ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED NUCLEAR POWER STATION ('NUCLEAR-1') AND ASSOCIATED INFRASTRUCTURE

Economic Impact Assessment

September 2013

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On behalf of: Eskom Holdings Ltd

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* Macroeconomic Analysis * Regional & sectoral analysis
* Cost-Benefit Analysis

12 August 2010

DECLARATION OF INDEPENDENCE

I, ***David Mullins*** as duly authorised representative of ***Conningarth Economists***, hereby confirm my independence (as well as that of ***Conningarth Economists*** as a specialist and declare that neither I nor ***Conningarth Economists*** have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which GIBB was appointed as environmental assessment practitioner in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), other than fair remuneration for worked performed, specifically in connection with the Environmental Impact Assessment for the proposed conventional nuclear power station ('Nuclear 1'). I further declare that I am confident in the results of the studies undertaken and conclusions drawn as a result of it – as is described in my attached report.

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13 August 2010

DECLARATION OF INDEPENDENCE

I, **William John Mullins** as duly authorised representative of ***Conningarth Economists***, hereby confirm my independence (as well as that of ***Conningarth Economists*** as a specialist and declare that neither I nor ***Conningarth Economists*** have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of which GIBB was appointed as environmental assessment practitioner in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), other than fair remuneration for worked performed, specifically in connection with the Environmental Impact Assessment for the proposed conventional nuclear power station ('Nuclear 1'). I further declare that I am confident in the results of the studies undertaken and conclusions drawn as a result of it – as is described in my attached report.

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EXECUTIVE SUMMARY

Eskom proposes to construct a nuclear power station with a power generation capacity of up to 4,000 MW on each of three sites, namely Thyspunt in the Eastern Cape, Bantamsklip in the Western Cape and Duynefontein in the Western Cape. The objective of the study is to analyse the economic cost-effectiveness of the three sites from a broader community prospective. This includes the capital and operational costs of the service provider as well as the costs to the community, taking into account the positive and negative externalities on the economy and the environment. The study also considers the broader macroeconomic impact of the three sites on their relevant provincial economies.

The study approach consisted of a combination of desk research, field interviews and the application of data collected to macroeconomic modelling.

The Duynefontein site is located in a far more developed and sophisticated area than are the other two sites (Bantamsklip and Thyspunt). The Cape Town metropolitan economy would find it far easier to absorb and service a nuclear power station and its staff than would be the case at Thyspunt or Bantamsklip.

Perceptions regarding a ***nuclear power station*** are frequently based on a lack of scientific information about perceived impacts. Our field interviews revealed that the public's level of concern is lower in the area around Duynefontein because of their experience with Koeberg; ***by contrast, there is significant opposition to a nuclear power station at the other two sites.*** In general, the business sectors around all three sites see opportunities arising from the establishment of a ***nuclear power station,*** quite apart from the importance of stabilising the electricity supply.

The two most sensitive industries in terms of their perceptions about the impacts of Nuclear-1 on their activities are fishing and tourism. However, the analysis shows that any negative impacts are likely to be slight and that in fact there would be overall positive impacts on tourism.

The macroeconomic impact analysis gives mixed results for the construction and operational phases at the three sites. Macroeconomic indicators favour the Western Cape sites but household and social indicators favour Thyspunt. The cost-effectiveness analysis indicates that Thyspunt has a very slight edge over Duynefontein and a somewhat larger edge over Bantamsklip. ***The difference between Thyspunt and Bantamsklip is R6.388 billion, and expressed as a percentage the difference is 5.93% in favour of Thyspunt. Between Thyspunt and Duynefontein the difference is R570 million, or 0.53% in favour of Thyspunt.*** Thus, the order of preference (from most to least preferred) is Thyspunt, Duynefontein and Bantamsklip. However, the differences are slight, and all the sites would have large positive economic impacts both on the local area and the province in which they are situated.

Mitigation measures proposed relate to operation and maintenance (particularly the skills issues), public perceptions and concerns, and compensation.

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ABBREVIATIONS

CBA	Cost-benefit analysis
CEA	Cost-effectiveness analysis
DBSA	Development Bank of Southern Africa
DEA	Department of Environmental Affairs (previously Department of Environmental Affairs and Tourism)
DME	Department of Minerals and Energy
DRC	Directorate of Radiation Control
EIA	Environmental Impact Assessment
EIR	Environmental Impact Report
EMP	Environmental Management Plan
EPZ	Emergency planning zone
EU	European Union
GDP	Gross domestic product

GGP	Gross geographic product
IAEA	International Atomic Energy Agency
IDP	Integrated Development Plan
ILW	Intermediate-level waste
LLW	Low-level waste
NNR	National Nuclear Regulator
NPS	Nuclear power station
PAZ	Protective action zone
SAM	Social accounting matrix
SASMIA	South African Squid Management Industrial Association
SMME	Small, medium and micro enterprises
UPZ	Urgent protective zone

1 INTRODUCTION

1.1 Project Background

GIBB (Pty) Ltd (GIBB) has been appointed by Eskom Holdings Limited (Eskom) to undertake an Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) for the proposed construction of nuclear power stations and associated infrastructure on three sites that are located in the Eastern and Western Cape Provinces. The Scoping Phase of this EIA process resulted in the two sites in the Northern Cape being recommended for exclusion from further investigation.

This report forms part of the Environmental Impact Report (EIR). The EIR details the Impact Assessment Phase of the EIA process, which is aimed at investigating the potential impacts of the proposed NPS on the receiving environment.

In many countries, including South Africa, economic growth and social needs are resulting in substantially greater energy demands, in spite of continued and accelerated energy efficiency advancements. As a result, electricity demand is growing faster than overall energy supply.

At present, only a few energy sources capable of providing a sustained power supply are available in sufficient quantities suitable for base-load power stations. Identified renewable forms of energy, for example, solar, cannot supply base-load power stations. In this context, nuclear power generation is likely to be able to provide an alternative mitigation strategy for greenhouse gas reductions, while providing the energy required.

1.2 Project Description

Eskom proposes to construct Nuclear-1 with a power generation capacity of 4,000 MW on each of three sites, namely Thyspunt in the Eastern Cape, Bantamsklip in the Western Cape and Duynefontein in the Western Cape. It is estimated that the entire development for a nuclear power station at each site will require in the order of ***250 to 280*** hectares (ha), including all auxiliary infrastructure. In the event that the proposed project is authorised, it is estimated that the construction of the NPS could commence in 2011 with commissioning of the first unit in 2018.

In 1976 South Africa began the construction of its first nuclear power station at Koeberg, approximately 30 km north of Cape Town near Melkbosstrand on the west coast. Unit 1 was synchronised to the grid in 1984 and Unit 2 in 1985. Koeberg is the only nuclear power station in South Africa.

It was anticipated that the plant would serve as the only base-load power station in the Western Cape. The high costs associated with the transportation of fossil fuels from other areas of the country to this point rendered coal-fired power stations in the Western Cape economically unfeasible. When Koeberg was commissioned, the Western Cape's demand was less than that of Koeberg's capacity, and thus the excess power generated by Koeberg was transmitted to other parts of South Africa.

Today, however, the Western Cape's demand exceeds Koeberg's capacity, and approximately 3,000 MW is imported into the Cape region to accommodate the demand.

The Impact Assessment Phase of the EIA process involves specialist investigations of the identified potential impacts associated with the proposed project and identified feasible alternatives. The specialist studies undertaken during the detailed assessment phase of the EIA process provide an in-depth understanding of the key issues and the potential positive and negative impacts of the proposed development on the social, biophysical and economic environments. Specialists were required to assess and rate potential impacts in terms of a rigorous assessment methodology, in order to ensure that potential environmental impacts have been adequately investigated and that any relevant shortcomings and/or gaps can be addressed. This includes consideration of uncertainty and potential cumulative effects. Specialists also considered and recommended appropriate mitigation measures in the light of their likely effectiveness and practicability.

1.3 Scope of this Study

This study will describe the economy within a 20 km radius of each of the three proposed sites, highlighting the major sectors. No specific radius was stipulated in the Terms of Reference (TOR), but 20 km was laid down in the TOR for the Agricultural Impact report. Since that study provides certain important information for the Economic Impact study, a comparable radius has been adopted. A largely qualitative analysis in Section 2 sets the scene for the quantitative analysis in Section 3.

The primary objective of this study was to measure the nature and magnitude of the economic and socio-economic impacts of the nuclear power station at each of the three sites. The economic impacts associated with this entity consist of a construction and a production (operational) phase. For the purposes of this assessment, both phases will be assessed. Direct, indirect and induced impacts of the construction and operational phases will be assessed.

These impacts focus on all direct and indirect linkages associated with the proposed nuclear power station. However, for purposes of this assessment, certain forward linkages (upstream industries) emanating from the need to utilise the outputs from the nuclear power station will also be measured.

In order to measure all the economic impacts associated with the construction and operational phases of this project, a partial general macroeconomic equilibrium analysis will be performed, based on three Social Accounting Matrices (SAM), namely:

- *The national SAM for the South African economy developed for 2004 by Conningarth Economists*
- *The regional SAM for the Eastern Cape for 2004 developed during 2006 by Conningarth Economists*
- *The regional SAM for the Western Cape for 2004 developed during 2006 by the Department of Agriculture in the Western Cape*

The partial general macroeconomic equilibrium analysis is used to determine the nature and magnitude of the macroeconomic impacts that emanate from the project in terms of its impacts on larger macroeconomic aggregates such as Gross Domestic Product (GDP), employment creation, investment, household income and expenditure. This macroeconomic analysis will be based on SAMs that have been transformed into a macro-econometric model. The focus of the assessment will be on the contribution and associated costs of the proposed investment on the economy of the relevant area (Eastern Cape or Western Cape) and the rest of South Africa.

The study is based on a combination of desk research, field interviews and the application of data collected to macroeconomic modelling. A short preparatory field visit to the three sites was undertaken in November 2007, followed by more intensive field visits in July-August 2008. In total 47 man-days were spent in the field with 15 spent at both Thyspunt and Bantamsklip, and 17 in Cape Town. The members of the study team were also able to visit the three sites.

Sources of information were central and provincial government publications, reports commissioned by the relevant local authorities, and data supplied by companies, institutions and individuals interviewed, sector organisations and Eskom. Existing macroeconomic models were a major resource. ***One of the authors of this report also worked on the Tourism Impact Assessment, and this report draws on information contained in the report of the Tourism, Agricultural, Marine Ecology, Visual Impact, Noise and Transportation Impact Assessment specialists. Participant confidentiality is a cornerstone of academic, scientific and market research, and information gathered in field interviews is therefore not attributed to respondents unless deemed to be necessary for purposes of allaying concerns about the coverage of fieldwork.***

1.4 Assumptions

The main assumptions of this study relate to the following:

1. The impacts shown in the Tourism and Agriculture Specialist Reports are accepted.
2. Roads and bridges between ports and the nuclear power station sites are able to carry the abnormal loads in respect of imported equipment.
3. All abnormal loads over 350 tons will be routed through Saldanha Bay, not Cape Town port, for Duynefontein and Bantamsklip.
4. ***All abnormal loads over 350 tons will be routed through Coega, not Port Elizabeth port, for Thyspunt.***
5. ***All the appropriate roads from Humansdorp to Thyspunt will be tarred.***

1.5 Limitations

Published economic data on the areas in a 20 km radius of the Nuclear-1 sites were not always available at a sufficiently disaggregated level. However, the authors believe that the information collected during fieldwork interviews was comprehensive enough to enable a sound analysis to be carried out.

Another limitation is that ***detailed*** information is ***not*** yet available on the capacity of the roads and bridges to carry the abnormal loads which will be involved in the transportation of imported equipment for the nuclear power station, ***as Level 1 assessments have been concluded thus far***. Some of these loads might weigh up to 750 tons. Although Eskom has given the assurance that road infrastructure will be upgraded wherever required, the costs could be very high and are not considered in this analysis. Should the road and bridge infrastructure be unable to handle this traffic, the alternative would be to barge the equipment to the site. This would involve the construction of a temporary pier at each site in order to stabilise the barge during offloading. The costs of such an alternative have not been considered in this analysis. Barging is technically feasible with many examples in other parts of the world. It is most likely to be a strong alternative for Thyspunt and Bantamsklip; it is more likely that abnormal loads could be carried on the road from Saldanha Bay to Duynefontein than on the Saldanha Bay-Bantamsklip and Port Elizabeth (or Coega)-Thyspunt roads.

Since the purpose of the report was to compare the three sites, it did not deal with the impact of a nuclear power station on local services. The costs of providing local services would be part of the costs associated with the normal incremental growth of a town. The majority of municipalities in South Africa are in financial distress. However, not all services are supplied by municipalities: policing falls under the central government, and medical clinics and education under the provincial government. Municipalities are responsible for providing electricity and water, but these costs are covered by user charges (the monthly municipal bills to householders and firms). New houses would have to pay municipal rates, which would result in an enhanced revenue stream to the municipality.

This report was essentially completed at the end of 2008, but there have been subsequent minor revisions from time to time as the public participation process has unfolded. However, the text and the model are based on statistical and cost data available at the time of fieldwork, i.e. the third quarter of 2008. Many of the data available relate to periods up to 2007, and subsequent data or economic trends such as inflation, cyclical changes in output and so on are not reflected.

2 DESCRIPTION OF AFFECTED ENVIRONMENT

Much of this section is based on field interviews by Imani Development with municipal officials, firms and individual operators, and the sources are not attributed for reasons of confidentiality, except where specifically mentioned. Some of the material was also used in the Tourism Impact (Imani 2010) and Agricultural Impact (Golder/Imani 2010) reports.

2.1 Thyspunt

2.1.1 Overview of the Economy

The Thyspunt site is located within the Kouga Local Municipality, which forms part of the Cacadu District Municipality in the Eastern Cape. A 20 km radius encompasses parts of Wards 1-6. According to the 2008-12 Integrated Development Plan (IDP), there is a population of approximately 28,000 in this area. Not included in this is Jeffreys Bay, which is reputed to be the fastest growing town in South Africa.

Provincially, the Eastern Cape recorded a growth rate of 5.2 % in 2006. This was marginally below the country's growth rate of 5.4 % for the year. The provincial GDP of R92 551 million in 2006 was the fourth largest in the country. The Eastern Cape has an estimated population of between 6.34-6.60 million. The province's main economic activities are finance and business services, general government services and manufacturing. Tourism is a very important sector, but is split between several of Statistics South Africa's broad industrial classifications. The Kouga economy is fairly diversified.

2.1.2 Agriculture

The area under the jurisdiction of the Agri Tsitsikamma East Agricultural Society covers parts of the Kouga and Tsitsikamma districts. It covers an area beyond the 20 km radius from the Thyspunt site. The main activity is dairying: the area around Humansdorp is the largest milk producer in South Africa. There are approximately 60 000 dairy cows producing a total of 820 000 litres per day valued at R900 million per annum. There are also approximately 5 000 head of beef cattle, and total beef production (from beef cattle and slaughtered calves) amounts to R37 million per annum. Dohne merino sheep produce wool valued at R1.2 million per annum and mutton at R5.5 million per annum. The area also produces 450 tons of wheat per annum. Using the 24-month average price of wheat, this translates into approximately R1 million per annum

2.1.3 Tourism

The tourism market around the Thyspunt site includes Oyster Bay and the St. Francis Bay area (comprising the village of St. Francis, Port St. Francis and Cape St. Francis). The tourism asset is predominately centred in St. Francis village which contains the main beaches and a well-known canal area. St. Francis in fact was founded as a tourism destination. It has a strong eco-tourism brand with an emphasis on water sports, golf and hiking. According to the Tourism Impact report (Imani 2010), the tourist season is extremely short, being concentrated in a ten-day period in December-January and over the Easter week-end. Officials of the local municipality stated that the normal population of 4,000 rises to 30,000 over Christmas and New

Year, and around 8,000 over Easter. There is no hotel, and accommodation is based on bed-and-breakfast establishments (B&Bs), guesthouses and house lets. The turnover of accommodation establishments was estimated at R77.7 million per annum.

Although Jeffreys Bay is beyond the 20 km radius of Thyspunt, there are strong negative perceptions in sections of the population there about the impact of a nuclear power station. This was ascertained both during field interviews and through the comments in the interested and affected parties' response trail. Thus, Jeffreys Bay is dealt with briefly, ***despite the fact that, according to the Marine Ecology and Visual Impact Assessment reports, a nuclear power station at Thyspunt would have no impact on the sea in the bay, while the town would lie outside the area of visual impact.*** Tourism dominates the economy of ***Jeffreys Bay***, and is heavily based on surfing. The normal population of 40,000 swells to 100,000 over Christmas and New Year and to 50,000 during the Billabong Pro International surfing competition over ten days in July. This is one of eleven world championship events, and is the most important surfing event in the country[1]. According to the Tourism Impact report (Imani 2010), the ***annual*** turnover of accommodaion establishments in Jeffreys Bay amounts to R633 million per annum.

In normal years property prices have reflected the premium market that is the St. Francis brand, but in 2008 prices were hit by the national economic downturn. A number of new premium housing estate developments have found it difficult to sell units, and one planned development has been abandoned. Prices over the last few years have ranged from R3 to R7 million for canal houses, up to R7 million for beachfront houses, and R1 to R3 million for non-waterfront houses in the village of St. Francis (Imani 2010).

2.1.4 Fishing

Information in this section is drawn from an interview with the largest commercial fishing company in Port St Francis, interviews with researchers at Marine and Coastal Management (MCM) in Cape Town, and a report of the South African Squid Management Industrial Association (SASMIA 2007).

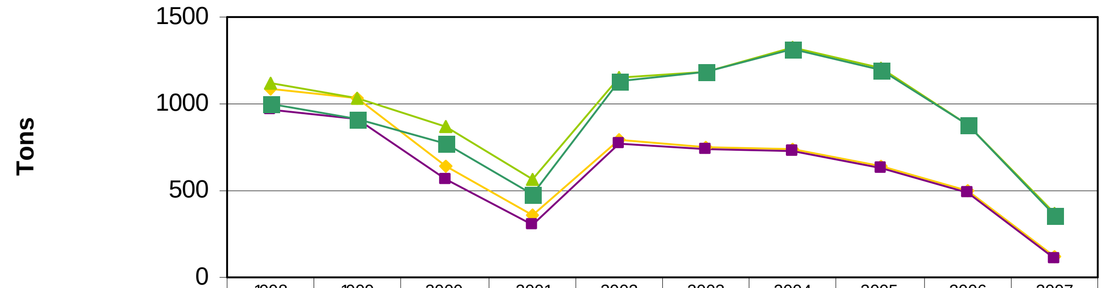
Fishing activities around St Francis Bay are part of an industry that exploits the area between Port Alfred and Plettenberg Bay, using the harbours at Port Elizabeth and Port St. Francis. The fleet consists of 136 vessels of which 36 are based at Port St. Francis and the balance at Port Elizabeth. The capital cost of a fully equipped vessel is between R2.5-6.0 million[2] with an average cost of R3 million for boats ***based*** in Port St. Francis.

Data for commercial fishing in the area between Seal Point and Slang River, of which Thyspunt is the midpoint, are shown in Figure 2.1.

[1] Jeffreys Bay is widely recognised as South Africa's premier surfing spot with the world's longest right-hand wave break.

[2] ***Quoted during interview with fishing company in Port St. Francis on 1 August 2008. Based on a subsequent written response from SASMIA in 2010, this cost has apparently increased to R6.0-8.0 million in 2010)***

Figure 2.1: Commercial Fishing, Seal Point-Slang River, 1998-2007 (Kg)



Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total - 0-2 km	1086	1032	640	363	791	745	737	641	496	120
Squid - 0-2 km	968	912	570	310	776	741	731	635	492	113
Total - 0-5 km	1118	1036	869	566	1149	1189	1322	1202	882	365
Squid - 0-5 km	996	915	775	479	1130	1182	1316	1194	875	357

Source: Marine and Coastal Management, 2008.

According to the fishing company, the industry did not have sufficient information on the effects of a nuclear power station on marine life, but is concerned about possible impacts on pelagic (hake) and inshore (squid) catches. It does not believe there would be any effect on demersal (deep-sea) fishing. ***One of its*** concerns relates to the demarcation of an exclusion zone at Thyspunt of an assumed similar size to that at Koeberg which is 3.2 km wide and extends 2 km into the ocean from the shore. Eskom has advised the authors, however, that the exclusion zone at Thyspunt and Bantamsklip will not exceed ***the length of the site and will not extend more than*** 1 km out to sea. The closure of such an area off Thyspunt would have no more than a slight impact on pelagic fishing. Longline catches of hake have averaged 2,500 tons per annum in the Eastern Cape and 800 tons per annum for Port St Francis-based vessels at an average price of €5.50/kg ***(R67.95 at the average exchange rate for the second quarter of 2008, i.e., immediately preceding the date of the interview).*** During field interviews with the local fishing industry, it was found that two of the richest fishing grounds are in Thysbaai and Oyster Bay, and catching occurs between 500 metres and 4-5 km offshore.

The more significant impact would be on the chokka squid industry but even then it would be slight. The concentration of squid shifts according to month and weather conditions, and the chokka squid catch fluctuates from year to year depending on sea temperature and wind conditions. Over the last 20 years the annual catch has ranged between 2,000 and 14,000 tons in the Eastern Cape with an average of 7,000 tons. ***Figure 2.1 illustrates the variability of squid catches in the Thyspunt area. Between 1998-2007 the yearly range for catches between 0-5km offshore was from 479-1,316 tons with a mean of 914 tons. However, most squid are caught 0-2km offshore, the mean between 1998-2007 being 587 tons per annum.*** Squid is the most viable fishing industry in the area, almost the entire catch being exported to the EU at an average price of about €7/kg ***(R86.48). Thus, the average annual value of squid caught between 0-2km offshore in the Thyspunt area would be €4.1 million. (R50.65 million)***

According to the information supplied by the South African Squid Management Industrial Association (SASMIA) (2007), between 1999-2005 an average of 33.2% of the total annual Eastern Cape catch originated in the area between 10 nautical miles (18.52 km) east and west of the proposed Thyspunt site. Thus, an exclusion zone of 1 km width would account for roughly 1.8% of the total ***average catch of 7,000 tons per annum.*** This would amount to about 127 tons per annum with an export value of €0.88 million ***(R10.87 million)*** per annum. Three points need to be made here. First, the Marine Ecology Impact Assessment report, ***in dealing with the impact of the release of warmed cooling water on squid spawning grounds, states that adult squid would avoid an area of 0.5km^2, i.e., 0.225 x 0.225 km, at Thyspunt. Thus, the result would be that the export value affected would be less than €0.88 million (R10.87 million) per annum. Secondly, the squid that avoid the 0.5km^2 area are not expected to avoid the rest of the bay area in general, so in fact the loss could be even lower. Thirdly, the loss would not be borne solely by Port St. Francis-based boats since Port Elizabeth-based boats also fish off Thyspunt. As the Marine Ecology Impact Assessment report states, the exclusion zone is not anticipated to significantly affect the chokka squid industry due to its small size relative to the area over which fishing boats operate.***

The fears of the local fishing industry ***about lost catches of squid appear to be groundless, given the conclusions of the Marine Ecology Impact Assessment report.*** Nevertheless, the fears expressed by the industry are described for the ***record in the rest of this sub-section.***

Port St. Francis has a small harbour that cannot accommodate the larger vessels, which catch an average of 250 tons each per annum. Entry is restricted to smaller vessels catching an average of 50 tons each per annum. Port Elizabeth, by contrast, can accommodate larger vessels. If the Thyspunt fishing grounds were to be closed off as part of the exclusion zone, the vessels based in Port St. Francis would have to venture further afield and therefore the companies would have to acquire larger vessels, which would not be able to enter Port St Francis. Thus, these companies would have to relocate their operations. However, vessels based in Port Elizabeth also fish off Thyspunt, and therefore any restrictions on access would also affect these vessels and not only those based in Port St. Francis.

Data from SASMIA show that in 2005 the Eastern Cape squid industry employed 2,300 fishing crew, 150 management staff and 1,500 factory staff. The industry generated approximately R400 million in foreign exchange per annum. Fishing activities have significant linkages in terms of local employment and procurement of provisions, ***and the effects of a potential decline in catches*** for labour and supplies would be serious. The industry at Port St. Francis consists largely of small medium and micro enterprises, which depend entirely on squid fishing and would not be able to divert their vessels so as to capture trawl and other (demersal or pelagic) revenue streams.

The largest company at Port St. Francis also operates a fish processing factory in Humansdorp. ***There are two other fish processing plants in Humansdorp and one at Port St. Francis.*** The capital cost of a fully equipped factory (including cold storage) is between R8-10 million. The Humansdorp factory salts, grades, packs and freezes fish. Hake is trucked to Johannesburg and air freighted to EU markets (mainly Spain and Portugal) while squid is exported by sea, mainly to Europe. The factory employs mainly women, the number varying between 20-140 at any one time depending on the work load.

The Port St. Francis boats are manned by local (St. Francis-Humansdorp-Jeffreys Bay) fishermen while Port Elizabeth's fishing companies also draw some of their crew from the St. Francis area. Altogether, an estimated 1,000 fishermen are from the local area. The number of men per boat ranges from 12-24 depending on the size of the vessels. All groceries for the Port St. Francis vessels are purchased locally as are fuel, engineering services, fishing tackle and some transport services. The impact of the fishing industry on the local economy ***is felt during*** the closed season when employment falls, turnover of supplier's declines, spending power in the village falls and the incidence of housebreaking rises.

Apart from the size of the exclusion zone, the other ***major*** concern of the industry regarding a nuclear power station at Thyspunt relates to perceptions in the foreign market with regard to fish caught in the vicinity of a nuclear facility. South African squid are regarded as the second best in the world behind Morocco. The industry stressed that perceptions rule in the marketplace. Chokka squid is a high-value commodity and is very sensitive to market perceptions. The industry points out that the lobby ***(driven by the growing consumer movement and improved consumer knowledge as a result of environmental education and awareness)*** in foreign markets for environmentally friendly and contaminant-free fish products is growing, and this lobby could exploit the close proximity of the Thyspunt fishing grounds to a nuclear site (especially with regard to the release of coolant water into the ocean). The international market is very competitive, and it would be easy for competitors to exploit the contamination issue no matter how remote the possibility of such an event might be. If this were to happen and the market were to be lost, the local fishing industry as well as the fish factories in Humansdorp would be affected and probably would be forced to close.

It should be noted that negative perceptions have not affected the market for agricultural and livestock produce emanating from the area around the Koeberg Nuclear Power Station or around similar facilities in France. The main market for squid is the EU, and it must be questioned whether consumers in a country such as France, for example, would react differently to squid as opposed to fresh produce in terms of their proximity to a nuclear power station. Mitigation measures are dealt with in Section 5.2.

As with the exclusion zone, this fear of negative market perceptions appears to be mitigable. The production and distribution of scientific evidence should be sufficient to dispel such perceptions.

2.1.5 Retail and Trading

The trading sector in Humansdorp consists largely of food and clothing retail stores but there is no shopping centre. A major retailer estimates the total annual turnover at R168 million.

In the St. Francis area (including Cape St. Francis and Oyster Bay), the total turnover is estimated ***from various interviews*** at R70 million per annum. Turnover shows large seasonal variations in line with the seasonal variation in population size. The sector is dominated by food stores but there are some clothing and boutique outlets. A new shopping centre opened in July 2008.

The largest retail sector in ***the general area, although outside a*** 20-km radius of the Thyspunt site, is at Jeffreys Bay. This sector is growing, and two shopping malls opened in late 2008, expanding total retail space by 400-500%. A major retail chain estimates the total turnover of the sector at R250 million per annum. The largest single enterprise in the town is the leisure apparel manufacturer and trader, Billabong, which employs 400 persons in its operations consisting of a factory print shop (finishing and embroidering imported surfing and leisure apparel) as well as wholesale and retail outlets. This enterprise estimates the total turnover in the Jeffreys Bay economy at a minimum of R500 million per annum.

2.1.6 Civil Installations

Table 2.1 contains information on the various civil structures that are located in the area of the Thyspunt site. This information was collected from the Kouga Municipality's most recent Spatial Development Framework and IDP. It is possible that this does not fully account for all the civil structures but it was the only information that the municipality was able to provide.

Table 2-1: Civil Structures within 30 km of the Thyspunt Site

	Ward 1	Ward 2	Ward 3	Ward 4	Ward 5	Ward 6	Total
Library	1	0	0	0	2	1	4
Parks	1	3	6	2	2	2	16
Sports facilities	1	2	1	2	1	2	9
Recreational facilities	2	3	0	0	1	3	9
Cemeteries	0	1	2	1	1	4	9
Primary schools	5	3	0	-	5	-	13
Secondary schools	0	0	0	-	3	-	3
Police stations	-	1	0	-	1	-	2
Hospitals/clinics	1	2	0	-	4	-	7
Community centres	2	5	-	-	4	-	11
Day-care centres	1	-	-	-	-	-	1

2.2 Bantamsklip

2.2.1 Overview of the Economy

The Bantamsklip site is located within the Overstrand Local Municipality, which forms part of the Overberg District Municipality in the Western Cape. Provincially, the Western Cape recorded a growth rate of 5.9 % in 2006. This was above the country's growth rate of 5.4 % for the year. The provincial GDP of R174,303 million was the third largest in the country. The Western Cape has an estimated population of between 5.18-5.30 million. The province's main economic activities are finance and business services, manufacturing, and wholesale and retail trade. Tourism is a very important sector, but is split between several of Statistics South Africa's broad industrial classifications.

The Overstrand economy is fairly diversified. The growth rate of the economy is fairly high at 5.9 % in the 2007/08 year. There has been a constant gradual decline in the growth rate from the 2004/05 high of 8.1 %, but the Overstrand Municipality has consistently exceeded the district's growth rate over this period. The population of approximately 73 000 makes Overstrand the second largest of the municipalities within the Overberg District Municipality (30.7% of the District population). The unemployment rate was 21.7 % in 2001, the latest year for which the Municipality was able to provide data. There has been a significant in-migration of low-skilled work-seekers from the Eastern Cape. It is likely that the lower unemployment levels in the

Western Cape, and the consequent higher possibility of finding a job, is what has caused the immigration of workers.

According to Statistics South Africa (2007), key sectors contributing to the Overstrand GGP are trade and catering, finance and business services, manufacturing, construction, government services and transport sectors. The trade and catering and transport sectors have been the fastest growing, followed by business services and construction. Government services and manufacturing have shown declining growth rates. The sectors employing the largest number of people are trade and catering, community services, agriculture, government and construction. The largest job losses have been in the agricultural and manufacturing sectors.

There are two dominant features of the local economy that warrant attention. First, the municipality has a fairly diversified economy and a great potential for tourism. The natural assets of the area (in terms of eco-tourism) are its single biggest asset, but the natural resource base may also limit growth if resources are not effectively managed. The Overstrand economy and its ecology are inseparable. Secondly, the highly geographically concentrated poverty of the area is a cause for concern. Economic forces (e.g. the decline in fishing and the seasonality of tourism and agriculture) negatively affect the semi-skilled and unskilled workforce, while the growth sectors have mainly benefited skilled workers. In-migration of poor and unskilled people to the area is associated with rising rates of poverty and inequality. Other than the formal safety nets of grants, the poor depend on informal work (construction) or on the third economy of illegal livelihoods (e.g. abalone poaching). A significant proportion of the population live below the household subsistence level of R1,600 per month.

2.2.2 Agriculture

Traditionally, agriculture has been dominated by cattle farming and indigenous flower harvesting (both wild field harvesting and cultivated fields), but lately the area has developed into the Agulhas wine region. According to field interviews, cattle farming is struggling in the area and it is generally assumed that most land presently used for cattle farming will, in the coming two decades, be used for wine farming, eco-tourism and conservation. In a semi-circle of about 30 km around the proposed site, several wine estates have been established and more are in the pipeline. The area is deemed to be very good for wine with respect to soil types and cool sea breezes, and is seen as a refuge from the traditional wine areas in the Western Cape if temperatures keep rising in those areas. Also raised during the field interviews was the general ***aspiration*** that the Agulhas wine region will become of major importance to the wine industry of the Western Cape.

2.2.3 Tourism

The Bantamsklip site is surrounded by the Greater Gansbaai tourism region, which stretches from Die Kelders past Pearly Beach to Die Dam. The area is a sea-based attraction centre with a clear focus on eco-tourism. The general tourism product is relatively underdeveloped with respect to basic services and facilities, and is overwhelmingly dominated by the whale-watching and shark-cage diving industries.
The area from Gansbaai to Cape Agulhas has become a major tourism drawcard for the Western Cape in the last few years. Gansbaai is famous for being both the best land-based whale-watching spot and the prime location for cage diving to see the Great White Shark. Most boat operators launch from Kleinbaai on the Danger Point Peninsula and cruise for whales and sharks in the waters off Pearly Beach (including Dyer Island and Geyser Rock).

These marine assets draw the majority of visitors and are largely responsible for driving the local tourism economy and associated industry. Accommodation is provided by the B&B/guesthouses sector and house lets. According to the Tourism Impact report (Imani 2010), the total turnover of accommodation establishments amounts to R62.2 million per annum, while the revenue from shark-cage diving and whale-watching tourism amounts to R56.4 million per annum. ***According to the Marine Ecology Impact Assessment report, no potential negative impact on the Great White Sharks or Southern Right Whales are expected at Bantamsklip.*** The Tourism Impact report found that operators of whale-watching tours could be affected by a 1km exclusion zone but not by more than about 10%,alternatively, the affected activities would be transferred to the rest of the area covered by the operators.

There is a strong drive for conservation in the region. The coastal area roughly from Hermanus to Cape Agulhas is gradually being converted into a conservation area. SANParks is buying out a number of farms and other plots of land in this area, and there is a plan to incorporate both the public sector (SANParks) and several private farms by removing the barriers and allowing the newly reintroduced animals to move freely and create a large consolidated conservation area. This will adjoin, but will be far larger than, the land Eskom will conserve. There are long-term plans to build a fence along the perimeter and around towns such as Gansbaai that fall within the reserve. Because there is a move towards flower and wine fields, and much of the output is exported to Europe, there is a general belief/understanding that, by helping the environment/biosphere, the creation of a large reserve will help enterprises to fetch higher prices and set themselves apart from other rivals. There is also a move towards ecotourism involving the establishment of nature reserves and fynbos estates, amongst which are: the 5-star Klein Paradys Country House near Pearly Beach, the 5-star Grootbos Private Nature Reserve near Gansbaai, and the 4-star Farm 215 Fynbos Reserve between Gansbaai and Elim. The Agulhas National Park is an important future development for tourism. ***There is no accommodation in the park and thus accommodation establishments in the surrounding area are important.***

In order to stimulate tourism development in the area, the Western Cape government decided to tar the road between Gansbaai and Bredasdorp, connecting the Whale Coast to Cape Agulhas. The first phase of this project (Bredasdorp to Elim) was completed in 2008 and the second phase (Elim to Gansbaai) is scheduled to be completed sometime between 2008 and 2010.

There is a strong speculative element in the property markets, based on the potential of the area to become increasingly attractive for holiday homes for people from Cape Town. However, the government’s new policy of restricting building development on the coastal edge could limit the growth of the Gansbaai area. Property prices have remained robust and have survived the 2008 national dip better than the Cape Town housing market has.

2.2.4 Fishing

Gansbaai is an important centre of the pelagic fishing industry. A factory (Gansbaai Marine) was established in 1962 and, until 1994 when tourism started growing and the area started attracting retirees, the local economy consisted of little else except the company. Gansbaai Marine is the only pelagic factory located between Mossel Bay and Hout Bay. The factory produces canned fish for major brands, as well as fishmeal and fish oil, which are supplied to the agricultural sector. There are 12 local boats that use the harbour. The capital cost of a fully equipped boat is between R10-

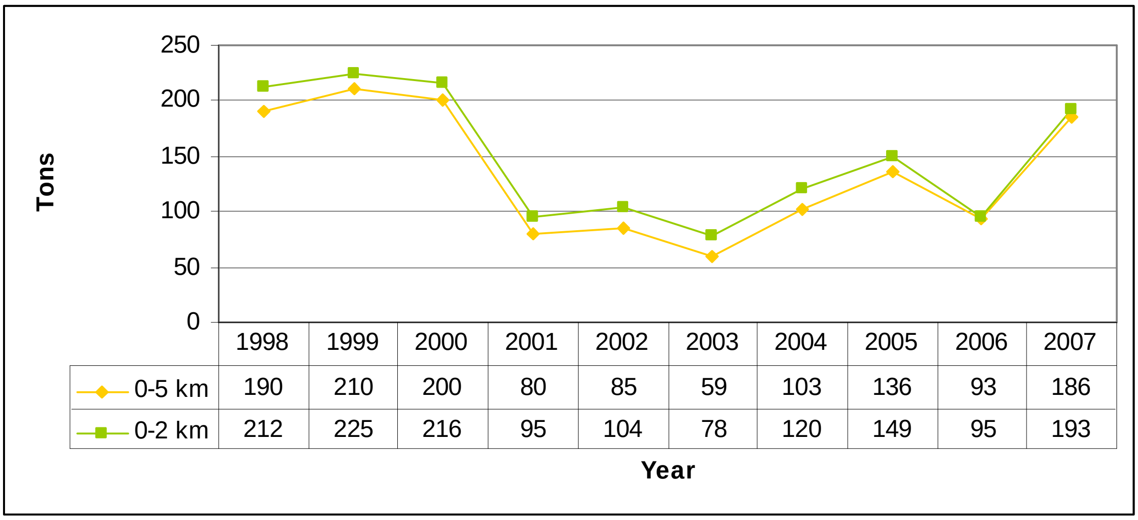
12 million. There are some smaller firms as well, and the local industry has a turnover averaging about R100 million per annum with 500 jobs and a salary bill of R30 million per annum. The gross markup averages 12%. The catch fluctuates according to weather conditions, but the output averages about 20,000 tons of canned fish and 38,000 tons of fishmeal per annum.

Data from commercial fishing in the area from Quoin Point to Danger Point (roughly equivalent to the east and west respectively of the Bantamsklip site) are shown in Figure 2.2.

The fishing industry is the major employer in Gansbaai, and its salaries and wages are higher than in construction and retail. The industry does not view a nuclear power station as a problem, pointing to the experience in the Koeberg area where fishing has continued. However, it stresses the importance of good maintenance and management.

The impact of an exclusion zone on communities would be felt more at Bantamsklip than at Thyspunt or Duynefontein. This is because the communities at Kleinbaai and Buffeljagsbaai are heavily dependent on ***non-commercial*** fishing; there is no equivalent dependence at Thyspunt. However, the impact would be minimised by the reduced exclusion zone of 1km advised by Eskom.

Figure 2.2: Commercial Fishing, Quoin Point-Danger Point, 1998-2007 (Tons)



	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0-5 km	190	210	200	80	85	59	103	136	93	186
0-2 km	212	225	216	95	104	78	120	149	95	193

Source: Marine and Coastal Management, 2008.

2.2.5 Aquaculture

The area between Cape Hangklip and Cape Agulhas produces 90% of the abalone sea harvest and 50 % of the farm harvest. Within this area, Gansbaai is the heart of the abalone aquaculture industry in South Africa. The largest marine abalone population in the country occurs between Gansbaai harbour and Quoin Point. However, since 1998 the sea harvesting of abalone has given way to abalone farming, ***partly because of a moratorium imposed on sea harvesting by the Department of Environmental Affairs.*** There are three such farms in the Gansbaai-Kleinbaai area, together producing 300 tons per annum. With a free-on-board price of \$27/kg (R210), the total turnover amounts to R61 million per annum. Abalone farming is labour intensive, total employment being about 240 persons.

There is great potential for increasing production from abalone farming in the Gansbaai area. Present output could in fact be increased by 100 tons per annum if there were a reliable supply of power. A nuclear power station at Bantamsklip could therefore lead to increased output through stabilising power supplies, but there is a concern in the industry about the impact of a nuclear power station on sea temperature; the farms pump in sea water, and the industry fears a risk of disease from bacteria in warmer water. However, according to the Marine Ecology Impact Assessment, this is not an issue as the warm water plume ***would occur in a very limited area and would*** not reach the farms, i.e., they would not experience increased water temperatures.

2.2.6 Kelp

The coast between Cape Agulhas and the Northern Cape is divided into rights areas for seaweed resources. The only resource being utilised is kelp, most of which is cut and sold fresh to perlemoen (abalone) farms, the balance being dried and exported. Kelp is the main food for abalone farms. The supply of kelp is relatively limited, whereas the number and size of abalone farms are increasing (South Africa is now the largest producer of farmed abalone outside Japan). There are four concession holders in a 16 km radius of the Bantamsklip site. This radius stretches from Walker Bay to Quoin Point and includes Dyer Island. The average annual harvest between 2001 and 2007 was 2,706 tons of wet and 304 tons of dried kelp. Fresh kelp fronds fetch R1,100/ton for an average value of R2,976 600 per annum; comparative figures for dried kelp are R550/ton and R167,200 per annum. In addition, one abalone farm collects loose seaweed rack for feeding; in 2007 this volume was eight tons valued at R8 000 (i.e., R1,000/ton).

Eskom has advised the authors that it has taken legal action against kelp harvesters who enter its property illegally in order to gain access to the beach, which would fall into the 1 km coastline exclusion zone. Eskom has indicated that it would allow controlled access (subject to a permit application and SAPS security clearance). In this way, there would be no reduction in the volume of kelp available to the industry as a result of an exclusion zone.

2.2.7 Retail and Trading

The only significant retail establishments in the area between Die Kelders and Quoin Point are at Gansbaai, where a shopping centre was opened in 2007. The two major retail chains each independently estimated the total turnover in the sector at an annual average of R120 million per annum. This includes Spaza and small shops as well as the building industry (brickmakers and building materials suppliers) and panel beaters. The holiday peaks are over a three-week period in December-January and then again at Easter. Average growth in turnover in real terms over the last four years has been between 7-10% per annum. The opening of the shopping centre has reduced the leakage of local spending power to Hermanus, which used to attract many shoppers from the Gansbaai area.

2.2.8 Civil Structures

Table 2.2 contains information on the various civil structures that are located in the area of the Bantamsklip site. This information was collected from the Overstrand Municipality's most recent Spatial Development Framework (2004). It is possible that this does not fully account for all the civil structures but, it was the only available source. There are no gas pipelines in the area.

Table 2-2: Civil Structures in the 20 km Radius of Bantamsklip

	Stanford	Gansbaai	Baardskeerderbos	Buffeljags	Viljoenshof	**Total**
Health service/clinic	1	2	1	0	0	**4**
Churches	6	13	1	0	0	**20**
Primary school	3	3	0	0	0	**6**
Secondary school	0	0	0	0	0	**0**
Sports fields	1	6	0	0	0	**7**
Golf course	0	1	0	0	0	**1**
Community hall	0	3	1	0	0	**4**
Police office	1	1	0	0	0	**2**
Taxi rank	0	0	0	0	0	**0**
Cemetery	3	5	1	0	0	**9**
Municipal office	1	1	0	0	0	**2**
Crèche	0	3	0	0	0	**3**
Library	1	1	0	0	0	**2**
Hospital	0	0	0	0	0	**0**
Community centre	0	0	0	0	0	**0**
Post office	1	1	0	0	0	**2**

Source: Overstrand Spatial Development Framework - Volume 1: Development Perspective, 2004.

2.3 Duynefontein

2.3.1 Overview of the Economy

The Duynefontein site is located in District B within the City of Cape Town. The city generates approximately 82% of the ***Gross Geographic Product (GGP – the regional equivalent of national Gross Domestic Product***) of the Western Cape. Provincially, the Western Cape recorded a growth rate of 5.9 % in 2006. This was above the country's growth rate of 5.4 % for the year. The provincial GDP of R174,303 million was the third largest in the country. The Western Cape has an estimated population of between 5.18-5.30 million. The province's main economic activities are finance and business services, manufacturing, and wholesale and retail trade. Tourism is a very important sector, but is split between several of Statistics South Africa's broad industrial classifications.

Cape Town has a relatively diverse economy with approximately 93 % of businesses being SMMEs, contributing 50% of total output and 40 % of total formal employment. However, there is a shift towards the services sector with the largest areas of growth being identified in finance, business services, trade, catering, accommodation, tourism and transport and communications. Manufacturing, which accounts for 19.4 % of employment, is in decline. Unemployment has remained high at 20.7 % (2005), but it appears that ***unemployment*** has been ***decreasing*** since 2003. The total population of the City of Cape Town for 2007 is estimated at 3.2 million, of which District B accounts for approximately 5.3% (170,000). Unemployment in District B was around 15.6 % in 2005 – significantly lower than the City's unemployment rate.

District B is one of the largest in the city and has some of the fastest growing areas, including Big Bay, Melkbosstrand, West Beach, Century City, Sunningdale and Parklands. There is a mix of urban, rural and farming areas. Most of the district is regarded as affluent, especially along the Atlantic coast. However, it also includes pockets of lower-income areas such as Atlantis and informal settlements with poor access to amenities and other services (especially economic opportunities). Century City is a key residential and commercial node in the city and will become increasingly so as the area is further developed. The majority of the land available for expansion of the City lies in the north. Thus, over the next 10-20 years this area is likely to become of increased importance in the Cape Town economy.

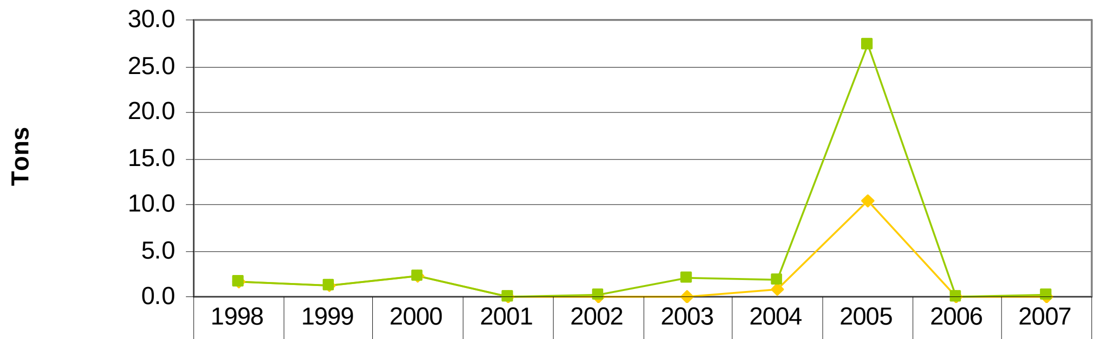
The most significant economic activity areas in the district are Table View, Killarney and Montague Gardens. Killarney and Montague Gardens are two of the City's most important industrial areas. Apart from industrial activity, the other noteworthy sectors include agriculture, tourism and retail trade. The commercial sector is growing in importance in District B.

2.3.2 Fishing

The Eskom Duynefontein site is not in a major commercial fishing area. Sardine trawlers operate just outside the present 2 km x 3.2 km exclusion zone laid down by the Sea-Shore Act, 1935 (and sometimes in fact enter the zone), while skiboat fishermen catch snoek and rock lobster. According to senior staff interviewed at Marine and Coastal Management, the nuclear power station has had no discernible effect on localised stock because of the absence of a reef, as it is located on a sandy stretch of coastline. Moreover, the impact on water temperature dissipates very quickly from the power station's outlet point, but in the small localised area both the growth speed and the size of rock lobster and abalone tend to increase.

Data for commercial fishing in the area between Blaauwberg Beach and Bok Point are shown in Figure 2.3. The Duynefontein site is located about midway between these points.

Figure 2.3: Commercial Fishing, Blaauwberg Beach-Bok Point, 1998-2007 (Tons)



	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0-5 km	1.7	1.2	2.2	0.1	0.0	0.0	0.8	10.4	0.1	0.0
0-2 km	1.7	1.2	2.3	0.1	0.2	2.0	1.8	27.3	0.1	0.1

Year

Source: Marine and Coastal Management, 2008.

Figure 2.3 confirms that there is no major commercial fishing area in the vicinity of the Duynefontein site. In terms of sensitivity to any impact from a nuclear power station on the fishing industry, ***therefore, the effects at Duynefontein would be zero to negligible.***

2.3.3 Industry

The 20 km radius around Duynefontein ***mainly*** includes small rather than large industries, but these industries are not clustered with the exception of those at Atlantis. Large industries are located mainly outside this radius in areas such as Epping.

The industrial sector within a 20 km radius of Duynefontein is dominated by the Chevron (Caltex) oil refinery and four cement companies. The Chevron refinery produces 74 000 barrels of refined product per day and employs 390 persons. In addition, there are 800-900 contractors at any one time, rising to 2,000 during the six-week biennial turnaround. The cement industry estimates its production in the area at 2 million tons of aggregate and about 120 000 m^3 of cement per annum. The turnover is estimated at between R300-350 million per annum, and total permanent employment at 150.

One of the largest industries at Atlantis is Bokomo Foods, which operates two factories. These preceded the construction of the Koeberg Nuclear Power Station. Bokomo employs 800 persons and has plans for expansion at Atlantis. With the closure of a number of industries since the withdrawal of incentives, serviced land at Atlantis is available at a reasonable price, and the Chamber of Commerce is attempting to promote the location. Although Atlantis was an artificial growth point and has not been an ideal location for industry, its appeal is likely to increase as the Cape Town metro region expands northwards.

The business sector is interested in securing a stable supply of power, and is not concerned about a second nuclear power station at Duynefontein provided that safety measures are in place. Industries at Atlantis, including the food industry, adjoin the Duynefontein site but do not view a nuclear power station there negatively. During field interviews, the business sector indicated that it believes that the technology will be more advanced than at Koeberg and that, therefore, the risk will be able to be managed. It further believes that it makes economic sense to provide new reticulation infrastructure parallel to that already existing at Koeberg. As the nuclear power station would be located in a zone that is already in effect an industrial area, the sense of place would not be a significant factor.

2.3.4 Tourism

Tourism around the Duynefontein site is largely represented by the Greater Northern Cape Town tourism region. This includes Atlantis, Bellville, Blaauwbergstrand, Century City, Durbanville, Edgemead, Goodwood, Langa, Melkbosstrand, Milnerton, Parow, Pinelands, Sunset Beach and Table View.

This area is characterised by a wide diversity of enterprises in the tourism industry, and it is difficult to differentiate between the tourist assets of the area itself and those of the Greater Cape Town and West Coast destinations. However, within the immediate site proximity, activities are focused on sea and eco-tourism activities such as kite-surfing, windsailing, golf, hiking and mountain biking. The area has a well-developed tourism infrastructure with a strong supply of services, facilities and amenities, including up-market golf estates. A number of large hotel developments are currently underway, and there are plans for a further golf estate near

Melkbosstrand. According to the Tourism Impact report (Imani 2010), the annual turnover of accommodation establishments in the area is R497.8 million per annum.

Estate agents believe that the direction of city expansion will be to the north. Urban growth in the form of holiday resorts and retirement complexes has already leapfrogged the Koeberg Nature Reserve and Atlantis, ***moving from Melkbosstrand*** to Grotto Bay, Yzerfontein and Jakkalsfontein. The opening of the Koeberg Nuclear Power Station in 1984 has not stopped the growth of Blaauwbergstrand (which has been particularly rapid in the last 15-20 years) and Melkbosstrand where growth is of a more recent vintage. Beachfront houses at Blaauwbergstrand are popular buys for foreigners who have paid up to R16.5 million for a property. At Big Bay house prices have been in the R4-6 million range. The Atlantic Beach Golf Estate is a prime facility in Melkbosstrand with units selling for up to R3.5 million. Inland, the Durbanville area is highly sought after with property prices ranging from R2.0-4.5 million.

2.3.5 Agriculture

There are a number of different agricultural activities in a 20 km radius of the Duynefontein site. In recent years there has been a shift from dairying and wheat farming to vineyards, and there are some up-market wine estates in the Durbanville and Vissershok areas. Based on responses collected during fieldwork, there has never been any concern that that the Koeberg Nuclear Power Station would adversely affect these estates. A game farm has been established north of Silverstream Road, and a number of equestrian stables have moved from Milnerton to Grotto Bay. Pig farming is conducted in the Philadelphia area.

2.3.6 Civil Structures

Table 2.3 contains information on the various civil structures that are located in the 20 km radius around the Duynefontein site. This information was collected from the City of Cape Town's Planning Districts Socio-economic Analysis. Data were also collected from the Cape Town map book produced by Map Studio. Unfortunately, data on civil installations are very scarce for the City of Cape Town. Thus, it is possible that this does not fully account for all the civil structures.

Table 2-3: Civil Structures in the 20 km radius around Duynefontein

	District B: West Coast
Hotel	7
Clinic	6
Hospital	5
Shopping mall	29
Post office	6
Law court	1
School	31
Service station	21
Religious site	9
Library	6
Caravan park	2
Police station	2
Fire station	3
Traffic department	1

Railway station	2
Water treatment works	3
Country club	2
Airfield	1
Refinery	1
Cement factory	1
Guest cottage/conference centre	1
Bus terminal	1
Wine estate	5

Source: Planning Districts Socio-economic Analysis 2007

The only gas pipelines in the Koeberg area are related to the Chevron refinery. The largest is the 110 km pipeline from Saldanha Bay that transports crude oil into the refinery and storage tanks at Killarney. There are also two smaller pipelines from the refinery into Cape Town harbour. The Saldanha Bay 26-inch pipeline passes about 3 km away from the Koeberg Nuclear Power Station. It carries 130 000 barrels per day but this could be increased to 180 000 barrels per day. White oil is carried to Cape Town harbour by a 12-inch pipeline and fuel oil by a 10-inch pipeline. Neither the refinery nor the municipality were able to provide data on the age, operating pressure, depth of burial, and type of isolation valves referred to in the Terms of Reference.

3 IMPACT IDENTIFICATION AND ASSESSMENT

3.1 Introduction

The objective of this section of the study is to analyse the economic cost-effectiveness of the three sites. The analysis includes the capital and the operational costs of the service provider as well as the costs to the community, taking into account the positive and negative externalities on the economy and certain restricted environmental factors. This section also looks at the broader macro-economic impact of the three sites based on their relevant economic support bases (i.e. the Eastern and Western Cape), with the objective of estimating contributions to economic growth and the distribution of income through the ability to create jobs in specific economic areas.

In the cost-effectiveness comparison it was necessary to use the construction and other cost estimates received from Eskom as calculated per site. In the economic analysis approach it is sometimes necessary to compare sites to show or highlight certain economic trends or realities.

3.2 Cost-effectiveness Comparison of the Three Sites

In order to compare the costs to the service provider as well as the broader costs to the community with the benefits of constructing and operating a new nuclear power station, a cost-effectiveness analysis (CEA) has been performed. The CEA compares the relative expenditure (costs) and physical outcomes (effects) associated with two or more courses of action. As such, the CEA compares the total costs to various stakeholders affected by the envisaged actions.

Technically, the CEA is done on the same basis as a cost-benefit analysis (CBA) by discounting future costs over time back to a base year. Standard practice is to express these costs in terms of a physical unit such as physical electricity units produced. The result is expressed as a Unit Reference Value as follows:

$$\text{Unit Reference Value (R/GWh)} = \frac{\text{PV of Cost (R)}}{\text{PV of Electricity (GWh)}}$$

Due to the fact that the proposed Nuclear Power Station will deliver the same output of electricity at all three sites with comparable construction and operational periods, the analysis has been simplified, and only considers the present value of the various costs over time.

Future values have been discounted back to present values using a real discount rate of 8%, which is in line with the discount rate recommended in the Manual for Cost-benefit Analysis in South Africa (Conningarth Economists (2007). All costs resulting from the existence of Nuclear-1 but which are ultimately passed on to end-users or absorbed by other users have been taken into account. These costs are:

- Upgrading of roads;
- Electricity connections to grid;
- Removal of nuclear waste;

- Housing and transport for the community;
- Externalities to the economic environment, i.e. fishing, agriculture and tourism; and
- A desalination plant.

3.2.1 Baseline Data and Cost Factor Assumptions

In constructing and executing the cost-effectiveness model for each of the sites detailed data made available by various Eskom staff were used. In some cases Eskom made available detailed physical and financial data; these were interpreted by the consultants and used as needed. However, in some specific cases it was necessary for the consultants to determine certain costs using other external sources or data from own internal data sources.

3.2.1.1 Land Acquisition

Most of the land needed for the various nuclear sites has already been acquired by Eskom. However, there are small pieces of land that still need to be purchased. The quantity and value of these additional tracts of land are given below (Table 3.1).

Table 3-1: Land to be acquired (2008 Prices)

	Units	Thyspunt	Bantamsklip	Duynefontein
Land to be acquired (ha)	ha	350	400	0
Value of land /ha	R	20,000	10,000	0

Source: Estates manager, Eskom Nuclear-1 sites, Consultant's assumptions

It was assumed that all purchases of land will take place from Year 1 to Year 3, and where applicable are incorporated as such in the model.

3.2.1.2 Construction Phase

3.2.1.2.1 Site Preparation

The various sites differ in terms of *inter alia*, topographical and geological aspects. Within this context, there are three identified aspects that are of importance of which will affect the cost comparison between the three sites:

- Sand to be removed to bedrock level;
- Bedrock to be removed to foundation levels; and
- Groundwater to be contained during the construction phase.

The volume and costs of this exercise are included in Table 3.2. These activities are scheduled to take place in the period Year 3 to Year 6 and are incorporated as such into the model.

Although the possibility of using the sand removed from the Thyspunt site to build up the beach at St Francis Bay (which suffered extensive storm damage two years ago) was discussed with the town engineer's office of the ***Kouga*** Municipality, and was identified as a possible benefit of ***a nuclear power station, the engineers working on the restoration of the beach have indicated that they have found a solution to this problem. Eskom has therefore indicated that it intends to dispose of*** sand at sea at all three ***alternative*** sites.

Table 3-2: Site Preparation Costs (2008 Prices)

	Unit	Thyspunt	Bantamsklip	Duynefontein
Volume of sand to be removed at each site to bedrock level.	mill m³	6.4	10	6.5
Cost of removing sand to bedrock level at each site.	R mill	127.4	201.0	129.6
Estimated volume of ground water to be removed ***from the foundation excavation*** during the construction phase.	mill m³	8	4	6
Cost of removing ground water ***from the foundation excavation*** during the construction phase.	R mill	1.3	0.7	1.1
Volume of bedrock to be removed	mill m³	0.7	1.2	1.3
Cost of removing bedrock to required level	R mill	56.7	95.9	102.6

Source: Mr J Breytenbach, Project Manager Nuclear-1.

3.2.1.2.2 Reactor Standard Cost

The capital costs of a nuclear power station for the different sites are effectively the same except for some site-specific variable items that are the subject of this study. The non-variable element of the capital amount, payable to the vendor, has been brought into the study as the “Reactor Standard Cost” (Table 3.3). The so called Correction Value refers to costs identified and calculated other than vendor costs

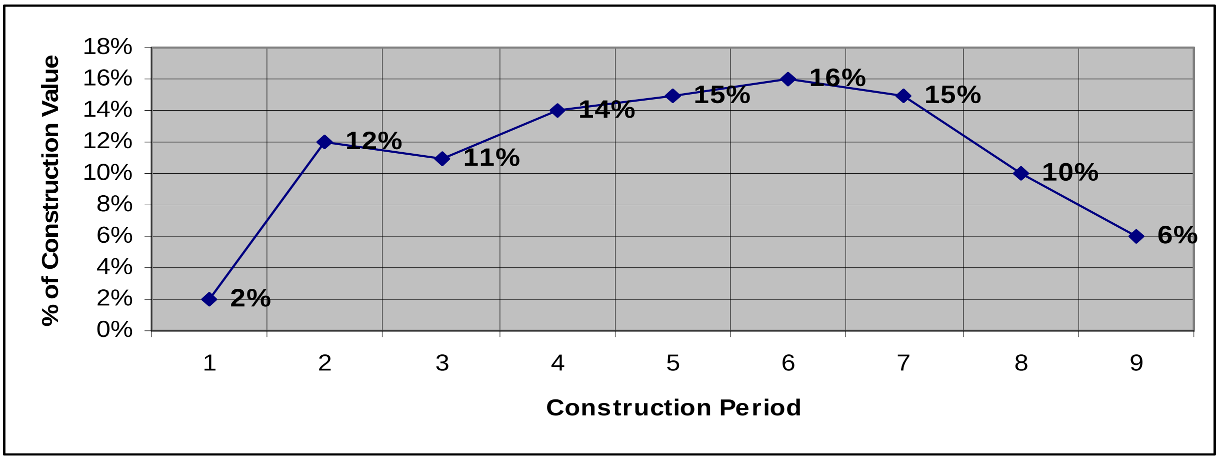
Table 3-3: Reactor Standard Cost (R million)

Reactor Construction Cost	170,000
Correction Value	19,725
Reactor Standard Cost	150,275

Source: Mr J Breytenbach, Project Manager Nuclear-1, later updated by Mr AC van Schalkwyk, Senior Manager, Nuclear-1 Client Office.

This amount will be spent as per the spending cycle supplied by the Nuclear project team, and will take place from Year 1 to Year 9. The proposed spending cycle is shown in Figure 3.1.

Figure 3.1: Nuclear-1 Construction Schedule



Source: Mr J Breytenbach, Project Manager Nuclear-1.

The amounts as specified in Table 3.3 were incorporated in the model using the specific construction schedule.

3.2.1.2.3 Construction Support Service - Transport

The variable cost element of the construction of a nuclear power station consists of the cost-effective transport of the following goods and services:

- support services during the construction phase;
- steel; and
- concrete (cement, sand and aggregate) and bricks.

The volume of goods and services as well as the weighted distances to the different sites are presented in Table 3.4.

Data on the number of trips to be made and volumes to be moved were received from Eskom. The support services for the different sites originate as follows:

- Thyspunt – Port Elizabeth;
- Bantamsklip – Cape Town; and
- Duynefontein – Cape Town.

Steel would be sourced from Vanderbijlpark in Gauteng, while concrete and bricks would be transported from sources closer to the sites. The distances quoted represent an estimated weighted average per site based on the estimates of the consultants, taking into consideration closest supply sources and rail and road options.

Table 3-4: Relative Variable Transport Distances, Volumes and Cost (2008 prices)

			Value (R million)		
Goods or Services	**Volume**	**Units**	**Thyspunt**	**Bantamsklip**	**Duynefontein**
Support service	193 700 trips to site	Weighted km	103.8	106.4	34.7
Steel	200,000 tons	Weighted km	1,133	1,440	1,360
Concrete and bricks	1,780,000 tons	Weighted km	57.00	71.00	42.00
Construction Support Services		R million	156.50	167.45	54.77
Construction steel		R million	96.04	122.06	115.28
Construction Concrete & Bricks		R Million	89.79	158.47	55.45

Source: Physical Volumes – Mr J Breytenbach, Project Manager Nuclear-1, later updated by correspondence received; weighted distances – Consultant's assumptions.

These aspects of the construction phase take place as per the spending cycle supplied by the Nuclear-1 project team, i.e. from Year 1 until Year 9.

3.2.1.2.4 Imported Material – Port to Site (Abnormal Loads)

The equipment for a nuclear power station includes items which are described as abnormal load items. These will be imported via the nearest capable harbour, and will be transported by road to the various sites. The mass of these loads can be as high as 550 tons - some are not as heavy, but are of an abnormal size. The total ***abnormal*** mass to be transported is 23 306 tons, comprising 167 loads. Certain access roads will need to be upgraded for this purpose, and are discussed in Section 3.2.1.2.11. The detail and cost of the transport of abnormal loads are given in Table 3.5.

Eskom made available to the consultants the actual number of loads per site, and Advanced Load Engineering made available to the consultants, on a confidential basis, tariffs which include their estimation of bridge and road works that will be necessary on the feeder roads from the port of entry to the specific site. At the time of the compilation of this report, the outcome of the engineering study on possible improvements to the identified roads was not yet available.

The activity of abnormal load transport will take place during the construction period and is modelled for the period Year 5 to Year 7. The calculations show that the average weighted transport cost per load will be the most expensive for the Bantamsklip site. This is because the route proposed is 550 km ***from Saldanha*** compared to the 120 km for Thyspunt ***from Coega*** and, for Duynefontein, 45 km from Saldanha and 130 km from Cape Town. The 550 km distance to the Bantamsklip site was calculated after Advanced Load Engineering (one of the two firms capable of transporting such loads) informed the consultants that, according to their calculations, it would not be possible to transport the extra abnormal loads over Sir Lowry's Pass. It would be necessary for such loads to be landed at Saldanha Bay, not Cape Town, and transported via an inland route to Bantamsklip.

Table 3-5: Road Transport cost for Abnormal Loads (2008 prices)

	Unit	Thyspunt	Bantamsklip	Duynefontein
Total cost per load (weighted average)	**R mill/load**	**4.72**	**14.04**	**3.36**
Fixed cost component per load	R mill	2.60	2.60	2.60
Variable cost component	R/km	21,667	21,667	21,667
Mass to be transported per site.	tons	23,306	23,306	23,306
Estimated number of heavy loads	ea	167	167	167
Number of load configurations		35	35	35
Number of load configurations heavier than 300 tons		5	5	5
Distance from site to harbour	km	120	550	45
Distance from site to harbour (Saldanha)	km	n/a	550	130
Port of entry for each site		Port Elizabeth	Saldanha	Cape Town, but loads larger than 300 tons will come from Saldanha.

Source: Volumes: Eskom Nuclear-1 Project team; costs from Advanced Load Engineering; Consultant's' assumptions

3.2.1.2.5 Imported Material – Port to Site (Normal Loads)

All material that is imported will need to be transported from the port of entry to site. For the purposes of this calculation, all imported material will be by road from the port of entry to the specific site. The volume of non-abnormal load imported material and the distances from the port of entry to each site are presented in Table 3.6.

According to Advanced Load Engineering, it would be possible to transport ordinary imported loads over Sir Lowry's Pass. Thus, Table 3.6 reflects the shorter distance of 190 km from Cape Town harbour to Bantamsklip via Sir Lowry's Pass and not the 550 km shown in Table 3.5 for the extra heavy loads from Saldanha Bay to Bantamsklip.

Table 3-6: Imported Material – Transport Distances, Volumes and Cost (2008 prices)

		Cost (R million)		
Goods or Services	**Units**	**Thyspunt**	**Bantamsklip**	**Duynefontein**
Mass of imported goods	tons	229,000	229,000	229,000
Distance from port of entry	weighted km	256.0	190.0	53.5
Average cost per ton	R 30	60.4	44.8	12.6

Source: Volumes, Eskom Nuclear-1 Project team; Consultant's Assumptions.

This activity will take place from Year 2 to Year 9 and is modelled as such. From the analysis, it appears that the difference in costs between the sites is within acceptable limits. However, transport to Duynefontein would be the cheapest and to Thyspunt the most expensive.

3.2.1.2.6 Construction Village – Capital

Eskom has made available the detailed requirements of the village to be constructed for the skilled and professional employees of the vendor, and the Eskom project managers for whom housing must be provided for a period up to seven years. Two of the proposed construction villages are in rural areas. The neighbouring towns ***(Humansdorp in the case of Thyspunt and Gansbaai in the case of Bantamsklip)*** would, according to on-site investigations, not be able to provide adequate housing

and a staff village would have to be provided by Eskom. Cape Town is obviously a different situation: a number of staff associated with the project would be able to find private accommodation, but a cost would still be associated with the project even though Eskom would not be the capital source.

During the construction period Eskom would also start to phase in their professional staff, which will eventually operate the power station. Provision had to be made for them over time. The villages will not be on site but as close as possible to existing towns, so that social and other services are available. Obviously these sites will be decided upon in cooperation with the local authorities. For purposes of this exercise, contact was made with the relevant local authorities to form an opinion of possible suitable sites. The village has to make provision for the entire social, commercial, and recreational needs of the workers, with the total estimated number of houses to be provided being as follows:

- 1,000 houses and 980 single staff units for the vendor;
- 180 houses and 40 single staff units for the Eskom project managers and consultants; and
- 1,000 houses for the permanent Eskom staff.

The consultants sourced and applied the current building and construction tariffs to the Eskom village model in order to calculate the total cost of this activity. Table 3.7 contains a summarised total construction estimate of the costs for the three sites. This includes the consultants' assumption regarding the benefits accruing to Duynefontein because of its close proximity to the Cape Town Metropole.

Table 3-7: Employee construction village costs (2008 prices)

	Unit	Thyspunt	Bantamsklip	Duynefontein
Employee village (2009-12)	R million	1 969.58	1 969.58	1 792.48

Source: Numbers, Nuclear-1 Project Team; Consultant's assumptions on building costs, etc.

The lower figure at Duynefontein is based on the possibility of eliminating duplication in administrative staff and project managers finding accommodation in the existing suburbs, and this resulted in a smaller number of houses to be built for Eskom staff. This activity will take place during two defined periods, namely, the first four years of the construction period for the vendor staff and Eskom project managers, and the second period with the phasing in of Eskom operational staff.

3.2.1.2.7 Construction Village – Transport Costs

The transport of staff during the construction phase will differ for the various sites, based on the difference in distance from the construction village to the sites. The travelling distance to the different sites and further assumptions are given below, based on interaction with the local authorities. Staff in the case of Thyspunt would be housed outside Humansdorp ***and Jeffreys Bay***, for Bantamsklip close to Pearly Beach, and in the case of Duynefontein, at ***Atlantis*** (Table 3.8).

Table 3-8: Personnel Travel from Lodging to Site (2008 prices)

	Units	Thyspunt	Bantamsklip	Duynefontein
Distance from village (km)	km	25	10	17
Travel cost (R/km)	R	4.90	4.90	4.90

Trips shared (%)		30	30	30
Average Cost	R million	314.83	125.93	198.69

Source: Consultant's assumptions; travelling costs – Automobile Association figures.

The maximum numbers allowed for are 1,259 operational staff, 180 project staff and 1,000 vendor staff. A build-up of construction staff has been allowed for during the construction phase, with the construction staff being taken on site from Year 1 to Year 9, and operational staff arriving on site in Year 3 and Year 4. Staff will remain at full complement until Year 11. The table shows that, due to distances, Bantamsklip will be the cheapest site in this regard and Thyspunt the most expensive, although the contribution of this cost item is very small.

3.2.1.2.8 Construction Village – Capital

Although it has been assumed that the construction company will employ as many staff as possible from local communities for the unskilled work, it is still foreseen that provision will have to be made for about 5500 workers to be accommodated in construction villages. Once again, Eskom has provided the specifications for the total construction camp facility, making provision for commercial, social and recreational facilities. These data were used to calculate the cost of constructing an appropriate camp (Table 3.9). It must be emphasised that these construction villages will not be on the site, but the actual placement will be in cooperation with the respective local authorities. The consultants were informed by Eskom that, in their planning, it was envisaged that the size of the village would be the same for all three sites. Thus, the capital costs for the three sites are the same.

Table 3-9: Construction Village – Capital Cost (2008 prices)

	Unit	Thyspunt	Bantamsklip	Duynefontein
Construction Camp (2009-2012)	R million	264.87	264.87	264.87

Source: Numbers, Nuclear-1 Project team; building costs – Consultant's assumptions.

This activity will take place during the first four years of the construction period. During on-site consultation with Nuclear-1 staff it was stated that the placement of the camps will be decided on in consultation with the local authorities. After interaction with the local authorities on possible sites, the consultants are of the opinion that the camps should not have an impact on property prices at any of the proposed sites.

3.2.1.2.9 Construction Village – Transport Costs

The cost of transporting construction labour differs for the three sites, based on the distance from the construction village to each site. In calculating this cost, the distance from the construction camp to site for the different sites was assumed to be the same as for the construction village above. The maximum number of staff to be transported is 6,848. It was assumed that these personnel will be transported by bus, with a passenger capacity of 50 people per bus, and travelling at a cost of R12.00 per km. The build up of staff and transport cost was estimated as follows (Table 3.10).

Table 3-10: Transport Costs of Construction Labour (2008 prices)

Period	**2010**	**2011**	**2012-16**
Labour build-up	2 054	4 565	6 848
	Thyspunt	Bantamsklip	Duynefontein
Distance	25 km	10 km	17 km
Cost per trip (Rand)	600	240	408

Average Cost (Rand million)	123.96	49.58	84.29

Source: Numbers, Nuclear-1 Project team; Consultant's assumptions.

The distance from each nuclear power station site to what is at this stage the most probable location for the construction camp was established after consultation with the local authorities. The table shows that the transport costs from Bantamsklip will be the lowest and from Thyspunt the highest.

3.2.1.2.10 Labour – Difference in Numbers

Although the theoretical possibility exists that some labour sharing can take place if the second power nuclear power station is constructed at Duynefontein. It was agreed by the consultants, after negotiations with the Nuclear Power Station project team's senior managers, that there will be no difference in numbers between Duynefontein and the other two sites. No further provision was therefore provided.

3.2.1.2.11 Access Roads – Capital Costs

Access roads to each of the construction sites will need to be upgraded. This includes immediate access roads at each site from the feeder roads. The estimated cost projected for the upgrading of the roads to the different sites was supplied by the Nuclear-1 team and is presented in Table 3.11. This activity will take place from late Year 2 through until Year 3.

In the case of Thyspunt an additional feeder road for heavy vehicles via Cape St. Francis was included at a later stage and is now incorporated into the model.

Table 3-11: Access Road Capital Cost (2008 prices)

	Unit	Thyspunt	Bantamsklip	Duynefontein
Road to construction site	km	15 + 10	5	3
Estimated cost to upgrade road if necessary	R million	539.39	122.59	204.31

Source: Distances, Nuclear-1 Project team; building costs per km from SANRA.

3.2.1.2.12 Connection to the National Grid – Capital Costs

The cost of connecting a nuclear power station to the national transmission grid differs for the various sites, and the information, as received from Eskom, is presented in Table 3.12. The value for Thyspunt includes a 132kV line to the site to supply electricity during the construction period. ***All estimates include powerline construction costs as well as the upgrading or construction of new sub-stations.***

Table 3-12: Cost of Connecting to the National Distribution Grid for Different Nuclear-1 Sites (2008 prices)

	Unit	Thyspunt	Bantamsklip	Duynefontein
Line cost from the Power Station to National Grid.	R billion	5.3	12.72	5.1

Source: Nuclear-1 Project team.

This activity of constructing the connection line to the national grid will take place from late Year 3 through until Year 6. From the table, Duynefontein would be the cheapest site and Bantamsklip the most expensive to connect to the national distribution grid.

3.2.1.2.13 Tourism Impact

The data used to calculate the impact of a new nuclear power station on tourism during the construction period were obtained from the Tourism Impact study (Imani 2009), and were used as shown in Table 3.13. ***The Tourism Impact study covered business and holiday tourism but did not take account of any industrial tourism which might occur, e.g. as a result of other countries with nuclear build programmes sending people to visit Eskom's sites as benchmarking exercises.***

Table 3-13: Estimated Impact on Tourism of the nuclear power station on the respective sites

	Unit	Thyspunt	Bantamsklip	Duynefontein
Present tourism turnover	R million	77.45	62.25	497.83
Impact – Years 1 to 6	%	-7.86%	+5.0%	-0.00%
Impact – Years 1 to 6	R million	-6.11	+3.11	0

Source: Imani (2009).

The Bantamsklip site, if selected, will experience a positive impact on tourism during construction, while for the other two sites a negative impact is predicted. Construction will have the largest negative impact on tourism in the Thyspunt area with a negligible negative impact on the Duynefontein area.

3.2.1.2.14 Value of Unskilled Job Creation

In certain areas of South Africa high levels of unemployment exist. This implies that the supply of labour exceeds demand which, under free market conditions, would cause the cost of labour to decline. However, as a result of the minimum wage application in South Africa, labour costs tend to be higher than what they would have been in the absence of this minimum wage. In order to compensate for this market-distorting factor, a so-called "shadow" labour cost has been used. The difference between the real wage and the shadow wage is viewed as a transfer payment and not as a cost of a scarce resource. Table 3.14 reflects the "shadow" price of the labour which has been used to adjust salaries for unskilled labour at the Thyspunt site in the Eastern Cape, and the Bantamsklip and Duynefontein sites in the Western Cape. The total salaries are based on the estimated number of unskilled workers on site and the minimum wages applicable for unskilled workers. These were calculated by the consultants.

Table 3-14: Shadow Value of Unskilled Jobs for Different Sites during Construction Phase (2008 prices)

	Units	Thyspunt	Bantamsklip	Duynefontein
Total salaries for unskilled jobs created	R mill.	3 333	4 367	4 202
Resource value factor		0.58	0.85	1

Source: Water Research Commission – Report TT305/07 – A Manual for Cost-Benefit Analysis in South Africa with Specific Reference to Water Resource Development

From the estimations made it is clear that all three sites would have a very positive impact on unskilled job creation, ***but in this case Thyspunt would be the most beneficial. It should be pointed out, however, that it is not only the positive impact on job creation that is important but also the induced market created for***

consumer goods in the area as a result of the increased consumer spending from the salaries paid.

3.2.1.3 Operational Phase

3.2.1.3.1 Power Balancing

In consultation with the Eskom transmission staff it became clear that an amount of power is lost in the transmission process and that a "balancing" power station at the end of the transmission grid will help to minimise this loss. The loss in electricity was taken as the difference between supplying an area from the Bravo sub-station, close to the power station at Kendal in Mpumalanga, and a nuclear power station of approximately 3,300 MW at the three different sites. The applicable loss per annum, according to Eskom transmission staff, is as shown in Table 3.15.

Table 3-15: Loss due to Lack of Power Supply Balance (2008 prices)

	Thyspunt	**Bantamsklip**	**Duynefontein**
Estimated Power Loss (MW)	351	293	275
Estimated Value of Power Savings ***Rand Million***	1 339.99	888.42	832.84

Source: Estimated power loss – Nuclear-1 Project team; value of power savings – Consultant's calculation.

According to the information provided, the two sites in the Western Cape experience less power loss because of balancing provided by Koeberg. It must be kept in mind that the total electricity use in the Western Cape is considerably higher than that in the Eastern Cape, and therefore the loss in the Eastern Cape in percentage terms is much larger than in the Western Cape. The loss in the Eastern Cape will be applicable in the case of a nuclear power station not being placed at Thyspunt. It will constitute a 100% loss for the period 2017-23, and a 50% loss for the period 2024-29. The motivation is that, according to Eskom's present long-term planning proposals, if the first plant is in the Western Cape the second will be in the Eastern Cape. For Bantamsklip and Duynefontein, the 100% loss will only apply from 2017-23 as, in the period thereafter, a plant would have been placed at one of the two sites supplying the Western Cape. The value of the loss was calculated using present average Eskom wholesale tariffs with the estimated loss being converted to megawatt hours based on present provincial electricity usage.

3.2.1.3.2 Power Supply Delays

Site preparation and construction delays at the different sites could cause a relative delay in the commencement of electricity supply. At present the Nuclear-1 team has provided an estimation of the possible magnitude of the electricity loss and the main reasons for possible delays (Table 3.16).

Table 3-16: Electricity Supply Commencement Delay (2008 prices)

Unit	**Thyspunt**	**Bantamsklip**	**Duynefontein**
Months delay	NA	4	3
Main reason		Bedrock removal	Sand and bedrock
Cost of Delay (Rand million)	00	222.02	124.88

Source: Time estimation – Nuclear-1 Project team; cost calculation – Consultant's assumptions.

The delay in the electricity supply will occur during Years 10 and 11, the projected completion date. This is added as a negative to the Bantamsklip and Duynefontein sites with a neutral position for Thyspunt.

3.2.1.3.3 Labour − Differences in Numbers

Although the theoretical possibility exists that some labour sharing can take place if the second power nuclear power station is constructed at Duynefontein. It was agreed by the consultants, after negotiations with the Nuclear-1 project team's senior managers, that there will be no difference in numbers between Duynefontein and the other two sites. No further provision was therefore provided.

3.2.1.3.4 Travel Cost – Labour

The transport of staff during the operational phase will differ for the various sites based on the difference in the distance from the staff village to the site. The travelling distances to the different sites as well as the other applicable assumptions used are presented in Table 3.17.

Table 3-17: Personnel Travel from Lodging to Site (2008 prices)

	Units	Thyspunt	Bantamsklip	Duynefontein
Distance from village (km)	km	25	10	17
Travel cost (R/km)	R	4.90	4.90	4.90
Trips shared (%)		40%	40%	40%
Travel Cost (Rand million)		229.60	91.84	156.13

Source: Rates – Automobile Association; other Consultant's assumptions.

The maximum operational staff number allowed for is 1,385 at the Thyspunt and Bantamsklip sites, and at Duynefontein. This effect is applicable for the operational phase from completion of project for a 30-year period. ***The CEA model uses discounted values, and mathematically any period longer than 20 to 25 years produces such small values that its inclusion in the analysis has a negligible effect on the results.***

3.2.1.3.5 Transport Cost – Radioactive Waste Removal

According to Nuclear-1 staff, a total mass of 32 tons of ***Low-level and Intermediate-level*** radioactive waste will be transported annually from Koeberg to the Vaalputs Nuclear Waste Site, at an average of two loads per month. A similar volume of waste was assumed for the Nuclear-1 plant. The distance from the different sites to Vaalputs and the estimated number of annual trips are presented in Table 3.18.

Table 3-18: Radioactive Waste Removal Distance and Volume (2008 prices)

	Unit	Thyspunt	Bantamsklip	Duynefontein
Vaalputs to site	km	930	940	723
Number of return trips per annum		24	24	24
Cost per return trip	Rands	55,800	56,200	47,520

Source: Number of Trips – Nuclear-1 Project team; Consultant's assumptions.

Transport costs of R40 per km loaded, and R20 per km on the unloaded return, have been assumed. These costs are incorporated into the model for the operational period from completion of the project for a 20-year period. From the analysis it appears that Duynefontein is the cheapest of the sites while the remaining sites are approximately the same value, but the differences are small.

3.2.1.3.6 Transport Cost – Support Services

During the operational phase a variety of support services will be rendered to the power station. The number of trips per annum is based on the actual number currently to the existing power station at Koeberg. The transport cost of supporting the services has been set at R6.00 per km. The weighted distances to the different sites were calculated by using the source of the service, the possible number of trips and the distance to the specific site. The results are shown in Table 3.19.

Table 3-19: Reactor Relative Support Service for the Operational Phase (2008 prices)

Goods or Services	Volume	Units	Thyspunt	Bantamsklip	Duynefontein
Support Service	576 trips p.a.	Weighted km	95.6	106.4	34.7
Annual Cost ***(Rands)***			440,527	490,291	159,898

Source: Number of trips – Nuclear-1 Project team; Consultant's assumptions.

Duynefontein, because of its proximity to support services, is the cheapest option. These values have been incorporated into the cost comparison model for a period of 20 years from completion of construction.

3.2.1.3.7 Impact on Tourism during the Operational Phase

The data used were obtained from the Tourism Impact report (Imani 2010) which forms part of the study, and are presented in Table 3.20.

Table 3-20: Impact on Tourism during the Operational Phase (2008 prices)

	Unit	Thyspunt	Bantamsklip	Duynefontein
Present Tourism Turnover	R million	77.45	62.25	497.83
Impact – years 7 to 20	%	0.00%	8.6%	1.43%
Impact – years 7 to 20	R million	0	5.34	7.11

Source: Imani (2009).

According to the tourism specialist, the economic impact during the operational phase on Bantamsklip will be positive, on Thyspunt ***zero***, and on Duynefontein ***positive***. The results were incorporated as such into the model for the years 2017-38.

3.2.1.3.8 Agriculture Impact

Data used were obtained from the Agricultural Impact report (Golder/Imani 2010) as part of this study for the 16 km radius ***around each site (defined for the agricultural impact assessment),*** and were adapted to a 30 km radius to obtain a larger turnover value. The reason for this is that, during the visit to the sites, it became apparent that farmers were not happy with the ***initial*** 16km radius claiming that it would not give a true reflection of the agricultural activities in the area. As this is a comparative model it does not really matter as long as the same area is used for all three sites. The 16 km and 30 km values are presented in Table 3.21.

Table 3-21: Agricultural Activities and the Impact of the Nuclear Power Station

	Unit	Thyspunt	Bantamsklip	Duynefontein
Annual turnover - 16 km radius	R million	150	29	75
Annual turnover - 30 km radius	R million	927	133	262
Impact Years 1-20 (16 km radius)	%	12.5%	-	-
Impact – Years 1-20	R million	-19	-	-

Source: Agriculture team, part of the Economics team. Golder/Imani.

It is estimated that the ***positive*** impact on agriculture in Thyspunt would be R18.7 million per annum and at Bantamsklip R0.75 million per annum, with no impact at Duynefontein.

3.2.1.3.9 Aquaculture Impact

Significant aquaculture activities only occur at the Gansbaai area, close to the Bantamsklip site. After discussions with aquaculture managers in Gansbaai, and with Eskom, it was determined that the size of the commercial farming sector of the industry would not be affected by Nuclear-1. The commercial "farming" segment of the aquaculture activity, namely, abalone farming, will not be affected at all as sea water is pumped to these farms. However, the future growth of the industry depends on the availability of kelp, but the area available for harvesting will not be affected as ***Eskom has indicated that it would allow controlled access (subject to a permit application and SAPS security clearance). In this way, there would be no reduction in the volume of kelp available to the industry as a result of an exclusion zone.***

3.2.1.3.10 Fishing Impact

Commercial fishing is discussed in separate sections of this report, and therefore Table 3.22 only presents the impacted values as used in this study. In the case of Thyspunt, only the value of squid is used as it is perceived that it is the one segment which could be negatively impacted. ***The figures used, however, could be overstated as the Marine Ecology Impact Assessment report found that a nuclear power station would have no significant impact on squid.***

Table 3-22: Estimated Impact of the Nuclear Power station on the Fishing Industry during the Operational Phase (2007 prices)

	Unit	Thyspunt	Bantamsklip	Duynefontein
Annual turnover	R million	400	100	n/a
Impact – Years 7 to 20	%	-1.8%	n/a	n/a
Impact – Years 7 to 20	R million	-7.2	n/a	n/a

Source: Consultant's field interviews, August 2008.

3.2.1.3.11 Value of Unskilled Job Creation

The same principle is followed as in the construction phase of applying shadow prices to labour. The values used for the operational phase are shown in Table 3.23.

Table 3-23: Value of Unskilled Jobs for Different Sites during Operation Phase (2008 prices)

	Units	Thyspunt	Bantamsklip	Duynefontein
Total salaries for unskilled jobs created in the operation phase per annum.	R Mill	123	115	108
Resource value factor as per Cost-benefit Analysis Manual		0.58	0.85	1
Economic value of unskilled jobs created	R Mill	263.62	88.05	0

The table shows that Thyspunt, and by implication the Eastern Cape, will benefit more than the other two sites in the Western Cape from a nuclear power station, if viewed from the angle of unskilled employment opportunities.

3.2.2 Comparison of Three Sites

The detailed results, as obtained from the cost comparison model, for the three proposed nuclear sites are reflected in Table 3.24.

Table 3-24: Comparison of Cost-effectiveness Values as Used in the Model, R million (2008 prices)

	Discount Rate: 8%	**Thyspunt**	**Bantamsklip**	**Duynefontein**
	Cost Factors	**PV**	**PV**	**PV**
1	**Land**	5.92	3.38	0.00
2	**Construction**			
2.1	**Site Preparation**			
2.1.1	**Sand removal & Disposal**	95.28	150.63	96.89
2.1.2	**Bedrock removal and disposal**	42.37	71.69	76.70
2.2	**Reactor**			
2.2.1	**Reactor Constant Cost**	101,902.31	101 ,902.31	101, 902.31
2.2.2	**Reactor Relative variable Cost Items**			
2.2.2.1	**Construction Support Services Transport**	156.50	167.45	54.77
2.2.2.2	**Construction Steel - transport**	96.04	122.06	115.28
2.2.2.3	**Construction Concrete & Bricks - transport**	89.79	158.47	55.45
2.2.3	**Foreign Import Material**			
2.2.3.1	**Import Material, Port to site (Abnormal load)**	489.40	1 441.49	350.23
2.2.3.2	**Import Material, Port to site (Normal load)**	39.56	29.36	8.27
2.2.4	**Construction Labour Cost**			
2.2.4.1	**Construction village Capital**	1,969.58	1,969.58	1,792.48
2.2.4.2	**Construction village Transport cost**	314.83	125.93	198.69
2.2.4.3	**Construction Camp Capital**	227.35	227.35	227.35
2.2.4.4	**Construction Camp Transport cost**	123.96	49.58	84.29
2.2.4.5	**Labour Difference in Numbers during Construction**	0.00	0.00	0 00
2.3	**Access Roads**			

	Discount Rate: 8%	Thyspunt	Bantamsklip	Duynefontein
2.3.1	Capital Costs of access roads	539.39	122.59	204.31
2.4	Connection National Grid			
2.4.1	Capital Costs of Connection National Grid	3,778.63	9,068.71	3,636.04
2.4.2	Capital Cost – 132kV line - Duynefontein	119.07	0.00	0.00
2.5	Operational Externalities / Side effects			
2.5.1	Tourism Impacted construction phase	43.20	-81.85	24.99
2.5.2	Value of unskilled Job creation Construction Phase	-949.25	-444.19	0.00
3	Operational - Plant			
3.1	Electricity savings			
3.1.1	Power balancing	-1,339.99	-888.42	-833.84
3.1.2	Commencement delay	0.00	222.02	156.13
3.2	Operational Labour Cost			
3.2.1	Labour Difference in numbers	0.00	0.00	0.00
3.2.2	Labour Travel cost	229.60	91.84	156.13
3.3	Waste Removal			
3.3.1	Waste Removal Transport cost	6.83	6.91	5.31
3.4	Supporting Service Industries			
3.4.1	Supporting Service Transport Costs	2.15	2.66	0.28
3.5	Operational Externalities / Side effects			
3.5.1	Tourism Impacted operational phase	26.83	-332.01	0.00
3.5.2	Agriculture Normal	18.75	0.75	0.00
3.5.3	Aquaculture	0.00	0.00	0.00
3.5.4	Fishing around each site	84.20	0.00	0.00
3.5.5	Value of unskilled Job creation	-263.62	-88.03	0.00
	Total	107,711.85	114,100.01	108,281.58

In Table 3.24 a negative value represents a relative benefit to a specific site. Table 3.25 shows the cost differences between the three sites.

Table 3-25: Cost Differences between the Proposed Nuclear-1 Sites

	Thyspunt	Bantamsklip	Duynefontein
Difference relative to Thyspunt (R million)	n/a	R6, 388	R570
Difference relative to Thyspunt (%)	n/a	5.93%	0.53%
Difference relative to Duynefontein (R million)	n/a	R5 ,818	n/a
Difference relative to Duynefontein (%)	n/a	5.37%	n/a

It is evident that the three sites do differ, ***but not by significant margins.*** Thyspunt is about 6% more cost-effective than Bantamsklip, and less than 1% more cost-effective than Duynefontein. This constitutes a difference between Duynefontein and Bantamsklip of R6.388 billion, and between Thyspunt and Duynefontein of R 570 million. It must be mentioned that, although R6.388 billion and R 570 million are very large amounts, ***especially in terms of the opportunity costs of other projects foregone (low-income housing being an example),*** they are relatively small amounts in terms of the total estimated cost of a nuclear power station (R170 billion in 2008 prices).

In Table 3.26 the relative advantages and disadvantages of the various sites are shown, again only for information purposes.

Table 3-26: Cost Assessment of the Three Sites

Key: * - Minor , ** - Significant, *** - Major			
Advantages		**Disadvantages**	
Aspect	**Rating**	**Aspect**	**Rating**
Thyspunt			
Value of unskilled job creation (construction phase)	**	Labour Travel cost Ops Phase	*
Power balancing	**	***Bedrock removal and disposal***	*
Value of unskilled job creation (ops phase)	*		
Bantamsklip			
Construction village Transport cost	*	Bedrock removal and disposal	**
Capital costs of access roads	*	Import Material, Port to site (Abnormal load)	**
Tourism Impacts (construction phase)	*	Capital Costs of Connection National Grid	***
Duynefontein			
Value of unskilled job creation	*	Commencement delay	**
Construction phase	*		
Construction support Services Transport	*	Bedrock removal and disposal	*
Tourism Impacts (operational phase)	*		
Construction Village capital	*	Commencement delay	*
Labour differences in numbers (cons)	*		
Labour difference in numbers (ops phase)	*		

3.2.3 Sensitivity Analysis

3.2.3.1 Discount Rates

To test the confidence level of the results, a sensitivity analysis has been performed with various real discount rates, i.e., 5 %, 8 % and 10 %. The 5 % is used as it is often the accepted discount rate for projects affecting the environment, while 10 % is the rate used by the World Bank to evaluate projects. The results in Table 3.27 indicate that there is no noticeable difference across these three discount rates***, and that the outcome still favours the Thyspunt site.***

Table 3-27: Sensitivity Analysis

Discount rate: 5%			
	Thyspunt	**Bantamsklip**	**Duynefontein**
Difference relative to Thyspunt (R Million)	N/A	7,134	833
Difference relative to Thyspunt (%)	N/A	5.75%	0.68%
Discount rate: 8%			
Difference relative to Thyspunt (R Million)	N/A	6,269	451
Difference relative to Thyspunt (%)	N/A	5.79%	0.42%
Discount rate: 10%			
Difference relative to Thyspunt (R Million)	N/A	5,751	283
Difference relative to Thyspunt (%)	N/A	5.79%	0.29%

3.2.3.2 The Value of Unskilled Job Creation

As the economic importance of the value of unskilled employment creation is used in the model, it is necessary to evaluate the impact of this item on the final result. In Table 3.28 the relative impact of the value of the unskilled labour is presented.

Table 3-28: Standard Scenario: Including Value of Unskilled Job Creation

	Thyspunt	Bantamsklip	Duynefontein
Difference relative to Thyspunt (R Million)	N/A	6,269	833
Difference relative to Thyspunt (%)	0.16%	6.43%	0.71%
Alternative Scenario: Ignoring value of unskilled job creation			
Difference relative to Thyspunt (R Million)	N/A	5, 909	224
Difference relative to Thyspunt (%)	N/A	5.46%	0.21%

The table shows that removing the value of the unskilled labour has an inconsequential effect on the figures in the base scenario.

3.2.4 Discussion

The main conclusion of the analyses is that there is no significant difference in the cost-effectiveness comparison between the three sites. Although there are noticeable differences in the magnitude of certain cost elements, the relative differences are minor. Thyspunt is the most cost-effective with a 5.8% cost advantage over Bantamsklip and a less than 1 % advantage over Duynefontein. However, if the "value of unskilled labour" is removed from the model, Thyspunt and Duynefontein are for all practical purposes on par, while Bantamsklip remains the least cost-effective option ***from a national viewpoint***. The sensitivity analysis shows no deviation from the base scenario, further supporting the results.

3.3 Macroeconomic Impact Analysis

In order to quantify the macroeconomic impact associated with the possible construction and operation of a new nuclear power station, a partial general macroeconomic equilibrium analysis was conducted. The nuclear power station is such a large capital investment (equivalent to that of six times the capital investment in Gautrain) that the economic ripple effects will go far beyond its direct boundaries. For this purpose the Eastern Cape was used as the economic service and support area for Thyspunt, and the Western Cape for the proposed nuclear facilities of Bantamsklip and Duynefontein. Macroeconomic impacts have been measured in terms of the following standard macroeconomic performance criteria:

- GDP (in order to assess the contribution to economic growth);
- capital formation (as an indicator of the demand for scarce production resources);
- employment creation (as an indicator of the impact on income distribution);
- low-income household income (as an indicator of the impact on poverty relief; and
- a series of social indicators.

3.3.1 Methodology

3.3.1.1 The Social Accounting Matrix

In undertaking a macroeconomic impact analysis of the three possible sites for a new nuclear power station, use was made of Social Accounting Matrices (SAMs) for the Eastern and Western Cape that were compiled as part of a recent project undertaken for the Development Bank of Southern Africa (DBSA) to produce provincial SAMs for all nine South African provinces. Box 1 below provides an overview of what a Social Accounting Matrix consists of, as well as its main uses.

Box 1: Overview of a Social Accounting Matrix

Social Accounting Matrix (SAM)
A SAM is a comprehensive, economy-wide database that contains information about the flow of resources that takes place between the different economic agents in an economy, i.e. business enterprises, households, government, etc., during a given period of time – usually one calendar year. A SAM is a presentation of the System of National Accounts (SNA) in a matrix format that incorporates an analysis of the interrelationships that exist between the various economic agents in the economy, including the distribution of income and expenditure amongst household groups, thereby providing the national accounts with a social dimension.

The SNA includes a consistent and integrated set of Supply and Use Tables (SU-Tables) that provide a detailed analysis of the process of production, the use of products/goods and services, and the income generated in their production. A SAM elaborates on the linkages between SU-Tables and institutional sector accounts. As stated earlier, it is a presentation of the SNA in matrix format that incorporates whatever degree of detail that might be of special interest.

There are two key reasons for compiling a SAM:

- First, a SAM provides a framework for organising information about the economic and social structure of a particular geographical entity (i.e., a country, region or province) for a particular time period, and
- secondly, to provide a database that can be used by any one of a number of different macroeconomic modelling tools for evaluating the impact of different economic decisions and/or economic development programmes.

The SAM's main contribution in the field of economic policy planning and impact analysis is divided in two categories:

As a Primary Source of Economic Information
Being a detailed and integrated national and regional accounting framework consistent with officially published socio-economic data, a SAM instantly projects a picture of the nature of a country's or region's economy. It lends itself to both descriptive and structural analysis.

As a Planning Tool
Due to its mathematical/statistical underpinnings it can be transformed into a macro-econometric model that can be used to:

- conduct economic forecasting exercises and scenario building;
- conduct economic impact analysis, both for policy adjustments at a national and provincial level, and for large project evaluation;
- self-sufficiency analysis, i.e. gap analysis to determine, with the help of the inter-industry and commodity flows contained in the provincial SAM, where possible investment opportunities exist; and
- calculate the inflationary impacts of price changes instigated at a national level (i.e., administered prices, VAT, etc.)

To sum up, the SAM mechanism provides a universally acceptable framework within which the economic impact of development projects and policy adjustments can be reviewed and assessed at both national and provincial/regional levels. It serves as an extension to the official National Accounts of a country's economy, and therefore provides a wealth of additional information, especially when disaggregated to more detailed levels.

3.3.1.2 Macroeconomic Impacts

In this particular study, the relevant SAMs were used to measure the quantified macroeconomic impact of a new nuclear power station in terms of its construction and operational activities. The impact is measured through a number of standard macroeconomic performance criteria which form part of the partial equilibrium model, viz:

- Impact on GDP - The value of the additional GDP that will be generated in either the Eastern or Western Cape provinces as a result of the construction and operation of a new nuclear power station.
- Impact on capital formation - for an economy to operate at a specific level, an amount of capital stock is needed to support such a level of activity. Capital, together with labour and entrepreneurship, form the basic factors needed for production in the economy. The effectiveness and efficiency with which these factors are combined influence the overall level of productivity/profitability of the production process.
- Impact on employment creation - as indicated above, labour is a key component of the production process. This study has determined the number of new employment opportunities that will be created by the construction and operation of a new nuclear power station. The employment opportunities created during the construction phase will be temporary, while those created during the operational phase will mostly be permanent.
- Impact on low-income households - additional employment means additional remuneration of employees, which obviously affects household income. This study measured the magnitude of the changes that will occur to household income as a result of the construction and operation of a new nuclear power station. The specific impact on low-income household income was isolated, measured, and reported on.
- Social impacts - the government is directly or indirectly affected by changes in economic activities occurring within the various sectors of the economy. Usually, government receives more income in the form of property tax/income, direct tax (mainly personal tax and company tax), indirect tax (VAT – which results from additional household spending and customs and excise taxes), and transfers. Depending upon the government's social spending priorities and funding capabilities, there are a number of social objectives that could be further emphasised from the construction and operation of a new nuclear power station, such as an increase in:
- the number of hospital beds that can be provided and supported each year;
- the number of doctors that can be trained, employed and supported each year;
- the number of educators that can be trained, employed and supported each year; and
- the number of low-cost houses that can be built each year.

3.3.1.3 Direct, Indirect, and Induced Impacts

The various impact figures presented in this section reflect total impacts and, as such, include direct, indirect and induced impacts. Box 2 provides an explanation of these three different types of impacts.

Box 2: Direct, Indirect, and Induced Impacts

Direct Impacts
These are the impacts occurring within a particular sector on the sector itself. For instance, direct impacts will measure the impact that the construction and operation of a new nuclear power station will have on GDP, capital formation, employment creation, etc., within the electricity-generation sector itself. These direct impacts are most closely related to the sector itself and, as such, are probably the most important impacts from a strategic planning point of view.

Indirect Impacts
These are the impacts that a particular sector will have on all other sectors that supply inputs (i.e., raw materials, services, etc.) to the sector that is directly affected. These 'backward linkages' are important as they measure the broader impact that changes in the direct sector will have on the broader economy. Frequently, these indirect impacts are very significant, and may even exceed the direct impacts themselves.

Induced Impacts
Economic impacts will result from the paying out of salaries and wages to people who are employed in a particular direct sector, as well as the salaries and wages paid by businesses operating in the sectors indirectly linked to this sector due to the supply of inputs. These additional salaries and wages lead to an increased demand for various consumable goods that need to be supplied by various other economic sectors throughout the broader economy. Clearly, these induced impacts can be considerable.

3.3.1.4 Analysing the Economic Impacts of the Construction and Operational Phases

In undertaking the macroeconomic impact analysis, a distinction has been made between the economic impact of the construction phase and that of the operational phase. The reason for this distinction is that, generally, the impact of the construction phase of a large project is relatively short-lived while the impact of the operational phase can extend over a number of decades. In this study, construction of a new nuclear power station was assumed to last seven years, while the operational phase of a nuclear power station was done for 23 years. The total period of 30 years was analysed as any longer period becomes statistically insignificant. Thus, although a nuclear power station will operate for 60 years, it becomes meaningless to estimate the remaining 37 years of operation. The results are eventually expressed as macro-economic impacts per annum. In the case of the construction period there might be variations as the building activities initially increase and then decrease towards the end.

The results of the macroeconomic impact analysis of the construction phase have been presented as an annual average impact over the estimated seven-year construction period. In the case of the operational phase, the results of this analysis are presented as the impact that will occur in each year of the lifetime of a new nuclear power station, starting at the end of the construction period.

3.3.2 Results of the Macroeconomic Impact Analysis

This section presents the results of quantifying the economic impact of constructing and operating a new nuclear power station at each of the three sites. In each instance, impacts are presented separately for the construction and operational phases.

3.3.2.1 Thyspunt

Construction Phase

The table below presents the impact results of constructing a new nuclear power station at the Thyspunt site. Total macroeconomic impact results, ***which include the aggregated direct, indirect and induced impacts***, are presented,. These total impacts are presented as average annual impacts over the seven-year construction period, i.e. these total impacts will occur in each of the seven years of the construction phase.

Table 3-29: Annual Economic Impact in the Eastern Cape of Constructing Nuclear-1 at the Thyspunt Site (constant 2008 prices)

		Total impact per annum
Macroeconomic Indicators	a. GDP (R million)	5,527
	b. Capital formation (R million)	10,186
	c. Employment (numbers)	67,673
	d. Household income	
	• Low-income household income (R million)	352
	• Medium and high-income HH income (R million)	2,347
	• Total household income (R million)	2,699

Table 3.29 indicates that the construction phase of Nuclear-1 at the Thyspunt site will have a significant positive impact on the economy of the Eastern Cape, as well as the local economy. The macroeconomic analysis indicates that:

- An additional amount of R5.5 billion will be contributed to provincial GDP during each of the seven years of the construction phase. This annual figure is equivalent to about 3.1 % of current GDP in this province.
- An additional amount of R10.2 billion will be invested in the province during each of the seven years of the construction phase. This figure represents the total amount invested by all sectors directly and indirectly influenced by the construction of a new nuclear power station. This annual figure is equivalent to 46.4 % of total current annual investment in this province.
- An additional 67,673 jobs can be sustained for the seven years of the construction phase. This figure is equivalent to about 6% of the total number of people currently employed in this province as reflected in the 2007 Labour Force Surveys.
- An additional amount of R2.7 billion will be added to total household income in this province during each of the nine years of the construction phase. This annual figure is equivalent to 3% of total current household income in this province. Of this total additional annual household income:
    - R0.35 billion will accrue to low-income households (13 %); and
    - R2.3 billion will accrue to medium-to-high-income households (87 %), which reflect the fact that constructing a new nuclear power station requires mostly semi-and highly skilled people.

Operational Phase

Table 3.30 presents the impact results of operating Nuclear-1 at the Thyspunt site. In this instance, direct, indirect, induced and total impacts are presented for the macroeconomic indicators (i.e., GDP, capital formation, and employment creation), while only total impact results are presented for household income and the social indicators.

Direct impacts reflect only the impact of a standard new nuclear power station. All other direct impacts of the externalities emanating from the electricity-generation sector, as well as modifications to the standard nuclear power station necessitated by the location and topography of individual sites, are included as indirect impacts.

Table 3-30: Annual Economic Impact of Operating Nuclear-1 at the Thyspunt Site (constant 2008 Prices)

		Direct	Indirect	Induced	Total
Macroeconomic indicators	a. GDP (R mil)	4,429	4,383	557	9,369
	b. Capital formation (R million)	170,000	804	1,262	172,066
	c. Employment (numbers)	1,340	2,624	5,460	9,424
	d. Household income				
	• Low-income household income(R million)				299
	• Medium and high-income HH (R million)				1,200
	• Total household income (R million)				1,499
Social Indicators	A. Additional number of educators				3,157
	B. Additional number of hospital beds serviced				680
	C. Additional number of doctors				71
	D. Additional number of low- cost houses				2,968

The table above indicates that operating Nuclear-1 at the Thyspunt site will create:

- An additional annual amount of R9.4 billion that will be contributed to GDP in this province. This will add about 5 % to current provincial GDP. Of this amount, R4.4 billion (47 %) is contributed directly by the electricity-generation activity or process.
- An additional amount of R172 billion that will be added to provincial capital stock, of which R170 billion (99 %) is added directly by investing in the electricity-generation facility. The investment of this amount is now sustaining the rest of the impacts namely GDP, employment, etc., on an annual basis.
- An additional 9,424 jobs that will be sustained in this province over the operational lifetime of this power station, where only 1,340 (14 %) occur directly in the electricity-generation part with 28% being created in the sectors that are backwardly linked, and 58% of jobs being created as a result of induced impacts throughout the broader economy due to the paying of salaries and wages that, in turn, give rise to increased consumption expenditure.
- An additional amount of R1.5 billion will be added to total household income in this province during each year of the operational life time of this nuclear power station – of this total additional annual household income:
  - R0.3 billion will accrue to low-income households (20 %), and
  - R1.2 billion will accrue to medium-to-high-income households (8 %), which reflects the fact that operating a nuclear power station requires mostly semi- and highly skilled people

With regard to the social indicators, this analysis suggests that, depending upon the national and provincial governments' social spending priorities in the Eastern Cape, the additional tax will be able to:

- Employ and support an additional 3,157 new educators in each year during which this power station remains operational;
- Provide and service an additional 680 new hospital beds in each year during which this power station remains operational;

- Employ and support an additional 71 new doctors in each year during which this power station remains operational; and
- Construct an additional 2,968 new low-cost houses in each year during which this power station remains operational. Over a ten-year period, this amounts to almost 30,000 new low-cost houses being built.

The above information is provided in order to indicate the magnitude of the social benefits that could flow from the operation of Nuclear-1 in the Eastern Cape, based on the additional government revenue that will be generated in the system in all spheres of government in the form of all kinds of taxes and levies. It is important to recognise that the cost of providing these social benefits includes the direct capital costs associated with buildings and equipment, plus direct salaries paid to educators and doctors, as well as all of the associated overhead costs associated with maintaining buildings and equipment, and supporting these education and health care professionals. Although it is accepted that the provision of this social infrastructure will depend on a number of practical factors like the cost of provision of the service, it is still a valid indication of what can be accomplished by the extra income to the fiscus.

The above figures indicate that operating Nuclear-1 at Thyspunt will have a significant impact on the Eastern Cape economy. As in the case of the construction phase, the most pronounced impact will occur in the area of capital formation. However, this nuclear power station will also have marked impacts on all of the other macroeconomic performance indicators throughout the province, particularly when one considers that this is a single but very large project, making it possible, with an assured power supply for other businesses to relocate to the province. A lot has been written about projects (which have been put on hold because of power shortages) in the Coega Industrial Development Zone. A nuclear power station at Thyspunt would help to fast-track their development process.

3.3.2.2 Bantamsklip

Construction Phase

The table below presents a summary of the impact results of constructing Nuclear-1 at the Bantamsklip site in the Western Cape. Only the total impact results are presented, which include the aggregated direct, indirect, and induced impacts. These total impacts are presented as average annual impacts over the nine-year construction period, i.e., these total impacts will occur in each of the nine years of the construction phase.

Table 3-31: Annual Impact of Constructing Nuclear a Power Station at the Bantamsklip Site (constant 2008 prices)

		Total Impact per Annum
Macroeconomic Indicators	a. GDP (R million)	6,961
	b. Capital formation (R million)	12,943
	c. Employment (numbers)	94,906
	d. Household income	
	• Low-income household Income (R million)	109
	• Medium and high-income HH Income (R million)	2,656
	• Total household income (R million)	2,766

The above table indicates that the construction phase of Nuclear-1 at the Bantamsklip site will create:

- An additional amount of R6.9 billion that will be contributed to provincial GDP during each of the nine years of the construction phase. This annual figure is equivalent to about 2.1 % of current GDP in this province.
- An additional amount of R12.9 billion that will be added to the provincial capital stock during each of the nine years of the construction phase. This figure represents the total amount invested by all sectors directly and indirectly influenced by the construction of a new nuclear power station. This annual figure is equivalent to 18.4 % of total current investment in this province.
- An additional 94,906 jobs, direct, indirect and induced that can be sustained for the nine years of the construction phase in this province. This figure is equivalent to about 4.8 % of the total number of people currently employed in this province as reflected in the 2007 Labour Force Survey.
- An additional amount of R2.6 billion being added to total household income in this province during each of the nine years of the construction phase. This annual figure is equivalent to 2% of the total GDP in this province – of this total additional annual household income:
    - R0.1 billion will accrue to low-income households (4 %), and
    - R2.7 billion will accrue to medium-to-high-income households (96 %).

Operational Phase

The table below presents the results of operating a nuclear power station at Bantamsklip site. In this instance, direct, indirect, induced, and total impacts are presented for the macroeconomic indicators (i.e. GDP, capital formation, and employment creation); whilst only total impact results are presented for household income and the social indicators.

Table 3-32: The Impact of Operating a Nuclear Power Station at the Bantamsklip Site (constant 2008 prices)

		Direct	Indirect	Induced	Total
Macroeconomic indicators	a. GDP (R million)	4,446	324	817	5,587
	b. Capital formation (R million)	170,000	6,562	1,635	178,197
	c. Employment (numbers)	1,340	3,185	7,338	11,863
	d. Household income				
	• Low-income household income(R million)				R57
	• Medium and high-income HH(R million)				1,606
	• Total household income (R million)				1,664
Social Indicators	A. Additional number of educators				2,858
	B. Additional number of hospital beds serviced				615
	C. Additional number of doctors				64
	D. Additional number of low-cost houses				2,687

The table above indicates that operating a nuclear power station at the Bantamsklip site in the Western Cape Province will create:

- An additional annual amount of R5.6 billion that will be contributed to GDP in this province. Of this amount, R4.4 billion (80 %) is contributed directly by the electricity generation facility.
- An additional amount of R158,2 billion that will be added to provincial capital stock during each year of the operational life time of this power station, of which R150 billion (95 %) is added directly by the electricity-generation sector.

- An additional 11,863 jobs being sustained in this province over the operational lifetime of this power station, where only 1,340 (11 %) occur directly in the electricity generation sector, with 27 % of jobs being created in the indirect sectors, and 62 % of jobs being created as a result of induced impacts throughout the broader economy
- An additional amount of R1.7 billion that will be added to total household income in this province during each year of the operational life time of this power station – of this total additional annual household income:
  - R0.06 billion will accrue to low-income households (3 %), and
  - R1.6 billion will accrue to medium-to-high-income households (97 %).

With regard to the social indicators, this analysis suggests that, depending upon the Western Cape Provincial Government's social spending priorities, it will be possible to:

- Employ and support an additional 2,858 new educators in each year during which this power station remains operational;
- Provide and service an additional 615 new hospital beds in each year during which this power station remains operational;
- Employ and support an additional 64 new doctors in each year during which this power station remains operational; and
- Construct an additional 2,687 new low-cost houses in each year during which this power station remains operational.

3.3.2.3 Duynefontein

Construction Phase

The table below presents the results of constructing Nuclear-1 at the Duynefontein site. Only the total impact results are presented, which include the direct, indirect, and induced impacts aggregated together. These total impacts are presented as average annual impacts over the seven-year construction period, i.e. these total impacts will occur in each of the nine years of the construction phase.

Table 3-33: Annual Impact of Constructing a Nuclear Power Station at the Duynefontein Site (constant 2008 prices)

		Total Impact per Annum
Macroeconomic Indicators	a. GDP (R million)	6, 546
	b. Capital formation (R million)	12,143
	c. Employment (numbers)	91,194
	d. Household income	
	• Low income household income (R million)	104
	• Medium and high income HH income (R million)	2,479
	• Total household income R million)	2,583

Given the fact that the Duynefontein site is also in the Western Cape Province, most of the results of the macroeconomic impact analysis of constructing a new nuclear power station at this site are slightly lower but very similar to the results of constructing a nuclear power station at the Bantamsklip site.

Operational Phase

The table below presents the results of operating Nuclear-1 at Duynefontein. In this instance, direct, indirect, induced and total impacts are presented for the macroeconomic indicators (i.e. GDP, capital formation, and employment creation), while only total impact results are presented for household income and the social indicators.

Table 3-34: The Impact of Operating a Nuclear Power Station at the Duynefontein Site (constant 2008 prices)

		Direct	Indirect	Induced	Total
Macroeconomic indicators	a. GDP (R million)	4,429	330	803	5,562
	b. Capital formation (R million)	170,000	649	1,607	172,256
	c. Employment (numbers)	1,140	3,227	7,139	11,560
	d. Household income				
	• Low- income household income (R million)				56
	• Medium and high-income HH (R million)				1,577
	• Total household income (R million)				1,633
Social Indicators	a. Additional number of educators				2,842
	b. Additional number of hospital beds serviced				612
	c. Additional number of doctors				64
	d. Additional number of low-cost houses				2,671

As in the case of the construction phase, most of the results of operating a new nuclear power station at the Duynefontein site are slightly lower but very similar to those results achieved at Bantamsklip.

3.3.3 Analysis of the Three Sites

This section presents a comparison of the macroeconomic impact results of the construction and operation of Nuclear-1 at the proposed three sites, not to rank them but only to give an indication of the relative significance of the impacts.

3.3.3.1 Cost Components

The two tables below present a comparison of the various cost components associated with the construction and operation of a Nuclear Power Station at each of the three sites evaluated in this study. These cost figures have been used to set in motion the macro-econometric model used to generate the results presented in this report. In econometric terms these figures are also termed the exogenous variables of the econometric model.

Construction Costs

The construction cost figures presented in Table 3.35 represent total costs over the construction period. A few items (i.e. value of job creation) have been excluded from the macroeconomic analysis as these items represent monetary transfer volumes. They are viewed as transfer payments in the economy and, as such do not represent the use of scarce resources.

Table 3-35: Comparison of the Construction Cost Elements Associated with a Nuclear Power Station (constant 2008 prices, R millions)

		Thyspunt Eastern Cape	Bantamsklip Western Cape	Duynefontein Western Cape
1	Land	7	4	0
2	Sand removal and disposal on site	127	201	130
3	Water removal	1.3	0.9	1.1
4	Bedrock removal and disposal	57	96	5103
5	Reactor – constant cost	150,275	150,275	150,275
6	Construction support services, transport	231	247	81
7	Construction steel – transport cost	142	180	170
8	Concrete and bricks – transport	133	234	82
9	Import material, port to site (abnormal loads)	793	2,339	567
10	Import material, port to site (normal load)	52	39	11
11	Construction village – capital	2,024	2,024	1,513
12	Construction village – transport cost	503	201	317
13	Construction camp – capital	265	265	265
14	Construction camp – transport cost	199	79	134
15	Labour – difference in numbers	0	0	-173
16	Capital cost of access roads	660	150	250
17	Capital cost of connection – national grid	5,300	12,720	5,100
18	Tourism impact	65	-124	38
19	Value of job creation	-1,399	- 655	0

Operational Costs

The operational cost figures presented in the Table 3.36 below represent average annual costs over the 23-year operational phase analysed (running at full capacity).

Table 3-36: Comparison of the Operational Cost Elements Associated with a Nuclear Power Station (constant 2008 prices, R millions)

		Thyspunt Eastern Cape	Bantamsklip Western Cape	Duynefontein Western Cape
1	Power balancing	0	0	0
2	Commencement date	0	22	12
3	Labour – difference in numbers	0	0	-54
4	Labour – travel cost	45	18	26
5	Waste – removable – transport cost	1	1	1
6	Supporting services – transport cost	0.4	0.5	0.06
7	Tourism impact	7	0	0
8	Agriculture –normal	0	0	0
9	Aquaculture	0	1	0
10	Fishing	17	0	0
11	Value of job creation	0	0	0
12	Selling of electricity	6,093	6,093	6,093

3.3.3.2 Comparison between sites of the Macroeconomic Impact Results for the Construction Phase

Table 3.37 presents a comparison of the macroeconomic impact analysis results from constructing a nuclear power station at each of the proposed sites.

It appears that during the construction phase each of the sites will have significant benefits to the local communities and respective provinces. However, it appears as if the two Western Cape sites will have a larger impact than the Eastern Cape site, because of ***greater leakages (i.e., money spent on goods and services that are***

not available locally) at the latter. The Western Cape economy is considerably larger than that of the Eastern Cape, and thus will be able to supply more services and material to the construction process; ***this also explains the higher number of jobs created in the Western Cape than the Eastern Cape.***

Table 3-37: Comparison of the Macroeconomic Impact Results of the Construction Phase

		Thyspunt	Bantamsklip	Duynefontein
Macroeconomic Indicators	a. GDP (R millions)	5,527	6,961	6,546
	b. Capital formation (R millions)	10,186	12,943	12,143
	c. Employment (numbers)	67, 673	94,906	91,194
	d. Household income:			
	• Low-income households (R millions)	352	109	104
	• Med & high-income households (R millions)	2,347	2,656	2, 479
	• Total household (R millions)	2, 699	2,766	2, 583

3.3.3.3 Comparison of the Macroeconomic Impact Results of the Operational Phase

Table 3.38 below presents the results of a macroeconomic impact analysis of operating a Nuclear Power Station at each of the three sites. Results are presented for the macro-economic and social indicators.

Table 3-38: Comparison of the Macroeconomic Impacts Results of the Operational Phase

		Thyspunt	Bantamsklip	Duynefontein
Macroeconomic Indicators	a. GDP (R millions)	9,369	5,587	5,562
	b. Capital formation (R millions)	172,066	178,198	172, 572
	c. Employment (numbers)	9,425	11,863	11,560
	d. Household income:			
	• Low-income household (R millions)	299	57	56
	• Med & high-income household (R millions)	1,200	1,606	1,577
	• Total household income (R millions)	1,499	1,664	1,633
Social indicators	a. Additional number of educators	3,157	2,858	2,842
	b. Additional number of hospital beds serviced	680	615	612
	c. Additional number of doctors	71	64	64
	d. Additional number of low-cost houses	2,968	2,687	2,672

The macroeconomic results for the operational phase confirm the results of the construction phase in that a nuclear power station would have a very positive impact on the economy of the two provinces. Moreover, in the case of the two sites in the Western Cape the impact will be more at the provincial level than in the case of the Thyspunt site in the Eastern Cape.

3.3.3.4 Decommissioning

The issue around decommissioning and economic impact of the action will be driven and influenced by a number of factors including the following:

- If the nuclear power station operates for its full anticipated lifetime of 60 years, it will be a closing down exercise with very little difference between the sites except for the cost of removing the nuclear waste where the actual disposal site is located further from the one proposed site than the other[3]***. In international practice, it is customary to use a figure of 15% in estimating the cost of decommissioning a nuclear power plant. If this is applied to the constant estimated reactor cost, a figure of between R17.5 and R20.0 billion in 2009 prices is projected as the cost.***

- Further scientific development over the lifetime of the plant can also mean that the plant can be revitalised and the lifetime extended. The present mothballed coal-fired power stations of Eskom are an example, where updating them has added fifteen plus years to their productive lives. Again, very little difference between the three sites will exist.
- The third issue to be considered is that if the envisaged Eskom nuclear programme materialises, more than one unit will by then be constructed at each site, with the expertise and know-how available to proceed with the decommissioning if still necessary.

3.3.4 Conclusions of the Macroeconomic Impact Analysis

The results of the macroeconomic impact analysis indicate that the construction and operation of Nuclear-1 will have a significant impact on the economies of both the Eastern and Western Cape provinces.

The overall ***positive*** impacts will be greater in the Western Cape (i.e., at Bantamsklip or Duynefontein). The reason for this is that this province has a larger, more diversified economy, with the result that more of the inputs required to construct and operate Nuclear-1 can be provided from within the provincial economy, and more of the household income that flows from this project will be spent within the boundaries of the province.

By contrast, the smaller, less-diversified Eastern Cape economy will not be able to supply as many of the inputs required, nor will it be able to retain as much of the household income, with the result that the macroeconomic impact of establishing a Nuclear Power Station at Thyspunt produces less of an impact for this province’s economy.

However, if one considers poverty alleviation as an important criterion in the location decision, then factors such as the impact on low-income households, the impact of the social indicators, and the opportunity to grow the economy of a province as reflected by the impact on GDP become much more significant. In this instance, the results of this exercise suggest that locating the Nuclear Power Station at Thyspunt would produce a larger impact than the two Western Cape sites. However, all three sites would be major positive economic growth generators in their respective regions and provinces.

3.4 Summary of Quantitative Analysis

The objective of this section of the study was twofold: first, to analyse the economic cost-effectiveness of the three sites and, secondly, to determine the broader macroeconomic impact of the three sites on their relevant economic support base. The cost-effectiveness study includes the capital and operational costs of the service

[3] ***It must be noted that South Africa does not have a designated long-term storage facility for spent fuel (High-Level Nuclear Waste) and that the current proposal is for spent fuel to be stored on the power station site indefinitely. Vaalputs in the Northern Cape, is currently only licensed for Low-Level and Intermediate-Level Radioactive Waste, The Department of Energy has not yet taken any decision on whether Vaalputs should in future also apply for licensing for High-Level Radioactive Waste. Until such time, no comparison can be made between the sites for the costs of transporting High-Level Nuclear Waste during decommissioning.***

provider as well as the costs to the community, taking into account the positive and negative externalities on the economy and the environment. The macroeconomic study has the objective of estimating the contribution to economic growth as well as looking at the distribution of income through the ability of a nuclear power station to create employment in its specific service support and impact area.

The quantitative analysis shows that, in terms of economic parameters, the differences between the three sites are not large. All three sites will have a very large positive economic impact on the immediate area as well as the province in which they are situated.

3.5 Climate Change

Before an evaluation of the possible impact of climate change on the construction and operation of a nuclear power station, it is necessary to first determine what is meant by climate change and then determine possible economic impacts.

The following is a definition that appears to answer the question: Climate change is associated with past observable changes and future projections for various climatic indicators, such as temperature, precipitation and wind velocity. Scientists tracking these changes globally have found sufficient evidence of change in climatic indicators to say with certainty that climate change is occurring (IPCC Fourth Assessment Report, 2007).

According to the literature, global temperature changes are affecting the tempo of ice melting at the poles which eventually can lead over time to dramatic sea-level changes and a possible increase in the number and intensity of sea and coastal storms.

3.5.1 Nuclear power station construction and operation

The next pressing question is: will the construction and operation of Nuclear-1 impact on the economic fluctuations caused by climate change? It appears as if scientists regard climate change as a given, and the specialists could not find any evidence that the construction and operation of a nuclear power station will impact on the possible risk of climate change at any of the three identified sites. The question that should be answered, then, is rather: how would the possibility and associated risk of climate change affect the construction and operation of Nuclear-1 at a specific site?

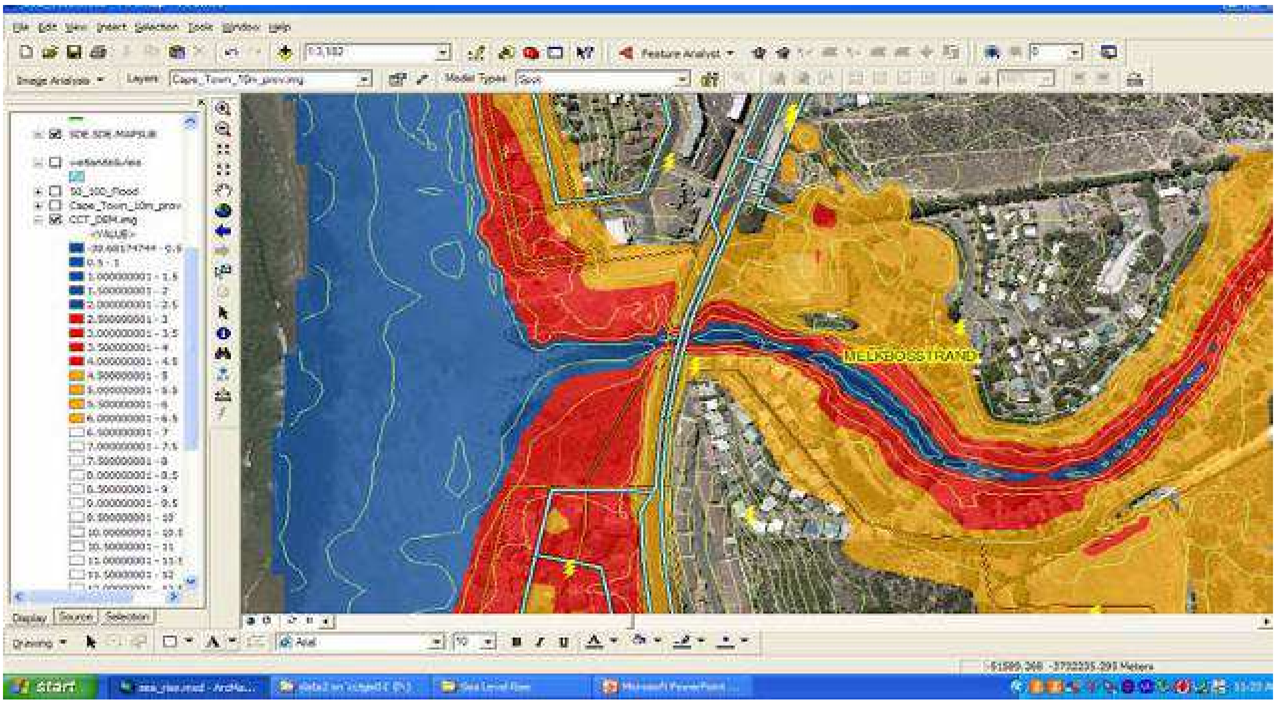
3.5.2 Available information

According to a report commissioned by the City of Cape Town (LaquaR Consultants CC, 2008) the City administers approximately 307 km of coastline, arguably its single greatest economic and social asset. In October 2003 the City formally adopted a Coastal Zone Management Strategy with the intention of managing and safeguarding the coastal asset for current and future generations.

The City's coast provides a range of social and economic opportunities, including recreational. The risks generated by sea-level rise should be seen in the context of the set of risks that climate is likely to create. It is the combination of climate change risks that is likely to be most damaging to South Africa. More important, a number of the potential responses to climate change risk, such as improved institutional coping capacity and better information, will mitigate risk across the spectrum of climate change events. For this reason, responses to sea-level rise should be seen in the context of broader climate change adaptation efforts, but this does not remove the need for certain sea-level measures."

From the above quotation it appears that the City of Cape Town regards sea level rise as a consequence of climate change, and that this must be taken into consideration in future planning and development.

The following graphics show the anticipated possible effects of a rising sea level at Melkbosstrand, about 7 kilometres south of the present Koeberg Nuclear Power Station and the new Duynefontein site. The graphic is from the same publication.



The blue area indicates the loss of coastal amenity and infrastructure at Melkbosstrand with a 2.5 m, the red with a 4.5 m and the orange with a 6.5 m rise in the sea level. According to the above graphics a considerable coastal area will be flooded if, in the next 20-30 years, the sea level rises by 2.5 m. This specific site is about 7 km from the present Koeberg site and the identified Duynefontein site.

Without commenting on the validity of the applicable scientific methodologies and the accompanying risk assessment, we would for the rest of the report accept that the most conservative scenario, namely, a 2.5 m sea-level rise, is the one that could materialise. This will be used as a benchmark for the comparison of the three different sites and the possible economic and financial impacts.

However the study ***(Estimating the 1:100 Year Flood Line from the Sea)*** done for Nuclear-1 came to the conclusion that the sea level elevations will be less dramatic than those emanating from the City of Cape Town study. It forecasts a maximum ***increase in sea levels of*** 1.3m for Thyspunt, 1.4m at Bantamsklip and 1.1 m at Duynefontein.

The economics team has decided that as both groups are basing their forecasting on probabilities we would for rather base our analysis on the more drastic impacts, which would then include the less drastic impacts.

3.5.3 Possible Preventive Measures

This study is not aimed at finding permanent solutions for the impact of rising sea levels on coastlines, but rather at establishing a benchmark which could be used to compare the three sites if a 2.5 m rise in sea levels materialises.

Possible solutions identified and applied with different success rates worldwide are hard engineering techniques such as seawalls, groynes, detached breakwaters and revetments. Other possible solutions could involve moving the construction platform to a site above the predicted waterline so as to minimise the risk of flooding.

3.5.4 Financial Implications

The total construction cost for the nuclear power station consists of the so-called standard reactor costs which are the same for all three sites, and then the site-specific costs as defined previously, namely roads, connection to the main grid, site preparation and other costs. The standard reactor costs, in turn, comprise three main sections, i.e. civil, electrical and mechanical. If it is accepted that part of the solution is engineering structures, they will probably involve on-site civil structures and strengthening the civil part of the standard reactor cost. As these measures would differ from site to site, because of the different physical conditions encountered at each, there would be different construction cost implications for the three sites.

The other possible solution could be to move the construction platform back, thereby reducing the possible risk of flooding. This, however, could also have financial implications in terms of construction costs, specifically as far as the cooling water inlet and outlet systems are concerned.

3.5.5 Site Analysis

3.5.5.1 Duynefontein

The proposed Duynefontein site is just west of the present Koeberg Nuclear Power Station. The picture below gives an indication of Koeberg from ground level.

Figure 3.2: Koeberg Nuclear Power Station

As previously stated, the Duynefontein site is about 7km from Melkbosstrand where predictions indicate major flooding if the sea level rises by 2.5 m. The physical conditions on the beach at Duynefontein are very similar to those at Melkbosstrand, and a 2.5m sea-level rise would probably flood large parts of the present Koeberg Nuclear Power Station, specifically the cooling water inlet system, as shown in the picture below.

Figure 3.3: Koeberg Nuclear Power Station from the air

In summary:

- The beach and immediate hinterland are very flat, and a 2.5 m sea-level rise could cause considerable flooding.
- The cooling water inlet structure could be affected.
- If the present construction platform is retained, then major civil works will be necessary to safeguard the nuclear power station.

3.5.5.2 Bantamsklip

The Bantamsklip site is not as flat as, and the sea is also deeper than at Duynefontein, which makes it possible to change the water inlet considerably. Present planning makes provision for a sea inlet using pipes to provide water to the NPS. The proposed construction platform site is also slightly higher than the one at Duynefontein. The photo below gives an indication of the physical properties of the site.

Figure 3.4: Proposed Bantamsklip nuclear power station site

If the present construction platform is maintained, certain civil structures would have to be put in place to safeguard the NPS against a possible 2.5m flooding. However, it appears unlikely that flooding would be as drastic as in the case of Duynefontein.

If the construction platform is moved inland, the flooding risk would be minimal, but the construction cost associated with the cooling water inlet will increase.

3.5.5.3 Thyspunt

The Thyspunt site is quite elevated and there is very little beach area as demonstrated by the following picture.

Figure 3.5: The Thyspunt proposed NPS site

The proposed construction platform is above the 2.5 m flood line and therefore a 2.5 m flood would not affect the proposed nuclear power station at all. The sea is also very deep, and an extended water inlet would not be necessary. It appears, then, that a 2.5 m sea-level rise would not affect the present construction platform.

3.5.6 Discussions of different sites

While construction and operation of a nuclear power station will not influence the possibility of climate change, climate change will have different financial implications for the different sites. In Table 3.39 the possible severity of the financial and economic impact is shown.

Table 3-39: Financial and Economic Impact of Climate Change by Site

	Impact		
	Thyspunt	**Bantamsklip**	**Duynefontein**
Present construction platform			
Flooding risk – main body	None	Medium	Severe
Flooding risk – water inlet	None	Minimal	Present – Severe Piping - Minimal
Construction Platform inland			
Flooding risk- main body	None	None	Minimal
Flooding risk – water inlet	None	Minimal	Present – Severe Piping - Minimal

From the above table it appears that the climate change scenario with a 2.5m sea-level rise would have the worst impact on Duynefontein in terms of the accompanying financial construction cost increase. It will have the least impact on Thyspunt with no financial impact on the construction of a nuclear power station at the present identified construction platform. From a climate change perspective, the Duynefontein site is very exposed, although from an economic viewpoint it is slightly more preferable than the Thyspunt site. However, the additional cost of securing the civil works at Duynefontein against flooding would swing the pendulum in favour of Thyspunt.

3.6 Summary of Qualitative Analysis

Duynefontein is part of the third largest metropolitan economy in South Africa. The area is better endowed with physical and social infrastructure – roads, port, housing, skills, educational and health facilities, commercial and financial services − than are Bantamsklip and Thyspunt to absorb a nuclear power station. There are no sectors which would appear to be adversely affected by the normal operation of a nuclear power station.

The economy around the Thyspunt site is more developed and sophisticated than in the Bantamsklip area. It is better located in relation to transport routes, sitting astride the N2, and it has a more diversified commercial sector and social facilities. The potentially sensitive economic activities around these two sites are limited to fishing at Thyspunt and shark-cage diving and whale-watching at Bantamsklip. Overall, the Thyspunt economy would be likely to suffer fewer disturbances than that at Bantamsklip.

The qualitative analysis shows that a nuclear power station would result in least disturbance at Duynefontein, followed by Thyspunt and Bantamsklip.

3.7 No-go Areas and Preferred Location on Site

Neither the qualitative nor the quantitative assessments have found that there are any "no-go" areas or a particular preferred location of the power station on any of the site plans provided to the consultants, nor did they find at Duynefontein that there would be any cumulative negative impacts on the economy from the addition of the proposed Nuclear Power Station, Pebble Bed Modular Reactor and training centre facilities on the site. These additional facilities would be highly unlikely to halt the continued expansion of urban growth in a northerly direction in Cape Town.

4 ENVIRONMENTAL ASSESSMENT

4.1 Key Impacts on the Economic Environment

The study team undertook visits to each of the sites in order to obtain an overview of the potential risks and key impacts associated with the proposed nuclear power station. Based on the findings of the site visits, field interviews and macroeconomic analysis, the team identified potential impacts and risks associated with the proposed nuclear power station. Potential economic impacts identified include:

- changes in land use and agricultural output;
- marine ecology disturbance and the impact on fishing and aquaculture;
- changes to community structures through the influx of workers and associated infrastructural requirements;
- change in tourism activities and numbers;
- changes in property prices;
- visual disturbance;
- construction of required facilities and infrastructure associated with accessibility to the site, transport and the integration of the generated power into the networks;
- crime and security;
- waste handling and management.
- improved generation capacity in the Eastern Cape and Western Cape regions and South Africa as a whole, which could stimulate much-needed local economic growth and reduce current power shortages;
- potential establishment of formal conservation areas;
- significantly lower greenhouse gas emissions when compared with that of coal-fired power stations;
- direct economic injection into the local economies; and
- provision of education, health and recreational facilities.

4.2 Assessment Scales

In this report the economies around the three proposed sites have been described qualitatively and analysed quantitatively. In qualitative terms, the local economy at Duynefontein would find it easier to absorb and service a nuclear power station and its staff than would be the case at Thyspunt or Bantamsklip. Differences in the quantitative economic impact among the three sites are not large, and any site would have a positive impact on the immediate area as well as the particular province in which it is situated.

The construction of Nuclear-1 at the three sites would have a strong national impact: By adding capacity to the national grid, it would assist in stabilising power supplies in South Africa and meeting the growing demand from consumers.

The consultants are highly confident that the impacts shown in Section 3 would occur.

4.3 Risk Assessment

4.3.1 General Safety Considerations

In any risk assessment the following two questions need to be asked:

1. What are the odds of a serious event occurring?
2. What would be the results if a serious event were to occur?

4.3.1.1 The Odds of a Serious Event Occurring

The nuclear industry throughout the world has rigid safety standards which are set by the International Atomic Energy Agency (IAEA) in Vienna. South Africa is a member of the IAEA and implements its standards, the responsibility being in the hands of the National Nuclear Regulator (NNR). Eskom will be obliged to prove to the NNR that the proposed plant can and will meet these stringent safety standards, while periodic inspections are required in order to ensure that each facility operates safely.

Any nuclear power station is required to have emergency plans in the event of a disaster and the proposed new nuclear power station will be no exception. At this stage, the exact delineation of the Emergency Planning Zones (EPZ) is unknown, but the zones for Koeberg are 5 km ***(Protective Action Zone – PAZ) and 16 km (Urgent Portective Zone – UPZ)*** radii around the site. ***The Eskom Requirements Specification requires set these requirements based on the European Utility Requirements document (EUR) for the new plants at 800 m and 3 km, respectively which is much smaller than the current zones for the Koeberg Nuclear Power Station and that the potential vendor must demonstrate to meet.*** In general terms, ***within the PAZ,*** no applications for further development rights for properties falling within or intersecting with this area may be approved, while low-density developments are accepted within the ***3 km radius. In any event, all land within the PAZ already belongs to Eskom at all three sites.***

In its recent White Paper on Nuclear Power (Great Britain, 2008), the British government gave its view on the safety and security of nuclear power. It stated that: "Based on the advice on the independent nuclear regulators, and the advances in the designs of nuclear power stations that might be proposed by energy companies, the government believes that the safety, security, health and non-proliferation risks of new nuclear power stations are very small and that there is an effective regulatory framework in place that ensures that these risks are minimised and sensibly managed by industry. Therefore, the government believes that they do not provide a reason to prevent energy companies from investing in new nuclear power stations."

Since the NNR's regulations conform to the highest international standards, it seems justifiable to state that, under normal operating conditions, it is extremely unlikely that an incident with any significant adverse effect on the economy would occur. Referring to the most serious nuclear event on record − at Chernobyl in the USSR in 1986 − the British White Paper commented: "…..for a number of reasons we must be careful before comparing past accidents that happened abroad with anything that might occur at new civil nuclear power stations in the UK. In particular, regulatory scrutiny of reactor operations in the former USSR was far less rigorous than it is in the UK today. We must also remember that many of these past accidents occurred in power stations with designs that would not be acceptable to regulators in the UK".

In order to compare a South African position with that of the UK government, it is worthwhile summarising the main strands of the Chernobyl disaster. Four reactors were opened between 1977-83 at the nuclear power station at Chernobyl in the Ukraine, now an independent state but then part of the Soviet Union. The technology used was the Soviet-designed RBMK (reaktor bolshoy moshchnosty kanalny). On 26th April 1986 one of the four reactors melted down during a shutdown and test. The accident had serious socio-economic repercussions in the north of Ukraine, the south and east of Belarus, and the border area between Russia and Belarus. Exhaustive studies by the International Atomic Energy Agency (IAEA) have found that the accident was caused by design deficiencies in the reactor, compounded by a violation of operating procedures. RBMK reactors do not have a containment structure, i.e., a concrete and steel dome over the reactor, itself designed to keep the radiation inside the plant in the event of such an accident. In addition, there was a deficient safety culture throughout the Soviet design, operating and regulatory organisations for nuclear power. By contrast, western nuclear power station designs which would be used in Nuclear-1 do have domes over the reactors, and South Africa adheres strictly to the IAEA safety measures and the Convention on Nuclear Safety. Given the technological and safety differences between the Soviet and western (French and US) systems, the likelihood of a Chernobyl-type incident occurring at Nuclear-1 is negligible.

4.3.1.2 The Results of a Nuclear Disaster

Following on from the conclusion reached in the previous paragraph, the second question is to all intents and purposes academic. Nevertheless, because of the lack of information about the Chernobyl incident which moulds public perceptions about nuclear safety, the incident has been summarised above and, for the record, it can be stated that, in the improbable case of such an event occurring at one of the three sites, the economic consequences for South Africa would be greatest if the plant were located at Duynefontein. It would affect the economy of the entire Cape Town metropolitan region and large parts of the neighbouring municipalities of the Western Cape. Such an incident at Thyspunt would seriously affect the economy of one of the major metropolitan regions in South Africa, namely, the Port Elizabeth-Uitenhage region. The impact would probably be lowest at Bantamsklip because of its greater distance from a large metropolitan region and sparse population, meaning that damage to human health would be on a smaller scale than at the other two sites. It is possible that the emergency response services might be weaker at Bantamsklip but, overall, the effects are likely to be less severe than at the other two sites. ***However, it is emphasised again that the likelihood of such an event would be negligible.***

4.3.2 Skills Requirements

The possibility of a nuclear ***incident*** is intimately connected to the issue of skills requirements, particularly with regard to the training and preparedness to which the people who operate these stations are exposed. The ***members of*** staff of a nuclear power station collectively have a variety of scientific, engineering and other technical backgrounds in fields required to effectively and safely operate and maintain the plant. The required skills include the following: nuclear engineering; instrumentation and control; electrical engineering; mechanical engineering; radiation protection; chemistry; ***physics, neotronics,*** emergency preparedness; and safety analysis and assessment. There is also a requirement to have access to national or international expertise to support the nuclear power station operating organisation and regulatory body in terms of scientific areas such as neutronics, physics, thermo- hydraulics and other technical areas such as radiation protection, radioactive waste management, quality management, maintenance, and spare parts management.

Of 1,400 permanent staff at a nuclear power station, 1,000 will be professional and technical personnel, i.e. they will have some tertiary qualification or trade. The balance will consist of secretarial and support staff.

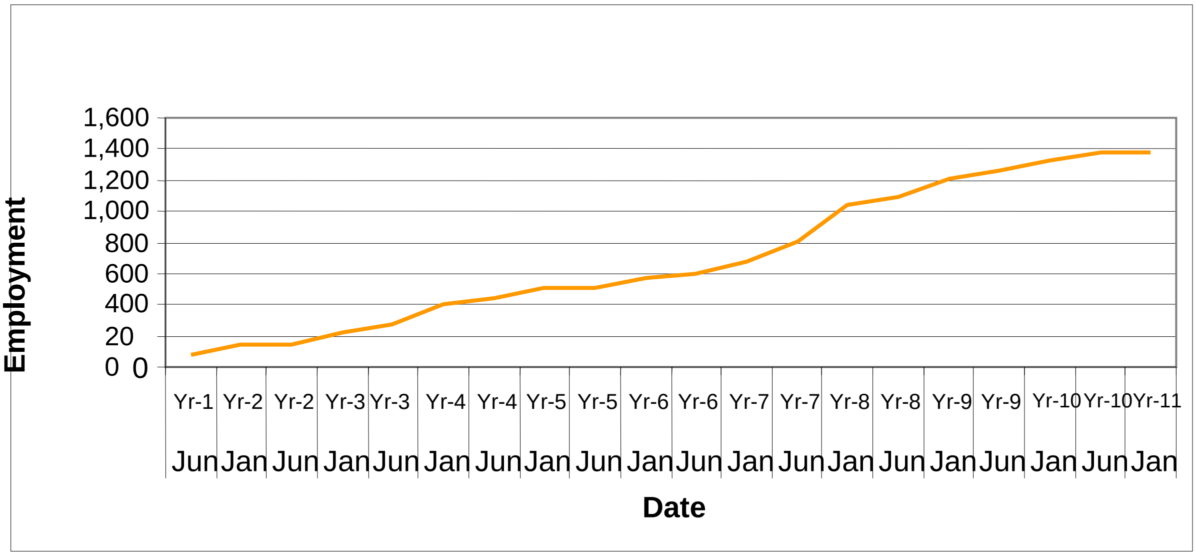
Table 4.1 shows Eskom's expected build-up of staff members from the commencement of construction to the commencement of operation of a nuclear power station. This is depicted in Figure 4.1.

Table 4-1: Appointment or Build-up Numbers, Years 1-11

	Jun Yr-1	Jan Yr-2	Jun Yr-2	Jan Yr-3	Jun Yr-3	Jan Yr-4	Jun Yr-4	Jan Yr-5	Jun Yr-5	Jan Yr-6	Jun Yr-6	Jan Yr-7	Jun Yr-7	Jan Yr-8	Jun Yr-8	Jan Yr-9	Jun Yr-9	Jan Yr-10	Jun Yr-10	Jan Yr-11
Senior management/ executives	6	7	8	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Middle management	3	5	5	11	12	18	18	28	29	32	32	40	40	40	40	40	40	40	40	40
Professionals	6	33	34	39	39	111	124	132	138	185	204	239	249	263	263	266	272	288	293	293
Engineers/technicians and other semi professionals	60	86	90	146	160	199	219	226	222	191	192	162	173	186	198	219	224	229	239	244
Technicians	0	5	6	10	34	46	56	70	70	86	91	138	212	297	329	399	414	445	464	464
Artisans level	0	1	2	8	8	8	9	22	27	39	46	54	76	195	200	218	228	238	253	253
Clerical staff	0	0	1	2	7	12	12	17	17	24	27	32	44	50	55	60	72	72	82	82
Total	**75**	**137**	**146**	**224**	**269**	**403**	**447**	**504**	**512**	**566**	**601**	**674**	**803**	**1,040**	**1,094**	**1,211**	**1,259**	**1,321**	**1,380**	**1,385**

Source: Mr S. Touffie, Chief Engineer, Nuclear-1 Project, Eskom.

Figure 4.1: Build-up of Labour, Years 1-11



Source: Mr S. Touffie, Chief Engineer, Nuclear-1 Project, Eskom.

There are two serious concerns with regard to skills. The first relates to the ability of the South African educational system to produce the skills, not only with regard to trainees but also trainers. Eskom is recruiting widely to find instructors and trainers in order to produce the number of operators required. Such recruits need mathematics and science qualifications, but these are in short supply in the educational system.

Eskom commenced recruiting and training for Nuclear-1 in 2007. Nuclear skills are a scare resource worldwide, and Eskom therefore cannot expect to find it easy to recruit such skills outside the country. Instead, it will have to rely very largely on its own training, and the focus at present is on engineering and operational staff. According to information provided by Eskom, it has thus far been able to recruit on the open market but, with growing competition in this market as more countries opt for nuclear power, it has developed a significant programme for skills training over the next ten years in order to produce the numbers required.

Investment in this programme includes a bursary scheme and funding the establishment of university courses in nuclear engineering.

- At the University of Cape Town elective courses in nuclear engineering for final-year engineering students commenced in 2008.
- Nuclear engineering will be offered in a post-graduate programme at the University of the Witwatersrand.
- Plans are at an advanced stage to establish an Eskom University with a campus for nuclear studies.

Before Nuclear-1 commences operating, 1,000 technical persons need to be trained as nuclear professionals. Already 60 operators are in training. In total, between 150 and 200 professionals are in training but this will increase to over 200 at any one time once the decision on a site is finalised. Some individuals will be trained overseas and at existing Eskom power stations. All training for the existing Koeberg Nuclear Power Station has been done locally, but the technology for Nuclear-1 will be different to that at Koeberg, and thus a large part of the training will be ***conducted overseas,*** depending on which system is chosen. However, local training will be increased over time.

The ability to retain skills is the second concern. A considerable investment is made in training an individual to the point where he is authorised to work in the plant. For example, it takes five years to train a nuclear reactor operator who has to be licensed to operate by the NNR. According to information provided by Eskom, its salaries were recently substantially increased in an effort to retain core skills. The loss of staff to overseas has not been significant but some staff are lost to South African firms. Eskom thus needs to train more individuals than it actually requires. The training period cannot be reduced but the tendency in recent years has been for operators not to stay for their entire careers.

4.3.3 Radioactive Waste Disposal

In our fieldwork we were made aware of concerns on the part of the local communities regarding the safety factor surrounding the issue of nuclear waste disposal.

The South African Cabinet approved a National Radioactive Management Policy and Strategy in 2005, and the National Radioactive Waste Management Agency Bill was presented to parliament in late-2008. In terms of this legislation, a National Radioactive Waste Management Agency will be established, and will exert tight control over the disposal of radioactive waste. For the proposed Nuclear-1, Eskom will be compelled to follow the practices for the management of radioactive waste laid down in the legislation, under the regulatory control of the NNR.

Low- and intermediate-level ***radioactive*** waste from Koeberg Nuclear Power Station is disposed of at the NNR-approved disposal site at Vaalputs (approximately 600 km north of Cape Town), which is owned and managed by the Nuclear Energy Corporation of South Africa (NECSA). At present, South Africa does not have an authorised facility for the disposal of spent fuel and high-level radioactive wastes. Thus, Koeberg Nuclear Power Station is required to store the waste at the plant. Similarly, the new nuclear power station will store spent fuel on site.

The transportation of radioactive material around the country is highly regulated. South Africa subscribes to the regulations set out by the IAEA for the safe transport of radioactive materials. The NNR is responsible for regulating the safe transport of radioactive material identified in terms of the NNR Act, and the Directorate of Radiation Control (DRC) for regulating the safe transport of radioactive material that falls within the ambit of the Hazardous Substances Act, 1973 (Act No. 15 of 1973).

4.4 Transportation of Heavy Equipment to the Proposed Site

Another concern on the part of local communities relates to the transportation of nuclear power station equipment. This concern centres around the ability of the existing road infrastructure to handle the abnormal loads that would need to be transported from the closest suitable harbour to the nuclear power station site.

The study into the capacity of the possible routes from a port to each site has been completed ***since the first draft of this report***. There are two aspects to road design that relate to the roads being considered as transit routes for the movement of heavy loads. These are geometric standards and structural design standards, and will apply to all classes of roads, i.e. national, provincial and municipal, over which loads will travel. The vehicles used will have to be compatible with the maximum permitted load-carrying capacities and geometric layouts of the roads, and designed to comply with the maximum loads of bridges en route to a site.

The standards referred to above relate to the present. However, the assessment of the existing roads must also be done in terms of the requirements of the codes and standards used for the original design of the roads. The problem that will be faced is that many, if not most, of the roads, bridges and mountain passes which would be used were designed and built as long as 40-50 years ago and even earlier, and might not be able to accommodate the abnormal loads which will require heavy-vehicle combinations exceeding anything yet handled on South African roads. Thus, although Eskom has informed the consultants that any additional infrastructure necessary will be provided, the capital costs involved could be considerable. Should that be the case, the alternative would be to barge the equipment to the particular site. This would involve the construction of a temporary pier at the site, but the costs of such an alternative have not been considered in this analysis. It appears that it would be easier to transport abnormal loads on the road from Saldanha Bay to Duynefontein than on the Saldanha Bay-Bantamsklip and Port Elizabeth/or Coega-Thyspunt roads.

4.5 Consideration of Alternatives

Two alternatives were considered to the construction of Nuclear-1. The first is to do nothing and the second is to use alternative forms of energy.

4.5.1 No-Go Alternative

If no Nuclear-1 is built, the differential effects on the three sites would be zero. However, based on the increasing electricity demands associated with increased economic growth in South Africa, the No-Go (no development) alternative is not considered to be a feasible alternative to the development of a nuclear power station or, for that matter, any other type of energy-generating facility.

The power outages experienced in 2008 affected all sectors of the economy and illustrated that the provision of additional power is imperative if new large development projects (especially those that are energy-intensive, e.g., the proposed aluminium smelter at Coega) are to go ahead. Indeed, Eskom has a considerable programme for producing additional power: it has to provide additional large-scale, base-load power stations, either through nuclear power or through the development of additional coal-fired power stations. If it does not, the economic growth of the country will grind to a halt since a modern economy requires constant additions to its power supplies if it is to grow. The current Eskom programme includes both nuclear and coal-fired power stations, ***as well as a number of smaller renewable technologies,*** while the Department of Energy is assessing private-sector interest in renewable energy projects. Expressions of interest by companies interested in such projects were submitted in October 2008. In addition, Eskom is to import power from a coal-fired power station to be constructed in Botswana.

It is clear, therefore, that the No-Go alternative is not a practical proposition for the South African economy.

4.5.2 Technological Alternatives

The technological alternative of power generation involving coal as a resource is not a viable option for the Eastern and Western Cape because of the cost of transporting coal over long distances. Power is lost in transmission over long distances, and therefore a base station is needed to balance power supplies at the end of a transmission line. It is cheaper to transmit electricity by power lines, even over long distances, than to transport coal from a mine to a distant power station. That is the reason why no coal-fired power stations have been built in the Western Cape or the Eastern Cape. Although the capital costs of a nuclear power station are high compared to a coal-fired power station, the operating costs for a nuclear power station are lower, and this makes the unit price of ***nuclear-generated*** electricity lower over the lifetime of the power plant. Moreover, coal-fired power stations are major ***polluters and emitters of greenhouse gases,*** and nuclear energy is much cleaner. Unless clean coal technology is perfected, Eskom's new coal-fired power stations will continue to increase the emissions of greenhouse gases and will also be major consumers of water. The availability of water is likely to be of growing importance in a water-scare country under conditions of climate change. By contrast, nuclear power stations ***use sea water for cooling. In Table 4.2 the construction and operational costs of coal-fired and nuclear power stations are presented.***

Table 4-2: Construction and Operational Costs of Coal-fired and Nuclear Power Stations

	Construction Costs	*Operational Cost*	
	R/kW	*O& M R/MWh*	*Fuel Cost R/MWh*
Coal-fired (4 856 MW)			
Plant cost estimates with FGD (January 2010)	*17,785*	*445.00*	*146.50*
Plant cost estimates without FGD (January 2010)	*15,470*	*348.00*	*144.60*
Nuclear (4 800 MW)			
Nuclear Areva EPR Technology	*27,605*	*97.30*	*62.50*
Nuclear AP1000 Technology	*32,440*	*121.10*	*62.50*

	Construction Costs	*Operational Cost*	
	R/kW	*O& M R/MWh*	*Fuel Cost R/MWh*
Coal-fired (4 856 MW)			
Plant cost estimates with FGD (January 2010)	*17,785*	*445.00*	*146.50*
Plant cost estimates without FGD (January 2010)	*15,470*	*348.00*	*144.60*
Nuclear (4 800 MW)			
Nuclear Areva EPR Technology	*27,605*	*97.30*	*62.50*
Nuclear AP1000 Technology	*32,440*	*121.10*	*62.50*

Source: Electricity Power Research Institute – May 2010: Power Generation Technology Data for Integrated Resource Plan of South Africa

FGD above refers to "Flue Gas Desulphurisation" which is a process applied to the coal-fired power stations to reduce sulphur released into the air. This is a prerequisite for the World Bank loans. The two nuclear options would be those using the technologies of the AREVA and Westinghouse. The table shows that, as far as construction costs are concerned, the coal-fired power stations are the cheaper option. However, in respect of fuel costs nuclear power costs less than 50% of coal. The above costs are only the direct costs and do not reflect the life-cycle environmental costs associated with mining and power station operations.

The other alternative technology would be that of renewable energy. Identified renewable forms of energy, for example, wind and solar, have inadequately developed technology to provide large-scale power generation facilities that can supply a reliable base load and easily integrate into the existing power network in South Africa. The question, nevertheless, is sometimes asked as to what the cost implication of Nuclear-1 would be in relation to other electricity-generating activities. In South Africa comparative costs are sketchy, but when all social costs (including the environmental impacts of carbon emissions) are taken into account, coal-fired power stations are more costly than nuclear. The technologies for renewable energy alternatives such as wind, solar and wave have not yet been developed to beyond the level of small-scale plants.

In Table 4.3 the cost of nuclear and two renewable energy options are compared.

Table 4-3: Comparative Costs of Nuclear and Renewable Energy Options

	Construction Costs	***Operational Cost***	
	R/kW	***Fixed O& M R/MWh***	***Fuel Cost R/MWh***
Wind 200 MW Capacity	***R 14 445***	***R 74.90***	***R 0.00***
Solar (Photo Voltaic – Thin Film) 125 MW (9 hour storage)	***R 50 910***	***R 167.90***	***R 0.00***
Nuclear Areva EPR Technology 4800 MW Capacity	***R 26 576***	***R 95.20***	***R 67.30***

Source: Electricity Power Research Institute – May 2010: Power Generation Technology Data for Integrated Resource Plan of South Africa

The table indicates that wind is the cheaper option, but note should be taken of the maximum capacities at present available, with the two renewable options delivering very small quantities if compared with nuclear. Another factor to be taken into consideration is the projected economic lifetime of the different options, nuclear being 60, wind 20 and solar 30 years. A further factor to be considered is that the capacity factor of wind generation (the percentage time that it can be guaranteed to produce power at full capacity) is only 29-40% due to the variability of wind, whilst that of nuclear is 93% (EPRI 2010). As a result, the installed capacity of wind turbines needs to be three times higher than the power output required, and would require a considerably larger geographic footprint.

The above analysis for South Africa is corroborated by the conclusions of the government White Paper in the UK (2008) which stated that all evidence pointed to the costs of nuclear power being lower than that of coal and gas. From available evidence, therefore, it seems clear ***that nuclear is the cheaper and more appropriate option for the three sites to produce enough power for a growing South African economy.***

5 MITIGATION MEASURES

A number of mitigation measures are proposed in this section to minimise negative impacts and enhance positive impacts on the economy around each proposed nuclear power station site.

An examination of international experience with regard to nuclear power stations shows that ***they blend into the local community and economy.*** The record of incidents at nuclear power stations shows that the impacts are largely of very short or short duration – from one month or one season to a few years. In Section 4 the safety issues were discussed: the probability of an incident occurring is small and of a major incident highly unlikely.

The mitigation measures proposed below relate, first, to a standard of operation and maintenance of the plan and secondly to public perceptions.

5.1 Operation and Maintenance

Eskom is obliged by legislation to adhere to the highest standards of operation and maintenance but nevertheless the severe skills shortage in South Africa is a negative factor which will need to be mitigated. The necessary mitigation measures are:

- Funding training programmes at tertiary institutions to produce more than the numbers required (in order to allow for the effects of attrition).
- In-house training.
- Training abroad.
- Recruitment programmes.
- Salary reviews to ensure competitive employment packages and in order to attract and retain the requisite skills.
- Merit as the only yardstick for employment – there can be no place for any other policy in an industry in which negligence or inefficiency can have such severe repercussions on the national economy and the local community.
- High-quality risk management and monitoring.

These measures may be judged on the following criteria:

- The number and level of training of individuals trained in any one year.
- The number and level of training of individuals recruited in any one year.
- The experience profile of the skilled staff in any one year.
- The turnover of skilled staff in any one year.

These measures are clearly aimed at avoidance of an adverse impact.

5.2 Public Perceptions and Concerns

There is a widespread (and, in field interviews, openly acknowledged) lack of information on the part of the public regarding the impact of a nuclear power station. Proposed mitigation measures are:

- An ***active*** public ***information*** campaign directed at the local community. This should involve the wide dissemination in easily understandable form of all the specialist studies in order to overcome public fears regarding, *inter alia*, loss of sense of place (visual impacts, pollution), impact on the marine environment (ocean temperatures, waves, fish), and social impacts (unemployment, squatter housing, crime) all of which could have an impact on the economy. This is an avoidance measure.
- A similar campaign should be aimed at international product markets (e.g., in the case of squid fishing) or international bodies (e.g., the International Association of Surfing Professionals) to counter negative perceptions and boycotts of local products and events. ***This campaign would probably involve extensive and expensive advertising; if the negative market perception for squid is related to forms of contamination, the campaign could include regular testing of squid for contamination and the issuing of certificates (e.g. certification) stipulating that the product is free of contamination.*** This is an avoidance measure.

(i) • Restoration of any damage to the ecology of the area that might occur in the construction phase, the expansion and enhancement of the nature reserves surrounding each site, and the establishment of visitor information and educational centres in order to attract tourists to the area. This would be a rectification measure.

- Controls on heavy-vehicle traffic during the construction phase in order to mitigate negative impacts such as noise, night-time visual effects (vehicle lights), road damage and congestion. These impacts affect the local economy but differ from one nuclear power station to another, and therefore the intensity of the measures will also differ. However, they should all at least encompass a scaling up of traffic policing. This would be an avoidance measure.
- The transfer, wherever possible, of construction workers to new nuclear power station sites once their involvement at Nuclear-1 is complete. This would be a reduction measure to mitigate the adverse impacts of unemployment and attendant social ills that could affect the local economy.

5.3 Compensation

The payment of compensation for at least short-term losses, for example, the squid-fishing and whale-watching industries, should be considered if it can be conclusively demonstrated by the industries that the construction and operation of Nuclear-1 has caused them financial damages. As mentioned earlier in this report, such damages are likely to be zero to minimal, and would probably be difficult to prove conclusively. Nonetheless, discussions with valuators (personal communications, 21 and 23 September 2010) suggest that liability for compensation on the part of the developer is constitutionally valid.

5.4 Comparison of Mitigated and Unmitigated Impacts

Table 5.1 sets out the impacts mentioned in this report.

Table 5-1: Comparison of Mitigated and unmitigated Impacts at all sites

To be updated

Impact	Nature	Intensity	Extent	Duration	Impact irreplaceable resources	Consequence	Probability	Significance
1A: Construction phase macroeconomic impacts – Local (positive)	Positive	High	High	Medium	Medium	High	High	High
2A: Construction phase macroeconomic impacts – Regional (positive)	Positive	Medium	Medium	Medium	Low	Medium	Medium	Medium
3A: Construction phase macroeconomic impacts – national (positive)	Positive	Medium	Medium	Medium	Low	Medium	Medium	Medium
4A; Operational phase macroeconomic impacts – Local (positive)	Positive	Medium	Medium	High	Low	Medium	Medium	Medium
5A; Operational phase macroeconomic impacts – Regional (positive)	Positive	Low	Low	Medium	Low	Low	Medium	Low
5A; Operational phase macroeconomic impacts – Regional (positive)	Positive	Low	Low	Low	Low	Low	Medium	Low

Table 5-2: Economic impact at Thyspunt

Impact	Nature	Intensity	Extent	Duration	Impact on irreplaceable resources	Consequence	Probability	Significance
1A: Loss of income arising from loss of part of fishing grounds	Negative	Low	Medium	High	Medium	Medium	Medium	Medium

Table 5-3: Economic impact at Bantamsklip

Impact	Nature	Intensity	Extent	Duration	Impact on irreplaceable resources	Consequence	Probability	Significance
1A; Loss of income arising from loss of access to part of whale watching area	Negative	Low	Low	Low	Low	Low	Low	Low

6 CONCLUSIONS AND RECOMMENDATIONS

A comparison of the economies in the 20 km radius of the three sites reveals that Duynefontein has a far more sophisticated and diversified economy than Thyspunt or Bantamsklip. The area around Duynefontein is part of the third largest metropolitan economy in South Africa, and hence is well endowed with physical and social infrastructure to absorb a nuclear power station. There are no sectors that would appear to be adversely affected by the normal operation of a nuclear power station at Duynefontein.

The economy around Thyspunt is slightly more diversified than around Bantamsklip. It is better located in relation to transport routes (astride the N2), and has a more diversified commercial sector and social facilities. Overall, the Thyspunt economy would be likely to suffer fewer disturbances than that at Bantamsklip where greater investment would be required in social infrastructure and civic installations.

All told, Nuclear-1 would result in less dislocation of economic activities if at Duynefontein than at either of the other sites.

By contrast, the cost-effectiveness analysis indicates that Thyspunt has a very slight edge over Duynefontein and a somewhat larger edge over Bantamsklip. ***The difference between Thyspunt and Bantamsklip is R6.388 billion, and expressed as a percentage the difference is 5.93% in favour of Thyspunt. Between Thyspunt and Duynefontein the difference is R570 million, or 0.53%, in favour of Thyspunt.*** The macroeconomic impact analysis gives mixed results for the construction and operational phases at the three sites, macroeconomic indicators favouring the Western Cape sites and social indicators Thyspunt. However, the differences in the results among the three sites are slight, and the construction of Nuclear-1 at any of the sites would have large positive economic impacts both on the local area and the province. Nuclear-1 would also have strong positive impacts on the national economy.

Feasible mitigation measures are proposed which relate to operation and maintenance, public perceptions and concerns. Particularly important mitigation measures relate to: the critical importance of a full complement of skilled professional and technical staff, high-level risk management, and recruitment policies based on merit only; and the necessity for a vigorous public education and public relations programme, particularly in disseminating the results of the specialist studies in order to overcome community ***and international market*** concerns about the perceived negative impacts of a nuclear power station. Most mitigation measures identified are aimed at avoidance.

Although we reiterate that the differences in economic impact among the three sites are ***relatively small and even*** marginal ***in terms of percentages,*** particularly between Thyspunt and Duynefontein, we give most weight to the results of the cost-effectiveness analysis in ranking the sites. The preferred site would be Thyspunt, the intermediate site Duynefontein, and the least preferred Bantamsklip.

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