are the regulatory challenges that would prevent BOO in SA? Is there anything legally, regulatory, that would prevent BOO in RSA?

7.5.1 Question 5 answers

The NNRA does not specify that the entity that applies for a licence should be South African or Eskom specifically. However, most of the interviewees were adamant that the Nuclear Energy Policy

was very clear that Eskom would be the owner and operator of any nuclear power station in South Africa. The option of a private public partnership would be allowed but Eskom would retain a controlling share.

7.5.2 Question 5 analysis

The Nuclear Energy Policy could be amended to cater for a BOO licensee but would have to follow the normal approval process for a policy amendment to be approved by parliament.

7.6 Interview Question 6

Politics: DoE promoter of NNB and in charge of NNR?
How would these almost contradictory principles affect the other?

7.6.1 Question 6 answers

The overall consensus was that the regulator should report to another ministry that is not promoting nuclear energy. The interviewees acknowledged how the public could perceive the relationship as apparent conflict of interest. One interviewee indicated that the NNR should specifically report to the Department of Environmental Affairs as they were already involved in the NISL application.

The NNR has an independent board that is appointed by the ministry. There was acknowledgement from the interviewees that some of the boards that are appointed by the different South African ministers are prone to some level of interference (SAA, SABC, Eskom, etc.). While there is some level of funding from government, complete regulatory independence might not be feasible.

7.6.2 Question 6 analysis

The NNRA ensured the NNR's independence de jure. The ministry was not involved in NNR decisions as the NNR reports to parliament for a decision to be ratified. There are clear lines of division between the NNR and the ministry's promotional activities.

If the minister of DoE were to change an NNR decision, the NNR could appeal the decision in the High Court. In addition, this could provide an opportunity for a public entity (like Greenpeace) to also appeal the minister's decision in the courts. As long as the NNR conducts itself in an open and transparent manner, the NNR should be able to sustain its independence.

7.7 Interview Question 7

Akkuyu is Rosatom's shopfront; HPC is EDF joint venture's shopfront.
Considering the constraints in the world of nuclear skills, is the BOO model repeatable in multiple countries at the same time?

7.7.1 Question 7 answers

The question refers specifically to the skill level of the entity licensed to construct a NPP.

One interviewee believed that the BOO model was not repeatable as Barakah NPS was "stealing' resources from KNPS instead of developing their own resources. South Africa's currency weakness makes KNPS resources vulnerable. Approximately 40 highly skilled resources have taken up lucrative positions at Barakah in the last two years.

Most of the interviewees believed that the pool of nuclear related skills should not be of concern from the regulator's perspective. The regulator's only criteria are safety and quality, regardless of the human resource (as long as they are accredited to perform their specific duties). Requirements should remain the same for all entities. The skill level of the human resources is more likely to have an impact on the project schedule and may have subsequent financial implications. The project's schedule and financial status is not the regulator's primary concern; safety and quality is.

Considering that China is building multiple NPPs concurrently utilising their own skills to a large extent suggests that skills can be developed locally with proper planning. When South Africa was building coal fired power stations, local skills development took place and there was no need to import large quantities of skilled staff.

Notwithstanding that coal fired power stations' quality criteria are very different from those of a NPP, the skills that South Africa attained with the construction of Medupi, Kusile and even Ingula will be valuable. Much of the civil construction skills can be supplemented to ensure that the quality criteria for a NPP can be met.

7.7.2 Question 7 analysis

The NNR cannot make different rules for different construction entities. If the construction licensee proves that its construction staff are accredited for their specific duties, the NNR is obligated to allow construction to continue.

Nuclear construction is an industry that is stringently regulated compared to other construction industries. Numerous hold points are included to ensure that the regulator is satisfied that the requirements are met. However, inspection points do not guarantee quality comprehensively as inspection points do not equate to permanent supervision by the nuclear regulator. It is acknowledged that permanent supervision by the nuclear regulator over every single construction activity is not feasible.

The interviewees' reference to China being able to run multiple NPP construction sites concurrently does not give the author confidence as question marks exist over the capacity of the Chinese nuclear regulator and the Chinese nuclear construction industry. If reports about work continuing at the Taishan NPP despite concerns over Creusot Forge forgings prove to be true, these questions are justified.

7.8 Interview Question 8

In your opinion, why has South Africa never signed up for Civil liability instruments:
1997 Vienna Convention on Civil Liability for Nuclear Damage (the "1997 Vienna Convention"); and-
Convention on Supplementary Compensation for Nuclear Damage (the "CSC").
Apparently they will (or already have?); can different rules now apply to BOO/2nd NPS operator/licensee?

7.8.1 Question 8 answers

There is general consensus that the reason for not participating in the civil liability instruments is due to KNPS being so far south in South Africa, and by implication, very far from the borders of the country, there is no urgent need to ratify these Conventions. It is acknowledged that when NNB programme is approved, the neighbouring countries will have to be consulted.

7.8.2 Question 8 analysis

The NNRA caters for nuclear liability for the operator of a NPP to be set by the relevant minister. The close proximity of especially European countries to each other necessitates the need to be party to the respective Conventions. The need for further ratification is not considered urgent.

7.9 Interview Question 9

As the Installation State, what recourse does SA have if:

a. BOO decides to leave?
b. BOO mother country uses NPP as political leverage (e.g. Turkey Russia scenario)?

7.9.1 Question 9 answers

The appropriate liability insurance as required by the NNRA will ensure that, as a minimum, funding will be available in the event of a nuclear accident. The same applies to a decommissioning fund.

If NPP is being used for political leverage, only politics can eventually resolve the issue; otherwise, limited recourse is available.

7.9.2 Question 9 analysis

Considering the negative perception that is often created in Western media about Russia, this question was designed to illicit a discussion about the accountability of the licensee in the event of a nuclear accident.

In the event of a nuclear accident being followed by the unlikely scenario of the nuclear operator absconding, the financial tool used to cater for nuclear liability will ensure that compensation is available for any damage that was caused. The scenario is considered unlikely as the global nuclear community will ensure that the licensee takes accountability for its actions. As the BOO operator's reputation would be irreparably damaged, the chances of any further new business in the nuclear community would be remote. In addition, other NPPs operated by entities linked to the BOO would face more measures to ensure that the same scenario is not repeated elsewhere.

7.10 Interview Question 10

Considering that politics play such a pivotal role in the initial approval of a nuclear programme: what sort of pressure could this put on the regulator in terms of supporting a NNB construction programme?

7.10.1 Question 10 answers

General consensus is that pressure on the regulator from government is a realistic probability. However, it is expected that the regulator will regulate and make decisions in a transparent manner ensuring that the public is informed. The regulator is ultimately answerable to parliament, the public and the law of the country.

Politics cannot be avoided; however, the onus is on professional people to choose the right way, the moral way.

7.10.2 Question 10 analysis

As mentioned earlier, as long as there is a financial dependency on the government for funding, some form of political pressure is inevitable. Suggestions of political meddling in other government appointed boards are frequently reported in the South African media. Further, NNR decisions and rationale should be publicly available to ensure greater transparency.

7.11 Interview Question 11

Benefits include: limited initial capital requirement from 'Installation State'; BOO comes with technical resources/solution to engineer, construct and operate; economic benefits to host country
Disadvantages include: uncertainty over tariff; concern over ability to repeat shopfront NNB; concern over BOO ability to be 'Intelligent Customer'; nature of BOO's regulatory support might present conflict of interest; BOO mother country could use NPP as political leverage;

Do the benefits of BOO outweigh the disadvantages?

7.11.1 Question 11 answers

The general consensus was that BOO was a good concept for countries without any existing nuclear infrastructure whose strategic intent was to have access to energy to boost the country's economy. BOO would not be suitable to South Africa in lieu of the objectives detailed in the Nuclear Energy Policy. Those interviewees who believed that BOO could work based their argument on the immedi-

ate financial benefits to the country. Those who believed it will not work based their argument on the model where 'most of the nuclear component-related manufacturing' will not be done in South Africa. BOO principles did not align with one of South Africa Nuclear Energy Policy objective where the country aims to develop the local economy, become self-sufficient and to export nuclear energy systems.

7.11.2 Question 11 analysis

If a country with no existing nuclear infrastructure embarked on a nuclear programme to ensure access to electrical energy, a BOO NPP options could be considered beneficial. However, countries with existing nuclear infrastructure might find certain aspects of the Russian version of the BOO model challenging.

The Chinese have followed a model where traditional nuclear vendor countries provided the designs, provided supervision and oversight of construction activities when the country started constructing NPPs. The Chinese subsequently acquired the intellectual property for these designs and proceeded to design similar NPPs with a greater reliance on Chinese suppliers (Nicobar Group, 2015). Today the Chinese are able to provide their own designs and is hoping to be responsible for the majority of the design and construction at the Bradwell site in the UK.

8 Conclusions and Recommendations

There is no singular definition of the BOO model, especially pertaining to the involvement of the nuclear regulator. This was not the purpose of this study.

Depending on the existence of an experienced nuclear regulator in the country, the BOO entity could provide regulatory support to establish a regulatory framework while supporting the development of the regulator. This is not applicable to South Africa.

When there is existing nuclear infrastructure with an experienced regulator, the need for direct regulatory support is minimised, and ideally, eliminated. This is applicable to South Africa.

Even though many NPS projects start out via intergovernmental agreements, the specific involvement of the government in nuclear regulation also becomes crucial when the independence of the regulator is considered. Hence, the political environment will have a significant bearing on the way the nuclear regulator is allowed to operate and oversee the construction of a NPS.

This implies that there cannot be an ideal implementation model for BOO that will fit every country as the environment will dictate the attributes of the BOO model specifically pertaining to the nuclear regulator.

8.1 Conclusions: Assessing the hypothesis

The Conclusion section of this chapter will be addressed by assessing the validity of the hypothesis by concluding on the research questions that have been raised. The challenges that will be focussed on when assessing the hypothesis will include:

- South Africa's Nuclear Energy Policy versus the objectives of NNB
- The South African regulatory framework
- The NNR's resources
- The NNR's independence
- The Intelligent customer principle

The respective financial models, even though not directly related to assessing the validity of the hypothesis, will also be concluded as it is considered a significant part of the BOO marketing strategy. From Chapter 2, 5 and 6 the BOO model is based on providing the financing model to fund the NNB programme over the complete lifecycle of the NPP:

- For the duration of the NNB programme, the host country does not incur significant direct construction related costs in relation to the BOO vendor. In the cases of HPC and Akkuyu, this is especially significant as all construction related costs including delays are borne by the BOO operator.
- In HPC's case, the tariff model (linked to a 35-year power purchase agreement) is deemed more expensive than existing (inflation adjusted) tariffs; however, in Akkuyu's case, the tariff model (linked to a 15-year power purchase agreement) is competitive in relation to other generation sources. As these are not reflective of all potential BOO models, the long term tariff impact on the end customer remains inconclusive.
- Decommissioning costs are built into the respective tariffs.
- In either cases, complete or majority ownership remains with the BOO operator for the life-time of the NPP.

The hypothesis read:

South Africa and specifically the NNR will face many challenges should it pursue the Build-Own-Operate model for its New Nuclear Build programme, given this model's novel and complex demands.

8.1.1 Legal requirements for NNB within the regulatory framework

From Chapter 4:

- The Nuclear Energy Policy of 2008 stipulates the objectives of South Africa regarding the nuclear industry. These objectives are in conflict with the principles of BOO as the country envisages becoming self-sufficient in the nuclear new-build environment. South Africa presents limited potential for NNB programmes within its borders. The export opportunities, especially within the African continent, make this intent significant in terms of the viability of BOO for South Africa.
- The Nuclear Energy Policy stipulates that Eskom will be the owner and operator of any nuclear power station in South Africa. If, within a private public participation venture, Eskom will retain majority shareholding. The NNRA is not that discriminatory and only refers to 'entity' when referring to licence applications. The Nuclear Energy Policy will have to be amended if South Africa chooses a BOO option.
- The Minister of DoE makes regulations, not the NNR. The NNR issues requirements documents, licensing guides and licensing documents.

8.1.2 NNR resource assessment

From Chapter 4:

- Even though the NNR identified that it needed to appoint additional employees in anticipation of a NNB programme, it has not been able to do so to the extent that is required.
- The base case from the 2016 IRP indicated that the first unit would only be required by 2037 which would make the NNR wary of having redundant staff. The uncertainty in the planning stages of the NNB provides an additional complexity to the NNR's ability to have the necessary expertise when needed for the NNB.
- Using licensing fees from existing nuclear facilities and the licensing fee for the NISL have allowed the NNR to appoint additional resources. These resources will work on the specific projects as per the respective licensing fees but the work will allow a phased approach without the pressure of a NNB construction programme.
- The NNR's use of TSOs and its affiliations with international regulatory bodies such as the US NRC and the IAEA can provide the needed expertise to support the NNR in a NNB.

8.1.3 Regulatory Independence

- The NNR's independence will remain a contentious issue as long as it reports to the same ministry that promotes nuclear energy. Thus far, there has been no apparent direct involvement between the minister and the decisions of the NNR.
- Time and cost pressures do not affect the NNR as much as the safety and quality criteria.
- NNB programmes tend to be concluded via intergovernmental agreements. The NNR is likely to be involved in critical path activities of this programme. It is therefore likely that most stakeholders will come under increased pressure to minimise delays during the project execution phase. This pressure will apply to the minister and the NNR.
- The regulatory framework is based on the NNRA and NEA. The Minister of DoE makes regulations, not the NNR. The NNR issues requirements documents, licensing guides and licensing documents.
- Any regulatory support from the BOO could affect the independence of the NNR.

8.1.4 Intelligent Customer requirements

From Chapter 5 and 6:

- For HPC BOO model be followed, the appointment of a design authority within the licensee which effectively creates an additional layer of verification serves to meet the Intelligent Customer requirements.
- The Akkuyu BOO model as applied in Turkey challenges the principles of the Intelligent Customer concept.

Therefore, the hypothesis has proven to be true. However, the challenges are not insurmountable and the author is confident that the NNR will be able to adapt to the novel and complex demands of a NNB programme, particularly when considering the recommendations made in the next section.

8.2 Recommendations

These recommendations provide possible solutions to address the NNR and South African challenges pertinent to BOO.

8.2.1 Legal requirements for NNB within the regulatory framework

- The Chinese have followed a model where foreign entities are used to design and construct the first of a particular type of NPP, followed by the Chinese obtaining intellectual property for the particular design allowing them to build their version of a similar NPP. Similarly, SA could still pursue the BOO option for the first NPP with the objective of learning as much as possible to enable the country to design the NPP, manufacture the equipment and construct the NPP. To align to the Nuclear Energy Policy, the operation of the NPP would have to be transferred to Eskom, meaning this is more likely to be a BOT option. This experience should then enable the country to eventually export nuclear energy which is aligned to the intent of the Nuclear Energy Policy.
- If the BOO is a requirement for the BOO vendor, the Nuclear Energy Policy would need to be amended to allow the BOO scenario to materialise.
- The NNR should be allowed to make its own regulations and should not be dependent on the DoE for this role.

8.2.2 NNR Resources

- The lack of local experienced resources could be addressed with the appointment of a TSO. The TSO will mitigate the concern over the NNR's ability to provide an oversight role for new and emerging technologies that will inevitably be associated with NNB.
- The appointment of a TSO will cater for the lack of short to medium term resources with operational experience. The TSO will have operational experience specific (or similar) to the technology that will be employed in South Africa and have as one of its focus areas knowledge transfer of complex technical concepts. The appointment of a TSO will reduce the need for permanent appointments which will assist in minimising the concern of redundancy of permanent staff.
- The NNR's affiliations with other nuclear regulatory bodies and IAEA support mechanisms allow access to a network of knowledge and operational experience that will bridge the gap between its present resource constraint and where it needs to be to regulate a NNB programme. These affiliations should be leveraged to obtain maximum benefit.
- The NNR should not in any way influence the contract with the BOO as this could jeopardize its reputation of being independent. The only type of support that the NNR should get from a potential BOO operator is the licensing fee linked to the specific application being made. There should be limited direct interaction between the NNR and the vendor, and only if facilitated by the licensee or vendor regulator.

8.2.3 Regulatory Independence

- The NNR should ideally not report to the same ministry that is responsible for promoting nuclear energy, particularly if the ministry is also responsible for the procurement of the NNB.
- The NNR should maintain, and even increase the transparency of its work and decisions to ensure greater public awareness. Greater public awareness with the implied access to information will ensure that the public and parliament hold the NNR to account to maintain its independence.
- The regulatory framework should be enhanced to report to a ministry that is not also responsible for nuclear energy promotion. Further, the enhancement should allow the NNR to make regulations.
- The NNR should not accept any financial or regulatory support from any potential BOO entity.

8.2.4 Intelligent Customer requirements

- Should the HPC BOO model be followed in South Africa, the appointment of a design authority within the licensee which effectively creates an additional layer of verification should be implemented for the South African NNB model.
- Should the Akkuyu BOO model be followed, the BOO operator should provide a detailed justification of how it will ensure that the intelligent customer principle will be applied and be ensured.

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9 Appendix: Interview transcriptions

9.1 Interview 1: Licensing

Questionnaire

Please note that the questionnaire can be answered anonymously. The department (if internal to Eskom) or entity name (if external to Eskom) will be used to describe the interviewee.

Provisional mini-dissertation title:

A Regulatory Assessment of the Build-Own-Operate model for New Nuclear Build in South Africa

Context

New Nuclear Build (NNB) projects face many risks. Part of this is the regulatory risk that may be encountered by an entity planning to embark on the challenging trip to NNB completion.

Build-Own-Operate (BOO) is a relatively novel concept in the NNB industry where a party, other than the local operator or utility, funds, builds and operates the nuclear power station (NPS).

The 2 examples that will be considered as part of this study includes:

a. Akkuyu: Russia's Rosatom in Turkey (Turkey has no other significant nuclear infrastructure with new regulator that is 'supported' by Rosatom via Russian regulator).
b. Hinkley Point C: EDF + Chines companies in UK (established, mature nuclear infrastructure with multiple NPSs with mature regulator).

Questions

1. A major factor in NNB projects is the lack of skills and resources, particular at an early stage in the project. How does/should the NNR deal with this and what steps have already been taken to ensure adequate regulatory skills and resources?
   How could the nature of the NNB contract, i.e BOO or otherwise affect the NNR skills and resources strategy?
   Answer:
   BOO should cater for regulatory resources but only via licensing fee. Only NNR can insist for Russian regulatory support but not via licensee applicant.
   NNR not gearing up for NNB as it has no funds; existing NNR resources are already struggling; NNR may have lost people to Emirates which is exacerbating situation.

   Uncertainty problem (when NNB will commence) difficult to be solved.
   However, contract should cater for additional regulatory resources via licensing fees.

2. The nature of the contract may impact stakeholders such as the NNR.
   Is there any intention for a BOO contract to include nuclear regulatory services? How will/should the NNR influence the nature of the contract?
   Answer:
   Yes; however, only within licensing application fee perspective.

3. If the primary contractor has vested interests in its sub-suppliers (e.g. EDF using Areva NP at HPC), how is 'Intelligent Customer' concept executed without some conflict of interest clouding the independence between the 2 parties?
   The nuclear regulatory environment relies on an 'intelligent customer' concept. To what extent could the contract detract from this concept?
   Answer:
   More thorough review of concept and other designs should be implemented; this can be achieved by 2 levels of review as per HPC.

4. Should Eskom play an oversight role of BOO operator? What are the implications if Eskom plays this role?
   Answer:
   Eskom should but there are doubts whether it would happen. There could be a scenario where one entity becomes responsible for the new plant and KNPS. This will allow the same company to run nuclear power stations in South Africa which has the benefit of not needing to double up on all resources. As per EDF model, common sources are shared between NPPs leading to a more efficient staff resourcing model.

5. What are the regulatory challenges that would prevent BOO in SA? Is there anything legally, regulatory, that would prevent BOO in RSA?
   Nothing that he is aware of.

6. Politics: DoE promoter of NNB and in charge of NNR?
   How would these almost contradictory principles affect the other?
   Answer:
   Is a problem; not sure of linking between different ministries;
   Could make a difference if NNR reporting to different ministry;

7. Akkuyu is Rosatom's shopfront; HPC is EDF joint venture's shopfront.
   Considering the constraints in the world of nuclear skills, is the BOO model repeatable in multiple countries at the same time?
   Answer:
   Model is not repeatable; example of Barakah 'stealing' resources;
   currency weakness probably main reason.

8. In your opinion, why has South Africa never signed up for Civil liability instruments:
   1997 Vienna Convention on Civil Liability for Nuclear Damage (the "1997 Vienna Convention"); and- Convention on Supplementary Compensation for Nuclear Damage (the "CSC").
   Apparently they will (or already have?); can different rules now apply to BOO/2nd NPS operator/licensee?
   Answer:
   Could be dated back to apartheid days but not sure.

9. As the Installation State, what recourse does SA have if:
   a. BOO decides to leave?
      Not aware of anything; local resources could be shifted ;
   b. BOO mother country uses NPP as political leverage (e.g. Turkey Russia scenario)?
      Naïve not to think political leverage;
      Answer:

Not sure

10. Considering that politics play such a pivotal role in the initial approval of a nuclear program: what sort of pressure could this put on the regulator in terms of supporting a NNB construction program?
    Answer:
    There might be attempts but the hope is that the NNR will remain steadfast.

11. Benefits include: limited initial capital requirement from 'Installation State'; BOO comes with technical resources/solution to engineer, construct and operate; economic benefits to host country
    Disadvantages include: uncertainty over tariff; concern over ability to repeat shopfront NNB; concern over BOO ability to be 'Intelligent Customer'; nature of BOO's regulatory support might present conflict of interest; BOO mother country could use NPP as political leverage;

    Do the benefits of BOO outweigh the disadvantages?

    Answer:
    Ignoring finances, local is preferable to own and operate.
    Realistically, BOO is one of few options that will make NNB a reality.

9.2 Interview 2: Licensing

Questionnaire

Please note that the questionnaire can be answered anonymously. The department (if internal to Eskom) or entity name (if external to Eskom) will be used to describe the interviewee.

Provisional mini-dissertation title:

A Regulatory Assessment of the Build-Own-Operate model for New Nuclear Build in South Africa

Context

New Nuclear Build (NNB) projects face many risks. Part of this is the regulatory risk that may be encountered by an entity planning to embark on the challenging trip to NNB completion.

Build-Own-Operate (BOO) is a relatively novel concept in the NNB industry where a party, other than the local operator or utility, funds, builds and operates the nuclear power station (NPS).

The 2 examples that will be considered as part of this study includes:

a. Akkuyu: Russia's Rosatom in Turkey (Turkey has no other significant nuclear infrastructure with new regulator that is 'supported' by Rosatom via Russian regulator).
b. Hinkley Point C: EDF + Chines companies in UK (established, mature nuclear infrastructure with multiple NPSs with mature regulator).

Questions

1. A major factor in NNB projects is the lack of skills and resources, particular at an early stage in the project. How does/should the NNR deal with this and what steps have already been taken to ensure adequate regulatory skills and resources?
   How could the nature of the NNB contract, i.e BOO or otherwise affect the NNR skills and resources strategy?
   Answer:
   The NNR Centre of Excellence was established. The NNR resource base can be supplemented by Technical Support Organisations (TSOs).

2. The nature of the contract may impact stakeholders such as the NNR.
   Is there any intention for a BOO contract to include nuclear regulatory services? How will/should the NNR influence the nature of the contract?
   Answer:
   The BOO would have to comply with existing RSA nuclear regulatory requirements. I don't see the NNR role being any different to its current one.

3. If the primary contractor has vested interests in its sub-suppliers (e.g. EDF using Areva NP at HPC), how is 'Intelligent Customer' concept executed without some conflict of interest clouding the independence between the 2 parties?
   The nuclear regulatory environment relies on an 'intelligent customer' concept. To what extent

could the contract detract from this concept?

Answer:

This would require more oversight from the regulator and/or its authorised inspection agencies e.g. Lloyds, TUV, etc.

As above, the Licensee would be levied for these inspection agencies.

4. Should Eskom play an oversight role of BOO operator? What are the implications if Eskom plays this role?

   Answer:

   I don't see why Eskom should be involved other than in matters related to the transmission/grid requirements. Eskom does not have the capacity to monitor a competing NPP vendor.

5. What are the regulatory challenges that would prevent BOO in SA? Is there anything legally, regulatory, that would prevent BOO in RSA?

   Answer:

   The policy legislation may have to be amended to enable a licensee other that Eskom to progress a BOO project.

6. Politics: DoE promoter of NNB and in charge of NNR?
   How would these almost contradictory principles affect the other?

   Answer:

   This is the current situation which is in conflict with IAEA recommendations.

7. Akkuyu is Rosatom's shopfront; HPC is EDF joint venture's shopfront.
   Considering the constraints in the world of nuclear skills, is the BOO model repeatable in multiple countries at the same time?

   Answer:

   Yes, there are several countries/companies which are capable of manufacturing, supplying and operating; it all depends on the reactor type and the resource base of the host country. RSA did this with Koeberg as there were no local nuclear skills in 1976 but by 1983 there were.

8. In your opinion, why has South Africa never signed up for Civil liability instruments:
   1997 Vienna Convention on Civil Liability for Nuclear Damage (the "1997 Vienna Convention"); and- Convention on Supplementary Compensation for Nuclear Damage (the "CSC").
   Apparently they will (or already have?); can different rules now apply to BOO/2nd NPS operator/licensee?

   Answer:

   This is a matter for RSA as a member state of the IAEA/UN. I do not have an answer on this. The rules are set by the state so all future licensees would be bound by the same rules.

9. As the Installation State, what recourse does SA have if:
   a. BOO decides to leave?
   b. BOO mother country uses NPP as political leverage (e.g. Turkey Russia scenario)?

      Answer:

      Close down the plant and refuse to pay any outstanding debts. Conversely, what happens if RSA expels the workers and takes over the NPP?

10. Considering that politics play such a pivotal role in the initial approval of a nuclear program: what sort of pressure could this put on the regulator in terms of supporting a NNB construction

program?

Answer:

This depends on how strong the individuals are in the NNR. I think public opinion and international pressure from the IAEA and governments would be major factors in deciding whether the NNR would be adversely influenced. Chernobyl/Fukushima reactions across the world are indicators of this.

11. Benefits include: limited initial capital requirement from 'Installation State'; BOO comes with technical resources/solution to engineer, construct and operate; economic benefits to host country
    Disadvantages include: uncertainty over tariff; concern over ability to repeat shopfront NNB; concern over BOO ability to be 'Intelligent Customer'; nature of BOO's regulatory support might present conflict of interest; BOO mother country could use NPP as political leverage;

    Do the benefits of BOO outweigh the disadvantages?

    Answer:

    Depends on your point of view and how you benefit from the deal.

9.3 Interview 3: Pebble Bed Modular Reactor

Questionnaire

Please note that the questionnaire can be answered anonymously. The department (if internal to Eskom) or entity name (if external to Eskom) will be used to describe the interviewee.

Provisional mini-dissertation title:

A Regulatory Assessment of the Build-Own-Operate model for New Nuclear Build in South Africa

Context

New Nuclear Build (NNB) projects face many risks. Part of this is the regulatory risk that may be encountered by an entity planning to embark on the challenging trip to NNB completion.

Build-Own-Operate (BOO) is a relatively novel concept in the NNB industry where a party, other than the local operator or utility, funds, builds and operates the nuclear power station (NPS).

The 2 examples that will be considered as part of this study includes:

a. Akkuyu: Russia's Rosatom in Turkey (Turkey has no other significant nuclear infrastructure with new regulator that is 'supported' by Rosatom via Russian regulator).
b. Hinkley Point C: EDF + Chines companies in UK (established, mature nuclear infrastructure with multiple NPSs with mature regulator).

Questions

1. A major factor in NNB projects is the lack of skills and resources, particular at an early stage in the project. How does/should the NNR deal with this and what steps have already been taken to ensure adequate regulatory skills and resources?
   How could the nature of the NNB contract, i.e BOO or otherwise affect the NNR skills and resources strategy?
   Answer:
   I am not aware of the NNR skills and resources strategy so cannot comment.
   I am not aware of the NNR skills and resources strategy so cannot comment.

2. The nature of the contract may impact stakeholders such as the NNR.
   Is there any intention for a BOO contract to include nuclear regulatory services? How will/should the NNR influence the nature of the contract?

   Answer:
   Not allowed in SA law, NNR cannot outsource its responsibility.
   The NNR will need to ensure the BOO is competent regardless of the nature of the contract.

3. If the primary contractor has vested interests in its sub-suppliers (e.g. EDF using Areva NP at HPC), how is 'Intelligent Customer' concept executed without some conflict of interest clouding the independence between the 2 parties?

The nuclear regulatory environment relies on an 'intelligent customer' concept. To what extent could the contract detract from this concept?

Answer:

Eskom will need to be the intelligent customer according to the national policy. An independent BOO will need to show independent review within the contracting mix.

Introduce an independent review within the consortium.

4. Should Eskom play an oversight role of BOO operator? What are the implications if Eskom plays this role?

   Answer:

   Eskom is the Operator and major owner according to policy. Eskom as major shareholder will establish an oversight committee outside of the company but Eskom as main shareholder will also set up governance structures inside the company. If the BOO is independent then why does Eskom need to play this role?

5. What are the regulatory challenges that would prevent BOO in SA? Is there anything legally, regulatory, that would prevent BOO in RSA?

   Answer:

   The national policy has Eskom as the Operators and majority owner. This is only policy so no law prevents private BOO like an IPP.

6. Politics: DoE promoter of NNB and in charge of NNR?
   How would these almost contradictory principles affect the other?

   Answer:

   The NNR makes the decision or not to issue a license without DoE involvement. SO the NNR is fairly independent in that regard. But, the NNR is not allowed to make regulation (only the minister of DoE) which can undermine the NNR's independence. Rather the NNR should report to another ministry in this regard.

7. Akkuyu is Rosatom's shopfront; HPC is EDF joint venture's shopfront.
   Considering the constraints in the world of nuclear skills, is the BOO model repeatable in multiple countries at the same time?

   Answer:

   No Idea.

8. In your opinion, why has South Africa never signed up for Civil liability instruments:
   1997 Vienna Convention on Civil Liability for Nuclear Damage (the "1997 Vienna Convention"); and- Convention on Supplementary Compensation for Nuclear Damage (the "CSC").
   Apparently they will (or already have?); can different rules now apply to BOO/2nd NPS operator/licensee?

   Answer:

   Given the Koeberg power station is not near any international boundary there is no pressure from any neighbours for SA to sign any Treaty. Also, there has been little internal (national) pressure to sign any treaty like to CSC to expand the liability provision.

9. As the Installation State, what recourse does SA have if:
   a. BOO decides to leave?

      Answer:

      Not sure what this question means? Presumably we would require a guarantee for the decommissioning provision.

b. BOO mother country uses NPP as political leverage (e.g. Turkey Russia scenario)?
Answer:
RSA should only do business with countries it can trust or have similar counter leverage.

10. Considering that politics play such a pivotal role in the initial approval of a nuclear program: what sort of pressure could this put on the regulator in terms of supporting a NNB construction program?
Answer:
To counter this pressure the issuing of a license should be brought to parliament.

11. Benefits include: limited initial capital requirement from 'Installation State'; BOO comes with technical resources/solution to engineer, construct and operate; economic benefits to host country
Disadvantages include: uncertainty over tariff; concern over ability to repeat shopfront NNB; concern over BOO ability to be 'Intelligent Customer'; nature of BOO's regulatory support might present conflict of interest; BOO mother country could use NPP as political leverage;

Do the benefits of BOO outweigh the disadvantages?
Answer:
This really depends on who we are dealing with and the actual benefits. An independent BOO will require substantial tariff guarantees from Eskom or the state which could be a problem for the SA government or Eskom.

9.4 Interview 4: Project Management

Questionnaire

Please note that the questionnaire can be answered anonymously. The department (if internal to Eskom) or entity name (if external to Eskom) will be used to describe the interviewee.

Provisional mini-dissertation title:

A Regulatory Assessment of the Build-Own-Operate model for New Nuclear Build in South Africa

Context

New Nuclear Build (NNB) projects face many risks. Part of this is the regulatory risk that may be encountered by an entity planning to embark on the challenging trip to NNB completion.

Build-Own-Operate (BOO) is a relatively novel concept in the NNB industry where a party, other than the local operator or utility, funds, builds and operates the nuclear power station (NPS).

The 2 examples that will be considered as part of this study includes:

a. Akkuyu: Russia's Rosatom in Turkey (Turkey has no other significant nuclear infrastructure with new regulator that is 'supported' by Rosatom via Russian regulator).
b. Hinkley Point C: EDF + Chines companies in UK (established, mature nuclear infrastructure with multiple NPSs with mature regulator).

Questions

1. A major factor in NNB projects is the lack of skills and resources, particular at an early stage in the project. How does/should the NNR deal with this and what steps have already been taken to ensure adequate regulatory skills and resources?
   How could the nature of the NNB contract, i.e BOO or otherwise affect the NNR skills and resources strategy?
   Answer:
   NNR has assessed skills requirement and have started recruitment.
   12 staff is already being trained via SGR as part of the Supplier Development & Localisation component.
   NNR has relationships with other regulators, e.g. ASN, STUK, NRC.
   Contract cannot cater for resources, only licensing skills since there is a need for independence in the regulatory approval process.

2. The nature of the contract may impact stakeholders such as the NNR.
   Is there any intention for a BOO contract to include nuclear regulatory services? How will/should the NNR influence the nature of the contract?
   Answer:
   Contract cannot cater for resources, only licensing skills since there is a need for independence in the regulatory approval process ;

Licensing fees can cater for additional resources as the structure allows for fixed and variable components.

3. If the primary contractor has vested interests in its sub-suppliers (e.g. EDF using Areva NP at HPC), how is 'Intelligent Customer' concept executed without some conflict of interest clouding the independence between the 2 parties?
   The nuclear regulatory environment relies on an 'intelligent customer' concept. To what extent could the contract detract from this concept?
   Answer:
   The operator is bound by rules and there will be separation of duties.
   In the USA, the NRC uses a prescriptive licensing philosophy with architect engineer responsible for checking integration issues, similar to design authority.
   In South Africa NNR is not prescriptive it allows the applicant an opportunity to propose a framework for regulator acceptance; ultimately, regulation compliance matters.
   Chinese regulator very strong but prescriptive.
   (See WANO –American - website on Chinese assessment)

4. Should Eskom play an oversight role of BOO operator? What are the implications if Eskom plays this role?
   Answer:
   BOO is not likely to happen.
   Eskom will need to be involved as a technical lead on behalf of SA government as the only SOC with nuclear power plant operation experience.

   In terms of future impartiality when KNPS and new NPP will be competitors: Eskom involvement is inevitable as SAPP is reliant on Eskom.

5. What are the regulatory challenges that would prevent BOO in SA? Is there anything legally, regulatory, that would prevent BOO in RSA?
   Answer:
   Eskom is the designated owner and operator from Nuclear Energy Policy;
   Gazette needs to change policy (approved by cabinet).
   Eskom has been identified as the owner operator and procurer of nuclear power plants in SA.

6. Politics: DoE promoter of NNB and in charge of NNR?
   How would these almost contradictory principles affect the other?
   Answer:
   As long as being funded by government , regulatory independence is difficult. There are rules that describe roles. Regulator has independent board that does aid independence.
   Level of independence (lack of thereof) not unique to South Africa. It is the minister's role to ensure independence.
   There is acknowledgement that the government's greater strategic goals cannot be ignored.
   The NRC and influence of Trump should be considered as an example of political influence.

7. Akkuyu is Rosatom's shopfront; HPC is EDF joint venture's shopfront.
   Considering the constraints in the world of nuclear skills, is the BOO model repeatable in multiple countries at the same time?
   Answer:
   HPC model is repeatable as Chinese can provide resources.
   French, not likely.
   USA: there are no new skills coming into nuclear;

8. In your opinion, why has South Africa never signed up for Civil liability instruments:
   1997 Vienna Convention on Civil Liability for Nuclear Damage (the "1997 Vienna Convention");
   and- Convention on Supplementary Compensation for Nuclear Damage (the "CSC").
   Apparently they will (or already have?); can different rules now apply to BOO/2nd NPS operator/licensee?
   Answer:
   Conventions have been compiled with the interest of Europeans and Americans; protects their companies to ensure only their companies can be involved in nuclear fuel cycle and nuclear manufacturing.

9. As the Installation State, what recourse does SA have if:
   a. BOO decides to leave?
   b. BOO mother country uses NPP as political leverage (e.g. Turkey Russia scenario)?
      Answer:
      No recourse, only diplomatic.

10. Considering that politics play such a pivotal role in the initial approval of a nuclear program: what sort of pressure could this put on the regulator in terms of supporting a NNB construction program?
    Answer:
    Pressure will be there to deliver; it is their moral responsibility to do right thing.

11. Benefits include: limited initial capital requirement from 'Installation State'; BOO comes with technical resources/solution to engineer, construct and operate; economic benefits to host country
    Disadvantages include: uncertainty over tariff; concern over ability to repeat shopfront NNB; concern over BOO ability to be 'Intelligent Customer'; nature of BOO's regulatory support might present conflict of interest; BOO mother country could use NPP as political leverage;

    Do the benefits of BOO outweigh the disadvantages?
    Answer:
    No. BOO is only good for new countries where nuclear capability does not exist. Countries that want to use nuclear to develop local capabilities and industry this model will not work.
    BOO is not beneficial to SD&L.
    Look at Doosan, JSW, etc. who was tasked to manufacture nuclear components without previous experience.
    HPC: this model keeps the money in Europe.

9.5 Interview 5: Project Management

Questionnaire

Please note that the questionnaire can be answered anonymously. The department (if internal to Eskom) or entity name (if external to Eskom) will be used to describe the interviewee.

Provisional mini-dissertation title:

A Regulatory Assessment of the Build-Own-Operate model for New Nuclear Build in South Africa

Context

New Nuclear Build (NNB) projects face many risks. Part of this is the regulatory risk that may be encountered by an entity planning to embark on the challenging trip to NNB completion.

Build-Own-Operate (BOO) is a relatively novel concept in the NNB industry where a party, other than the local operator or utility, funds, builds and operates the nuclear power station (NPS).

The 2 examples that will be considered as part of this study includes:

a. Akkuyu: Russia's Rosatom in Turkey (Turkey has no other significant nuclear infrastructure with new regulator that is 'supported' by Rosatom via Russian regulator).
b. Hinkley Point C: EDF + Chines companies in UK (established, mature nuclear infrastructure with multiple NPSs with mature regulator).

Questions

1. A major factor in NNB projects is the lack of skills and resources, particular at an early stage in the project. How does/should the NNR deal with this and what steps have already been taken to ensure adequate regulatory skills and resources?
   How could the nature of the NNB contract, i.e BOO or otherwise affect the NNR skills and resources strategy?
   Answer:
   Licensee fee should cater for resources.
   Effective NNR preferably needs operational experience but due to lack thereof locally, parties being appointed are very likely to be inexperienced.

2. The nature of the contract may impact stakeholders such as the NNR.
   Is there any intention for a BOO contract to include nuclear regulatory services? How will/should the NNR influence the nature of the contract?
   Answer:
   No direct influence by NNR on contract; NNR should specify licensing fee structure and this should be included in the contract via license fee.

3. If the primary contractor has vested interests in its sub-suppliers (e.g. EDF using Areva NP at HPC), how is 'Intelligent Customer' concept executed without some conflict of interest clouding the independence between the 2 parties?

The nuclear regulatory environment relies on an 'intelligent customer' concept. To what extent could the contract detract from this concept?

Answer:

Different example: Previous project, Civil contractor is part of Eskom; Eskom can deal with Contractor contractually, up to a point; as there is a common board, common goal of making company successful.

Similar common goal principle can be applied if nuclear safety was the goal;

HPC model of design authority separate from DIN, i.e. additional layer of verification looks feasible.

Rosatom - Akkuyu: not sure how Intelligent Customer capability could work in this setup.

4. Should Eskom play an oversight role of BOO operator? What are the implications if Eskom plays this role?

   Answer:

   No; Eskom should not get involved.

5. What are the regulatory challenges that would prevent BOO in SA? Is there anything legally, regulatory, that would prevent BOO in RSA?

   Answer:

   Nuclear Energy Policy is only obstacle where Eskom will be owner and operator.

6. Politics: DoE promoter of NNB and in charge of NNR?
   How would these almost contradictory principles affect the other?

   Answer:

   NNR reports to DoE on all nuclear matters.
   NNR have proven to be independent thus far.
   Acknowledge that perception of other 'compromised' boards in South Africa.
   However, the public's perception of the NNR board (thus far, indifferent) could change as press' focus has not been on NNR thus far.

7. Akkuyu is Rosatom's shop-front; HPC is EDF joint venture's shop-front.
   Considering the constraints in the world of nuclear skills, is the BOO model repeatable in multiple countries at the same time?

   Answer:

   Initially but supply and demand will ensure eventual supply chain of skills and resources.
   Barakah poaching Eskom people part of cycle: skills lag, skills catch-up, skills over supply, skill lag etc.

8. In your opinion, why has South Africa never signed up for Civil liability instruments:
   1997 Vienna Convention on Civil Liability for Nuclear Damage (the "1997 Vienna Convention"); and- Convention on Supplementary Compensation for Nuclear Damage (the "CSC").
   Apparently they will (or already have?); can different rules now apply to BOO/2nd NPS operator/licensee?

   Answer:

   South Africa not linked to any "European ways".
   Do not want to be prescribed to.

9. As the Installation State, what recourse does SA have if:
   a. BOO decides to leave?

b. BOO mother country uses NPP as political leverage (e.g. Turkey Russia scenario)?
Answer:
No recourse as Africa might be too divided;
BRICS affiliation might assist' via connection to China.

10. Considering that politics play such a pivotal role in the initial approval of a nuclear program: what sort of pressure could this put on the regulator in terms of supporting a NNB construction program?
Answer:
Most likely as intergovernmental agreement concluded these deals;

11. Benefits include: limited initial capital requirement from 'Installation State'; BOO comes with technical resources/solution to engineer, construct and operate; economic benefits to host country
Disadvantages include: uncertainty over tariff; concern over ability to repeat shopfront NNB; concern over BOO ability to be 'Intelligent Customer'; nature of BOO's regulatory support might present conflict of interest; BOO mother country could use NPP as political leverage;

Do the benefits of BOO outweigh the disadvantages?
Answer:
All about what price per kWh.
Power Price Agreement would need to be signed, but at what price; then comes down best technical solution and best economical solution.

9.6 Interview 6: Project Management

Questionnaire

Please note that the questionnaire can be answered anonymously. The department (if internal to Eskom) or entity name (if external to Eskom) will be used to describe the interviewee.

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A Regulatory Assessment of the Build-Own-Operate model for New Nuclear Build in South Africa

Context

New Nuclear Build (NNB) projects face many risks. Part of this is the regulatory risk that may be encountered by an entity planning to embark on the challenging trip to NNB completion.

Build-Own-Operate (BOO) is a relatively novel concept in the NNB industry where a party, other than the local operator or utility, funds, builds and operates the nuclear power station (NPS).

The 2 examples that will be considered as part of this study includes:

a. Akkuyu: Russia's Rosatom in Turkey (Turkey has no other significant nuclear infrastructure with new regulator that is 'supported' by Rosatom via Russian regulator).
b. Hinkley Point C: EDF + Chines companies in UK (established, mature nuclear infrastructure with multiple NPSs with mature regulator).

Questions

1. A major factor in NNB projects is the lack of skills and resources, particular at an early stage in the project. How does/should the NNR deal with this and what steps have already been taken to ensure adequate regulatory skills and resources?
   How could the nature of the NNB contract, i.e BOO or otherwise affect the NNR skills and resources strategy?
   Answer:
   Licensing starts before application.
   New approaches are required;
   The NNR Strategy doc is very likely outdated (in reference to the NNR not being able to appoint additional resources).
   NISL has made funds available which has been gazette.
   NNR correct to not appoint resources directly for NNB as still too much uncertainty.

2. The nature of the contract may impact stakeholders such as the NNR.
   Is there any intention for a BOO contract to include nuclear regulatory services? How will/should the NNR influence the nature of the contract?
   Answer:
   When contract is concluded, licensing support implied access to other regulators.
   MDEP: assessment of different designs which would give the NNR access already to technical information.

NNR will only interact with Eskom or entity that hold specific licence (assuming it is not Eskom).

3. If the primary contractor has vested interests in its sub-suppliers (e.g. EDF using Areva NP at HPC), how is 'Intelligent Customer' concept executed without some conflict of interest clouding the independence between the 2 parties?
   The nuclear regulatory environment relies on an 'intelligent customer' concept. To what extent could the contract detract from this concept?
   Answer:
   Nothing wrong with everything under one roof.
   Eskom as example: there are different divisions; all parties follow commercial rules.
   The business practice does not dilute as there is an instilled culture of addressing wrongs.
   There is no compromise for quality.
   Different does not mean wrong; roles and responsibilities should be clear.

   Akkuyu: the supply chain should not matter.
   The onus remains with the licensee to prove IC capability.
   An audit can help identify flaws.

4. Should Eskom play an oversight role of BOO operator? What are the implications if Eskom plays this role?
   Answer:
   Eskom has no business unless requested by NNR but not ideal.

5. What are the regulatory challenges that would prevent BOO in SA? Is there anything legally, regulatory, that would prevent BOO in RSA?
   Answer:
   Nuclear Energy Policy

6. Politics: DoE promoter of NNB and in charge of NNR?
   How would these almost contradictory principles affect the other?
   Answer:
   I would like to offer a binary answer: there is a level of convergence (between promotion and regulation) at some level.
   There is clear division of duties but understand how this could be seen as bias.
   There is acknowledgement that boards could be influenced.

   Need 1 degree of separation between different activities.
   The NNR should report to the Department of Environmental Affairs is already involved in NISL application.

7. Akkuyu is Rosatom's shopfront; HPC is EDF joint venture's shopfront.
   Considering the constraints in the world of nuclear skills, is the BOO model repeatable in multiple countries at the same time?
   Answer:
   Back in 70s when South Africa wanted to build power stations, the country did not wait.
   Skills will evolve due to a need.
   The industry will sustain business.

8. In your opinion, why has South Africa never signed up for Civil liability instruments:
   1997 Vienna Convention on Civil Liability for Nuclear Damage (the "1997 Vienna Convention"); and- Convention on Supplementary Compensation for Nuclear Damage (the "CSC").
   Apparently they will (or already have?); can different rules now apply to BOO/2nd NPS operator/licensee?
   Answer:
   Not fully conversant conventions.
   No neighbours close by so probably not urgent.

9. As the Installation State, what recourse does SA have if:
a. BOO decides to leave?
b. BOO mother country uses NPP as political leverage (e.g. Turkey Russia scenario)?
   Answer:
   Fundamental risk with BOO or BOT; most expensive approach;
   Akkuyu loss leader which explains the reason for their competitive tariffs.

10. Considering that politics play such a pivotal role in the initial approval of a nuclear program: what sort of pressure could this put on the regulator in terms of supporting a NNB construction program?
    Answer:
    There is professional pride with all people; people are passionate about their job.
    However, politics cannot be avoided; the onus is on professionals to choose the right way. Governance is above board for Eskom as being guided by governance principles.
    Similarly for the NNR.

11. Benefits include: limited initial capital requirement from 'Installation State'; BOO comes with technical resources/solution to engineer, construct and operate; economic benefits to host country
    Disadvantages include: uncertainty over tariff; concern over ability to repeat shopfront NNB; concern over BOO ability to be 'Intelligent Customer'; nature of BOO's regulatory support might present conflict of interest; BOO mother country could use NPP as political leverage;

    Do the benefits of BOO outweigh the disadvantages?
    Answer:
    If country does not have money, sounds good; but only if transferred to locals.
    Long term not good.
    If the need for a country is abundant electricity to stimulate economy, then BOO could be considered.
    However, country will not become self-sufficient.

    General comments:
    BOO is not ideal based on our needs and strategy.

9.7 Interview 7: Engineering

Questionnaire

Please note that the questionnaire can be answered anonymously. The department (if internal to Eskom) or entity name (if external to Eskom) will be used to describe the interviewee.

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A Regulatory Assessment of the Build-Own-Operate model for New Nuclear Build in South Africa

Context

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Build-Own-Operate (BOO) is a relatively novel concept in the NNB industry where a party, other than the local operator or utility, funds, builds and operates the nuclear power station (NPS).

The 2 examples that will be considered as part of this study includes:

a. Akkuyu: Russia's Rosatom in Turkey (Turkey has no other significant nuclear infrastructure with new regulator that is 'supported' by Rosatom via Russian regulator).
b. Hinkley Point C: EDF + Chines companies in UK (established, mature nuclear infrastructure with multiple NPSs with mature regulator).

Questions

1. A major factor in NNB projects is the lack of skills and resources, particular at an early stage in the project. How does/should the NNR deal with this and what steps have already been taken to ensure adequate regulatory skills and resources?
   How could the nature of the NNB contract, i.e BOO or otherwise affect the NNR skills and resources strategy?
   Answer:
   There is lack of certainty as no decision has been made.
   The NNR should increases resources on existing projects to aid preparation for NNB.
   The NNR should ask the government for additional funds.
   The NNR should use countries where NNB is not active; e.g. Sweden, Americans, Germany, Belgium in employee relationships that can mentor new staff.

2. The nature of the contract may impact stakeholders such as the NNR.
   Is there any intention for a BOO contract to include nuclear regulatory services? How will/should the NNR influence the nature of the contract?
   Answer:
   The contract should not cater for NNR as regulator must be seen as independent by public;

3. If the primary contractor has vested interests in its sub-suppliers (e.g. EDF using Areva NP at HPC), how is 'Intelligent Customer' concept executed without some conflict of interest clouding

the independence between the 2 parties?
The nuclear regulatory environment relies on an 'intelligent customer' concept. To what extent could the contract detract from this concept?

Answer:

In general, I am opposed.
With Rosatom, I cannot see how Intelligent Customer principle can be applied.
There should be strong regulatory oversight.
The Intelligent Customer can only be South African.
HPC: This is a different case as the British public trusts the licensee.

4. Should Eskom play an oversight role of BOO operator? What are the implications if Eskom plays this role?

   Answer:

   This sounds like a good idea but Eskom (nuclear division thereof) should be separate from the rest of Eskom;
   But future scenario of competition might compromise our oversight role;

5. What are the regulatory challenges that would prevent BOO in SA? Is there anything legally, regulatory, that would prevent BOO in RSA?

   Answer:

   The Nuclear Energy Policy is very clear about ownership and operation should be the responsibility of Eskom.

6. Politics: DoE promoter of NNB and in charge of NNR?
   How would these almost contradictory principles affect the other?

   Answer:

   Not a major issue as NNR should (at some level) reports to the same governmental anyway;
   The DoE should put controls in place for opposing views.

7. Akkuyu is Rosatom's shopfront; HPC is EDF joint venture's shopfront.
   Considering the constraints in the world of nuclear skills, is the BOO model repeatable in multiple countries at the same time?

   Answer:

   It is repeatable but need experienced resources.
   Experienced resources will be spread thin which requires a strong HR development plan.
   The regulator wants a stable organisation with clearly defined roles and responsibilities.
   There is a concern that multiple nationalities might lead to decreased communication where important issues are lost in translation.
   This contributes to difficulty in building a consistent nuclear safety culture.

8. In your opinion, why has South Africa never signed up for Civil liability instruments:
   1997 Vienna Convention on Civil Liability for Nuclear Damage (the "1997 Vienna Convention"); and- Convention on Supplementary Compensation for Nuclear Damage (the "CSC").
   Apparently they will (or already have?); can different rules now apply to BOO/2nd NPS operator/licensee?

   Answer:

   We have faith in own jurisdiction.
   Eskom owns vast assets which can act as some form of collateral.

9. As the Installation State, what recourse does SA have if:

a. BOO decides to leave?

b. BOO mother country uses NPP as political leverage (e.g. Turkey Russia scenario)?
Answer:
There is not much recourse as we will become dependent on BOO.
If diplomatic relations deteriorates, BOO entity's mother country might exert pressure. However, the contractual obligations should help to address the issue.

10. Considering that politics play such a pivotal role in the initial approval of a nuclear program: what sort of pressure could this put on the regulator in terms of supporting a NNB construction program?
Answer:
This is absolutely a real issue.
The NNR reports to DoE minister.
There will be pressure;

11. Benefits include: limited initial capital requirement from 'Installation State'; BOO comes with technical resources/solution to engineer, construct and operate; economic benefits to host country
Disadvantages include: uncertainty over tariff; concern over ability to repeat shopfront NNB; concern over BOO ability to be 'Intelligent Customer'; nature of BOO's regulatory support might present conflict of interest; BOO mother country could use NPP as political leverage;

Do the benefits of BOO outweigh the disadvantages?
Answer:
No; BOO is not good for the country.
BOO entities are in it for money.
There are elements of mistrust.
I am broadly unsure as BOO model does not work in the South African context; other models are available that could work better.
South Africa wants to grow local nuclear industry; South Africa will get loans easier that perceived as SGR is an example of how easily financing is available.

9.8 Interview 8: NNR

The NNR representative was advised by the company's legal department that the information gathered during the interview could not be used in this mini-disseration.