Techno-economic analysis for construction and operation of a fleet of Nuclear Power Plants in South Africa as proposed by the IRP 2010

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ABSTRACT

The South African Government has prioritized industrialization and infrastructure investment to ensure electricity supply and distribution to its people and industries. In order to realize this, the Government intends to construct a fleet of nuclear power plants (NPPs) with a combined output capacity of 9 600 MW, which is in alignment with the updated Integrated Resources Plan (IRP 2016) for South Africa. However, before a procurement decision can be made, policymakers must first address concerns regarding the economic viability of nuclear technology. A study is therefore required to support the policy-making process.

This research proposes that a techno-economic analysis be performed in order to provide some context to the debate about the cost of nuclear energy, i.e. nuclear power economics.

The methodology for this research starts with an initial survey of literature concerning nuclear power economics and the key aspects by which it is influenced. Literature concerning various nuclear power projects and the various nuclear power plant technologies was also considered.

The scope of this research is limited to Generation III and Generation III+ plants that are currently operational, under construction, as well as approved nuclear projects that have valid contracts in place. The Generation III and Generation III+ reactor technologies that were considered for this research include the AP1000, EPR1600, Hualong One, APR1400, and the VVER1200 reactor technologies. The research focuses on accumulating costing information to be used for conducting economic simulations. The various designs were also evaluated for their technical capabilities.

A mathematical model was developed to perform the economic evaluation. The model inputs for the calculation of the Overnight Capital Cost (OCC) are explained and described. It is assumed for this research that the nuclear component industry is fully integrated with components being sourced internationally at competitive prices, and that nuclear power economics is sensitive to variations in the labour cost as well as labour productivity. The emphasis is therefore on determining the Overnight Capital Cost (OCC) for each project, were it to be constructed within the South African economic landscape, but also to observe the influence of labour cost and labour productivity on the OCC.

The different scenarios were prepared on a country-by-country basis and were developed by reference to a common set of generic assumptions for each scenario, as described in the modelling procedure (refer to § 4.1).

The Total Capital Investment Cost (TCIC) component of each project was transformed to a localized (South African) OCC for projects, were it to be constructed within the South African economic landscape.

The results indicate that the average OCC for constructing one of the five technologies within the South African economic landscape is \$2 910/kW. The technology with the lowest localized OCC is the APR1400 at a cost of \$2 293/kW.

A sensitivity analysis will also indicate which assumed or determined variable will have the greatest impact on the localized Overnight Capital Cost.

Keywords: Techno-economic, overnight capital cost, nuclear power economics, labour cost, labour productivity.

OPSOMMING

Die Suid-Afrikaanse Regering het voorkeur verleen aan plaaslike industrialisering en investering in infrastruktuur om te verseker dat die land se mense en industrieë toegang het tot elektrisiteit. Om dit te bewerkstellig, beoog die Regering om ’n reeks kernkragaanlegte te bou met ’n gesamentlike vermoë van 9 600 MW, wat strook met die 2016 weergawe van die Geïntegreerde Hulpbronne Plan. Voordat ’n aankoopbesluit egter gemaak kan word, moet beleidmakers eers aspekte soos die ekonomiese gangbaarheid van kerntegnologie oorweeg. Om stukrag aan die besluitnemingsproses te verleen, word ’n deeglike studie benodig.

Hierdie navorsing stel voor dat dat ’n tegno-ekonomiese ontleding gedoen word om duidelikheid te verleen aan die debat rakende die koste van kernenergie of te wel, kernkrag-ekonomie.

Die metodiek vir hierdie navorsing begin met ’n oorsig van beskikbare literatuur rakende kernkrag-ekonomie en die sleutelaspekte waardeur dit beïnvloed word. Literatuur rakende etlike kernkragprojekte en die verskillende kernaanlegtegnologieë is ook oorweeg.

Die bestek van hierdie navorsing is beperk tot Generasie III en Generasie III+ aanlegte wat tans in bedryf is, wat in aanbou is, en goedgekeurde kernprojekte waarvoor kontrakte reeds aangegaan is. Die Generasie III en Generasie III+ reaktortegnologieë wat vir hierdie navorsing oorweeg is, behels die volgende: AP1000, EPR1600, Hualong Een, APR1400, en die VVER1200 reaktortegnologieë. Die navorsing is gerig daarop om koste-inligting in te win wat vir ekonomiese simulasies gebruik sal word. Die verskillende ontwerpe is ook vir hulle tegniese vermoë geëvalueer.

Ten einde hierdie ekonomiese evaluering te kon doen, is ’n wiskundige model ontwikkel. Insette vir hierdie model vir die berekening van die oornag kapitale koste word beskryf en verduidelik. Daar word ook aangeneem dat die industrie vir kernkragkomponente ten volle geïntegreer is, dus kan komponente wêreldwyd verkry word teen mededingende pryse, en dat kernkragekonomie vatbaar is vir skommeling in arbeidskoste as ook arbeidsproduktiwiteit. Die klem is dus op die berekening van die oornag kapitale koste vir elk van hierdie projekte sou dit in die Suid-Afrikaanse ekonomiese landskap opgerig word, en ook om die invloed van arbeidskoste en arbeidsproduktiwiteit op die oornag kapitale koste te beskou.

Verskeie scenarios is ontwikkel op ’n land tot land grondslag deur te verwys na ’n gemeenskaplike stel generiese aannames vir elke scenario soos beskryf in die modelleringsprosedure soos beskry in § 4.1.

Die totale kapitale beleggingskoste van elke projek is omgeskakel na ’n plaaslike (Suid-Afrikaanse) oornag kapitale koste vir elke projek moontlik gemaak het sou daardie tegnologie in die Suid-Afrikaanse ekonomiese landskap gebou word.

Die uitslag toon dat die gemiddelde oornag kapitale koste om een van die vyf tegnologieë vir konstruksie te gebruik, \$2 910/kW beloop. Die tegnologie met die kleinste oornag kapitale koste is die APR1400 teen ’n koste van \$2 293/kW.

’n Sensitiwiteitsanalise sal ook aandui watter aangenome of bepaalde veranderlike die grootste invloed op die plaaslike oornag kapitale koste sal hê.

Sleutelwoorde: Tegno-ekonomies, oornag kapitale koste, kernkragekonomie, arbeidskoste, arbeidsproduktiwiteit.

LIST OF ABBREVIATIONS AND ACRONYMS

BU	Burn-up
BWR	Boiling Water Reactor
CCL	Cost of Construction Loan
CEU	Commission of the European Union
CGNPG	China General Nuclear Power Group
CIAB	Coal Industry Advisory Board
CIDB	Construction Industry Development Board
CNNC	China National Nuclear Corporation
DOE	Department of Energy
EDF	Électricité de France
EMWG	Economics Modeling Working Group
EPC	Engineering, Procurement, and Construction
EPCC	Engineering, Procurement, and Construction Cost
EPR	European Pressurized Reactor
EPRI	Electric Power Research Institute
EUR	European Utility Requirements
FOAK	First of a Kind
IAEA	International Atomic Energy Agency
IDC	Interest during Construction
IEP	Integrated Energy Plan
IPP	Independent Power Producer
IRP	Integrated Resource Plan
IRR	Internal Rate of Return
KEPCO	Korea Electric Power Corporation
KHNP	Korea Hydro & Nuclear Power
KNPS	Koeberg Nuclear Power Station
LCOE	Levelized Cost of Electricity
LWR	Light Water Reactor

MW	Megawatt
NDP	National Development Plan
NETL	National Energy Technology Laboratory
NNBP	Nuclear New Build Programme
NNEECC	National Nuclear Energy Executive Coordinating Committee
NPP	Nuclear Power Plant
NPV	Net Present Value
NREL	National Renewable Energy Laboratory
O&M	Operations and Maintenance
OC	Owner’s Cost
OCC	Overnight Capital Cost
OCGT	Open Cycle Gas Turbine
OECD	Organization for Economic Cooperation and Development
PRIS	Power Reactor Information Systems
PWR	Pressurized Water Reactor
SA	South Africa
SG	Steam Generator
SSC	System, Structure, Component
SSE	Safe-Shutdown Earthquake
TCIC	Total Capital Investment Cost
TMI	Three Mile Island
UCLF	Unplanned Capability Loss Factor
URD	Utility Requirements Document
USA	United States of America
US EIA	United States Energy Information Administration
US NRC	United States Nuclear Regulatory Commission
WACC	Weighted Average Cost of Capital
WNA	World Nuclear Association
WNN	World Nuclear News

DEFINITIONS

Advanced reactor – A nuclear power reactor with an evolutionary design (when compared with Generation II designs) with enhanced safety features.

Base load power stations – Stations capable of continuously producing large amounts of energy on a 24-hour basis; also referred to as primary energy sources.

Boiling water reactor – A nuclear power reactor in which boiling of coolant occurs in the reactor pressure vessel, with the steam resulting from boiling being directed to the turbine-generator for electricity production.

Burn-up – The percentage of heavy metal fissioned during the period in which the nuclear fuel is exposed during reactor operation. Burn-up is normally expressed in terms of megawatt days per tonne (MWd/t) or megawatt days per kilogram (MWd/kg).

Condenser – The structure in which steam that has passed through the turbine is cooled and condensed by a circulating water system, with the hot condensate being returned to the steam generators for re-use.

Confinement – An enclosure around a nuclear reactor intended to reduce, but not prevent, release of radioactive materials to the environment.

Containment – A structure around a nuclear reactor that is designed to withstand, with minimal leakage, the pressure resulting from design basis accidents, e.g. a loss of coolant accident or a main steam line break. The containment is relied upon in severe accidents to prevent or minimize the release of radioactive materials to the environment in a controlled manner.

Core catcher – An engineered device or system intended to collect core debris in the event where the reactor pressure vessel fails due to core melt-through during a severe accident.

Efficiency – A measure of the electricity generated when compared with the thermal energy produced in the reactor core.

Energy availability factor (EAF) – This is the ratio of the available energy generated over a certain period, compared to the reference energy generation over the same period. This is normally expressed as a percentage.

Enrichment – A process used to increase in the percentage concentration of uranium-235 in material intended for use in fuel rods for a nuclear power plant, normally enriched to a level of 5% for power reactors, although some use fuel enriched to just under 20%.

Hydro power stations – Conventional power systems, in which a mass of water stored behind a dam wall is released to drive turbines, which are connected to generators for power generation.

Load factors – A measure of how much electricity a power plant produces when compared with its theoretical capability.

Load shedding – A controlled process used by a utility to reduce load on the grid in order to respond to unplanned events (i.e. the loss of supply) to protect the power system from a total black-out.

Mothballed – Refers to power stations taken out of service indefinitely and maintained for restart at a later date.

MOX (Mixed Oxide Fuel) – Reactor fuel consisting of both uranium and plutonium oxides (typically contains about 5% plutonium).

Payback period – The period predicted by the electricity utility during which all cost associated with the construction of a nuclear plant is recovered.

Peak – A high demand for electricity, especially early morning and evening by domestic users.

Peaking station – A station used for generating electricity when there is a sudden peak in the demand which cannot be met immediately by the base load power stations; i.e. peaking stations are employed to supplement base load stations.

Pressurized water reactor – A nuclear reactor in which the coolant is kept from boiling by a pressurizer, and in which the primary coolant is circulated through a steam generator (heat exchanger) in order to produce steam for power generation by boiling water in the secondary circuit.

Pumped storage system – Akin to a hydro power station, in which water being used for generation during peak periods is returned (pumped) to a high-elevation reservoir during off-peak periods when excess generating capacity is available.

Reactor coolant – The medium used to transfer heat from the reactor core, either to steam generators (PWR) or directly to the turbine (BWR). A variety of coolants are used, including light water, heavy water, helium, carbon dioxide, sodium, lead, and lead-bismuth eutectic.

Reflector – A purpose built metal structure used to reflect neutrons back into the reactor core to enhance fuel efficiency.

Reserve margin – Excess supply to meet unexpected demand.

Severe accident – An event sequence in a nuclear reactor that results in severe fuel damage or fuel melting.

Spent fuel – Used fuel assemblies removed from a reactor after use for energy production, either for reprocessing or for eventual disposal as high-level radioactive waste.

Station black-out – When a nuclear plant loses its normal electrical power supply, normally supplied by the electrical grid, it depends on the emergency diesel generators at the site, which is normally part of the plant design. These emergency diesel generators automatically start up and provide power to essential emergency equipment. However, if for some reason this emergency supply is not available, the plant would be in a condition called “station black-out”.

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CHAPTER 1 INTRODUCTION

1.1 BACKGROUND

Energy is essential for the development of a country’s economy as well as its people. This is evident in large parts of Africa where millions of people are trapped in extreme and abject poverty due to energy shortages that hampers sustainable development. Reports from the International Atomic Energy Agency (IAEA) indicates that more than 10 countries in Africa have 75% of their population living without access to electricity, which is an extremely damning factor considering we live in the 21st century (Brown, 2016). It is for this reason that the South African government has prioritized industrialization and infrastructure investment to ensure electricity supply and distribution to its people and industries (Brown, 2016). Investment to stimulate industrialization and infrastructure development will form the foundation for the economic growth objective in accordance with the National Development Plan (NDP, 2012).

A lack of timely coordination and planning and the delayed implementation of the South Africa’s energy programmes have led to electricity supply shortages, which had a debilitating effect on the economic growth. Energy supply shortages were aggravated by a time-worn power generating infrastructure. The South African government is currently in the process of developing a plan to achieve the optimal energy mix that will ensure long-term energy security as well as a low-carbon economy.

In alignment with the updated Integrated Resources Plan (IRP), the South African Government declared its intentions to procure a fleet of nuclear reactors, which will render a total capacity of 9 600 MW (IRP, 2016).

The South African Government has signed a range of bilateral country-to-country nuclear cooperation agreements. This provided vendor companies from the signatory countries the opportunity to showcase their technologies to South Africa’s nuclear experts. In 2011, the National Nuclear Energy Executive Coordinating Committee (NNEECC) was formed in order to drive the decision-making process. The committee has completed various technical studies, which include in-depth studies into the cost of nuclear power, funding and financing models, and the economic impact on localization. However, a decision on the proposed vendor is still pending. The main reason for the delay is the diverging views on the economics of NPPs between factions of the general public and the elected representatives.

This research will analyse the techno-economic aspects of Generation III and Generation III+ reactor designs that are currently operational, being constructed, as well as approved projects with valid contracts in place.

The following reactor technologies are considered:

- USA – AP1000,
- France – EPR1600,
- China – Hualong1000 (ACPR1000),
- Korea – APR1400,
- Russia – VVER1200 reactor designs.

The research is designed to produce credible costing information for the use of energy policymakers when comparing power generation options in the current energy and economic policy context. It considers current real-world examples to source information on the projected TCIC for nuclear projects around the world, predominantly from the IAEA and the World Nuclear Association (WNA). On occasions, where credible parameters could not be established for a specific cost component, approximations with reliance on available literature were applied.

From the OCC, the labour cost component of each nuclear project is determined, which is compared to the cost of labour in South Africa. The labour cost and labour productivity comparison forms the basis for the calculation of the OCC for the proposed reactor technologies within the South African economic landscape.

The outcome of this study will be used as input for the development and testing of a macro-economic model. The macro-economic model will be used in a socio-economic study of the impact of the nuclear new build programme (NNBP) in South Africa, which is beyond the scope of this research.

This report should not be considered a detailed construction cost plan, but rather a scenario-dependent cost estimate prepared in advance of the detailed engineering preparations required to proceed with construction.

1.2 PROBLEM STATEMENT

Despite the South African Government's public backing of a NNBP, minimal progress has been made in this regard. The lack of progress is primarily due to the uncertainty surrounding the affordability of nuclear technology in South Africa.

The uncertainty is intensified by reported capital costs of current nuclear new build projects such as Olkiluoto in Finland and Flamanville in France, and also the projected cost of the Hinkley Point C project in the UK. However, a study by J.R. Lovering has advised not to draw any strong conclusions about future projects based on past projects, as there is no expected cost trend for nuclear power technology (J.R. Lovering et al, 2016).

With no new nuclear power plants being constructed in South Africa over the past three decades, the amount of information on the costs of building nuclear plants is somewhat limited. Therefore, the problem to be solved in this study is the unavailability of economic data of the five different reactor technologies if it were to be constructed within the South African economic landscape, as well as how the labour cost and labour productivity might impact the projected project cost.

1.3 RESEARCH AIM

The aim of the research is to produce comprehensive costing information that could be used to address the uncertainty surrounding the affordability of nuclear technology in South Africa. Emphasis is placed on the calculation of the OCC for five particular reactor technologies if it were to be constructed within the South African economic landscape. The South African Government have indicated that localization is considered to be a key factor in the selection of a vendor, therefore the research will also consider the impact labour cost and labour productivity of South Africa have in calculating the localized OCC.

1.4 RESEARCH METHODOLOGY

The methodology used for this research (refer to Figure 1) starts with a literature survey of nuclear power economics. The initial literature survey discusses the key aspects that influence nuclear power economics. In addition to this, a high-level technical evaluation provides some insight into the differences between the reactor technologies under consideration.

The literature survey is based on information gathered from accredited international peer-reviewed journals and reports that deliberate on the economics of new nuclear power projects around the world. Reactor vendors were specifically excluded during the information-gathering process.

The calculations in this research are based on the reported total capital investment costs (TCIC) of the projects under consideration.

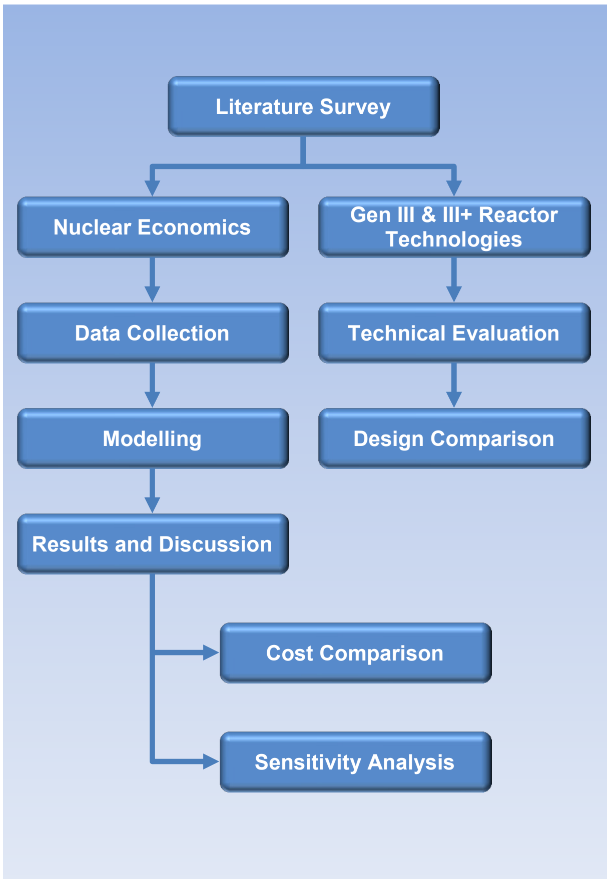

Figure 1: Research methodology

Firstly, the reported TCIC for all the projects were converted from nominal dollar values to constant 2016-dollar values to account for inflation. From here, the OCC for each project was calculated.

Using Microsoft® Excel®, the cost data obtained from literature was captured in a spreadsheet, which was sequentially set up to allow the reader to follow how the TCIC was used to determine the OCC of a particular project in the South African economic landscape.

The TCIC was used, together with mathematical correlations obtained from nuclear power economics literature, to calculate the OCC of each project if it were to be constructed in the South African economic landscape (refer to Appendices 9 – 30).

Finally, a cash flow model will be developed in order to calculate the total loan amount required for each project, which will allow for a high-level cost comparison. In addition to this, a sensitivity model is derived in order to determine which factor between CCL, labour cost and labour productivity, will have the most significant influence on the localized OCC.

1.5 RESEARCH OBJECTIVES AND PROJECT SCOPE

The main objective of this research is to develop OCC cost estimations for different Generation III and Generation III+ reactor technologies within the South African economic landscape. The outcome of this study will be of value to the energy policymakers to address the uncertainty surrounding the affordability of nuclear technology in South Africa.

This research only considers light water reactor (LWR) reactor designs of the Generation III and Generation III+ types, which are currently operational or under construction. In addition to this, the cost predictions for various other projects that were approved by utilities and governments around the world were also taken into consideration.

The following are the specific objectives for this research:

- Give concise introduction and background of the problem.
- Analyse and deliberate on nuclear power economics.
- Analyse and deliberate on unit labour cost, labour rates, and labour productivity within the South African construction industry.
- Analyse and deliberate on the different reactor technologies within the scope.
- Calculate the OCC of the identified nuclear new build projects.
- Calculate the labour cost component for each of the identified nuclear new build projects.
- Determine the unit labour cost (ULC) of the countries that are currently constructing or planning to construct nuclear new build projects.

- Compare the ULC of the various countries to that of South Africa.
- Determine the OCC of each reactor technology within the South African economic landscape by taking the ULC into account.
- Analyse and discuss the OCC for the different reactor technologies within the South African economic landscape.
- Conduct a sensitivity analysis in order to determine which factor between CCL, labour cost and labour productivity, will have the most significant influence on the localized OCC.
- Compile a research conclusion and produce recommendations for further studies.

Technologies to be considered in this research are listed in Table 1.

Table 1: Reactor technologies under consideration

#	Vendor Country	Vendor	Reactor Design	Reason for Consideration
1	USA	Westinghouse	AP1000	Vendors with extensive experience in the construction and operation of NPPs.
2	French Republic	Areva	EPR1600	
3	Russian Federation	Rosatom	VVER1200	
4	South Korea	KEPCO	APR1400	The standardised approach from the South Korean utility has consistently delivered low execution costs.
5	People's Republic of China	CNNC	Hualong One	With 19 reactors under construction, apart from its 38 plants already operational, China is currently the country with the biggest expansion plans for nuclear energy.

1.6 OUTPUTS AND DELIVERABLES

The outcome of this research project will provide costing information that will be useful to the policymakers as a reference in the decision-making process for a NNBP in South Africa. The outputs shall include the following:

- The difference in labour cost requirements between South Africa and those countries that have current, recently constructed, or planned nuclear new build projects. This will indicate the impact of labour cost and labour productivity on OCC.
- The localized OCC of each of the reactor technologies under consideration.
- The total loan amount required for each of the different reactor technologies in the South African economic landscape.
- A sensitivity analysis.

1.7 WORK EXCLUDED

Due to time constraint, some of the following topics will not be discussed in this research report, whereas others will purely be introduced:

- The development and testing of a macro-economic model to be used in a socio-economic study of the impact of the NNBP in South Africa.
- Reactor design: Existing design data used to represent each concept.
- The debate on nuclear safety.
- Generation I, II, & IV reactor technologies.
- Detailed discussion on levelized cost of electricity (LCOE).
- Detailed discussion on operation and maintenance cost (O&M).
- Detailed discussion on material costs.
- Detailed discussion on weighted average cost of capital (WACC).
- Detailed discussion on NPV and IRR.

1.8 RESEARCH BACKGROUND

1.8.1 Power Shortages

The South African national power system became severely strained in the latter months of 2007 due to the ever-increasing demand for electricity. This increase in demand was mainly due to economic and social development. The power system became more and more constrained due to the generating fleet not being as reliable as it once was and the failure to bring new generating capacity on line. The outcome of this was that at times, electricity demand exceeded the supply. In order to protect the national power system, Eskom, the state-owned power utility, had to resort to controlled rotational load shedding. This became customary in the latter months of 2007 (Eskom, 2014).

Eskom embarked on various interventions in an attempt to meet the increasing demand, and in so doing, attempted to limit the impact of what was then deemed an energy crisis. The interventions included upgrades performed on infrastructure, which resulted in improved plant performance and reliability. Eskom also re-commissioned units at three power stations that were mothballed in the late 1980s and early 1990s when the country was experiencing electricity overcapacity (Fin24, 2011). Through these interventions, Eskom managed to produce almost 3 800 MW in additional capacity, bringing some alleviation to the constrained power system. However, even these interventions could not preclude load shedding entirely.

In an attempt to eliminate load shedding, Eskom made a decision to operate their ageing coal power stations at full capacity for extended periods. This interfered with the plant maintenance regimes, resulting in much needed maintenance being deferred. This strategy enabled Eskom to suspend load shedding in May 2008, a feat that lasted for most of a 4-year period (Eskom, 2014).

The global financial crisis of 2008 also led to an economic downturn, which caused a decrease in the demand for electricity, yet bringing some alleviation to the constrained power system (Van der Nest, 2015).

Ultimately, the deferred maintenance strategy would catch up with Eskom with intermittent plant breakdowns becoming regular phenomena (refer to Figure 2). In November 2014, South Africa was again exposed to load shedding when a coal silo collapsed at Majuba power station. The collapsed silo hindered the delivery of coal to the operational units of power station, causing a loss of 3 000 MW. This, as well as other unplanned outages, showed in the energy availability factor (EAF) for Eskom's fleet declining from 85% to 75% over five years since 2008 (Eskom, 2014).

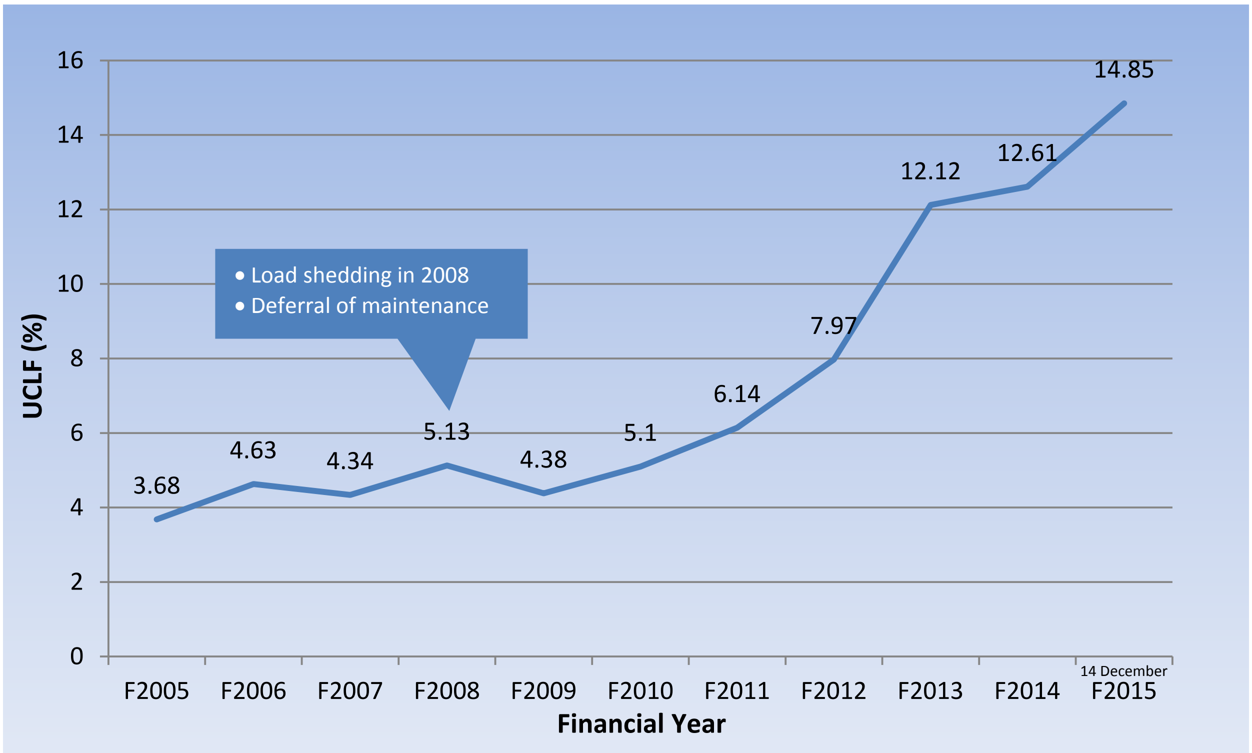

Figure 2: MW not available due to plant breakdowns (Eskom, 2014)

At times, up to 34% of the installed generating capacity was unavailable due to planned and unplanned outages, leaving as little as 29 115 MW to serve the country with a peak demand of just over 37 000 MW (Eskom, 2014).

Since then, plant availability has improved vastly from 67.84% in April 2015 to 77.3% in March 2017. The major role players in this step change were Eskom reinstating and adhering to a rigorous plant maintenance schedule, the extensive operation of the open cycle gas turbines (OCGTs) until late 2016, and the economic downturn which caused a decrease in the demand for electricity (Eskom Integrated Report, 2017).

1.8.2 Energy Outlook

The lack of access to a secure electricity supply remains one of the biggest barriers to the development and prosperity of the people of South Africa, and to a greater extent, the African continent. As a result, millions of people remain trapped in debilitating poverty (Brown, 2016).

At present, Eskom owns and operates a generation capacity of close to 42 100 MW (nominal), which amounts to 96% of the South African electricity needs (Koko and Singh, 2016). International best practice prescribes a reserve margin of 15% within any electricity supply system in order for it to be considered “healthy”. This reserve margin is designed to cater for unexpected surges in demand (US EIA, 2012).

The highest ever peak supply of just over 37 000 MW was recorded in 2014 (Kenny, 2015). Due to the increase in population, the current peak supply could be well over 37 000 MW. This assumption is backed up by Eskom stating that the reserve capacity has been reduced from the 15% level to about 8%, which is insufficient for reliable supply (Eskom, 2017). The situation will deteriorate over time as more power stations, especially the conventional coal-fired power stations of which 65% is already past their mid-live point, will reach the end of their operational life. In order to address this, the South African Government has prioritized the supply and distribution of electricity to its people and industries (Brown, 2016).

1.8.3 Strategy – Integrated Resource Plan 2010 (updated)

In October 2010, the South African Government released, through the Department of Energy (DOE), a draft integrated resource plan (IRP) for the period 2010-2030, which outlines the country’s electricity demands in order to meet the objectives of the national development plan (NDP). Part of the objectives of the NDP is to ensure that at least 90% of the population will have access to grid electricity by 2030 (NDP, 2012).

The IRP was released in early 2011 for public consultation on matters such as:

- Energy security and affordability in order to progress local industry.
- Recommendations on how to diversify the power sources.
- Recommendations on how to reduce climate change.

The revised plan, passed by Cabinet in March 2011, strives for a balanced scenario, aiming to produce the best trade-off between least investment cost, climate change mitigation, diversity of supply, localization, and regional development (IRP, 2016).

Due to a number of developments in the energy sector in Southern Africa as well as the demand outlook that has changed since the approval of the IRP 2010-2030, Government deemed it necessary to update the IRP for the period 2020-2050 (IRP, 2016). The public was again given the opportunity to interrogate the choices and cost assumptions used by the policymakers to reach their conclusions regarding technology choices.

The updated plan predicts that the existing capacity will start to decline dramatically from 2025 onwards, with significant plant retirement occurring in 2031, 2041, and 2048 as the majority of the coal-fired power stations come to their end of life. This means that only 20% of the current electricity generation capacity will remain come 2050 (IRP, 2016). The updated IRP states various requirements in order to maintain an adequate supply in support of economic growth. One of the requirements is a nuclear new build programme that will generate an additional 9 600 MW, with the first unit coming on line by 2026 (IRP, 2016).

1.8.4 Nuclear New Build

In 2007, Eskom's Board approved a plan to expand its generation fleet. The idea was to construct a fleet of nuclear power stations that would increase generating capacity to nearly 80 GWe. However, in December 2008, Eskom announced a decision to put their nuclear build programme on hold as the procurement process stalled in the wake of the global financial crisis. At the time, the South African Government supported Eskom's decision, as they believed it to be too expensive (WNN, 2008).

The nuclear new build plan was revisited following the approval of the IRP 2010, in which it was recommended that the nuclear component of the total energy mix be increased to 13.4% by 2030. The current nuclear contribution to the total generation mix is about 4.4%, which is less than a third of the required 13.4%.

The South African Government has stated its stance on nuclear on many occasions, and this was backed up by the approval of the IRP 2010. In November 2011, Government established the National Nuclear Energy Executive Coordinating Committee (NNEECC), which is a leadership structure at state level. Led by the then Deputy President Kgalema Motlanthe, this committee, containing eight Cabinet members, was given the authority for decision making, monitoring, and general oversight of the nuclear new build programme (Van Wyk, 2013).

To date, minimal progress has been made with regard to procurement. In order to meet the objective of a 13.4% nuclear contribution by 2030, nuclear power plants (NPPs) need to come on line from 2026 (DOE, 2016).

1.9 OUTLINE OF DISSERTATION

This research report comprises six chapters, the contents of which are as follows:

- **Chapter 1** – Introduction, Background, Problem Statement, Research Aim, Research Methodology, Research Objectives and Project Scope, Outputs and Deliverables, Work Excluded, Research Background, and the Outline of Dissertation.
- **Chapter 2** – Literature Survey discussing the economic impact of load shedding in South Africa, South Africa's Capacity Overview, Eskom's New Build Programme, Nuclear Build Projects around the World, as well as Nuclear Power Economics.
- **Chapter 3** – PWR Technology Overview.
- **Chapter 4** – Economic Evaluation of Reactor Technologies under consideration for South Africa's NNB, Results and Discussion.
- **Chapter 5** – Conclusion and Recommendations.

The chapters are followed by:

- **Bibliography**
- **Appendices**

CHAPTER 2 LITERATURE SURVEY

In the early part of the twentieth century, electricity supply in South Africa was mainly driven by the demand from the mining industry, which has been a key factor in developing South Africa's economy over the years. This supply came in the form of various power projects initiated by the South African Government, through Eskom, during the 1960s and 1970s. These projects were predominantly coal-fired power stations. The majority of power stations were positioned in the north and north-eastern parts of South Africa where the bulk of coal reserves are concentrated. In order to supply the increasing demand from the coastal regions in South Africa, the South African Government opted to build the country's first NPP near Cape Town in the Western Cape, with construction starting in the mid-1970s (WNA, 2016).

Eskom's ambitious build programme led to the country having a large electricity reserve margin in the early 1980s, which permitted relatively low electricity prices. However, this resulted in a lack of investment in new generating capacity, as well as electricity tariffs not being reflective of what would be required to support future capital expansion projects (Koko and Singh, 2016).

Since 1990, energy consumption has increased rapidly, the chief consumers being industrialization and infrastructure development due to the growth in population. In addition to this, energy consumption also intensified after 1994 when the democratically elected Government initiated the mass rollout of electrification in order to lend a new sense of belonging to people who were previously excluded from accessing electricity services. In South Africa, access to electricity for household usage in the mid-1980s was at a mere 35%. Since then, this figure has more than doubled to 83% by 2011 (DOE, 2015). Electricity has become one of modern society's greatest necessities after food, water, and shelter; hence, it can be expected that the demand for electricity will continue to rise (Wilson, 2009). The South African Government envisage having more than 90% of the population to have access to electricity by 2030 (DOE, 2016).

In order to cater for the increase in energy demand, additional capacity is required. However, a lack of timely coordination and planning delayed the implementation of the country's energy programmes, which has subsequently led to serious supply shortages.

2.1 ECONOMIC IMPACT

The intermittent power outages that occurred between 2007 and 2015 have led to a decline in the South African economy and investor confidence (Van der Nest, 2015).

The South African economy relies heavily on the large-scale, energy-intensive mining industry (US EIA, 2015). This was evident in the wake of Eskom's decision to enter into interruptible load agreements with key customers in the mining industry and various other industrial sectors. Even though Eskom's load shedding schedule was broken down into two-and-a-half-hour periods per area, it significantly affected industry operations. For large industries such as mining operations or steel foundries, power outages lasted much longer. It normally takes several hours for miners to be evacuated from the mines, and smelters and refineries have complex restart sequences that require up to a full day or even longer to get production up and running again. This resulted in significant loss of production time (Van der Nest, 2015).

South Africa relies heavily on the export of its precious metals and coal to finance its current account deficit. As a result, the load shedding on mining operations led to a strong depreciation of the Rand, as well as a stalling of economic growth and downward revisions in growth forecasts. Several rating agencies have also downgraded the country’s credit rating, which has had a negative impact on the outlook of the country as an investment destination (Van der Nest, 2015).

Industrialization and infrastructure development, especially in the mining sector, were key aspects in driving the South African economy over the years to become the second largest economy in Africa (US EIA, 2015). Energy security is therefore crucial for the realization of the NDP’s objectives, one of which is achieving economic growth of 5.5%, currently estimated to be around 4% (Joemat-Pettersson, 2015).

2.2 CAPACITY OVERVIEW

At present, Eskom owns and operates a generation capacity of close to 42 100 MW (nominal), which amounts to 96% of the South African electricity needs (Koko and Singh, 2016). The remaining 4% is being provided through local authorities, industry, and other imports through the Southern African Power Pool (SAPP). Eskom’s generating fleet comprises a variety of sources as illustrated in Figure 3.

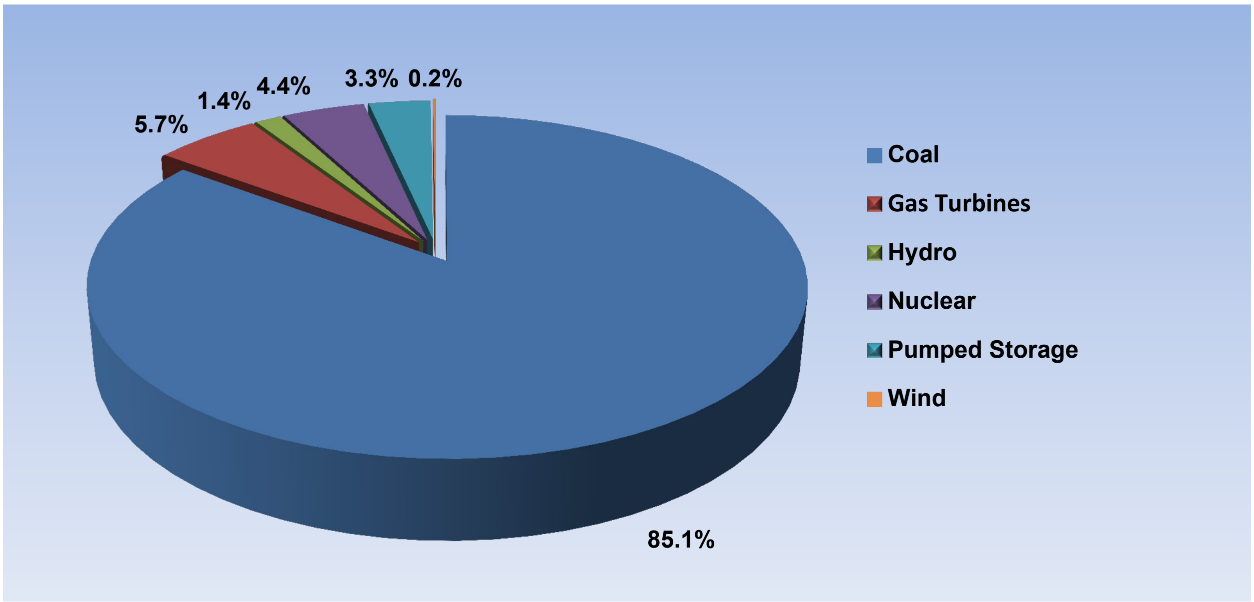

Figure 3: Eskom generation plant mix (Koko and Singh, 2016)

Operation of an electric power system is dictated by the daily load requirements of the country. For most power systems in the world, there is a required minimum level of demand for electricity over a 24-hour period. This required minimum level is termed the "base load" of the power system. The concept of base load demand is illustrated in Figure 4, that is, the area below the green 24 000 MW line.

Base load capacity is traditionally supplied using fossil fuels and nuclear. These stations normally operate continuously at a steady load for 24 hours per day, and are generally only shut down for scheduled maintenance or emergency repairs. South Africa's base load capacity is predominantly supplied by several coal-fired power stations and by one nuclear power station (Eskom, 2016).

The demand for electricity varies throughout the day due to changes in business operations and residential activities. This results in the demand increasing to a higher-than-usual level over a 24-hour period. The higher-than-usual demands are termed "peak loads". Peak loads are the highest load demands above base load demand (refer to Figure 4), that are experienced throughout a 24-hour period. In South Africa, the main peaks usually occur from around 06:00 in the morning and lasts until about 09:00. A second peak period is normally experienced from about 16:00 until 21:00. During these times, demand approaches the available capacity (Eskom, 2016); refer to Figure 4.

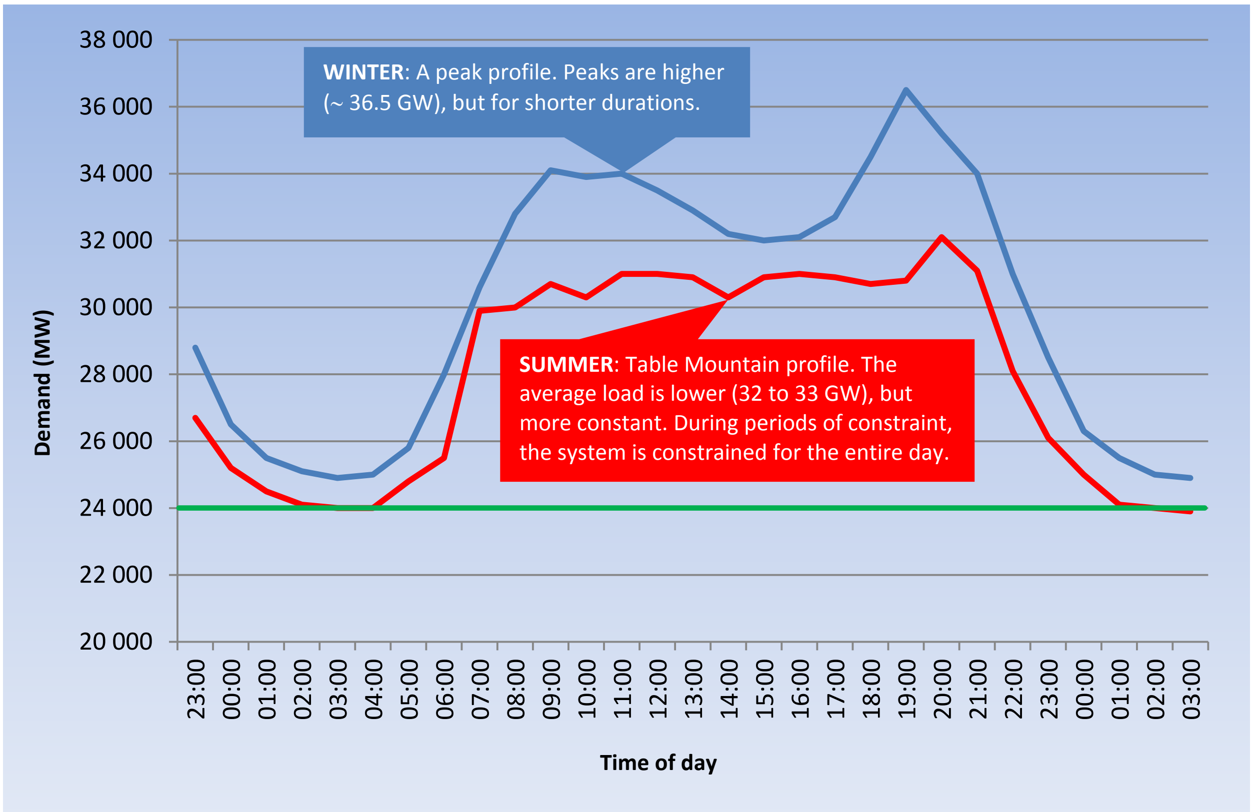

Figure 4 Typical winter and summer load profiles (Eskom, 2016)

Generally, base load power stations do not have much flexibility for following the load variations. For this reason, they are supplemented with more flexible peak-load and intermediate-load power stations. Peak-load and intermediate-load power stations start up rapidly and can go from shutdown to full load within minutes in order to meet peak demands. In South Africa, these peak-load and intermediate-load power stations comprise pump storage, hydroelectric, and OCGTs.

2.3 VARIOUS ENERGY SOURCES

2.3.1 Coal

South Africa is amongst the top 10 producers of coal in the world, which also makes it one of the leading coal export nations (CIAB, 2016). As a result, coal is relatively inexpensive, hence it being a favourite for electricity production. This is borne out by the 85.1% share that coal-fired power stations have of the total primary energy generated (Koko and Singh, 2016).

However, burning coal for energy production has become a controversial issue as it is considered to be a leading contributor to greenhouse gas (GHG) emissions, the primary cause of global warming according to the Union of Concerned Scientists USA (UCSUSA). For this reason, the use of fossil fuels for energy production has come under scrutiny in recent years as GHG is also deemed to have a negative impact on respiratory health. This led to the international community implementing various policies in attempt to limit GHG emissions.

South Africa is said to be the leading emitter of carbon dioxide in Africa, accounting for 40% of emissions in Africa and the 13th largest emitter in the world (US EIA, 2015). This is putting the South African Government and Eskom under pressure, which is one of the reasons why the IRP is aiming for a diverse energy supply in order to limit the effects on climate change (Integrated Energy Plan, 2016).

2.3.2 Natural Gas and Diesel

In South Africa, as in most other countries, OCGT and diesel engines are mostly used when the demand exceeds the maximum output, i.e. for peak load production. Currently, OCGT and diesel-powered generators contribute 5.4% to the total generated capacity. They are generally more expensive to operate in the South African economic landscape due to the uncertainty surrounding proven gas resources and the volatile price of crude oil. However, in countries such as North America where abundant gas reserves are available at a relatively low price, gas is widely used as an alternative base-load solution (WNA, 2015).

During the period when load shedding was prevalent in South Africa, Eskom used the OCGTs to supplement the base-load stations. However, this came at a very high expense; in the region of R8.7 billion compared to a budgeted R2.9 billion (Eskom Integrated Report, 2016).

Currently, South Africa has limited gas resources at its disposal, but the South African Government has initiated various surveys in order to establish the potential of shale gas resources in the country. Initial estimations indicated approximately 485 trillion cubic feet of natural gas resources (US EIA, 2015). Should this be confirmed, South Africa would be in a position to explore the potential of using natural gas as a low-carbon alternative for electricity generation. This potential was enhanced by the discovery of gas reserves along the southern coast (offshore) of South Africa (Modise and Mahotas, 2016). In addition to this, there is also the possibility of sourcing gas from neighbouring countries such as Mozambique and Namibia. Based on these estimates, the option of natural gas shows real potential in South Africa (Modise and Mahotas, 2016).

2.3.3 Hydro and Pumped Storage

The current generation plant mix includes two conventional hydroelectric power stations and three hydro pumped storage schemes. These two types of stations have a combined installed capacity of 2 000 MW which accounts for 4.7% of Eskom's total generating capacity (Koko and Singh, 2016).

In order to generate hydroelectricity, a significant difference in elevation is required between two platforms that will allow water to flow from the top platform to the hydro generating plant at the bottom. South Africa has no great prospects in terms of water resources combined with a favourable landscape required for a hydro generation plant; hence the small contribution to the total generating capacity.

South Africa supplements its electricity supply by importing capacity from hydropower facilities in neighbouring countries such as Mozambique (Cahora Bassa), Zambia, Zimbabwe, and Zaire (DOE, 2015).

2.3.4 Renewable Energy

Renewable energy technology options were marginalized in the past due to Eskom having had excess capacity. Developments were often left to a few pilot projects largely driven by the international donor community. However, since the first implementation of load shedding in 2008, the landscape has changed dramatically. Such is the drive for renewable energy technologies that it is forming the basis of the energy mix proposed in the IRP. Consequently, the IRP 2010 has set a target of 17 800 MW (equivalent to 42%) of renewable capacity, comprising largely solar (photovoltaics and concentrated solar power) and wind (DOE, 2015).

The main objective of this initiative is to provide for some stability in terms of supply in the short to medium term as renewable technologies take considerably less time than conventional power stations to come on line and be integrated with the system (Joemat-Pettersson, 2015).

At present, Eskom has few commercially operating renewable power sources, amounting to 100 MW (0.2% of total capacity). Since 2011, the country has introduced a world-class competitive bidding process, which to date has attracted 92 independent power producers (IPPs) who will contribute in excess of 6 327 MW (DOE, 2015).

2.3.5 Nuclear

Eskom has one nuclear power plant in its generation fleet, namely Koeberg Nuclear Power Station (KNPS) located about 30 km north of Cape Town. KNPS is a Generation II plant, based on the French CP-900 MW reactor technology.

KNPS is the only commercially operated NPP on the African continent and comprises two pressurized water reactor (PWR) units. Construction of the two reactors units, done by the French consortium Framatome (now Areva), began in 1976 with the first unit starting commercial operation in April 1984 (WNA, 2015). This means that the KNPS is now approaching the 40-year operational life span of a conventional NPP, which will be around seven years from now, in 2024. This might have some impact on the IRP and the objectives of the NDP. As an interim measure, Eskom is in the process of conducting a self-assessment with the view on long-term operation, along with the implementation of various plant modifications at KNPS in order to prolong the plant's operating life to 60 years (Austin, 2015).

KNPS contributes 1 860 MW to the national grid, which amounts to 4.4% of the total generating capacity, and has an availability factor of 83.9% (IAEA, 2017).

As part of the long-term energy security strategy, the South African Government has highlighted nuclear to be an integral part of the future energy mix alongside a variety of renewables and low-carbon fossil fuel sources (Joemat-Pettersson, 2015).

2.4 ESKOM'S NEW BUILD PROGRAMME

Eskom is currently expediting the construction of three major power projects across the country. This comprises two new coal-fired power stations, Medupi and Kusile in the Limpopo an Mpumalanga provinces respectively, consisting of 6 units each with a combined installed capacity of 9 600 MW once completed (Eskom Integrated Report, 2016). In addition to this is the Ingula pump storage facility in Kwa-Zulu Natal, comprising 4 units, which came into full commercial operation in January 2017.

On 23 August 2015, Eskom announced the commercial operation of the first unit at Medupi (unit 6) which added 794 MW to the South African national grid (Alstom, 2015). This was shortly followed by the commercial operation of unit 5 on 3 April 2017 (Reuters, 2017).

Unit 1 of Kusile power station was connected to the national grid for the first time on 27 December 2016. This facility, once fully commercially operable, will add 800 MW to the national grid. Together these projects promise to add roughly 11 000 MW to the grid between June 2015 and May 2020 (Eskom Integrated Report, 2016).

2.5 NUCLEAR BUILD PROJECTS AROUND THE WORLD

The focus currently is on renewable energy technologies, predominantly subsidized wind and PV solar systems, and how these technologies can be incorporated into current and future energy mixes. Renewable energy technologies have great potential for a variety of applications, but the debate on whether renewable technology can be employed to produce large-scale continuous supply of electricity, i.e. base load demand, is still ongoing (WNA, 2015).

Historically, coal and nuclear have been the sources for large-scale base-load power generation, not considering countries such as the North America where the price of gas is relatively low and its future supply fairly secured. However, the use of fossil fuels is becoming less favourable with national policymakers and the public due to CO_2 emission and the perceived detrimental effects it has on climate change and human health (WNA, 2015).

There is an ever-growing demand and consumption of energy due to population growth and industrial development in developing countries (WNA, 2015). As a result, many countries, mainly in Eastern Europe and Asia, are retaining nuclear as a primary energy source. China, Russia, and India are currently among the countries with major nuclear new build projects. Globally, there are 58 reactors under construction in 15 countries, with 19 of these being in China (IAEA, 2016); refer to Figure 5. Various other countries, including South Africa, are also considering nuclear build projects to form part of a balanced energy mix (IRP, 2016).

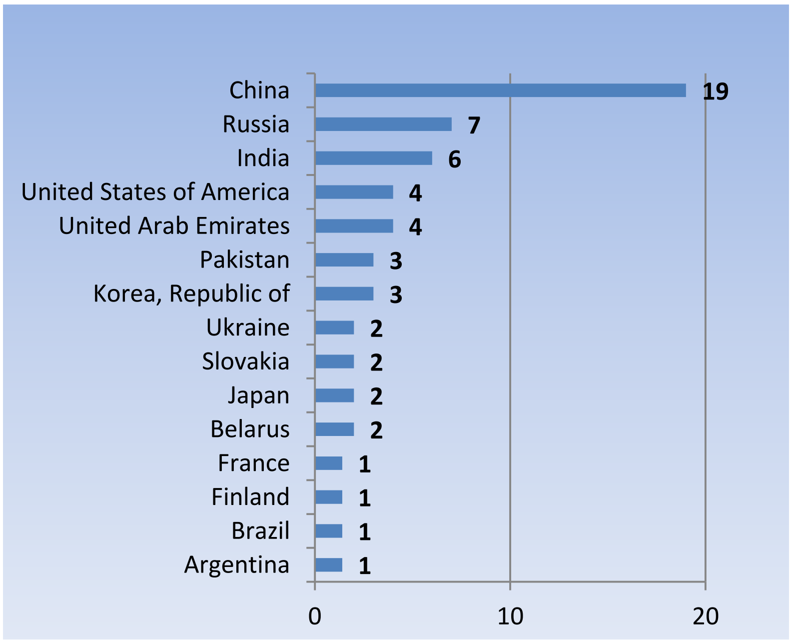

Figure 5 Total number of reactors under construction (IAEA, 2017)

Despite the upturn in the international number of nuclear new build projects, the proposed NNBP in South Africa remains a controversial issue. This is mainly due to the uncertainty around the associated cost, i.e. what a nuclear fleet will cost, and whether the country can afford it. In an attempt to address this, the NDP called for an investigation into various aspects of the NNBP, including cost, before a procurement decision is taken (NDP, 2012).

2.6 NUCLEAR POWER ECONOMICS

A review of available information indicates that the average capital investment costs of advanced nuclear power plants were estimated to be at about US $5 945/kW in 2015 dollars (US EIA, 2016). Findings from various studies that have been performed on nuclear economics indicate that nuclear energy projects are capital intensive and their economic competitiveness is heavily influenced by its construction schedule and the associated interest charges (WNA, 2017). Other factors that also have an impact on nuclear economics are the rising costs of capital, higher global commodity prices, and skills shortages (US EIA, 2016).

2.6.1 Nuclear Economic Definitions

2.6.1.1 Total Capital Investment Cost

The total capital investment cost (TCIC), also referred to as the “all-in cost”, is the total up-front cost incurred for constructing an NPP and bringing it to a commercially operable state (EMWG Guidelines, 2007). Several studies on nuclear power economics consider the TCIC by far the most important factor in the cost of nuclear electricity (D’haeseleer, 2013).

The TCIC, here expressed in $/kWe, consists of the total overnight construction cost (OCC) and the cost involved in repaying the cost of construction loan (CCL). Mathematically, the TCIC can be expressed by the following formula:

$$TCIC = (CCL) + (OCC)$$

2.6.1.2 Cost of Construction Loan

The cost relating to the construction loan is a combination of the cost incurred due to interest during construction (IDC) and the cost incurred due to escalation (Gonzalez, 2014).

2.6.1.2.1 Interest during construction

Interest during construction (IDC) is the amount payable on the up-front financing cost required to bring the plant to a commercial operating state (D’haeseleer, 2013). As soon as the project capital is raised and the construction payments begin, an interest payment becomes due to investors (equity) as well as interest payments to service loans (debt). These interest payments on debt and equity are applicable from the start of construction until commercial operation (EMWG Guidelines, 2007).

Nuclear power technology is known for having relatively high up-front cost and generally takes longer to construct when compared to construction cost of other electricity generating sources. This makes IDC a significant cost component in the evaluation of nuclear power economics (US EIA, 2016).

IDC is influenced by factors including the construction period, the OCC and the reference time for OCC, the financing arrangements, the discount rate (WACC), and inflation (D’haeseleer, 2013). These factors allow for IDC to be determined through the following equation (CEU, 2008):

$$IDC = OCC \times (IDC)_{fract}$$

Where: $(IDC)_{fract} = \sum_{k=1}^{C_T} W_k \left[(1+r)^{C_T-(k-1)} - 1\right]$

$OCC = Overnight\ Construction\ Cost$

$(IDC)_{fract}$ = The additional fraction of the OCC due to interest during construction

C_T = The construction period [months]

Wk = The fraction of the total capital expended in year k

r = The discount rate

NOTE: *The discount rate “r” is expressed in decimal form and that “W_k” and “r” are both expressed in either nominal or real terms (D’haeseleer, 2013).*

2.6.1.2.2 Cost escalation

Cost escalation is essentially the cost incurred due to increased materials and labour costs as a result of inflation. The cost escalation is normally predicted by considering some of the following factors (D’haeseleer, 2013):

- Change in the inflation rate.
- Change in the project schedule.
- Change in the predicted price evolution of particular goods and services.

Historical data, in particular cost estimates or actual construction costs, are used in order to extrapolate this information.

2.6.1.3 Overnight Capital Cost

The overnight capital cost (OCC) is described as the cost of a construction project excluding the finance cost, i.e. as if the project was completed “overnight” with no interest incurred and no escalation cost taken into consideration. The OCC comprises base construction costs (also referred to as the engineering, procurement, and construction cost), owner’s costs, contingency costs, as well as the first core costs and commissioning cost (EMWG Guidelines, 2007).

2.6.1.4 Engineering Procurement and Construction Cost

The engineering, procurement, and construction cost (EPCC) is described as the most-likely plant construction cost and comprise the direct costs, indirect costs, and the cost of services provided by the EPC contractor (D’haeseleer, 2013). The EPCC makes provision for costs that relate to site preparation, materials, equipment, manpower aspects, as well as the supervision services for construction, engineering, and licensing activities (D’haeseleer, 2013).

The direct cost comprises the cost of the physical plant equipment as well as the labour and the materials to assemble it, and accounts for 60% of the EPCC cost (WNA, 2017).

The remaining 40% of the EPCC is allocated for the indirect cost and other services provided by the EPCC contractor. This accounts for all the costs that are not directly associated with the plant and comprises supervision of construction, engineering, and licensing activities, design and project management services, as well as support labour (Mitev, 2014; EMWG Guidelines, 2007).

2.6.1.5 Owner’s Cost

A study by William D. D’haeseleer explains several definitions of owner’s cost (OC). All these definitions concur that the OC is dependent on which costs are accepted by the owner outside the EPCC contract, i.e. all the cost that the utility owner will have to cover from its own resources (D’haeseleer, 2013). The OC will vary from project to project but in most cases, it will include the following (US EIA, 2010; WNA, 2017):

- Development cost including preliminary feasibility and engineering studies, environmental studies, licences and legal fees, and project management and insurance cost.
- The purchase of land and the preparatory site works to prepare the site for construction.
- Site works, including construction of administration and associated buildings, as well as the plant switchyard.
- Owner’s contingency as well as property taxes during construction.

2.6.1.6 Contingency Cost

Contingency cost is the cost that is added upfront to the OCC to cater for uncertainties and errors in the initial estimation. It also caters for the unpredictability that comes with site-specific differences (NREL, 2012). Operational experience has shown that contingency costs are likely and expected to be incurred, even though they cannot be explicitly determined at the time of cost estimation (NETL, 2011).

Project contingency does not make provision for potential changes from external factors such as changing regulatory requirements, major design or project scope changes, natural disasters, labour unrest, or project funding limitations (EMWG Guidelines, 2007).

2.6.1.7 Weighted Average Cost of Capital

The weighted average cost of capital (WACC) represents the overall cost of financing which would be incurred by a utility raising the funds to be invested in a nuclear project (IAEA Nuclear Contracting Toolkit, 2016). The WACC for a proposed project is calculated by taking into account the split between debt and equity financing, i.e. how much of the financing will be via share issuance versus how much will be borrowed. The WACC can be calculated by using the following formula (IAEA, 2016):

$$WACC = (k_E \times share\ of\ Equity) + (k_D \times share\ of\ Debt) \times (1 - t)$$

Where: k_E = *Estimated cost of Equity.*

k_D = *Estimated cost of Debt.*

t = *Tax rate faced by the company.*

$(1 - t)$ = *The tax deductibility of corporate borrowing.*

The WACC for a proposed project is compared to the utility's cost of capital, also known as the discount rate, to determine the feasibility of the proposed project, i.e. if the minimum return on the proposed project will be sufficient to satisfy its creditors, the owners, and other providers of capital (IAEA, 2016).

The WACC of a project is dependent on various project related risks. If the project is deemed high risk, the cost of debt and equity will also be higher which will result in the investors seeking a higher return on investment (US EIA, 2016).

2.6.1.8 Discount Rate

The discount rate caters for the time value of money by taking unforeseen investment risk into account. This is based on the concept that money that is to be paid or received in the future will be less valuable than money paid or received in the moment (IAEA, 2016). A utility will therefore only proceed with a new venture if forecasts show that a proposed project will be profitable, i.e. its expected revenues will be larger than its expected costs. Ultimately, the discount rate makes it possible to estimate how much the project's future cash flow would be worth in the present (net present value). The higher the discount rate, the smaller the present investment needs to be to achieve the revenue required for the project to succeed. The EMWG recommends the use a discount rate equal to the WACC, which will be the expected return on investment (EMWG, 2007).

2.6.1.9 Net Present Value

The net present value (NPV) is a common component in discounting future cash flows and widely used to analyse the profitability of a proposed project. To assess whether the cash flow of a new project is sufficient to reimburse the investment and capital costs used to finance a project, investors calculate the NPV. NPV calculations are based on expected prices and takes into account the variation and uncertainty of the expected prices over time (IEA and NEA, 2015).

This is done by calculating the difference between the discounted, or present, value of the revenues that will be accrued over the commercial life of a project, and the investment made during construction, operation, and for the purpose of decommissioning (G.S. Rothwell, 1997). The calculation for the NPV is done by using the following formula (G.S. Rothwell, 1997):

$$NPV = \sum \frac{(R_t - C_t)}{(1 + r)^t}$$

Where: R_t = *"Cash in-flow per period" which is the revenue expected in each future period t.*

C_t = *"Cash out flow per period" which is the cost in each future period t.*

r = *The real discount rate.*

A positive value for the NPV implies that projected earnings generated by a project exceed the initial cost, i.e. the project earns a higher yield than the assumed discount rate (Winkler & Streit, 2008) whereas a negative NPV implies that the proposed project will not deliver a sufficient return (IEA and NEA, 2015). The NPV will not be covered as part of this study as it is not the objective to compare profitability of the various generating sources under consideration.

2.6.1.10 Internal Rate of Return

The internal rate of return (IRR) of a project is that rate of return, or interest rate, at which the NPV of that particular project becomes zero and is used to show the effect of the construction lifetime on the cost of capital (Winkler & Streit, 2008). This means that the project's expected revenue in each future period is equal to the cash outflow in each future period. In order to calculate the IRR, the same formula as calculating NPV is applicable. The formula is as follows (G.S. Rothwell, 1997):

$$NPV = \sum \frac{(R_t - C_t)}{(1 + r)^t}$$

Where: R_t = *"Cash inflow per period" which is the revenue expected in each future period t.*

C_t = *"Cash outflow per period" which is the cost in each future period t.*

r = *IRR.*

In this calculation, estimated discount rates are used and adjusted in an iterative process to determine the value of the discount rate at which the NPV equals zero, which is the value of IRR (IAEA INPRO, 2014). Generally, the higher a project's internal rate of return, the more desirable it is to undertake the project (Winkler & Streit, 2008).

2.6.1.11 Levelized Cost of Electricity (LCOE)

The levelized cost of electricity (LCOE), normally expressed in \$/MWh, is the most common standard and measure used in the energy industry to do an overall competitiveness assessment of a variety of electricity generating technologies. LCOE is described as the constant unit cost for generating electricity, charged by the utility to cover the cost for owning, operating, and maintaining a power plant over its entire lifetime (WNA, 2017). The key inputs into calculating the LCOE include the OCC, the fixed and variable operations and maintenance (O&M) cost, the fuel cost, the financing cost, the expected operational lifetime, and the assumed load factor. The LCOE can be calculated by the following formula (D'haeseleer, 2013):

$$LCOE = \frac{[OCC \times CRF + FOM]}{8760 \times LF} + VOM + FC$$

Where: $OCC = Overnight\ capital\ cost\ (\$/kW)$

$CRF = Capital\ recovery\ factor = \frac{r(1+r)^N}{(1+r)^N - 1}$

$N = The\ expected\ operational\ lifetime\ of\ the\ plant\ (years)$

$r = The\ discount\ rate$

$FOM = Annualized\ fixed\ operation\ and\ maintenance\ Cost\ (\$/kW\text{-}yr)$

$VOM = Annualized\ variable\ operation\ and\ maintenance\ Cost\ (\$/kWh)$

$LF = Annualized\ load\ factor\ of\ the\ plant$

$FC = Annualised\ fuel\ cost\ during\ plant\ lifetime\ operation$

It is important to recognize that the LCOE measure for a particular technology is purely hypothetical due to taking into account various industry-based assumptions and financing terms. As a result, this may differ from the real prices (D'haeseleer, 2013).

2.6.1.12 Operation and maintenance (O&M) cost

The operations and maintenance (O&M) cost forms part of the plant operating cost. The other constituents of operation cost include the fuel costs and the provision of funding for the decommissioning of the plant, as well as the treatment and disposing of used fuel and wastes (WNA, 2012).

O&M costs comprise non-fuel related O&M costs and fuel costs (US EIA, 2010). The non-fuel related O&M costs can be divided into three categories namely fixed O&M cost (FOM), variable O&M cost (VOM), and major maintenance cost (US EIA, 2010).

The FOM costs are those that do not vary significantly with any changes in production. These include, but are not limited to, the following (US EIA, 2010):

- Monthly fees and bonuses paid out to permanent staff.
- Plant support equipment, which includes equipment rentals and temporary labour.
- Plant-related general and administrative expenses, i.e. internet, postage, telephone, etc.
- Routine preventive and predictive maintenance performed during operations.
- Maintenance of general plant areas as well as systems, structures, and components (SSCs).

VOM costs are those that are production-related and vary with electrical generation. These include, but are not limited to, the following (US EIA, 2010):

- Water usage for production processes, e.g. demineralized water production.
- The disposal of general and radioactive waste, as well as wastewater.
- Chemicals, resins, catalysts, and gases.
- Lubricants.
- Consumable materials and supplies.

For the purpose of this study, the fuel cost will form part of variable O&M cost (D’haeseleer, 2013).

Major maintenance costs are generally those incurred during extended maintenance and re-fuelling outages. This depends on the maintenance and refuelling strategy, as well as original equipment manufacturer recommendations and requirements. These major maintenance costs include, but are not restricted to, the following:

- Scheduled major overhauls in order to maintain the SSCs.
- The maintenance labour and spares required for major overhauls.

Historical data shows that the O&M cost has a tendency to increase as the plants get older (WNA, 2012).

2.6.1.12.1 Fuel cost

Fuel cost includes the cost incurred for purchasing new fuel, as well as the allowances provided for plant decommissioning and the management of used fuel and waste disposal. Contributions are normally made over the economic lifetime of the plant in order to have the necessary funds available when required for the treatment and disposal of used fuel and nuclear waste, as well as the decommissioning of the power plant (WNA, 2016).

2.6.2 Construction Delays

Nuclear power generation has always been a contentious issue, mainly due to concerns regarding uncontrolled release of radiation and the generation of radioactive waste during the nuclear power cycle. In order to ensure safe operation of nuclear facilities the nuclear industry is strictly regulated by national and international regulatory bodies during construction, commercial operation, as well as decontamination and decommissioning.

The siting, construction, operation, decontamination, or decommissioning of any nuclear installation must be authorized by way of a nuclear licence, which is granted by the National Nuclear Regulator as defined in National Nuclear Regulatory Act (Act no. 47 of 1999). However, before this licence is granted, the regulating authority requires the utility to demonstrate that it has the necessary management skills and resources, and that it can master all the systems needed to operate the reactors. The licensing process as well as regulation have become some of the main factors influencing nuclear power economics (Kidd, 2011).

Protracted construction schedules lead to the delay of the commercial operation of the reactor. The delay of the commercial operation has a knock-on effect on the sale of electricity, which leads to a loss of income, which ultimately results in the utility not being able to repay the sum of the overnight and accrued interest charges (Cohen, 1990). The delay of construction due to regulation was particularly evident in the aftermath of the accidents at Three Mile Island (TMI) in March 1979 and at Chernobyl in Ukraine in 1986. This resulted in the United States regulatory authorities introducing more stringent criteria for licensing NPPs (Greenpeace, 2008).

Reactors that were under construction at the time of the TMI accident were eventually completed at 2.8 times the median cost, and 2.2 times the median construction period of those reactors that were completed before the TMI accident occurred (J.R. Lovering et al, 2016).

A more recent example of how rigorous regulatory requirements have affected the construction schedule of an NPP, is the unit 3 of the Olkiluoto power plant in Finland. Olkiluoto unit 3 was the first ever EPR 1600 reactor design to be constructed in the world. Construction of the unit began in July 2005, with a planned construction period of 60 months, and commercial operation expected in 2010. However, construction issues highlighted poor workmanship and poor oversight of construction activities. This led to an investigation by the Finnish nuclear regulator

STUK, and resultantly caused major construction delays. Following the initial delays, completion of the project was set at over 7 years. However, more recent projections have put the start-up date at 2018 (WNN, 2014). The estimated cost of completion in December 2012 was put at €8.5 billion, almost three times the original delivery price of €3 billion (BBC news, 2012).

The economics of nuclear power electricity generation is important for decision making on choices for future electricity supply. The following sections will provide some insight into the various cost components of nuclear economics.

2.6.3 Labour

The successful outcome of any project—successful meaning that the project is completed within the cost estimate—depends on the adherence to the execution plan and the assumptions without any deviation (EPRI, 2015). Labour is integral to the adherence to the execution plan, especially for large civil projects. This is notable in the construction experience of the Medupi and Kusile projects. Eskom initially reported that the first unit of Medupi would be on line by 2012, followed by the first unit of Kusile a year later. However, due to labour strife and skills shortages, commercial operation of these projects only started in August 2015 and December 2016 respectively (Alstom, 2015; Eskom, 2016).

Table 2: Breakdown of NPP costs by major components (WNA, 2017)

Equipment	Percentage
Nuclear Steam Supply System	12
Electrical and Generating Equipment	12
Mechanical Equipment	16
Information and Control System (incl. software)	8
Construction Materials	12
Labour on Site	25
Project Management Services	10
Other Services	2
First Fuel Load	3
Total	**100**

The economics for the new NPPs that were constructed over the last decade show significant variation in the capital cost for nuclear power projects in different countries, most notable when comparing cost data from projects in East Asia, Europe, and North America (WNA, 2017). This is influenced by a number of factors, which include the following (WNA, 2017):

- Labour cost and labour productivity, i.e. the level of skill and experience of the labour force.

- Whether the utility is building multiple units, which will allow for a streamlined licensing process.
- Experienced project management capacity with significant civil engineering project experience.
- The commodities and manufacturing capacity needed in the design and construction of new power plants (Schlissel and Biewald, 2008).

The South African Government has emphasized that localization will be a key factor in the selection of a preferred vendor; therefore it is important to understand the impact of the labour cost and labour productivity on capital cost calculations.

The sections that follow consider the factors that influence the labour component, and how this may affect the project capital cost of a nuclear project. The focus will mainly be on labour cost, labour productivity, and other factors that may influence construction cost of an NPP in the South African economic landscape.

2.6.3.1 South African Labour Force

Currently, South Africa has an employment rate of around 74%. The breakdown of the skill level of the South African workforce is described in Table 3 below (STATS SA, 2016):

Table 3: Skill level of South African workforce (Stats SA, 2016)

Skill Level	Percentage	Occupational Group
Skilled	25	Managers
		Professionals
		Technicians
Semi-Skilled	46	Clerks
		Sales and Services
		Skilled Agriculture
		Craft
		Machine Operators
Low Skilled	29	Elementary
		Domestic Workers

The construction industry in South Africa is a significant employment provider, providing employment to more than 1.18 million people, either permanently employed or on a contract basis (Stats SA, 2016). In addition to this, there is also further employment opportunities created that stems from the construction industry; these include the materials manufacturing and supply sector, as well as in the services sector. Around 70% of the labour employed in the South African construction industry is either semi-skilled or low skilled (CIDB, 2015).

2.6.4 Labour Productivity

Labour productivity is essentially a tool that is used to measure labour effectiveness relative to a standard (EMWG Guidelines, 2007). It measures the ratio between the actual output produced per standard period worked, or per standard unit cost. This is described in the following equation:

$$Labour\ Productivity = \frac{Total\ Output}{Total\ Input}$$

Where: $\text{“}Total\ Input\text{”} = standard\ time\ (h)\ or\ standard\ cost\ (\$).$

From the equation above, it can be concluded that the more output is produced over a given period, or at a certain cost, the higher the productivity.

External factors such as inflation, the national economy, as well as competition from other service (labour) providers may affect productivity. However, labour productivity is the one factor over which the utility has more control.

A study that focuses on labour productivity and work conditions in the South African construction industry indicates deterioration in the labour productivity over the last decade (CIDB, 2015). The main reason behind the deterioration in the labour productivity is believed to be labour unrest. Labour unrest is caused mainly by disputes over earnings, be it wages, bonuses, or other compensation disputes. In 2013, this labour unrest accounted for around 76.6% of the total working days lost (CIDB, 2015).

Other factors that may affect labour productivity include the following (CIDB, 2015):

- The skill level of the workforce. If the workers become more skilled with the relevant training, then this can increase productivity. A skilled workforce generally requires minimal supervision and produces work of a higher quality, whereas unskilled labour requires more supervision in order to produce an acceptable standard of work.

- Technological advancement. The incorporation of new technology and automated processes, machinery, and equipment is some of the factors that improved productivity.

- Labour rights and regulations. The rigorous labour legislation makes it difficult for an employer to dismiss lacklustre workers, which may result in deterioration in productivity. However, the absence of such regulations could lead to the employer demanding more from the workforce in order to generate higher turnover, which in turn will affect worker morale and in the process diminish labour productivity.

With labour productivity declining over the last decade, it means that a utility might need more labourers to do a particular job. It is therefore widely expected that the number of labour hours required for the construction of an NPP in South Africa would be higher than that of other countries (EPRI, 2015).

2.6.5 Labour Costs

Labour cost differs from country to country which is also one of the reasons why capital cost for nuclear projects varies between countries, particularly between the emerging industrial economies of East Asia, and the developed economies of western Europe and North America (WNA, 2017).

The labour cost of a construction project is dependent on the number of labourers employed to perform construction activities, and the average wage of these labourers, including benefits (Rothwell, 2016).

$$Labour\ cost = L \times P_L$$

Where: $L = Labour;\ number\ of\ employees$

$P_L = Price\ of\ labour;\ average\ wages\ and\ benefits$

The number of employees required to do a specific job within a certain period is based on the labour productivity, whereas the wages and benefits are normally governed by country-specific labour rights and regulations (CIDB, 2015).

In South Africa, labour rights and regulations have become an ingrained element of South African society (CIDB, 2015). This is illustrated by the fact that the Congress of South African Trade Unions (COSATU) forms part of a formal alliance with the governing party, the African National Congress (ANC), and the South African Communist Party. As a result, market forces are not allowed to dictate wage levels on the basis of supply and demand. Instead, labour rights and regulations are used to some degree to address the problem of poverty and inequality in society that was created by the apartheid regime (CIDB, 2015). It can therefore be expected that the cost of labour will remain relatively high for the foreseeable future.

2.6.6 Unit Labour Cost

The unit labour costs are defined as the average cost of labour per unit produced, which is mostly used as a broad reflection of international price competitiveness (OECD, 2017). It represents a direct link between productivity and the cost of labour used to generate an output, and can be expressed in the following way (OECD, 2017):

$$Unit\ Labour\ Costs = \frac{Cost\ of\ labour}{Unit\ of\ output\ (labour\ productivity)}$$

An increase in a country's unit labour cost represents an increased reward to the labourers of that country for their contribution. However, if the increase in cost of labour becomes far greater than the labour productivity, then the country's economy might lose its competitive edge (OECD, 2017).

2.6.7 Material Costs

Historically, the cost of bulk materials in South Africa has been relatively inexpensive due to its abundant mineral resources (McCarthy, 2005). However, a study of power generation technology for the IRP of South Africa states that even though the prices of raw materials remain relatively inexpensive in South Africa when compared to the United States, the potential savings are offset by higher production costs. The higher production cost results from a declining labour productivity, relatively high cost of labour, and the use of less sophisticated production processes and techniques (EPRI, 2015).

In addition to this, it has been established that the supply chain for nuclear components has become fully integrated and globalized, i.e. components for nuclear plants are being sourced internationally (Groskopf, 2016). Many of the heavy manufactured components can now be sourced from various suppliers in different countries around the world. In the past, there were only a few manufacturers of nuclear components, especially the larger equipment such as reactor pressure vessels, SGs, and turbines. Nowadays, there are at least twenty-three manufacturers spread across eleven countries that can supply this equipment (Groskopf, 2016). Essentially, this has enabled the prices of nuclear systems, structures, and components to become more comparable internationally, making the cost thereof more predictable. Based on this, it is assumed in this study that the material costs are internationally comparable, i.e. nuclear material cost is the same everywhere in the world.

CHAPTER 3 PWR TECHNOLOGY OVERVIEW

3.1 PRESSURIZED WATER REACTOR (PWR) TECHNOLOGY

The first commercial nuclear power plant was the Shippingport Power Station in Pennsylvania. Shippingport was a light water reactor (LWR) and was connected to the grid for the first time in December 1957 (IAEA, 2017).

In April 2017, there were 448 commercial NPPs operating in 30 countries around the world with a total capacity of more than 391 120 MW (IAEA, 2017). The list of commercially operated power plants includes a variety of reactor technologies, with over 80% being LWRs of the pressurized water reactor (PWR) or boiling water reactor (BWR) designs (IAEA, 2017); refer to Figure 6.

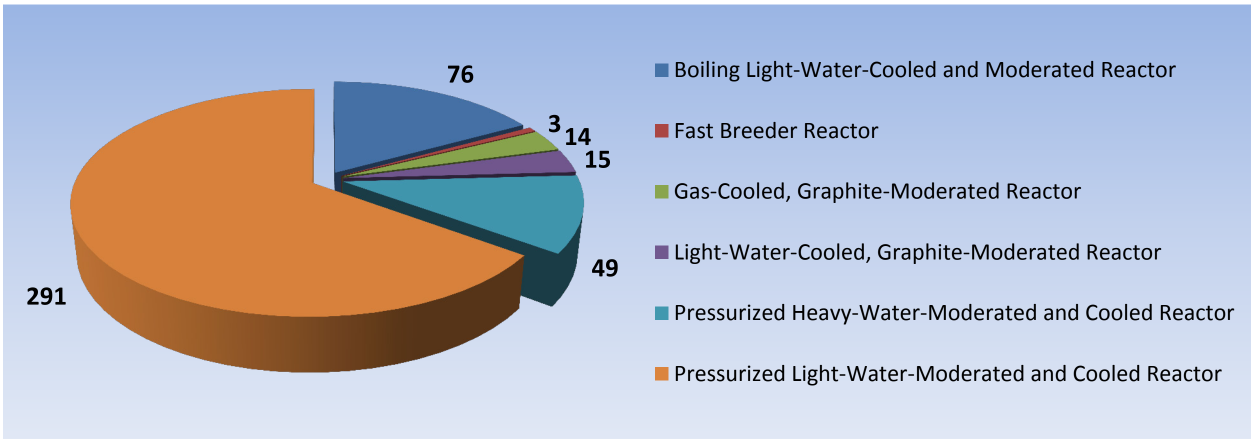

Figure 6: Total number of reactors by type (IAEA, 2017)

3.1.1 Basic Operation of the PWR Technology

The basic operation of a PWR is illustrated in Figure 7. A conventional PWR operates through heat transfer that takes place between three interdependent systems, i.e. the primary, secondary, and tertiary systems. These three systems are physically separated from one another in order to limit the spread of radioactive effluents (Lamarsh, 2001).

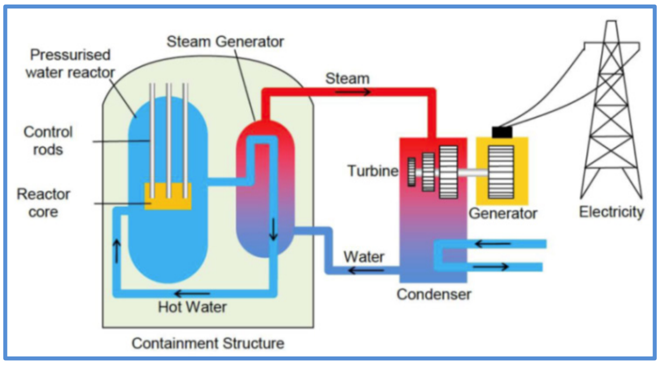

Figure 7: Basic layout of a PWR (Eskom, 2016)

Heat is generated in the reactor core by the fission of uranium atoms. This heat is transferred to the primary coolant, which, in the LWR design, is water. When the reactor is at power, the primary coolant pumps maintain a continuous flow of primary coolant through the reactor core during steady state and transient conditions. This ensures that the heat is evacuated from the core and transferred to the secondary side of the steam generators (SGs) The primary coolant is maintained under pressure (normally around 15 MPa) by a pressurizer to prevent the primary coolant from boiling; hence the name, pressurized water reactor (Lamarsh, 2001).

The heated coolant is pumped through three independent closed looped SGs where it transfers its thermal energy to the secondary system through a large number of narrow tubes that act as a heat exchanger (Lamarsh, 2001).

On the shell side of the SG, secondary coolant, also known as feedwater, is pumped into the SG. This feedwater is under a lower pressure (normally 7 MPa) compared to that of the primary system (normally 15 MPa). In the SG, the feedwater absorbs the heat through the SG tube walls until it starts to boil and generates steam. The steam is conveyed to turbines. As the steam moves through the turbine it expands and produces work that causes the turbine to rotate. The turbine shaft is connected to the stator of an electric generator (Lamarsh, 2001).

After giving off most of its energy whilst passing through the turbine, the secondary water-steam mixture is cooled down to a condensate in another heat exchanger, i.e. the condenser, before being pumped back to the steam generator as feedwater. In certain NPP, the feedwater is pre-heated in order to increase plant efficiency and also to minimize thermal shock in the SG tubes (Lamarsh, 2001).

The tertiary system, also called the cooling loop, is normally an open loop circuit, which is used as the heat sink. During normal operation, cool water (13°C at Koeberg NPP) is pumped through the condenser, in order to cool the water-steam mixture. The cool seawater absorbs the latent heat from the water-steam mixture that exits the turbine. This is done through a large number of heat exchanger tubes in the condenser. The heat transfer process increases the temperature of the seawater from 13°C to about 24°C before the water is returned to the sea.

3.1.2 Reactor Designs

Nuclear reactor technology for commercial electricity production has been around since 1957, which means the nuclear power industry stretches over six decades. During this time, many developments have taken place. These developments were based on research findings, lessons learned from industry, as well as policy amendments in response to the nuclear incidents that occurred at Three Mile Island, Chernobyl, and Fukushima. In order to distinguish between reactor designs, the nuclear industry introduced a system in the late 1990s whereby reactor designs are classified in generational groups (refer to Figure 8).

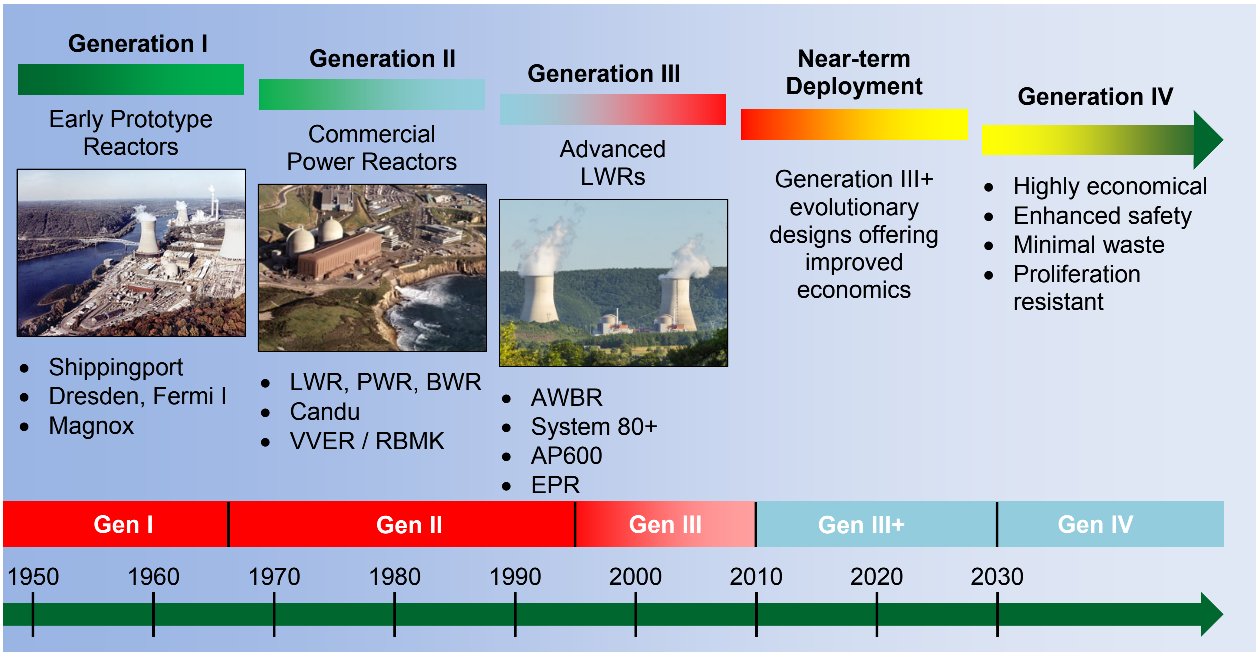

Figure 8: The evolution of nuclear power reactors (Goldberg & Rosner, 2011)

The sections that follow give a brief overview of the various generation designs. These designs will be evaluated for their technical capabilities only.

3.1.2.1 Generation I

Generation I reactors are the early prototype designs that were established in the 1950s and 1960s. These reactors were mainly designed for plutonium production, which was used in nuclear weapons and naval applications, i.e. submarines. Westinghouse, a United States utility, used this prototype technology for the basis of the first land-based PWR (Goldberg and Rosner, 2011). This was closely followed by a General Electric initiative, also in the United States, who developed the BWR technology (Goldberg and Rosner, 2011).

BWRs essentially started the trend of using nuclear energy for commercial electricity production. Safety was not a main priority during these early designs. The developments were mainly motivated by the search for higher thermal efficiencies, lower system pressures, the ability to stay on-line for longer periods, and the better utilization of uranium resources (WNA, 2012).

Wylfa Nuclear Power Station in Wales was the last commercially operated Generation I plant to be decommissioned. Decommissioning took place in December 2015 (Goldberg and Rosner, 2011). Generation I reactor technology falls outside the scope of this research.

3.1.2.2 Generation II

Generation II reactors were designed for the reliable production of electricity for commercial use. These reactors were initially designed to have an operational life of 40 years. Generation II reactors are characterized by the Westinghouse (American) and EDF (French) fleets, which started operation in the late 1960s and form the bulk of the reactors used for commercial electricity production in the world today. These reactor designs employ what is known as “traditional active safety features”. This involves electrical and/or mechanical operations that are initiated automatically or manually by the plant operators. Generation II reactor designs have some engineered safety systems, i.e. safety systems that will operate passively and function without operator control or loss of auxiliary power (Goldberg and Rosner, 2011).

One major disadvantage of Generation II designs is the production of significant quantities of nuclear waste. The nuclear waste, also referred to as spent fuel, generally requires reprocessing or depositing, which adds to the operating cost of the power plant (Goldberg and Rosner, 2011). Generation II reactor technology falls outside the scope of this research.

3.1.2.3 Generation III

Generation III designs are based on the construction and operating experiences of the Generation II Westinghouse and EDF fleets. These designs were developed by incorporating inputs from the Electric Power Research Institute (EPRI) in the USA and the European utility requirements (EUR). The inputs came from the utility requirements document (URD) which was developed by EPRI and EUR. The URD prescribes the requirements for the newer generation of nuclear power plants, i.e. advanced LWRs or Generation III designs. These requirements are based on the lessons learned from the nuclear industry with regard to safety. Fundamentally, the URD ensures that additional passive safety features are incorporated in new reactor designs (Goldberg and Rosner, 2011).

Generation III nuclear reactors are essentially Generation II reactors with evolutionary, advanced design improvements. These improvements were also aimed at increasing plant operational life to the order of 60 years, with the potential to greatly exceed 60 years before the need to the overhaul major equipment or reactor pressure vessel replacement (Goldberg and Rosner, 2011).

The objectives of Generation III reactor design improvements are as follows (Goldberg and Rosner, 2011):

- Standardised designs that will expedite the licensing process. This provides potential for a reduced construction period and also reduced capital cost.
- Simple yet robust designs that will allow for ease of operation and maintenance, and are less prone to operational upsets.
- Increased availability and longer operational life, typically 60 years.
- Improved safety performance with inherent safety features.
- A core damage frequency that is about ten times better than the current United States Nuclear Regulatory Commission (US NRC) requirement of 1×10^{-4}.

- Increased resistance to proliferation.
- Greater use of passive safety features compared to previous generation reactors.
- Higher burn-up rates that will allow for more effective and efficient fuel usage, whilst reducing the amount of waste generated.

3.1.2.4 Generation III+

Generation III+ reactor designs are essentially advanced Generation III reactor designs with the incorporation of innovative passive safety features. The Generation III+ reactor design was also motivated to achieve higher fuel burn-up factors than any predecessor, and thus reducing fuel consumption and waste generation (Goldberg and Rosner, 2011). A defining feature of Generation III+ reactor designs is the need for larger integral forgings, which will further enhance safety. Reports suggest that Generation III+ reactor designs require around twice the amount of large forgings compared to that of Generation II reactor designs (Jackson, 2012).

The Generation III and Generation III+ PWR designs that are currently being constructed around the world are:

- The American design – Westinghouse AP1000 is based on the Westinghouse AP600 reactor design with increased power output.
- The French design – European pressurized reactor (EPR1600) is an evolutionary descendant of the Framatome N4 reactors and the Siemens power generation division Konvoi reactors.
- The Chinese design – Hualong One design is based on Framatome's 900 MW three-loop Generation II design.
- The Korean design – APR1400 is an advanced PWR design that evolved from the Korean next generation reactor, i.e. US System 80+ design.
- The Russian design – VVER1200/392M.

3.1.2.5 Generation IV

Generation IV reactor designs are still in the development phase and are expected to only reach maturity by 2030. The motivation behind the designs is mainly an improvement in sustainability, safety and reliability, economics, proliferation resistance, and physical protection, when compared to earlier reactor technologies (Sholly, 2013). Generation IV reactor technology falls outside the scope of this research.

3.2 TECHNOLOGIES UNDER CONSIDERATION

The South African Government has entered into negotiations with a number of nuclear vendor countries with the aim of procuring a fleet of NPPs that will render a total capacity of 9 600 MW (DOE, 2015). Each country was given the opportunity to present their strategy on how and where they can participate in the outlay of South Africa's proposed nuclear new build programme. The consultation process ended late in March 2015 when the South African Government concluded their pre-procurement preparatory phase. This was done by signing inter-governmental framework agreements (IGFA) with the USA, the French Republic, the People's Republic of China, South Korea, the Russian Federation, Japan, and Canada (DOE, 2015).

The sections that follow will briefly explain each technology under consideration. It will conclude with a summary highlighting the main features and key differences.

This study will focus on Generation III and Generation III+ reactor technologies, limited to the following designs:

- AP1000 (USA)
- EPR1600 (France)
- Hualong One (China)
- APR1400 (Korea)
- VVER1200 (Russia)

Reactor designs from Japan and Canada are not considered in this study due to their limited construction and operation experience in the field of PWR (PRIS, 2017). Japan operates predominantly BWRs, whilst Canada employs mostly heavy water reactors.

The assessments done on the reactor technologies are based on technical information available in the public domain, i.e. the vendors were not engaged at any stage during the process.

3.2.1 Westinghouse AP1000

Westinghouse has contributed to the successful construction and operation of almost half of the world's 440 nuclear plants (Jackson, 2012). The AP1000 was designed with great emphasis on passive safety according to URD requirements. It is currently the only Generation III+ reactor design to have received design certification from the United States Nuclear Regulatory Commission (US NRC).

The AP1000 is a scaled-up version of the AP600 reactor design, which was of the Generation III technology, but was never constructed. The design is functionally similar to that of the AP600 design, but with requirements to increase the capacity of the containment building, reactor vessel, SGs, reactor coolant pumps, and pressurizers in order to accommodate the increase in thermal power.

The AP1000 reactor is of the Generation III+ design with a capacity of 1 115 MWe net (1 200 MW gross), at an average fuel BU of 60 GWd/tU. It was designed by Westinghouse in the United States and has a two-loop (two hot legs), four-reactor coolant pump design (four cold legs).

The fuel design of the AP1000 is based on the fuel design used successfully in plants in the USA and Europe, which is the 17 × 17 fuel assembly design. It can operate on enriched uranium dioxide of less than 4.95% enrichment, or alternatively on MOX fuel. The AP1000 design also claims to have an 18-month fuel cycle (EPRI, 2015).

The AP1000 design philosophy focuses on extensive plant simplification and claims to have 50% less valves, 35% less pumps, 80% less piping, 80% fewer heating, ventilation, and cooling units, 45% less seismic building volume, and 70% less cable than any standard PWR (Mycle Schneider et al, 2015).

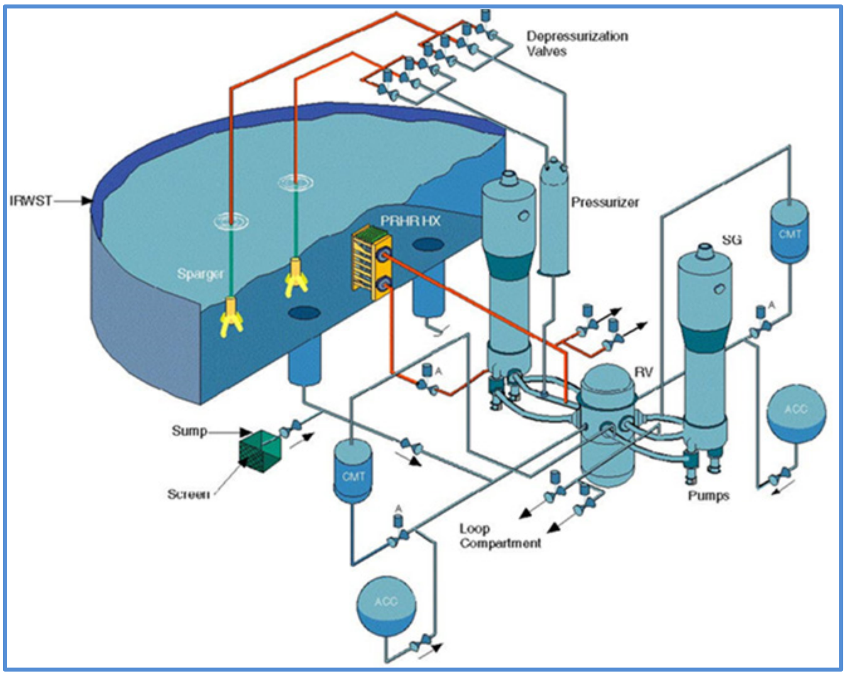

Figure 9: Basic layout of the AP1000 design (Westinghouse, 2011)

The simplification provides potential to lower the complexity of safety systems, produce smaller plant footprints, and enable modular construction techniques. This in turn, provides potential to decrease the construction schedule and capital costs. This is all done while still maintaining the high quality and safety standards of regulating authorities. Plant simplification further provides potential for simplified O&M processes due to fewer components and less construction material than previous Westinghouse PWR designs (ARIS, 2017).

The designers of the AP1000 reactor technology claim to have achieved the following (Lambert & Nghiem, 2014):

- A greatly simplified plant, which enhances licensing processes and reduce customer costs.
- Simplified safety systems.

- Passive safety systems for accident mitigation with no requirement for emergency diesel generators in cases where off-site power sources are not available.
- Shorter construction schedules. This can be achieved through modular construction techniques whereby the AP1000 units are manufactured in modules in factories and then shipped (rail and/or barge) to the construction site upon order. This creates potential for enhanced construction and for improved cost control since the project is less affected by supply chain challenges.

The safety systems that are unique to the AP1000 design (Lambert & Nghiem, 2014):

- Natural forces such as pressurized gas, gravity, natural circulation, and convection to serve safety-related functions and ensure the safe shutdown and cooling of the reactor with no operator action required during a loss of all on-site and off-site alternating current (ac) power.
- In-containment refuelling water storage tank, situated above the reactor core, which acts as an additional source of water injection with the core make-up tanks and the accumulators.
- An externally cooled steel containment vessel which surrounds the nuclear island.
- The capability to rapidly depressurize the containment.
- Canned reactor coolant pumps to reduce the probability of leakage and to improve reliability.
- In the case of core melt, flooding of the core prevents core debris from spilling into the containment.
- A seismic design (SSE) of 0.3 g.

Westinghouse claims a construction period of approximately 3 years for the NOAK plant, which is extremely ambitious when compared to the industry average of 9.4 years (Mycle Schneider et al, 2015).

The world's first AP1000 unit commenced construction in Sanmen, China, on 19 April 2009, with the start-up expected in the first 6 months of 2018. A second unit is being constructed in parallel, with its schedule running a year later than the first unit (WNA, 2016). The cost for the dual units at Sanmen was estimated at an OCC of $3 204/kW (WNA, 2016).

Other AP1000 reactor construction projects include (ARIS, 2017):

- Haiyang 1, 2 (Shandong province, China) which started construction on 24 September 2009.
- Vogtle units 3, 4 (Georgia, United States) which started construction on 9 March 2013.

- VC Summer units 2, 3 (South Carolina, United States) is planned with an approved contract in place.

3.2.2 AREVA EPR1600

The European pressurized reactor (EPR) is a Generation III+ reactor design produced by Areva. It is an evolutionary design based on the construction and operating experiences of the N4 reactors in France and Konvoi reactors in Germany. The key objectives of this design include improved economics, safety, and reliability (EPRI, 2015). The design approach aims to guarantee its safety objectives through the following:

- Redundancy and diversity to guard against single failures.
- An optimized combination of active and passive safety systems.

The EPR1600 has four loops, each containing a steam generator and a reactor coolant pump. The core is considerably larger than that of any other reactor design, producing a net output 1 600 MWe and with a fuel cycle ranging between 12-24 months. The core consists of 241 fuel assemblies (17 × 17 lattice with 265 rods per assembly) and is surrounded by a neutron reflector, which allows for optimized fuel utilization and protection to the pressure vessel against radiation damage (EPRI, 2015). The reactor can operate on low enriched uranium, i.e. up to 5%, or MOX fuel and allows for a flexible operating cycle, ranging from 12 to 24 months.

Safety systems of the EPR are designed to be mechanically simple and arranged in accordance with the general principles of diversity, redundancy, and physical robustness (IAEA, 2016). The plant design only incorporates those features and materials that have shown superior performance over the last 40 years of nuclear power plant operation, improving both reliability and O&M costs (EPRI, 2015).

Construction methods for the EPR focus more on on-site assembly rather than modular construction due to the large number of components and high volume of materials (EPRI, 2015).

Key design features of the EPR design include the following (Framatome ANP, 2005):

- Reactor coolant system is contained in a double-layered containment structure.
    - The first layer (on the inside) is the pre-stressed concrete containment shell, furnished with a steel liner.
    - The containment shell is enclosed by a shield building wall, made from reinforced concrete, with an annular space between the two buildings.

- The reactor building internal structures and components, the fuel building, and two of the four safeguard buildings are protected against aircraft hazard and external explosions.
- Four safeguard buildings, one of which houses the main control room of the reactor, which also houses the reactor safety and control systems. These include the safety injection system, emergency feedwater system, and the residual heat removal system. Each safety system in each of the safeguard buildings is capable of performing the entire safety function for the reactor, providing redundancy and divisional separation. Two of the safeguard buildings are protected by the same reinforced concrete structure as the reactor, able to withstand impact by an aircraft and explosions. The other two safeguard buildings are not protected against aircraft hazard or external explosions.
- Safeguard buildings are strictly separated into four divisions around the reactor building, which restricts damage from external events to a single safeguard building.
- In the event of a loss of off-site power, each safeguard building is powered by a dedicated emergency diesel generator.
- An additional core make-up system in the form of an in-containment refuelling water storage tank (IRWST).
- In addition to the four safety-related diesels (fuelled for three days), two independent diesel generators are available, along with emergency dc batteries to power essential equipment during a postulated station black-out (SBO) event.
- A core catcher, in the form of a dedicated area in which molten corium is collected following a postulated worst-case severe accident.
- A seismic design (SSE) of 0.25 g.

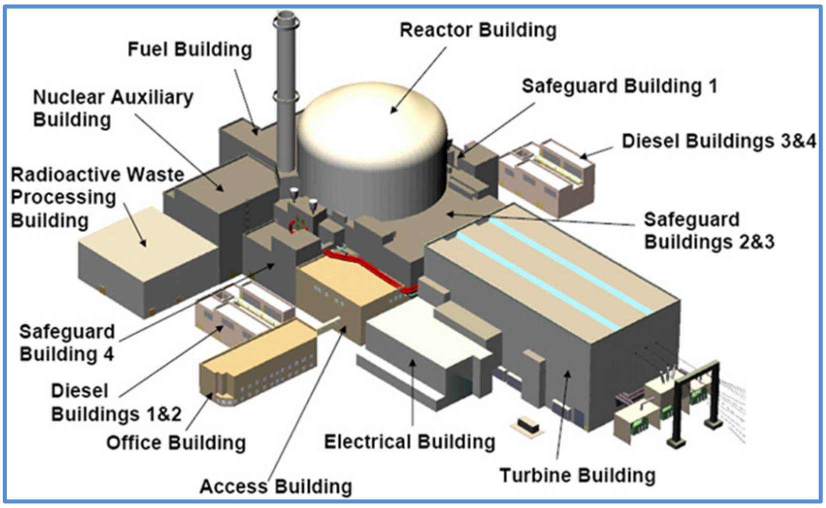

Figure 10: Basic layout of EPR1600 design (Framatome ANP, 2005)

The EPR was the first Generation III+ reactor to be deployed. The first EPR project to have gone into construction was at Olkiluoto unit 3, in Finland, with construction starting in August 2005. The projected cost in December 2003 was estimated at €3.2 billion. Currently, this unit is still under construction with a projected cost of more than €8.5 billion and commercial operation planned for December 2018 (WNA, 2017).

Other EPR projects that are currently being constructed include Flamanville unit 3 in France and two units at Taishan NPP in China (Jackson, 2012).

3.2.3 Chinese ACPR1000 and Hualong One

Currently, China is the country with the largest nuclear energy expansion programme, having 19 reactors under construction, apart from its 38 reactors that are already in operation (PRIS, 2017). China has successfully developed domestic PWR designs through technology transfers from utilities such as Westinghouse and AREVA, while incorporating the lessons learned of their construction and operation experiences gained over the years.

The Hualong One reactor, also referred to as HPR1000 by the Chinese Government, is a Generation III nuclear design jointly developed by the China National Nuclear Corporation (CNNC) and the China General Nuclear Power Group (CGNPG). The Hualong One design is a merger of two Chinese designs, namely the ACPR1000 and the ACP1000 designs (Lambert & Nghiem, 2014). Both these designs are evolutions of the Generation II+ CPR1000 reactor design. The CPR1000 is based on the French M310 technology, which forms the basis for nuclear power technology in China (WNA, 2017).

The Hualong One design has a three-loop reactor coolant system. It has a design capacity of 1 092 MWe net (1 150 MWe gross), with a core design of 177 fuel assemblies, each 3.66 m in length, at an average BU of 45 000 MWd/tU. Furthermore, the design is in line with China's latest safety regulations, the American (URD), and European (EUR) standards, as well as major post-Fukushima safety requirements (Sholly, 2013). As a whole, the design meets all the technical and economic standards required of Generation III and Generation III+ reactors.

Key design features of the Hualong One design include the following:

- Double containment of which the outer containment can withstand large impact.
- A core catcher.
- Active safety systems backed up by passive safety elements.
- Enhanced seismic protection (SSE) – tolerance of 0.3 g.

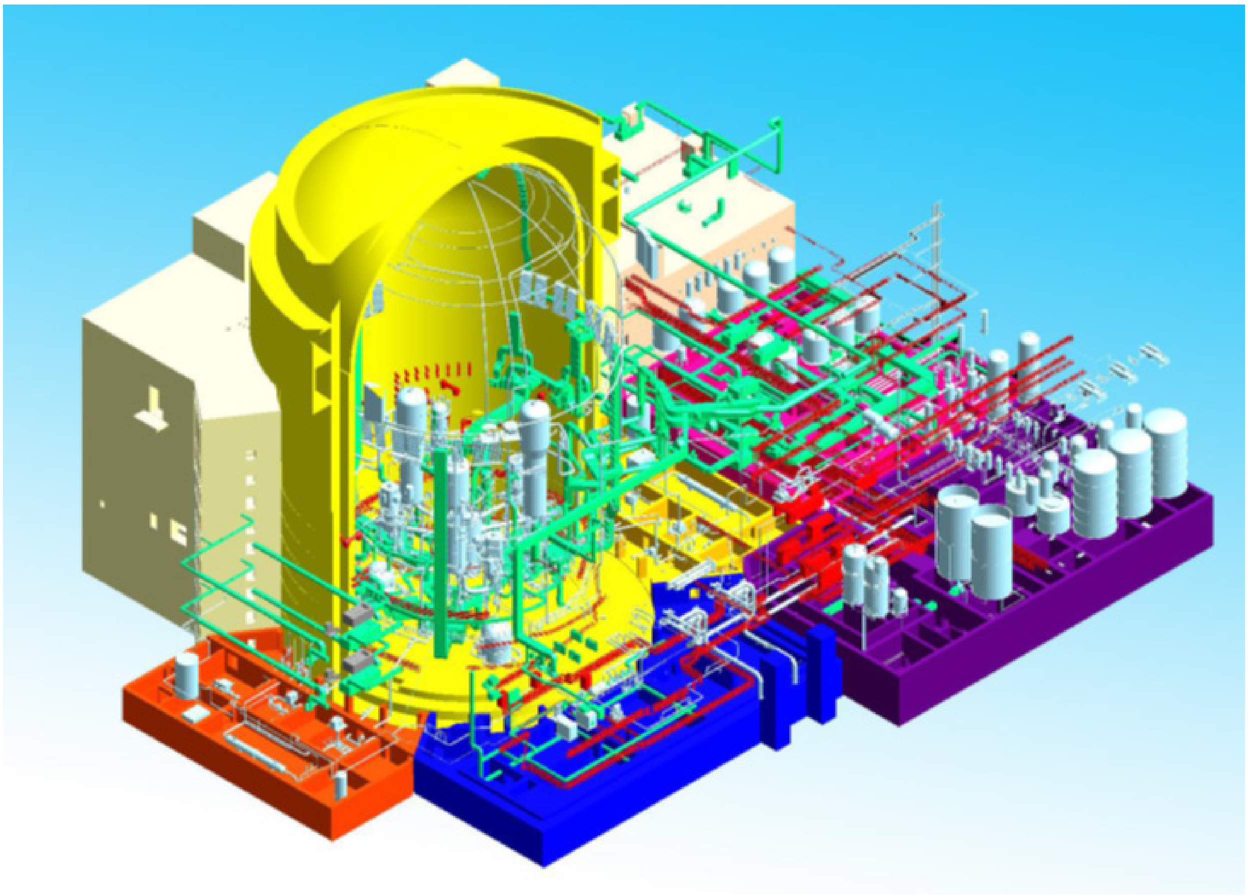

Figure 11: Basic layout of Hualong One design (CNNC, 2015)

The first Hualong One reactor started construction on 7 May 2015 at Fuqing 5, with construction scheduled to be completed in 2019, and followed by Fangchenggang 3, where construction started on 25 December 2015 (IAEA, 2016). Another Hualong One project started in Pakistan at KANUPP-2 on 20 August 2015, followed by KANUPP-3 on 31 May 2016 (PRIS, 2016).

The target cost for the reactors under construction in China is in the region of $3 500/kW (WNA, 2016).

China is in the process of developing a strong nuclear export market based on the success of its initial units. The Hualong One design successfully completed the generic reactor safety review (GRSR) governed by the IAEA in December 2014 (EPRI, 2015). The international use of the design will still depend on meeting country-specific standards and requirements, but passing the IAEA safety review should make this process easier (EPRI, 2015).

3.2.4 Korean APR1400

South Korea currently has 25 operating reactors, and has three more reactors under construction, which is of the APR1400 technology (PRIS, 2017). The APR1400 is a standard evolutionary advanced PWR design, jointly developed by the Korea Electric Power Corporation (KEPCO) and the Korea Hydro and Nuclear Power (KHNP) (EPRI, 2015). The APR1400 design is based on the reactor development, construction, and operational experiences of the OPR1000 reactor design. The OPR1000 reactor design is an indigenous Korean reactor, which was based on the Westinghouse System 80+ reactor design. As of September 2016, a total of 12 OPR1000 units are operational in Korea, demonstrating performance of the highest order (IAEA, 2016).

The objectives for the designers of the APR1400 technology included (WNA, 2016):

- Enhanced safety features.
- Engineering improvements to alleviate transients or operational occurrences.
- Improved economics.
- Improved seismic robustness.
- Increased size and coolant inventory of the pressurizer and steam generators that allow for higher design margins.

The APR1400 design has a two-loop reactor coolant system with a design capacity of 1 400 MWe nett (1 455 MWe gross) (ARIS, 2017). The APR1400 fuel and core was designed to allow for diverse fuel management strategies. The core consists of 241 fuel assemblies, each with a height of 3.81 m, and provides for an average fuel cycle of 18 months at an average BU of 55 000 MWd/tU (ARIS, 2017).

Key features of the APR1400 design include the following (ARIS, 2017):

- Direct vessel injection that allows emergency cooling water to be directly injected into the core in the case of a LOCA.
- A safety depressurization system that allows for the depressurization of the containment following a transient, without releasing significant amounts of radioactivity to the environment.
- Vessel cooling and cavity flooding systems to aid in-vessel retention of the corium in the case of a severe accident with core melt.
- Increased redundancy with regard to core make-up capability.
- Enhanced in-containment hydrogen mitigation systems that control the hydrogen build-up during or after a severe accident.

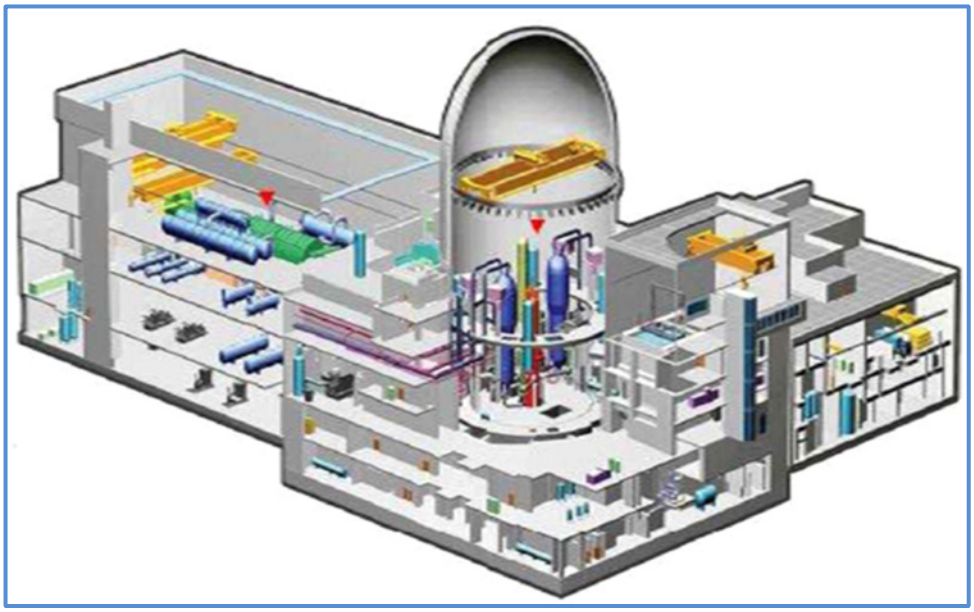

Figure 12: Basic layout of APR1400 design (Doosan, 2012)

The APR1400 received design certification by the Korean Institute of Nuclear Safety in May 2003. The first unit, Shin-Kori 3, commenced construction on 16 October 2008 and started commercial operation on 29 December 2015, with an estimated OCC of $2 300/kW (WNA, 2017). Other APR1400 projects that are currently under construction in Korea include (PRIS, 2016):

- Shin-Kori 4 – Started construction on 19 August 2009,
- Shin-Hanul 1 – Started construction on 10 July 2012,
- Shin-Hanul 2 – Started construction on 19 June 2012.

South Korea has experienced sustained construction cost reductions throughout its nuclear power history (J. R. Lovering et al, 2016). With its modular construction approach, it is envisaged that construction time will reduce further from 52 months to 36 months for the APR1400 (EPRI, 2015).

As with China, South Korea has ambitions to make advancements in the export market. The US NRC accepted the application from KEPCO and KHNP to complete the US design certification of the APR1400.

In 2012, construction started on the first of four APR1400 units at Barakah in the UAE. It is reported that the first unit, which is now more than 87% complete, is scheduled to start up in 2017, with all four units due to be on line by 2020 (WNN, 2016). The current OCC estimate for the UAE project is approximately $3 571/kW (EPRI, 2015).

3.2.5 Russian VVER1200

VVER reactors are developed by OKB Gidropress, which is a subsidiary of the Russian utility Rosatom. Russia's nuclear experience stretches well over 50 years, having played a part in the successful design, construction, and operation of more than 60 reactors worldwide (PRIS, 2017).

The current most advanced deployable Russian PWR design is VVER1200/AES 2006. This design is based on the design of the proven VVER1000 technology, which was used in the AES-92 and AES-91 plants series (Goldberg & Rosner, 2011).

There are two types of AES-2006 designs. The first type is the VVER1200/V-392M design, which was developed by Moscow Atomenergoproekt, on the basis of the AES-92 design. The second type is the VVER1200/491, developed by Saint Petersburg Atomenergoproekt, on the basis of the AES-91 design. It is basically the same design, employing different cooling systems (ARIS, 2017). The objective of the designers for both these designs were to reduce capital cost, while maintaining a high level of safety through the employment of active and passive safety systems.

The VVER1200/AES 2006 is Generation III+ design and retains the four coolant loops of the VVER1000 series, with a design capacity of 1 109 MWe nett (1 198 MWe gross). The core consists of 163 fuel assemblies, each 3.75 m long, and allows for a fuel cycle of 12-18 months, at an average BU of 60 GWd/tU (WNA, 2017).

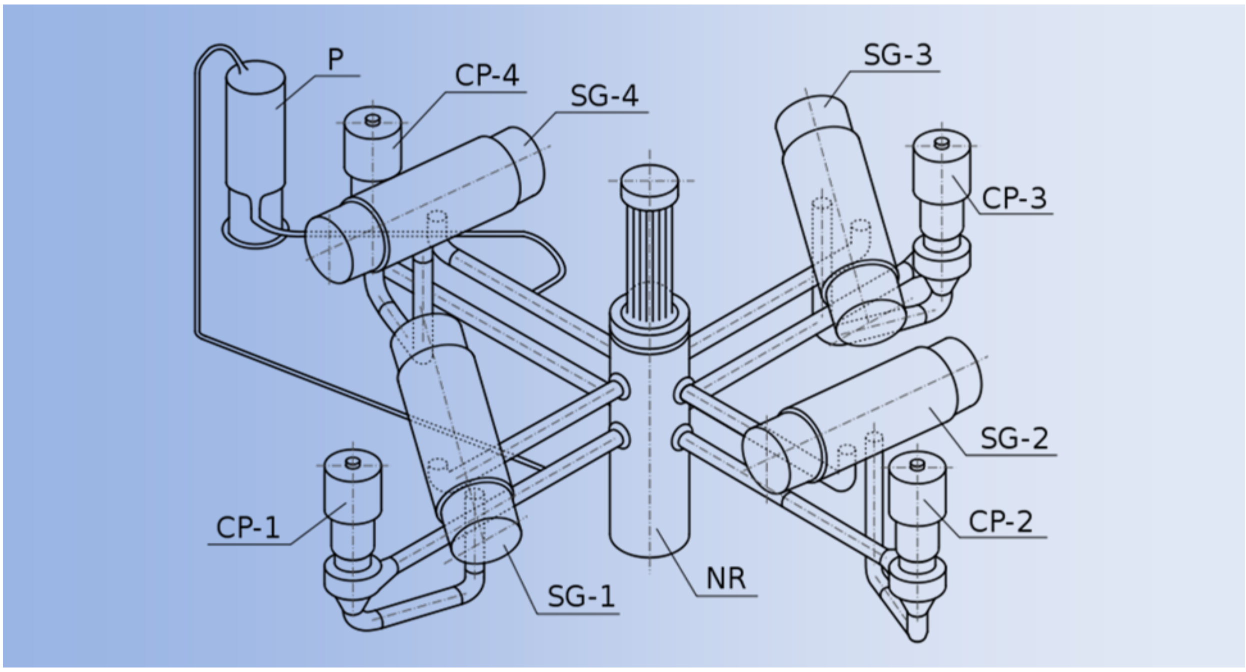

Figure 13: Basic layout of the VVER1200 primary circuit (Gidopress, 2015)

Distinctive design features of the VVER1200 include the following (ARIS, 2017; Lambert & Nghiem, 2014):

- Horizontal steam generator designs with proven performance. Industry OE indicates steam generators in Russian plants have operated safely and efficiently for over 40 years without the need for them to be replaced.

- Hexagonal fuel assemblies,
- Double layered containment consisting of an inner containment steel lining, 1.2 m thick pre-stressed concrete structure, and a 0.6 m thick reinforced concrete outer containment (acts as a secondary containment).
- An increased primary coolant volume that act as a damping mechanism for operational transients.
- Increased secondary feedwater volumes to aid the cooling capability of the core via natural circulation mechanisms.
- No penetrations in the reactor lower head for enhanced vessel integrity.
- The reactor pressure vessel is forged as one piece; i.e. no longitudinal welds. This enables less frequent maintenance and surveillance tests on the RPV.

Russia's Atomstroyexport successfully constructed and commissioned Tianwan 1 and 2 (VVER1000/V428 power plants) in China, as well as Kudankulam 1 and 2 (VVER1000/V-412) in India. The first VVER1200/V-392M design is in the commissioning phase at Novovoronezh II unit 1 in Russia. The projected OCC of the Novovoronezh II project is estimated at $2 933/kW (WNA, 2014). Other VVER reactors that are still under construction include (Lambert & Nghiem, 2014):

- Baltic – Started construction on 22 February 2012.
- Leningrad II, unit 1 – Started construction on 25 October 2008.
- Leningrad II, unit 2 – Started construction on 15 April 2010.
- Novovoronezh II unit 2 – Started construction on 12 July 2009.
- Tianwan unit 3 – Started construction 27 December 2012.
- Tianwan unit 4 – Started construction 23 September 2013.

3.3 REACTOR TECHNOLOGY COMPARISON

The assessment has yielded some key differences between the designs under consideration. Although certain technologies have distinct advantages over others, most of the design features of the technologies are comparable.

The main differences are highlighted in Table 4, supplemented by the descriptive bullet points.

Table 4: Summary of reactor technology comparison

Reactor Design	Loops	Pumps	Generation	Capacity Gross (MW)	Capacity nett (MW)	Containment Structure	MOX Fuel	Fuel Cycle (months)	Safety Features	SSE	Qualitative Summary	Projected Construction (months)	Projected Cost ($/kW)
AP1000	2	4	III+	1200	1115	Double	Yes	18	Passive safety systems.	0.3 g	• Extensive use of passive safety features by using natural forces such as pressurized gas, gravity, natural circulation, and convection. • No requirement for emergency diesel generators. • Extensive simplified design using 50% less valves, 35% less pumps, 80% less piping than any standard PWR. • Smaller plant footprint. • In-containment refuelling water storage tank, which allows for an additional core make-up source. • Externally cooled steel containment dome, which surrounds the nuclear island.	36	3204
EPR1600	4	4	III+	1750	1600	Double	Yes	12-24	Combination of active and passive safety systems.	0.25 g	• Double layered containment structure. • Four safeguard buildings, all strictly separated, with each housing reactor safety and control systems capable of performing the entire safety function for the reactor. • Considerably larger core compared to other reactors. • Core is surrounded by a neutron reflector, which allows for optimised fuel utilization and protection of the pressure vessel against radiation damage. • Safety objectives are ensured through redundancy and diversity to guard against single failures. • Make use of emergency diesel generators. • Considerably larger plant footprint compared to other reactors.	57	3737
Hualong One	3	3	III	1150	1092	Double	Still under consideration	18	Combination of active and passive safety systems.	0.3 g	• China is one of the few countries to have recent power plant construction experience. It is also the country with the largest nuclear energy expansion programme, having 20 reactors under construction. • The Hualong One design is in line with China's latest safety regulations, the American (URD) and European (EUR) standards, as well as major post-Fukushima safety requirements. • Comparable to other Generation III designs.	50	3500
APR1400	2	4	III+	1455	1400	Single	Yes	18	Combination of active and passive safety systems.	0.3 g	• Single containment structure. • Direct vessel injection allows emergency cooling water to be injected directly into the core in the case of a LOCA. • A safety depressurization system that allows for the depressurization of the containment building following a transient, without releasing significant amounts of radioactivity to the environment. • Vessel cooling and cavity flooding systems to aid in-vessel retention of the corium in the case of a severe accident with core melt. • Increased redundancy with regard to core make-up capability. • Enhanced in-containment hydrogen mitigation systems that controls hydrogen build-up during and after a severe accident. • Employ modular construction techniques.	48	2300
VVER1200	4	4	III+	1195	1109	Double	Still under consideration	12-18	Combination of active and passive safety systems.	0.25 g	• Horizontal steam generator designs with proven performance. • Unique double-layered containment structure. • An increased primary coolant volume that act as a damping mechanism for operational transients. • Increased secondary feedwater volumes to aid the cooling capability of the core via natural circulation mechanisms. • No penetrations in the reactor lower head, which brings about enhanced vessel integrity. • Forged reactor pressure vessel shells without longitudinal welds. This enables less frequent maintenance and surveillance tests on the RPV.	54	2933

3.3.1 Safety, Regulation and Construction Schedules

Research has shown that a direct link exists between safety, regulation, construction, and the capital cost of a project (Cohen, 1990; Goldberg and Rosner, 2011; J. R. Lovering et al, 2016). This link has often proven to be one of the great weaknesses in the project life cycle of NPPs, and as a result, policymakers have set objectives for designers to produce designs that will have the right balance in terms of the four influencing factors. Refer to Figure 14.

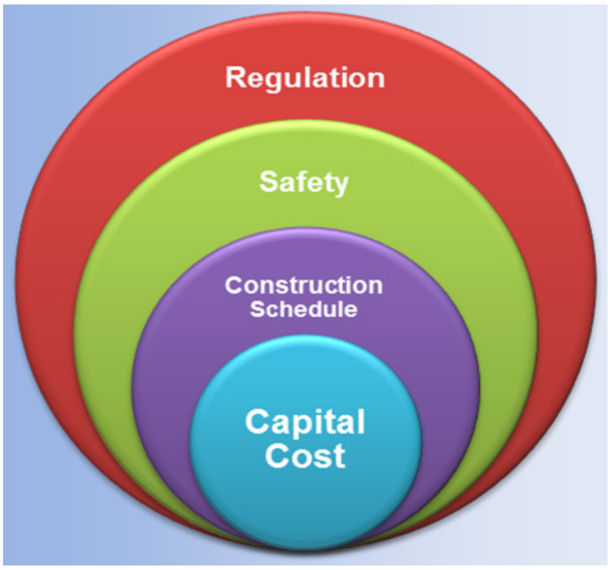

Figure 14: Factors influencing capital cost

The following strategies were suggested to avoid or limit the impact of the aforementioned concerns (Goldberg and Rosner, 2011; WNA, 2015):

- Standardized designs for each reactor type, in order to expedite the licensing process, which could potentially reduce construction time and capital cost.
- Simplified yet robust designs, which allows for a smaller plant footprint with fewer SSC and gives potential for ease of operation and makes the plant less susceptible to operational transients.
- Greater use of passive safety features, which relates to the simplification of the design, thus making use of less equipment and materials.

Modern reactor technologies are experiencing various levels of success in terms of construction, with quite a few of the Generation III and III+ projects being hampered by regulatory issues. This has intensified the drive for utilities to make use of design standardization, which will also allow for the deployment of generic regulatory safety reviews and thus streamlining the licensing process. A streamlined licensing process will have a positive impact on the construction schedule. A protracted construction schedule leads to a delay of the commercial operation of the reactor. The delay of the commercial operation has a knock-on effect on sales of electricity, which leads to a loss of income, which ultimately results in the utility not being able to repay the sum of the overnight and accrued interest charges (Cohen, 1990; Goldberg and Rosner, 2011).

Construction delays of nuclear projects due to regulation were particularly prevalent in the aftermath of the accidents at TMI in March 1979 and at Chernobyl in Ukraine in 1986. This was mainly due the US regulatory authorities introducing more stringent criteria for licensing NPPs.

Table 5 offers a qualitative summary of the designs under consideration with the focus mainly on the aspects mentioned earlier, namely safety, construction, and regulation. It predicts which aspects may have the most impact on the construction schedule, and ultimately the capital cost of a certain reactor technology.

Disclaimer: *No elimination of one or more of the technologies was intended.*

Table 5: Qualitative comparison based on construction and regulation

Design Differences - Qualitative		Financial Benefit / Drawback
AP1000	Extensive Plant Simplification	Benefit: Regulation and construction – less components, resulting in smaller plant foot print.
	Passive Safety Systems	Benefit: Less components Drawback: Regulation – less conventional safety systems, structures and components
	Modular Construction	Benefit: Construction schedule – allows for enhanced construction schedule (36 months).
EPR-1600	Redundancy and Diversity of Safety Systems	Benefit: Regulation – increased redundancy. Drawback: Regulation – complicated design
	Complex Plant Design	Drawback: Construction and regulation – big plant footprint due to a great number of components and large volume of materials used for plant construction.
Hualong One	Construction Experience	Benefit: Construction – recent NPP construction experience with the largest nuclear energy expansion programme (20 reactors under construction). Drawback: Regulation – limited international construction experience.
	Safety Systems	Benefit: Regulation – active safety systems (new) backed-up with passive safety (old) elements.
APR-1400	Containment Structure (Single)	Benefit – Construction Drawback: Regulation – due safety concerns.
	Construction Experience	Benefit: Construction – recent NPP construction experience in South Korea as well as in the UAE. Drawback: regulation – limited international experience.
	Increase Coolant Volumes	Benefit: Regulation – conventional safety systems with increased coolant and secondary feedwater volumes.
VVER-1200	SG Design	Benefit: regulation – proven design, over 40 years OE.
	Reactor Pressure Vessel Design	Benefit: Construction – forged as one piece, i.e. no welding activities on-site (modular construction).
	Construction Experience	Drawback: regulation – limited international experience.

CHAPTER 4 ECONOMIC EVALUATION

This part of the study explains the development of a spreadsheet-based economic model for the purpose of calculating the OCC for each of the technologies if it were to be constructed within the South African economic landscape.

Calculations were made based on the relationships between cost variables as described in Table 6.

Table 6: Model assumptions

Cost Variable	Value	Reference
TCIC = OCC + CCL		Gonzalez, 2014
CCL = IDC + cost due to escalation	Calculated	D'haeseleer, 2013
OCC = EPCC + contingency + owner's cost		Gonzalez, 2014
EPCC	0.694% (OCC)	Assumption
TPC = EPCC + contingency cost		D'haeseleer, 2013
Contingency cost	1.2 (EPCC)	Gen IV International Forum, 2014
Owner's cost	20% (TPC)	NTEL, 2012
Material cost	74% (TPC)	D'haeseleer, 2013
Labour cost	26% (TPC)	D'haeseleer, 2013
Labour rates	Calculated	www.worlddata.info, 2017
Labour productivity	Calculated	www.tradingeconomics.com, 2017
Unit labour cost	Calculated	www.worlddata.info, 2017
O&M cost (including fuel)	$83 333 333/y	WNA, 2017
Loan payback period	30 years	IRP, 2016
Discount Rate	8,2%	IRP, 2016
Load factor	90%	IRP, 2016

4.1 MODELLING PROCEDURE

The spreadsheet provides introductory information on each of the projects under consideration. Reference is made to the project owner (country), the name of the power plant project, the vendor, the reactor technology employed, the number of units, as well as the gross capacity for the plant.

The cost calculations are based on the TCIC of a particular project as obtained from literature. The TCIC represents the "all inclusive construction cost", including the EPC cost, contingency cost, owners' cost, as well as the finance cost (Gonzalez, 2014); refer to Figure 15.

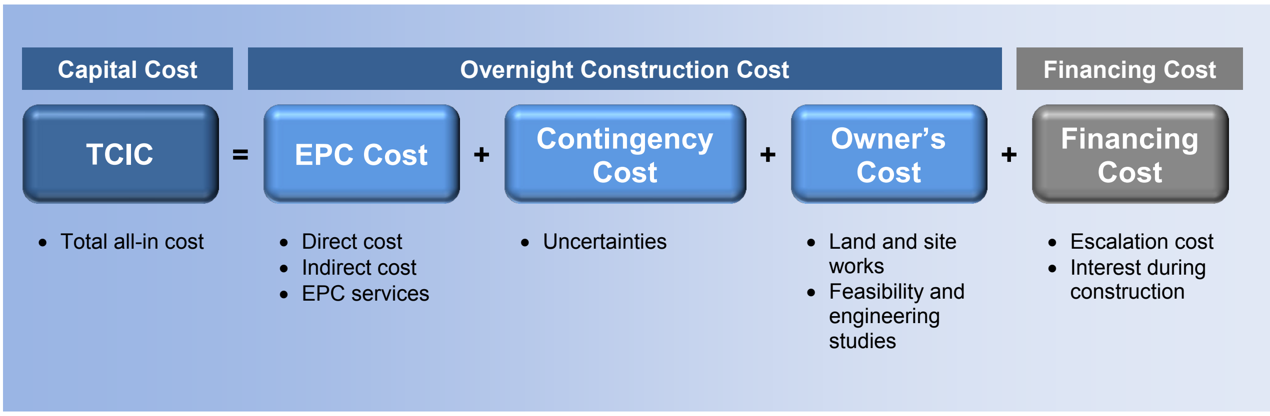

Figure 15: Breakdown of the TCIC (Gonzales, 2014)

4.1.1 Total Capital Investment Cost

The total capital investment cost (TCIC), also referred to as the "all-in cost", is the total up-front cost incurred for constructing an NPP and bringing it to a commercially operable state (EMWG Guidelines, 2007).

The TCIC reported for all the projects within the scope of this study were converted from nominal dollar values to constant 2016-dollar values to account for inflation. This was done by multiplying the initial dollar amount by an inflation factor. The inflation factor is the ratio between the consumer price index (CPI) in 2016 and the CPI at the time when the project cost was estimated (x). The inflation factor was calculated in the following manner:

$$Inflation\ factor = \frac{CPI_{2016}}{CPI_x}$$

The inflation adjusted TCIC ($) was then divided by the gross capacity (kWe) for each project, in order to get the TCIC in $/kWe.

$$TCIC = \frac{Total\ project\ cost\ (\$)}{Gross\ capacity\ (kWe)}$$

4.1.2 Cost on Construction Loan

The cost relating to the construction loan (CCL) is a combination of two cost components, i.e. the cost incurred due to interest during construction (IDC) and the cost incurred due to escalation (Gonzalez, 2014). The cost relating to the construction loan is therefore dependent on the construction period as well as on the cost of capital. The relationship between these two factors is described in Table 7 (D'haeseleer, 2013).

Table 7: Financing costs as a fraction of total construction costs

	Construction Period		
	One Year	Five Years	Ten Years
5% cost of capital	2%	12%	22%
10% cost of capital	4%	22%	40%
15% cost of capital	6%	30%	54%

It is assumed that all cash for the capital expenditure (CAPEX) will be supplied as capital investment by the South African Government, i.e. no loans and thus no interest on debt. Taking the estimated construction schedule of each power plant into consideration, and assuming a cost of capital of 10%, the CCL was calculated through interpolation by using Table 7 as a reference. Figure 16 presents a graphic interpretation of the data in Table 7.

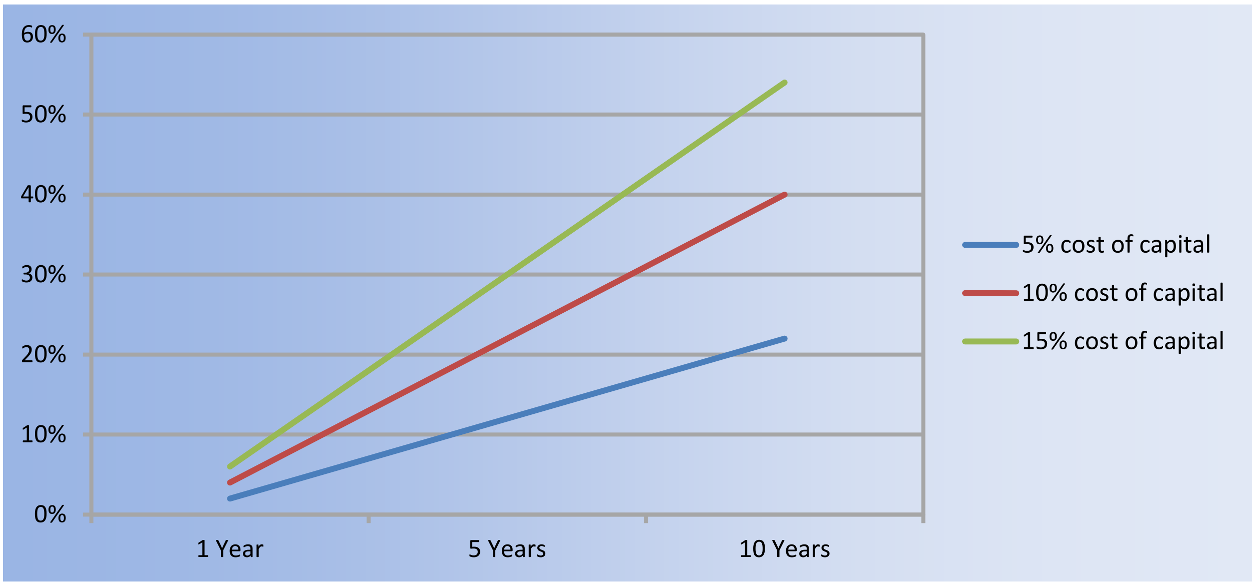

Figure 16: Financing costs as a fraction of total construction costs

4.1.3 Overnight Capital Cost (OCC)

The overnight capital cost (OCC) is described as the cost of a construction project as if the project was completed “overnight” with no interest incurred and no escalation cost taken into consideration, i.e. excluding the financing cost. The OCC of the projects within the scope of this study were calculated by making use of the relationship between the TCIC ($/kWe), OCC ($/kWe), and the CCL ($/kWe) as described in the cost breakdown of TCIC (Gonzales, 2014). This relationship is as follows:

$$TCIC = OCC + CCL$$

$$\therefore OCC = TCIC - CCL$$

4.1.4 Total Plant Cost (TPC)

The OCC comprises the EPC cost, contingency cost, as well as the owner's cost (Gonzales, 2014).

$$OCC = EPCC + Contingency\ cost + Owner's\ cost$$

Where: $EPCC + Contingency\ cost = Total\ plant\ cost$

For this study, it is assumed that contingency costs add an additional 20% to the EPCC, i.e. the base cost (EMWG Guidelines, 2007), and that the owner's cost is 20% of the total plant cost (TPC) is (NETL, 2012).

$$\therefore Total\ plant\ cost = 1.2\ EPCC$$

$$Owner's\ cost = 0.2\ total\ plant\ cost$$

$$\therefore Owner's\ cost = 0.2 \times 1.2\ EPCC$$

$$\therefore Owner's\ cost = 0.2 \times 1.2\ EPCC$$

$$OCC = 1.44 EPCC$$

$$\therefore EPCC = \frac{OCC}{1.44}$$

$$\therefore Total\ plant\ cost = 1.2\ EPCC$$

4.1.5 International Labour Cost

The labour cost of a construction project is dependent on two factors, i.e. the number of labourers employed to perform construction activities and the average wage of the labourers that are required (Rothwell, 2016). According to a study done by EPRI, the labour cost accounts for 26% of the total plant cost, with the remaining 74% accounting for the material cost (EPRI, 2011).

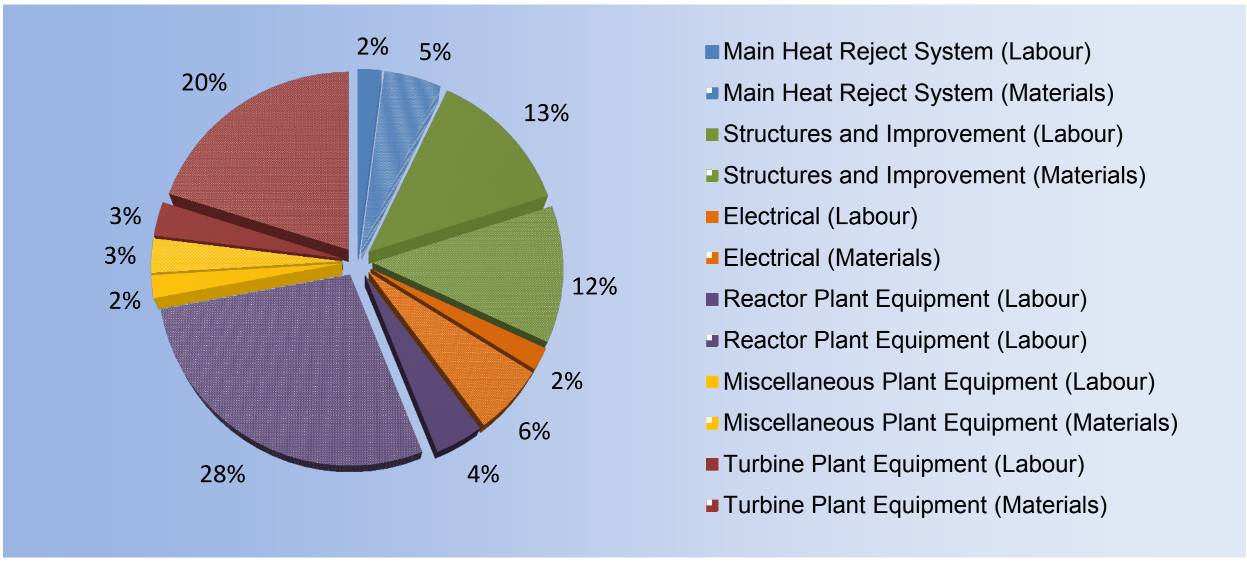

Figure 17: Generic nuclear plant cost breakdown as a percentage of total plant costs (EPRI, 2011)

4.1.6 Unit Labour Cost (ULC)

The ULC represents the link that exist between the cost of labour ($/h) and the labour productivity. The UCL was determined for each power plant within the scope of this study in order to do a comparison between the ULC of the country where the power plant is constructed and the ULC of South Africa.

The labour productivity was determined by the mathematical ratio:

$$Unit\ labour\ costs = \frac{Cost\ of\ labour\ (\frac{\$}{h})}{Labour\ productivity\left(\frac{\$}{h}\right)}$$

Where: $Cost\ of\ Labour = L \times P_L$

$L = Labourers\ (number\ of\ employees)$

$P_L = Price\ of\ labour\ (average\ wages\ and\ benefits)$

$$Labour\ productivity = \frac{Total\ output}{Total\ Input} = \frac{Gross\ domestic\ product\ (\$)}{Average\ no\ of\ hours\ worked\ annually\ (h)}$$

$$ULC_{ratio} = \frac{ULC_{International}}{ULC_{South\ Africa}}$$

4.1.7 South African Labour Cost

The ULC comparison ratio was used to determine the labour cost of each power plant if it were to be constructed in the South African economic landscape. The South African labour cost was calculated as follows:

$$Labour\ cost_{SA} = (UCL_{ratio} - 1) \times labour\ cost_{International}$$

4.1.8 Localized OCC

The South African labour cost was used to calculate the OCC of each power plant if it were to be constructed in the South African economic landscape, using the previously defined relationships between labour cost, TPC, owner's cost, and the OCC. These relationships include:

$$TPC_{SA} = \Delta labour\ cost + labour\ cost_{International} + Material\ cost_{International}$$

$$EPCC_{SA} = \frac{TPC_{SA}}{1.2}$$

$$OCC_{SA} = EPCC_{SA} \times 1.44$$

4.2 RESULTS AND DISCUSSION

The main objective of this research was to produce comprehensive costing information for five different reactor technologies within the South African economic landscape in order to address the uncertainty surrounding the affordability of nuclear technology in South Africa. This was achieved by evaluating open-source data gathered from 23 nuclear projects (44 plants) in 12 countries. The results of this evaluation are discussed below. The evaluation produced the following results:

4.2.1 AP1000 Technology

Three AP1000 reactor technology projects were evaluated. In addition to these projects, there is one other nuclear project, namely VC Summer in South Carolina USA that was approved by the authorities and has a valid contract in place. The calculated OCC for these projects ranges between \$2 771/kW (Sanmen in China) and \$3 976/kW (Vogtle in the USA), with an average of \$3 327/kW.

The two projects in China were the first AP1000 reactors to be ordered and constructed, of which the construction at Sanmen started in April 2009, with Haiyang starting construction five months later (PRIS, 2017). These types of projects are called first-of-a-kind (FOAK) projects, i.e. the plant has not been constructed or operated anywhere in the world before. As a result, the construction costs of these plants are generally higher compared to the subsequent nuclear projects of its type. Subsequent nuclear projects are projects that are of the same reactor technology and are normally constructed at the same site as the FOAK project. The subsequent projects are also known as n^{th}-of-a-kind (NOAK) projects.

The inflated cost for FOAK projects is normally attributed to unforeseen issues that are experienced during FOAK construction. A case in point for the AP1000 reactor technology was the issues that were experienced with the design and supply of the reactor coolant pumps for both the Chinese AP1000 projects (Mycle Schneider et al, 2015).

If the different AP1000 projects were to be constructed within the South African economic landscape, taking into account South African labour cost and labour productivity, the localized OCC ranges between $2 862/kW (VC Summer project in the USA) and $4 330/kW (Haiyang project in China), with an average localized OCC of $3 580/kW.

On average, the OCC of the projects that were constructed in the USA ($3 220/kW) are less than the projects that were constructed in China ($3 941/kW).

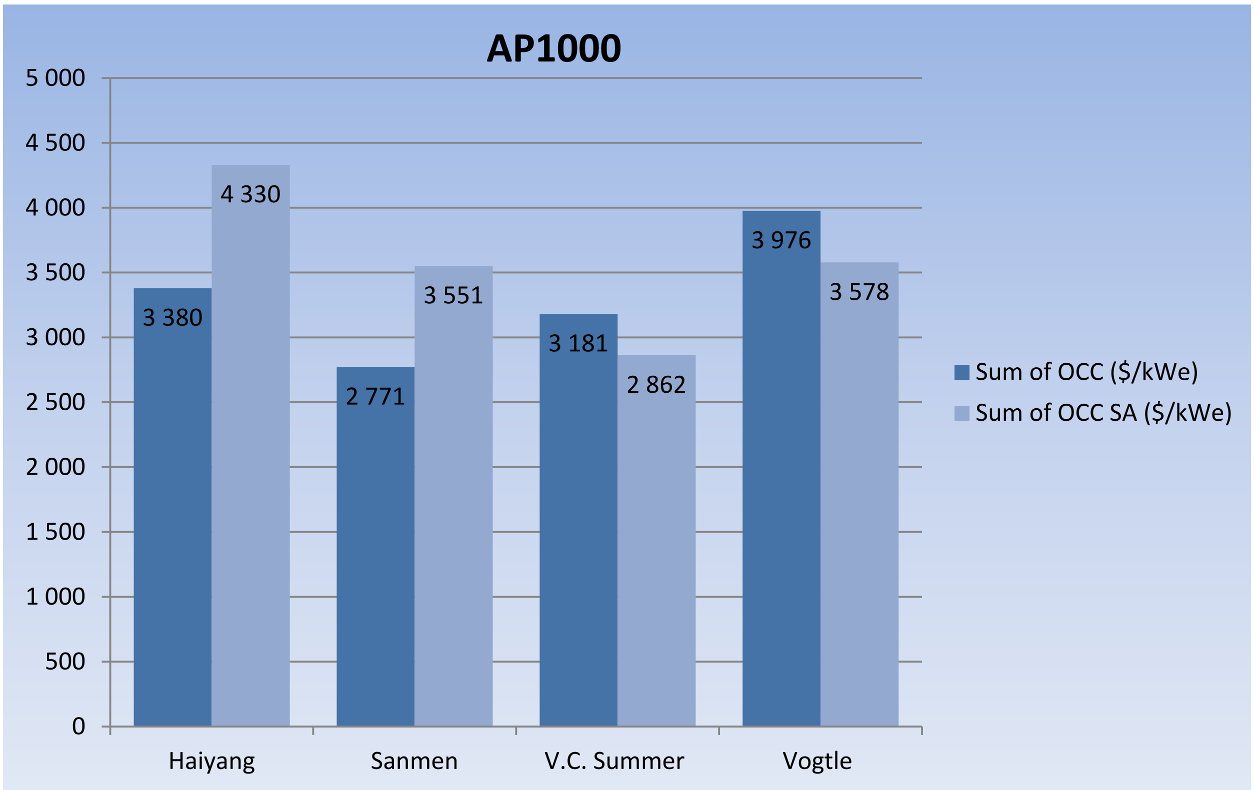

Figure 18: AP1000 Sum of OCC; SA v International ($/kWe)

4.2.2 EPR1600 Technology

Three projects were evaluated of the EPR1600 reactor technology that is currently being constructed. Added to this, is Hinkley Point C in the UK that was approved by the authorities and has a valid contract in place. The OCC for these projects ranges between $5 078/kW (Hinkley Point C in the UK) and $1 625/kW (Taishan in China), with an average OCC of $2 985/kW.

The first EPR1600 project to have gone into construction was at Olkiluoto unit 3 in Finland, with construction starting in August 2005 (PRIS, 2017). Other projects that followed were Flamanville (unit 3) in France and Taishan NPP (units 1 and 2) in China (Jackson, 2012).

To date, it has been reported that all the EPR projects at Olkiluoto 3, Flamanville 3, and Taishan I & II incurred construction delays. The delays were related to quality control issues experienced at Olkiluoto 3 (FOAK project issues). The first issue that caused major delays was the finding of irregularities in the concrete used for the building of the basemat of the reactor. There were also manufacturing errors, relating to quality issues on welding joints on the tops and bottoms of the reactor pressure vessel (Mycle Schneider et al, 2015). However, the issue that had the greatest impact on the construction of EPR1600 projects was the redundancy requirements for instrumentation and control (I&C) systems, which took Areva almost five years to resolve (Mycle Schneider et al, 2015).

Results for the EPR1600 projects indicate a decrease in the OCC for post-Olkiluoto projects.

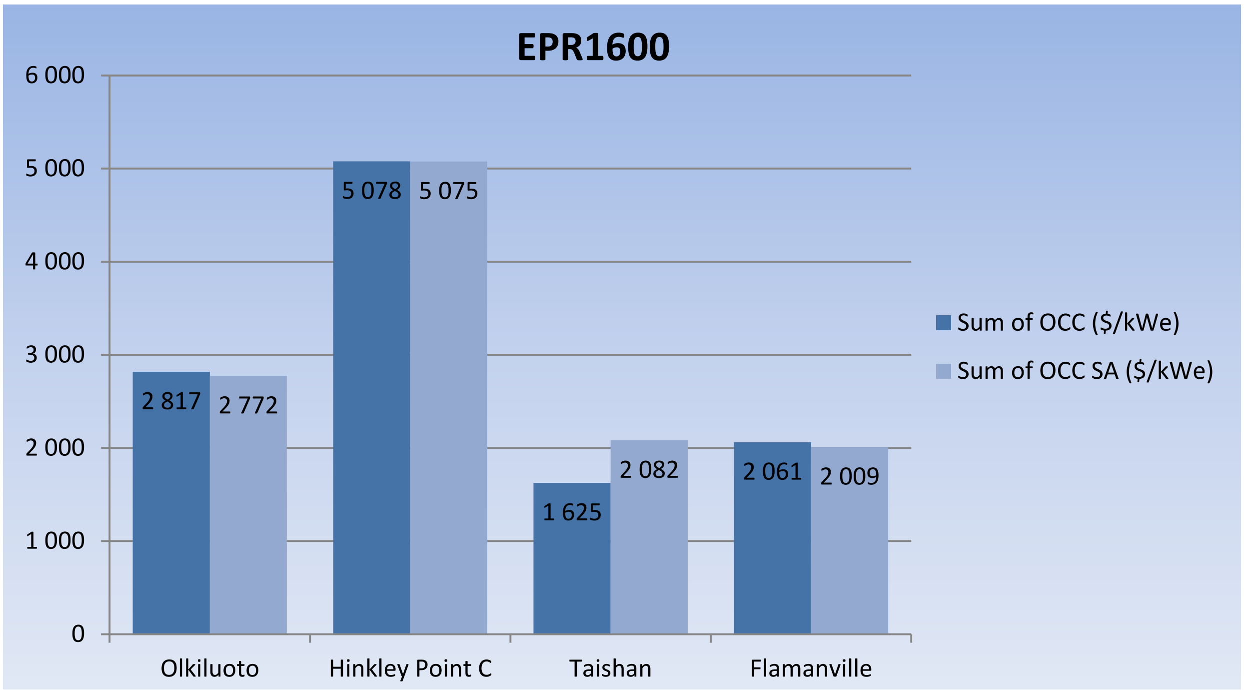

Figure 19: EPR1600 Sum of OCC; SA v International ($/kWe)

If the different EPR1600 projects were to be constructed within the South African economic landscape, taking into account South African labour cost and labour productivity, the localized OCC ranges between $5 075/kW (Hinkley Point C project in the UK) and $2 009/kW (Flamanville project in France), with an average localized OCC of $2 985/kW. If the Hinkley Point C project data is omitted from the research, then the average localized OCC of the EPR1600 project is reduced to $2 288/kW.

4.2.3 Hualong One Technology

With 19 reactors under construction, apart from its 38 plants already operational, China is currently the country with the biggest expansion plans for nuclear energy (PRIS, 2017). Most of the reactors that are being constructed as part of this expansion programme are of the Generation II type. The Hualong One technology is a Generation III reactor design that was developed by the China National Nuclear Corporation (CNNC) and the China General Nuclear Power Group (CGNPG). Currently, there are only three Hualong One projects under construction. The projects include the Fangchenggang II project in China, consisting two units with an OCC of $1 779/kW and the Kanupp project that is being constructed in Karachi, Pakistan, with an OCC of $3 239/kW. In addition to these two projects, there is the Fuqing project (units 5 and 6) being constructed in China. However, due to a lack of economic information, this project was omitted from the research.

The Kanupp project is the first Chinese reactor technology project to be constructed outside of the borders of China. It is therefore to be expected that the OCC of the Karachi project would be higher, in this case, almost double the cost of the reference project Fangchenggang II. However, the OCC is still within the $3 500/kW that the Chinese Government envisaged for the Hualong One technology (WNA, 2016).

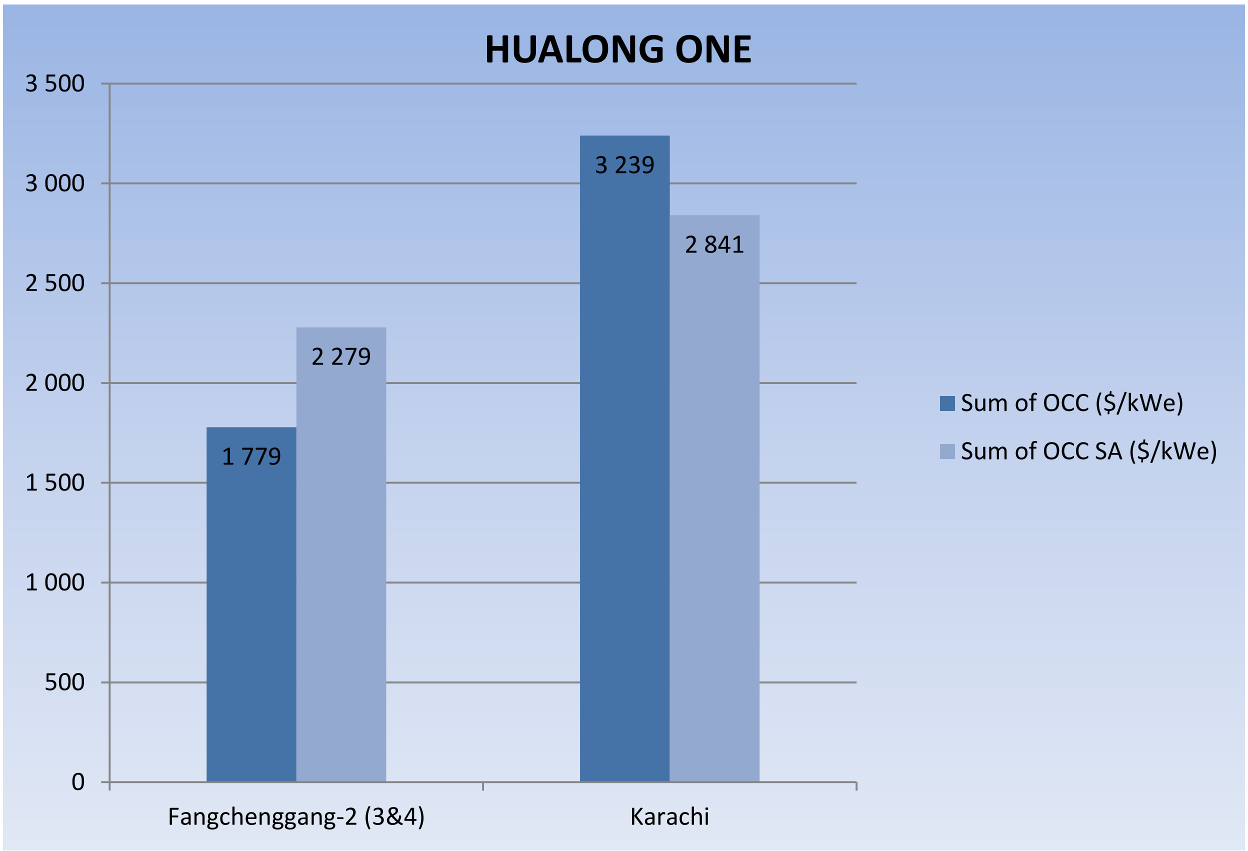

Figure 20: Hualong One Sum of ACC; SA v International ($/kWe)

If these Hualong One projects were to be constructed within the South African economic landscape, taking into account South African labour cost and labour productivity, the localized OCC ranges between $2 279/kW (Fangchenggang project in China) and $2 841/kW (Kanupp project in Pakistan).

4.2.4 APR1400 Technology

Construction of the first APR1400 reactor in the Republic of Korea started in October 2008 at Shin-Kori II unit 3, with unit 4 starting construction almost a year later in August 2009 (PRIS, 2017). In addition to this project, there are two other APR1400 projects underway. These include a two-unit plant being constructed at Shin-Hanul (unit 1 and unit 2), and a 4-unit plant currently under construction in the United Arab Emirates (UAE). The plant in the UAE is the first APR1400 to be constructed outside of the borders of South Korea.

KEPCO disclosed that the major factors considered, and which got them the Barakah contract, despite facing strong competition from France, USA, and Japan, was the relatively low construction cost and short construction time that KEPCO achieved (WNA, 2017). This was backed up by various studies that showed that the South Korean utility have experienced sustained reductions in construction cost throughout its nuclear power experience (Jessica R. Lovering et al, 2016).

This is visible in the OCC figures for the APR1400 projects currently under construction which ranges between $3 070/kW (Barakah in the UAE) and $1 777/kW (Shin-Hanul I in South Korea), with an average of OCC $2 162/kW.

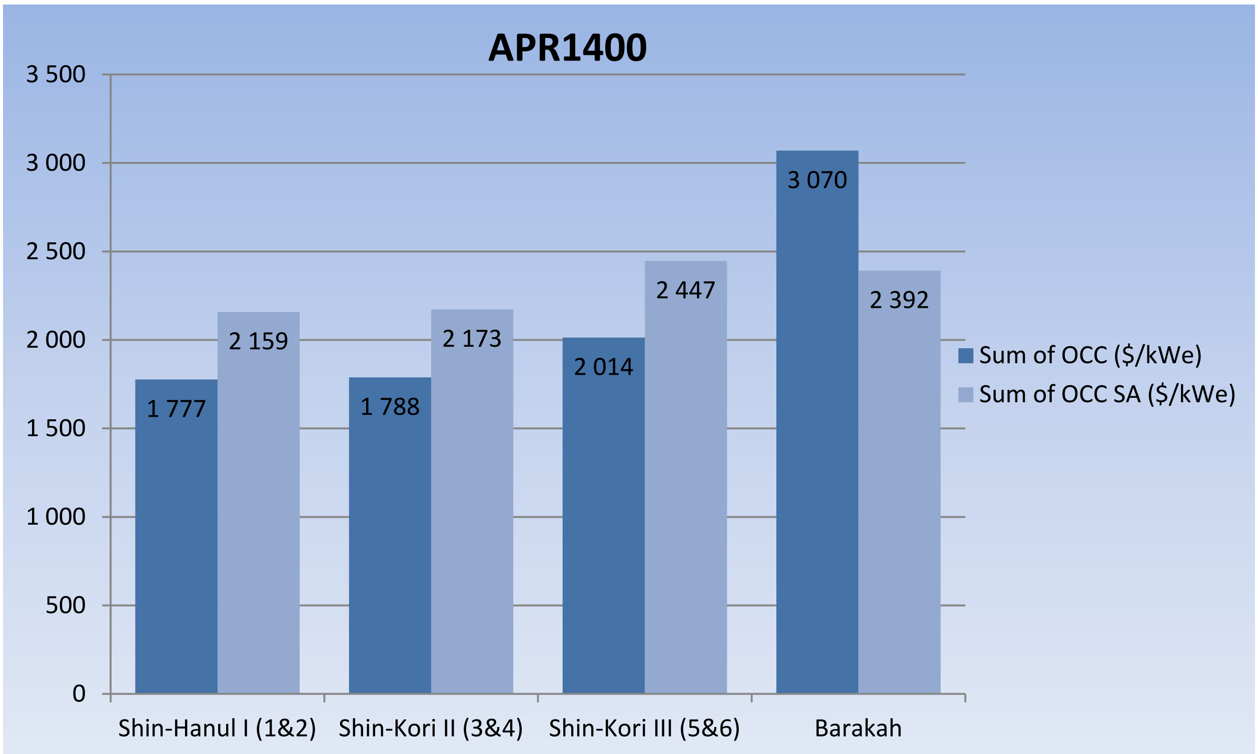

Figure 21: APR1400 Sum of SCC; SA v International ($/kWe)

It should be noted that some of the APR1400 projects also incurred delays due to quality control issues with cables. However, the cost implications of these project delays were not disclosed and it can therefore be expected that the cost mentioned before could be slightly higher than determined here.

If these APR1400 projects were to be constructed within the South African economic landscape, taking into account South African labour cost and labour productivity, the localized OCC ranges between $2 293/kW (Shin-Hanul project in South Korea) and $2 447/kW (Shin-Kori project in

South Korea), with an average localized OCC of $2 293/kW. Again, the higher OCC of the Barakah plant is to be expected since it is the first APR1400 to be constructed outside of the borders of South Korea. Although having a slightly higher OCC than the projects being constructed in South Korea, the Barakah project cost is still comparable to, and in some instances even better than, the AP1000 and the EPR1600 projects that are being constructed outside of its country of origin.

4.2.5 VVER1200 Technology

The VVER1200 reactor design is being constructed in four countries, at seven sites, around the world, with another two projects planned with valid contracts in place. This makes the VVER1200 technology the most employed technology of the five technologies under consideration. Russia's nuclear experience stretches well over 50 years, having played a part in the successful design, construction, and operation of more than 60 reactors worldwide (PRIS, 2017). Together with Areva and Westinghouse, Rosatom is one of the most experienced utilities in terms of power plant construction and operation, be it in national or international nuclear power projects.

The OCC for the VVER1200 projects under consideration as well as the planned projects with approved contracts, ranges between $4 892/kW (Hanhikivi in the Finland) and $1 416/kW (Taiwan I in China), with an average OCC of $2 912/kW.

The OCC for the Kaliningrad project in Russia and the Hanhikivi project in Finland is relatively higher, compared to the cost of the other VVER1200 projects. It should also be mentioned that for both these projects the OCC calculated is only for a single unit. The key issue here is that all the supply chain costs, including the design, construction, production of equipment and the qualification thereof, are all being borne by a single unit. Resultantly, the OCC is expected to be higher than that of twin-unit plants.

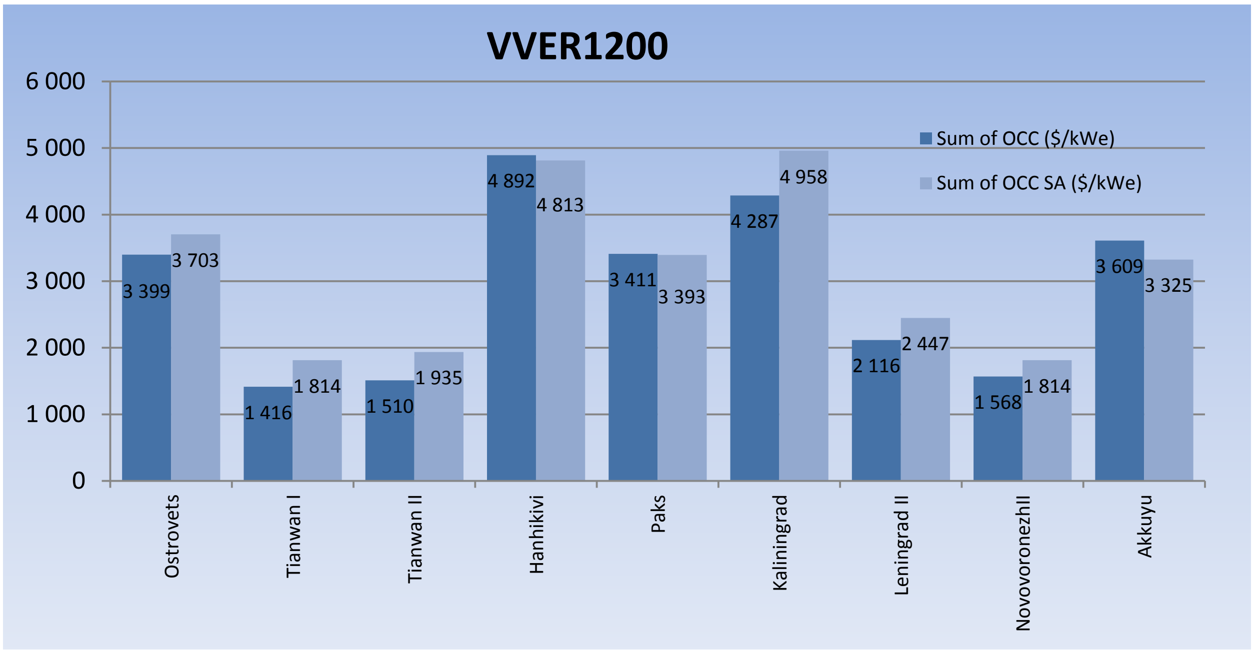

Figure 22: VVER1200 Sum of OCC; SA v International ($/kWe)

If these VVER1200 projects were to be constructed within the South African economic landscape, taking into account South African labour cost and labour productivity, the localized OCC ranges between $4 958/kW (Kaliningrad in Russia) and $1 814/kW (Tianwan I in China), with an average localized OCC of $3 134/kW.

4.2.6 Summary of Results

The results indicate that the average OCC for constructing each of the different reactor technologies within the South African economic landscape, taking into account South African labour cost and labour productivity, ranges between $2 293/kW (APR1400) and $3 580/kW (AP1000).

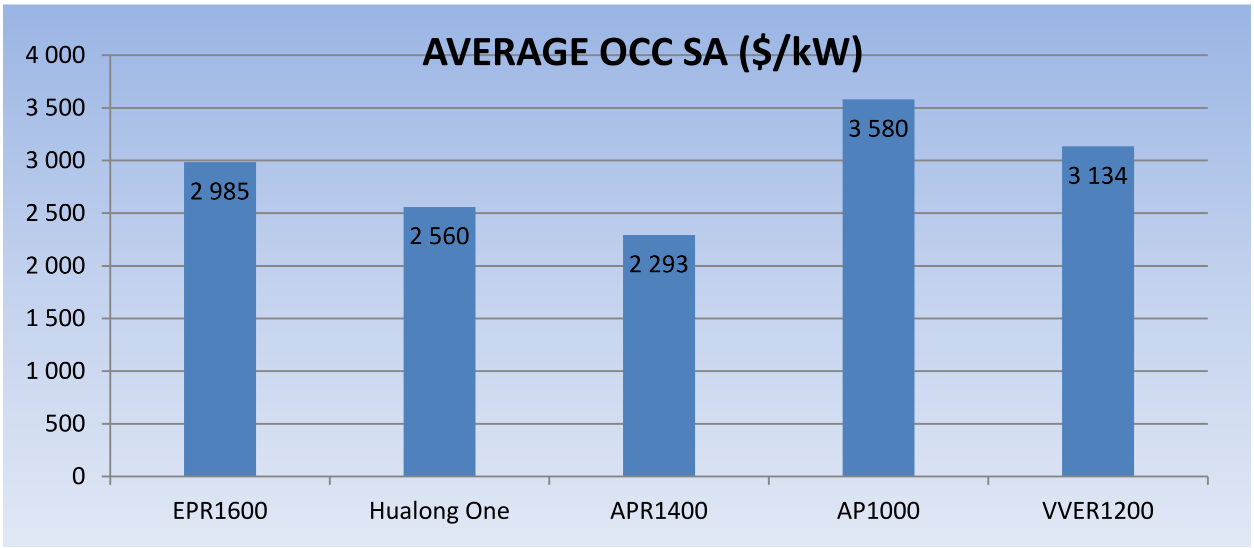

Figure 23: Average OCC SA ($/kW)

The results show that the technology with the least localized OCC is the APR1400 at a cost of $2 293/kW. This is slightly cheaper than the localized OCC for the Hualong One technology, which came to $2 560/kW.

The costs for constructing the AP1000 ($3 580/kW), VVER1200 ($3 134/kW), and the EPR1600 ($2 985/kW) technologies within the South African economic landscape is noticeably higher than that of the other two technologies. However, the cost of the VVER1200 technology is influenced by the number of projects that are currently under construction. There are 0.75% more VVER1200 projects than AP1000, and 125% more VVER1200 projects than EPR1600 projects.

The average OCC for constructing one of the five technologies within the South African economic landscape is $2 910/kW.

4.2.7 Sensitivity Analysis

The sensitivity analysis as performed to determine how certain factors will influence the localized OCC. The graph below illustrates the effect that labour cost, labour productivity and CCL have on localized OCC.

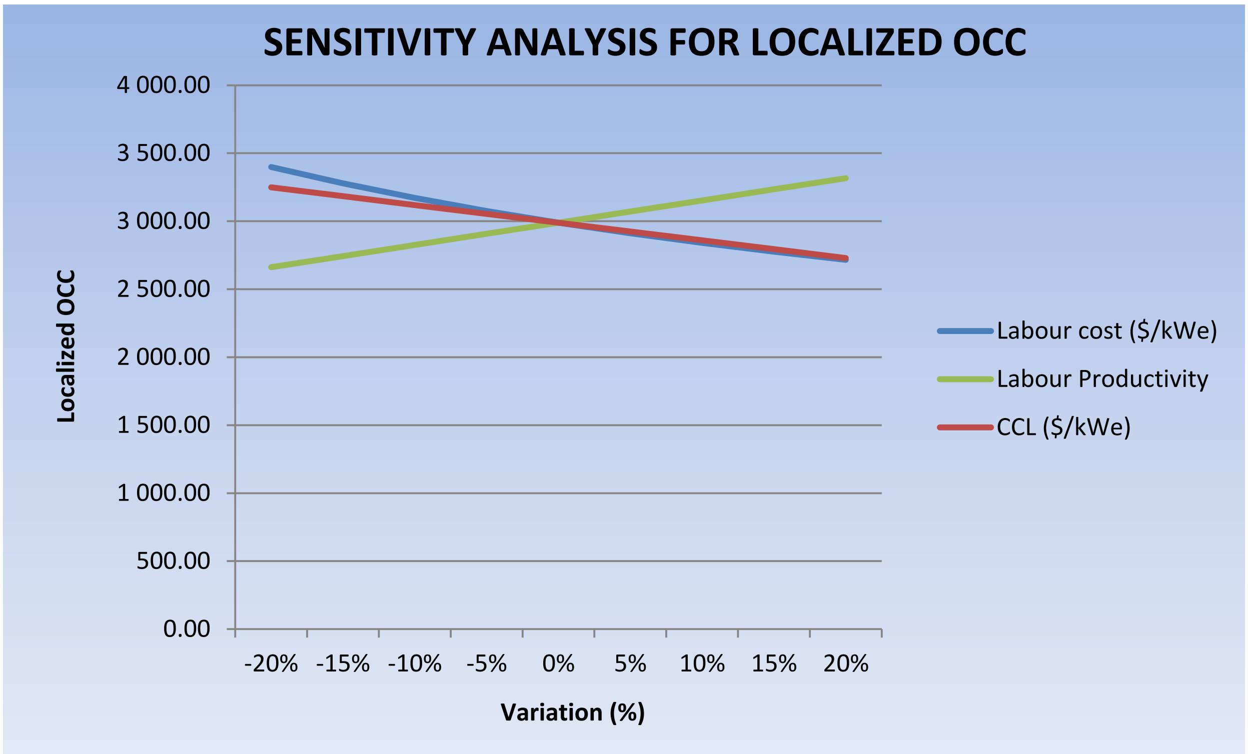

Figure 24: Sensitivity analysis for localized OCC

The resulting graph indicates how sensitive the localized OCC is to variations in CCL and the labour cost, but most sensitive for the labour productivity. This validates the assumption that labour cost and labour productivity could potentially have a great influence on the capital cost nuclear projects.

CHAPTER 5 CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION OF THE RESULTS

Over the past five years, the South African Government has on numerous occasions expressed their commitment to plan and build a fleet of NPPs. Despite the South African Government's public backing of a NNBP, minimal progress has been made in this regard. The lack of progress is primarily due to the uncertainty surrounding the affordability of nuclear technology in South Africa.

In this research, the economics of various international nuclear projects have been analysed in order to determine the OCC for five particular reactor technologies within the South African economic landscape. In addition to this, the research also discussed the various Generation III and Generation III+ nuclear technologies that are currently available for construction. The technology evaluation concluded with a qualitative summary that highlights the key differences between the various technologies. Although certain technologies have distinct advantages over others, most of the design features of the technologies are comparable.

The economic evaluation concluded that the average OCC for constructing one of the five technologies within the South African economic landscape is \$2 910/kW. The technology with the lowest localized OCC is the APR1400 at a cost of \$2 293/kW. This is marginally cheaper than the localized OCC for the Hualong One technology, which came to \$2 560/kW. The OCC for constructing the AP1000, VVER1200, and the EPR1600 technologies within the South African economic landscape is somewhat higher at \$3 580/kW, \$3 134/kW, and \$2 985/kW respectively.

The updated IRP conservatively assumes an OCC of \$5 981/kW (2016 dollar value) for advanced nuclear power stations (IRP, 2016). This figure is noticeably higher—more than double the average localized OCC calculated for the different projects evaluated in this research. However, in a country such as South Africa where construction of nuclear reactors has not occurred for more than 30 years, any nuclear project would be considered a FOAK project. As a result, the OCC for the first dual units to be constructed as part of the NNBP are expected to be somewhat higher than the figures calculated in this research.

However, South Africa can benefit from the experiences, both good and bad, of other FOAK projects. This is demonstrated where KEPCO is constructing the first AP1400 reactor beyond the borders of South Korea in the UAE at the Barakah NPP. To date, no significant delays have been reported and construction is on schedule for all four units. Unit 1 is almost complete and commercial operation is expected in 2018 (WNA, 2017). A key factor to be considered is that South Korea, China, and Russia have continuously been involved in nuclear construction activities; even during the time when the USA and the Western European countries decided to halt the construction of nuclear power facilities in the 1990s. This enabled a continuum of learning on the manufacturing, construction, and commissioning of NPPs, which allowed for a standardised design approach and enhanced regulation processes, which in turn, can lead to sustained construction cost reductions (Jessica R. Lovering et al, 2016).

A similar approach as in the UAE can be assumed for South Africa NNBP. It can therefore be concluded that it is highly likely that the OCC for a fleet of NPPs can be below $5 000/kW, which will result in an estimated total cost of a R600 billion, and not the R1 trillion as published in the South African media (EWN, 2017).

A sensitivity analysis validated the assumed influence of labour cost and labour productivity; therefore, although it accounts for only 26% of the TPC, the cost of labour as well as labour productivity has a real impact on the cost of nuclear. This aspect is important as the South African Government is calling for localization to be a key factor in contract negotiations.

5.2 RECOMMENDATIONS

The following recommendations are made with regard to follow-up studies:

- Develop a cash-flow model to calculate the Internal Rate of Return (IRR) and the Net Present Value (NPV) of all the technologies within the scope. This can be of great help to policymakers as it can show the effect of different construction time lines and selling electricity at different points on a timeline, displaying the effect of cost of capital during the expensive construction phase of a nuclear power plant (NPP).
- A further study could also be conducted to determine the effectiveness of using standardised design and licensing approaches, and the cost implications thereof.
- This study can be enhanced by the taking into account the economic data of other countries that have new build programmes, e.g. India.

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APPENDICES

APPENDIX 1
INTERPOLATION CCL

Country	Site	Construction	% CoCL
Belarus	Ostrovets	5	0.22
China	Tianwan I	8	0.33
China	Tianwan II	6	0.25
Finland	Hanhikivi	5	0.22
Hungary	Paks	8	0.33
Russia	Kaliningrad	8	0.33
Russia	Leningrad II	8	0.33
Russia	NovovoronezhII	10	0.4
Turkey	Akkuyu	6	0.25
China	Taishan	8	0.33
Finland	Olkiluoto	13	0.51
France	Flamanville	11	0.44
UK	Hinkley Point C	7	0.29
China	Fangchenggang-2 (3&4)	4	0.18
Pakistan	Karachi	6	0.25
South Korea	Shin-Hanul I (1&2)	6	0.25
South Korea	Shin-Kori II (3&4)	7	0.29
South Korea	Shin-Kori III (5&6)	5	0.22
UAE	Barakah	6	0.25
China	Haiyang	8	0.33
China	Sanmen	8	0.33
USA	Vogtle (Georgia)	7	0.29
USA	V.C. Summer (South Carolina)	7	0.29

APPENDIX 2
COST OF LABOUR CALCULATION

Source: https://www.worlddata.info/average-income.php

	SA	Belarus	China	Finland	Hungary	Russia	Turkey	France	UK	Pakistan	South Korea	UAE	USA
Monthly salary (local currency)	28042.00	770.60	5169.08	3392.00	274799.00	37640.00	7029.00	2957.00	2211.73	104.73	3480465.00	18003.00	3816.86
Covertion factor (local currency to $)	0.08	0.54	0.14	1.09	0.00	0.02	0.28	1.09	1.29	1.00	0.00	0.27	1.00
monthly salary ($)	547	467	688	3728	1048	810	932	3246	3533	126	2300	4861	3533
weekly salary ($)	125.88	107.47	158.33	857.95	241.18	186.41	214.49	747.02	813.07	29.00	529.31	1118.65	813.07
ave work week (hr)	45.00	40.00	40.00	40.00	40.00	40.00	45.00	35.00	38.20	48.00	40.00	48.00	40.00
ave cost per labour hour ($)	2.80	2.69	3.96	21.45	6.03	4.66	4.77	21.34	21.28	0.60	13.23	23.31	20.33

APPENDIX 3
LABOUR PRODUCTIVITY CALCULATION

Country	GDP (US$ billion)	No of workers	Ave no of hrs worked annually	Labour Productivity
Belarus	54.61	4372600	2080.00	6.00
China	11064.66	776030000	2122.98	6.72
Finland	232.40	2439000	1646.00	57.89
Hungary	121.72	4367928	1749.00	15.93
Russia	1331.20	71800000	1978.00	9.37
Turkey	717.88	26672000	1832.00	14.69
France	2418.84	27798000	1482.00	58.71
United Kingdom	2861.10	30668000	1674.00	55.73
Pakistan	271.05	57420000	2282.60	2.07
South Korea	1377.87	26622000	2113.00	24.49
UAE	370.29	3910000	2216.07	42.73
United States	18036.65	153000000	1790.00	65.86
South Africa	314.57	9690000	2215.20	14.65

APPENDIX 4
INTERNATIONAL LABOUR CALCULATION

Country	Site	Vendor	Technology	Units	Gross Capacity (kWe)	CPI Ratio	Cost after inflation	TCIC ($/Kwe)	CCL ($/kWe)	OCC ($/kWe)	EPC Cost ($/kWe)	TPC Cost ($/kWe)	Material Cost ($/kWe)	Int Labour cost ($/kWe)
Belarus	Ostrovets	Rosatom	VVER AES-2006 V-491	2	2 400 000	1.11	$ 10 459 615 287	4 358	959	3 399	2 361	2 833	2 096	**737**
China	Tianwan I	Rosatom	VVER (AES91/V428)	2	2 120 000	1.06	$ 4 479 219 512	2 113	697	1 416	983	1 180	873	**307**
China	Tianwan II	Rosatom	VVER (AES91/V428M)	2	2 120 000	1.11	$ 4 269 400 616	2 014	503	1 510	1 049	1 259	931	**327**
Finland	Hanhikivi	Rosatom	VVER V-491	1	1 200 000	1.01	$ 7 525 541 206	6 271	1 380	4 892	3 397	4 076	3 016	**1 060**
Hungary	Paks	Rosatom	VVER-1200	2	2 400 000	1.01	$ 12 218 065 693	5 091	1 680	3 411	2 369	2 842	2 103	**739**
Russia	Kaliningrad	Rosatom	VVER AES-2006 V-491	1	1 194 000	1.11	$ 7 639 980 050	6 399	2 112	4 287	2 977	3 573	2 644	**929**
Russia	Leningrad II	Rosatom	VVER AES-2006 V-491	2	2 340 000	1.14	$ 7 388 892 863	3 158	1 042	2 116	1 469	1 763	1 305	**458**
Russia	NovovoronezhII	Rosatom	VVER AES-2006 (V-392M)	2	2 400 000	1.19	$ 5 617 632 390	2 341	772	1 568	1 089	1 307	967	**340**
Turkey	Akkuyu	Rosatom	VVER AES-2006 (V-392)	4	4 800 000	1.05	$ 23 096 579 179	4 812	1 203	3 609	2 506	3 007	2 225	**782**
China	Taishan	CGN + EDF	EPR 1600	2	3 500 000	1.14	$ 8 486 352 982	2 425	800	1 625	1 128	1 354	1 002	**352**
Finland	Olkiluoto	Areva	EPR 1600	1	1 720 000	1.05	$ 9 889 535 267	5 750	2 932	2 817	1 957	2 348	1 737	**610**
France	Flamanville	EDF (Areva)	EPR 1600	1	3 260 000	1.01	$ 12 000 187 328	3 681	1 620	2 061	1 432	1 718	1 271	**447**
UK	Hinkley Point C	Areva	EPR 1600	2	3 300 000	1.00	$ 23 600 000 000	7 152	2 074	5 078	3 526	4 231	3 131	**1 100**
China	Fangchenggang-2 (3&4)	CGN	Hualong-1	2	2 300 000	1.03	$ 4 989 043 491	2 169	390	1 779	1 235	1 482	1 097	**385**
Pakistan	Karachi	CNNC	Hualong-1	2	2 300 000	1.03	$ 9 933 012 530	4 319	1 080	3 239	2 249	2 699	1 997	**702**
South Korea	Shin-Hanul I (1&2)	KEPCO	APR1400	2	2 800 000	1.10	$ 6 632 369 667	2 369	592	1 777	1 234	1 480	1 096	**385**
South Korea	Shin-Kori II (3&4)	KEPCO	APR1400	2	2 800 000	1.12	$ 7 053 034 096	2 519	730	1 788	1 242	1 490	1 103	**387**
South Korea	Shin-Kori III (5&6)	KEPCO	APR1400	2	2 800 000	1.03	$ 7 229 022 202	2 582	568	2 014	1 398	1 678	1 242	**436**
UAE	Barakah	KEPCO	APR1400	4	5 600 000	1.11	$ 22 919 940 150	4 093	1 023	3 070	2 132	2 558	1 893	**665**
China	Haiyang	Westinghouse	AP-1000	1	1 250 000	1.14	$ 6 305 210 146	5 044	1 665	3 380	2 347	2 816	2 084	**732**
China	Sanmen	Westinghouse	AP-1000	1	1 250 000	1.03	$ 5 170 467 103	4 136	1 365	2 771	1 925	2 309	1 709	**600**
USA	Vogtle (Georgia)	Westinghouse	AP-1000	2	2 500 000	1.02	$ 14 000 000 000	5 600	1 624	3 976	2 761	3 313	2 452	**861**
USA	V.C. Summer (South Carolina)	Westinghouse	AP-1000	2	2 500 000	1.02	$ 11 199 893 552	4 480	1 299	3 181	2 209	2 651	1 961	**689**

APPENDIX 5
LOCALIZED OCC CALCULATION

Country	Site	Vendor	Technology	Units	Gross Capacity (kWe)	Int Labour cost ($/kWe)	Labour Rate ($/hr)	Labour Prodctivity ($/labour hr)	ULC International	ULC ratio	Labour cost SA ($/kWe)	Difference in Labour Cost ($/kWe)	TPC SA ($/kWe)	EPCC SA ($/kWe)	OCC SA ($/kWe)
Belarus	Ostrovets	Rosatom	VVER AES-2006 V-491	2	2 400 000	**737**	2.69	6	0.45	2.34	**989**	253	3 085	2 571	**3 703**
China	Tianwan I	Rosatom	VVER (AES91/V428)	2	2 120 000	**307**	3.96	7	0.59	3.08	**639**	332	1 512	1 260	**1 814**
China	Tianwan II	Rosatom	VVER (AES91/V428M)	2	2 120 000	**327**	3.96	7	0.59	3.08	**681**	354	1 613	1 344	**1 935**
Finland	Hanhikivi	Rosatom	VVER V-491	1	1 200 000	**1 060**	21.45	58	0.37	1.94	**995**	-65	4 011	3 343	**4 813**
Hungary	Paks	Rosatom	VVER-1200	2	2 400 000	**739**	6.03	16	0.38	1.98	**725**	-14	2 828	2 357	**3 393**
Russia	Kaliningrad	Rosatom	VVER AES-2006 V-491	1	1 194 000	**929**	4.66	9	0.50	2.60	**1 488**	559	4 132	3 443	**4 958**
Russia	Leningrad II	Rosatom	VVER AES-2006 V-491	2	2 340 000	**458**	4.66	9	0.50	2.60	**734**	276	2 039	1 699	**2 447**
Russia	NovovoronezhII	Rosatom	VVER AES-2006 (V-392M)	2	2 400 000	**340**	4.66	9	0.50	2.60	**544**	205	1 512	1 260	**1 814**
Turkey	Akkuyu	Rosatom	VVER AES-2006 (V-392)	4	4 800 000	**782**	4.77	15	0.32	1.70	**546**	-236	2 771	2 309	**3 325**
China	Taishan	CGN + EDF	EPR 1600	2	3 500 000	**352**	3.96	7	0.59	3.08	**733**	381	1 735	1 446	**2 082**
Finland	Olkiluoto	Areva	EPR 1600	1	1 720 000	**610**	21.45	58	0.37	1.94	**573**	-38	2 310	1 925	**2 772**
France	Flamanville	EDF (Areva)	EPR 1600	1	3 260 000	**447**	21.34	59	0.36	1.90	**403**	-44	1 674	1 395	**2 009**
UK	Hinkley Point C	Areva	EPR 1600	2	3 300 000	**1 100**	21.28	56	0.38	2.00	**1 098**	-2	4 229	3 525	**5 075**
China	Fangchenggang-2 (3&4)	CGN	Hualong-1	2	2 300 000	**385**	3.96	7	0.59	3.08	**802**	417	1 899	1 583	**2 279**
Pakistan	Karachi	CNNC	Hualong-1	2	2 300 000	**702**	0.60	2	0.29	1.53	**370**	-332	2 367	1 973	**2 841**
South Korea	Shin-Hanul I (1&2)	KEPCO	APR1400	2	2 800 000	**385**	13.23	24	0.54	2.83	**703**	318	1 799	1 499	**2 159**
South Korea	Shin-Kori II (3&4)	KEPCO	APR1400	2	2 800 000	**387**	13.23	24	0.54	2.83	**708**	321	1 811	1 509	**2 173**
South Korea	Shin-Kori III (5&6)	KEPCO	APR1400	2	2 800 000	**436**	13.23	24	0.54	2.83	**797**	361	2 039	1 699	**2 447**
UAE	Barakah	KEPCO	APR1400	4	5 600 000	**665**	23.31	106	0.22	1.15	**100**	-565	1 993	1 661	**2 392**
China	Haiyang	Westinghouse	AP-1000	1	1 250 000	**732**	3.96	7	0.59	3.08	**1 524**	792	3 609	3 007	**4 330**
China	Sanmen	Westinghouse	AP-1000	1	1 250 000	**600**	3.96	7	0.59	3.08	**1 250**	650	2 959	2 466	**3 551**
USA	Vogtle (Georgia)	Westinghouse	AP-1000	2	2 500 000	**861**	20.33	66	0.31	1.61	**530**	-332	2 982	2 485	**3 578**
USA	V.C. Summer (South Carolina)	Westinghouse	AP-1000	2	2 500 000	**689**	20.33	66	0.31	1.61	**424**	-265	2 385	1 988	**2 862**

APPENDIX 6
LOCALIZED OCC SUMMARY

Country	Site	Vendor	OCC SA ($/kWe)
Belarus	Ostrovets	Rosatom	3 703
China	Fangchenggang-2 (3&4)	CGN	2 279
China	Haiyang	Westinghouse	4 330
China	Sanmen	Westinghouse	3 551
China	Taishan	CGN + EDF	2 082
China	Tianwan I	Rosatom	1 814
China	Tianwan II	Rosatom	1 935
Finland	Hanhikivi	Rosatom	4 813
Finland	Olkiluoto	Areva	2 772
France	Flamanville	EDF (Areva)	2 009
Hungary	Paks	Rosatom	3 393
Pakistan	Karachi	CNNC	2 841
Russia	Kaliningrad	Rosatom	4 958
Russia	Leningrad II	Rosatom	2 447
Russia	NovovoronezhII	Rosatom	1 814
South Korea	Shin-Hanul I (1&2)	KEPCO	2 159
South Korea	Shin-Kori II (3&4)	KEPCO	2 173
South Korea	Shin-Kori III (5&6)	KEPCO	2 447
Turkey	Akkuyu	Rosatom	3 325
UAE	Barakah	KEPCO	2 392
UK	Hinkley Point C	Areva	5 075
USA	V.C. Summer (South Carolina)	Westinghouse	2 862
USA	Vogtle (Georgia)	Westinghouse	3 578

APPENDIX 7
LOCALIZED OCC GROUPED

Country	Site	Vendor	Technology	OCC SA ($/kWe)	Total Capital Cost	Total Capital Cost for per plant	Total Interest Accumulated & O&M Costs	Total Loan amount	LCOE ($/MWh)
Belarus	Ostrovets	Rosatom	VVER AES-2006 V-491	**3 703**	$ 4 443 032 625	$ 4 443 032 625	$ 22 247 549 203	$ 26 690 581 828	**47.02**
China	Tianwan I	Rosatom	VVER (AES91/V428)	**1 814**	$ 1 922 648 766	$ 1 922 648 766	$ 12 463 591 199	$ 14 386 239 965	**28.69**
China	Tianwan II	Rosatom	VVER (AES91/V428M)	**1 935**	$ 2 051 402 953	$ 2 051 402 953	$ 12 963 406 159	$ 15 014 809 112	**29.94**
China	Taishan	CGN + EDF	EPR 1600	**2 082**	$ 3 642 660 523	$ 3 642 660 523	$ 19 140 559 366	$ 22 783 219 889	**27.52**
China	Fangchenggang-2 (3&4)	CGN	Hualong-1	**2 279**	$ 2 620 921 098	$ 2 620 921 098	$ 15 174 236 700	$ 17 795 157 797	**32.71**
China	Haiyang	Westinghouse	AP-1000	**4 330**	$ 5 412 864 663	$ 5 412 864 663	$ 26 012 370 938	$ 31 425 235 601	**53.15**
China	Sanmen	Westinghouse	AP-1000	**3 551**	$ 4 438 716 240	$ 4 438 716 240	$ 22 230 793 292	$ 26 669 509 533	**45.10**
Finland	Hanhikivi	Rosatom	VVER V-491	**4 813**	$ 5 776 146 750	$ 5 776 146 750	$ 27 422 607 188	$ 33 198 753 938	**58.48**
Finland	Olkiluoto	Areva	EPR 1600	**2 772**	$ 4 768 456 677	$ 4 768 456 677	$ 23 510 823 147	$ 28 279 279 824	**34.76**
France	Flamanville	EDF (Areva)	EPR 1600	**2 009**	$ 6 549 057 653	$ 6 549 057 653	$ 30 422 994 527	$ 36 972 052 180	**23.97**
Hungary	Paks	Rosatom	VVER-1200	**3 393**	$ 4 072 186 020	$ 4 072 186 020	$ 20 807 948 009	$ 24 880 134 029	**43.83**
Pakistan	Karachi	CNNC	Hualong-1	**2 841**	$ 3 266 744 676	$ 3 266 744 676	$ 17 681 279 723	$ 20 948 024 399	**38.51**
Russia	Kaliningrad	Rosatom	VVER AES-2006 V-491	**4 958**	$ 5 920 329 786	$ 5 920 329 786	$ 27 982 315 886	$ 33 902 645 672	**60.02**
Russia	Leningrad II	Rosatom	VVER AES-2006 V-491	**2 447**	$ 2 862 879 367	$ 2 862 879 367	$ 16 113 502 176	$ 18 976 381 543	**34.29**
Russia	NovovoronezhII	Rosatom	VVER AES-2006 (V-392M)	**1 814**	$ 2 176 591 833	$ 2 176 591 833	$ 13 449 380 841	$ 15 625 972 674	**27.53**
South Korea	Shin-Hanul I (1&2)	KEPCO	APR1400	**2 159**	$ 3 022 003 470	$ 3 022 003 470	$ 16 731 211 075	$ 19 753 214 544	**29.83**
South Korea	Shin-Kori II (3&4)	KEPCO	APR1400	**2 173**	$ 3 042 280 844	$ 3 042 280 844	$ 16 809 926 459	$ 19 852 207 303	**29.98**
South Korea	Shin-Kori III (5&6)	KEPCO	APR1400	**2 447**	$ 3 425 619 579	$ 3 425 619 579	$ 18 298 021 245	$ 21 723 640 823	**32.80**
Turkey	Akkuyu	Rosatom	VVER AES-2006 (V-392)	**3 325**	$ 3 990 172 067	$ 3 990 172 067	$ 20 489 575 448	$ 24 479 747 515	**43.12**
UAE	Barakah	KEPCO	APR1400	**2 392**	$ 3 348 598 844	$ 3 348 598 844	$ 17 999 032 012	$ 21 347 630 855	**32.23**
UK	Hinkley Point C	Areva	EPR 1600	**5 075**	$ 8 374 260 592	$ 8 374 260 592	$ 37 508 307 678	$ 45 882 568 270	**58.78**
USA	Vogtle (Georgia)	Westinghouse	AP-1000	**3 578**	$ 4 472 287 778	$ 4 472 287 778	$ 22 361 115 710	$ 26 833 403 488	**45.38**
USA	V.C. Summer (South Carolina)	Westinghouse	AP-1000	**2 862**	$ 3 577 796 218	$ 3 577 796 218	$ 18 888 760 564	$ 22 466 556 782	**38.00**

APPENDIX 8
AMORTIZATION: OSTROVETS, BELARUS

Country	**Belarus**	
Plant	**Ostrovets**	
Technology	**VVER AES-2006 V-491**	
Vendor	**Rosatom**	
	Loan amount	$4 443 032 625
	Annual interest rate	98%
	Loan period in years	60
	Monthly Payment	$367 577 402
	O&M	$83 333 333
	Total Interest	

No.	Beginning Balance	Payment	Interest	Principal	O&M	Total Payment	Ending Balance
1	$4 443 032 625	$367 577 402	$364 328 675	$3 248 727	$83 333 333	$450 910 735	$4 439 783 898
2	$4 439 783 898	$367 577 402	$363 774 040	$3 515 122	$83 333 333	$450 622 495	$4 436 268 776
3	$4 436 268 776	$367 577 402	$363 462 164	$3 803 362	$83 333 333	$450 598 859	$4 432 465 414
4	$4 432 465 414	$367 577 402	$363 124 714	$4 115 238	$83 333 333	$450 573 286	$4 428 350 176
5	$4 428 350 176	$367 577 402	$362 759 594	$4 452 687	$83 333 333	$450 545 615	$4 423 897 489
6	$4 423 897 489	$367 577 402	$362 364 534	$4 817 808	$83 333 333	$450 515 675	$4 419 079 681
7	$4 419 079 681	$367 577 402	$361 937 079	$5 212 868	$83 333 333	$450 483 280	$4 413 866 813
8	$4 413 866 813	$367 577 402	$361 474 572	$5 640 323	$83 333 333	$450 448 229	$4 408 226 490
9	$4 408 226 490	$367 577 402	$360 974 140	$6 102 830	$83 333 333	$450 410 303	$4 402 123 661
10	$4 402 123 661	$367 577 402	$360 432 673	$6 603 262	$83 333 333	$450 369 268	$4 395 520 399
11	$4 395 520 399	$367 577 402	$359 846 805	$7 144 729	$83 333 333	$450 324 867	$4 388 375 670
12	$4 388 375 670	$367 577 402	$359 212 896	$7 730 597	$83 333 333	$450 276 826	$4 380 645 073
13	$4 380 645 073	$367 577 402	$358 527 007	$8 364 506	$83 333 333	$450 224 846	$4 372 280 567
14	$4 372 280 567	$367 577 402	$357 784 874	$9 050 395	$83 333 333	$450 168 603	$4 363 230 172
15	$4 363 230 172	$367 577 402	$356 981 887	$9 792 528	$83 333 333	$450 107 748	$4 353 437 644
16	$4 353 437 644	$367 577 402	$356 113 055	$10 595 515	$83 333 333	$450 041 903	$4 342 842 129
17	$4 342 842 129	$367 577 402	$355 172 978	$11 464 347	$83 333 333	$449 970 659	$4 331 377 782
18	$4 331 377 782	$367 577 402	$354 155 815	$12 404 424	$83 333 333	$449 893 572	$4 318 973 358
19	$4 318 973 358	$367 577 402	$353 055 245	$13 421 586	$83 333 333	$449 810 165	$4 305 551 772
20	$4 305 551 772	$367 577 402	$351 864 428	$14 522 156	$83 333 333	$449 719 918	$4 291 029 616
21	$4 291 029 616	$367 577 402	$350 575 965	$15 712 973	$83 333 333	$449 622 271	$4 275 316 642
22	$4 275 316 642	$367 577 402	$349 181 847	$17 001 437	$83 333 333	$449 516 617	$4 258 315 205
23	$4 258 315 205	$367 577 402	$347 673 411	$18 395 555	$83 333 333	$449 402 300	$4 239 919 650
24	$4 239 919 650	$367 577 402	$346 041 284	$19 903 990	$83 333 333	$449 278 608	$4 220 015 660
25	$4 220 015 660	$367 577 402	$344 275 322	$21 536 118	$83 333 333	$449 144 773	$4 198 479 542
26	$4 198 479 542	$367 577 402	$342 364 552	$23 302 079	$83 333 333	$448 999 965	$4 175 177 463
27	$4 175 177 463	$367 577 402	$340 297 098	$25 212 850	$83 333 333	$448 843 281	$4 149 964 613
28	$4 149 964 613	$367 577 402	$338 060 113	$27 280 304	$83 333 333	$448 673 750	$4 122 684 309
29	$4 122 684 309	$367 577 402	$335 639 696	$29 517 288	$83 333 333	$448 490 317	$4 093 167 021
30	$4 093 167 021	$367 577 402	$333 020 804	$31 937 706	$83 333 333	$448 291 843	$4 061 229 315
31	$4 061 229 315	$367 577 402	$330 187 163	$34 556 598	$83 333 333	$448 077 094	$4 026 672 717
32	$4 026 672 717	$367 577 402	$327 121 163	$37 390 239	$83 333 333	$447 844 736	$3 989 282 478
33	$3 989 282 478	$367 577 402	$323 803 752	$40 456 239	$83 333 333	$447 593 324	$3 948 826 239
34	$3 948 826 239	$367 577 402	$320 214 312	$43 773 650	$83 333 333	$447 321 296	$3 905 052 589
35	$3 905 052 589	$367 577 402	$316 330 539	$47 363 089	$83 333 333	$447 026 962	$3 857 689 500
36	$3 857 689 500	$367 577 402	$312 128 296	$51 246 863	$83 333 333	$446 708 492	$3 806 442 637
37	$3 806 442 637	$367 577 402	$307 581 470	$55 449 106	$83 333 333	$446 363 908	$3 750 993 531
38	$3 750 993 531	$367 577 402	$302 661 803	$59 995 932	$83 333 333	$445 991 069	$3 690 997 599
39	$3 690 997 599	$367 577 402	$297 338 724	$64 915 599	$83 333 333	$445 587 656	$3 626 082 000
40	$3 626 082 000	$367 577 402	$291 579 152	$70 238 678	$83 333 333	$445 151 164	$3 555 843 322
41	$3 555 843 322	$367 577 402	$285 347 296	$75 998 249	$83 333 333	$444 678 879	$3 479 845 073
42	$3 479 845 073	$367 577 402	$278 604 427	$82 230 106	$83 333 333	$444 167 866	$3 397 614 967
43	$3 397 614 967	$367 577 402	$271 308 643	$88 972 974	$83 333 333	$443 614 951	$3 308 641 993
44	$3 308 641 993	$367 577 402	$263 414 605	$96 268 758	$83 333 333	$443 016 697	$3 212 373 234
45	$3 212 373 234	$367 577 402	$254 873 256	$104 162 797	$83 333 333	$442 369 386	$3 108 210 438
46	$3 108 210 438	$367 577 402	$245 631 516	$112 704 146	$83 333 333	$441 668 995	$2 995 506 292
47	$2 995 506 292	$367 577 402	$235 631 953	$121 945 886	$83 333 333	$440 911 172	$2 873 560 406
48	$2 873 560 406	$367 577 402	$224 812 427	$131 945 448	$83 333 333	$440 091 208	$2 741 614 958
49	$2 741 614 958	$367 577 402	$213 105 699	$142 764 975	$83 333 333	$439 204 007	$2 598 849 982
50	$2 598 849 982	$367 577 402	$200 439 019	$154 471 703	$83 333 333	$438 244 055	$2 444 378 279
51	$2 444 378 279	$367 577 402	$186 733 672	$167 138 383	$83 333 333	$437 205 388	$2 277 239 896
52	$2 277 239 896	$367 577 402	$171 904 486	$180 843 730	$83 333 333	$436 081 549	$2 096 396 166
53	$2 096 396 166	$367 577 402	$155 859 306	$195 672 916	$83 333 333	$434 865 556	$1 900 723 250
54	$1 900 723 250	$367 577 402	$138 498 423	$211 718 095	$83 333 333	$433 549 851	$1 689 005 155
55	$1 689 005 155	$367 577 402	$119 713 946	$229 078 979	$83 333 333	$432 126 259	$1 459 926 175
56	$1 459 926 175	$367 577 402	$99 389 143	$247 863 455	$83 333 333	$430 585 932	$1 212 062 720
57	$1 212 062 720	$367 577 402	$77 397 706	$268 188 259	$83 333 333	$428 919 298	$943 874 461
58	$943 874 461	$367 577 402	$53 602 971	$290 179 696	$83 333 333	$427 116 000	$653 694 765
59	$653 694 765	$367 577 402	$27 857 067	$313 974 431	$83 333 333	$425 164 832	$339 720 334
60	$339 720 334	$367 577 402	$0	$339 720 334	$83 333 333	$423 053 668	$0
			$17 247 549 202.66		**$4 999 999 999.98**	**$26 690 581 827.50**	

APPENDIX 9
AMORTIZATION: TIANWAN I, CHINA

Country	**China**	
Plant	**Tianwan I**	
Technology	**VVER (AES91/V428)**	
Vendor	**Rosatom**	
	Loan amount	$1 922 648 766
	Annual interest rate	98%
	Loan period in years	60
	Monthly Payment	$159 063 031
	O&M	$83 333 333
	Total Interest	

No.	Beginning Balance	Payment	Interest	Principal	O&M	Total Payment	Ending Balance
1	$1 922 648 766	$159 063 031	$157 657 199	$1 405 833	$83 333 333	$242 396 365	$1 921 242 934
2	$1 921 242 934	$159 063 031	$157 417 189	$1 521 111	$83 333 333	$242 271 634	$1 919 721 823
3	$1 919 721 823	$159 063 031	$157 282 230	$1 645 842	$83 333 333	$242 261 406	$1 918 075 981
4	$1 918 075 981	$159 063 031	$157 136 205	$1 780 801	$83 333 333	$242 250 339	$1 916 295 180
5	$1 916 295 180	$159 063 031	$156 978 205	$1 926 827	$83 333 333	$242 238 365	$1 914 368 353
6	$1 914 368 353	$159 063 031	$156 807 249	$2 084 826	$83 333 333	$242 225 409	$1 912 283 527
7	$1 912 283 527	$159 063 031	$156 622 275	$2 255 782	$83 333 333	$242 211 391	$1 910 027 744
8	$1 910 027 744	$159 063 031	$156 422 133	$2 440 756	$83 333 333	$242 196 223	$1 907 586 988
9	$1 907 586 988	$159 063 031	$156 205 579	$2 640 898	$83 333 333	$242 179 811	$1 904 946 090
10	$1 904 946 090	$159 063 031	$155 971 268	$2 857 452	$83 333 333	$242 162 054	$1 902 088 638
11	$1 902 088 638	$159 063 031	$155 717 744	$3 091 763	$83 333 333	$242 142 840	$1 898 996 874
12	$1 898 996 874	$159 063 031	$155 443 430	$3 345 288	$83 333 333	$242 122 051	$1 895 651 587
13	$1 895 651 587	$159 063 031	$155 146 623	$3 619 601	$83 333 333	$242 099 557	$1 892 031 985
14	$1 892 031 985	$159 063 031	$154 825 477	$3 916 409	$83 333 333	$242 075 219	$1 888 115 577
15	$1 888 115 577	$159 063 031	$154 477 998	$4 237 554	$83 333 333	$242 048 885	$1 883 878 023
16	$1 883 878 023	$159 063 031	$154 102 025	$4 585 034	$83 333 333	$242 020 392	$1 879 292 989
17	$1 879 292 989	$159 063 031	$153 695 223	$4 961 006	$83 333 333	$241 989 562	$1 874 331 983
18	$1 874 331 983	$159 063 031	$153 255 062	$5 367 809	$83 333 333	$241 956 204	$1 868 964 174
19	$1 868 964 174	$159 063 031	$152 778 809	$5 807 969	$83 333 333	$241 920 111	$1 863 156 205
20	$1 863 156 205	$159 063 031	$152 263 503	$6 284 223	$83 333 333	$241 881 058	$1 856 871 982
21	$1 856 871 982	$159 063 031	$151 705 941	$6 799 529	$83 333 333	$241 838 803	$1 850 072 453
22	$1 850 072 453	$159 063 031	$151 102 660	$7 357 090	$83 333 333	$241 793 083	$1 842 715 363
23	$1 842 715 363	$159 063 031	$150 449 909	$7 960 372	$83 333 333	$241 743 614	$1 834 754 991
24	$1 834 754 991	$159 063 031	$149 743 633	$8 613 122	$83 333 333	$241 690 089	$1 826 141 869
25	$1 826 141 869	$159 063 031	$148 979 443	$9 319 398	$83 333 333	$241 632 174	$1 816 822 471
26	$1 816 822 471	$159 063 031	$148 152 588	$10 083 589	$83 333 333	$241 569 510	$1 806 738 882
27	$1 806 738 882	$159 063 031	$147 257 932	$10 910 443	$83 333 333	$241 501 708	$1 795 828 439
28	$1 795 828 439	$159 063 031	$146 289 914	$11 805 099	$83 333 333	$241 428 347	$1 784 023 339
29	$1 784 023 339	$159 063 031	$145 242 518	$12 773 118	$83 333 333	$241 348 969	$1 771 250 222
30	$1 771 250 222	$159 063 031	$144 109 236	$13 820 513	$83 333 333	$241 263 083	$1 757 429 709
31	$1 757 429 709	$159 063 031	$142 883 025	$14 953 795	$83 333 333	$241 170 154	$1 742 475 913
32	$1 742 475 913	$159 063 031	$141 556 264	$16 180 007	$83 333 333	$241 069 604	$1 726 295 907
33	$1 726 295 907	$159 063 031	$140 120 709	$17 506 767	$83 333 333	$240 960 810	$1 708 789 140
34	$1 708 789 140	$159 063 031	$138 567 439	$18 942 322	$83 333 333	$240 843 094	$1 689 846 818
35	$1 689 846 818	$159 063 031	$136 886 800	$20 495 592	$83 333 333	$240 715 726	$1 669 351 225
36	$1 669 351 225	$159 063 031	$135 068 350	$22 176 231	$83 333 333	$240 577 914	$1 647 174 994
37	$1 647 174 994	$159 063 031	$133 100 786	$23 994 682	$83 333 333	$240 428 801	$1 623 180 313
38	$1 623 180 313	$159 063 031	$130 971 881	$25 962 246	$83 333 333	$240 267 461	$1 597 218 067
39	$1 597 218 067	$159 063 031	$128 668 407	$28 091 150	$83 333 333	$240 092 890	$1 569 126 917
40	$1 569 126 917	$159 063 031	$126 176 048	$30 394 624	$83 333 333	$239 904 006	$1 538 732 293
41	$1 538 732 293	$159 063 031	$123 479 315	$32 886 983	$83 333 333	$239 699 632	$1 505 845 309
42	$1 505 845 309	$159 063 031	$120 561 451	$35 583 716	$83 333 333	$239 478 500	$1 470 261 593
43	$1 470 261 593	$159 063 031	$117 404 321	$38 501 581	$83 333 333	$239 239 235	$1 431 760 012
44	$1 431 760 012	$159 063 031	$113 988 307	$41 658 710	$83 333 333	$238 980 351	$1 390 101 302
45	$1 390 101 302	$159 063 031	$110 292 179	$45 074 725	$83 333 333	$238 700 237	$1 345 026 577
46	$1 345 026 577	$159 063 031	$106 292 969	$48 770 852	$83 333 333	$238 397 155	$1 296 255 725
47	$1 296 255 725	$159 063 031	$101 965 824	$52 770 062	$83 333 333	$238 069 220	$1 243 485 663
48	$1 243 485 663	$159 063 031	$97 283 853	$57 097 207	$83 333 333	$237 714 394	$1 186 388 456
49	$1 186 388 456	$159 063 031	$92 217 961	$61 779 178	$83 333 333	$237 330 472	$1 124 609 278
50	$1 124 609 278	$159 063 031	$86 736 665	$66 845 071	$83 333 333	$236 915 069	$1 057 764 207
51	$1 057 764 207	$159 063 031	$80 805 903	$72 326 366	$83 333 333	$236 465 603	$985 437 841
52	$985 437 841	$159 063 031	$74 388 818	$78 257 128	$83 333 333	$235 979 280	$907 180 712
53	$907 180 712	$159 063 031	$67 445 533	$84 674 213	$83 333 333	$235 453 079	$822 506 499
54	$822 506 499	$159 063 031	$59 932 898	$91 617 498	$83 333 333	$234 883 730	$730 889 001
55	$730 889 001	$159 063 031	$51 804 227	$99 130 133	$83 333 333	$234 267 694	$631 758 868
56	$631 758 868	$159 063 031	$43 009 005	$107 258 804	$83 333 333	$233 601 143	$524 500 063
57	$524 500 063	$159 063 031	$33 492 575	$116 054 026	$83 333 333	$232 879 935	$408 446 037
58	$408 446 037	$159 063 031	$23 195 798	$125 570 456	$83 333 333	$232 099 587	$282 875 581
59	$282 875 581	$159 063 031	$12 054 684	$135 867 234	$83 333 333	$231 255 252	$147 008 347
60	$147 008 347	$159 063 031	$0	$147 008 347	$83 333 333	$230 341 680	$0
			$7 463 591 198.68		**$4 999 999 999.98**	**$14 386 239 964.86**	

APPENDIX 10
AMORTIZATION: TIANWAN II, CHINA

Country	**China**	
Plant	**Tianwan II**	
Technology	**VVER (AES91/V428M)**	
Vendor	**Rosatom**	
	Loan amount	$2 051 402 953
	Annual interest rate	98%
	Loan period in years	60
	Monthly Payment	$169 715 019
	O&M	$83 333 333
	Total Interest	

No.	Beginning Balance	Payment	Interest	Principal	O&M	Total Payment	Ending Balance
1	$2 051 402 953	$169 715 019	$168 215 042	$1 499 977	$83 333 333	$253 048 353	$2 049 902 976
2	$2 049 902 976	$169 715 019	$167 958 960	$1 622 975	$83 333 333	$252 915 269	$2 048 280 001
3	$2 048 280 001	$169 715 019	$167 814 963	$1 756 059	$83 333 333	$252 904 356	$2 046 523 942
4	$2 046 523 942	$169 715 019	$167 659 159	$1 900 056	$83 333 333	$252 892 548	$2 044 623 885
5	$2 044 623 885	$169 715 019	$167 490 578	$2 055 861	$83 333 333	$252 879 772	$2 042 568 025
6	$2 042 568 025	$169 715 019	$167 308 174	$2 224 441	$83 333 333	$252 865 948	$2 040 343 584
7	$2 040 343 584	$169 715 019	$167 110 813	$2 406 845	$83 333 333	$252 850 991	$2 037 936 738
8	$2 037 936 738	$169 715 019	$166 897 268	$2 604 207	$83 333 333	$252 834 808	$2 035 332 531
9	$2 035 332 531	$169 715 019	$166 666 212	$2 817 752	$83 333 333	$252 817 297	$2 032 514 780
10	$2 032 514 780	$169 715 019	$166 416 210	$3 048 807	$83 333 333	$252 798 350	$2 029 465 972
11	$2 029 465 972	$169 715 019	$166 145 707	$3 298 810	$83 333 333	$252 777 850	$2 026 167 163
12	$2 026 167 163	$169 715 019	$165 853 024	$3 569 312	$83 333 333	$252 755 669	$2 022 597 851
13	$2 022 597 851	$169 715 019	$165 536 340	$3 861 995	$83 333 333	$252 731 669	$2 018 735 856
14	$2 018 735 856	$169 715 019	$165 193 688	$4 178 679	$83 333 333	$252 705 701	$2 014 557 176
15	$2 014 557 176	$169 715 019	$164 822 939	$4 521 331	$83 333 333	$252 677 603	$2 010 035 846
16	$2 010 035 846	$169 715 019	$164 421 789	$4 892 080	$83 333 333	$252 647 202	$2 005 143 766
17	$2 005 143 766	$169 715 019	$163 987 744	$5 293 230	$83 333 333	$252 614 308	$1 999 850 535
18	$1 999 850 535	$169 715 019	$163 518 107	$5 727 275	$83 333 333	$252 578 716	$1 994 123 260
19	$1 994 123 260	$169 715 019	$163 009 961	$6 196 912	$83 333 333	$252 540 206	$1 987 926 348
20	$1 987 926 348	$169 715 019	$162 460 146	$6 705 059	$83 333 333	$252 498 538	$1 981 221 289
21	$1 981 221 289	$169 715 019	$161 865 246	$7 254 874	$83 333 333	$252 453 453	$1 973 966 416
22	$1 973 966 416	$169 715 019	$161 221 565	$7 849 773	$83 333 333	$252 404 671	$1 966 116 643
23	$1 966 116 643	$169 715 019	$160 525 101	$8 493 455	$83 333 333	$252 351 889	$1 957 623 188
24	$1 957 623 188	$169 715 019	$159 771 528	$9 189 918	$83 333 333	$252 294 779	$1 948 433 270
25	$1 948 433 270	$169 715 019	$158 956 162	$9 943 491	$83 333 333	$252 232 986	$1 938 489 779
26	$1 938 489 779	$169 715 019	$158 073 936	$10 758 857	$83 333 333	$252 166 126	$1 927 730 922
27	$1 927 730 922	$169 715 019	$157 119 367	$11 641 084	$83 333 333	$252 093 784	$1 916 089 838
28	$1 916 089 838	$169 715 019	$156 086 523	$12 595 653	$83 333 333	$252 015 509	$1 903 494 185
29	$1 903 494 185	$169 715 019	$154 968 987	$13 628 496	$83 333 333	$251 930 816	$1 889 865 689
30	$1 889 865 689	$169 715 019	$153 759 812	$14 746 033	$83 333 333	$251 839 178	$1 875 119 657
31	$1 875 119 657	$169 715 019	$152 451 485	$15 955 207	$83 333 333	$251 740 026	$1 859 164 449
32	$1 859 164 449	$169 715 019	$151 035 875	$17 263 534	$83 333 333	$251 632 743	$1 841 900 915
33	$1 841 900 915	$169 715 019	$149 504 185	$18 679 144	$83 333 333	$251 516 663	$1 823 221 770
34	$1 823 221 770	$169 715 019	$147 846 897	$20 210 834	$83 333 333	$251 391 064	$1 803 010 936
35	$1 803 010 936	$169 715 019	$146 053 711	$21 868 122	$83 333 333	$251 255 167	$1 781 142 814
36	$1 781 142 814	$169 715 019	$144 113 483	$23 661 309	$83 333 333	$251 108 125	$1 757 481 505
37	$1 757 481 505	$169 715 019	$142 014 157	$25 601 536	$83 333 333	$250 949 027	$1 731 879 969
38	$1 731 879 969	$169 715 019	$139 742 687	$27 700 862	$83 333 333	$250 776 882	$1 704 179 108
39	$1 704 179 108	$169 715 019	$137 284 956	$29 972 332	$83 333 333	$250 590 621	$1 674 206 775
40	$1 674 206 775	$169 715 019	$134 625 690	$32 430 064	$83 333 333	$250 389 087	$1 641 776 712
41	$1 641 776 712	$169 715 019	$131 748 365	$35 089 329	$83 333 333	$250 171 028	$1 606 687 383
42	$1 606 687 383	$169 715 019	$128 635 100	$37 966 654	$83 333 333	$249 935 087	$1 568 720 729
43	$1 568 720 729	$169 715 019	$125 266 546	$41 079 920	$83 333 333	$249 679 799	$1 527 640 809
44	$1 527 640 809	$169 715 019	$121 621 772	$44 448 473	$83 333 333	$249 403 578	$1 483 192 336
45	$1 483 192 336	$169 715 019	$117 678 125	$48 093 248	$83 333 333	$249 104 706	$1 435 099 089
46	$1 435 099 089	$169 715 019	$113 411 100	$52 036 894	$83 333 333	$248 781 327	$1 383 062 195
47	$1 383 062 195	$169 715 019	$108 794 179	$56 303 919	$83 333 333	$248 431 431	$1 326 758 275
48	$1 326 758 275	$169 715 019	$103 798 670	$60 920 841	$83 333 333	$248 052 844	$1 265 837 435
49	$1 265 837 435	$169 715 019	$98 393 529	$65 916 350	$83 333 333	$247 643 212	$1 199 921 085
50	$1 199 921 085	$169 715 019	$92 545 167	$71 321 490	$83 333 333	$247 199 990	$1 128 599 595
51	$1 128 599 595	$169 715 019	$86 217 239	$77 169 852	$83 333 333	$246 720 425	$1 051 429 742
52	$1 051 429 742	$169 715 019	$79 370 421	$83 497 780	$83 333 333	$246 201 535	$967 931 962
53	$967 931 962	$169 715 019	$71 962 164	$90 344 598	$83 333 333	$245 640 096	$877 587 364
54	$877 587 364	$169 715 019	$63 946 430	$97 752 855	$83 333 333	$245 032 618	$779 834 508
55	$779 834 508	$169 715 019	$55 273 405	$105 768 590	$83 333 333	$244 375 328	$674 065 919
56	$674 065 919	$169 715 019	$45 889 193	$114 441 614	$83 333 333	$243 664 140	$559 624 305
57	$559 624 305	$169 715 019	$35 735 475	$123 825 826	$83 333 333	$242 894 635	$435 798 478
58	$435 798 478	$169 715 019	$24 749 153	$133 979 544	$83 333 333	$242 062 030	$301 818 934
59	$301 818 934	$169 715 019	$12 861 952	$144 965 867	$83 333 333	$241 161 152	$156 853 068
60	$156 853 068	$169 715 019	$0	$156 853 068	$83 333 333	$240 186 401	$0
			$7 963 406 158.65		**$4 999 999 999.98**	**$15 014 809 111.72**	

APPENDIX 11
AMORTIZATION: HANHIKIVI, FINLAND

Country	**Finland**	
Plant	**Hanhikivi**	
Technology	**VVER V-491**	
Vendor	**Rosatom**	
	Loan amount	$5 776 146 750
	Annual interest rate	98%
	Loan period in years	60
	Monthly Payment	$477 867 527
	O&M	$83 333 333
	Total Interest	

No.	Beginning Balance	Payment	Interest	Principal	O&M	Total Payment	Ending Balance
1	$5 776 146 750	$477 867 527	$473 644 033	$4 223 494	$83 333 333	$561 200 861	$5 771 923 256
2	$5 771 923 256	$477 867 527	$472 922 982	$4 569 820	$83 333 333	$560 826 135	$5 767 353 436
3	$5 767 353 436	$477 867 527	$472 517 529	$4 944 546	$83 333 333	$560 795 408	$5 762 408 890
4	$5 762 408 890	$477 867 527	$472 078 829	$5 349 998	$83 333 333	$560 762 161	$5 757 058 891
5	$5 757 058 891	$477 867 527	$471 604 156	$5 788 698	$83 333 333	$560 726 187	$5 751 270 193
6	$5 751 270 193	$477 867 527	$471 090 559	$6 263 372	$83 333 333	$560 687 264	$5 745 006 822
7	$5 745 006 822	$477 867 527	$470 534 848	$6 776 968	$83 333 333	$560 645 149	$5 738 229 853
8	$5 738 229 853	$477 867 527	$469 933 568	$7 332 679	$83 333 333	$560 599 581	$5 730 897 174
9	$5 730 897 174	$477 867 527	$469 282 984	$7 933 959	$83 333 333	$560 550 276	$5 722 963 215
10	$5 722 963 215	$477 867 527	$468 579 051	$8 584 544	$83 333 333	$560 496 928	$5 714 378 671
11	$5 714 378 671	$477 867 527	$467 817 396	$9 288 476	$83 333 333	$560 439 206	$5 705 090 195
12	$5 705 090 195	$477 867 527	$466 993 285	$10 050 131	$83 333 333	$560 376 750	$5 695 040 063
13	$5 695 040 063	$477 867 527	$466 101 597	$10 874 242	$83 333 333	$560 309 173	$5 684 165 821
14	$5 684 165 821	$477 867 527	$465 136 791	$11 765 930	$83 333 333	$560 236 054	$5 672 399 891
15	$5 672 399 891	$477 867 527	$464 092 871	$12 730 736	$83 333 333	$560 156 940	$5 659 669 155
16	$5 659 669 155	$477 867 527	$462 963 349	$13 774 657	$83 333 333	$560 071 339	$5 645 894 498
17	$5 645 894 498	$477 867 527	$461 741 206	$14 904 179	$83 333 333	$559 978 718	$5 630 990 319
18	$5 630 990 319	$477 867 527	$460 418 848	$16 126 321	$83 333 333	$559 878 502	$5 614 863 998
19	$5 614 863 998	$477 867 527	$458 988 056	$17 448 680	$83 333 333	$559 770 069	$5 597 415 318
20	$5 597 415 318	$477 867 527	$457 439 939	$18 879 471	$83 333 333	$559 652 744	$5 578 535 847
21	$5 578 535 847	$477 867 527	$455 764 877	$20 427 588	$83 333 333	$559 525 799	$5 558 108 259
22	$5 558 108 259	$477 867 527	$453 952 460	$22 102 650	$83 333 333	$559 388 443	$5 536 005 609
23	$5 536 005 609	$477 867 527	$451 991 424	$23 915 067	$83 333 333	$559 239 825	$5 512 090 542
24	$5 512 090 542	$477 867 527	$449 869 584	$25 876 103	$83 333 333	$559 079 020	$5 486 214 439
25	$5 486 214 439	$477 867 527	$447 573 753	$27 997 943	$83 333 333	$558 905 029	$5 458 216 495
26	$5 458 216 495	$477 867 527	$445 089 663	$30 293 775	$83 333 333	$558 716 771	$5 427 922 720
27	$5 427 922 720	$477 867 527	$442 401 878	$32 777 864	$83 333 333	$558 513 076	$5 395 144 856
28	$5 395 144 856	$477 867 527	$439 493 695	$35 465 649	$83 333 333	$558 292 678	$5 359 679 207
29	$5 359 679 207	$477 867 527	$436 347 041	$38 373 832	$83 333 333	$558 054 206	$5 321 305 374
30	$5 321 305 374	$477 867 527	$432 942 361	$41 520 487	$83 333 333	$557 796 181	$5 279 784 887
31	$5 279 784 887	$477 867 527	$429 258 497	$44 925 167	$83 333 333	$557 516 997	$5 234 859 721
32	$5 234 859 721	$477 867 527	$425 272 557	$48 609 030	$83 333 333	$557 214 920	$5 186 250 690
33	$5 186 250 690	$477 867 527	$420 959 769	$52 594 971	$83 333 333	$556 888 073	$5 133 655 720
34	$5 133 655 720	$477 867 527	$416 293 333	$56 907 758	$83 333 333	$556 534 425	$5 076 747 961
35	$5 076 747 961	$477 867 527	$411 244 249	$61 574 195	$83 333 333	$556 151 777	$5 015 173 767
36	$5 015 173 767	$477 867 527	$405 781 140	$66 623 279	$83 333 333	$555 737 752	$4 948 550 488
37	$4 948 550 488	$477 867 527	$399 870 056	$72 086 387	$83 333 333	$555 289 777	$4 876 464 101
38	$4 876 464 101	$477 867 527	$393 474 264	$77 997 471	$83 333 333	$554 805 068	$4 798 466 630
39	$4 798 466 630	$477 867 527	$386 554 016	$84 393 264	$83 333 333	$554 280 613	$4 714 073 366
40	$4 714 073 366	$477 867 527	$379 066 308	$91 313 511	$83 333 333	$553 713 153	$4 622 759 854
41	$4 622 759 854	$477 867 527	$370 964 608	$98 801 219	$83 333 333	$553 099 161	$4 523 958 635
42	$4 523 958 635	$477 867 527	$362 198 569	$106 902 919	$83 333 333	$552 434 821	$4 417 055 716
43	$4 417 055 716	$477 867 527	$352 713 714	$115 668 959	$83 333 333	$551 716 006	$4 301 386 757
44	$4 301 386 757	$477 867 527	$342 451 101	$125 153 813	$83 333 333	$550 938 248	$4 176 232 944
45	$4 176 232 944	$477 867 527	$331 346 954	$135 416 426	$83 333 333	$550 096 714	$4 040 816 518
46	$4 040 816 518	$477 867 527	$319 332 267	$146 520 573	$83 333 333	$549 186 174	$3 894 295 945
47	$3 894 295 945	$477 867 527	$306 332 376	$158 535 260	$83 333 333	$548 200 969	$3 735 760 685
48	$3 735 760 685	$477 867 527	$292 266 494	$171 535 151	$83 333 333	$547 134 978	$3 564 225 533
49	$3 564 225 533	$477 867 527	$277 047 209	$185 601 034	$83 333 333	$545 981 576	$3 378 624 500
50	$3 378 624 500	$477 867 527	$260 579 943	$200 820 318	$83 333 333	$544 733 595	$3 177 804 181
51	$3 177 804 181	$477 867 527	$242 762 361	$217 287 585	$83 333 333	$543 383 279	$2 960 516 597
52	$2 960 516 597	$477 867 527	$223 483 737	$235 105 166	$83 333 333	$541 922 237	$2 725 411 430
53	$2 725 411 430	$477 867 527	$202 624 266	$254 383 790	$83 333 333	$540 341 390	$2 471 027 640
54	$2 471 027 640	$477 867 527	$180 054 319	$275 243 261	$83 333 333	$538 630 913	$2 195 784 379
55	$2 195 784 379	$477 867 527	$155 633 636	$297 813 208	$83 333 333	$536 780 178	$1 897 971 171
56	$1 897 971 171	$477 867 527	$129 210 457	$322 233 891	$83 333 333	$534 777 682	$1 575 737 280
57	$1 575 737 280	$477 867 527	$100 620 577	$348 657 070	$83 333 333	$532 610 981	$1 227 080 209
58	$1 227 080 209	$477 867 527	$69 686 327	$377 246 950	$83 333 333	$530 266 611	$849 833 259
59	$849 833 259	$477 867 527	$36 215 469	$408 181 200	$83 333 333	$527 730 002	$441 652 059
60	$441 652 059	$477 867 527	$0	$441 652 059	$83 333 333	$524 985 392	$0
			$22 422 607 187.99		**$4 999 999 999.98**	**$33 198 753 937.87**	

APPENDIX 12
AMORTIZATION: PAKS, HUNGARY

Country	**Hungary**	
Plant	**Paks**	
Technology	**VVER-1200**	
Vendor	**Rosatom**	
	Loan amount	$4 072 186 020
	Annual interest rate	98%
	Loan period in years	60
	Monthly Payment	$336 896 819
	O&M	$83 333 333
	Total Interest	

No.	Beginning Balance	Payment	Interest	Principal	O&M	Total Payment	Ending Balance
1	$4 072 186 020	$336 896 819	$333 919 254	$2 977 565	$83 333 333	$420 230 152	$4 069 208 455
2	$4 069 208 455	$336 896 819	$333 410 912	$3 221 725	$83 333 333	$419 965 971	$4 065 986 729
3	$4 065 986 729	$336 896 819	$333 125 067	$3 485 907	$83 333 333	$419 944 308	$4 062 500 822
4	$4 062 500 822	$336 896 819	$332 815 784	$3 771 751	$83 333 333	$419 920 868	$4 058 729 071
5	$4 058 729 071	$336 896 819	$332 481 139	$4 081 035	$83 333 333	$419 895 507	$4 054 648 036
6	$4 054 648 036	$336 896 819	$332 119 053	$4 415 680	$83 333 333	$419 868 066	$4 050 232 356
7	$4 050 232 356	$336 896 819	$331 727 276	$4 777 765	$83 333 333	$419 838 375	$4 045 454 591
8	$4 045 454 591	$336 896 819	$331 303 374	$5 169 542	$83 333 333	$419 806 250	$4 040 285 049
9	$4 040 285 049	$336 896 819	$330 844 712	$5 593 445	$83 333 333	$419 771 490	$4 034 691 604
10	$4 034 691 604	$336 896 819	$330 348 439	$6 052 107	$83 333 333	$419 733 879	$4 028 639 497
11	$4 028 639 497	$336 896 819	$329 811 472	$6 548 380	$83 333 333	$419 693 185	$4 022 091 117
12	$4 022 091 117	$336 896 819	$329 230 473	$7 085 347	$83 333 333	$419 649 154	$4 015 005 770
13	$4 015 005 770	$336 896 819	$328 601 833	$7 666 346	$83 333 333	$419 601 512	$4 007 339 424
14	$4 007 339 424	$336 896 819	$327 921 644	$8 294 986	$83 333 333	$419 549 963	$3 999 044 438
15	$3 999 044 438	$336 896 819	$327 185 680	$8 975 175	$83 333 333	$419 494 188	$3 990 069 263
16	$3 990 069 263	$336 896 819	$326 389 366	$9 711 139	$83 333 333	$419 433 839	$3 980 358 124
17	$3 980 358 124	$336 896 819	$325 527 755	$10 507 453	$83 333 333	$419 368 541	$3 969 850 672
18	$3 969 850 672	$336 896 819	$324 595 492	$11 369 064	$83 333 333	$419 297 889	$3 958 481 608
19	$3 958 481 608	$336 896 819	$323 586 783	$12 301 327	$83 333 333	$419 221 443	$3 946 180 281
20	$3 946 180 281	$336 896 819	$322 495 360	$13 310 036	$83 333 333	$419 138 729	$3 932 870 246
21	$3 932 870 246	$336 896 819	$321 314 441	$14 401 459	$83 333 333	$419 049 232	$3 918 468 787
22	$3 918 468 787	$336 896 819	$320 036 686	$15 582 378	$83 333 333	$418 952 397	$3 902 886 409
23	$3 902 886 409	$336 896 819	$318 654 155	$16 860 133	$83 333 333	$418 847 621	$3 886 026 276
24	$3 886 026 276	$336 896 819	$317 158 256	$18 242 664	$83 333 333	$418 734 254	$3 867 783 612
25	$3 867 783 612	$336 896 819	$315 539 694	$19 738 563	$83 333 333	$418 611 590	$3 848 045 049
26	$3 848 045 049	$336 896 819	$313 788 410	$21 357 125	$83 333 333	$418 478 868	$3 826 687 924
27	$3 826 687 924	$336 896 819	$311 893 520	$23 108 409	$83 333 333	$418 335 263	$3 803 579 515
28	$3 803 579 515	$336 896 819	$309 843 250	$25 003 298	$83 333 333	$418 179 882	$3 778 576 217
29	$3 778 576 217	$336 896 819	$307 624 857	$27 053 569	$83 333 333	$418 011 759	$3 751 522 648
30	$3 751 522 648	$336 896 819	$305 224 556	$29 271 962	$83 333 333	$417 829 851	$3 722 250 687
31	$3 722 250 687	$336 896 819	$302 627 431	$31 672 262	$83 333 333	$417 633 027	$3 690 578 424
32	$3 690 578 424	$336 896 819	$299 817 341	$34 269 388	$83 333 333	$417 420 062	$3 656 309 036
33	$3 656 309 036	$336 896 819	$296 776 824	$37 079 478	$83 333 333	$417 189 635	$3 619 229 558
34	$3 619 229 558	$336 896 819	$293 486 984	$40 119 995	$83 333 333	$416 940 312	$3 579 109 564
35	$3 579 109 564	$336 896 819	$289 927 378	$43 409 834	$83 333 333	$416 670 546	$3 535 699 729
36	$3 535 699 729	$336 896 819	$286 075 884	$46 969 441	$83 333 333	$416 378 658	$3 488 730 288
37	$3 488 730 288	$336 896 819	$281 908 567	$50 820 935	$83 333 333	$416 062 835	$3 437 909 353
38	$3 437 909 353	$336 896 819	$277 399 530	$54 988 252	$83 333 333	$415 721 115	$3 382 921 101
39	$3 382 921 101	$336 896 819	$272 520 753	$59 497 288	$83 333 333	$415 351 374	$3 323 423 813
40	$3 323 423 813	$336 896 819	$267 241 915	$64 376 066	$83 333 333	$414 951 315	$3 259 047 747
41	$3 259 047 747	$336 896 819	$261 530 213	$69 654 903	$83 333 333	$414 518 450	$3 189 392 844
42	$3 189 392 844	$336 896 819	$255 350 152	$75 366 606	$83 333 333	$414 050 090	$3 114 026 238
43	$3 114 026 238	$336 896 819	$248 663 325	$81 546 667	$83 333 333	$413 543 325	$3 032 479 571
44	$3 032 479 571	$336 896 819	$241 428 178	$88 233 494	$83 333 333	$412 995 006	$2 944 246 077
45	$2 944 246 077	$336 896 819	$233 599 750	$95 468 640	$83 333 333	$412 401 724	$2 848 777 436
46	$2 848 777 436	$336 896 819	$225 129 390	$103 297 069	$83 333 333	$411 759 792	$2 745 480 368
47	$2 745 480 368	$336 896 819	$215 964 461	$111 767 429	$83 333 333	$411 065 223	$2 633 712 939
48	$2 633 712 939	$336 896 819	$206 048 008	$120 932 358	$83 333 333	$410 313 699	$2 512 780 581
49	$2 512 780 581	$336 896 819	$195 318 405	$130 848 811	$83 333 333	$409 500 550	$2 381 931 770
50	$2 381 931 770	$336 896 819	$183 708 975	$141 578 414	$83 333 333	$408 620 722	$2 240 353 357
51	$2 240 353 357	$336 896 819	$171 147 572	$153 187 843	$83 333 333	$407 668 749	$2 087 165 513
52	$2 087 165 513	$336 896 819	$157 556 134	$165 749 247	$83 333 333	$406 638 714	$1 921 416 267
53	$1 921 416 267	$336 896 819	$142 850 198	$179 340 685	$83 333 333	$405 524 216	$1 742 075 582
54	$1 742 075 582	$336 896 819	$126 938 375	$194 046 621	$83 333 333	$404 318 329	$1 548 028 961
55	$1 548 028 961	$336 896 819	$109 721 782	$209 958 444	$83 333 333	$403 013 560	$1 338 070 517
56	$1 338 070 517	$336 896 819	$91 093 429	$227 175 036	$83 333 333	$401 601 799	$1 110 895 481
57	$1 110 895 481	$336 896 819	$70 937 551	$245 803 389	$83 333 333	$400 074 274	$865 092 091
58	$865 092 091	$336 896 819	$49 128 892	$265 959 267	$83 333 333	$398 421 492	$599 132 824
59	$599 132 824	$336 896 819	$25 531 922	$287 767 927	$83 333 333	$396 633 182	$311 364 897
60	$311 364 897	$336 896 819	$0	$311 364 897	$83 333 333	$394 698 230	$0
			$15 807 948 008.98		**$4 999 999 999.98**	**$24 880 134 028.59**	

APPENDIX 13
AMORTIZATION: KALININGRAD, RUSSIA

Country	**Russia**	
Plant	**Kaliningrad**	
Technology	**VVER AES-2006 V-491**	
Vendor	**Rosatom**	
	Loan amount	$5 920 329 786
	Annual interest rate	98%
	Loan period in years	60
	Monthly Payment	$489 795 962
	O&M	$83 333 333
	Total Interest	

No.	Beginning Balance	Payment	Interest	Principal	O&M	Total Payment	Ending Balance
1	$5 920 329 786	$489 795 962	$485 467 042	$4 328 920	$83 333 333	$573 129 296	$5 916 000 866
2	$5 916 000 866	$489 795 962	$484 727 992	$4 683 891	$83 333 333	$572 745 217	$5 911 316 975
3	$5 911 316 975	$489 795 962	$484 312 418	$5 067 970	$83 333 333	$572 713 722	$5 906 249 004
4	$5 906 249 004	$489 795 962	$483 862 768	$5 483 544	$83 333 333	$572 679 645	$5 900 765 460
5	$5 900 765 460	$489 795 962	$483 376 246	$5 933 195	$83 333 333	$572 642 774	$5 894 832 265
6	$5 894 832 265	$489 795 962	$482 849 829	$6 419 717	$83 333 333	$572 602 879	$5 888 412 549
7	$5 888 412 549	$489 795 962	$482 280 246	$6 946 133	$83 333 333	$572 559 713	$5 881 466 415
8	$5 881 466 415	$489 795 962	$481 663 957	$7 515 716	$83 333 333	$572 513 007	$5 873 950 699
9	$5 873 950 699	$489 795 962	$480 997 133	$8 132 005	$83 333 333	$572 462 471	$5 865 818 694
10	$5 865 818 694	$489 795 962	$480 275 629	$8 798 829	$83 333 333	$572 407 792	$5 857 019 864
11	$5 857 019 864	$489 795 962	$479 494 962	$9 520 334	$83 333 333	$572 348 628	$5 847 499 531
12	$5 847 499 531	$489 795 962	$478 650 279	$10 301 001	$83 333 333	$572 284 614	$5 837 198 530
13	$5 837 198 530	$489 795 962	$477 736 333	$11 145 683	$83 333 333	$572 215 350	$5 826 052 847
14	$5 826 052 847	$489 795 962	$476 747 444	$12 059 629	$83 333 333	$572 140 406	$5 813 993 218
15	$5 813 993 218	$489 795 962	$475 677 465	$13 048 518	$83 333 333	$572 059 317	$5 800 944 700
16	$5 800 944 700	$489 795 962	$474 519 749	$14 118 497	$83 333 333	$571 971 579	$5 786 826 203
17	$5 786 826 203	$489 795 962	$473 267 099	$15 276 214	$83 333 333	$571 876 646	$5 771 549 989
18	$5 771 549 989	$489 795 962	$471 911 732	$16 528 863	$83 333 333	$571 773 929	$5 755 021 126
19	$5 755 021 126	$489 795 962	$470 445 225	$17 884 230	$83 333 333	$571 662 789	$5 737 136 896
20	$5 737 136 896	$489 795 962	$468 858 465	$19 350 737	$83 333 333	$571 542 535	$5 717 786 159
21	$5 717 786 159	$489 795 962	$467 141 590	$20 937 497	$83 333 333	$571 412 421	$5 696 848 661
22	$5 696 848 661	$489 795 962	$465 283 932	$22 654 372	$83 333 333	$571 271 637	$5 674 194 289
23	$5 674 194 289	$489 795 962	$463 273 945	$24 512 031	$83 333 333	$571 119 309	$5 649 682 259
24	$5 649 682 259	$489 795 962	$461 099 140	$26 522 017	$83 333 333	$570 954 490	$5 623 160 241
25	$5 623 160 241	$489 795 962	$458 746 000	$28 696 823	$83 333 333	$570 776 156	$5 594 463 419
26	$5 594 463 419	$489 795 962	$456 199 903	$31 049 962	$83 333 333	$570 583 199	$5 563 413 457
27	$5 563 413 457	$489 795 962	$453 445 027	$33 596 059	$83 333 333	$570 374 419	$5 529 817 398
28	$5 529 817 398	$489 795 962	$450 464 250	$36 350 936	$83 333 333	$570 148 519	$5 493 466 462
29	$5 493 466 462	$489 795 962	$447 239 049	$39 331 713	$83 333 333	$569 904 095	$5 454 134 749
30	$5 454 134 749	$489 795 962	$443 749 383	$42 556 913	$83 333 333	$569 639 629	$5 411 577 837
31	$5 411 577 837	$489 795 962	$439 973 563	$46 046 580	$83 333 333	$569 353 476	$5 365 531 257
32	$5 365 531 257	$489 795 962	$435 888 126	$49 822 399	$83 333 333	$569 043 859	$5 315 708 857
33	$5 315 708 857	$489 795 962	$431 467 684	$53 907 836	$83 333 333	$568 708 853	$5 261 801 021
34	$5 261 801 021	$489 795 962	$426 684 765	$58 328 279	$83 333 333	$568 346 377	$5 203 472 743
35	$5 203 472 743	$489 795 962	$421 509 647	$63 111 197	$83 333 333	$567 954 178	$5 140 361 545
36	$5 140 361 545	$489 795 962	$415 910 169	$68 286 316	$83 333 333	$567 529 818	$5 072 075 230
37	$5 072 075 230	$489 795 962	$409 851 534	$73 885 794	$83 333 333	$567 070 661	$4 998 189 436
38	$4 998 189 436	$489 795 962	$403 296 091	$79 944 429	$83 333 333	$566 573 853	$4 918 245 007
39	$4 918 245 007	$489 795 962	$396 203 101	$86 499 872	$83 333 333	$566 036 306	$4 831 745 136
40	$4 831 745 136	$489 795 962	$388 528 486	$93 592 861	$83 333 333	$565 454 681	$4 738 152 274
41	$4 738 152 274	$489 795 962	$380 224 553	$101 267 476	$83 333 333	$564 825 363	$4 636 884 798
42	$4 636 884 798	$489 795 962	$371 239 698	$109 571 409	$83 333 333	$564 144 440	$4 527 313 389
43	$4 527 313 389	$489 795 962	$361 518 084	$118 556 264	$83 333 333	$563 407 682	$4 408 757 125
44	$4 408 757 125	$489 795 962	$350 999 298	$128 277 878	$83 333 333	$562 610 510	$4 280 479 247
45	$4 280 479 247	$489 795 962	$339 617 972	$138 796 664	$83 333 333	$561 747 969	$4 141 682 583
46	$4 141 682 583	$489 795 962	$327 303 377	$150 177 991	$83 333 333	$560 814 700	$3 991 504 592
47	$3 991 504 592	$489 795 962	$313 978 985	$162 492 586	$83 333 333	$559 804 904	$3 829 012 006
48	$3 829 012 006	$489 795 962	$299 561 992	$175 816 978	$83 333 333	$558 712 304	$3 653 195 028
49	$3 653 195 028	$489 795 962	$283 962 807	$190 233 970	$83 333 333	$557 530 110	$3 462 961 058
50	$3 462 961 058	$489 795 962	$267 084 488	$205 833 156	$83 333 333	$556 250 977	$3 257 127 903
51	$3 257 127 903	$489 795 962	$248 822 147	$222 711 474	$83 333 333	$554 866 955	$3 034 416 428
52	$3 034 416 428	$489 795 962	$229 062 294	$240 973 815	$83 333 333	$553 369 443	$2 793 442 613
53	$2 793 442 613	$489 795 962	$207 682 133	$260 733 668	$83 333 333	$551 749 135	$2 532 708 945
54	$2 532 708 945	$489 795 962	$184 548 800	$282 113 829	$83 333 333	$549 995 962	$2 250 595 116
55	$2 250 595 116	$489 795 962	$159 518 532	$305 247 163	$83 333 333	$548 099 028	$1 945 347 953
56	$1 945 347 953	$489 795 962	$132 435 783	$330 277 430	$83 333 333	$546 046 546	$1 615 070 523
57	$1 615 070 523	$489 795 962	$103 132 248	$357 360 180	$83 333 333	$543 825 761	$1 257 710 343
58	$1 257 710 343	$489 795 962	$71 425 824	$386 663 714	$83 333 333	$541 422 871	$871 046 629
59	$871 046 629	$489 795 962	$37 119 472	$418 370 139	$83 333 333	$538 822 944	$452 676 490
60	$452 676 490	$489 795 962	$0	$452 676 490	$83 333 333	$536 009 824	$0
			$22 982 315 886.49		**$4 999 999 999.98**	**$33 902 645 672.38**	

APPENDIX 14
AMORTIZATION: LENINGRAD II, RUSSIA

Country	**Russia**	
Plant	**Leningrad II**	
Technology	**VVER AES-2006 V-491**	
Vendor	**Rosatom**	
	Loan amount	$2 862 879 367
	Annual interest rate	98%
	Loan period in years	60
	Monthly Payment	$236 849 433
	O&M	$83 333 333
	Total Interest	

No.	Beginning Balance	Payment	Interest	Principal	O&M	Total Payment	Ending Balance
1	$2 862 879 367	$236 849 433	$234 756 108	$2 093 325	$83 333 333	$320 182 767	$2 860 786 042
2	$2 860 786 042	$236 849 433	$234 398 727	$2 264 978	$83 333 333	$319 997 038	$2 858 521 064
3	$2 858 521 064	$236 849 433	$234 197 769	$2 450 706	$83 333 333	$319 981 809	$2 856 070 358
4	$2 856 070 358	$236 849 433	$233 980 333	$2 651 664	$83 333 333	$319 965 330	$2 853 418 694
5	$2 853 418 694	$236 849 433	$233 745 067	$2 869 100	$83 333 333	$319 947 500	$2 850 549 594
6	$2 850 549 594	$236 849 433	$233 490 509	$3 104 367	$83 333 333	$319 928 209	$2 847 445 227
7	$2 847 445 227	$236 849 433	$233 215 077	$3 358 925	$83 333 333	$319 907 335	$2 844 086 302
8	$2 844 086 302	$236 849 433	$232 917 060	$3 634 357	$83 333 333	$319 884 749	$2 840 451 946
9	$2 840 451 946	$236 849 433	$232 594 605	$3 932 374	$83 333 333	$319 860 312	$2 836 519 572
10	$2 836 519 572	$236 849 433	$232 245 709	$4 254 828	$83 333 333	$319 833 871	$2 832 264 743
11	$2 832 264 743	$236 849 433	$231 868 204	$4 603 724	$83 333 333	$319 805 261	$2 827 661 019
12	$2 827 661 019	$236 849 433	$231 459 743	$4 981 230	$83 333 333	$319 774 306	$2 822 679 789
13	$2 822 679 789	$236 849 433	$231 017 788	$5 389 691	$83 333 333	$319 740 812	$2 817 290 099
14	$2 817 290 099	$236 849 433	$230 539 593	$5 831 645	$83 333 333	$319 704 572	$2 811 458 454
15	$2 811 458 454	$236 849 433	$230 022 186	$6 309 840	$83 333 333	$319 665 360	$2 805 148 613
16	$2 805 148 613	$236 849 433	$229 462 352	$6 827 247	$83 333 333	$319 622 932	$2 798 321 366
17	$2 798 321 366	$236 849 433	$228 856 611	$7 387 081	$83 333 333	$319 577 026	$2 790 934 285
18	$2 790 934 285	$236 849 433	$228 201 200	$7 992 822	$83 333 333	$319 527 355	$2 782 941 463
19	$2 782 941 463	$236 849 433	$227 492 045	$8 648 233	$83 333 333	$319 473 612	$2 774 293 230
20	$2 774 293 230	$236 849 433	$226 724 739	$9 357 388	$83 333 333	$319 415 461	$2 764 935 842
21	$2 764 935 842	$236 849 433	$225 894 514	$10 124 694	$83 333 333	$319 352 542	$2 754 811 147
22	$2 754 811 147	$236 849 433	$224 996 211	$10 954 919	$83 333 333	$319 284 463	$2 743 856 228
23	$2 743 856 228	$236 849 433	$224 024 246	$11 853 223	$83 333 333	$319 210 802	$2 732 003 005
24	$2 732 003 005	$236 849 433	$222 972 581	$12 825 187	$83 333 333	$319 131 101	$2 719 177 819
25	$2 719 177 819	$236 849 433	$221 834 679	$13 876 852	$83 333 333	$319 044 865	$2 705 300 966
26	$2 705 300 966	$236 849 433	$220 603 469	$15 014 754	$83 333 333	$318 951 557	$2 690 286 212
27	$2 690 286 212	$236 849 433	$219 271 300	$16 245 964	$83 333 333	$318 850 598	$2 674 040 248
28	$2 674 040 248	$236 849 433	$217 829 893	$17 578 133	$83 333 333	$318 741 360	$2 656 462 115
29	$2 656 462 115	$236 849 433	$216 270 291	$19 019 540	$83 333 333	$318 623 164	$2 637 442 576
30	$2 637 442 576	$236 849 433	$214 582 802	$20 579 142	$83 333 333	$318 495 277	$2 616 863 434
31	$2 616 863 434	$236 849 433	$212 756 938	$22 266 632	$83 333 333	$318 356 903	$2 594 596 802
32	$2 594 596 802	$236 849 433	$210 781 353	$24 092 496	$83 333 333	$318 207 182	$2 570 504 306
33	$2 570 504 306	$236 849 433	$208 643 771	$26 068 080	$83 333 333	$318 045 184	$2 544 436 226
34	$2 544 436 226	$236 849 433	$206 330 906	$28 205 663	$83 333 333	$317 869 902	$2 516 230 563
35	$2 516 230 563	$236 849 433	$203 828 387	$30 518 527	$83 333 333	$317 680 247	$2 485 712 036
36	$2 485 712 036	$236 849 433	$201 120 661	$33 021 046	$83 333 333	$317 475 041	$2 452 690 990
37	$2 452 690 990	$236 849 433	$198 190 902	$35 728 772	$83 333 333	$317 253 007	$2 416 962 218
38	$2 416 962 218	$236 849 433	$195 020 902	$38 658 531	$83 333 333	$317 012 767	$2 378 303 686
39	$2 378 303 686	$236 849 433	$191 590 963	$41 828 531	$83 333 333	$316 752 827	$2 336 475 155
40	$2 336 475 155	$236 849 433	$187 879 768	$45 258 471	$83 333 333	$316 471 572	$2 291 216 685
41	$2 291 216 685	$236 849 433	$183 864 256	$48 969 665	$83 333 333	$316 167 254	$2 242 247 019
42	$2 242 247 019	$236 849 433	$179 519 471	$52 985 178	$83 333 333	$315 837 982	$2 189 261 842
43	$2 189 261 842	$236 849 433	$174 818 414	$57 329 962	$83 333 333	$315 481 710	$2 131 931 879
44	$2 131 931 879	$236 849 433	$169 731 871	$62 031 019	$83 333 333	$315 096 223	$2 069 900 860
45	$2 069 900 860	$236 849 433	$164 228 230	$67 117 563	$83 333 333	$314 679 126	$2 002 783 297
46	$2 002 783 297	$236 849 433	$158 273 292	$72 621 203	$83 333 333	$314 227 828	$1 930 162 095
47	$1 930 162 095	$236 849 433	$151 830 048	$78 576 142	$83 333 333	$313 739 523	$1 851 585 953
48	$1 851 585 953	$236 849 433	$144 858 459	$85 019 385	$83 333 333	$313 211 177	$1 766 566 568
49	$1 766 566 568	$236 849 433	$137 315 199	$91 990 975	$83 333 333	$312 639 507	$1 674 575 593
50	$1 674 575 593	$236 849 433	$129 153 391	$99 534 235	$83 333 333	$312 020 959	$1 575 041 358
51	$1 575 041 358	$236 849 433	$120 322 316	$107 696 042	$83 333 333	$311 351 691	$1 467 345 316
52	$1 467 345 316	$236 849 433	$110 767 092	$116 527 117	$83 333 333	$310 627 543	$1 350 818 199
53	$1 350 818 199	$236 849 433	$100 428 340	$126 082 341	$83 333 333	$309 844 015	$1 224 735 858
54	$1 224 735 858	$236 849 433	$89 241 811	$136 421 093	$83 333 333	$308 996 237	$1 088 314 765
55	$1 088 314 765	$236 849 433	$77 137 986	$147 607 623	$83 333 333	$308 078 942	$940 707 143
56	$940 707 143	$236 849 433	$64 041 647	$159 711 448	$83 333 333	$307 086 428	$780 995 695
57	$780 995 695	$236 849 433	$49 871 409	$172 807 786	$83 333 333	$306 012 528	$608 187 909
58	$608 187 909	$236 849 433	$34 539 210	$186 978 025	$83 333 333	$304 850 569	$421 209 884
59	$421 209 884	$236 849 433	$17 949 772	$202 310 223	$83 333 333	$303 593 328	$218 899 661
60	$218 899 661	$236 849 433	$0	$218 899 661	$83 333 333	$302 232 994	$0
			$11 113 502 175.89		**$4 999 999 999.98**	**$18 976 381 542.89**	

APPENDIX 15
AMORTIZATION: NOVOVORONEZH II, RUSSIA

Country	**Russia**	
Plant	**NovovoronezhII**	
Technology	**VVER AES-2006 (V-392M)**	
Vendor	**Rosatom**	
	Loan amount	$2 176 591 833
	Annual interest rate	98%
	Loan period in years	60
	Monthly Payment	$180 072 045
	O&M	$83 333 333
	Total Interest	

No.	Beginning Balance	Payment	Interest	Principal	O&M	Total Payment	Ending Balance
1	$2 176 591 833	$180 072 045	$178 480 530	$1 591 515	$83 333 333	$263 405 378	$2 175 000 318
2	$2 175 000 318	$180 072 045	$178 208 821	$1 722 019	$83 333 333	$263 264 173	$2 173 278 299
3	$2 173 278 299	$180 072 045	$178 056 036	$1 863 224	$83 333 333	$263 252 594	$2 171 415 075
4	$2 171 415 075	$180 072 045	$177 890 723	$2 016 009	$83 333 333	$263 240 066	$2 169 399 066
5	$2 169 399 066	$180 072 045	$177 711 855	$2 181 322	$83 333 333	$263 226 510	$2 167 217 745
6	$2 167 217 745	$180 072 045	$177 518 319	$2 360 190	$83 333 333	$263 211 843	$2 164 857 555
7	$2 164 857 555	$180 072 045	$177 308 914	$2 553 726	$83 333 333	$263 195 973	$2 162 303 829
8	$2 162 303 829	$180 072 045	$177 082 337	$2 763 131	$83 333 333	$263 178 802	$2 159 540 698
9	$2 159 540 698	$180 072 045	$176 837 181	$2 989 708	$83 333 333	$263 160 222	$2 156 550 990
10	$2 156 550 990	$180 072 045	$176 571 922	$3 234 864	$83 333 333	$263 140 119	$2 153 316 127
11	$2 153 316 127	$180 072 045	$176 284 912	$3 500 123	$83 333 333	$263 118 368	$2 149 816 004
12	$2 149 816 004	$180 072 045	$175 974 367	$3 787 133	$83 333 333	$263 094 833	$2 146 028 871
13	$2 146 028 871	$180 072 045	$175 638 358	$4 097 678	$83 333 333	$263 069 369	$2 141 931 194
14	$2 141 931 194	$180 072 045	$175 274 796	$4 433 687	$83 333 333	$263 041 816	$2 137 497 507
15	$2 137 497 507	$180 072 045	$174 881 421	$4 797 249	$83 333 333	$263 012 004	$2 132 700 257
16	$2 132 700 257	$180 072 045	$174 455 790	$5 190 624	$83 333 333	$262 979 747	$2 127 509 633
17	$2 127 509 633	$180 072 045	$173 995 257	$5 616 255	$83 333 333	$262 944 845	$2 121 893 378
18	$2 121 893 378	$180 072 045	$173 496 960	$6 076 788	$83 333 333	$262 907 082	$2 115 816 590
19	$2 115 816 590	$180 072 045	$172 957 803	$6 575 085	$83 333 333	$262 866 221	$2 109 241 506
20	$2 109 241 506	$180 072 045	$172 374 436	$7 114 242	$83 333 333	$262 822 011	$2 102 127 264
21	$2 102 127 264	$180 072 045	$171 743 232	$7 697 609	$83 333 333	$262 774 174	$2 094 429 655
22	$2 094 429 655	$180 072 045	$171 060 269	$8 328 813	$83 333 333	$262 722 416	$2 086 100 842
23	$2 086 100 842	$180 072 045	$170 321 303	$9 011 776	$83 333 333	$262 666 413	$2 077 089 066
24	$2 077 089 066	$180 072 045	$169 521 743	$9 750 742	$83 333 333	$262 605 818	$2 067 338 324
25	$2 067 338 324	$180 072 045	$168 656 618	$10 550 302	$83 333 333	$262 540 254	$2 056 788 022
26	$2 056 788 022	$180 072 045	$167 720 553	$11 415 427	$83 333 333	$262 469 313	$2 045 372 594
27	$2 045 372 594	$180 072 045	$166 707 730	$12 351 492	$83 333 333	$262 392 556	$2 033 021 102
28	$2 033 021 102	$180 072 045	$165 611 857	$13 364 315	$83 333 333	$262 309 505	$2 019 656 787
29	$2 019 656 787	$180 072 045	$164 426 121	$14 460 188	$83 333 333	$262 219 643	$2 005 196 599
30	$2 005 196 599	$180 072 045	$163 143 155	$15 645 924	$83 333 333	$262 122 413	$1 989 550 675
31	$1 989 550 675	$180 072 045	$161 754 986	$16 928 890	$83 333 333	$262 017 209	$1 972 621 786
32	$1 972 621 786	$180 072 045	$160 252 988	$18 317 059	$83 333 333	$261 903 380	$1 954 304 727
33	$1 954 304 727	$180 072 045	$158 627 825	$19 819 057	$83 333 333	$261 780 216	$1 934 485 670
34	$1 934 485 670	$180 072 045	$156 869 399	$21 444 220	$83 333 333	$261 646 952	$1 913 041 450
35	$1 913 041 450	$180 072 045	$154 966 782	$23 202 646	$83 333 333	$261 502 761	$1 889 838 803
36	$1 889 838 803	$180 072 045	$152 908 150	$25 105 263	$83 333 333	$261 346 747	$1 864 733 540
37	$1 864 733 540	$180 072 045	$150 680 711	$27 163 895	$83 333 333	$261 177 939	$1 837 569 646
38	$1 837 569 646	$180 072 045	$148 270 622	$29 391 334	$83 333 333	$260 995 289	$1 808 178 312
39	$1 808 178 312	$180 072 045	$145 662 905	$31 801 423	$83 333 333	$260 797 662	$1 776 376 888
40	$1 776 376 888	$180 072 045	$142 841 355	$34 409 140	$83 333 333	$260 583 829	$1 741 967 748
41	$1 741 967 748	$180 072 045	$139 788 439	$37 230 690	$83 333 333	$260 352 462	$1 704 737 058
42	$1 704 737 058	$180 072 045	$136 485 183	$40 283 606	$83 333 333	$260 102 123	$1 664 453 452
43	$1 664 453 452	$180 072 045	$132 911 060	$43 586 862	$83 333 333	$259 831 256	$1 620 866 590
44	$1 620 866 590	$180 072 045	$129 043 860	$47 160 985	$83 333 333	$259 538 178	$1 573 705 605
45	$1 573 705 605	$180 072 045	$124 859 548	$51 028 185	$83 333 333	$259 221 067	$1 522 677 420
46	$1 522 677 420	$180 072 045	$120 332 124	$55 212 497	$83 333 333	$258 877 954	$1 467 464 924
47	$1 467 464 924	$180 072 045	$115 433 450	$59 739 921	$83 333 333	$258 506 705	$1 407 725 002
48	$1 407 725 002	$180 072 045	$110 133 085	$64 638 595	$83 333 333	$258 105 014	$1 343 086 407
49	$1 343 086 407	$180 072 045	$104 398 091	$69 938 960	$83 333 333	$257 670 384	$1 273 147 448
50	$1 273 147 448	$180 072 045	$98 192 826	$75 673 954	$83 333 333	$257 200 114	$1 197 473 494
51	$1 197 473 494	$180 072 045	$91 478 731	$81 879 219	$83 333 333	$256 691 282	$1 115 594 275
52	$1 115 594 275	$180 072 045	$84 214 079	$88 593 314	$83 333 333	$256 140 727	$1 027 000 961
53	$1 027 000 961	$180 072 045	$76 353 726	$95 857 966	$83 333 333	$255 545 025	$931 142 994
54	$931 142 994	$180 072 045	$67 848 823	$103 718 319	$83 333 333	$254 900 476	$827 424 675
55	$827 424 675	$180 072 045	$58 646 519	$112 223 222	$83 333 333	$254 203 074	$715 201 453
56	$715 201 453	$180 072 045	$48 689 626	$121 425 526	$83 333 333	$253 448 485	$593 775 927
57	$593 775 927	$180 072 045	$37 916 268	$131 382 419	$83 333 333	$252 632 020	$462 393 509
58	$462 393 509	$180 072 045	$26 259 494	$142 155 777	$83 333 333	$251 748 605	$320 237 731
59	$320 237 731	$180 072 045	$13 646 865	$153 812 551	$83 333 333	$250 792 749	$166 425 180
60	$166 425 180	$180 072 045	$0	$166 425 180	$83 333 333	$249 758 514	$0
			$8 449 380 840.62		**$4 999 999 999.98**	**$15 625 972 673.66**	

APPENDIX 16
AMORTIZATION: AKKUYU, TURKEY

Country	**Turkey**	
Plant	**Akkuyu**	
Technology	**VVER AES-2006 (V-392)**	
Vendor	**Rosatom**	
	Loan amount	$3 990 172 067
	Annual interest rate	98%
	Loan period in years	60
	Monthly Payment	$330 111 706
	O&M	$83 333 333
	Total Interest	

No.	Beginning Balance	Payment	Interest	Principal	O&M	Total Payment	Ending Balance
1	$3 990 172 067	$330 111 706	$327 194 110	$2 917 597	$83 333 333	$413 445 040	$3 987 254 471
2	$3 987 254 471	$330 111 706	$326 696 006	$3 156 840	$83 333 333	$413 186 179	$3 984 097 631
3	$3 984 097 631	$330 111 706	$326 415 918	$3 415 701	$83 333 333	$413 164 952	$3 980 681 930
4	$3 980 681 930	$330 111 706	$326 112 864	$3 695 788	$83 333 333	$413 141 985	$3 976 986 142
5	$3 976 986 142	$330 111 706	$325 784 959	$3 998 843	$83 333 333	$413 117 135	$3 972 987 299
6	$3 972 987 299	$330 111 706	$325 430 165	$4 326 748	$83 333 333	$413 090 246	$3 968 660 551
7	$3 968 660 551	$330 111 706	$325 046 279	$4 681 541	$83 333 333	$413 061 153	$3 963 979 010
8	$3 963 979 010	$330 111 706	$324 630 914	$5 065 428	$83 333 333	$413 029 675	$3 958 913 583
9	$3 958 913 583	$330 111 706	$324 181 489	$5 480 793	$83 333 333	$412 995 615	$3 953 432 790
10	$3 953 432 790	$330 111 706	$323 695 211	$5 930 218	$83 333 333	$412 958 762	$3 947 502 573
11	$3 947 502 573	$330 111 706	$323 169 058	$6 416 495	$83 333 333	$412 918 887	$3 941 086 077
12	$3 941 086 077	$330 111 706	$322 599 761	$6 942 648	$83 333 333	$412 875 743	$3 934 143 429
13	$3 934 143 429	$330 111 706	$321 983 782	$7 511 945	$83 333 333	$412 829 060	$3 926 631 484
14	$3 926 631 484	$330 111 706	$321 317 292	$8 127 925	$83 333 333	$412 778 550	$3 918 503 560
15	$3 918 503 560	$330 111 706	$320 596 150	$8 794 414	$83 333 333	$412 723 898	$3 909 709 145
16	$3 909 709 145	$330 111 706	$319 815 874	$9 515 556	$83 333 333	$412 664 764	$3 900 193 589
17	$3 900 193 589	$330 111 706	$318 971 616	$10 295 832	$83 333 333	$412 600 781	$3 889 897 756
18	$3 889 897 756	$330 111 706	$318 058 129	$11 140 090	$83 333 333	$412 531 552	$3 878 757 666
19	$3 878 757 666	$330 111 706	$317 069 735	$12 053 578	$83 333 333	$412 456 646	$3 866 704 088
20	$3 866 704 088	$330 111 706	$316 000 294	$13 041 971	$83 333 333	$412 375 598	$3 853 662 117
21	$3 853 662 117	$330 111 706	$314 843 158	$14 111 413	$83 333 333	$412 287 904	$3 839 550 705
22	$3 839 550 705	$330 111 706	$313 591 137	$15 268 549	$83 333 333	$412 193 019	$3 824 282 156
23	$3 824 282 156	$330 111 706	$312 236 450	$16 520 570	$83 333 333	$412 090 353	$3 807 761 586
24	$3 807 761 586	$330 111 706	$310 770 679	$17 875 256	$83 333 333	$411 979 269	$3 789 886 330
25	$3 789 886 330	$330 111 706	$309 184 715	$19 341 027	$83 333 333	$411 859 075	$3 770 545 303
26	$3 770 545 303	$330 111 706	$307 468 702	$20 926 992	$83 333 333	$411 729 026	$3 749 618 311
27	$3 749 618 311	$330 111 706	$305 611 975	$22 643 005	$83 333 333	$411 588 313	$3 726 975 306
28	$3 726 975 306	$330 111 706	$303 602 997	$24 499 731	$83 333 333	$411 436 062	$3 702 475 575
29	$3 702 475 575	$330 111 706	$301 429 283	$26 508 709	$83 333 333	$411 271 326	$3 675 966 866
30	$3 675 966 866	$330 111 706	$299 077 324	$28 682 423	$83 333 333	$411 093 081	$3 647 284 443
31	$3 647 284 443	$330 111 706	$296 532 505	$31 034 382	$83 333 333	$410 900 220	$3 616 250 061
32	$3 616 250 061	$330 111 706	$293 779 010	$33 579 201	$83 333 333	$410 691 545	$3 582 670 859
33	$3 582 670 859	$330 111 706	$290 799 729	$36 332 696	$83 333 333	$410 465 759	$3 546 338 163
34	$3 546 338 163	$330 111 706	$287 576 147	$39 311 977	$83 333 333	$410 221 458	$3 507 026 186
35	$3 507 026 186	$330 111 706	$284 088 231	$42 535 559	$83 333 333	$409 957 124	$3 464 490 627
36	$3 464 490 627	$330 111 706	$280 314 306	$46 023 475	$83 333 333	$409 671 115	$3 418 467 152
37	$3 418 467 152	$330 111 706	$276 230 920	$49 797 400	$83 333 333	$409 361 653	$3 368 669 753
38	$3 368 669 753	$330 111 706	$271 812 695	$53 880 787	$83 333 333	$409 026 815	$3 314 788 966
39	$3 314 788 966	$330 111 706	$267 032 176	$58 299 011	$83 333 333	$408 664 521	$3 256 489 955
40	$3 256 489 955	$330 111 706	$261 859 655	$63 079 530	$83 333 333	$408 272 518	$3 193 410 425
41	$3 193 410 425	$330 111 706	$256 262 987	$68 252 052	$83 333 333	$407 848 371	$3 125 158 373
42	$3 125 158 373	$330 111 706	$250 207 392	$73 848 720	$83 333 333	$407 389 445	$3 051 309 653
43	$3 051 309 653	$330 111 706	$243 655 238	$79 904 315	$83 333 333	$406 892 886	$2 971 405 339
44	$2 971 405 339	$330 111 706	$236 565 807	$86 456 469	$83 333 333	$406 355 609	$2 884 948 870
45	$2 884 948 870	$330 111 706	$228 895 044	$93 545 899	$83 333 333	$405 774 276	$2 791 402 971
46	$2 791 402 971	$330 111 706	$220 595 277	$101 216 663	$83 333 333	$405 145 273	$2 690 186 308
47	$2 690 186 308	$330 111 706	$211 614 930	$109 516 429	$83 333 333	$404 464 693	$2 580 669 879
48	$2 580 669 879	$330 111 706	$201 898 194	$118 496 776	$83 333 333	$403 728 304	$2 462 173 103
49	$2 462 173 103	$330 111 706	$191 384 686	$128 213 512	$83 333 333	$402 931 532	$2 333 959 591
50	$2 333 959 591	$330 111 706	$180 009 071	$138 727 020	$83 333 333	$402 069 424	$2 195 232 571
51	$2 195 232 571	$330 111 706	$167 700 655	$150 102 636	$83 333 333	$401 136 624	$2 045 129 935
52	$2 045 129 935	$330 111 706	$154 382 948	$162 411 052	$83 333 333	$400 127 333	$1 882 718 884
53	$1 882 718 884	$330 111 706	$139 973 190	$175 728 758	$83 333 333	$399 035 282	$1 706 990 126
54	$1 706 990 126	$330 111 706	$124 381 832	$190 138 516	$83 333 333	$397 853 681	$1 516 851 610
55	$1 516 851 610	$330 111 706	$107 511 982	$205 729 874	$83 333 333	$396 575 190	$1 311 121 735
56	$1 311 121 735	$330 111 706	$89 258 805	$222 599 724	$83 333 333	$395 191 862	$1 088 522 011
57	$1 088 522 011	$330 111 706	$69 508 867	$240 852 901	$83 333 333	$393 695 102	$847 669 110
58	$847 669 110	$330 111 706	$48 139 434	$260 602 839	$83 333 333	$392 075 607	$587 066 271
59	$587 066 271	$330 111 706	$25 017 708	$281 972 272	$83 333 333	$390 323 313	$305 093 998
60	$305 093 998	$330 111 706	$0	$305 093 998	$83 333 333	$388 427 332	$0
			$15 489 575 447.60		**$4 999 999 999.98**	**$24 479 747 514.95**	

APPENDIX 17
AMORTIZATION: TAISHAN, CHINA

Country	**China**
Plant	**Taishan**
Technology	**EPR 1600**
Vendor	**CGN + EDF**
Loan amount	$3 642 660 523
Annual interest rate	98%
Loan period in years	60
Monthly Payment	$301 361 661
O&M	$83 333 333
Total Interest	

No.	Beginning Balance	Payment	Interest	Principal	O&M	Total Payment	Ending Balance
1	$3 642 660 523	$301 361 661	$298 698 163	$2 663 498	$83 333 333	$384 694 994	$3 639 997 025
2	$3 639 997 025	$301 361 661	$298 243 440	$2 881 905	$83 333 333	$384 458 678	$3 637 115 120
3	$3 637 115 120	$301 361 661	$297 987 746	$3 118 221	$83 333 333	$384 439 300	$3 633 996 899
4	$3 633 996 899	$301 361 661	$297 711 085	$3 373 915	$83 333 333	$384 418 333	$3 630 622 984
5	$3 630 622 984	$301 361 661	$297 411 737	$3 650 576	$83 333 333	$384 395 647	$3 626 972 408
6	$3 626 972 408	$301 361 661	$297 087 844	$3 949 923	$83 333 333	$384 371 100	$3 623 022 485
7	$3 623 022 485	$301 361 661	$296 737 391	$4 273 817	$83 333 333	$384 344 541	$3 618 748 668
8	$3 618 748 668	$301 361 661	$296 358 201	$4 624 270	$83 333 333	$384 315 804	$3 614 124 398
9	$3 614 124 398	$301 361 661	$295 947 917	$5 003 460	$83 333 333	$384 284 710	$3 609 120 938
10	$3 609 120 938	$301 361 661	$295 503 990	$5 413 744	$83 333 333	$384 251 067	$3 603 707 194
11	$3 603 707 194	$301 361 661	$295 023 661	$5 857 671	$83 333 333	$384 214 665	$3 597 849 523
12	$3 597 849 523	$301 361 661	$294 503 945	$6 338 000	$83 333 333	$384 175 278	$3 591 511 524
13	$3 591 511 524	$301 361 661	$293 941 612	$6 857 716	$83 333 333	$384 132 661	$3 584 653 808
14	$3 584 653 808	$301 361 661	$293 333 168	$7 420 049	$83 333 333	$384 086 550	$3 577 233 759
15	$3 577 233 759	$301 361 661	$292 674 832	$8 028 492	$83 333 333	$384 036 658	$3 569 205 267
16	$3 569 205 267	$301 361 661	$291 962 512	$8 686 829	$83 333 333	$383 982 674	$3 560 518 438
17	$3 560 518 438	$301 361 661	$291 191 782	$9 399 149	$83 333 333	$383 924 264	$3 551 119 289
18	$3 551 119 289	$301 361 661	$290 357 852	$10 169 879	$83 333 333	$383 861 064	$3 540 949 410
19	$3 540 949 410	$301 361 661	$289 455 539	$11 003 809	$83 333 333	$383 792 682	$3 529 945 601
20	$3 529 945 601	$301 361 661	$288 479 237	$11 906 121	$83 333 333	$383 718 692	$3 518 039 480
21	$3 518 039 480	$301 361 661	$287 422 879	$12 882 423	$83 333 333	$383 638 635	$3 505 157 056
22	$3 505 157 056	$301 361 661	$286 279 898	$13 938 782	$83 333 333	$383 552 014	$3 491 218 274
23	$3 491 218 274	$301 361 661	$285 043 194	$15 081 762	$83 333 333	$383 458 290	$3 476 136 512
24	$3 476 136 512	$301 361 661	$283 705 080	$16 318 467	$83 333 333	$383 356 880	$3 459 818 045
25	$3 459 818 045	$301 361 661	$282 257 240	$17 656 581	$83 333 333	$383 247 154	$3 442 161 464
26	$3 442 161 464	$301 361 661	$280 690 678	$19 104 421	$83 333 333	$383 128 432	$3 423 057 043
27	$3 423 057 043	$301 361 661	$278 995 657	$20 670 983	$83 333 333	$382 999 973	$3 402 386 060
28	$3 402 386 060	$301 361 661	$277 161 645	$22 366 004	$83 333 333	$382 860 982	$3 380 020 056
29	$3 380 020 056	$301 361 661	$275 177 243	$24 200 016	$83 333 333	$382 710 593	$3 355 820 040
30	$3 355 820 040	$301 361 661	$273 030 121	$26 184 417	$83 333 333	$382 547 872	$3 329 635 622
31	$3 329 635 622	$301 361 661	$270 706 935	$28 331 540	$83 333 333	$382 371 808	$3 301 304 083
32	$3 301 304 083	$301 361 661	$268 193 247	$30 654 726	$83 333 333	$382 181 307	$3 270 649 357
33	$3 270 649 357	$301 361 661	$265 473 437	$33 168 413	$83 333 333	$381 975 184	$3 237 480 943
34	$3 237 480 943	$301 361 661	$262 530 603	$35 888 223	$83 333 333	$381 752 160	$3 201 592 720
35	$3 201 592 720	$301 361 661	$259 346 456	$38 831 058	$83 333 333	$381 510 847	$3 162 761 662
36	$3 162 761 662	$301 361 661	$255 901 210	$42 015 204	$83 333 333	$381 249 747	$3 120 746 458
37	$3 120 746 458	$301 361 661	$252 173 453	$45 460 451	$83 333 333	$380 967 237	$3 075 286 006
38	$3 075 286 006	$301 361 661	$248 140 019	$49 188 208	$83 333 333	$380 661 561	$3 026 097 798
39	$3 026 097 798	$301 361 661	$243 775 845	$53 221 641	$83 333 333	$380 330 819	$2 972 876 157
40	$2 972 876 157	$301 361 661	$239 053 808	$57 585 816	$83 333 333	$379 972 957	$2 915 290 341
41	$2 915 290 341	$301 361 661	$233 944 564	$62 307 853	$83 333 333	$379 585 750	$2 852 982 488
42	$2 852 982 488	$301 361 661	$228 416 362	$67 417 097	$83 333 333	$379 166 792	$2 785 565 392
43	$2 785 565 392	$301 361 661	$222 434 848	$72 945 299	$83 333 333	$378 713 480	$2 712 620 093
44	$2 712 620 093	$301 361 661	$215 962 849	$78 926 813	$83 333 333	$378 222 995	$2 633 693 280
45	$2 633 693 280	$301 361 661	$208 960 146	$85 398 812	$83 333 333	$377 692 292	$2 548 294 468
46	$2 548 294 468	$301 361 661	$201 383 222	$92 401 514	$83 333 333	$377 118 070	$2 455 892 954
47	$2 455 892 954	$301 361 661	$193 184 990	$99 978 439	$83 333 333	$376 496 762	$2 355 914 515
48	$2 355 914 515	$301 361 661	$184 314 503	$108 176 671	$83 333 333	$375 824 507	$2 247 737 845
49	$2 247 737 845	$301 361 661	$174 716 636	$117 047 157	$83 333 333	$375 097 127	$2 130 690 687
50	$2 130 690 687	$301 361 661	$164 331 744	$126 645 024	$83 333 333	$374 310 102	$2 004 045 663
51	$2 004 045 663	$301 361 661	$153 095 291	$137 029 916	$83 333 333	$373 458 541	$1 867 015 746
52	$1 867 015 746	$301 361 661	$140 937 449	$148 266 370	$83 333 333	$372 537 152	$1 718 749 377
53	$1 718 749 377	$301 361 661	$127 782 664	$160 424 212	$83 333 333	$371 540 209	$1 558 325 165
54	$1 558 325 165	$301 361 661	$113 549 186	$173 578 997	$83 333 333	$370 461 516	$1 384 746 168
55	$1 384 746 168	$301 361 661	$98 148 563	$187 812 475	$83 333 333	$369 294 371	$1 196 933 693
56	$1 196 933 693	$301 361 661	$81 485 089	$203 213 098	$83 333 333	$368 031 520	$993 720 595
57	$993 720 595	$301 361 661	$63 455 210	$219 876 572	$83 333 333	$366 665 115	$773 844 023
58	$773 844 023	$301 361 661	$43 946 881	$237 906 451	$83 333 333	$365 186 665	$535 937 572
59	$535 937 572	$301 361 661	$22 838 869	$257 414 780	$83 333 333	$363 586 982	$278 522 792
60	$278 522 792	$301 361 661	$0	$278 522 792	$83 333 333	$361 856 125	$0
			$14 140 559 366.00		**$4 999 999 999.98**	**$22 783 219 888.85**	

APPENDIX 18
AMORTIZATION: OLKILUOTO, FINLAND

Country	**Finland**	
Plant	**Olkiluoto**	
Technology	**EPR 1600**	
Vendor	**Areva**	
	Loan amount	$4 768 456 677
	Annual interest rate	98%
	Loan period in years	60
	Monthly Payment	$394 500 123
	O&M	$83 333 333
	Total Interest	

No.	Beginning Balance	Payment	Interest	Principal	O&M	Total Payment	Ending Balance
1	$4 768 456 677	$394 500 123	$391 013 448	$3 486 675	$83 333 333	$477 833 456	$4 764 970 002
2	$4 764 970 002	$394 500 123	$390 418 188	$3 772 583	$83 333 333	$477 524 104	$4 761 197 419
3	$4 761 197 419	$394 500 123	$390 083 470	$4 081 934	$83 333 333	$477 498 737	$4 757 115 485
4	$4 757 115 485	$394 500 123	$389 721 304	$4 416 653	$83 333 333	$477 471 291	$4 752 698 832
5	$4 752 698 832	$394 500 123	$389 329 441	$4 778 819	$83 333 333	$477 441 593	$4 747 920 013
6	$4 747 920 013	$394 500 123	$388 905 445	$5 170 682	$83 333 333	$477 409 460	$4 742 749 332
7	$4 742 749 332	$394 500 123	$388 446 682	$5 594 678	$83 333 333	$477 374 693	$4 737 154 654
8	$4 737 154 654	$394 500 123	$387 950 299	$6 053 441	$83 333 333	$477 337 074	$4 731 101 213
9	$4 731 101 213	$394 500 123	$387 413 214	$6 549 823	$83 333 333	$477 296 371	$4 724 551 390
10	$4 724 551 390	$394 500 123	$386 832 087	$7 086 909	$83 333 333	$477 252 330	$4 717 464 481
11	$4 717 464 481	$394 500 123	$386 203 309	$7 668 035	$83 333 333	$477 204 677	$4 709 796 445
12	$4 709 796 445	$394 500 123	$385 522 970	$8 296 814	$83 333 333	$477 153 117	$4 701 499 631
13	$4 701 499 631	$394 500 123	$384 786 843	$8 977 153	$83 333 333	$477 097 330	$4 692 522 478
14	$4 692 522 478	$394 500 123	$383 990 354	$9 713 280	$83 333 333	$477 036 967	$4 682 809 199
15	$4 682 809 199	$394 500 123	$383 128 553	$10 509 768	$83 333 333	$476 971 655	$4 672 299 430
16	$4 672 299 430	$394 500 123	$382 196 085	$11 371 569	$83 333 333	$476 900 987	$4 660 927 861
17	$4 660 927 861	$394 500 123	$381 187 153	$12 304 038	$83 333 333	$476 824 525	$4 648 623 823
18	$4 648 623 823	$394 500 123	$380 095 490	$13 312 969	$83 333 333	$476 741 793	$4 635 310 853
19	$4 635 310 853	$394 500 123	$378 914 310	$14 404 633	$83 333 333	$476 652 276	$4 620 906 221
20	$4 620 906 221	$394 500 123	$377 636 273	$15 585 813	$83 333 333	$476 555 419	$4 605 320 408
21	$4 605 320 408	$394 500 123	$376 253 438	$16 863 849	$83 333 333	$476 450 620	$4 588 456 559
22	$4 588 456 559	$394 500 123	$374 757 210	$18 246 685	$83 333 333	$476 337 228	$4 570 209 874
23	$4 570 209 874	$394 500 123	$373 138 291	$19 742 913	$83 333 333	$476 214 537	$4 550 466 961
24	$4 550 466 961	$394 500 123	$371 386 621	$21 361 832	$83 333 333	$476 081 786	$4 529 105 129
25	$4 529 105 129	$394 500 123	$369 491 313	$23 113 502	$83 333 333	$475 938 149	$4 505 991 627
26	$4 505 991 627	$394 500 123	$367 440 591	$25 008 809	$83 333 333	$475 782 734	$4 480 982 817
27	$4 480 982 817	$394 500 123	$365 221 709	$27 059 532	$83 333 333	$475 614 574	$4 453 923 286
28	$4 453 923 286	$394 500 123	$362 820 880	$29 278 413	$83 333 333	$475 432 626	$4 424 644 872
29	$4 424 644 872	$394 500 123	$360 223 182	$31 679 243	$83 333 333	$475 235 758	$4 392 965 629
30	$4 392 965 629	$394 500 123	$357 412 472	$34 276 941	$83 333 333	$475 022 747	$4 358 688 688
31	$4 358 688 688	$394 500 123	$354 371 285	$37 087 650	$83 333 333	$474 792 269	$4 321 601 038
32	$4 321 601 038	$394 500 123	$351 080 720	$40 128 838	$83 333 333	$474 542 891	$4 281 472 200
33	$4 281 472 200	$394 500 123	$347 520 329	$43 419 402	$83 333 333	$474 273 065	$4 238 052 798
34	$4 238 052 798	$394 500 123	$343 667 986	$46 979 793	$83 333 333	$473 981 113	$4 191 073 004
35	$4 191 073 004	$394 500 123	$339 499 751	$50 832 136	$83 333 333	$473 665 221	$4 140 240 868
36	$4 140 240 868	$394 500 123	$334 989 721	$55 000 372	$83 333 333	$473 323 426	$4 085 240 496
37	$4 085 240 496	$394 500 123	$330 109 868	$59 510 402	$83 333 333	$472 953 603	$4 025 730 094
38	$4 025 730 094	$394 500 123	$324 829 867	$64 390 255	$83 333 333	$472 553 455	$3 961 339 839
39	$3 961 339 839	$394 500 123	$319 116 906	$69 670 256	$83 333 333	$472 120 495	$3 891 669 584
40	$3 891 669 584	$394 500 123	$312 935 482	$75 383 217	$83 333 333	$471 652 032	$3 816 286 367
41	$3 816 286 367	$394 500 123	$306 247 182	$81 564 641	$83 333 333	$471 145 156	$3 734 721 726
42	$3 734 721 726	$394 500 123	$299 010 440	$88 252 941	$83 333 333	$470 596 715	$3 646 468 785
43	$3 646 468 785	$394 500 123	$291 180 286	$95 489 682	$83 333 333	$470 003 302	$3 550 979 102
44	$3 550 979 102	$394 500 123	$282 708 060	$103 319 836	$83 333 333	$469 361 229	$3 447 659 266
45	$3 447 659 266	$394 500 123	$273 541 111	$111 792 063	$83 333 333	$468 666 507	$3 335 867 203
46	$3 335 867 203	$394 500 123	$263 622 472	$120 959 012	$83 333 333	$467 914 817	$3 214 908 191
47	$3 214 908 191	$394 500 123	$252 890 504	$130 877 651	$83 333 333	$467 101 489	$3 084 030 540
48	$3 084 030 540	$394 500 123	$241 278 516	$141 609 618	$83 333 333	$466 221 467	$2 942 420 922
49	$2 942 420 922	$394 500 123	$228 714 344	$153 221 607	$83 333 333	$465 269 284	$2 789 199 314
50	$2 789 199 314	$394 500 123	$215 119 910	$165 785 779	$83 333 333	$464 239 022	$2 623 413 535
51	$2 623 413 535	$394 500 123	$200 410 732	$179 380 213	$83 333 333	$463 124 279	$2 444 033 323
52	$2 444 033 323	$394 500 123	$184 495 402	$194 089 390	$83 333 333	$461 918 126	$2 249 943 932
53	$2 249 943 932	$394 500 123	$167 275 015	$210 004 720	$83 333 333	$460 613 069	$2 039 939 212
54	$2 039 939 212	$394 500 123	$148 642 557	$227 225 107	$83 333 333	$459 200 997	$1 812 714 105
55	$1 812 714 105	$394 500 123	$128 482 236	$245 857 566	$83 333 333	$457 673 136	$1 566 856 539
56	$1 566 856 539	$394 500 123	$106 668 769	$266 017 887	$83 333 333	$456 019 989	$1 300 838 652
57	$1 300 838 652	$394 500 123	$83 066 598	$287 831 353	$83 333 333	$454 231 285	$1 013 007 299
58	$1 013 007 299	$394 500 123	$57 529 050	$311 433 524	$83 333 333	$452 295 907	$701 573 774
59	$701 573 774	$394 500 123	$29 897 422	$336 971 073	$83 333 333	$450 201 828	$364 602 701
60	$364 602 701	$394 500 123	$0	$364 602 701	$83 333 333	$447 936 035	$0
			$18 510 823 147.06		**$4 999 999 999.98**	**$28 279 279 823.92**	

APPENDIX 19
AMORTIZATION: FLAMANVILLE, FRANCE

Country	**France**	
Plant	**Flamanville**	
Technology	**EPR 1600**	
Vendor	**EDF (Areva)**	
	Loan amount	$6 549 057 653
	Annual interest rate	98%
	Loan period in years	60
	Monthly Payment	$541 811 371
	O&M	$83 333 333
	Total Interest	

No.	Beginning Balance	Payment	Interest	Principal	O&M	Total Payment	Ending Balance
1	$6 549 057 653	$541 811 371	$537 022 728	$4 788 643	$83 333 333	$625 144 704	$6 544 269 010
2	$6 544 269 010	$541 811 371	$536 205 191	$5 181 312	$83 333 333	$624 719 836	$6 539 087 698
3	$6 539 087 698	$541 811 371	$535 745 485	$5 606 179	$83 333 333	$624 684 997	$6 533 481 519
4	$6 533 481 519	$541 811 371	$535 248 082	$6 065 886	$83 333 333	$624 647 301	$6 527 415 633
5	$6 527 415 633	$541 811 371	$534 709 892	$6 563 289	$83 333 333	$624 606 514	$6 520 852 344
6	$6 520 852 344	$541 811 371	$534 127 571	$7 101 478	$83 333 333	$624 562 383	$6 513 750 866
7	$6 513 750 866	$541 811 371	$533 497 499	$7 683 800	$83 333 333	$624 514 632	$6 506 067 066
8	$6 506 067 066	$541 811 371	$532 815 762	$8 313 871	$83 333 333	$624 462 967	$6 497 753 195
9	$6 497 753 195	$541 811 371	$532 078 122	$8 995 609	$83 333 333	$624 407 064	$6 488 757 586
10	$6 488 757 586	$541 811 371	$531 279 996	$9 733 249	$83 333 333	$624 346 578	$6 479 024 337
11	$6 479 024 337	$541 811 371	$530 416 423	$10 531 375	$83 333 333	$624 281 131	$6 468 492 963
12	$6 468 492 963	$541 811 371	$529 482 037	$11 394 948	$83 333 333	$624 210 318	$6 457 098 015
13	$6 457 098 015	$541 811 371	$528 471 032	$12 329 333	$83 333 333	$624 133 699	$6 444 768 681
14	$6 444 768 681	$541 811 371	$527 377 124	$13 340 339	$83 333 333	$624 050 796	$6 431 428 343
15	$6 431 428 343	$541 811 371	$526 193 516	$14 434 247	$83 333 333	$623 961 096	$6 416 994 096
16	$6 416 994 096	$541 811 371	$524 912 852	$15 617 855	$83 333 333	$623 864 040	$6 401 376 241
17	$6 401 376 241	$541 811 371	$523 527 173	$16 898 519	$83 333 333	$623 759 025	$6 384 477 722
18	$6 384 477 722	$541 811 371	$522 027 869	$18 284 197	$83 333 333	$623 645 400	$6 366 193 525
19	$6 366 193 525	$541 811 371	$520 405 622	$19 783 502	$83 333 333	$623 522 457	$6 346 410 023
20	$6 346 410 023	$541 811 371	$518 650 351	$21 405 749	$83 333 333	$623 389 433	$6 325 004 275
21	$6 325 004 275	$541 811 371	$516 751 147	$23 161 020	$83 333 333	$623 245 500	$6 301 843 254
22	$6 301 843 254	$541 811 371	$514 696 209	$25 060 224	$83 333 333	$623 089 766	$6 276 783 031
23	$6 276 783 031	$541 811 371	$512 472 765	$27 115 162	$83 333 333	$622 921 261	$6 249 667 868
24	$6 249 667 868	$541 811 371	$510 067 000	$29 338 605	$83 333 333	$622 738 938	$6 220 329 263
25	$6 220 329 263	$541 811 371	$507 463 961	$31 744 371	$83 333 333	$622 541 666	$6 188 584 892
26	$6 188 584 892	$541 811 371	$504 647 474	$34 347 410	$83 333 333	$622 328 216	$6 154 237 482
27	$6 154 237 482	$541 811 371	$501 600 034	$37 163 897	$83 333 333	$622 097 264	$6 117 073 585
28	$6 117 073 585	$541 811 371	$498 302 704	$40 211 337	$83 333 333	$621 847 374	$6 076 862 249
29	$6 076 862 249	$541 811 371	$494 734 994	$43 508 666	$83 333 333	$621 576 993	$6 033 353 582
30	$6 033 353 582	$541 811 371	$490 874 731	$47 076 377	$83 333 333	$621 284 441	$5 986 277 206
31	$5 986 277 206	$541 811 371	$486 697 926	$50 936 640	$83 333 333	$620 967 900	$5 935 340 566
32	$5 935 340 566	$541 811 371	$482 178 624	$55 113 444	$83 333 333	$620 625 402	$5 880 227 121
33	$5 880 227 121	$541 811 371	$477 288 739	$59 632 747	$83 333 333	$620 254 819	$5 820 594 375
34	$5 820 594 375	$541 811 371	$471 997 883	$64 522 632	$83 333 333	$619 853 848	$5 756 071 743
35	$5 756 071 743	$541 811 371	$466 273 177	$69 813 488	$83 333 333	$619 419 998	$5 686 258 255
36	$5 686 258 255	$541 811 371	$460 079 045	$75 538 194	$83 333 333	$618 950 572	$5 610 720 061
37	$5 610 720 061	$541 811 371	$453 376 994	$81 732 326	$83 333 333	$618 442 653	$5 528 987 736
38	$5 528 987 736	$541 811 371	$446 125 375	$88 434 376	$83 333 333	$617 893 085	$5 440 553 359
39	$5 440 553 359	$541 811 371	$438 279 124	$95 685 995	$83 333 333	$617 298 452	$5 344 867 364
40	$5 344 867 364	$541 811 371	$429 789 480	$103 532 247	$83 333 333	$616 655 060	$5 241 335 117
41	$5 241 335 117	$541 811 371	$420 603 685	$112 021 891	$83 333 333	$615 958 909	$5 129 313 226
42	$5 129 313 226	$541 811 371	$410 664 654	$121 207 686	$83 333 333	$615 205 674	$5 008 105 540
43	$5 008 105 540	$541 811 371	$399 910 624	$131 146 716	$83 333 333	$614 390 673	$4 876 958 824
44	$4 876 958 824	$541 811 371	$388 274 762	$141 900 747	$83 333 333	$613 508 843	$4 735 058 077
45	$4 735 058 077	$541 811 371	$375 684 760	$153 536 608	$83 333 333	$612 554 702	$4 581 521 469
46	$4 581 521 469	$541 811 371	$362 062 378	$166 126 610	$83 333 333	$611 522 322	$4 415 394 858
47	$4 415 394 858	$541 811 371	$347 322 961	$179 748 992	$83 333 333	$610 405 287	$4 235 645 866
48	$4 235 645 866	$541 811 371	$331 374 911	$194 488 410	$83 333 333	$609 196 654	$4 041 157 456
49	$4 041 157 456	$541 811 371	$314 119 122	$210 436 459	$83 333 333	$607 888 914	$3 830 720 997
50	$3 830 720 997	$541 811 371	$295 448 357	$227 692 249	$83 333 333	$606 473 940	$3 603 028 748
51	$3 603 028 748	$541 811 371	$275 246 590	$246 363 013	$83 333 333	$604 942 937	$3 356 665 735
52	$3 356 665 735	$541 811 371	$253 388 278	$266 564 780	$83 333 333	$603 286 392	$3 090 100 955
53	$3 090 100 955	$541 811 371	$229 737 585	$288 423 092	$83 333 333	$601 494 010	$2 801 677 862
54	$2 801 677 862	$541 811 371	$204 147 534	$312 073 786	$83 333 333	$599 554 654	$2 489 604 076
55	$2 489 604 076	$541 811 371	$176 459 100	$337 663 836	$83 333 333	$597 456 269	$2 151 940 240
56	$2 151 940 240	$541 811 371	$146 500 213	$365 352 271	$83 333 333	$595 185 818	$1 786 587 969
57	$1 786 587 969	$541 811 371	$114 084 699	$395 311 157	$83 333 333	$592 729 189	$1 391 276 812
58	$1 391 276 812	$541 811 371	$79 011 111	$427 726 672	$83 333 333	$590 071 117	$963 550 140
59	$963 550 140	$541 811 371	$41 061 490	$462 800 259	$83 333 333	$587 195 083	$500 749 880
60	$500 749 880	$541 811 371	$0	$500 749 880	$83 333 333	$584 083 214	$0
			$25 422 994 527.15		**$4 999 999 999.98**	**$36 972 052 180.39**	

APPENDIX 20
AMORTIZATION: HINKLEY POINT C, UNITED KINGDOM

Country	**UK**	
Plant	**Hinkley Point C**	
Technology	**EPR 1600**	
Vendor	**Areva**	
	Loan amount	$8 374 260 592
	Annual interest rate	98%
	Loan period in years	60
	Monthly Payment	$692 812 592
	O&M	$83 333 333
	Total Interest	

No.	Beginning Balance	Payment	Interest	Principal	O&M	Total Payment	Ending Balance
1	$8 374 260 592	$692 812 592	$686 689 369	$6 123 224	$83 333 333	$776 145 926	$8 368 137 368
2	$8 368 137 368	$692 812 592	$685 643 987	$6 625 328	$83 333 333	$775 602 649	$8 361 512 040
3	$8 361 512 040	$692 812 592	$685 056 162	$7 168 605	$83 333 333	$775 558 100	$8 354 343 435
4	$8 354 343 435	$692 812 592	$684 420 134	$7 756 431	$83 333 333	$775 509 898	$8 346 587 005
5	$8 346 587 005	$692 812 592	$683 731 953	$8 392 458	$83 333 333	$775 457 744	$8 338 194 547
6	$8 338 194 547	$692 812 592	$682 987 340	$9 080 639	$83 333 333	$775 401 313	$8 329 113 907
7	$8 329 113 907	$692 812 592	$682 181 670	$9 825 252	$83 333 333	$775 340 255	$8 319 288 655
8	$8 319 288 655	$692 812 592	$681 309 934	$10 630 922	$83 333 333	$775 274 190	$8 308 657 733
9	$8 308 657 733	$692 812 592	$680 366 716	$11 502 658	$83 333 333	$775 202 708	$8 297 155 075
10	$8 297 155 075	$692 812 592	$679 346 154	$12 445 876	$83 333 333	$775 125 364	$8 284 709 199
11	$8 284 709 199	$692 812 592	$678 241 906	$13 466 438	$83 333 333	$775 041 678	$8 271 242 761
12	$8 271 242 761	$692 812 592	$677 047 110	$14 570 686	$83 333 333	$774 951 129	$8 256 672 075
13	$8 256 672 075	$692 812 592	$675 754 341	$15 765 482	$83 333 333	$774 853 156	$8 240 906 593
14	$8 240 906 593	$692 812 592	$674 355 564	$17 058 252	$83 333 333	$774 747 149	$8 223 848 341
15	$8 223 848 341	$692 812 592	$672 842 088	$18 457 028	$83 333 333	$774 632 449	$8 205 391 313
16	$8 205 391 313	$692 812 592	$671 204 506	$19 970 505	$83 333 333	$774 508 344	$8 185 420 808
17	$8 185 420 808	$692 812 592	$669 432 643	$21 608 086	$83 333 333	$774 374 063	$8 163 812 722
18	$8 163 812 722	$692 812 592	$667 515 487	$23 379 949	$83 333 333	$774 228 770	$8 140 432 773
19	$8 140 432 773	$692 812 592	$665 441 125	$25 297 105	$83 333 333	$774 071 563	$8 115 135 669
20	$8 115 135 669	$692 812 592	$663 196 665	$27 371 467	$83 333 333	$773 901 465	$8 087 764 201
21	$8 087 764 201	$692 812 592	$660 768 158	$29 615 928	$83 333 333	$773 717 420	$8 058 148 273
22	$8 058 148 273	$692 812 592	$658 140 515	$32 044 434	$83 333 333	$773 518 282	$8 026 103 840
23	$8 026 103 840	$692 812 592	$655 297 405	$34 672 077	$83 333 333	$773 302 815	$7 991 431 762
24	$7 991 431 762	$692 812 592	$652 221 159	$37 515 188	$83 333 333	$773 069 680	$7 953 916 575
25	$7 953 916 575	$692 812 592	$648 892 662	$40 591 433	$83 333 333	$772 817 428	$7 913 325 141
26	$7 913 325 141	$692 812 592	$645 291 227	$43 919 931	$83 333 333	$772 544 491	$7 869 405 211
27	$7 869 405 211	$692 812 592	$641 394 475	$47 521 365	$83 333 333	$772 249 174	$7 821 883 846
28	$7 821 883 846	$692 812 592	$637 178 190	$51 418 117	$83 333 333	$771 929 640	$7 770 465 729
29	$7 770 465 729	$692 812 592	$632 616 169	$55 634 402	$83 333 333	$771 583 905	$7 714 831 326
30	$7 714 831 326	$692 812 592	$627 680 062	$60 196 423	$83 333 333	$771 209 819	$7 654 634 903
31	$7 654 634 903	$692 812 592	$622 339 195	$65 132 530	$83 333 333	$770 805 058	$7 589 502 373
32	$7 589 502 373	$692 812 592	$616 560 376	$70 473 398	$83 333 333	$770 367 107	$7 519 028 975
33	$7 519 028 975	$692 812 592	$610 307 694	$76 252 216	$83 333 333	$769 893 244	$7 442 776 759
34	$7 442 776 759	$692 812 592	$603 542 293	$82 504 898	$83 333 333	$769 380 524	$7 360 271 861
35	$7 360 271 861	$692 812 592	$596 222 128	$89 270 300	$83 333 333	$768 825 761	$7 271 001 561
36	$7 271 001 561	$692 812 592	$588 301 710	$96 590 464	$83 333 333	$768 225 508	$7 174 411 097
37	$7 174 411 097	$692 812 592	$579 731 818	$104 510 882	$83 333 333	$767 576 033	$7 069 900 215
38	$7 069 900 215	$692 812 592	$570 459 194	$113 080 775	$83 333 333	$766 873 302	$6 956 819 440
39	$6 956 819 440	$692 812 592	$560 426 215	$122 353 398	$83 333 333	$766 112 947	$6 834 466 042
40	$6 834 466 042	$692 812 592	$549 570 533	$132 386 377	$83 333 333	$765 290 243	$6 702 079 665
41	$6 702 079 665	$692 812 592	$537 824 684	$143 242 060	$83 333 333	$764 400 077	$6 558 837 605
42	$6 558 837 605	$692 812 592	$525 115 675	$154 987 909	$83 333 333	$763 436 917	$6 403 849 697
43	$6 403 849 697	$692 812 592	$511 364 528	$167 696 917	$83 333 333	$762 394 778	$6 236 152 780
44	$6 236 152 780	$692 812 592	$496 485 787	$181 448 064	$83 333 333	$761 267 184	$6 054 704 715
45	$6 054 704 715	$692 812 592	$480 386 989	$196 326 806	$83 333 333	$760 047 128	$5 858 377 910
46	$5 858 377 910	$692 812 592	$462 968 089	$212 425 604	$83 333 333	$758 727 026	$5 645 952 306
47	$5 645 952 306	$692 812 592	$444 120 840	$229 844 503	$83 333 333	$757 298 676	$5 416 107 803
48	$5 416 107 803	$692 812 592	$423 728 116	$248 691 752	$83 333 333	$755 753 202	$5 167 416 050
49	$5 167 416 050	$692 812 592	$401 663 189	$269 084 476	$83 333 333	$754 080 999	$4 898 331 574
50	$4 898 331 574	$692 812 592	$377 788 938	$291 149 403	$83 333 333	$752 271 675	$4 607 182 171
51	$4 607 182 171	$692 812 592	$351 956 998	$315 023 654	$83 333 333	$750 313 986	$4 292 158 517
52	$4 292 158 517	$692 812 592	$324 006 840	$340 855 594	$83 333 333	$748 195 767	$3 951 302 923
53	$3 951 302 923	$692 812 592	$293 764 768	$368 805 753	$83 333 333	$745 903 854	$3 582 497 171
54	$3 582 497 171	$692 812 592	$261 042 846	$399 047 824	$83 333 333	$743 424 004	$3 183 449 346
55	$3 183 449 346	$692 812 592	$225 637 727	$431 769 746	$83 333 333	$740 740 806	$2 751 679 601
56	$2 751 679 601	$692 812 592	$187 329 388	$467 174 865	$83 333 333	$737 837 587	$2 284 504 736
57	$2 284 504 736	$692 812 592	$145 879 766	$505 483 204	$83 333 333	$734 696 303	$1 779 021 532
58	$1 779 021 532	$692 812 592	$101 031 274	$546 932 827	$83 333 333	$731 297 434	$1 232 088 705
59	$1 232 088 705	$692 812 592	$52 505 206	$591 781 318	$83 333 333	$727 619 857	$640 307 387
60	$640 307 387	$692 812 592	$0	$640 307 387	$83 333 333	$723 640 720	$0
			$32 508 307 678.45		**$4 999 999 999.98**	**$45 882 568 270.31**	

APPENDIX 21
AMORTIZATION: FANGCHENGGANG-2 (3&4), CHINA

Country	**China**	
Plant	**Fangchenggang-2 (3&4)**	
Technology	**Hualong-1**	
Vendor	**CGN**	
	Loan amount	$2 620 921 098
	Annual interest rate	98%
	Loan period in years	60
	Monthly Payment	$216 831 936
	O&M	$83 333 333
	Total Interest	

No.	Beginning Balance	Payment	Interest	Principal	O&M	Total Payment	Ending Balance
1	$2 620 921 098	$216 831 936	$214 915 530	$1 916 406	$83 333 333	$300 165 270	$2 619 004 691
2	$2 619 004 691	$216 831 936	$214 588 353	$2 073 552	$83 333 333	$299 995 238	$2 616 931 140
3	$2 616 931 140	$216 831 936	$214 404 380	$2 243 583	$83 333 333	$299 981 296	$2 614 687 557
4	$2 614 687 557	$216 831 936	$214 205 320	$2 427 557	$83 333 333	$299 966 210	$2 612 260 000
5	$2 612 260 000	$216 831 936	$213 989 937	$2 626 616	$83 333 333	$299 949 887	$2 609 633 384
6	$2 609 633 384	$216 831 936	$213 756 894	$2 841 999	$83 333 333	$299 932 226	$2 606 791 385
7	$2 606 791 385	$216 831 936	$213 504 740	$3 075 043	$83 333 333	$299 913 116	$2 603 716 342
8	$2 603 716 342	$216 831 936	$213 231 910	$3 327 196	$83 333 333	$299 892 440	$2 600 389 146
9	$2 600 389 146	$216 831 936	$212 936 708	$3 600 026	$83 333 333	$299 870 068	$2 596 789 119
10	$2 596 789 119	$216 831 936	$212 617 299	$3 895 229	$83 333 333	$299 845 861	$2 592 893 891
11	$2 592 893 891	$216 831 936	$212 271 699	$4 214 637	$83 333 333	$299 819 669	$2 588 679 253
12	$2 588 679 253	$216 831 936	$211 897 759	$4 560 238	$83 333 333	$299 791 330	$2 584 119 016
13	$2 584 119 016	$216 831 936	$211 493 157	$4 934 177	$83 333 333	$299 760 667	$2 579 184 839
14	$2 579 184 839	$216 831 936	$211 055 377	$5 338 780	$83 333 333	$299 727 490	$2 573 846 059
15	$2 573 846 059	$216 831 936	$210 581 699	$5 776 560	$83 333 333	$299 691 592	$2 568 069 500
16	$2 568 069 500	$216 831 936	$210 069 179	$6 250 237	$83 333 333	$299 652 750	$2 561 819 262
17	$2 561 819 262	$216 831 936	$209 514 633	$6 762 757	$83 333 333	$299 610 724	$2 555 056 505
18	$2 555 056 505	$216 831 936	$208 914 615	$7 317 303	$83 333 333	$299 565 251	$2 547 739 202
19	$2 547 739 202	$216 831 936	$208 265 394	$7 917 322	$83 333 333	$299 516 049	$2 539 821 881
20	$2 539 821 881	$216 831 936	$207 562 938	$8 566 542	$83 333 333	$299 462 813	$2 531 255 338
21	$2 531 255 338	$216 831 936	$206 802 880	$9 268 999	$83 333 333	$299 405 212	$2 521 986 340
22	$2 521 986 340	$216 831 936	$205 980 497	$10 029 057	$83 333 333	$299 342 887	$2 511 957 283
23	$2 511 957 283	$216 831 936	$205 090 679	$10 851 439	$83 333 333	$299 275 452	$2 501 105 844
24	$2 501 105 844	$216 831 936	$204 127 896	$11 741 257	$83 333 333	$299 202 487	$2 489 364 587
25	$2 489 364 587	$216 831 936	$203 086 165	$12 704 040	$83 333 333	$299 123 538	$2 476 660 547
26	$2 476 660 547	$216 831 936	$201 959 012	$13 745 772	$83 333 333	$299 038 116	$2 462 914 775
27	$2 462 914 775	$216 831 936	$200 739 432	$14 872 925	$83 333 333	$298 945 690	$2 448 041 850
28	$2 448 041 850	$216 831 936	$199 419 846	$16 092 505	$83 333 333	$298 845 684	$2 431 949 346
29	$2 431 949 346	$216 831 936	$197 992 055	$17 412 090	$83 333 333	$298 737 478	$2 414 537 256
30	$2 414 537 256	$216 831 936	$196 447 185	$18 839 881	$83 333 333	$298 620 399	$2 395 697 374
31	$2 395 697 374	$216 831 936	$194 775 635	$20 384 752	$83 333 333	$298 493 720	$2 375 312 623
32	$2 375 312 623	$216 831 936	$192 967 018	$22 056 301	$83 333 333	$298 356 653	$2 353 256 321
33	$2 353 256 321	$216 831 936	$191 010 095	$23 864 918	$83 333 333	$298 208 346	$2 329 391 403
34	$2 329 391 403	$216 831 936	$188 892 704	$25 821 841	$83 333 333	$298 047 879	$2 303 569 562
35	$2 303 569 562	$216 831 936	$186 601 687	$27 939 232	$83 333 333	$297 874 253	$2 275 630 330
36	$2 275 630 330	$216 831 936	$184 122 807	$30 230 249	$83 333 333	$297 686 389	$2 245 400 081
37	$2 245 400 081	$216 831 936	$181 440 658	$32 709 130	$83 333 333	$297 483 121	$2 212 690 951
38	$2 212 690 951	$216 831 936	$178 538 573	$35 391 278	$83 333 333	$297 263 185	$2 177 299 672
39	$2 177 299 672	$216 831 936	$175 398 517	$38 293 363	$83 333 333	$297 025 214	$2 139 006 309
40	$2 139 006 309	$216 831 936	$172 000 977	$41 433 419	$83 333 333	$296 767 729	$2 097 572 890
41	$2 097 572 890	$216 831 936	$168 324 838	$44 830 959	$83 333 333	$296 489 131	$2 052 741 931
42	$2 052 741 931	$216 831 936	$164 347 256	$48 507 098	$83 333 333	$296 187 688	$2 004 234 833
43	$2 004 234 833	$216 831 936	$160 043 513	$52 484 680	$83 333 333	$295 861 526	$1 951 750 153
44	$1 951 750 153	$216 831 936	$155 386 862	$56 788 424	$83 333 333	$295 508 619	$1 894 961 729
45	$1 894 961 729	$216 831 936	$150 348 366	$61 445 075	$83 333 333	$295 126 774	$1 833 516 654
46	$1 833 516 654	$216 831 936	$144 896 713	$66 483 571	$83 333 333	$294 713 617	$1 767 033 083
47	$1 767 033 083	$216 831 936	$138 998 025	$71 935 224	$83 333 333	$294 266 581	$1 695 097 860
48	$1 695 097 860	$216 831 936	$132 615 644	$77 833 912	$83 333 333	$293 782 889	$1 617 263 948
49	$1 617 263 948	$216 831 936	$125 709 908	$84 216 293	$83 333 333	$293 259 534	$1 533 047 655
50	$1 533 047 655	$216 831 936	$118 237 901	$91 122 029	$83 333 333	$292 693 263	$1 441 925 627
51	$1 441 925 627	$216 831 936	$110 153 191	$98 594 035	$83 333 333	$292 080 559	$1 343 331 592
52	$1 343 331 592	$216 831 936	$101 405 533	$106 678 746	$83 333 333	$291 417 613	$1 236 652 846
53	$1 236 652 846	$216 831 936	$91 940 568	$115 426 403	$83 333 333	$290 700 305	$1 121 226 443
54	$1 121 226 443	$216 831 936	$81 699 476	$124 891 368	$83 333 333	$289 924 178	$996 335 075
55	$996 335 075	$216 831 936	$70 618 614	$135 132 460	$83 333 333	$289 084 408	$861 202 615
56	$861 202 615	$216 831 936	$58 629 122	$146 213 322	$83 333 333	$288 175 777	$714 989 293
57	$714 989 293	$216 831 936	$45 656 491	$158 202 814	$83 333 333	$287 192 639	$556 786 479
58	$556 786 479	$216 831 936	$31 620 105	$171 175 445	$83 333 333	$286 128 883	$385 611 033
59	$385 611 033	$216 831 936	$16 432 735	$185 211 832	$83 333 333	$284 977 900	$200 399 202
60	$200 399 202	$216 831 936	$0	$200 399 202	$83 333 333	$283 732 535	$0
			$10 174 236 699.58		**$4 999 999 999.98**	**$17 795 157 797.28**	

APPENDIX 22
AMORTIZATION: KARACHI, PAKISTAN

Country	**Pakistan**	
Plant	**Karachi**	
Technology	**Hualong-1**	
Vendor	**CNNC**	
	Loan amount	$3 266 744 676
	Annual interest rate	98%
	Loan period in years	60
	Monthly Payment	$270 261 693
	O&M	$83 333 333
	Total Interest	

No.	Beginning Balance	Payment	Interest	Principal	O&M	Total Payment	Ending Balance
1	$3 266 744 676	$270 261 693	$267 873 063	$2 388 630	$83 333 333	$353 595 027	$3 264 356 046
2	$3 264 356 046	$270 261 693	$267 465 267	$2 584 497	$83 333 333	$353 383 098	$3 261 771 549
3	$3 261 771 549	$270 261 693	$267 235 960	$2 796 426	$83 333 333	$353 365 720	$3 258 975 123
4	$3 258 975 123	$270 261 693	$266 987 850	$3 025 733	$83 333 333	$353 346 916	$3 255 949 389
5	$3 255 949 389	$270 261 693	$266 719 395	$3 273 843	$83 333 333	$353 326 571	$3 252 675 546
6	$3 252 675 546	$270 261 693	$266 428 926	$3 542 298	$83 333 333	$353 304 558	$3 249 133 248
7	$3 249 133 248	$270 261 693	$266 114 639	$3 832 767	$83 333 333	$353 280 740	$3 245 300 481
8	$3 245 300 481	$270 261 693	$265 774 581	$4 147 054	$83 333 333	$353 254 968	$3 241 153 427
9	$3 241 153 427	$270 261 693	$265 406 638	$4 487 112	$83 333 333	$353 227 083	$3 236 666 315
10	$3 236 666 315	$270 261 693	$265 008 523	$4 855 055	$83 333 333	$353 196 912	$3 231 811 259
11	$3 231 811 259	$270 261 693	$264 577 763	$5 253 170	$83 333 333	$353 164 267	$3 226 558 089
12	$3 226 558 089	$270 261 693	$264 111 681	$5 683 930	$83 333 333	$353 128 944	$3 220 874 159
13	$3 220 874 159	$270 261 693	$263 607 380	$6 150 012	$83 333 333	$353 090 726	$3 214 724 147
14	$3 214 724 147	$270 261 693	$263 061 726	$6 654 313	$83 333 333	$353 049 373	$3 208 069 834
15	$3 208 069 834	$270 261 693	$262 471 329	$7 199 967	$83 333 333	$353 004 629	$3 200 869 867
16	$3 200 869 867	$270 261 693	$261 832 519	$7 790 364	$83 333 333	$352 956 217	$3 193 079 503
17	$3 193 079 503	$270 261 693	$261 141 327	$8 429 174	$83 333 333	$352 903 834	$3 184 650 329
18	$3 184 650 329	$270 261 693	$260 393 457	$9 120 366	$83 333 333	$352 847 157	$3 175 529 963
19	$3 175 529 963	$270 261 693	$259 584 262	$9 868 236	$83 333 333	$352 785 831	$3 165 661 726
20	$3 165 661 726	$270 261 693	$258 708 712	$10 677 432	$83 333 333	$352 719 477	$3 154 984 295
21	$3 154 984 295	$270 261 693	$257 761 368	$11 552 981	$83 333 333	$352 647 682	$3 143 431 313
22	$3 143 431 313	$270 261 693	$256 736 341	$12 500 326	$83 333 333	$352 570 000	$3 130 930 988
23	$3 130 930 988	$270 261 693	$255 627 262	$13 525 352	$83 333 333	$352 485 948	$3 117 405 636
24	$3 117 405 636	$270 261 693	$254 427 239	$14 634 431	$83 333 333	$352 395 003	$3 102 771 205
25	$3 102 771 205	$270 261 693	$253 128 814	$15 834 454	$83 333 333	$352 296 601	$3 086 936 750
26	$3 086 936 750	$270 261 693	$251 723 917	$17 132 880	$83 333 333	$352 190 130	$3 069 803 870
27	$3 069 803 870	$270 261 693	$250 203 820	$18 537 776	$83 333 333	$352 074 929	$3 051 266 094
28	$3 051 266 094	$270 261 693	$248 559 074	$20 057 873	$83 333 333	$351 950 281	$3 031 208 221
29	$3 031 208 221	$270 261 693	$246 779 459	$21 702 619	$83 333 333	$351 815 412	$3 009 505 602
30	$3 009 505 602	$270 261 693	$244 853 916	$23 482 234	$83 333 333	$351 669 483	$2 986 023 368
31	$2 986 023 368	$270 261 693	$242 770 478	$25 407 777	$83 333 333	$351 511 589	$2 960 615 591
32	$2 960 615 591	$270 261 693	$240 516 199	$27 491 215	$83 333 333	$351 340 747	$2 933 124 376
33	$2 933 124 376	$270 261 693	$238 077 068	$29 745 494	$83 333 333	$351 155 896	$2 903 378 882
34	$2 903 378 882	$270 261 693	$235 437 929	$32 184 625	$83 333 333	$350 955 887	$2 871 194 257
35	$2 871 194 257	$270 261 693	$232 582 380	$34 823 764	$83 333 333	$350 739 478	$2 836 370 493
36	$2 836 370 493	$270 261 693	$229 492 677	$37 679 313	$83 333 333	$350 505 323	$2 798 691 180
37	$2 798 691 180	$270 261 693	$226 149 617	$40 769 017	$83 333 333	$350 251 967	$2 757 922 163
38	$2 757 922 163	$270 261 693	$222 532 427	$44 112 076	$83 333 333	$349 977 836	$2 713 810 087
39	$2 713 810 087	$270 261 693	$218 618 627	$47 729 266	$83 333 333	$349 681 227	$2 666 080 821
40	$2 666 080 821	$270 261 693	$214 383 896	$51 643 066	$83 333 333	$349 360 295	$2 614 437 755
41	$2 614 437 755	$270 261 693	$209 801 917	$55 877 797	$83 333 333	$349 013 047	$2 558 559 958
42	$2 558 559 958	$270 261 693	$204 844 215	$60 459 777	$83 333 333	$348 637 325	$2 498 100 181
43	$2 498 100 181	$270 261 693	$199 479 982	$65 417 478	$83 333 333	$348 230 793	$2 432 682 703
44	$2 432 682 703	$270 261 693	$193 675 881	$70 781 712	$83 333 333	$347 790 926	$2 361 900 991
45	$2 361 900 991	$270 261 693	$187 395 845	$76 585 812	$83 333 333	$347 314 990	$2 285 315 179
46	$2 285 315 179	$270 261 693	$180 600 845	$82 865 849	$83 333 333	$346 800 027	$2 202 449 331
47	$2 202 449 331	$270 261 693	$173 248 656	$89 660 848	$83 333 333	$346 242 837	$2 112 788 483
48	$2 112 788 483	$270 261 693	$165 293 586	$97 013 038	$83 333 333	$345 639 957	$2 015 775 445
49	$2 015 775 445	$270 261 693	$156 686 202	$104 968 107	$83 333 333	$344 987 642	$1 910 807 338
50	$1 910 807 338	$270 261 693	$147 373 011	$113 575 491	$83 333 333	$344 281 836	$1 797 231 847
51	$1 797 231 847	$270 261 693	$137 296 140	$122 888 682	$83 333 333	$343 518 155	$1 674 343 165
52	$1 674 343 165	$270 261 693	$126 392 964	$132 965 554	$83 333 333	$342 691 851	$1 541 377 611
53	$1 541 377 611	$270 261 693	$114 595 728	$143 868 729	$83 333 333	$341 797 791	$1 397 508 882
54	$1 397 508 882	$270 261 693	$101 831 119	$155 665 965	$83 333 333	$340 830 417	$1 241 842 917
55	$1 241 842 917	$270 261 693	$88 019 812	$168 430 574	$83 333 333	$339 783 720	$1 073 412 343
56	$1 073 412 343	$270 261 693	$73 075 978	$182 241 881	$83 333 333	$338 651 192	$891 170 462
57	$891 170 462	$270 261 693	$56 906 749	$197 185 715	$83 333 333	$337 425 798	$693 984 747
58	$693 984 747	$270 261 693	$39 411 644	$213 354 944	$83 333 333	$336 099 921	$480 629 803
59	$480 629 803	$270 261 693	$20 481 940	$230 850 049	$83 333 333	$334 665 323	$249 779 753
60	$249 779 753	$270 261 693	$0	$249 779 753	$83 333 333	$333 113 087	$0
			$12 681 279 722.79		**$4 999 999 999.98**	**$20 948 024 398.85**	

APPENDIX 23
AMORTIZATION: SHIN-HANUL I (1&2), SOUTH KOREA

Country	**South Korea**	
Plant	**Shin-Hanul I (1&2)**	
Technology	**APR1400**	
Vendor	**KEPCO**	
	Loan amount	$3 022 003 470
	Annual interest rate	98%
	Loan period in years	60
	Monthly Payment	$250 013 961
	O&M	$83 333 333
	Total Interest	

No.	Beginning Balance	Payment	Interest	Principal	O&M	Total Payment	Ending Balance
1	$3 022 003 470	$250 013 961	$247 804 285	$2 209 676	$83 333 333	$333 347 294	$3 019 793 794
2	$3 019 793 794	$250 013 961	$247 427 040	$2 390 870	$83 333 333	$333 151 243	$3 017 402 924
3	$3 017 402 924	$250 013 961	$247 214 912	$2 586 921	$83 333 333	$333 135 166	$3 014 816 003
4	$3 014 816 003	$250 013 961	$246 985 390	$2 799 048	$83 333 333	$333 117 772	$3 012 016 955
5	$3 012 016 955	$250 013 961	$246 737 048	$3 028 570	$83 333 333	$333 098 951	$3 008 988 385
6	$3 008 988 385	$250 013 961	$246 468 341	$3 276 913	$83 333 333	$333 078 587	$3 005 711 472
7	$3 005 711 472	$250 013 961	$246 177 600	$3 545 620	$83 333 333	$333 056 553	$3 002 165 852
8	$3 002 165 852	$250 013 961	$245 863 018	$3 836 361	$83 333 333	$333 032 712	$2 998 329 491
9	$2 998 329 491	$250 013 961	$245 522 641	$4 150 942	$83 333 333	$333 006 917	$2 994 178 549
10	$2 994 178 549	$250 013 961	$245 154 353	$4 491 320	$83 333 333	$332 979 006	$2 989 687 229
11	$2 989 687 229	$250 013 961	$244 755 865	$4 859 608	$83 333 333	$332 948 806	$2 984 827 621
12	$2 984 827 621	$250 013 961	$244 324 701	$5 258 096	$83 333 333	$332 916 130	$2 979 569 526
13	$2 979 569 526	$250 013 961	$243 858 182	$5 689 259	$83 333 333	$332 880 775	$2 973 880 266
14	$2 973 880 266	$250 013 961	$243 353 408	$6 155 779	$83 333 333	$332 842 520	$2 967 724 487
15	$2 967 724 487	$250 013 961	$242 807 243	$6 660 553	$83 333 333	$332 801 129	$2 961 063 935
16	$2 961 063 935	$250 013 961	$242 216 292	$7 206 718	$83 333 333	$332 756 343	$2 953 857 217
17	$2 953 857 217	$250 013 961	$241 576 883	$7 797 669	$83 333 333	$332 707 885	$2 946 059 548
18	$2 946 059 548	$250 013 961	$240 885 043	$8 437 078	$83 333 333	$332 655 454	$2 937 622 470
19	$2 937 622 470	$250 013 961	$240 136 471	$9 128 918	$83 333 333	$332 598 723	$2 928 493 552
20	$2 928 493 552	$250 013 961	$239 326 517	$9 877 489	$83 333 333	$332 537 340	$2 918 616 063
21	$2 918 616 063	$250 013 961	$238 450 147	$10 687 443	$83 333 333	$332 470 924	$2 907 928 619
22	$2 907 928 619	$250 013 961	$237 501 914	$11 563 814	$83 333 333	$332 399 061	$2 896 364 806
23	$2 896 364 806	$250 013 961	$236 475 926	$12 512 047	$83 333 333	$332 321 306	$2 883 852 759
24	$2 883 852 759	$250 013 961	$235 365 807	$13 538 034	$83 333 333	$332 237 175	$2 870 314 725
25	$2 870 314 725	$250 013 961	$234 164 659	$14 648 153	$83 333 333	$332 146 145	$2 855 666 572
26	$2 855 666 572	$250 013 961	$232 865 016	$15 849 302	$83 333 333	$332 047 651	$2 839 817 270
27	$2 839 817 270	$250 013 961	$231 458 803	$17 148 944	$83 333 333	$331 941 080	$2 822 668 325
28	$2 822 668 325	$250 013 961	$229 937 280	$18 555 158	$83 333 333	$331 825 771	$2 804 113 168
29	$2 804 113 168	$250 013 961	$228 290 992	$20 076 681	$83 333 333	$331 701 006	$2 784 036 487
30	$2 784 036 487	$250 013 961	$226 509 708	$21 722 969	$83 333 333	$331 566 010	$2 762 313 518
31	$2 762 313 518	$250 013 961	$224 582 360	$23 504 252	$83 333 333	$331 419 945	$2 738 809 266
32	$2 738 809 266	$250 013 961	$222 496 969	$25 431 601	$83 333 333	$331 261 903	$2 713 377 665
33	$2 713 377 665	$250 013 961	$220 240 575	$27 516 992	$83 333 333	$331 090 901	$2 685 860 673
34	$2 685 860 673	$250 013 961	$217 799 158	$29 773 385	$83 333 333	$330 905 876	$2 656 087 288
35	$2 656 087 288	$250 013 961	$215 157 544	$32 214 803	$83 333 333	$330 705 680	$2 623 872 485
36	$2 623 872 485	$250 013 961	$212 299 318	$34 856 417	$83 333 333	$330 489 068	$2 589 016 068
37	$2 589 016 068	$250 013 961	$209 206 717	$37 714 643	$83 333 333	$330 254 693	$2 551 301 425
38	$2 551 301 425	$250 013 961	$205 860 523	$40 807 244	$83 333 333	$330 001 100	$2 510 494 181
39	$2 510 494 181	$250 013 961	$202 239 941	$44 153 438	$83 333 333	$329 726 712	$2 466 340 743
40	$2 466 340 743	$250 013 961	$198 322 471	$47 774 020	$83 333 333	$329 429 824	$2 418 566 724
41	$2 418 566 724	$250 013 961	$194 083 769	$51 691 489	$83 333 333	$329 108 592	$2 366 875 234
42	$2 366 875 234	$250 013 961	$189 497 494	$55 930 191	$83 333 333	$328 761 018	$2 310 945 043
43	$2 310 945 043	$250 013 961	$184 535 143	$60 516 467	$83 333 333	$328 384 944	$2 250 428 576
44	$2 250 428 576	$250 013 961	$179 165 880	$65 478 817	$83 333 333	$327 978 031	$2 184 949 758
45	$2 184 949 758	$250 013 961	$173 356 338	$70 848 080	$83 333 333	$327 537 751	$2 114 101 678
46	$2 114 101 678	$250 013 961	$167 070 413	$76 657 623	$83 333 333	$327 061 369	$2 037 444 055
47	$2 037 444 055	$250 013 961	$160 269 042	$82 943 548	$83 333 333	$326 545 923	$1 954 500 507
48	$1 954 500 507	$250 013 961	$152 909 958	$89 744 919	$83 333 333	$325 988 211	$1 864 755 588
49	$1 864 755 588	$250 013 961	$144 947 430	$97 104 002	$83 333 333	$325 384 766	$1 767 651 586
50	$1 767 651 586	$250 013 961	$136 331 975	$105 066 531	$83 333 333	$324 731 838	$1 662 585 055
51	$1 662 585 055	$250 013 961	$127 010 052	$113 681 986	$83 333 333	$324 025 371	$1 548 903 069
52	$1 548 903 069	$250 013 961	$116 923 731	$123 003 909	$83 333 333	$323 260 973	$1 425 899 160
53	$1 425 899 160	$250 013 961	$106 010 332	$133 090 229	$83 333 333	$322 433 895	$1 292 808 931
54	$1 292 808 931	$250 013 961	$94 202 035	$144 003 628	$83 333 333	$321 538 996	$1 148 805 302
55	$1 148 805 302	$250 013 961	$81 425 457	$155 811 926	$83 333 333	$320 570 716	$992 993 376
56	$992 993 376	$250 013 961	$67 601 200	$168 588 504	$83 333 333	$319 523 037	$824 404 873
57	$824 404 873	$250 013 961	$52 643 353	$182 412 761	$83 333 333	$318 389 448	$641 992 112
58	$641 992 112	$250 013 961	$36 458 963	$197 370 607	$83 333 333	$317 162 904	$444 621 504
59	$444 621 504	$250 013 961	$18 947 454	$213 554 997	$83 333 333	$315 835 784	$231 066 507
60	$231 066 507	$250 013 961	$0	$231 066 507	$83 333 333	$314 399 840	$0
			$11 731 211 074.68		**$4 999 999 999.98**	**$19 753 214 544.34**	

APPENDIX 24
AMORTIZATION: SHIN-KORI III (5&6), SOUTH KOREA

Country	**South Korea**	
Plant	**Shin-Kori III (5&6)**	
Technology	**APR1400**	
Vendor	**KEPCO**	
	Loan amount	$3 425 619 579
	Annual interest rate	98%
	Loan period in years	60
	Monthly Payment	$283 405 604
	O&M	$83 333 333
	Total Interest	

No.	Beginning Balance	Payment	Interest	Principal	O&M	Total Payment	Ending Balance
1	$3 425 619 579	$283 405 604	$280 900 805	$2 504 798	$83 333 333	$366 738 937	$3 423 114 780
2	$3 423 114 780	$283 405 604	$280 473 176	$2 710 192	$83 333 333	$366 516 702	$3 420 404 588
3	$3 420 404 588	$283 405 604	$280 232 717	$2 932 428	$83 333 333	$366 498 478	$3 417 472 161
4	$3 417 472 161	$283 405 604	$279 972 540	$3 172 887	$83 333 333	$366 478 761	$3 414 299 274
5	$3 414 299 274	$283 405 604	$279 691 029	$3 433 063	$83 333 333	$366 457 426	$3 410 866 211
6	$3 410 866 211	$283 405 604	$279 386 434	$3 714 575	$83 333 333	$366 434 342	$3 407 151 636
7	$3 407 151 636	$283 405 604	$279 056 862	$4 019 170	$83 333 333	$366 409 365	$3 403 132 466
8	$3 403 132 466	$283 405 604	$278 700 265	$4 348 742	$83 333 333	$366 382 340	$3 398 783 724
9	$3 398 783 724	$283 405 604	$278 314 428	$4 705 339	$83 333 333	$366 353 099	$3 394 078 386
10	$3 394 078 386	$283 405 604	$277 896 951	$5 091 176	$83 333 333	$366 321 461	$3 388 987 210
11	$3 388 987 210	$283 405 604	$277 445 242	$5 508 653	$83 333 333	$366 287 228	$3 383 478 557
12	$3 383 478 557	$283 405 604	$276 956 492	$5 960 362	$83 333 333	$366 250 188	$3 377 518 195
13	$3 377 518 195	$283 405 604	$276 427 665	$6 449 112	$83 333 333	$366 210 110	$3 371 069 083
14	$3 371 069 083	$283 405 604	$275 855 474	$6 977 939	$83 333 333	$366 166 746	$3 364 091 144
15	$3 364 091 144	$283 405 604	$275 236 363	$7 550 130	$83 333 333	$366 119 827	$3 356 541 013
16	$3 356 541 013	$283 405 604	$274 566 485	$8 169 241	$83 333 333	$366 069 060	$3 348 371 773
17	$3 348 371 773	$283 405 604	$273 841 678	$8 839 119	$83 333 333	$366 014 130	$3 339 532 654
18	$3 339 532 654	$283 405 604	$273 057 436	$9 563 926	$83 333 333	$365 954 695	$3 329 968 728
19	$3 329 968 728	$283 405 604	$272 208 886	$10 348 168	$83 333 333	$365 890 387	$3 319 620 560
20	$3 319 620 560	$283 405 604	$271 290 755	$11 196 718	$83 333 333	$365 820 806	$3 308 423 841
21	$3 308 423 841	$283 405 604	$270 297 337	$12 114 849	$83 333 333	$365 745 520	$3 296 308 993
22	$3 296 308 993	$283 405 604	$269 222 460	$13 108 267	$83 333 333	$365 664 059	$3 283 200 726
23	$3 283 200 726	$283 405 604	$268 059 442	$14 183 144	$83 333 333	$365 575 919	$3 269 017 582
24	$3 269 017 582	$283 405 604	$266 801 056	$15 346 162	$83 333 333	$365 480 552	$3 253 671 419
25	$3 253 671 419	$283 405 604	$265 439 483	$16 604 548	$83 333 333	$365 377 364	$3 237 066 872
26	$3 237 066 872	$283 405 604	$263 966 262	$17 966 120	$83 333 333	$365 265 715	$3 219 100 751
27	$3 219 100 751	$283 405 604	$262 372 236	$19 439 342	$83 333 333	$365 144 911	$3 199 661 409
28	$3 199 661 409	$283 405 604	$260 647 499	$21 033 368	$83 333 333	$365 014 201	$3 178 628 041
29	$3 178 628 041	$283 405 604	$258 781 335	$22 758 105	$83 333 333	$364 872 773	$3 155 869 936
30	$3 155 869 936	$283 405 604	$256 762 145	$24 624 269	$83 333 333	$364 719 747	$3 131 245 667
31	$3 131 245 667	$283 405 604	$254 577 381	$26 643 459	$83 333 333	$364 554 174	$3 104 602 208
32	$3 104 602 208	$283 405 604	$252 213 467	$28 828 223	$83 333 333	$364 375 023	$3 075 773 985
33	$3 075 773 985	$283 405 604	$249 655 712	$31 192 137	$83 333 333	$364 181 182	$3 044 581 848
34	$3 044 581 848	$283 405 604	$246 888 220	$33 749 892	$83 333 333	$363 971 446	$3 010 831 955
35	$3 010 831 955	$283 405 604	$243 893 795	$36 517 384	$83 333 333	$363 744 512	$2 974 314 572
36	$2 974 314 572	$283 405 604	$240 653 827	$39 511 809	$83 333 333	$363 498 969	$2 934 802 763
37	$2 934 802 763	$283 405 604	$237 148 181	$42 751 777	$83 333 333	$363 233 292	$2 892 050 985
38	$2 892 050 985	$283 405 604	$233 355 072	$46 257 423	$83 333 333	$362 945 829	$2 845 793 562
39	$2 845 793 562	$283 405 604	$229 250 928	$50 050 532	$83 333 333	$362 634 794	$2 795 743 030
40	$2 795 743 030	$283 405 604	$224 810 245	$54 154 675	$83 333 333	$362 298 254	$2 741 588 355
41	$2 741 588 355	$283 405 604	$220 005 426	$58 595 359	$83 333 333	$361 934 118	$2 682 992 996
42	$2 682 992 996	$283 405 604	$214 806 611	$63 400 178	$83 333 333	$361 540 123	$2 619 592 818
43	$2 619 592 818	$283 405 604	$209 181 494	$68 598 993	$83 333 333	$361 113 820	$2 550 993 825
44	$2 550 993 825	$283 405 604	$203 095 117	$74 224 110	$83 333 333	$360 652 560	$2 476 769 715
45	$2 476 769 715	$283 405 604	$196 509 657	$80 310 487	$83 333 333	$360 153 477	$2 396 459 227
46	$2 396 459 227	$283 405 604	$189 384 189	$86 895 947	$83 333 333	$359 613 470	$2 309 563 280
47	$2 309 563 280	$283 405 604	$181 674 433	$94 021 415	$83 333 333	$359 029 181	$2 215 541 865
48	$2 215 541 865	$283 405 604	$173 332 477	$101 731 171	$83 333 333	$358 396 981	$2 113 810 694
49	$2 113 810 694	$283 405 604	$164 306 481	$110 073 127	$83 333 333	$357 712 941	$2 003 737 567
50	$2 003 737 567	$283 405 604	$154 540 352	$119 099 123	$83 333 333	$356 972 809	$1 884 638 444
51	$1 884 638 444	$283 405 604	$143 973 402	$128 865 252	$83 333 333	$356 171 987	$1 755 773 192
52	$1 755 773 192	$283 405 604	$132 539 961	$139 432 202	$83 333 333	$355 305 497	$1 616 340 990
53	$1 616 340 990	$283 405 604	$120 168 978	$150 865 643	$83 333 333	$354 367 955	$1 465 475 347
54	$1 465 475 347	$283 405 604	$106 783 575	$163 236 625	$83 333 333	$353 353 534	$1 302 238 722
55	$1 302 238 722	$283 405 604	$92 300 569	$176 622 029	$83 333 333	$352 255 931	$1 125 616 693
56	$1 125 616 693	$283 405 604	$76 629 956	$191 105 035	$83 333 333	$351 068 324	$934 511 658
57	$934 511 658	$283 405 604	$59 674 353	$206 775 648	$83 333 333	$349 783 334	$727 736 010
58	$727 736 010	$283 405 604	$41 328 390	$223 731 251	$83 333 333	$348 392 975	$504 004 759
59	$504 004 759	$283 405 604	$21 478 059	$242 077 214	$83 333 333	$346 888 606	$261 927 545
60	$261 927 545	$283 405 604	$0	$261 927 545	$83 333 333	$345 260 879	$0
			$13 298 021 244.58		**$4 999 999 999.98**	**$21 723 640 823.41**	

APPENDIX 25
AMORTIZATION: BARAKAH, UAE

Country	**UAE**
Plant	**Barakah**
Technology	**APR1400**
Vendor	**KEPCO**
Loan amount	$3 348 598 844
Annual interest rate	98%
Loan period in years	60
Monthly Payment	$277 033 586
O&M	$83 333 333
Total Interest	

No.	Beginning Balance	Payment	Interest	Principal	O&M	Total Payment	Ending Balance
1	$3 348 598 844	$277 033 586	$274 585 105	$2 448 481	$83 333 333	$360 366 920	$3 346 150 363
2	$3 346 150 363	$277 033 586	$274 167 091	$2 649 257	$83 333 333	$360 149 681	$3 343 501 106
3	$3 343 501 106	$277 033 586	$273 932 038	$2 866 496	$83 333 333	$360 131 867	$3 340 634 610
4	$3 340 634 610	$277 033 586	$273 677 711	$3 101 548	$83 333 333	$360 112 593	$3 337 533 062
5	$3 337 533 062	$277 033 586	$273 402 529	$3 355 875	$83 333 333	$360 091 738	$3 334 177 186
6	$3 334 177 186	$277 033 586	$273 104 783	$3 631 057	$83 333 333	$360 069 173	$3 330 546 129
7	$3 330 546 129	$277 033 586	$272 782 621	$3 928 804	$83 333 333	$360 044 758	$3 326 617 326
8	$3 326 617 326	$277 033 586	$272 434 042	$4 250 966	$83 333 333	$360 018 341	$3 322 366 360
9	$3 322 366 360	$277 033 586	$272 056 879	$4 599 545	$83 333 333	$359 989 757	$3 317 766 815
10	$3 317 766 815	$277 033 586	$271 648 789	$4 976 708	$83 333 333	$359 958 830	$3 312 790 107
11	$3 312 790 107	$277 033 586	$271 207 235	$5 384 798	$83 333 333	$359 925 366	$3 307 405 310
12	$3 307 405 310	$277 033 586	$270 729 475	$5 826 351	$83 333 333	$359 889 159	$3 301 578 959
13	$3 301 578 959	$277 033 586	$270 212 537	$6 304 112	$83 333 333	$359 849 983	$3 295 274 847
14	$3 295 274 847	$277 033 586	$269 653 211	$6 821 049	$83 333 333	$359 807 594	$3 288 453 798
15	$3 288 453 798	$277 033 586	$269 048 021	$7 380 375	$83 333 333	$359 761 729	$3 281 073 423
16	$3 281 073 423	$277 033 586	$268 393 204	$7 985 566	$83 333 333	$359 712 103	$3 273 087 857
17	$3 273 087 857	$277 033 586	$267 684 693	$8 640 382	$83 333 333	$359 658 408	$3 264 447 475
18	$3 264 447 475	$277 033 586	$266 918 084	$9 348 893	$83 333 333	$359 600 310	$3 255 098 581
19	$3 255 098 581	$277 033 586	$266 088 612	$10 115 503	$83 333 333	$359 537 449	$3 244 983 079
20	$3 244 983 079	$277 033 586	$265 191 125	$10 944 974	$83 333 333	$359 469 432	$3 234 038 105
21	$3 234 038 105	$277 033 586	$264 220 043	$11 842 462	$83 333 333	$359 395 838	$3 222 195 643
22	$3 222 195 643	$277 033 586	$263 169 332	$12 813 544	$83 333 333	$359 316 209	$3 209 382 099
23	$3 209 382 099	$277 033 586	$262 032 463	$13 864 254	$83 333 333	$359 230 051	$3 195 517 845
24	$3 195 517 845	$277 033 586	$260 802 371	$15 001 123	$83 333 333	$359 136 828	$3 180 516 722
25	$3 180 516 722	$277 033 586	$259 471 412	$16 231 215	$83 333 333	$359 035 960	$3 164 285 507
26	$3 164 285 507	$277 033 586	$258 031 313	$17 562 175	$83 333 333	$358 926 821	$3 146 723 332
27	$3 146 723 332	$277 033 586	$256 473 127	$19 002 273	$83 333 333	$358 808 733	$3 127 721 059
28	$3 127 721 059	$277 033 586	$254 787 169	$20 560 460	$83 333 333	$358 680 962	$3 107 160 599
29	$3 107 160 599	$277 033 586	$252 962 963	$22 246 417	$83 333 333	$358 542 714	$3 084 914 182
30	$3 084 914 182	$277 033 586	$250 989 172	$24 070 624	$83 333 333	$358 393 129	$3 060 843 558
31	$3 060 843 558	$277 033 586	$248 853 530	$26 044 415	$83 333 333	$358 231 278	$3 034 799 143
32	$3 034 799 143	$277 033 586	$246 542 765	$28 180 057	$83 333 333	$358 056 155	$3 006 619 087
33	$3 006 619 087	$277 033 586	$244 042 518	$30 490 821	$83 333 333	$357 866 672	$2 976 128 265
34	$2 976 128 265	$277 033 586	$241 337 250	$32 991 069	$83 333 333	$357 661 652	$2 943 137 197
35	$2 943 137 197	$277 033 586	$238 410 151	$35 696 336	$83 333 333	$357 439 820	$2 907 440 860
36	$2 907 440 860	$277 033 586	$235 243 029	$38 623 436	$83 333 333	$357 199 798	$2 868 817 425
37	$2 868 817 425	$277 033 586	$231 816 203	$41 790 558	$83 333 333	$356 940 094	$2 827 026 867
38	$2 827 026 867	$277 033 586	$228 108 378	$45 217 383	$83 333 333	$356 659 094	$2 781 809 484
39	$2 781 809 484	$277 033 586	$224 096 511	$48 925 209	$83 333 333	$356 355 053	$2 732 884 275
40	$2 732 884 275	$277 033 586	$219 755 670	$52 937 076	$83 333 333	$356 026 080	$2 679 947 199
41	$2 679 947 199	$277 033 586	$215 058 881	$57 277 916	$83 333 333	$355 670 131	$2 622 669 283
42	$2 622 669 283	$277 033 586	$209 976 955	$61 974 705	$83 333 333	$355 284 994	$2 560 694 578
43	$2 560 694 578	$277 033 586	$204 478 312	$67 056 631	$83 333 333	$354 868 276	$2 493 637 947
44	$2 493 637 947	$277 033 586	$198 528 779	$72 555 275	$83 333 333	$354 417 387	$2 421 082 672
45	$2 421 082 672	$277 033 586	$192 091 385	$78 504 807	$83 333 333	$353 929 526	$2 342 577 865
46	$2 342 577 865	$277 033 586	$185 126 124	$84 942 202	$83 333 333	$353 401 659	$2 257 635 663
47	$2 257 635 663	$277 033 586	$177 589 712	$91 907 462	$83 333 333	$352 830 508	$2 165 728 201
48	$2 165 728 201	$277 033 586	$169 435 315	$99 443 874	$83 333 333	$352 212 522	$2 066 284 327
49	$2 066 284 327	$277 033 586	$160 612 257	$107 598 272	$83 333 333	$351 543 861	$1 958 686 056
50	$1 958 686 056	$277 033 586	$151 065 708	$116 421 330	$83 333 333	$350 820 371	$1 842 264 726
51	$1 842 264 726	$277 033 586	$140 736 341	$125 967 879	$83 333 333	$350 037 554	$1 716 296 847
52	$1 716 296 847	$277 033 586	$129 559 967	$136 297 245	$83 333 333	$349 190 546	$1 579 999 602
53	$1 579 999 602	$277 033 586	$117 467 131	$147 473 619	$83 333 333	$348 274 083	$1 432 525 983
54	$1 432 525 983	$277 033 586	$104 382 681	$159 566 456	$83 333 333	$347 282 470	$1 272 959 527
55	$1 272 959 527	$277 033 586	$90 225 307	$172 650 905	$83 333 333	$346 209 546	$1 100 308 622
56	$1 100 308 622	$277 033 586	$74 907 028	$186 808 279	$83 333 333	$345 048 641	$913 500 342
57	$913 500 342	$277 033 586	$58 332 650	$202 126 558	$83 333 333	$343 792 542	$711 373 784
58	$711 373 784	$277 033 586	$40 399 174	$218 700 936	$83 333 333	$342 433 443	$492 672 848
59	$492 672 848	$277 033 586	$20 995 152	$236 634 413	$83 333 333	$340 962 898	$256 038 435
60	$256 038 435	$277 033 586	$0	$256 038 435	$83 333 333	$339 371 768	$0
			$12 999 032 011.62		**$4 999 999 999.98**	**$21 347 630 855.45**	

APPENDIX 26
AMORTIZATION: HAIYANG, CHINA

Country	**China**	
Plant	**Haiyang**	
Technology	**AP-1000**	
Vendor	**Westinghouse**	
	Loan amount	$5 412 864 663
	Annual interest rate	98%
	Loan period in years	60
	Monthly Payment	$447 812 766
	O&M	$83 333 333
	Total Interest	

No.	Beginning Balance	Payment	Interest	Principal	O&M	Total Payment	Ending Balance
1	$5 412 864 663	$447 812 766	$443 854 902	$3 957 864	$83 333 333	$531 146 099	$5 408 906 799
2	$5 408 906 799	$447 812 766	$443 179 200	$4 282 408	$83 333 333	$530 794 942	$5 404 624 391
3	$5 404 624 391	$447 812 766	$442 799 248	$4 633 566	$83 333 333	$530 766 147	$5 399 990 825
4	$5 399 990 825	$447 812 766	$442 388 139	$5 013 518	$83 333 333	$530 734 991	$5 394 977 307
5	$5 394 977 307	$447 812 766	$441 943 320	$5 424 627	$83 333 333	$530 701 280	$5 389 552 680
6	$5 389 552 680	$447 812 766	$441 462 025	$5 869 446	$83 333 333	$530 664 805	$5 383 683 234
7	$5 383 683 234	$447 812 766	$440 941 264	$6 350 741	$83 333 333	$530 625 339	$5 377 332 493
8	$5 377 332 493	$447 812 766	$440 377 801	$6 871 502	$83 333 333	$530 582 636	$5 370 460 991
9	$5 370 460 991	$447 812 766	$439 768 134	$7 434 965	$83 333 333	$530 536 432	$5 363 026 027
10	$5 363 026 027	$447 812 766	$439 108 474	$8 044 632	$83 333 333	$530 486 440	$5 354 981 395
11	$5 354 981 395	$447 812 766	$438 394 722	$8 704 292	$83 333 333	$530 432 347	$5 346 277 103
12	$5 346 277 103	$447 812 766	$437 622 443	$9 418 044	$83 333 333	$530 373 820	$5 336 859 060
13	$5 336 859 060	$447 812 766	$436 786 836	$10 190 323	$83 333 333	$530 310 493	$5 326 668 737
14	$5 326 668 737	$447 812 766	$435 882 710	$11 025 930	$83 333 333	$530 241 973	$5 315 642 807
15	$5 315 642 807	$447 812 766	$434 904 446	$11 930 056	$83 333 333	$530 167 835	$5 303 712 751
16	$5 303 712 751	$447 812 766	$433 845 963	$12 908 320	$83 333 333	$530 087 617	$5 290 804 431
17	$5 290 804 431	$447 812 766	$432 700 686	$13 966 803	$83 333 333	$530 000 821	$5 276 837 628
18	$5 276 837 628	$447 812 766	$431 461 495	$15 112 080	$83 333 333	$529 906 909	$5 261 725 548
19	$5 261 725 548	$447 812 766	$430 120 691	$16 351 271	$83 333 333	$529 805 295	$5 245 374 277
20	$5 245 374 277	$447 812 766	$428 669 941	$17 692 075	$83 333 333	$529 695 349	$5 227 682 202
21	$5 227 682 202	$447 812 766	$427 100 229	$19 142 825	$83 333 333	$529 576 388	$5 208 539 376
22	$5 208 539 376	$447 812 766	$425 401 801	$20 712 537	$83 333 333	$529 447 671	$5 187 826 839
23	$5 187 826 839	$447 812 766	$423 564 102	$22 410 965	$83 333 333	$529 308 400	$5 165 415 874
24	$5 165 415 874	$447 812 766	$421 575 711	$24 248 664	$83 333 333	$529 157 709	$5 141 167 210
25	$5 141 167 210	$447 812 766	$419 424 273	$26 237 055	$83 333 333	$528 994 661	$5 114 930 155
26	$5 114 930 155	$447 812 766	$417 096 416	$28 388 493	$83 333 333	$528 818 243	$5 086 541 661
27	$5 086 541 661	$447 812 766	$414 577 676	$30 716 350	$83 333 333	$528 627 359	$5 055 825 312
28	$5 055 825 312	$447 812 766	$411 852 398	$33 235 090	$83 333 333	$528 420 822	$5 022 590 221
29	$5 022 590 221	$447 812 766	$408 903 648	$35 960 368	$83 333 333	$528 197 349	$4 986 629 853
30	$4 986 629 853	$447 812 766	$405 713 100	$38 909 118	$83 333 333	$527 955 552	$4 947 720 735
31	$4 947 720 735	$447 812 766	$402 260 928	$42 099 666	$83 333 333	$527 693 927	$4 905 621 070
32	$4 905 621 070	$447 812 766	$398 525 677	$45 551 838	$83 333 333	$527 410 849	$4 860 069 232
33	$4 860 069 232	$447 812 766	$394 484 136	$49 287 089	$83 333 333	$527 104 558	$4 810 782 143
34	$4 810 782 143	$447 812 766	$390 111 188	$53 328 630	$83 333 333	$526 773 152	$4 757 453 512
35	$4 757 453 512	$447 812 766	$385 379 659	$57 701 578	$83 333 333	$526 414 570	$4 699 751 934
36	$4 699 751 934	$447 812 766	$380 260 144	$62 433 107	$83 333 333	$526 026 585	$4 637 318 827
37	$4 637 318 827	$447 812 766	$374 720 829	$67 552 622	$83 333 333	$525 606 784	$4 569 766 205
38	$4 569 766 205	$447 812 766	$368 727 290	$73 091 937	$83 333 333	$525 152 560	$4 496 674 268
39	$4 496 674 268	$447 812 766	$362 242 281	$79 085 476	$83 333 333	$524 661 090	$4 417 588 792
40	$4 417 588 792	$447 812 766	$355 225 501	$85 570 485	$83 333 333	$524 129 320	$4 332 018 307
41	$4 332 018 307	$447 812 766	$347 633 345	$92 587 265	$83 333 333	$523 553 944	$4 239 431 042
42	$4 239 431 042	$447 812 766	$339 418 633	$100 179 421	$83 333 333	$522 931 387	$4 139 251 621
43	$4 139 251 621	$447 812 766	$330 530 314	$108 394 133	$83 333 333	$522 257 780	$4 030 857 488
44	$4 030 857 488	$447 812 766	$320 913 153	$117 282 452	$83 333 333	$521 528 938	$3 913 575 036
45	$3 913 575 036	$447 812 766	$310 507 385	$126 899 613	$83 333 333	$520 740 331	$3 786 675 423
46	$3 786 675 423	$447 812 766	$299 248 343	$137 305 381	$83 333 333	$519 887 058	$3 649 370 042
47	$3 649 370 042	$447 812 766	$287 066 061	$148 564 423	$83 333 333	$518 963 817	$3 500 805 619
48	$3 500 805 619	$447 812 766	$273 884 831	$160 746 705	$83 333 333	$517 964 869	$3 340 058 914
49	$3 340 058 914	$447 812 766	$259 622 740	$173 927 935	$83 333 333	$516 884 009	$3 166 130 979
50	$3 166 130 979	$447 812 766	$244 191 158	$188 190 026	$83 333 333	$515 714 517	$2 977 940 953
51	$2 977 940 953	$447 812 766	$227 494 186	$203 621 608	$83 333 333	$514 449 127	$2 774 319 346
52	$2 774 319 346	$447 812 766	$209 428 063	$220 318 580	$83 333 333	$513 079 976	$2 554 000 766
53	$2 554 000 766	$447 812 766	$189 880 517	$238 384 703	$83 333 333	$511 598 554	$2 315 616 063
54	$2 315 616 063	$447 812 766	$168 730 073	$257 932 249	$83 333 333	$509 995 655	$2 057 683 814
55	$2 057 683 814	$447 812 766	$145 845 292	$279 082 693	$83 333 333	$508 261 318	$1 778 601 121
56	$1 778 601 121	$447 812 766	$121 083 959	$301 967 474	$83 333 333	$506 384 766	$1 476 633 647
57	$1 476 633 647	$447 812 766	$94 292 197	$326 728 807	$83 333 333	$504 354 337	$1 149 904 840
58	$1 149 904 840	$447 812 766	$65 303 510	$353 520 569	$83 333 333	$502 157 413	$796 384 271
59	$796 384 271	$447 812 766	$33 937 751	$382 509 256	$83 333 333	$499 780 340	$413 875 015
60	$413 875 015	$447 812 766	$0	$413 875 015	$83 333 333	$497 208 348	$0
			$21 012 370 938.00		**$4 999 999 999.98**	**$31 425 235 601.02**	

APPENDIX 27
AMORTIZATION: SANMEN, CHINA

Country	**China**	
Plant	**Sanmen**	
Technology	**AP-1000**	
Vendor	**Westinghouse**	
	Loan amount	$4 438 716 240
	Annual interest rate	98%
	Loan period in years	60
	Monthly Payment	$367 220 302
	O&M	$83 333 333
	Total Interest	

No.	Beginning Balance	Payment	Interest	Principal	O&M	Total Payment	Ending Balance
1	$4 438 716 240	$367 220 302	$363 974 732	$3 245 570	$83 333 333	$450 553 635	$4 435 470 670
2	$4 435 470 670	$367 220 302	$363 420 635	$3 511 707	$83 333 333	$450 265 675	$4 431 958 963
3	$4 431 958 963	$367 220 302	$363 109 062	$3 799 667	$83 333 333	$450 242 063	$4 428 159 295
4	$4 428 159 295	$367 220 302	$362 771 941	$4 111 240	$83 333 333	$450 216 514	$4 424 048 056
5	$4 424 048 056	$367 220 302	$362 407 175	$4 448 362	$83 333 333	$450 188 870	$4 419 599 694
6	$4 419 599 694	$367 220 302	$362 012 498	$4 813 127	$83 333 333	$450 158 959	$4 414 786 567
7	$4 414 786 567	$367 220 302	$361 585 459	$5 207 804	$83 333 333	$450 126 596	$4 409 578 763
8	$4 409 578 763	$367 220 302	$361 123 401	$5 634 844	$83 333 333	$450 091 578	$4 403 943 920
9	$4 403 943 920	$367 220 302	$360 623 456	$6 096 901	$83 333 333	$450 053 690	$4 397 847 019
10	$4 397 847 019	$367 220 302	$360 082 514	$6 596 847	$83 333 333	$450 012 694	$4 391 250 172
11	$4 391 250 172	$367 220 302	$359 497 216	$7 137 788	$83 333 333	$449 968 337	$4 384 112 384
12	$4 384 112 384	$367 220 302	$358 863 922	$7 723 087	$83 333 333	$449 920 342	$4 376 389 298
13	$4 376 389 298	$367 220 302	$358 178 699	$8 356 380	$83 333 333	$449 868 412	$4 368 032 918
14	$4 368 032 918	$367 220 302	$357 437 288	$9 041 603	$83 333 333	$449 812 224	$4 358 991 315
15	$4 358 991 315	$367 220 302	$356 635 081	$9 783 014	$83 333 333	$449 751 428	$4 349 208 301
16	$4 349 208 301	$367 220 302	$355 767 092	$10 585 221	$83 333 333	$449 685 647	$4 338 623 079
17	$4 338 623 079	$367 220 302	$354 827 929	$11 453 210	$83 333 333	$449 614 472	$4 327 169 870
18	$4 327 169 870	$367 220 302	$353 811 755	$12 392 373	$83 333 333	$449 537 461	$4 314 777 497
19	$4 314 777 497	$367 220 302	$352 712 254	$13 408 547	$83 333 333	$449 454 135	$4 301 368 949
20	$4 301 368 949	$367 220 302	$351 522 594	$14 508 048	$83 333 333	$449 363 976	$4 286 860 901
21	$4 286 860 901	$367 220 302	$350 235 382	$15 697 708	$83 333 333	$449 266 423	$4 271 163 193
22	$4 271 163 193	$367 220 302	$348 842 618	$16 984 920	$83 333 333	$449 160 872	$4 254 178 273
23	$4 254 178 273	$367 220 302	$347 335 648	$18 377 684	$83 333 333	$449 046 665	$4 235 800 589
24	$4 235 800 589	$367 220 302	$345 705 107	$19 884 654	$83 333 333	$448 923 094	$4 215 915 935
25	$4 215 915 935	$367 220 302	$343 940 861	$21 515 195	$83 333 333	$448 789 389	$4 194 400 740
26	$4 194 400 740	$367 220 302	$342 031 946	$23 279 441	$83 333 333	$448 644 721	$4 171 121 298
27	$4 171 121 298	$367 220 302	$339 966 501	$25 188 356	$83 333 333	$448 488 190	$4 145 932 942
28	$4 145 932 942	$367 220 302	$337 731 690	$27 253 801	$83 333 333	$448 318 824	$4 118 679 142
29	$4 118 679 142	$367 220 302	$335 313 623	$29 488 613	$83 333 333	$448 135 569	$4 089 190 529
30	$4 089 190 529	$367 220 302	$332 697 276	$31 906 679	$83 333 333	$447 937 288	$4 057 283 850
31	$4 057 283 850	$367 220 302	$329 866 388	$34 523 026	$83 333 333	$447 722 747	$4 022 760 824
32	$4 022 760 824	$367 220 302	$326 803 367	$37 353 915	$83 333 333	$447 490 614	$3 985 406 909
33	$3 985 406 909	$367 220 302	$323 489 178	$40 416 936	$83 333 333	$447 239 447	$3 944 989 974
34	$3 944 989 974	$367 220 302	$319 903 226	$43 731 124	$83 333 333	$446 967 683	$3 901 258 849
35	$3 901 258 849	$367 220 302	$316 023 225	$47 317 076	$83 333 333	$446 673 635	$3 853 941 773
36	$3 853 941 773	$367 220 302	$311 825 065	$51 197 077	$83 333 333	$446 355 475	$3 802 744 696
37	$3 802 744 696	$367 220 302	$307 282 656	$55 395 237	$83 333 333	$446 011 226	$3 747 349 459
38	$3 747 349 459	$367 220 302	$302 367 769	$59 937 646	$83 333 333	$445 638 748	$3 687 411 813
39	$3 687 411 813	$367 220 302	$297 049 861	$64 852 533	$83 333 333	$445 235 728	$3 622 559 279
40	$3 622 559 279	$367 220 302	$291 295 885	$70 170 441	$83 333 333	$444 799 659	$3 552 388 838
41	$3 552 388 838	$367 220 302	$285 070 082	$75 924 417	$83 333 333	$444 327 833	$3 476 464 421
42	$3 476 464 421	$367 220 302	$278 333 764	$82 150 220	$83 333 333	$443 817 317	$3 394 314 201
43	$3 394 314 201	$367 220 302	$271 045 068	$88 886 538	$83 333 333	$443 264 939	$3 305 427 663
44	$3 305 427 663	$367 220 302	$263 158 699	$96 175 234	$83 333 333	$442 667 266	$3 209 252 429
45	$3 209 252 429	$367 220 302	$254 625 648	$104 061 603	$83 333 333	$442 020 584	$3 105 190 827
46	$3 105 190 827	$367 220 302	$245 392 886	$112 594 654	$83 333 333	$441 320 874	$2 992 596 172
47	$2 992 596 172	$367 220 302	$235 403 038	$121 827 416	$83 333 333	$440 563 787	$2 870 768 756
48	$2 870 768 756	$367 220 302	$224 594 022	$131 817 264	$83 333 333	$439 744 620	$2 738 951 492
49	$2 738 951 492	$367 220 302	$212 898 667	$142 626 280	$83 333 333	$438 858 281	$2 596 325 212
50	$2 596 325 212	$367 220 302	$200 244 293	$154 321 635	$83 333 333	$437 899 261	$2 442 003 578
51	$2 442 003 578	$367 220 302	$186 552 261	$166 976 009	$83 333 333	$436 861 603	$2 275 027 569
52	$2 275 027 569	$367 220 302	$171 737 481	$180 668 041	$83 333 333	$435 738 856	$2 094 359 527
53	$2 094 359 527	$367 220 302	$155 707 890	$195 482 821	$83 333 333	$434 524 044	$1 898 876 706
54	$1 898 876 706	$367 220 302	$138 363 872	$211 512 412	$83 333 333	$433 209 618	$1 687 364 294
55	$1 687 364 294	$367 220 302	$119 597 645	$228 856 430	$83 333 333	$431 787 408	$1 458 507 864
56	$1 458 507 864	$367 220 302	$99 292 587	$247 622 657	$83 333 333	$430 248 578	$1 210 885 207
57	$1 210 885 207	$367 220 302	$77 322 514	$267 927 715	$83 333 333	$428 583 563	$942 957 492
58	$942 957 492	$367 220 302	$53 550 896	$289 897 788	$83 333 333	$426 782 017	$653 059 704
59	$653 059 704	$367 220 302	$27 830 004	$313 669 406	$83 333 333	$424 832 744	$339 390 298
60	$339 390 298	$367 220 302	$0	$339 390 298	$83 333 333	$422 723 631	$0
			$17 230 793 292.41		**$4 999 999 999.98**	**$26 669 509 532.65**	

APPENDIX 28
AMORTIZATION: VOGTLE (GEORGIA), USA

Country	**USA**	
Plant	**Vogtle (Georgia)**	
Technology	**AP-1000**	
Vendor	**Westinghouse**	
	Loan amount	$4 472 287 778
	Annual interest rate	98%
	Loan period in years	60
	Monthly Payment	$369 997 716
	O&M	$83 333 333
	Total Interest	

No.	Beginning Balance	Payment	Interest	Principal	O&M	Total Payment	Ending Balance
1	$4 472 287 778	$369 997 716	$366 727 598	$3 270 118	$83 333 333	$453 331 049	$4 469 017 660
2	$4 469 017 660	$369 997 716	$366 169 310	$3 538 267	$83 333 333	$453 040 911	$4 465 479 393
3	$4 465 479 393	$369 997 716	$365 855 381	$3 828 405	$83 333 333	$453 017 120	$4 461 650 988
4	$4 461 650 988	$369 997 716	$365 515 710	$4 142 335	$83 333 333	$452 991 377	$4 457 508 653
5	$4 457 508 653	$369 997 716	$365 148 185	$4 482 006	$83 333 333	$452 963 524	$4 453 026 647
6	$4 453 026 647	$369 997 716	$364 750 524	$4 849 531	$83 333 333	$452 933 387	$4 448 177 116
7	$4 448 177 116	$369 997 716	$364 320 254	$5 247 192	$83 333 333	$452 900 779	$4 442 929 924
8	$4 442 929 924	$369 997 716	$363 854 702	$5 677 462	$83 333 333	$452 865 497	$4 437 252 462
9	$4 437 252 462	$369 997 716	$363 350 975	$6 143 014	$83 333 333	$452 827 322	$4 431 109 449
10	$4 431 109 449	$369 997 716	$362 805 942	$6 646 741	$83 333 333	$452 786 016	$4 424 462 708
11	$4 424 462 708	$369 997 716	$362 216 217	$7 191 774	$83 333 333	$452 741 324	$4 417 270 934
12	$4 417 270 934	$369 997 716	$361 578 134	$7 781 499	$83 333 333	$452 692 966	$4 409 489 435
13	$4 409 489 435	$369 997 716	$360 887 728	$8 419 582	$83 333 333	$452 640 643	$4 401 069 853
14	$4 401 069 853	$369 997 716	$360 140 709	$9 109 988	$83 333 333	$452 584 030	$4 391 959 866
15	$4 391 959 866	$369 997 716	$359 332 434	$9 857 007	$83 333 333	$452 522 774	$4 382 102 859
16	$4 382 102 859	$369 997 716	$358 457 881	$10 665 281	$83 333 333	$452 456 496	$4 371 437 578
17	$4 371 437 578	$369 997 716	$357 511 615	$11 539 834	$83 333 333	$452 384 783	$4 359 897 744
18	$4 359 897 744	$369 997 716	$356 487 755	$12 486 101	$83 333 333	$452 307 189	$4 347 411 643
19	$4 347 411 643	$369 997 716	$355 379 938	$13 509 961	$83 333 333	$452 223 232	$4 333 901 683
20	$4 333 901 683	$369 997 716	$354 181 280	$14 617 778	$83 333 333	$452 132 391	$4 319 283 905
21	$4 319 283 905	$369 997 716	$352 884 332	$15 816 435	$83 333 333	$452 034 101	$4 303 467 469
22	$4 303 467 469	$369 997 716	$351 481 035	$17 113 383	$83 333 333	$451 927 752	$4 286 354 086
23	$4 286 354 086	$369 997 716	$349 962 667	$18 516 681	$83 333 333	$451 812 681	$4 267 837 406
24	$4 267 837 406	$369 997 716	$348 319 793	$20 035 048	$83 333 333	$451 688 175	$4 247 802 358
25	$4 247 802 358	$369 997 716	$346 542 204	$21 677 922	$83 333 333	$451 553 459	$4 226 124 435
26	$4 226 124 435	$369 997 716	$344 618 852	$23 455 512	$83 333 333	$451 407 697	$4 202 668 923
27	$4 202 668 923	$369 997 716	$342 537 785	$25 378 864	$83 333 333	$451 249 982	$4 177 290 059
28	$4 177 290 059	$369 997 716	$340 286 071	$27 459 931	$83 333 333	$451 079 335	$4 149 830 129
29	$4 149 830 129	$369 997 716	$337 849 716	$29 711 645	$83 333 333	$450 894 694	$4 120 118 484
30	$4 120 118 484	$369 997 716	$335 213 580	$32 148 000	$83 333 333	$450 694 913	$4 087 970 484
31	$4 087 970 484	$369 997 716	$332 361 281	$34 784 136	$83 333 333	$450 478 750	$4 053 186 348
32	$4 053 186 348	$369 997 716	$329 275 093	$37 636 435	$83 333 333	$450 244 861	$4 015 549 913
33	$4 015 549 913	$369 997 716	$325 935 838	$40 722 623	$83 333 333	$449 991 794	$3 974 827 290
34	$3 974 827 290	$369 997 716	$322 322 764	$44 061 878	$83 333 333	$449 717 975	$3 930 765 412
35	$3 930 765 412	$369 997 716	$318 413 418	$47 674 952	$83 333 333	$449 421 703	$3 883 090 460
36	$3 883 090 460	$369 997 716	$314 183 505	$51 584 298	$83 333 333	$449 101 137	$3 831 506 163
37	$3 831 506 163	$369 997 716	$309 606 740	$55 814 210	$83 333 333	$448 754 284	$3 775 691 952
38	$3 775 691 952	$369 997 716	$304 654 680	$60 390 976	$83 333 333	$448 378 989	$3 715 300 977
39	$3 715 300 977	$369 997 716	$299 296 551	$65 343 036	$83 333 333	$447 972 920	$3 649 957 941
40	$3 649 957 941	$369 997 716	$293 499 056	$70 701 164	$83 333 333	$447 533 553	$3 579 256 777
41	$3 579 256 777	$369 997 716	$287 226 166	$76 498 660	$83 333 333	$447 058 159	$3 502 758 117
42	$3 502 758 117	$369 997 716	$280 438 898	$82 771 550	$83 333 333	$446 543 782	$3 419 986 567
43	$3 419 986 567	$369 997 716	$273 095 075	$89 558 817	$83 333 333	$445 987 226	$3 330 427 750
44	$3 330 427 750	$369 997 716	$265 149 059	$96 902 640	$83 333 333	$445 385 032	$3 233 525 110
45	$3 233 525 110	$369 997 716	$256 551 469	$104 848 657	$83 333 333	$444 733 459	$3 128 676 453
46	$3 128 676 453	$369 997 716	$247 248 877	$113 446 246	$83 333 333	$444 028 457	$3 015 230 207
47	$3 015 230 207	$369 997 716	$237 183 472	$122 748 839	$83 333 333	$443 265 644	$2 892 481 368
48	$2 892 481 368	$369 997 716	$226 292 704	$132 814 243	$83 333 333	$442 440 281	$2 759 667 124
49	$2 759 667 124	$369 997 716	$214 508 893	$143 705 011	$83 333 333	$441 547 238	$2 615 962 113
50	$2 615 962 113	$369 997 716	$201 758 810	$155 488 822	$83 333 333	$440 580 966	$2 460 473 291
51	$2 460 473 291	$369 997 716	$187 963 220	$168 238 906	$83 333 333	$439 535 459	$2 292 234 385
52	$2 292 234 385	$369 997 716	$173 036 391	$182 034 496	$83 333 333	$438 404 220	$2 110 199 889
53	$2 110 199 889	$369 997 716	$156 885 562	$196 961 325	$83 333 333	$437 180 220	$1 913 238 564
54	$1 913 238 564	$369 997 716	$139 410 366	$213 112 153	$83 333 333	$435 855 852	$1 700 126 411
55	$1 700 126 411	$369 997 716	$120 502 203	$230 587 350	$83 333 333	$434 422 886	$1 469 539 061
56	$1 469 539 061	$369 997 716	$100 043 571	$249 495 513	$83 333 333	$432 872 417	$1 220 043 548
57	$1 220 043 548	$369 997 716	$77 907 331	$269 954 145	$83 333 333	$431 194 809	$950 089 404
58	$950 089 404	$369 997 716	$53 955 920	$292 090 384	$83 333 333	$429 379 637	$657 999 019
59	$657 999 019	$369 997 716	$28 040 492	$316 041 796	$83 333 333	$427 415 622	$341 957 223
60	$341 957 223	$369 997 716	$0	$341 957 223	$83 333 333	$425 290 557	$0
			$17 361 115 709.69		**$4 999 999 999.98**	**$26 833 403 487.82**	

APPENDIX 29
AMORTIZATION: VC SUMMERS (SOUTH CAROLINA), USA

Country	**USA**	
Plant	**V.C Summers (South Carolina)**	
Technology	**AP-1000**	
Vendor	**Westinghouse**	
	Loan amount	$3 577 796 218
	Annual interest rate	98%
	Loan period in years	60
	Monthly Payment	$295 995 359
	O&M	$83 333 333
	Total Interest	

No.	Beginning Balance	Payment	Interest	Principal	O&M	Total Payment	Ending Balance
1	$3 577 796 218	$295 995 359	$293 379 290	$2 616 069	$83 333 333	$379 328 693	$3 575 180 149
2	$3 575 180 149	$295 995 359	$292 932 664	$2 830 587	$83 333 333	$379 096 584	$3 572 349 561
3	$3 572 349 561	$295 995 359	$292 681 523	$3 062 695	$83 333 333	$379 077 552	$3 569 286 866
4	$3 569 286 866	$295 995 359	$292 409 788	$3 313 836	$83 333 333	$379 056 958	$3 565 973 030
5	$3 565 973 030	$295 995 359	$292 115 772	$3 585 571	$83 333 333	$379 034 676	$3 562 387 459
6	$3 562 387 459	$295 995 359	$291 797 645	$3 879 588	$83 333 333	$379 010 566	$3 558 507 872
7	$3 558 507 872	$295 995 359	$291 453 433	$4 197 714	$83 333 333	$378 984 480	$3 554 310 158
8	$3 554 310 158	$295 995 359	$291 080 995	$4 541 926	$83 333 333	$378 956 255	$3 549 768 232
9	$3 549 768 232	$295 995 359	$290 678 017	$4 914 364	$83 333 333	$378 925 715	$3 544 853 867
10	$3 544 853 867	$295 995 359	$290 241 995	$5 317 342	$83 333 333	$378 892 671	$3 539 536 525
11	$3 539 536 525	$295 995 359	$289 770 219	$5 753 364	$83 333 333	$378 856 917	$3 533 783 161
12	$3 533 783 161	$295 995 359	$289 259 758	$6 225 140	$83 333 333	$378 818 231	$3 527 558 021
13	$3 527 558 021	$295 995 359	$288 707 438	$6 735 602	$83 333 333	$378 776 373	$3 520 822 420
14	$3 520 822 420	$295 995 359	$288 109 829	$7 287 921	$83 333 333	$378 731 083	$3 513 534 499
15	$3 513 534 499	$295 995 359	$287 463 215	$7 885 530	$83 333 333	$378 682 079	$3 505 648 969
16	$3 505 648 969	$295 995 359	$286 763 580	$8 532 144	$83 333 333	$378 629 057	$3 497 116 825
17	$3 497 116 825	$295 995 359	$286 006 574	$9 231 780	$83 333 333	$378 571 687	$3 487 885 045
18	$3 487 885 045	$295 995 359	$285 187 493	$9 988 786	$83 333 333	$378 509 612	$3 477 896 260
19	$3 477 896 260	$295 995 359	$284 301 248	$10 807 866	$83 333 333	$378 442 448	$3 467 088 394
20	$3 467 088 394	$295 995 359	$283 342 331	$11 694 111	$83 333 333	$378 369 775	$3 455 394 283
21	$3 455 394 283	$295 995 359	$282 304 783	$12 653 028	$83 333 333	$378 291 144	$3 442 741 255
22	$3 442 741 255	$295 995 359	$281 182 156	$13 690 576	$83 333 333	$378 206 065	$3 429 050 678
23	$3 429 050 678	$295 995 359	$279 967 473	$14 813 204	$83 333 333	$378 114 010	$3 414 237 475
24	$3 414 237 475	$295 995 359	$278 653 186	$16 027 886	$83 333 333	$378 014 406	$3 398 209 588
25	$3 398 209 588	$295 995 359	$277 231 128	$17 342 173	$83 333 333	$377 906 634	$3 380 867 415
26	$3 380 867 415	$295 995 359	$275 692 461	$18 764 231	$83 333 333	$377 790 026	$3 362 103 184
27	$3 362 103 184	$295 995 359	$274 027 623	$20 302 898	$83 333 333	$377 663 855	$3 341 800 286
28	$3 341 800 286	$295 995 359	$272 226 269	$21 967 736	$83 333 333	$377 527 338	$3 319 832 550
29	$3 319 832 550	$295 995 359	$270 277 204	$23 769 090	$83 333 333	$377 379 627	$3 296 063 460
30	$3 296 063 460	$295 995 359	$268 168 315	$25 718 156	$83 333 333	$377 219 804	$3 270 345 304
31	$3 270 345 304	$295 995 359	$265 886 497	$27 827 044	$83 333 333	$377 046 875	$3 242 518 260
32	$3 242 518 260	$295 995 359	$263 417 571	$30 108 862	$83 333 333	$376 859 766	$3 212 409 398
33	$3 212 409 398	$295 995 359	$260 746 192	$32 577 789	$83 333 333	$376 657 314	$3 179 831 610
34	$3 179 831 610	$295 995 359	$257 855 760	$35 249 167	$83 333 333	$376 438 261	$3 144 582 443
35	$3 144 582 443	$295 995 359	$254 728 313	$38 139 599	$83 333 333	$376 201 245	$3 106 442 844
36	$3 106 442 844	$295 995 359	$251 344 415	$41 267 046	$83 333 333	$375 944 795	$3 065 175 798
37	$3 065 175 798	$295 995 359	$247 683 038	$44 650 944	$83 333 333	$375 667 315	$3 020 524 854
38	$3 020 524 854	$295 995 359	$243 721 428	$48 312 321	$83 333 333	$375 367 082	$2 972 212 532
39	$2 972 212 532	$295 995 359	$239 434 965	$52 273 932	$83 333 333	$375 042 230	$2 919 938 601
40	$2 919 938 601	$295 995 359	$234 797 013	$56 560 394	$83 333 333	$374 690 740	$2 863 378 207
41	$2 863 378 207	$295 995 359	$229 778 749	$61 198 346	$83 333 333	$374 310 428	$2 802 179 861
42	$2 802 179 861	$295 995 359	$224 348 986	$66 216 611	$83 333 333	$373 898 930	$2 735 963 250
43	$2 735 963 250	$295 995 359	$218 473 984	$71 646 373	$83 333 333	$373 453 690	$2 664 316 877
44	$2 664 316 877	$295 995 359	$212 117 231	$77 521 375	$83 333 333	$372 971 940	$2 586 795 502
45	$2 586 795 502	$295 995 359	$205 239 225	$83 878 128	$83 333 333	$372 450 686	$2 502 917 374
46	$2 502 917 374	$295 995 359	$197 797 222	$90 756 135	$83 333 333	$371 886 690	$2 412 161 239
47	$2 412 161 239	$295 995 359	$189 744 974	$98 198 138	$83 333 333	$371 276 445	$2 313 963 102
48	$2 313 963 102	$295 995 359	$181 032 443	$106 250 385	$83 333 333	$370 616 161	$2 207 712 717
49	$2 207 712 717	$295 995 359	$171 605 484	$114 962 916	$83 333 333	$369 901 733	$2 092 749 800
50	$2 092 749 800	$295 995 359	$161 405 514	$124 389 876	$83 333 333	$369 128 723	$1 968 359 925
51	$1 968 359 925	$295 995 359	$150 369 146	$134 589 845	$83 333 333	$368 292 325	$1 833 770 079
52	$1 833 770 079	$295 995 359	$138 427 797	$145 626 213	$83 333 333	$367 387 343	$1 688 143 866
53	$1 688 143 866	$295 995 359	$125 507 257	$157 567 562	$83 333 333	$366 408 152	$1 530 576 304
54	$1 530 576 304	$295 995 359	$111 527 233	$170 488 102	$83 333 333	$365 348 668	$1 360 088 202
55	$1 360 088 202	$295 995 359	$96 400 846	$184 468 127	$83 333 333	$364 202 306	$1 175 620 075
56	$1 175 620 075	$295 995 359	$80 034 096	$199 594 513	$83 333 333	$362 961 942	$976 025 562
57	$976 025 562	$295 995 359	$62 325 273	$215 961 263	$83 333 333	$361 619 869	$760 064 299
58	$760 064 299	$295 995 359	$43 164 325	$233 670 087	$83 333 333	$360 167 745	$526 394 212
59	$526 394 212	$295 995 359	$22 432 181	$252 831 034	$83 333 333	$358 596 548	$273 563 179
60	$273 563 179	$295 995 359	$0	$273 563 179	$83 333 333	$356 896 512	$0
			$13 888 760 564.13		**$4 999 999 999.98**	**$22 466 556 782.01**	