# Sustainability principles and EIA report quality in renewable energy projects

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# DEDICATION

I dedicate this dissertation to my late mother Esther Mosele Mahloko: your unconditional love is what keeps me going. Thank you for allowing me to channel your strength even in spirit. I love you so much. I miss you Ma.

# ACKNOWLEDGEMENTS

To the Lord Almighty. Thank you for guiding me and showing me your undeserved mercy throughout this entire journey.

To my late mother (Esther Mosele Mahloko). You live within me. Your soul has found a home inside of me. I feel you everywhere I go and that’s how I keep going. Thank you for loving me, looking over me and for comforting me always. I love you and I miss you.

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*To the 10-year-old me, look what you made me do* 😉

# ABSTRACT

The concept of sustainability is the principal objective of Environmental Impact Assessment (EIA), but the uncertainty that sparks the EIA and sustainability debate has resulted in the EIA process being criticized. The EIA process is criticised for overlooking some aspects of the environment while others are prioritized.

Sustainability Assessment is a more holistic process that can better integrate the objectives of sustainability as opposed to project-level EIA. Gibson (2006) advocates sustainability principles as a preferred approach to Sustainability Assessment since the principles allow for a specific project to be evaluated based on the requirements of the principles of sustainability. These principles include "*Socio-ecological system integrity*", "*Livelihood sufficiency and opportunity*", "*Intragenerational equity*", *"Intergenerational equity",* "*Resource maintenance and efficiency*", "*Socio-ecological civility and democratic governance",* "*Precaution and adaptation*" as well as "*Immediate and long-term integration*".

This study makes a contribution to the EIA and sustainability debate by investigating how the EIRQ of Renewable Energy Projects corresponds to Gibson's (2006) Principles of Sustainability. This would outline the extent to which EIRQ represents EIA in Sustainability Assessment and reveal how much of Sustainability Assessment is currently being achieved through EIA.

The results indicate that the quality of the EIRs of Renewable Energy Projects is satisfactory with 2Bs (Generally complete and satisfactory with only a few exclusions and weaknesses) and 4Cs (Has weaknesses and omissions but is considered satisfactory). Review Areas 1 (Description of the development, local environment and baseline conditions) and 4 (Communication of results) were the best performing while most of the weaknesses can be ascribed to Review Areas 2 (Identification and evaluation of key impact) and 3 (Alternatives and Mitigation).

The sustainability principles were satisfactorily contemplated (C grades) in three of the reports while the other three were just unsatisfactory (D grades). The requirements of Review Areas 1 (Socio-ecological system integrity) and 5 (Resource maintenance and sufficiency) were the most well contemplated while weaknesses were observed in Review Areas 3 (Intragenerational equity), 7 (Precaution and adaptation) and 8 (Immediate and long-term integration).

The comparison between the EIRQ requirements and the sustainability principles requirements indicates that a part of Sustainability Assessment is achieved through EIA. However, not all of the sustainability principles requirements were considered in the EIRQ criteria and this suggests imbalances in EIA.

This study confirms that project-level EIA achieves a part of Sustainability Assessment whereas Sustainability Assessment provides an all-inclusive alternative to achieving sustainability where all biophysical, social and economic impacts are contemplated. It is concluded that the correspondence between the EIRQ of Renewable Energy Projects and Gibson's (2006) principles of sustainability is poor, since the EIRQ criteria are not fully reflective of the sustainability principles requirements. Therefore, to move closer toward Sustainability Assessment in Renewable Energy Projects, the formulated sustainability principles criteria should be integrated into the EIRQ review criteria of Solar CSP projects.

**Keywords**: EIA, EIRQ, Sustainability, Sustainability Assessment, Sustainability Principles, Renewable Energy Projects, Solar CSP.

***“We are led through the darkness of loss and pain and into the light of grace”.***

**-Max Depree**

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## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| AC | Alternating Current |
| CALS | Centre for Applied Legal Studies |
| CSP | Concentrating Solar Power |
| DBEDT | Department of Business, Economic Development and Training |
| DBSA | Development Bank of South Africa |
| DC | Direct Current |
| DEA | Department of Environmental Affairs |
| DEAT | Department of Environmental Affairs and Tourism |
| DMR | Department of Mineral Resources |
| DNI | Direct Normal Irradiance |
| DOE | Department of Energy |
| DWAF | Department of Water Affairs and Fisheries |
| EAP(s) | Environmental Assessment Practitioner(s) |
| ECA | Environment Conservation Act |
| EC | European Commission |
| ECO(s) | Environmental Control Officers |
| EIA | Environmental Impact Assessment |
| EIR(s) | Environmental Impact Reports |
| EIS | Environmental Impact Statement |
| EIRQ | Environmental Impact Report Quality |
| EMPr | Environmental Management Programme |
| EU | European Union |
| Gal. | Gallon |
| GHG(s) | Green House Gases |
| Ha. | Hectares |
| HTF(s) | Heat Transfer Fluids |
| IPP(s) | Independent Power Producers |

| | |
|---|---|
| IRP | Integrated Resource Plan |
| $Km^2$ | Kilometre square |
| kW/kWe | Kilowatt |
| m | Meter |
| mm | Milli Meter |
| MWh | Megawatt hours |
| NECER | National Environmental Compliance and Enforcement Report |
| NEMA | National Environmental Management Act |
| NEPA | National Environmental Policy Act |
| NWU | Northwest University |
| OECD | Organisation for Economic Co-operation and Development (OECD) |
| PV | Photovoltaic |
| PAIA | Promotion of Access to Information Act |
| REIPPPP | Renewable Energy Independent Power Project Procurement Program |
| SANS | South African National Standards |
| SANRAL | South African National Roads Agency Limited |
| SASTELA | Southern Africa Solar Thermal and Electricity Association |
| SEA | Strategic Impact Assessment |
| SIA | Social Impact Assessment |
| SIP(s) | Strategic Infrastructure Projects |
| TBL | Triple Bottom Line |
| TDS | Total Dissolved Solids |
| U.K. | United Kingdom |
| U.S. | United States |
| U.N. | United Nations |
| UNCED | United Nations Conference on Environment and Development |
| UNEP | United Nations Energy Program |

| | |
|---|---|
| WCED | World Commission on Environment and Development |
| WWF-SA | World Wildlife Fund South Africa |

# CHAPTER 1

# INTRODUCTION

## 1.1 Background and Problem Statement

Environmental Impact Assessment (EIA) is recognised as a potential tool for achieving sustainability (Bruhn-Tysk & Eklund, 2002; Weaver *et al*., 2008; Saidi, 2010; Betey & Godfred, 2013). The EIA process ensures that the possible impacts that a development may impose on the environment are identified and that mitigation measures are established and implemented. One of the objectives of EIA is to strengthen project level decision-making through the collection of information that ensures guided and informed decisions (Bilgin, 2015). The role of EIA in achieving sustainable outcomes is however criticized by practitioners and experts.

Determining the effectiveness of EIA has therefore evolved as a global practice which has revealed the weaknesses of EIA. One of the major components concerned with evaluating EIA effectiveness is the documentation of the information used for project level decision-making (Sandham *et al*., 2013*b*).

In South Africa, reviewing the quality of environmental impact reports has been part of the on-going process of assessing the effectiveness of EIA. Environmental Impact Report Quality (EIRQ) has been examined for projects in the explosives industry (Van der Vyver, 2008), projects affecting wetlands (Sandham *et al*., 2008*a*), mining projects (Sandham *et al*., 2008*b*), filling station projects (Kruger, 2012) and Social Impact Assessment Reports (Hildebrandt & Sandham, 2014). These studies revealed that some of the weaknesses associated with EIA include the assessment of impacts (Sandham *et al*., 2013*b*), the consideration of alternatives (Sandham *et al*., 2008*b*) as well as the development of mitigation measures (Kruger, 2012). Guiding legislation has been reformulated and very little difference was observed in terms of its influence on the effectiveness of the country's EIA system (Sandham *et al*., 2013*b*). Shortcomings observed under different regulations highlighted the poor application of legislation and public participation (Ridl & Couzens, 2010).

A key weakness of EIA is balancing the objectives of the environmental, social and economic dimensions of sustainability, which is defined as *developmen*t *which meets the needs of the present without compromising the ability of future generations to meet their own needs*" (WCED, 1987: 24). Wright *et al*., (2005) argue that EIAs are more concerned with biophysical impacts and that the consideration of social interests tends to be orphaned. This observation is advocated by Hildebrandt & Sandham (2014) in the evaluation of the role of Social Impact Assessment (SIA) in EIA. Hildebrandt & Sandham (2014) disclose that the report quality of SIAs is weak with shortcomings relating to the poor evaluation of important impacts as well as a lack of public consultation. It was also discovered that SIA reports fail to indicate the contemplation of alternatives and mitigation measures.

The practice of SIA is mostly motivated by international best practice by South African social experts more than it is by the achievement of sustainability. Concerns with broadening the role of SIA in impact assessment are raised by the fact that social scientists are not adequately capacitated and are faced with the challenge of defining the scope of social studies while integrating different aspects of society in the studies (Du Pisoni & Sandham, 2006).

Latest findings suggest that in South Africa, the effective implementation of SIA is hindered by inadequate SIA framework. Social Impact Assessment practitioners argue that the regulatory framework under the 1989 Environment Conservation Act (ECA) and its changes to the National Environmental Management Act (NEMA) 2006 and 2010 regulations (South Africa, 2006; South Africa, 2010), and further amendments from the 2010 to the 2014 regulations are not broadly defined and results in incompetency (Kruger & Sandham, 2018). These weaknesses are concerning because in order to achieve sustainable outcomes in EIA, all three components of sustainability should be integrated, this includes both biophysical, economic and social needs (Gibson, 2013).

Sustainability Assessment is introduced as a better approach towards the integration of the dimensions of sustainability in impact assessment. The concept is defined as a decision-making process which ensures that the objectives of sustainability are considered in development and plans (Bond & Morrison-Saunders, 2011). It is a process which seeks to provide a comprehensive understanding of sustainability and how it can be interpreted in different context. The process aims to evaluate a project's impacts on sustainability as a way through which sustainability concerns can be integrated in project level decision-making (Waas *et al*., 2014).

A clear understanding of sustainability is essential in a Sustainability Assessment and context specific criteria are important in indicating what sustainability is (Pope *et al*., 2004). In this regard, Gibson (2006: 4) proposes the use of principles in the assessment of sustainability, these principles include:

- "*Socio-ecological system integrity*";
- "*Livelihood sufficiency and opportunity*";
- "*Intragenerational equity*";
- *"Intergenerational equity";*
- "*Resource maintenance and efficiency*";

- “*Socio-ecological civility and democratic governance”;*
- “*Precaution and adaptation*”; and
- “*Immediate and long-term integration*”.

This approach involves the formulation of sustainability criteria from the sustainability principles where the interrelationship between the sustainability dimensions is outlined and the sustainability objectives of a project are defined.

### 1.2 Motivation of the study

The correspondence between EIRQ and the consideration of Gibson’s (2006) sustainability principles has not yet been investigated in South Africa. The consideration of the sustainability principles in the EIA reports will give a reflection of the measure to which the principles are considered in the EIA process and prove that the criticism surrounding the contribution of EIA towards sustainability is invalid. Given the sound research of EIRQ in South Africa, a comparison between EIRQ and the consideration of the sustainability principles will describe the relationship between EIRQ and the sustainability principles by indicating the degree to which EIRQ is an indicator of sustainability in EIA.

### 1.3 Aims and objectives

This study aims to investigate the correspondence between Environmental Impact Report Quality of Renewable Energy Projects and the Sustainability Principles developed by Gibson (2006).

The objectives of the study are:

**1.** To apply the Lee and Colley Review Package (Lee *et al*., 1999) to a sample of EIRs of Renewable Energy Projects.

**2.** To investigate the extent to which the Sustainability Principles are considered in the EIRs and

**3.** To compare the EIRQ of Renewable Energy Projects and the consideration of the Sustainability Principles in the EIRs.

### 1.4 Research approach

The research includes an investigation of six EIRs obtained from the National Department of Environmental Affairs in Pretoria. The data is collected through a document interrogation package where the Lee and Colley Review Package (Lee *et al*., 1999) is applied. The EIRQ is determined using the Northwest University (NWU) EIRQ Review Package which is adapted from the original Lee and Colley Review Package (Lee *et al*., 1999). Sustainability Principles

Review Criteria are formulated to determine the degree to which the Sustainability Principles are considered in the reports. The results are then presented using tables. This methodology is defined in more detail in Chapter 3.

### 1.5 Layout of the study

This research is presented in 6 chapters as follows:

**Chapter 1** introduces the research problem and the aims and objectives of the research.

**Chapter 2** is a review of literature related to the study's aims and objectives. The chapter outlines the evolution of EIA since its promulgation in 1969 and its practice in South Africa. The chapter also includes the national and international practice of EIRQ. It then provides definitions to the concepts of sustainability and Sustainability Assessment. The last part of the chapter is an overview of Renewable Energy Projects.

**Chapter 3** describes the research method used in the study. The Lee and Colley Review Package is introduced and described. The NWU EIRQ Review Package is presented for the purpose of determining EIRQ. Sustainability Principles Review Criteria are formulated to determine the degree to which the sustainability principles are considered in the environmental impact reports. This chapter also includes an explanation of the development of the sustainability criteria chosen in formulating the Sustainability Principles Review Criteria.

**Chapter 4** presents the results, analysis and discussion. The results are displayed in different tables. Both the results for the EIRQ and the consideration of the sustainability principles are discussed. Following this discussion, a comparison between the two set of results is presented in **Chapter 5**. All conclusions and recommendations are provided in **Chapter 6.**

# CHAPTER 2

# LITERATURE REVIEW

This chapter provides a review of literature on EIA, EIRQ and Sustainability Assessment to address the aims and objectives of this study. The literature begins with an introduction of the evolution of the EIA process since the late 1960s. The process is defined as a planning tool which is integrated into legislation and project-level decision-making. The South African environmental governing legislation is outlined and the National Environmental Management Act (Act No. 107 of 1998) is described as the main piece of environmental legislation in South Africa. The South African EIA regime's urgency to integrate sustainability is seen as the changes in the South African EIA legislation are discussed.

The national and international stance of EIRQ is discussed through a presentation of existing studies on EIRQ. The review defines the concept of sustainability since a comprehension thereof is significant in Sustainability Assessment. The concept of Sustainability Assessment is introduced as a new dimension where the impacts that a project poses on sustainability are evaluated. Different renewable energy technologies are also discussed to understand the Sustainability Principles Review Criteria that is used to determine the consideration of the sustainability principles in the EIRs.

## 2.1. Introduction

Environmental Impact Assessment evolved in response to environmental degradation and social inequality. The EIA process evaluates and identifies the impacts that projects have on the environment as a way to support decision-making and provide effective environmental management (Kidd *et al*., 2018). Environmental Impact Assessment originated with the publication of the National Environmental Policy Act (NEPA) in the United States (U.S.) which requires the assessment of environmental impacts of national development activities before they began (Morgan, 2012). In 1987, the World Commission on Environment and Development (WCED) highlighted EIA as a potential tool for achieving sustainability (WCED, 1987). In this regard, the WCED explained that pressures on the environment should be responded to, ecological systems should be protected, citizens should be part of decision-making and technology should provide for and research solutions for problems related to current conditions.

Although fit to meet these requirements, the weaknesses of the EIA process have been revealed by many (Nieslony, 2004; Wright *et al*., 2005; Morrison-Saunders & Fischer, 2006; Middle & Middle, 2010) who question the role of the process toward sustainability. It is suggested that the EIA process fails to ensure that the planning and execution of development effectively addresses the objectives of sustainability. Environmental Impact Assessment is criticized as a process that is more concerned with financial benefits as opposed to eradicating poverty and securing natural resources for current and future generations (Wright *et al*., 2013). Environmental Impact Reports in South Africa indicate that the impacts that a project may impose on the environment are poorly identified in EIA (Sandham *et al*., 2013*a*), alternatives are poorly contemplated (Sandham *et al*., 2008*a*) and the proponent fails to show commitment to mitigation measures (Kruger, 2012).

However, in order for EIA to effectively deliver on the objectives of sustainability, all three dimensions of sustainability should be understood and treated with equal importance. Sustainability Assessment is therefore advocated as a process that can guarantee that the sustainability objectives of a project are defined and achieved.

### 2.2 The evolution of Environmental Impact Assessment

Environmental Impact Assessment is one of the tools applied in identifying (Anderson, 2000) and managing environmental impacts of projects (Betey & Godfred, 2013). The process evolved over time and is now amongst the leading environmental management tools in the world (Kidd *et al*., 2018). One of the objectives of EIA is to ensure that the objectives of sustainability are considered in a project’s decision-making phase (Nizami, 2007). The evolution of EIA dates back to the early 1960s when the U.S. developed environmental laws in response to environmental degradation (Achieng Ogola, 2007). Since then, countries the world over have made legal provisions for EIA implementation. The evolution of the EIA process is illustrated in *Table 2-1*. The table depicts the origin of EIA, developments and current practice in South Africa.

**Table 2-1: The evolution of EIA (Dalal-Clayton, 1992; Glasson *et al*., 2005; Morgan, 2012; Kidd *et al*., 2018).**

| EIA Phase | Development |
|---|---|
| Mid 70s | • National Environmental Policy Act (NEPA) promulgated (1970)<br>• First EIS documented in the U.S.<br>• Basic Principles, processes and guidelines established. Public participation introduced.<br>• United Nations Conference on the Human Environment formalizes EIA (1972)<br>• Organisation for Economic Co-operation and Development (OECD) recommends EIA to neighbouring countries (1974-1979)<br>• Canada, New Zealand and Australia adopt NEPA approach (1973-1974)<br>• South Africa adopts EIA (1976) |
| Early 1980s | • World Conservation Strategy presents principles on development and conservation (1980)<br>• Development of United Nations Environment Program (1980)<br>• Council for environment and sub-committee for EIA developed (South Africa, 1983)<br>• Presidents Council endorses EIA (South Africa, 1984)<br>• European Community (EC) issued directive 85/337 to mandate EIA (1985)<br>• EC Directive develops basic principles and process requirements for state.<br>• EIA integration in World Bank Policy (1987)<br>• Operational Directive on Environment Assessment from World Bank (1987)<br>• Establishment of working groups (South Africa, 1987)<br>• WCED (Brundtland Report) introduces Sustainable Development (1987)<br>• EIA goals and principles published by the United Nations Environment Programme (UNEP)<br>• UNEP guides neighbouring countries on the basic EIA process (1988)<br>• EIA adoption in the UK (1988)<br>• Establishment of ECA No. 73 of 1989 (South Africa, 1989)<br>• EIA adopted by developing countries (Brazil, China, Indonesia) |
| 1990s | • EIA guidelines published by the Asian Development Bank (1990)<br>• Rio Summit emphasises environmental protection (1992)<br>• OECD publishes guidelines for best practice EIA (1992)<br>• Technology use in EIA rises.<br>• EIA training and other related activities expand.<br>• EIA legislation established in developing countries<br>• EIA provisions under Environment Conservation Act (ECA) published in South Africa (1997)<br>• White Paper on Environmental Policy published (South Africa, 1998)<br>• Promulgation of NEMA No. 103 of 1998 (South Africa, 1998). |
| From 2000 to date | • Integration of Sustainability principles in EIA<br>• Johannesburg Earth Summit-evaluates progress on sustainability (2002)<br>• Our future our choice summit re-emphasizes challenges of environmental protection (2001-2010)<br><br>**Main events in the South African EIA regime**<br>• South African EIA Regulations published (2006):<br>• South African 2010 EIA Regulations published (2010)<br>• South African 2014 EIA Regulations published (2014)<br>• Changes made to South African 2014 EIA regulations (2017) |

### 2.2.1. The beginning of EIA (MID 1970s)

The origin of the EIA process dates back to 1969 where the process was officially formalized by the United States under the National Environmental Policy Act (NEPA). This formal introduction of environmental legislation was supported by basic principles and guidelines and other methods of impact investigation and identification. Following the NEPA requirements, public consultation was introduced to ensure that the concerns of the public were taken into consideration during project planning and decision-making.

Environmental Impact Statements (EIS) were compiled for the first time during the early 1970s. These documents are a compilation of all of the findings of each phase of the EIA process (Glasson *et al*., 2005). Environmental Impact Statements are delivered to regulating authorities and the public as evidence that the impacts of the development were assessed and that mitigation measures were contemplated.

The need for impact assessment was officially formalized at the United Nations Conference on the Human Environment in 1972 (Stockholm declaration, 1972). In 1985, the Organisation of Economic Co-operation and Development (OECD) proposed EIA to its member states. The OECD Development Assistance Committee later established principles for the assessment of impacts imposed by development activities. In 1989, the OECD council made recommendations for using an environmental checklist for high-level decision-making (Dalal-Clayton, 1992).

Between 1974 and 1979, the OECD endorsed EIA to neighbouring countries including Canada, Australia, France, Thailand and New Zealand. Environmental Impact Assessment was only introduced to developing countries at a later stage. The voluntary practice of EIA in South Africa dates back to 1976 (Kidd *et al*., 2018) where the process has since progressed to become a compulsory tool of sustainability.

### 2.2.2 Environmental Impact Assessment in the 1980s

The 1980s were focused on providing a framework and endorsing the adoption of EIA. In 1980, the World Conservation Strategy presented guiding principles on the coexistence of human and development. The United Nations Conference on the Human Environment nurtured the growth of EIA through the development of the United Nations Environment Program (UNEP) in 1980 (Handl, 2012). The purpose of the UNEP was to communicate the objectives of environmental management throughout the United Nations organization. The urgency to conserve environmental resources advanced with these programs and conferences. In 1983, South Africa established a Council for the Environment and a sub-committee for EIA. The purpose of the sub-committee was to conduct research through workshops and consultation to create an approach that would fit a South African context to EIA.

Environmental Impact Assessment in South Africa was endorsed by the Presidents Council in 1984. The Council published two reports that made obligatory requirements for introducing EIA in projects that were not within Guide Plan Areas (Kidd *et al*., 2018). A workshop on the significance and need for impact assessment was later established in 1985 where professionals, academics and members of state embraced EIA as an all-inclusive planning process. In 1985, the EIA process evolved as the European Commission (EC) mandated EIA to European Union (EU) member states (France, Netherlands, Portugal, Greece). The EU Directive 85/337 established basic EIA principles and procedural requirements and influenced the adoption of EIA in the United Kingdom (UK) in 1988 (Glasson *et al*., 2005).

Environmental Impact Assessment was introduced by the World Bank Policy in 1987 where an operational directive on environmental assessment was issued. In the same year, the WCED (Brundtland Report, 1987) introduced the concept of sustainable development. It was through this conference that the objectives of the EIA process changed to integrate sustainability in EIA. According to the WCED (1987), sustainability is characterised by the maintenance of the quality of life where current and future generations have continued access to natural resources and the deterioration of the environment is prevented. Following this integration, the UNEP published the goals and principles of the EIA process.

The UNEP also guided EU member states on the basic procedures of EIA. This inspired the development of environmental legislation in countries such as Brazil and China. In order to develop an EIA perspective that is unique to its context, South Africa established a Working Group in 1987. Finally, in 1989 specific environmental management provisions were made under the Environment Conservation Act (ECA Act 73 of 1989). The Act provided for environmental policy and the assessment of impacts that may significantly affect the environment (Kidd *et al*., 2018).

### 2.2.3. Environmental Impact Assessment advances as a sustainability tool (1990s)

Environmental Impact Assessment in the 1990s was driven by the urgency to progress towards sustainability. This phase of EIA was driven by different conventions and agreements with the objective of improving EIA practice. The Rio Declaration on Environment and Development Summit in 1992, together with other conventions played an important role in the development of EIA as a sustainability tool.

The 1991 Convention on Environmental Impact Assessment in a Transboundary Context served as the first multi-lateral EIA agreement (Achieng Ogola, 2007). The convention made it mandatory for proponents to evaluate the environmental impacts of specified projects as early as the pre-planning phase of the EIA process. The Convention directed various states to share communication on anticipated proposals that may have transboundary impacts. The activities that were relevant to transboundary impacts were defined, together with the applicable processes, principles and provisions (Achieng Ogola, 2007).

The Rio Summit in 1992 emphasised the importance of protecting both the environment and socio-economic needs and provided guiding principles on how this could be achieved. The Rio principles influenced the growth of EIA, driving the Asian Development Bank to publish EIA guidelines and the OECD to publish best practice guidelines. Other conventions include the United Nations Convention on Climate Change and Biological Diversity which advocated EIA as an important tool in meeting the set requirements. The importance of public consultation in project level decision-making was revealed at UNECE (Aarhus) Convention on Access to Information, Public Participation in Decision Making and Access to Justice in Environmental Matters (Achieng Ogola, 2007).

Environmental Impact Assessment in the late 1990s was also supported by technological advancements and more attempts in enhancing environmental legislation. In 1998, the White Paper on Environmental Policy was promulgated in South Africa. This was succeeded by the promulgation of the National Environmental Management Act (NEMA103 of 1998) which made provision for EIA regulations that set requirements in terms of the ECA of 1989 for listed project-level activities (Kidd *et al*., 2018).

### 2.2.4. The effectiveness of EIA (2002-current)

In this phase of the evolution of EIA, the concept of sustainability became more prominent and measures were established to improve EIA as a sustainability tool. The concept of sustainability was emphasised at the Johannesburg Earth Summit in 2002 and at the "*Our Future Our Choice*" Summit. The Johannesburg Earth Summit evaluated the progress made on sustainability and indicated shortcomings with current practices in EIA. The "*Our Future Our Choice*" Summit was the 6$^{th}$ Environment Action Programme which began in 2002 and ended in 2012. The summit developed environmental legislative framework to address climate change and protect the environment, health, natural resources and biodiversity (Halmaghi, 2016).

The measures to ensure sustainable outcomes in EIA became apparent as more informed debates on defining and integrating the concept of sustainability in EIA took place. Environmental Impact Assessment Practitioners (EAPs) became aware of their potential contribution towards the EIA and sustainability integration (Weaver *et al*., 2008). The practitioners were encouraged to motivate proponents to contemplate the environmental impacts of development as early as the planning phase. They were also encouraged to accumulate the necessary knowledge to ensure that decisions were better informed and would contribute to the improved practice of environmental management. Sustainability Assessments were introduced as a way to determine the sustainability potential of projects (Gibson, 2011). The objectives of the Sustainability Assessment process were defined in what Bond *et al*., (2012: 56) refer to as "*state-of-the-art*" Sustainability Assessment.

In South Africa, measures to achieve the objectives of sustainability in EIA were presented by continuous changes to legislative requirements. The 1997 ECA EIA regulations were substituted by the 2006 regulations with the objective of introducing recent provisions related to impact assessments. New regulations were introduced in 2010. These regulations presented a method of prioritizing impacts imposed on sensitive environments. Legislative amendments were made again in 2014. The 2014 EIA regime was characterised by changes in environmental monitoring requirements with main changes on the contents of environmental audit reports. Recent changes in the South African EIA regime are the 2017 regulations which indicate more measures of improving the South African screening process (South Africa, 2017). A comprehensive discussion of the different EIA phases is provided in section 2.4.3.

### 2.3. The Environmental Impact Assessment Process

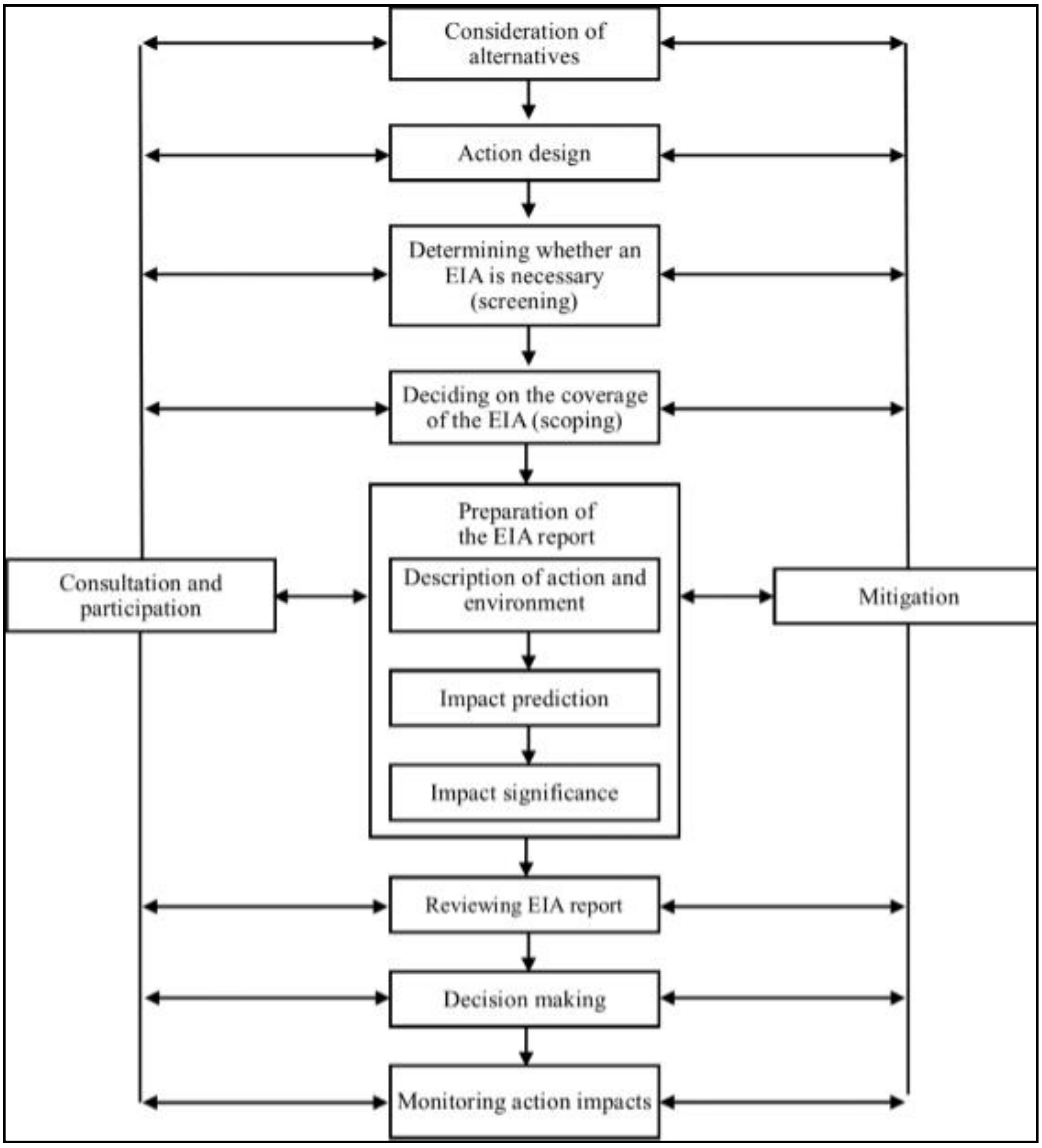


**Figure 2-1: The Environmental Impact Assessment Process (Wood, 2003).**

The principal purpose of the EIA process is to prevent environmental harm or employ mitigation measures where harm cannot be ignored or reversed. Although the process has been traditionally applied in impact identification, its application is not as systematic and all-inclusive as required by the EIA process (Glasson *et al*., 2005). The effective application of the EIA process takes place in different phases as illustrated in *Figure 2-1*.

According to Anderson (2000); DEAT (2004*a*); Morrison-Saunders *et al*., (2007); Pinho *et al*., (2010) and Weston (2000) the generic steps of an EIA process include:

1. ***Screening***: an assessment of a project's potential environmental impacts. Determines whether or not a project should undergo an EIA.
2. ***Scoping***: the process of identifying possible environmental impacts that may affect project approval.
3. ***Impact Assessment***: evaluates potential significant impacts that a development may impose on the environment.
4. ***Alternatives***: establishing alternatives to ensure that the developer has contemplated other practical options (technology, location, procedures, "*no-go*" alternative).
5. ***Reporting***: the results of the impact assessment process are documented and reported to all stakeholders and decision makers in the form of an Environmental Impact Report (EIR). The EIR seeks to communicate the potential impacts of the project and intended response measures to the public and stakeholders.
6. ***EIR Review***: involves a review of the information documented in the EIR. The adequacy of the information contained in the EIR determines whether or not the project will be approved.
7. ***Decision-making***: this is the core of the Environmental Impact Assessment process and occurs throughout the process. The final decision is made by the regulating authorities who decide whether to approve the project or not.
8. ***Follow-up***: involves the monitoring and evaluation phases of the development. It includes the continuous establishment, implementation and review of environmental management measures.

Although the basic steps of the EIA process are generic, practice differs from country to country. Screening in the U.S for example, is done through a clustered exclusion criterion established by state agencies which help decide on the environmental assessment of a development. An environmental assessment is then undertaken when a project has potential environmental impacts. Should the project show no impacts on the environment, a "*finding of no significant impact*" (King & Olsen, 2013: 3) is supplied by the assessment agency. An Environmental Impact Statement is the "information gathering" phase of the EIA process in the U.S. This document is a compilation of the anticipated impacts of the project and includes project alternatives as well as proposed mitigation measures to the development.

In Japan, the public is involved at the planning stages of the EIA process. The Japanese screening process involves both the public and local government. The results of the screening process and the views of the public and the government are compiled. The layout of the project is then submitted to the National Government by the developer. This is done to determine the project classification. Projects in Japan are classified into two classes, Class 1 includes projects which do not require an assessment. Projects that require a more detailed assessment are classified as Class 2 projects (Ministry of the Environment Government of Japan, 2012).

The South African EIA process makes provision for all of the above-mentioned generic steps of the EIA process. Screening in South Africa follows a list-based screening approach which leads to two forms of impact assessment namely: A Basic Assessment for smaller projects with minor environmental impacts or a more comprehensive Scoping/full EIA for bigger projects with adverse environmental impacts. Environmental Impact Assessment in South Africa is mandated by a strong legislative framework which is presented in the following section.

### 2.4. South African EIA legislation

The South African environmental legislative framework has influenced the progression of the country's EIA practice through time. Initially, EIA in South Africa was practiced on a voluntary basis. It was only in September 1997 that the country adopted mandatory EIA under the regulations set in terms of the Environment Conservation Act (ECA) (Act 73 of 1989).

The Constitution (Act 108 of 1998) and the National Environmental Management Act (NEMA) (Act 107 of 1998) were introduced by the new political dispensation in 1994. The NEMA (Act 107 of 1998) served as the first comprehensive set of environmental management legislation and gives effect to the environmental right guaranteed in the Constitution (Act 108 of 1998).

From 1999 to 2006, environmental management in South Africa served under the provisions of both ECA (Act 73 of 1989) and NEMA (Act 107 of 1998). The ECA (Act 73 of 1989) requirements were applied to identified activities while NEMA (Act 107 of 1998) was applied to activities that were not identified under the ECA (Act 73 of 1989) requirements, but had significant impacts on the environment. It was only in April 2006 that the first set of regulations promulgated under NEMA (Act 107 of 1998) were fully adopted (Kidd *et al*., 2018).

#### 2.4.1 The Constitution Act (Act 108 OF 1996)

The Constitution of South Africa affords everyone an environmental right. In development, government spheres, environmental management practitioners and proponents are all mandated by the Constitution to meet the objectives of sustainability. This can be achieved by establishing measures that encourage conservation, pollution prevention and the minimal destruction of natural habitat. The current legislative framework requires the security of ecological resources and the sustainable use of natural resources while driving socio-economic development (South Africa, 1996).

### 2.4.2 National Environmental Management Act (Act 107 OF 1998)

The National Environmental Management Act (Act 107 of 1998) serves as framework environmental management legislation in South Africa. Chapters one and five of NEMA (Act 107 of 1998) give effect to the directive of the Constitution by including the principles of sustainability in project planning. The NEMA (Act 107 of 1998) provides minimum requirements where environmental impacts should be evaluated, investigated and communicated. Since its promulgation in 1998, the NEMA (Act 107 of 1998) has been modified several times.

The first amendment was in 2006, where listed activities and definitions in the 2006 EIA regulations were refined. The 2006 regulations were amended in 2010, 2014 and recently in 2017. The NEMA (Act 107 of 1998) was further articulated through a series of new focused environmental management legislation including the NEM: Air Quality Act (Act 39 of 2004), NEM: Biodiversity Act (Act 10 of 2004), NEM: Integrated Coastal Management Act (Act 24 of 2008), NEM: Protected Areas Act (Act 57 of 2003), NEM: Waste Act (Act 59 of 2008) and the NEM: National Water Act (Act 36 of 1998).

### 2.4.3 Environmental Impact Assessment Regulations in South Africa

The EIA regulations are the driving force of sustainability in South Africa. The regulations set out the requirements that have to be met for a development to be approved. The primary objective of the regulations is to ensure that the impacts that developments have on the environment are identified and that possible remedial actions are established.

The South African EIA process has existed under different regulatory regimes. The principal purpose of the different regimes was to enhance the screening process, time-frames (EIA process) as well as the requirements of the public consultation process (Kidd *et al*., 2018). This section provides an overview of the different EIA regimes.

#### 2.4.3.1 ECA Regulations 1997

The 1997 EIA regulations where announced under sections 21, 22 and 26 of the ECA (South Africa, 1997). Concerns leading to the amendment of the regulations include the uncertainty related to undertaking the EIA process, which resulted in the inconsistent application of legislation. The EIA process was also overwhelmed by time delays, extensive public participation requirements and poor report quality (Retief *et al*., 2011). A major concern leading to the amendment of these regulations was related to the screening process, which was conducted through a list-based assessment of activities that were considered harmful to the environment.

The listed activities were broadly defined with minimal indication of thresholds. The regulations could not be easily understood and the degree to which certain activities were applicable was unclear. More EIAs were therefore triggered, causing a backlog of applications which delayed the authorisation process. The regulations were amended to lower the amount of EIA applications and fast track the authorisation process (Retief *et al*., 2011). Due to the comprehensive nature of the screening requirements of the regulations, the data documented in the scoping reports was extended to include more information than normally required for a scoping report, this is what Sandham *et al*., (2005: 52) refer to as "*beefed up*" scoping.

#### 2.4.3.2 NEMA 2006 EIA Regulations

The 2006 EIA regulations were published in terms of Section 24 of NEMA (Act 107 of 1998). This new set of regulations were established with the aim of improving the South African EIA process and strengthening the weaknesses of the 1997 EIA regime.

The listed activities were comprehensively defined and a detailed format for authorisation applications was provided. A major objective with this set of regulations was to reduce time frames by introducing mandatory time frames and removing certain activities from the authorisation process. These regulations also included thresholds for the different listed activities. The two types of impact assessments were introduced, namely: The Basic Assessment which is concerned with the evaluation of projects with smaller threshold and the full Scoping/EIA for much complex projects with higher threshold (South Africa, 2006).

One of the concerns related to the 2006 EIA regulations was the provision of public participation requirements. Murombo (2008) argues that these regulations failed to guide the public participation process. The regulations made provision for Environmental Assessment Practitioners (EAPs) to apply for authorisation and then give out a notice to the public. The concern was that the views and opinions of the public were not included in the early stages of project level decision-making and that the development of alternatives was based only on the views of the developer and the EAP. Schoeman (2017) investigated public participation before and during an EIA process and found that public concerns were not considered in the final decision-making process since the views and concerns of the public were not fully addressed in Environmental Authorisations. The effective implementation of public engagement requires the public to be involved as early as possible in decision-making.

### 2.4.3.3 NEMA 2010 EIA Regulations

The 2010 regulations represent the third regime of the South African EIA system. Under these regulations, two new lists of activities specific to the air and waste sectors were established with the promulgation of the National Environmental Management: Air Quality Act and the National Environmental Management: Waste Act.

These new regulations also established a way through which impacts imposed on sensitive environments could be mitigated, therefore introducing a listing notice for sensitive areas (South Africa, 2010). The enhancement of the screening process was a major aim of the 2010 regulations. The objective was to reduce the amount of EIA applications by simplifying the screening process- the listing notices were therefore amended by removing some of the listed activities. Measures to improve public participation were also introduced, these included the exclusion of the 15 December to 2 January target for decisions and appeals. Regulating authorities were pressured to decide on whether or not to grant an authorisation after the extension of the time frames had lapsed.

The public participation process was one of the concerns leading to the amendment of the regulations. The Centre for Applied Legal Studies (CALS, 2013) revealed that the public participation process under the 2010 regulations was plagued by subjectivity where EAPs were more subjective to the proponent and were less attentive to the socio-economic issues of a project.

The 2010 regulations also made provision for follow-up and monitoring in EIA. Environmental Impact follow-up and monitoring ensures sustainable outcomes by monitoring whether or not a project complies with regulatory framework. It is a way through which the environmental performance of the proposed development is communicated and managed (Marshall *et al*., 2012). Environmental Impact Assessment follow-up and monitoring is proven to positively influence sustainable outcomes. Environmental Control Officers (ECOs) and regulators are deemed persuasive when involved in the screening phase of large developments with adverse impacts. Independent follow-up verifiers also play an important role in evaluating legal compliance and reporting compliance results (Wessels *et al*., 2014).

The positive influence of ECOs and regulators is reflected through the satisfactory performance of EIA Follow-up and monitoring under these regulations. An evaluation of EIA follow-up performance under the regulations shows that follow-up results and objectives were well stipulated in the regulations, commitment to follow-up activities was evident, follow-up programs for both prior and post authorisation EIA stages were adapted and enough resources were supplied for monitoring, evaluation and auditing (Alers, 2016). These results are supported by a study aimed at evaluating follow-up conditions in Environmental Authorisations of the Mpumalanga Province (Ndlovu, 2015). The study indicates that the requirements of Regulation 37 of the 2010 Regulations were fully provided for in Environmental Authorisations (Ndlovu, 2015). The concern was that some of the conditions in the Environmental Authorisations could hinder follow-up since specific requirements of the Environmental Authorisations were not possible to implement because they were not practical. Other concerns were that the conditions did not apply to the project life cycle but were more relevant to the construction phase of the project.

The success of follow-up techniques in South Africa is advocated by the National Environmental Compliance and Enforcement Report (2012/2013) which shows that the implementation mechanisms that were established during the 2010 EIA regime depicted strengths in designated compliance and enforcement departments (DEA, 2012/2013).

#### 2.4.3.4 NEMA 2014 EIA Regulations

Amendments to the 2010 regulations were dedicated to more improvements of EIA efficiency and effectiveness. Efforts to enhance follow-up activities were evident in the 2014 EIA regulations. In Chapter 3 of the 2014 EIA regulations, the relevant information mandated by authorities for granting an authorisation was clearly described (South Africa, 2014). Chapter 3 of the regulations specify that the monitoring, management and reporting of all identified impacts for the pre-construction, construction and decommissioning phases of the project must be documented in an EMPr (Environmental Management Programme) (South Africa, 2014).

Regulation 34(1) mandated the developer to confirm compliance with the requirements of both the Environmental Authorisation and the Environmental Management Programme and submit an environmental compliance audit report to regulators (South Africa, 2014). Independent EAPs were required to compile EIRs and ECOs were required to compile environmental compliance audit reports. The regulations also clearly specified the duties and responsibilities of persons accountable for undertaking EIA follow-up (South Africa, 2014).

The performance of EIA follow-up and monitoring under the 2014 EIA regulations is just as commendable as that observed under the 2010 EIA regulations. An evaluation of EMPrs of the South African mining industry suggests that the overall quality of the reports is satisfactory. The only concern that could hinder implementation was that the socio-economic impacts and mitigation measures documented in the reports were not context specific. Another shortcoming was related to legislative guidance. According to Joubert (2015), the Department of Mineral Resources' (DMR) guidelines failed to clearly stipulate direct requirements on the compilation of EMPrs. Strengthening the practice of EIA follow-up and monitoring would therefore require strong institutional arrangements. Follow-up requirements should also be considered in the compilation of EIRs (Arts *et al.,* 2001).

#### 2.4.3.5 NEMA 2017 EIA Regulations

The 2017 EIA regulations represent more attempts to refine the South African EIA system by improving the screening process and changing time frames. The 13 April 2014 notice was amended to shorten the decision-making timeframe from 107 to 57 days. Certain listed activities were removed from the listing notices. A Basic Assessment could replace a full EIA/Scoping process for certain activities. Similar to the requirement of a Strategic Environmental Assessment (SEA) for wind and solar energy projects, a Basic Assessment instead of a full EIA/Scoping may be required for activities in Renewable Energy Development Zones (South Africa, 2017).

### 2.4.4 Section summary and conclusion

This section has provided an overview of the progression of the EIA process through time. The generic process of EIA has been depicted. However, different countries have their own unique way of conducting EIA. The effective implementation of EIA in South Africa is built on strong legislation which drives sustainability through NEMA (Act 107 of 1998). Attempts at achieving the objectives of sustainability are seen through continuous legislative amendments because since 2006, it can be seen that the South African EIA system is focused on improving the screening process, public participation requirements and time frames. These changes in regulations do not however improve the performance of the South African EIA system (Sandham *et al*., 2013*b*). The evaluation of EIRQ is one of the processes involved in determining EIA effectiveness and is discussed in the following section.

## 2.5 ENVIRONMENTAL IMPACT REPORT QUALITY

Environmental Impact Reporting is a process through which the results of an EIA are compiled and presented to authorities and to the public (DEAT, 2004*b*). The process involves the presentation of project specific information through EIRs. Environmental impact reporting offers the public and stakeholders an opportunity to better understand the impacts of a proposed project on the environment. This phase of the EIA process ensures that the identified impacts of a project are documented and that the proponent's commitment to mitigation is reflected (DEAT, 2004*b*).

Environmental impact reporting plays an important role in evaluating the role of EIA towards sustainability. Different methods have been developed to determine the quality of environmental impact reports. Criteria and principles have also been established to assess the quality of different EIA systems (Gibson, 1993; Sadler, 1996; Barker & Wood, 1999).

Environmental Impact Report Quality Review has been conducted using a set of standards, known as a review package. In this assessment method, the environmental impact reports are subjected to a review quality model which is established to assess the degree to which certain assessment tasks have been carried out. Existing review packages include the "*European Commission Guidelines on EIS Review*", the "*Oxford-Brookes Review Package"* ("*Impact Assessment Unit Review Package*") and the "*Lee and Colley Review Package*" (Lee *et al*., 1999).

✓ **The European Commission Guidelines on EIS Review**

The guidelines were created to evaluate the EIRQ of European Union member states. The EC guidelines are made up of 143 review questions which are classified into seven categories and sub-categories (European Commission, 2001).

✓ **The Oxford-Brookes Review Package (1996)**

The Oxford-Brookes Review Package (1996) was formulated at Oxford University by the Impact Assessment Unit and has been applied in EIA review (Glasson *et al*., 2005). The review package consists of 92 criteria but not all of the criteria can be applied to development activities (Glasson *et al*., 2005).

✓ **The Lee and Colley Review Package (Lee *et al*., 1999)**

The Lee and Colley Review Package is the most widely used package for evaluating EIRQ. The package was developed in 1989 under the United Kingdom Environmental Assessment Regulations (Lee *et al*., 1999). The review package instructs reviewers and provides information on how to use the standards. Since its establishment, the review package has been refined and used in evaluating EIRQ. For the purposes of this study, this review package has been adapted to determine the EIRQ of Renewable Energy Projects and review criteria were formulated to determine the degree to which the sustainability principles were considered in the EIRs. A detailed structure of the Lee and Colley Review Package occurs in Chapter 3. This part of the review provides an overview of the national and international assessment of EIRQ.

### 2.5.1. International Environmental Impact Report Quality

The Lee and Colley Review Package was applied between 1988 and 1889 to evaluate the EIRQ of 12 environmental impact reports in the United Kingdom (Lee & Colley, 1992). The findings of the study indicated unsatisfactory performance where only three of the reports were of acceptable quality. Improvements in EIRQ were indicated by a study conducted by Lee *et al*., (1994). The results revealed that reports compiled between 1988 and 1989 had a weaker performance than those compiled between 1990 and 1991.

With the urgency to improve the EIRQ of various EIA systems, the evaluation of EIRQ was adopted by different countries. The EIRQ of Spain and Portugal was evaluated through the Guidance on EIA-EIA review Jun 2001 package (Canelas *et al*., 2004). The findings indicated that between 1998 and 2003, 65% of EIA reports in Spain were satisfactory and 75% in Portugal were satisfactory.

Lee & Dancey (1993) evaluated the quality of Environmental Impact Statements in Ireland and the United Kingdom between 1988 and 1992. The findings indicated that the overall quality of Environmental Impact Statements from both countries was unsatisfactory but had improved over time. The EIS quality of both countries was similar, with 60% of the statements achieving poor grades and 20% of the statements performing well. The Ireland statements revealed a higher percentage of poor quality, illustrating EIS quality that is significantly lower than that of the U.K.

Unsatisfactory quality was observed for EIS(s) of the Scottish Forest Sector (Gray & Edwards-Jones, 1999). The overall quality of the EIA process and the EIS(s) was poor. It was revealed that a full scoping phase was not conducted and major concerns were not identified. The statements indicated that only 25% attempted to identify and evaluate major impacts. Most of the statements did not indicate the use of external sources or specialists and failed to indicate the views and opinions of the public. Alternatives were poorly attempted with 56% of the statements failing to substantiate the reason for the chosen alternative.

Wende (2002) evaluated EIA effectiveness and quality in Germany. Environmental Impact Assessment was revealed as a planning tool that emphasizes spatial issues as improvements were observed in Germany's EIA process.

Peterson (2009) used the EC Guidance on EIS Review (2001) and found the EIS quality of Estonia satisfactory. The EIS(s) were randomly selected and reviewed by an independent reviewer and then reviewed by a group of 24 individuals. The results indicated that 65% of the statements were satisfactory. A comparison between both reviews indicated that a group review was more comprehensive than an individual review.

The implementation of EIAs in developing countries is considered to fall short of international best practice (Li, 2008). The process is often plagued by poor public consultation processes, the poor contemplation of alternatives and the poor identification of impacts. These weaknesses are evident in the EIRQ studies of some developing countries.

Mounir (2015) reveals that EIA in Nigeria is inadequately conducted with main weaknesses related to Review Areas 2 (Identification and evaluation of key impacts) and 3 (Follow-up). The statements reviewed achieved a 60% satisfactory grade while 40% achieved grades between D (Poor) and E (Very poor). The results indicate that 33% of the statements were found unsatisfactory for Review Area 1 (Description of the development and baseline conditions) while Review Area 4 (Presentation of EIS) was the best performing with only 20% of the statements achieving unsatisfactory grades.

Environmental Impact Statements in Lesotho are unsatisfactory (Talime, 2011). These results indicated that all four Review Areas were poorly completed. The weakest performance was identified in Review Area 2 (Identification and evaluation of impacts) where only 27% of the statements achieved satisfactory performance. In Review Area 3 (Alternatives and Mitigation), 33% of the statements were assigned B-C grades. It was observed that the identification and evaluation of impacts was poorly conducted, no alternatives were contemplated and significance assessment was not attempted. Satisfactory performance was observed in Review Areas 1 (Description of development) and 4 (Communication of results) which both achieved a score of 47%. Contrary to these results, EIA practice in Namibia indicates international best practice (Husselmann, 2016). Identified concerns are related to screening and EIA follow-up which are a result of the poor implementation of legislative requirements.

### 2.5.2. Environmental Impact Report Quality in South Africa

Environmental Impact Quality Review in South Africa is still in its infancy. Since South Africa mandated EIA in 1998, limited studies have been conducted to determine the quality of information presented in EIRs. The available literature is however sufficient to give an overview of EIRQ in South Africa.

Environmental Impact Report Quality in South Africa has been investigated for renewable energy projects (Boshoff, 2013), filling station projects (Kruger, 2012), mining projects (Sandham *et al*., 2008*b*), Social Impact Assessment reports (Hildebrandt & Sandham, 2014), projects affecting wetlands (Sandham *et al*., 2008*a*) and projects in the explosives industry (Van der Vyver, 2008). Some EIRQ studies have also been conducted in the Northwest Province (Sandham & Pretorius, 2008) and in the Free State Province (Kruger & Chapman, 2005).

#### 2.5.2.1 EIRQ in the Northwest and Free State Provinces

The results of EIRs from the Free State Province indicate good conformance to regulations. The weaknesses that were identified were related to the identification of socio-economic impacts, the impact assessment methodology, alternatives and the public participation process. The results illustrated that the task on baseline studies was poorly attempted with 16% of the reports showing no evidence of physical studies, 42% of the reports that attempted baseline studies were of poor quality while 20% were of average quality, and only 22% had good quality.

The assessment procedure used in the study was regarded subjective since 49% of the reports used only one assessment method and 22% of the reports used a checklist and another different type of assessment. Specialist input was not considered in 44% of the reports. The concern related to alternatives was that the identified alternatives were not comprehensive. It was found that 47% of the reports did consider alternatives but 79% of the considered alternatives were related to the project location.

The performance of the public participation process was also not satisfactory. The results show that 38% of the reports used one communication method to consult the public. Out of 48% of the reports that required public participation, 38% did not use adverts. At least 30% of the reports indicated the use of two types of public consultation methods and only one of the reports used five types of consultation measures (Kruger & Chapman, 2005). Latest studies indicate improvements in the way the public participation process is conducted (Aregbeshola, 2009; Sutton-Pryce, 2015; Suwanteep *et al*., 2017). The public is consulted through a variety of methods such as letters, meetings and press adverts, all of which should be reflected in the EIR as required by Regulation 41 of the 2014 and 2017 EIA Regulations.

An evaluation of EIRQ in the Northwest Province shows satisfactory performance with 86% of the reports achieving A-C grades. Only 21% of the reports were generally satisfactory and 64% satisfactory, while 11% was unsatisfactory and 4% was poorly attempted with an achievement of E grades. The best performing tasks included communication of results where 96% of the reports performed well.

The second-best performing task was the description of the environment and the project which achieved a performance score of 86%. Review Areas 2 and 3 did not perform poorly but achieved the lowest frequency of satisfactory scores. The task on the identification and evaluation of key impacts achieved a performance score of 71% while the task on mitigation and alternatives achieved a performance score of 61%. Some of the weaknesses that were identified were related to the methods used to identify alternatives where only 21% of the reports were graded satisfactory. The task on indicating the effectiveness of the methods also performed poorly with only 34% of the reports achieving satisfactory grades. Other identified weaknesses were related to estimates on waste, workers entering the site, transportation to and from the site and the duration of the different project phases (Sandham & Pretorius, 2008).

#### 2.5.2.2 EIRQ of renewable energy projects

The environmental impact reports of renewable energy projects indicate good quality (Boshoff, 2013). Most of the reports performed well with at least 70% achieving A-C grades. The best performing tasks were the description of the environment and the development where 83% of the reports achieved A-C grades. The identification and evaluation of key impacts also performed well with mostly A-C grades. These results suggest that the project was comprehensively described with the purpose of the project and its aims and objectives clearly explained. The category on alternatives and mitigation was the third best performing with 57% of the reports achieving grades between C-D. The same grades were reported for category on the communication of results where 50% of the reports achieved C-D grades. The weaknesses identified included insufficient non-technical summaries and weak summaries of key concerns.

#### 2.5.2.3 EIRQ of filling station projects

The findings from this study reveal that the overall EIRQ of filling station projects is poor (Kruger, 2012). The results indicate that 65% of the reports achieved C grades while only 7% achieved B grades and 33% achieved D grades. The best performing categories with an achievement of 100% (A-C grades) include the description of the environment, the identification of impacts, the scoping of impacts, the assessment of significance as well as emphasis on the impacts (Kruger, 2012).

The identified weaknesses include the tasks on waste and emissions and commitment to mitigation. The findings reveal that only 30% of the reports achieved A-C grades for both tasks. The identification of cumulative impacts achieved the lowest grades with only 24% of the reports achieving A-C grades. This poor performance is related to inadequate information or the fact that the task was not attempted at all.

A comparison between these results and the results obtained for renewable energy projects and EIRs in the Free State Province show an improvement in the South African EIRQ between 1997 and 2010. The results show that the description of baseline studies in 2010 and the way that impacts were identified is more comprehensive and well performed than it was in 1997. This improvement reflects a satisfactory advancement in EIRQ.

#### 2.5.2.4 EIRQ of projects in the explosives industry

The same pattern of results is observed in EIRs of projects in the explosives industry. The environment is well described and the scoping is well performed. The results show that in the description of the environment, the reports achieved 1A and 3Bs while the task on scoping achieved 1A, 2Bs and 1C. The reports were also well presented with a good layout. These tasks achieved 1A and 3Bs and 1C and 3Bs. The task on waste and residuals was satisfactory with 1C and 3Bs.

These results contradict the findings from filling station projects where the task on waste performed slightly weaker. The weaknesses identified from these findings were related to the production rate, the required raw material, the procedure for assessing significance, required infrastructure, expected visitors on site, the recording of the views of the public as well as the acknowledgment of different sources. All of these tasks achieved grades between D, E and F (Sandham *et al*., 2013*b*). The overall quality of this set of EIRs was however satisfactory.

#### 2.5.2.5 EIRQ in the mining industry

The overall performance of the EIRQ of the mining industry is satisfactory (Sandham *et al*., 2008*b*). The results indicate that 85% of the reports were of good quality. Strengths were identified in the scoping process, the layout and presentation of the reports and wastes. All of these tasks achieved A-B grades. A comparison of these results and the results from the other projects reveals that the Review Area on the communication of results is very well performed. This means that the information in the reports is logically communicated and presented.

Some of the weaknesses found in these reports include the prediction of impact magnitude which was the worst performed sub-category, followed by the consideration of alternatives. The sub-category on identifying possible alternatives to the project was also poorly performed in the reports of the Northwest Province. The contemplation of alternatives has been identified as one of the main concerns related to the EIA process. It has been suggested that the poor consideration of alternatives is due to the fact that only a few alternatives are considered in EIA (Kvaener *et al*., 2006). Environmental Impact Assessment practitioners tend to overlook the best alternatives and evaluate alternatives as a motive to comply to requirements as opposed to ensuring sustainable outcomes (Steinemann, 2001).

#### 2.5.2.6 EIRQ of Social Impact Assessments

This study was a comparison of the EIRQ of Social Impact Assessments under the 1997 ECA EIA regime and the 2006 NEMA regime. The findings reveal that although the general EIRQ performance was weak, there was a slight improvement under the NEMA 2006 regime. The best performances were identified under Review Areas 1 (Description of the environment) and 4 (Communication of results) which is consistent to the findings from Kruger (2012), Sandham *et al*., (2008*b*), Boshoff (2013) and Sandham & Pretorius (2008). Weaknesses were identified under Review Areas 2 (Identification of key social impacts) and 3 (Alternatives and mitigation) where the frequency of A-B grades was a bit low. Under Review Area 2, the identification of impacts and predicting the significance of the impacts were the worst performing sub-categories while the requirements on community arrangements were also weak with 46% of the reports achieving grades between E-F. In Review Area 3, 50% of the reports achieved grades between E-F (Hildebrandt & Sandham, 2014).

#### 2.5.2.7 EIRQ for projects affecting wetlands

The findings from this study are consistent with those from the other studies. The results indicate that the information provided in South African EIRs is well presented. The environment and baseline conditions are also well described. The identified weaknesses include the prediction of impact magnitude, the assessment of significance, wastes, site description and scoping (Sandham *et al*., 2008*a*). Inadequate scoping processes are likely to result in the poor identification of impacts which was significantly the worst performing task in this set of reports. This result is concerning since the identification of impacts is the centre of the EIA process. The methods used to identify impacts in these types of projects should therefore be enhanced and supported by more specialist input.

#### 2.5.2.8 EIRQ of biological pest control

In comparison to the rest of the studies, this study had the lowest results. The findings indicate that these reports failed to identify the environmental impacts of the development, to evaluate the impacts and to establish mitigation measures and monitoring programs (Sandham *et al*., 2010). Similar to the reports on projects affecting wetlands, it is observed that a poor scoping process can result in the poor identification of impacts. All of these requirements achieved grades between D, E and F- meaning that the tasks were either poorly attempted or had significant omissions.

Similar to the findings of Barker & Wood (1999), Canelas *et al*., (2004) and Lee & George (2000), the findings from these studies reveal that the South African EIRQ is satisfactory and reflects international best practice. The observation that some tasks perform better than others confirms the issue surrounding the EIA process, which is the need to equally prioritize all environmental, social and economic dimensions of sustainability.

The process of Sustainability Assessment has been presented as a potential solution to this concern. In order to understand the Sustainability Assessment process, it is important to have a clear understanding of the concept of sustainability. In the following sections, this review will give a definition of the term sustainability and give an overview of Sustainability Assessment.

## 2.6. SUSTAINABILITY DEFINED

The notion of sustainability is derived from the term sustainable development. In most cases, the two terms are used synonymously. A distinction between the concepts is however important if sustainability is to be integrated into EIA. The concept of sustainable development is concerned with development or growth (Waas *et al*., 2014). It is a process which seeks to ensure equity, education and opportunities. Sustainable development is commonly defined by the World Commission on Environment and Development (WCED: 1987) as:

"*development which meets the needs of the present without compromising the ability of future generations to meet their own needs*" (WCED, 1987: 24).

This definition has however been scrutinized and criticized as the objectives of sustainable development became clearer. The problem is that the definition is vague and unclear in terms of how sustainable development should be met (Sadooni, 2007). The definition does not provide detailed information on how to integrate social issues, economic development and environmental protection.

In an effort to better define and understand the concept, various interpretations have emerged. These interpretations are based on two important aspects. The first aspect is concerned with the principles of intragenerational equity and intergenerational equity which suggest that the objectives of sustainable development are equity between what is to be "developed" and what is "developing", as well as equity between current and future generations. The Triple Bottom Line (TBL) method is the second aspect and suggests that sustainable development is an integration between the three dimensions of sustainability (*Figure 2-2*).

On the contrary, the term sustainability means ensuring that humans can survive in a healthy environment. It certifies that everyone's needs are provided for and focuses on the protection of biodiversity and ecosystems, resources, cultures, groups and places (Kates *et al*., 2005). The concept seeks to meet the environmental, social and economic needs of both man and the environment in a manner that ensures that (Lawrence, 1997):

- Current activities do not compromise the wellbeing of future generations.
- Some geographic areas do not take preference over others.
- Investments from natural resources are maintained and human needs do not go beyond biological limits.

- Ethical tools of decision making are established.
- Efforts are made to sustain and maintain the sustainable and eradicate the unstainable.
- Sustainability is adopted as a concept that can be redefined to fit different context.

Sustainability has also been defined in terms of weak and strong sustainability:

- Weak Sustainability

  Proposes that natural resources should be dominated so as to meet the needs of society and that economic growth indicates progress. This definition suggests that natural resources can never be depleted and can be replaced by future technological advancements (Huang, 2018; Williams & Millington, 2004).

- Strong Sustainability

  Supports the conservation of natural resources and believes that the natural environment should be left unharmed. This definition proposes the establishment of social and economic development measures that have less pressure on natural resources (Huang, 2018; Williams & Millington, 2004).

Sustainability is often defined to consider three dimensions: Environmental, Social and Economic (*Figure 2-2*).

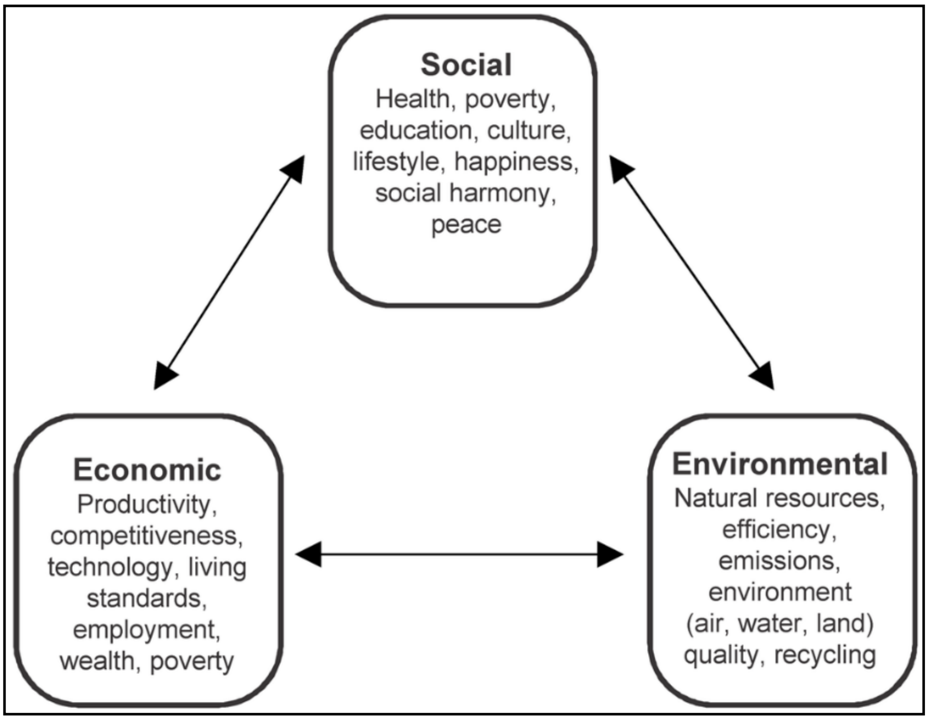


**Figure 2-2: Pillars of sustainable development (Rosen & Kishway, 2012).**

This definition of sustainability is referred to as the TBL approach, which means that sustainability should ensure that all three dimensions of sustainability are integrated. The TBL approach defines the three dimensions of sustainability as follows (Harris, 2003):

1. **Environmental**: Environmental sustainability is concerned with the protection and conservation of natural resources. It ensures that the physical and biological resource system is secured, maintained and improved.

2. **Social**: Social sustainability is concerned with providing the basic needs of society. It seeks to ensure that opportunities and social services (health, education, employment, gender) are equally and adequately provided.

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3. **Economic**: Economic sustainability seeks to ensure that the economy is managed in a way that continuously provides goods and services. It guarantees that a country's debt does not go beyond levels that cannot be managed or maintained.

Current debates on sustainability do not support the TBL approach of defining sustainability. It is argued that this manner of defining the concept overlooks the fact that there's a difference between the objectives of environmental protection and wellbeing. Kuhlman & Farrington (2010) argue that this definition weakens the importance of the biophysical component of sustainability and divides social aspects from economic aspects which cannot exist in isolation.

The TBL approach is also discouraged by Gibson (2001) who argues that the objective of sustainability has always been perceived as an integration of the sustainability dimensions, not an interrelation thereof. There should therefore be a distinction between the dimensions of sustainability as "*material gains are not sufficient measures or preservers of human well-being*" (Gibson, 2001:10). Therefore, in defining sustainability the concept should be defined as a set of requirements represented by sustainability principles namely (Gibson, 2006: 4):

1. *"Socio-ecological system integrity"*
2. *"Livelihood sufficiency and opportunity"*
3. *"Intragenerational equity"*
4. *"Intergenerational equity"*
5. *"Resource maintenance and efficiency"*
6. *"Socio-ecological civility and democratic governance"*
7. *"Precaution and adaptation" and*
8. *"Immediate and long-term integration"*

The principles focus on how sustainability requirements are associated and have been grouped together to avoid the TBL approach of defining sustainability (Gaudreau and Gibson, 2010). The sustainability principles are the heart of Sustainability Assessment and are discussed in the following section.

## 2.7. SUSTAINABILITY ASSESSMENT

Sustainability Assessment has evolved as a process that can guarantee that the objectives of sustainability are equally considered in development (Bond & Morrison-Saunders, 2011). The aim of Sustainability Assessment is to provide a comprehensive understanding of the concept of sustainability and how it can be interpreted in different context. The process seeks to determine whether a proposed development can deliver sustainable outcomes or not (Waas *et al*., 2014).

The concept of Sustainability Assessment can be approached in different ways. Pope *et al*., (2004) differentiate between two approaches: An EIA-Integrated Sustainability Assessment and an Objectives-led Sustainability Assessment.

The EIA-Integrated Sustainability Assessment is applied after a development has been established. The objectives of this assessment are to evaluate and identify the impacts that a development will have on the environmental, social and economic dimensions of sustainability and to contrast between these impacts and the baseline conditions of the proposed environment. This will then make it easier to decide on whether the impacts can be mitigated or reversed. The contribution of this type of assessment to sustainability is that it embraces the three dimensions of sustainability. This way of assessing sustainability seeks to ensure that all identified impacts are not adverse and can result in sustainable outcomes (Pope *et al*., 2004).

An Objectives-led Sustainability Assessment indicates the intention to meet the objectives of sustainability. It evaluates the degree to which a proposed development can integrate these objectives. This form of assessment needs a detailed definition of the sustainability objectives against which the assessment can be conducted. According to Pope *et al*., (2004), the objectives of the three dimensions of sustainability are more likely to be equally prioritised in an Objectives-led Sustainability Assessment than in a generic environmental impact assessment. Sustainability Assessment can therefore be applied as an alternative to EIA (Pope *et al*., 2004).

The process can be used by regulating authorities to decide on whether a proposal is sustainable or not. It can also be applied during project planning to determine whether or not the contemplated alternatives can meet the set sustainability criteria. The Sustainability

Assessment process is conducted using multiple criteria and indicators. The concept of sustainability indicators evolved from the Sustainability Indicator Systems Agenda 21 of the 1992 Rio declaration and the 1994 Charter of Aalborg (UNCED, 1992). An indicator is defined as:

"*the operational representation of an attribute (quality, characteristic, property) of a given system, by a quantitative or qualitative variable (for example numbers, graphics, colours, symbols) (or function of variables), including its value, related to a reference value"* (Waas *et al*., 2014: 5520).

### 2.7.1 Sustainability Assessment indictors and criteria

The use of indicators and criteria has evolved and different studies have been conducted where the indicators/criteria are used to identify the potential sustainability of different projects.

The studies illustrated in *Table 2-2* have used different criteria and indicators to determine the sustainability outcomes of projects in varying context. Afghan *et al*., (2000) have defined and determined indicators to evaluate the sustainability of an energy system. The indicators are defined to provide the information on which the best alternative was chosen. The indicators include resource indicators which are characterised by fuel resources, copper and aluminium resources as well as stainless steel resources. The second indicator is the environment indicator represented by the job, community and standard indictors. Environmental indicators include carbon dioxide, sulphates and nitrates.

Buri *et al*., (2016) determined sustainability protocols and certification criteria for switch grass-based bioenergy. This study was motivated by the impacts of bioenergy generation on the environment. The generation of bio-energy has impacts on land use, water resources, biodiversity and Green House Gas (GHG) emissions. The criteria were established for a certification program specific to switch-grass bioenergy. Different criteria were developed for impacts resulting from agrochemical applications, stand establishment and harvest as well as biodiversity.

The required criteria and indicators for agrochemical application included:

- pH tests and the availability of phosphorus and potassium in soil;
- to minimise the application of nitrogen and adjust to nitrogen use that is sufficient for soil fertility.

The criteria for stand establishment and harvest included:

- the monitoring of the "critical biomass density" of harvest levels, to harvest in a way that winter cover is not disturbed;
- to avoid impacts on the soil organic carbon;
- to store harvest in a covered area;
- to follow guidelines on the harvesting and storage;

The biodiversity indicators were:

- the monitoring of trends in local biodiversity index; and
- to monitor ecological corridors and provide suitable buffer ones

These indicators were established to reflect the importance of using switch-grass based bioenergy while avoiding the associated risks (Buri *et al*., 2016).

Fritsche *et al*., (2012) developed sustainability indicators for the generation of solid bioenergy from forests. The problem was related to the impacts that the generation of solid bioenergy has on forests. These include losses in biodiversity, soil nutrient depletion and physical disturbances while water resources may be vulnerable to contamination (Fritsche *et al*., 2012). This process may also introduce new species to the area.

The indicators that were used in the study included protecting biodiversity, sustainable forest management and the net reduction of GHG emissions. The criteria on biodiversity protection included defining "*no-go areas*" and protecting biodiversity on managed locations. The criteria for sustainable forest management are fundamental for harvestable areas where indicators are applied to guarantee legitimacy and improve the sustainable management of the forest.

Fritsche *et al*., (2012) explain that a principal objective in creating sustainability criteria is to minimise the risks imposed on future forests. Future forests are threatened due to the high demand of bioenergy and attempts at reducing GHG emissions. In the development of the criteria, international legislative framework was considered and areas of ecological relevance were omitted from the study.

**Table 2-2: Sustainability Assessment studies using indicators and criteria.**

| Author | Indicator/Criteria | Name of study |
|---|---|---|
| Afghan *et al.*, (2000) | Resources<br>Environment<br>Social | Energy System Assessment with Sustainability Indicators |
| Buri *et al.*, (2016) | Agrochemical application<br>Stand establishment and harvest<br>Biodiversity | Sustainability protocols and certification criteria for Switch grass-based Bioenergy |
| Bautista *et al.*, (2016) | Rights of land access<br>Food supply<br>Air Quality<br>Efficient use of water<br>Local water quality<br>Soil quality | Biodiesel-triple bottom line (TBL): A new hierarchical sustainability framework of principles criteria and indicators (PC&I) for biodiesel production. Part 1-validation |
| Fritsche *et al.*, (2012) | Protecting Biodiversity<br>Sustainable Forest Management<br>Net GHG Reduction | Sustainability Criteria and Indicators for Solid Bioenergy from Forests based on the Joint Workshops on Extending the RED Sustainability Requirements to Solid Bioenergy |
| Govindan *et al.*, (2016) | Delivery reliability<br>Quality assurance<br>Operational Cost<br>Use of clean material in production Process<br>Efficient energy use | Effect of product recovery and sustainability enhancing indicators on the location selection of manufacturing facility |
| Kurka & Blackwood (2013) | Provision of economic incentives for environmental protection<br>Accessible programs to teach rural populations about the importance of sustainable forest management<br>Volumes of wood extracted for households. charcoal | Participatory selection of sustainability criteria and indicators for bioenergy developments |
| Milutiovic *et al.*, (2014) | GHGs<br>Volume reduction<br>Investment and operational costs<br>Revenue<br>Job creation | Multi-criteria analysis as a tool for sustainability assessment of a waste management model |

### 2.7.2 Gibson's Principles of Sustainability Assessment

The most widely adopted criteria created specifically for Sustainability Assessment are the Gibson (2006) principles of Sustainability Assessment (*Table 2-3*). Gibson (2006) advocates the criteria as the heart of Sustainability Assessment, where expected sustainability outcomes are relevant to the context of the project. Gibson (2001) explains that the sustainability of a development or proposal has to be reflected by a set of criteria represented by the principles of sustainability.

**Table 2-3: Sustainability Assessment Principles (Gibson *et al*., 2005: 116-118).**

| Principle | Requirement |
|---|---|
| **1. Socio-ecological system integrity** | Build human–ecological relations to establish and maintain the long-term integrity of socio-biophysical systems and protect the irreplaceable life support functions upon which human and ecological well-being depends. |
| **2. Livelihood sufficiency and opportunity** | Ensure that everyone and every community has enough for a decent life and that everyone has opportunities to seek improvements in ways that do not compromise future generations' possibilities for sufficiency and opportunity. |
| **3. Intragenerational equity** | Ensure that sufficiency and effective choices for all are pursued in ways that reduce dangerous gaps in sufficiency and opportunity (and health, security, social recognition, political influence, and so on) between the rich and the poor. |
| **4. Intergenerational equity** | Favour present options and actions that are most likely to preserve or enhance the opportunities and capabilities of future generations to live sustainably. |
| **5. Resource maintenance and efficiency** | Provide a larger base for ensuring sustainable livelihoods for all, while reducing threats to the long-term integrity of socio-ecological systems by reducing extractive damage, avoiding waste and cutting overall material and energy use per unit of benefit. |
| **6. Socio-ecological civility and democratic governance** | Build the capacity, motivation and habitual inclination of individuals, communities and other collective decision-making bodies to apply sustainability requirements through more open and better-informed deliberations, greater attention to fostering reciprocal awareness and collective responsibility, and more integrated use of administrative, market, customary and personal decision-making practices. |
| **7. Precaution and adaptation** | Respect uncertainty, avoid even poorly understood risks of serious or irreversible damage to the foundations for sustainability, plan to learn, design for surprise, and manage for adaptation. |
| **8. Immediate and long-term integration** | Apply all principles of sustainability at once, seeking mutually supportive benefits and multiple gain. |

The first principle on **socio-ecological system integrity** reflects the objectives of sustainability in that it seeks the long-term protection of the environment and its natural resources.

The principle on **livelihood sufficiency and opportunity** is related to the provision of opportunities through which man can improve their well-being and survival.

**Intragenerational equity** seeks to ensure that opportunities (employment, health, security) are distributed equally between current generations, whereas **intergenerational equity** is concerned with securing current provisions and opportunities for future generations.

There is an overlap between the principle on socio-ecological system integrity and that on **resource maintenance and efficiency**. Both principles focus on maintaining the natural state of ecological systems and implementing measures through which natural resources can be conserved and protected.

The principle on **socio-ecological civility and democratic governance** ensures that sustainability is achieved through the empowerment of the public, through awareness and information transfer so that the public can make more informed decisions.

The principle on **precaution and adaptation** is concerned with preparing for uncertainty, implementing measures of managing and preventing risk as well as learning from previous experiences.

The final principle on **immediate and long-term integration** seeks to ensure that the objectives of all of the principles are integrated in order to achieve better outcomes.

An important aspect of the sustainability principles is that they allow sustainability to be evaluated based on the context of the development. This therefore provides a generic perspective on how sustainable a development is.

The principles were applied to determine the sustainability of a power station (Hariram, 2014) while Ratshibvumo (2016) investigated the extent to which the principles were incorporated in EMPrs and Social & Labour Plans of a gold mine. The principles were also applied to assess the sustainability and resilience of a biodiesel project by Gaudreau and Gibson (2010) in Barbados. For this study, Gaudreau and Gibson (2010) developed integrated criteria which included environmental impacts, scale impacts and concerns related to providing knowledge to the affected community. The results indicate that the project had sustainable impacts on the environment since it decreased the amount of waste oil and fossil diesel that was transported into the island. A small-scale project would also involve many stakeholders and be operated easily. Other impacts associated with the scale of the project include job creation and increased resilience. The project was found to positively impact society by building relationships between stakeholders, raising awareness and motivating the research for sustainable diesel production methods.

The project was however deemed water intensive, involved the generation of a waste product that was poorly handled and the project's electricity supply was from a diesel generator. The scale of the project had negative impacts on diesel producers that were affected by subsidized diesel, insufficient biodiesel funding and high prices of methanol. It was also observed that the diesel producers did not have the capacity to handle waste and hazardous material due to costs related to training and quality control (Gaudreau & Gibson, 2010).

The sustainability principles were also applied in a panel review of the sustainability of a gas project in Canada (Gibson, 2011). The findings of the review indicated that the project would have positive impacts on sustainability. Although a "*No-go* "alternative would result in less environmental impacts and conserve the gas resource for future use, the panel argued that this alternative would not positively contribute to the socio-economic wellbeing of the affected communities. The project was therefore chosen as the preferred alternative but would only contribute to sustainability if the recommendations of the panel were fully implemented.

Some of the recommendations made by the panel included clarity on how income would be distributed between federal and territorial governments and how women and people from small communities would access opportunities provided by the project. To meet the objectives of intergenerational equity, the panel recommended the establishment of measures to preserve protected areas and to manage the size and time frame of the project. Government authorities were also required to reduce the impacts from trade-offs and develop a strong legislative framework that would ensure that environmental resources are maintained and conserved (Gibson, 2011).

The sustainability principles are guaranteed to address a wide range of requirements to achieve sustainable outcomes. The context of the project should however be clearly understood to address the set requirements. Therefore, in order to get a perspective on the sustainability requirements of Renewable Energy Projects, this review looks at the context of Renewable Energy Projects.

## 2.8. RENEWABLE ENERGY

Renewable energy is derived from non-renewable sources such as the sun, wind, geothermal heat, waves etc. (Johansson *et al*., 2004). The use of renewable energy is encouraged as a sustainable energy alternative which can reduce carbon emissions and minimize water consumption.

Investments in renewable energy in South Africa are on the rise. The 2014 United Nations Environment Program (UNEP) revealed South Africa as one of the top ten countries in the world with the highest investments in renewable energy (DOE, 2015). Renewable energy exists in different types and each type contributes differently towards sustainability. The different types of renewable energy are discussed below.

### 2.8.1. Wind Energy

Wind energy is the energy produced from wind. It is generated by the fusion of hydrogen and helium atoms. The helium fusion process generates heat resulting in the release of electromagnetic radiation streams from the sun.  Wind energy is converted into energy through wind turbines which are grouped according to the energy supply mode, turbine capacity, the generator-driving pattern, the turbine generator configuration, the setting of the turbine installation and the airflow path relative to the turbine rotor (Tong, 2010).

The earliest wind turbine in the world was designed in 1888. The turbine had 144 cedar blades with a 17m rotating diameter. Modern day wind turbines are designed with three blades which operate at high wind speeds to generate more energy. The mean wind speed and the distribution frequency (Weibull distribution) of the wind speed determine the amount of energy that can be produced (Tong, 2010).

### 2.8.2. Hydropower

Hydropower generates electricity by converting water into mechanical power. Energy is produced when water moves through a turbine which generates electrical energy through a generator (Banerjee, 2016). The amount of water moving through the turbine determines the total capacity of a hydroelectric plant to produce energy.

A hydroelectric power plant consists of a reservoir, a dam, a penstock, surge tank, trash rack, generator, spillway, prime mover and a forebay (Rotilio *et al*., 2017). The reservoir is used as a water storage area.

The height of the reservoir determines the amount of potential energy that can be produced by the water. A greater height signifies a greater capacity to produce potential energy. The dam is placed behind the reservoir to increase the amount of potential energy. The dam is protected from flooding by the spillway, which is constructed to have enough capacity for flood discharge and to minimize water levels in the reservoir (Holmeset, 2013).

The water from the reservoir is transported into the turbines by the penstock. The purpose of the surge tank is to ease the movement of the water flowing through the penstock. The trash rack functions as a sieve and stops the movement of debris into the turbine or wicket gates (Holmeset, 2013). The electricity is produced in the generator. The water turbine rotates the generator which produces a current in the generator. The shaft inside the generator then spins to produce a magnetic field which is transferred into power by an electromagnetic induction (Singh *et al*., 2015).

### 2.8.3. Biomass Energy

Biomass is all organic material that is generated by photosynthesis. This includes plants, animal manure, forestry or farming residues and municipal waste which store the energy from the sun in chemical bonds (oxygen, carbon and hydrogen) (Nada & Alrikabi, 2014). Energy is released when these bonds are broken down through digestion, gasification, fermentation, pyrolysis or combustion.

The production of biomass energy through combustion takes place when wood or municipal waste is burnt to generate steam. The steam rotates the turbine which drives the generator to produce power. During the gasification process, a solid fuel is exposed to extreme heat and low levels of oxygen to generate a gaseous fuel which drives the gas turbine (Sriram & Shahidehpour, 2005).

Pyrolysis occurs when the biomass is heated until charcoal is left behind. The charcoal increases the energy density of the original biomass and burns at higher temperatures, making the fuel easier to transport. The digestion process involves the combination of anaerobic bacteria and organic matter to emit gas which can be used to produce energy (Sriram & Shahidehpour, 2005).

### 2.8.4. Wave Energy

A wave is defined as a disturbance that moves through a medium from one location to another (Chenari *et al*., 2016). Wave energy produces energy through the movement of waves on the surface of a water body. The generation of wave energy uses wave energy convertors which convert wave power into electrical energy. The wave energy is initially converted to energy in working fluids. The energy is then converted into mechanical energy inside a turbine. Electrical energy is produced when the generator is rotated by the mechanical energy.

Wave energy convertors are normally placed at three locations: on-shore, near-shore and off-shore. An on-shore location refers to coastal areas which have a water depth of 10-15 meters and a maximum height of 7.8 meters. A near-shore location refers to shallow waters with a water depth between 15-25 meters and a wave height of 15.6 meters. Off-shore locations have deep waters and do not have a limit on the water depth and the wave height (Chenari *et al*., 2016).

### 2.8.5. Geothermal Energy

Geothermal energy is the heat that is discharged from rocks and fluids (gasses, water, brines) (Goldstein *et al*., 2012). Power generation using geothermal energy takes place through the abstraction of heat energy from geothermal reservoirs. This energy is flown into turbines where it is converted from kinetic and thermal energy into electrical energy. Geothermal systems exist in two types:

- Convection-dominated systems: consist of hydrothermal systems that use liquid and vapour.

- Conduction-dominated systems: consist of hot rocks and hybrid systems that are produced by conduction, convection and rocks that generate high heat.

Geothermal energy is extracted in three different ways: dry steam power plants, flash steam plants and binary cycle (Csànyi *et al*., 2010). Dry steam power plants produce energy through steam that is derived from wells. Flash steam power plants use water at temperatures as high as 182˚C. The hot water is pumped at high pressures to reach the earth's surface. The water pressure is then reduced so that it can be converted into steam to produce power. The remaining water that was not turned into steam is injected back into the well (Nitsch *et al*., 2004).

In a binary cycle, the steam from the geothermal source is not injected into the generator or turbine. The steam is instead used to heat another medium (working fluid) which turns the generator/turbine. A binary cycle plant is environmentally friendly because it operates under minimal temperatures (225˚C-369˚C) and does not discharge air emissions (Csànyi *et al*., 2010).

### 2.8.6. Solar Energy

Solar energy exists in different forms. The two most widely used solar systems are Photovoltaics (PV) and Concentrated Solar Power (CSP). Solar energy can be used for the generation of cold, steam, light, heat and electricity (Johansson *et al*., 2004) and is also applied in water heating for industrial, domestic and commercial use. Photovoltaic and CSP are used for power generation while heat pump hybrid systems are used for space, water heating and cooling.

#### 2.8.6.1 Photovoltaic Systems (PV)

Photovoltaic systems produce energy through the direct conversion of solar light. The conversion of solar energy into electricity takes place inside a solar cell which transports electrical energy. Photovoltaic systems consist of solar panels, a balance system and load. The solar panels are made up of batteries which store electricity, DC/AC (Direct Current or Alternating Current) invertors that link the solar system to the power grid and other electrical units.

The heat absorption capacity of the solar panel depends on the components of the silicon (Wang & Lu, 2016). The silicon works as a semi-conductor providing the photovoltaic effect or the power generation. Silicon can be used in a crystalline form or a non-crystalline form (Ferry & Monoian, 2012). Crystalline silicon exists in two forms: Monocrystalline and Polycrystalline. The Monocrystalline is the most cost intensive but is efficient for energy conversion. The Polycrystalline is manufactured easily but is slightly less efficient for energy conversion.

To ensure maximum exposure to the sun, solar panels are mounted in two ways: through a single axis tracking system or a fixed axis tracking system. In a single-axis tracking system, the panels are set in a way that allows them to rotate in the Eastern and Western directions. A fixed-axis tracking system means that the panels are located in a Northly direction and are not able to rotate (Prinsloo & Dobson, 2015).

#### 2.8.6.2 Concentrated Solar Power (CSP)

Concentrated Solar Power is generated using mirrors to concentrate sunlight for a greater capacity and solar thermal energy for smaller capacities. Electricity generation using CSP takes place through the conversion of light into heat. This heat drives the steam turbine that is connected to the electricity generator (Jager *et al*., 2014).

##### 2.8.6.2.1 Types of Concentrated Solar Power (CSP) technologies

Concentrated Solar Power generates power using mirrors. The mirrors reflect sunlight onto a heat transfer medium. Salt, water and oil are commonly used to transfer the heat which produces steam through a steam exchanger to drive the turbine generator (Carter & Campbell, 2009). There are four different types of CSP technology and each type is made up of a concentrator and a receiver:

Concentrator: the concentrator focuses the sunlight onto a receiver to increase the amount of energy that is received (Schlaifer, 2012).

Receiver: the receiver moves the fluid that is used to remove the energy from the radiation (Schlaifer, 2012).

Concentrated Solar Power technology is divided into two collectors namely, line-focusing collectors and point-focusing collectors. The line focusing collectors direct the solar radiation onto a tube with a single-axis tracking system, these include Parabolic Troughs and the Linear Fresnel Collectors which can reach maximum temperatures of 120˚C and 450˚C. Point-focusing technology focus sunlight onto a point and have a two-axis sun-tracking system. These are the Solar Tower Plants and Parabolic Dish Plants which reach maximum temperatures of 2000˚C.

- Parabolic Trough

The parabolic trough concentrates light onto a parabolic dish (*Figure 2-3*). The parabolic dish emits the solar radiation onto a tube that is located along the focal line of the collector. The parabolic trough moves around horizontally during the day to track the sun and absorb radiation (Carter & Campbell, 2009).

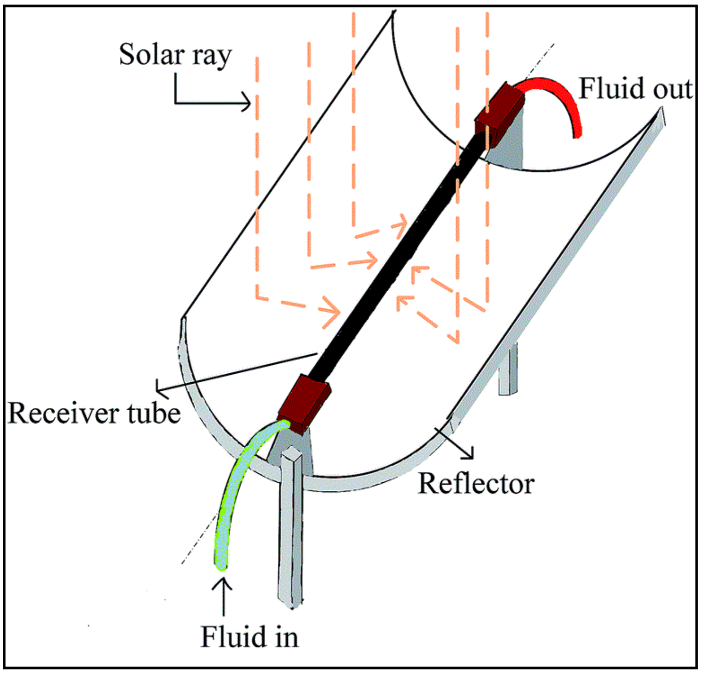


**Figure 2-3: Parabolic Trough Collector (Dabiri & Rahimi, 2016).**

- Linear Fresnel

Linear Fresnel technology (*Figure 2-4*) consist of multiple planar mirrors which can be turned to track the sun and determine a parabolic concentration on the tube that is located on top of the mirrors. A linear Fresnel is a line focusing technology and requires a one-axis sun tracking system. This type of technology is more cost efficient than the parabolic troughs and requires less land than the other CSP technology (Carter & Campbell, 2009).

**Figure 2-4: Linear Fresnel Collector (Alalewi, 2014).**

- Solar Tower

Solar power is generated through a Rankine cycle as illustrated in *Figure 2-5*. The solar fields of a solar tower power technology consist of multiple planar mirrors referred to as heliostats.

The heliostats track the sun through a two-axis system and concentrate the radiation onto a receiver located on top of a high tower.

Solar tower technology use heat transfer fluids such as molten salts or water which is transferred into steam by the heliostats. The solar tower can also transfer heat through air, sodium or helium. The turbine increases the steam and converts the steam power into mechanical energy. The mechanical energy is converted into electricity by the generator. The remaining steam is condensed back into water by a condenser (Schlaifer, 2012).

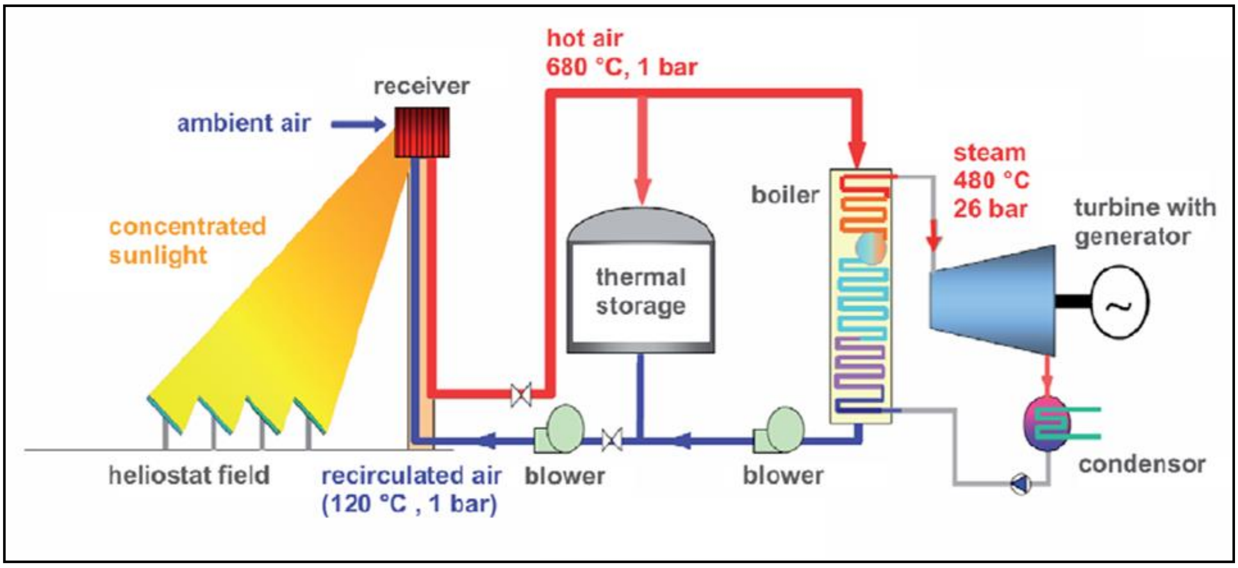


**Figure 2-5: Central Receiver Power Plant (Rankine cycle) (Ahlbrink *et al*., 2009).**

- Dish Sterling

The dish sterling (*Figure 2-6*) is a point-focusing technology which can be employed in large power plants consisting of multiple dishes or as individual power systems. The collector consists of a parabolic dish which emits solar radiation onto a receiver. The receiver is located in the sun tracking system to ensure that the mirrors receive maximum radiation. The solar radiation heats the transfer fluid (hydrogen/helium) which drives the Stirling Engine. The Stirling Engine can generate power between 5-25kWe (Kilowatt) per dish. Electricity is generated when mechanical energy is produced by the generator (Schlaifer, 2012).

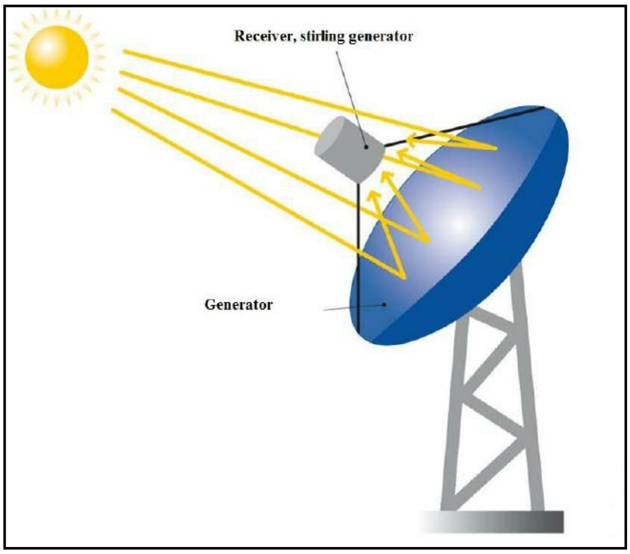


**Figure 2-6: Diagram representation of a dish collector (Alalewi, 2014).**

#### 2.8.6.2.2 Renewable Energy Technology and water requirements

A sustainability concern related to Solar CSP technology is water consumption. Water is required in CSP technology to generate the steam that drives the steam turbines. According to Carter & Campbell (2009), a CSP Solar Trough/Tower that uses wet cooling consumes more water per MWh (Megawatt hours) than the other types of renewable technologies.

As illustrated in *Table 2-4*, a Solar Trough consumes an average 3455-4182 litres of water per MWh while a Solar Tower consumes 3409 litres per MWh. Biomass and geothermal energy have minimal water requirements in comparison to CSP renewable energies. Wind, PV and hydroelectric are renewable technology with the lowest water consumption requirements.

**Table 2-4: Water consumption requirements of different renewable energy technologies (Carter & Campbell, 2009).**

| Generation Technology | Water Consumed in Wet Cooling[a] (gal/MWh) | Other Water Consumed in Generation[b] (gal/MWh) | Water Consumed in Producing Fuel Source (gal/MWh) |
|---|---|---|---|
| Solar Trough | 760-920 | 80[c] | 0 |
| Solar Tower | 750 | 80[c] | 0 |
| PV | 0 | 5[d] | 0 |
| Wind | 0 | 0 | 0 |
| Fossil Thermal | 300-480 | 30 | 5-74 |
| Biomass | 300-480 | 30 | Highly variable depending on whether biomass is irrigated[e] |
| Nuclear | 400-720[f] | 30 | 45-150 |
| Geothermal | 1400 | Not available | Not available |
| Natural Gas Combined Cycle | 180 | 7-10 | 11 |
| Coal IGCC[g] | 200 | 137-140 | 5-74 |
| Hydroelectric | Not applicable | 0 | Highly variable, avg. 4,500 due to evaporation |

Concentrated Solar Power uses water through two processes, the steam turbine system and the cooling process. The amount of water consumed during a cooling process is determined by the type of cooling process used. The cooling process uses a closed-loop system where the produced steam is cooled and changed back into liquid form. There a three types of cooling systems, namely wet cooling, dry cooling and hybrid cooling (Poullikkas *et al*., 2011).

**1. Wet cooling**

Water is used during wet cooling to eliminate the heat from the condenser. The water is moved to a cooling tower where it can evaporate and release the collected heat energy into the atmosphere. Wet cooling can also occur through the direct movement of the condensed steam into the cooling tower (Poullikkas *et al*., 2011).

**2. Dry cooling**

Dry cooling is used by directly condensing the steam through air in a heat exchanger. The water is then moved into the boiler through a closed-loop system that is similar to that used in wet cooling. Mechanical fans are used to drive the movement of air for condensation.

Although dry cooling requires less water than wet cooling, dry cooling is less efficient in terms of removing heat. The use of mechanical cooling fans to remove the heat also consumes some of the generated electricity in the power plant (Poullikkas *et al*., 2011).

**3. Hybrid Cooling**

Hybrid systems use cooling coils consisting of a regular cooling tower to reduce plumes. These systems are used for reducing plumes or reducing water consumption by retrieving evaporated water. Hybrid systems are more efficient at lower ambient temperatures and are able to reduce condensation as the ambient temperature increases.

The hybrid cooling system is more cost effective than the wet cooling system and has the potential to reduce water consumption (Poullikkas *et al*., 2011). The problem with hybrid cooling is that it may not meet the maximum water use requirements of certain projects.

## 2.9 RENEWABLE ENERGY AND SUSTAINABILITY

Investments in renewable energy are motivated by global problems such as climate change and the increasing demand for electricity (Pearce, 2002; Altintas *et al*., 2016). Society has depended on fossil fuels (coal, oil, natural gas etc.) for decades. As a result, the availability and quality of natural resources have been compromised. Evidence is seen in Canada, New-Zealand and South Africa.

The extraction of oil in Canada has implications on the environment. The operations on the Canadian Oil Sands emit chemical substances (sulphur oxides, hydrocarbons, nitrogen oxides and fine particulate matter) which have negative impacts on air quality. The oil extractions also contribute to sedimentation and the deposition of metals (Poveda & Lipsett, 2013).

In New Zealand, the exploration of petroleum has raised concerns associated with water and soil contamination (Greer *et al*., 2013). It has been observed that the activities have polluted coastal waters and that soil has been contaminated by radioactive substances from the exploration activities.

Acid Mine Drainage is one of South Africa's biggest environmental management challenges (Ochieng *et al*., 2010). The Olifant's River Catchment is considered one of the country's most contaminated rivers with high levels of Total Dissolved Solids (TDS) and sulphate concentrations resulting from the mining activities (WWF-SA, 2011). The country's intense mining operations have also resulted in declining coal reserves (Hartnady, 2010). According to Hartnady (2010), Southern Africa only has an estimated 15 billion tonnes of coal remaining.

Renewable energy is therefore considered a sustainable alternative that can reduce the pressure on natural resources and the demand on fossil fuels. Fossil resources such as coal, wood and paraffin are key sources of energy in most rural parts of South Africa (South Africa, 2015). Investments in renewable energy will serve as a better source of electricity which can respond to the environmental issues related to the use of fossil fuels.

### 2.9.1 The advantages of renewable energy

Renewable energy sources have multiple contributions to sustainability. Wind energy provides a clean and cost-efficient source of energy and generates less waste (Tong, 2010). The use of hydropower exposes the environment to minimal heat and can control flooding (Kadar, 2014; Singh *et al*., 2015). Biomass energy does not result in acid rain or produce radioactive waste (Sriram & Shahidehpour, 2005). Wave energy has the highest potential to produce power (Chenari *et al*., 2016) while geothermal energy does not generate any pollution and requires minimal land use (Hasan, 2013). The advantages of solar energy include the recovery of degraded land and the potential to improve water quality (Tsoutsos *et al*., 2005).

### 2.9.2 The environmental impacts of renewable energy

Although renewable energy is defined as a sustainable alternative source of energy, there are some environmental impacts that should be contemplated in the development of renewable energy projects (*Table 2-5).* The evaluation of the different impacts is important in this study since the impacts indicate the sustainability concerns that should be addressed when developing the Sustainability Principles Review Criteria.

**Table 2-5: The environmental impacts of renewable energy projects (DBEDT, 2002; Goodwin *et al*., 2006; Langhamer, 2009; Nada & Alrikabi, 2014; South Africa, 2015; Rudman *et al*., 2017; Yilmaz & Kaptan, 2017).**

| Renewable Energy Source | Impact Description |
|---|---|
| **Wind** | Visual<br>Noise<br>Land use<br>Biodiversity<br>Electro-magnetic<br>Air quality<br>Cultural heritage<br>Habitat fragmentation |
| **Hydropower** | Visual<br>Land use transformation<br>Cultural heritage<br>Displacement of communities<br>Water resource use<br>Upstream/downstream water course<br>Biodiversity<br>Damming effects<br>Electromagnetic interference and seismic activity |
| **Biomass** | Visual<br>Noise<br>Odour<br>Land use transformation<br>Deforestation<br>Raw material transportation<br>Water resources<br>Waste disposal<br>Atmospheric emissions<br>Waste disposal<br>Habitat fragmentation |
| **Wave energy** | Aquatic life<br>Carbon dioxide emissions |
| **Geothermal** | Chemical discharges |
| **Solar (PV and CSP)** | Visual<br>Noise (CSP)<br>Land use transformation<br>Cultural heritage<br>Biodiversity<br>Water resources<br>Hazardous waste generation<br>Loss of agricultural land<br>Sterilization of natural resources |

The environmental impacts associated with wind energy include noise, visual impacts and the displacement of communities. During construction and operation, wind turbines may distract species biodiversity, result in habitat loss and fragment flora and other avifauna including bats and birds (South Africa, 2015). Wind turbines may also result in habitat fragmentation and electro-magnetic impacts.

The construction of dams for hydropower generation may impact flow regimes and the transportation of sediment. Other impacts include disturbing riparian vegetation and ecological impacts such as the reduction of habitat diversity, the introduction of alien vegetation and changes in water quality (Goodwin *et al*., 2006).

Biomass is made up of waste and is likely to release odour. The discharge of air emissions is expected from the transportation of raw material during construction. A main activity that should be addressed in the use of bio-energy is the plantation of biomass where ground and surface water resources are likely to be impacted by the use of pesticides. Soil nutrient depletion may also occur from the bio-energy plantations (Nada & Alrikabi, 2014).

Wave energy convertors have significant impacts on ecological biodiversity (Langhamer, 2009). The instruments can also result in noise pollution and coastal erosion (DBEDT, 2002). The environmental impacts of geothermal energy maybe temporary or irreversible (Yilmaz & Kaptan, 2017). These include land use transformation, the contamination of ground and surface water resources and the generation of solid waste.

Solar energy projects may have impacts on flora and fauna, result in landscape modifications and affect soil quality. Other concerns include visual and noise impacts (Rudman *et al*., 2017). The manufacturing of PV cells includes toxic substances such as sulphuric and nitric acid, hydrochloric acid and hydrogen fluoride. Probable impacts would result from the poor disposal of the cells into the environment (South Africa, 2015).

### 2.9.3 Sustainability Assessment in Renewable Energy Projects

The sustainability of various Renewable Energy Projects has been evaluated to determine the potential of the projects in addressing the environmental, social and economic needs of a proposed environment (Mutatkar, 2010; Munguia *et al*., 2015; Rodriguez-Serrano *et al*., 2017; Ko *et al*., 2018).

Ko *et al*., (2018) conduced a Sustainability Assessment study of a Solar CSP Plant which employs molten salt. The study assessed the three dimensions of sustainability throughout the life cycle of the project, the construction phase, operational phase and the end of life phase. The findings indicate that the construction and operational phases of the project were more likely to impact the environment while the end of life of the project had minimal environmental impacts. The findings suggest that the solar field has a higher contribution to global warming than the other technologies. The dry cooling system was estimated to contribute 6% toward global warming and the storage of the molten salt and the transportation of the raw material were estimated to contribute 25%. This study indicates that the plant operation would require the most energy and maintaining the solar field has the most abiotic resource depletion potential (Ko *et al*., 2018).

The study indicates that most of the project's capital would be used in South Africa since this is where the plant is located and where the construction would take place. The rest of the project's capital would be spent in Chile where the molten salt is mined and in Germany where the power block manufacturing takes place.

Munguia *et al*., (2015) conducted a Sustainability Assessment of different alternatives to produce heat. The study compared the sustainability potential of a Fresnel Lens Solar Concentrator against 12 other alternatives. The findings illustrate that Infrared Carbon Photovoltaic, Infrared Metal Photovoltaic and the Infrared Ceramic Photovoltaic were the most sustainable PV systems. The study concluded that Fresnel equipment were environmentally sustainable since they do not release Green House Gases but the construction and operation of the technologies were cost intensive.

This section has provided an overview of the characteristics of different renewable energy technologies and their potential contribution to sustainability. Although Renewable Energy Projects are considered "a clean" alternative, there are some environmental concerns that need to be addressed in the development of the projects. These environmental concerns will contribute as indicators in the development of the Sustainability Principles Review Criteria that will be used to determine the consideration of the sustainability principles in the EIRQ of Renewable Energy Projects.

## 2.10. CONCLUSION

The review has revealed the sustainability concerns of the EIA process which have been disclosed overtime through the assessment of EIRQ. The review has indicated how the application of Sustainability Assessment can potentially respond to these concerns. Sustainability Assessment has evolved with Gibson's (2006) sustainability principles playing a fundamental role as a set of indicators/requirements of a development. Sustainability Assessment studies of different projects have provided evidence of the contemplation of evaluating the sustainability of development activities.

This evaluation is however based on the TBL approach of defining sustainability, where the objectives of the three dimensions of sustainability are evaluated. There are few studies that have applied Gibson's (2006) principles of sustainability in Sustainability Assessment. This study will not only contribute toward determining EIA effectiveness through the evaluation of

EIRQ but will also determine the degree to which the sustainability principles were considered in EIA.

# CHAPTER 3

# METHODOLOGY

This chapter is presented in three sections. The first section gives an overview of the Lee and Colley Review Package (Lee *et al*., 1999). The second section describes the study area and explains the data sourcing process, namely the use of the NWU EIRQ Review Package and the development and use of the Sustainability Principle Review Criteria. The review procedure is explained in the third part of the section.

### 3.1 The Lee and Colley Review Package

Review packages are a global approach to EIR quality review. Different review packages have been created to assess EIR quality. The Lee and Colley Review Package originated in the United Kingdom in 1989 where it was used to review EIRs that were assessed in accordance to the United Kingdom Environmental Assessment Regulations of 1988. This review package has become one of the most extensively used review packages (Ibrahim, 1992; Lee & Colley, 1992; Lee & Dancey, 1993; Rout, 1994; Sandham *et al*., 2008*a*; Sandham *et al*., 2013*a*; Sandham *et al*., 2013*b*) because of its adaptability, structure and systematic approach to quality review (Lee *et al*., 1999; Sandham & Pretorius, 2008).

The Lee and Colley Review Package is generic since the criteria are not based on a specific context that is significant in determining EIRQ. Therefore, the package's review criteria have to be revised to apply to different context (Kruger, 2012). The review package revised by Van Heerden (2010) was used to determine the EIRQ of the EIRs in South Africa.

#### 3.1.1 Structure and use the of Lee and Colley Review Package

The Lee and Colley Review Package is structured in a hierarchy of four levels (*Figure 3-1*):

- **Level 1**: consists of the less complex criteria- namely the review sub-categories and are represented by three numbers (e.g. 1.1.1) in the list of review topics.
- **Level 2**: includes the more complex criteria (review categories) and are represented by two numbers (e.g. 1.1) in the list of review topics.
- **Level 3:** consists of the review areas which are the main areas in the review procedure, these include (Lee *et al*., 1999:32):
    1. *"Review Area 1:* ***Description of the development, local environment and baseline conditions"***
    2. *"Review Area 2:* ***Identification and evaluation of key impacts"***
    3. *"Review Area 3:* ***Alternatives and mitigation"***

4. *"Review Area 4:* ***Communication of results"***

- **Level 4**: is the highest level and represents the overall assessment which is concluded based on the performance of levels 1, 2 and 3.

The review starts with the less complex criteria and moves to the next level where complex and broader criteria are evaluated. The Lee and Colley Review Package directs the reviewer to begin the review from the sub-category level (level 1). Based on the assessment of this level, the quality of the review categories (level 2) will be assessed. The reviewer then moves to the assessment of the review areas (level 3) and ultimately gives an overall assessment of the EIR (level 4). The content and quality of the EIR is reviewed under different review categories and review areas using an assessment score (*Table 3-1*).

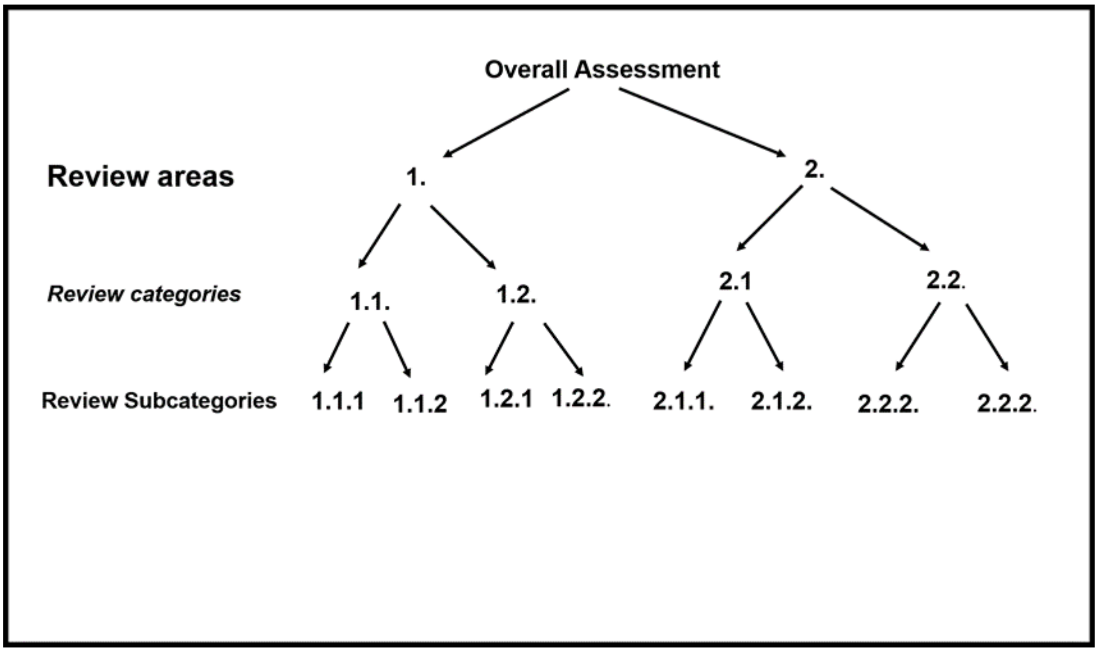


**Figure 3-1: Hierarchical structure of the Lee and Colley Review Package (Lee *et al*., 1999).**

### 3.1.2 Assessment score sheet

The assessment sheet is used to conduct the review and uses assessment symbols (*Table 3-1*) arranged from A-F which all represent varying performance as follows: A represents *good performance,* B represents *satisfactory/complete performance,* C represents *just satisfactory performance* and E-F represent varying unsatisfactory or poor performance. The assessment uses letters instead of numbers to avoid a mathematical addition or subtraction which may misrepresent the results of the assessment (Lee *et al*., 1999).

**Table 3-1: Assessment scores (Lee *et al*., 1999).**

| SYMBOL | EXPLANATION |
|---|---|
| A | Relevant tasks well performed, all tasks well completed |
| B | Generally complete and satisfactory with only a few exclusions and weaknesses |
| C | Has weaknesses and omissions but is considered satisfactory |
| D | Unsatisfactory because some aspects were poorly attempted and others were omitted |
| E | Not Satisfactory, important tasks omitted or weak attempted |
| F | Very unsatisfactory, important tasks not addressed or weakly attempted |
| N/A | Not applicable or not relevant the context of the report |

### 3.1.3. Collation sheet

The results of the assessment are recorded on a collation sheet (*Table 3-2*). The collation sheet records all of the assessment symbols which give an overview of the strengths and weaknesses of the reports. This review procedure is applied in this study using the NWU EIRQ Package and the Sustainability Principle Review Criteria.

**Table 3-2: Collation Sheet (Lee *et al*., 1999).**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **1** | **.........** | **2** | **.........** | **3** | **.........** | **4** | **.........** |
| **1.1** | ......... | **2.1** | ......... | **3.1** | ......... | **4.1** | ......... |
| 1.1.1 | ......... | 2.1.1 | ......... | 3.1.1 | ......... | 4.1.1 | ......... |
| 1.1.2 | ......... | 2.1.2 | ......... | 3.1.2 | ......... | 4.1.2 | ......... |
| 1.1.3 | ......... | 2.1.3 | ......... | 3.1.3 | ......... | 4.1.3 | ......... |
| 1.1.4 | ......... | 2.1.4 | ......... | 3.1.4 | ......... | 4.1.4 | ......... |
| 1.1.5 | ......... | | | | | | |
| 1.1.6 | ......... | | | | | | |
| 1.1.7 | ......... | | | | | | |
| **1.2** | ......... | **2.2** | ......... | **3.2** | ......... | **4.2** | ......... |
| 1.2.1 | ......... | 2.2.1 | ......... | 3.2.1 | ......... | 4.2.1 | ......... |
| 1.2.2 | ......... | 2.2.2 | ......... | 3.2.2 | ......... | 4.2.2 | ......... |
| 1.2.3 | ......... | | | 3.2.3 | ......... | 4.2.3 | ......... |
| **1.3** | ......... | **2.3** | ......... | **3.3** | ......... | **4.3** | ......... |
| 1.3.1 | ......... | 2.3.1 | ......... | 3.3.1 | ......... | 4.3.1 | ......... |
| 1.3.2 | ......... | 2.3.2 | ......... | 3.3.2 | ......... | 4.3.2 | ......... |
| 1.3.3 | ......... | 2.3.3 | ......... | 3.3.3 | ......... | 4.3.3 | ......... |
| **1.4** | ......... | **2.4** | ......... | | | **4.4** | ......... |
| 1.4.1 | ......... | 2.4.1 | ......... | | | 4.4.1 | ......... |
| 1.4.2 | ......... | 2.4.2 | ......... | | | 4.4.2 | ......... |
| | | 2.4.3 | ......... | | | | |
| **1.5** | ......... | **2.5** | ......... | | | | |
| 1.5.1 | ......... | 2.5.1 | ......... | | | | |
| 1.5.2 | ......... | 2.5.2 | ......... | | | | |
| 1.5.3 | ......... | 2.5.3 | ......... | | | | |

### 3.2 Data collection

In terms of the Promotion of Access to Information Act (PAIA), Act 02 of 2000, a PAIA request was submitted to the National DEA offices in Pretoria (Directorate of Impact Assessment and Authorisations). The Directorate handles all state related developments such as Eskom, Rand Water and the South African National Roads Agency (SANRAL). The Directorate is also involved in Strategic Infrastructure Projects (SIPs) which have been established for the purpose of sustaining the country's economic development strategies and addressing socio-economic inequalities. There are 18 SIPs which address social and economic infrastructure in South Africa. The SIPs are divided into "*five geographically focused SIPs", "three spatial SIPs", "three energy SIPs", "three social infrastructure SIPs", "two knowledge SIPs", "one regional integration SIP"* and one *"water and sanitation SIP"* (South Africa, 2012:17).

Renewable Energy Projects form part of the SIPs and are supported by the development of power stations which fall under SIP 9. The objective of SIP 9 is to fast track the development of new power generation capacity which conforms to the Integrated Resource Plan (IRP) 2010 in order to address socio-economic imbalances (South Africa, 2012). Renewable Energy Projects fall under SIP 8 which focuses on green energy initiatives with the objective of providing clean energy alternatives as contemplated in the IRP2010.

The PAIA request was granted and six Solar CSP EIRs were randomly selected from the Departmental archives. Since one of the objectives of this research is to determine the consideration of the Sustainability Principles in the EIRs, Solar CSP projects were specifically chosen because they require more water than the other renewable technologies and this triggers interest from a sustainable water resource use perspective.

The sets of data were collected using the NWU Review Package and the Sustainability Principles Review Criteria. The NWU Review Package (*Table 3-4*) was used to determine the EIRQ and the Sustainability Principles Review Criteria were used to determine the consideration of the Sustainability Principles. For this review, the eight Sustainability Principles were treated as the Review Areas and the Review Categories and Sub-categories were designed to fit the context of Renewable Energy Projects.

### 3.2.1 Project Locality Area

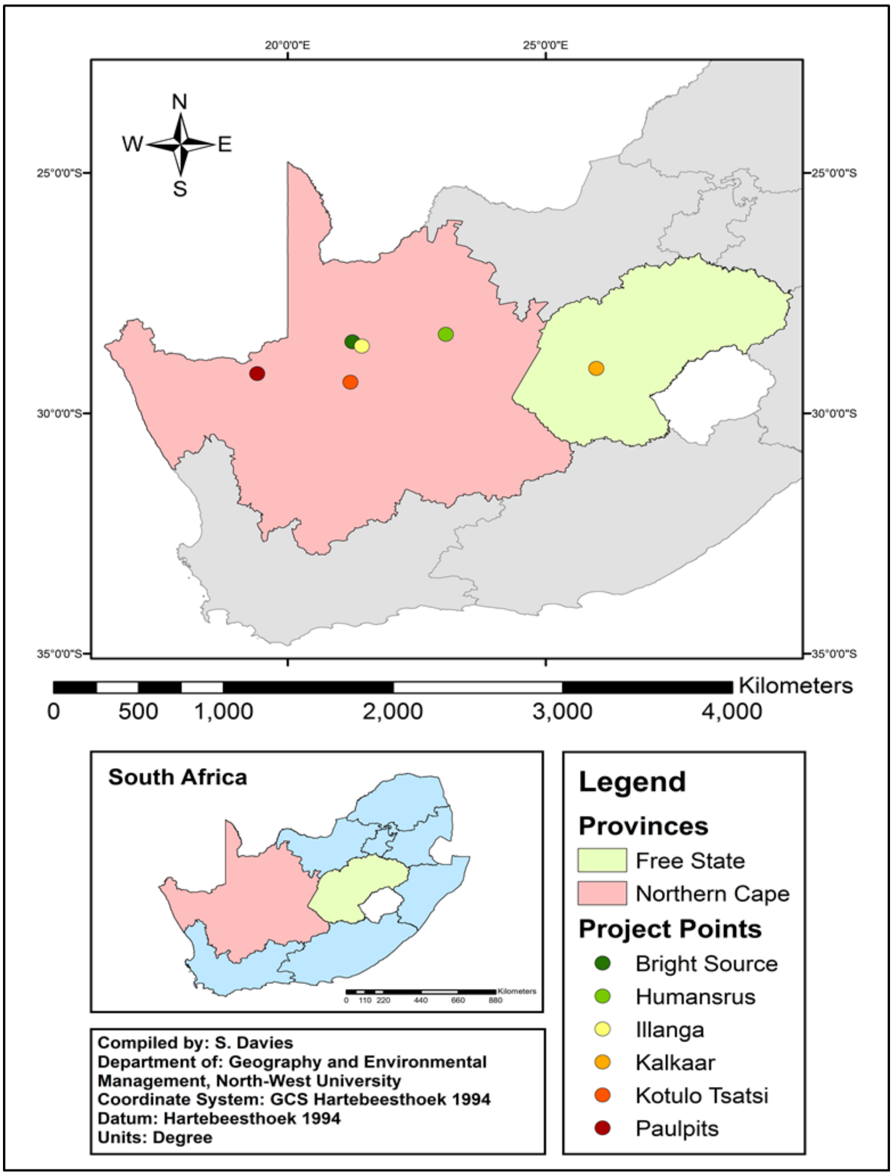


**Figure 3-2: Project Locality.**

The six projects that are used in the study are located in the Free State and the Northern Cape Provinces (*Figure 3-2*). These two provinces have some of the highest temperatures in the country, therefore giving them great potential for solar developments. The Free State Province has a hot and arid climate. Average summer temperatures in the Free State range between 15˚C and 32˚C and the mean annual rainfall is 500-600mm (DWS, 2017; South African Weather Services, 2018). The climatic conditions in the Northern Cape Province are semi-desert and dry. The Province receives little rainfall with an annual mean rainfall between 50-400mm. Temperatures vary between 34˚C-40˚C and reach a maximum of 50˚C (Jordaan *et al*., 2013; South African Weather Services, 2018).

**Table 3-3: Project location, technology, capacity and land use area.**

| No. | Name | Location | Technology | Capacity (MW.) | Land Area (ha/Km$^2$) |
|---|---|---|---|---|---|
| 1. | Bright Source | Upington | Solar tower | 150 | 10000 |
| 2. | Humansrus | Postmasburg | Solar tower | 107 | 600 |
| 3. | Illanga | Upington | Parabolic trough | 150 | 208 |
| 4. | Kalkaar | Kalkaar | Solar tower | 200 | 800 |
| 5. | Kotulo Tsatsi | Kenhardt | Solar tower | 200 | 1000 |
| 6. | Paulpits | Pofadder | Solar tower | 200 | 900 |

The projects are illustrated in *Table 3-3*. The Illanga development used parabolic trough technology and the other five projects used solar towers/central receivers with molten salt. The projects have the capacity to generate power between 100MW-200MW. The land use requirements of the projects range between 208ha/km$^2$ and 1000ha/km$^2$.

### 3.2.2 The NWU Review Package

The NWU EIRQ Review Package was adapted from the original Lee and Colley Review Package by Van Heerden (2010). Some review categories and sub-categories were added to review aspects of EIA practice as required by the South African EIA regulations (Sandham *et al*., 2013*b*; Van Heerden, 2010). The structure of the package was retained to maintain the objective of evaluating best practice. In this regard, all review areas and their supporting categories and sub-categories were used as they appear in the original package. A summarised version of the NWU Review Package is illustrated in *Table 3-4*. The full review package appears in Annexure 1.

**Table 3-4: NWU EIRQ Review Package (Van Heerden, 2010).**

| | | |
|---|---|---|
| **REVIEW AREA 1 Description of development, environment & baseline conditions** | 2.1 Definition of impacts | 3.1.4. Comparative assessment of all alternatives identified |
| 1.1. Description of the development | 2.1.1. Description of all possible effects of project on environment | 3.2 Scope and effectiveness of mitigation measures: All significant adverse impacts should be considered for mitigation. |
| 1.1.1. Purpose and objectives of development | 2.1.2. Identify and describe effects & interaction on natural components | 3.2.1. Mitigation of all significant adverse impacts |
| 1.1.2. Design and size of development | 2.1.3. Impacts from non-standard operating conditions due to Accidents or Adverse weather | 3.2.2. Mitigation measures to should include project modification, alternative facilities & pollution control |
| 1.1.3. Physical presence & appearance of complete development in environment | 2.1.4 Impact arising from deviation from baseline conditions | 3.2.3. Extent of effectiveness of mitigation when implemented |
| 1.1.4. Nature of production processes intended to be employed in completed development and expected rate of production | 2.2 Identification of impacts: Methods used for identification of all significant impacts | 3.3 Commitment to mitigation |
| 1.1.5. Nature and quantity of raw materials needed during different phases | 2.2.1 Impact Identification methodology | 3.3.1 Commitment to mitigation measures |
| 1.1.6. Identification of applicant | 2.2.2 Impact identification methods | 3.3.2 Monitoring arrangements |
| 1.1.7. Details of EAP to carry out environmental impact assessment | 2.3 Scoping | **REVIEW AREA 4 Communication of results** |
| 1.2 Site Description | 2.3.1 Public participation | 4.1 Layout of the report |
| 1.2.1. Land area taken up by development site | 2.3.2. Arrangements to collect opinions and concerns of I&APs | 4.1.1. Introduction |
| 1.2.2. Description of demarcation of Land use areas | 2.3.3. Key impacts | 4.1.2. Arrangement of information |
| 1.2.3. Estimated duration of different phases | 2.4 Prediction of impact magnitude | 4.1.3. Chapter summaries (unless chapters are very short) |
| 1.2.4 Estimated No. of workers/visitors on site | | |
| 1.2.5 Means of transporting raw material | | |
| 1.3 Wastes: Estimated types and quantities of wastes produced & proposed disposal routes | 2.4.1 Data used to estimate magnitude of main impacts and gaps in data clearly indicated | 4.1.4. External sources |
| 1.3.1. Estimated types and quantities of wastes and rate of production | 2.4.2. Methods predicting impact magnitude clearly described | 4.2. Presentation: Information should be accessible to the non-specialist |
| 1.3.2. Proposed handling/treatment, disposal and disposal routes to the environment | 2.4.3. Express predictions of impact in measurable quantities with confidence limits | 4.2.1. Presentation of Information |
| 1.3.3. Methods of obtaining quantity of residuals and waste | 2.5 Assessment of impact significance: Expected significance of impacts for society | 4.2.2 Technical terms, acronyms, initials defined |
| 1.4. Environment Description: Area and location likely to be affected by development proposal | 2.5.1. Description of significance of impacts on affected community and society in general | 4.2.3. Statement presented as an integrated whole |
| 1.4.1. Indication of area to be affected | 2.5.2. Significance of impacts in terms of national and international quality standards | 4.3. Emphasis: Information should be represented without bias |
| 1.4.2. Area to accommodate significant effects occurring away from immediate environment | 2.5.3. Justification of proposed method of assessing significance | 4.3.1. Prominence and emphasis to potentially severe impacts |
| 1.5. Baseline Conditions: Description of current & expected conditions of environment | **REVIEW AREA 3: Alternatives and mitigation** | 4.3.2. Statement must be unbiased |
| 1.5.1. Identification & description of key components of affected environment | 3.1 Alternatives | 4.3.3. Opinion as to whether the activity should/should not be authorized |
| 1.5.2. Existing data sources searched and utilized | 3.1.1. Consideration/description of alternative sites | 4.4. Non-technical summary: Clearly written non-technical summary of main findings |
| 1.5.3. Local land use plans, policies & data collected to determine baseline conditions | 3.1.2. Consideration/description of alternative processes, designs and operating conditions | 4.4.1. Non-technical summary of main findings and conclusions |
| **REVIEW AREA 2 Identification and evaluation of key impacts** | 3.1.3. For unexpectedly severe adverse impacts identified | 4.4.2. Summary must cover all main issues |

### 3.2.3 Development of the Sustainability Principles Review Criteria

The degree to which the sustainability principles were considered in Renewable Energy Projects was determined by formulating Sustainability Principles Review Criteria. The criteria were formulated by treating the eight principles of sustainability (Gibson, 2006) as review areas and the review categories and sub-categories were formulated in the context of Solar CSP projects.

#### 3.2.3.1 Adaptation of review areas

The Gibson (2006) sustainability principles were translated into eight review areas as illustrated in *Table 3-5*.

**Table 3-5: Revised sustainability principle review areas.**

| Review Area | Requirement |
|---|---|
| **1. Socio-ecological system integrity** | Build human–ecological relations to establish and maintain the long-term integrity of socio-biophysical systems and protect the irreplaceable life support functions upon which human and ecological well-being depends. |
| **2. Livelihood sufficiency and opportunity** | Ensure that everyone and every community has enough for a decent life and that everyone has opportunities to seek improvements in ways that do not compromise future generations' possibilities for sufficiency and opportunity. |
| **3. Intragenerational equity** | Ensure that sufficiency and effective choices for all are pursued in ways that reduce dangerous gaps in sufficiency and opportunity (and health, security, social recognition, political influence, and so on) between the rich and the poor. |
| **4. Intergenerational equity** | Favour present options and actions that are most likely to preserve or enhance the opportunities and capabilities of future generations to live sustainably. |
| **5. Resource maintenance and efficiency** | Provide a larger base for ensuring sustainable livelihoods for all, while reducing threats to the long-term integrity of socio-ecological systems by reducing extractive damage, avoiding waste and cutting overall material and energy use per unit of benefit. |
| **6. Socio-ecological civility and democratic governance** | Build the capacity, motivation and habitual inclination of individuals, communities and other collective decision-making bodies to apply sustainability requirements through more open and better-informed deliberations, greater attention to fostering reciprocal awareness and collective responsibility, and more integrated use of administrative, market, customary and personal decision-making practices. |
| **7. Precaution and adaptation** | Respect uncertainty, avoid even poorly understood risks of serious or irreversible damage to the foundations for sustainability, plan to learn, design for surprise, and manage for adaptation. |
| **8. Immediate and long-term integration** | Apply all principles of sustainability at once, seeking mutually supportive benefits and multiple gain. |

#### 3.2.3.2 Adaptation of review categories and sub-categories

Based on the requirements of the review areas, the sustainability principles criteria were formulated into review categories and review sub-categories. The information to develop the criteria was obtained from different sources, including:

- The sustainable development objectives of South Africa's Renewable Energy Independent Power Producer Procurement Program (REIPPPP) (Eberhard *et al*., 2014).
- The requirements set in the 2014 South African EIA regulations.
- The requirements set in the environmental authorisations of the renewable energy projects.
- The environmental impacts of the projects as identified in the South African EIA Guidelines on Renewable Energy Projects (DEA, 2015) and

- The characteristics of Solar CSP technologies.

Due to the overlap between the requirements of the sustainability principles, some requirements were divided to suit the context of the specific review areas.

**1. Review Area 1 (Socio-ecological system integrity): Review categories and sub-categories**

Review Area 1 seeks to ensure that the environment and surrounding natural resources are protected. **Review categories 1.1** (Impacts on natural resources), **1.2 (Biodiversity conservation)** and **1.3 (Demographic impacts)** were defined based on requirement 2(h)(vii) in Appendix 2 of the 2014 EIA regulations. This requirement states that the proponent must identify the positive and negative impacts that the development may impose on the environment and emphasis should be on the cultural, biological, physical, social, geographical and heritage aspects (South Africa, 2014). The sub-categories under **Review Category 1.1** were developed based on the environmental impacts of Renewable Energy Projects as described in the South African EIA Guidelines on Renewable Energy Projects (DEA, 2015).

The sub-categories under **Review Category 1.2 (Biodiversity conservation)** were defined according to the environmental impacts of Renewable Energy Projects as described in the South African EIA Guidelines on Renewable Energy Projects and some of the conditions that appear in the environmental authorisations of the projects. The social implications defined in Appendix 2 of the regulations were translated into demographic impacts (1.3) which include changes in population structures (1.3.1) due to the influx of job seekers. Sub-category 1.3.2 was defined based on the involuntary migration that may result from occupied proposed locations and Sub-category 1.3.3 was defined based on possible land losses that may result from the development (Hernandez *et al*., 2014).

**Review Category 1.4 (Significance assessment)** was based on requirement 2(h)(v) of the regulations (South Africa, 2014). This requirement states that the significance, degree, extent and nature of the identified impacts must be determined. It should be noted that the impacts identified in this study were exclusive to Renewable Energy Projects.

**2. Review Area 2: Livelihood sufficiency and opportunity**

Review Area 2 seeks to ensure the provision of equal opportunities that can improve the well-being of society. Socio economic development contributions are one of the objectives of the Department of Energy (DOE) therefore, Renewable Energy Developments under the Renewable Energy Independent Power Producer Procurement Program (REIPPPP) are required to make socio-economic contributions to impacted communities. One of the procurement conditions of the REIPPPP is for local communities to own 2.5% of the development (DOE, 2015). This requirement defines **Review Category 2.1** which seeks to ensure that local ownership is contemplated through economic empowerment programs (2.1.1).

The REIPPPP also requires developments to contribute 0.6% of their dividends to local communities through community trusts (2.1.2) (Eberhardt *et al*., 2014). As one the directives to Independent Power Producers (IPPs), the Department of Energy requires socio-economic empowerment through employment opportunities. This requirement defines **Review Category 2.2 (Employment and income)** and its sub-categories.

### 3. Review Area 3: Intra-generational equity

The requirements of Intra-generational equity include the distribution of opportunities between current generations. Socio-economic contributions identified in Review Area 2 have overlapped into this review area because empowering current generations is one of the important requirements of sustainability. The REIPPPP also requires IPPs to contribute to the socio-economic empowerment of affected communities.

These requirements define **Review Category 3.1 (Socio-economic contributions)**. In order to develop the sub-categories, the socio-economic contributions were translated into partnership agreements between local stakeholders and foreign providers (3.1.1) and national investments (3.1.2). Although some of the investments and stakeholders are defined by the Department of Energy (2015), it is important that they are mentioned in the reports to promote transparency and knowledge transfer.

The DOE has directed IPPs to prioritize local companies in the service delivery of Renewable Energy Developments (DOE, 2015). This requirement was translated into Sub-categories 3.1.3 (Local equipment supply), 3.1.4 (Promotion of local CSP markets) and 3.1.5 (Local CSP supply survey). The reports are required to indicate evidence of the promotion/consideration of local companies in equipment supply and the proponent's role in promoting local CSP markets. An example can be the report indicating that the proponent and its investors are part of or have invested in the Southern Africa Solar Thermal and Electricity Association (SASTELA). The purpose of the association is to promote CSP developments while organizing the local manufacturing of CSP components in the Southern Africa Development Community.

**Review Category 3.2 (Human health and social considerations)** is motivated by the importance of driving the consideration of social sustainability in EIA. The review category is defined by requirement 2(h)(vii) in Appendix 2 of the 2014 EIA regulations. The Sub-categories 3.2.2 (Measures to mitigate reflective glare), 3.2.3 (Identify & Mitigate noise impacts) and 3.2.4 (Traffic impacts on the community) were developed based on the environmental impacts of the projects as identified in the South African EIA Guidelines on Renewable Energy Projects (DEA, 2015).

**4. Review Area 4: Intergenerational equity**

Review Area 4 emphasises long-term measures to create and secure opportunities for future generations. **Review Category 4.1 (Pollution prevention and abatement)** was considered an intergenerational sustainability requirement because current pollution prevention measures ensure that the environment is maintained and protected for future generations. Pollution prevention is also an important factor in the reduction of Green House Gas (GHG) emissions. Review Category 4.1 and sub-categories 4.1.1 (Identify types of pollution) and 4.1.2 (the application of pollution control technologies) were developed from requirement 1(f)(i) in Appendix 4 of the 2014 EIA regulations. The requirement stipulates that proposed measures to manage impacts must be described and these must include actions to avoid or control activities that may cause pollution.

Since weed control using pesticides is one of the proposed management measures for a parabolic trough power plant (Ritter *et al*., 2017), this management technique was translated into Sub-category 4.1.3 (Management of pesticides for parabolic trough power plant). The mitigation of climate change is one of South Africa's Sustainable Development Goals and was translated into Sub-category 4.1.4 which requires the identification of sources of greenhouse gases in order to establish prevention or mitigation measures.

**Review Category 4.2 (Technology alternatives)** was defined from requirement 2(h)(i) in Appendix 2 of the 2014 EIA regulations. The requirement stipulates that a scoping report must identify and describe all contemplated alternatives (South Africa, 2014). Sub-category 4.2.1 (Cooling system alternatives) is defined from the sustainability potential of the different cooling systems. Dry cooling systems are more water efficient than wet cooling systems, while hybrid cooling systems generate less waste (Poullikkas *et al*., 2011).

Sub-category 4.2.3 (Water treatment) requires the proponent to discuss and substantiate the preferred water desalination process. There are two water treatment processes that are employed in Solar CSP projects, these include reverse osmosis and ion exchange. Both treatment processes are energy efficient and have some environmental risks, but the ion exchange process is more economically feasible (Patel, 2016) than reverse osmosis (Moridpour, 2014).

**Review category 4.3 (Cost projections)** was considered a sustainability indicator since the knowledge of current and future financial implications of the project are important for planning and evaluation.

**5. Review Area 5: Resource maintenance and efficiency**

The objectives of Review Area 5 are closely linked to those of Review Area 1 (Socio-ecological system integrity). Both review areas emphasise environmental protection and the maintenance and conservation of natural resources. Review Area 5 seeks to ensure that natural resources are used efficiently to secure use for current and future generations. **Review Category 5.1 (Waste Management)** is defined by the requirements of the National Environmental Management: Waste Act (Act No 59 of 2008) and the idea of recycling as a significant sustainability indictor.

**Review Category 5.2 (Water Use)** emphasises the efficient use of water in development activities. This category was motivated by the concerns surrounding the availability of water resources in South Africa (Donnenfeld *et al*., 2018) and the water consumption requirements of Solar CSP technologies (Carter & Campbell, 2009). The identification (5.2.1) and substantiation (5.2.2) of the preferred water source is important in sustainable planning and the same applies to the contemplation of water use requirements (5.2.4). The requirement on storm water management (5.2.3) is a sustainability indicator because storm water structures allow water to be collected for reuse while pollutants can be removed through the management of storm water (Kim & Lee, 2016).

**6. Review Area 6: Socio-ecological civility and democratic governance**

Review Area 6 emphasises the importance of public empowerment through consultation, awareness and information transfer. It also aims to ensure that the opinions and views of the public are known and considered. **Review Category 6.1 (CSP knowledge transfers)** was inspired by the need to raise awareness and empower communities on Renewable Energy Projects and enterprise development. Workshops or other knowledge transfer programs can ensure that communities are aware of the potential opportunities that are provided by Renewable Energy Projects.

**Review Category 6.2 (Citizen Participation)** was developed from the requirements of Regulation 41 of the 2014 EIA regulations. The EIA process is required to provide evidence that the public was involved in the project decision-making process (6.2.1) and that the method of delivering information is clear and easily understandable (6.2.2). It is also important to see evidence that the views and opinions of the public were indeed considered in the project decision-making process (6.2.4) because the public participation process is often considered as a compliance driven objective more than a sustainability objective (Eckerd, 2014; Olsen & Hansen, 2014).

The development of **Review Category 6.3 (Cultural implications)** and its sub-categories was motivated by the importance of identifying the social impacts of developments as regulated by requirement 2(h)(vii) in Appendix 2 of the 2014 EIA regulations. The consideration of cultural implications is a Socio-ecological system integrity (Review Area 1) requirement as well as an Intragenerational equity (Review Area 3) requirement since the contemplation of demographic impacts (Category 1.3) is a social sustainability indicator and the identification of social and human health impacts (Category 3.2) ensures that the social and health needs of current generations are protected. However, the fact that communities have better knowledge of their cultural practices/beliefs and can play an important role in identifying the implications of a project on these beliefs- drives public engagement, encourages collective responsibility and ensures that the cultural values that communities are accustomed to are not compromised as required by Review Area 6 (Socio-ecological civility and democratic governance).

### 7. Review Area 7: Precaution and adaptation

Review Area 7 requires the proponent to plan for uncertainty and establish measures in response to risk management. The substantiation of the technology alternatives (7.1.1) allows the proponent to understand the environmental risks associated with the preferred alternative in order to contemplate **response measures (Review Category 7.2)**. The different auxiliary facilities employed in Solar Power Plants (generators, transformers, switch yard) are gas or diesel fuelled. Although gas is expensive, it is slightly environmentally friendly than diesel which may result in noise pollution and leaks. The choice between gas or diesel use in the auxiliary facilities is a sustainability indicator which was translated into Sub-category 7.1.2 (Preference for auxiliary facilities).

Environmental Impact Assessment is a sustainability tool that can ensure that the precautionary principle is applied in environmental decision-making since it evaluates and aims to minimise risks imposed by development (Jalava *et al*., 2013). **Review Category 7.2 (Precautionary Measures)** therefore seeks to determine the extent to which precautionary measures were considered in the EIRs of Renewable Energy Projects.

## 8. Review Area 8: Immediate and long-term integration

Review Area 8 evaluates the requirement for the integration of the objectives of the first seven sustainability principles. **Monitoring, evaluation and follow-up (8.1)** are considered drivers of long-term integration since they allow the evaluation and dissemination of performance results to learn from past experiences. It is important for the proponent to reflect on past experiences and share information on the challenges and strengths of previous developments for proponents, Environmental Assessment Practitioners (EAPs) and authorities to consider this information in future project planning.

**Integration (8.2)** is defined by evidence that the first seven principles of sustainability were integrated in project decision-making. This is indicated by the EAPs opinion on whether or not the project should be granted (requirement 3(q) in Appendix 3 of the 2014 EIA regulations) since this conclusion is based on the impacts that were identified **(Review Area 1. Socio-ecological system integrity)**, the measures provided to support the livelihood of society **(Review Area 2. Livelihood sufficiency and opportunity)**, socio-economic development contributions and the consideration of human impacts **(Review Area 3. Intra-generational equity)**, the implementation of long-term measures to sustain the environment for future generations **(Review Area 4. Intergenerational equity and Review Area 5. Resource maintenance and efficiency)**, the inclusion of the public during the project decision-making phase **(Review Area 6. Socio-ecological system integrity)** and considering uncertainty and planning for the unknown **(Review Area 7. Precaution and adaptation)**.

These requirements were summarised and documented into the review criteria depicted in *Table 3-6*. The full criteria appear in Annexure 2.

## Table 3-6: Sustainability Principles Review Criteria.

| | | |
|---|---|---|
| **Review Area 1 Socio-ecological system integrity** | 3.1.3 Consideration of local companies | 6.2.2 Public participation simple & comprehendible |
| 1.1 Impacts on natural resources | 3.1.4 Promote local manufacturing of CSP equipment | 6.2.3 Documentation of public views & opinions |
| 1.1.1 Ground & surface | 3.1.5 Survey local suppliers to establish material that can be sourced locally. | 6.2.4 Consideration/application of public views |
| 1.1.2 Soil (Erosion & contamination) | 3.2 Human health and social considerations | 6.3 Cultural implications |
| 1.1.3 Land use | 3.2.1 Identify human health issues | 6.3.1 Identify heritage/cultural areas on site |
| 1.1.4 Air quality | 3.2.2 Identify impacts of reflective glare | 6.3.2 Identify impacts on heritage |
| 1.1 Biodiversity conservation | 3.2.3 Identify noise impacts | 6.3.3 Identify impacts on cultural beliefs/ sites. |
| 1.2.1 Impacts on bird communities | 3.2.4 Identify traffic impacts | **Review Area 7 Precaution and adaptation** |
| 1.2.2 Survey bird communities | **Review Area 4 Intergenerational equity** | 7.1 Consideration of alternatives |
| 1.2.3 Anti-collision devices (bird flappers) | 4.1 Pollution prevention and abatement | 7.1.1 Substantiate reason for CSP technology |
| 1.2.4 Impacts on fauna and flora | 4.1.1 Identify possible types of pollution | 7.1.2 Preference of fuel for auxiliary facilities |
| 1.2.5 Alien invasive management plan | 4.1.2 Pollution control technologies | 7.2 Precautionary Measures |
| 1.2.6 Plant rescue and protection plan | 4.1.3 Management for a parabolic trough plant | 7.2.1 Measures against overheating |
| 1.3 Demographic impacts | 4.1.4 Sources of GHGs (Construction phase). | 7.2.2 Presence of warning/monitoring systems. |
| 1.3.1 Changes in population & demographic | 4.2 Technology alternatives | 7.2.3 Response measures to water shortages |
| 1.3.2 Involuntary migration from/to site | 4.2.1 Cooling system alternatives | 7.2.4 Establish measures to mitigate plumes |
| 1.3.3 Changes due to land loss | 4.2.2 Substantiate cooling system used | 7.2.5 Response measures |
| 1.4 Impact significance | 4.2.3 Water treatment | 7.2.6 Response measures to adverse weather |
| 1.4.1 Ground & surface water resource | 4.3 Cost projections | **Review Area 8 Immediate and long-term integration** |
| 1.4.2 Soil erosion & contamination | 4.3.1 Calculate project costs | 8.1 Monitoring and follow-up |
| 1.4.3 Land use | 4.3.2 Future capital costs of development | 8.1.1 Monitoring, evaluating and dissemination |
| 1.4.4 Air quality | 4.3.3 Project future investment costs | 8.1.2 knowledge dissemination measures |
| 1.4.5 Birds | **Review Area 5 Resource maintenance and efficiency** | 8.2 Holistic integration |
| 1.4.6 Fauna & flora | 5.1 Waste management | 8.2.1 Evidence of integration of first 7 principles in report (i.e. Silos) |
| 1.4.7 Reflective glare | 5.1.1 Identify hazardous substances | |
| 1.4.8 Noise | 5.1.2 Identify potential impacts of hazardous waste | |
| 1.4.9 Traffic | 5.1.3 Methods of recycling & re-using waste | |
| 1.4.10 Culture and heritage | 5.2 Water use | |
| **Review Area 2 Livelihood sufficiency and opportunity** | 5.2.1 Source of water for all water use requirements | |
| 2..1 Community share in project | | |
| 2.1.1 Local or regional ownership | 5.2.2 Substantiate chosen water source | |
| 2.1.2 Distribution of share of project | 5.2.3 Evidence of storm water management | |
| 2.2 Employment and income | 5.3.4 Estimates of water consumption | |
| 2.2.1 Number of local employees recruited | **Review Area 6 Socio-ecological civility and democratic governance** | |
| 2.2.2 Remuneration packages (Benefits) | 6.1 CSP knowledge transfers | |
| **Review Area 3 Intragenerational equity** | 6.1.1 Workshops on local CSP markets | |
| 3.1 Socio-economic development contributions | 6.1.2 Training local professionals on CSP Technologies. | |
| 3.1.1 Partnership agreements | 6.2 Citizen participation | |
| 3.1.2. National Investments in the project | 6.2.1 Public involvement | |

### 3.3 Review procedure

The review in this study was conducted in two parts to give results on the EIRQ and the consideration of the sustainability principles. As recommended by Lee *et al*., (1999), two reviewers (The author and Ms P. Masilo (BSc. Hon.Biochemistry)) independently reviewed the reports for both the EIRQ and the consideration of the sustainability principles. The two reviewers then discussed the results and gave final assessments based on a consensus. For both reviews, each of the reports were reviewed using the Lee and Colley Review Methodology (Lee *et al*., 1999). The assessment began at the sub-category level and systematically continued to the category level and then the review areas. An overall assessment of the whole report was ultimately given at the end of the review. The reports were assessed using the assessment scores illustrated in *Table 3-1.* The results for both reviews were recorded on a collation sheet (*Table 3-2*). The collation sheets of the NWU EIRQ and the Sustainability Principles Review Criteria are attached in Annexures 3 and 4. The findings of the reviews are presented and discussed in the following Chapter.

# CHAPTER 4

# REVIEW RESULTS: EVIRONMENTAL IMPACT REPORT QUALITY AND THE CONSIDERATION OF THE SUSTAINABILITY PRINCIPLES IN THE EIRS OF RENEWABLE ENERGY PROJECTS

This chapter presents the results of the study. The chapter is divided into two sections- the first section presents the EIRQ of Renewable Energy Projects (Objective 1) using the Lee and Colley Review Package (Lee *et al*., 1999), the consideration of the Sustainability Principles (Objective 2) is then presented in the second section.

## 4.1. Environmental Impact Report Quality (EIRQ) Results

The assessment symbols A (*well performed*), B (*satisfactory and complete performance*), and C (*just satisfactory performance*) indicate varying degrees of satisfactory performance. Unsatisfactory performance is indicated by assessment symbols D, E and F- where D represents *unsatisfactory performance*, E represents performance that is *not satisfactory* because important tasks were omitted and F represents *very unsatisfactory performance*. Only A and B grades are considered well performed, while E and F grades are considered poorly performed (Lee *et al*., 1999; Sandham 2013*b*). The well performed (A to B) and poorly performed (E to F) grades are therefore discussed to determine the strengths and weaknesses of the EIRs.

The EIRQ results at the highest level and at review area, category and sub-category levels are summarised in *Table 4-1*- the full set of results appears in Annexure 3. The results are presented in four sections as follows:

- Section 4.1.1- presents the overall quality of the EIRs (*Table 4-2*)
- Section 4.1.2- presents the EIRQ at review area level (*Table 4-2*)
- Section 4.1.3- presents the EIRQ at review category level (Table 4-2)
- The EIR quality at sub-category level is presented in Section 4.1.4 (*Table 4-3*).

All summaries and conclusions are presented in section 4.1.5.

The discussion first starts by describing the EIRQ at the highest level- the overall quality of the reports. The results of the review areas, the categories and sub-categories are then discussed with some focus on the sub-categories where needed.

### 4.1.1 Overall quality of the EIR sample

The overall quality of the EIRs is mostly satisfactory with 2Bs (satisfactory/complete performance) and 4Cs (satisfactory performance) (*Tables 4-1* and *4-2*). These results support findings from previous studies (Sandham *et al*., 2008*a*; Sandham *et al*., 2008*b*; Van Heerden, 2010) where the EIRQ was reported as satisfactory. The results also support findings from an evaluation of EIRs in the South African Energy Sector (Madlome, 2016). The quality of the environmental impact reports was reported satisfactory, with 80% of the reports achieving grades between A and C. Similar to these results, none of the reports achieved E and F grades.

Boshoff's (2013) evaluation of EIRQ in Renewable Energy Projects opposes these findings since the EIRQ of Renewable Energy Projects was unsatisfactory. Only 17% (5/30) of the reports were graded satisfactory and complete (B) while 53% (16/30) were assigned C (just satisfactory) grades. Eight of the 30 reports were unsatisfactory and 3% were poorly attempted with E grades.

**Table 4-1: EIRQ results at review area, review category and sub-category levels.**

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hum: Humansrus- BS: Bright Source- Ila: Ilanga- KK: Kalkaar- PP: Paulpits- KT: Kotulo Tsatsi | | | | | | | | | | | | | |
| Overall EIRQ scores | | | | | | | | | | | | | |
| Overall scores: | B | C | C | C | B | C | Overall scores: | B | C | C | C | B | C |
| Project Name | Hum | BS | Ila | KK | PP | KT | Project Name | Hum | BS | Ila | KK | PP | KT |
| Review Area 1 Description of the development | B | B | C | B | C | C | 2.4.1 Magnitude of main impacts | B | C | B | B | C | D |
| **1.1 Description of the development** | B | B | B | C | B | C | 2.4.2 Predicting impact magnitude | B | B | E | C | B | C |
| 1.1.1 Purpose of development | B | B | B | A | B | C | 2.4.3 Predictions of impact | C | C | A | D | A | C |
| 1.1.2 Dev. design and size | B | B | B | D | B | B | **2.5 Assessment of impact significance** | C | B | D | C | B | B |
| 1.1.3 Physical presence of dev. | B | C | B | D | B | B | 2.5.1 Impacts on community | C | B | A | B | A | B |
| 1.1.4 Nature of production processes | A | B | C | B | B | B | 2.5.2 Significance | B | A | A | D | B | B |
| 1.1.5 Nature & quantity of raw materials | B | B | B | D | B | C | 2.5.3 Significance methodology | C | B | E | A | B | C |
| 1.1.6 Applicant identified | B | B | B | A | B | C | Review Area 3 Alternatives | C | C | B | D | B | C |
| 1.1.7 EAP details | B | A | A | A | A | C | **3.1 Alternatives** | D | C | B | C | B | C |
| 1.2 Site Description | B | B | B | B | B | B | 3.1.1 Alternative sites | B | B | B | B | A | B |
| 1.2.1 Land area of development | B | B | B | B | B | B | 3.1.2 Alternative processes | A | B | B | A | A | B |
| 1.2.2 Demarcation of Land use areas | C | B | B | C | B | B | 3.1.3 Severe adverse impacts | E | D | C | C | B | D |
| 1.2.3 Duration of different phases | A | B | B | A | A | B | 3.1.4 Alternatives identified | D | A | A | C | B | B |
| 1.2.4 No. of worker/ visitors | B | A | B | A | C | C | **3.2 Scope of mitigation measures** | B | C | B | E | B | C |
| 1.2.5 Transporting raw material | C | D | A | D | A | B | 3.2.1 Mitigation of impacts | B | B | B | A | B | B |
| **1.3 Wastes** | D | B | D | C | D | D | 3.2.2 Mitigation considered | B | C | A | D | A | C |
| 1.3.1 Types & quantities of wastes | C | B | B | A | C | D | 3.2.3 Effectiveness of mitigation | B | C | A | D | B | D |
| 1.3.2 Handling/treatment/disposal | B | B | D | B | C | C | 3.3 Commitment to mitigation | B | B | B | C | B | C |
| 1.3.3 Methods of obtaining waste quantities | E | B | D | E | F | E | 3.3.1 Commitment to mitigation | B | B | B | C | B | C |
| **1.4 Environment Description** | B | B | C | B | C | C | 3.3.2 Monitoring in EMP | C | C | B | B | B | D |
| 1.4.1 Indication of affected area | B | B | B | A | B | C | 3.3.3 Commitment to mitigation | B | A | A | C | A | B |
| 1.4.2 Effects away from environment | B | A | D | C | C | C | Review Area 4: Communication | B | B | B | C | B | C |
| **1.5 Baseline Conditions** | C | B | C | B | B | B | **4.1 Layout of the report** | B | B | B | C | B | D |
| 1.5.1 Identification of affected environment | B | B | E | B | D | B | 4.1.1 Introduction | B | B | A | B | B | C |
| 1.5.2 Existing data sources searched | C | B | C | B | B | C | 4.1.2 Arrangement of information | B | B | B | C | B | D |
| 1.5.3 Local land use plans/policies | C | A | B | A | A | B | 4.1.3 Unless chapters are short | B | A | B | E | B | C |
| Review Area 2: Identification and evaluation of key impacts | B | D | C | C | B | B | 4.1.4 External sources | A | A | A | A | A | E |
| **2.1 Definition of impacts** | B | B | D | C | B | B | **4.2 Presentation** | B | A | B | B | B | C |
| 2.1.1 Effects on environment | B | B | A | A | B | B | 4.2.1 Presentation of Information | B | A | B | B | B | C |
| 2.1.2 Effects on natural components | B | B | A | B | A | B | 4.2.2 Technical terms, acronyms, | B | B | B | A | B | D |
| 2.1.3 Impacts from Accidents/Weather | C | C | E | D | C | C | 4.2.3 Statement presentation | A | A | A | C | A | C |
| 2.1.4 Deviation from baseline conditions | B | B | A | B | B | C | **4.3 Emphasis** | B | B | C | C | B | B |
| **2.2 Identification of impacts** | B | B | A | B | C | C | 4.3.1 Emphasis to severe impacts | B | B | A | C | B | A |
| 2.2.1 Impact identification methodology | A | B | A | B | D | C | 4.3.2 Statement must be unbiased | A | B | B | C | A | B |
| 2.2.2 Impact identification methods | B | B | A | A | B | D | 4.3.3 Opinion to authorized project | B | B | D | B | B | B |
| **2.3 Scoping** | B | D | A | B | B | B | 4.4 Non-technical summary | B | B | B | C | B | B |
| 2.3.1 Public participation | A | E | A | B | C | C | 4.4.1 Non-technical summary of findings | B | B | A | C | B | B |
| 2.3.2 Opinions and concerns of I&APs | B | D | A | A | B | B | 4.4.2 Main issues of summary | A | A | B | C | A | A |
| 2.3.3 Key impacts | B | C | A | B | A | B | | | | | | | |
| 2.4 Prediction of impact magnitude | B | C | D | D | B | C | | | | | | | |

### 4.1.2. EIRQ results at review area level

**Table 4-2: EIRQ results at review area and review category levels.**

| Review category | Review results | | | | | |
|---|---|---|---|---|---|---|
| | Humansrus | Bright source | Illanga | Kalkaar | Paulpits | Kotulo Tsatsi |
| **Overall scores:** | **B** | **C** | **C** | **C** | **B** | **C** |
| **Review Area 1: Description of the development, local environment and baseline conditions** | **B** | **B** | **C** | **B** | **C** | **C** |
| 1.1 Description of the development | B | B | B | C | B | C |
| 1.2 Site Description | B | B | B | B | B | B |
| 1.3 Wastes | D | B | D | C | D | D |
| 1.4 Environment Description | B | B | C | B | C | C |
| 1.5 Baseline Conditions | C | B | C | B | B | B |
| **Review Area 2: Identification and evaluation of key impacts** | **B** | **D** | **C** | **C** | **B** | **B** |
| 2.1 Definition of impacts | B | B | C | C | B | B |
| 2.2 Identification of impacts | B | B | A | B | C | C |
| 2.3 Scoping | B | D | A | B | B | B |
| 2.4 Prediction of impact magnitude | B | C | D | D | B | C |
| 2.5 Assessment of impact significance | C | B | D | C | B | B |
| **Review Area 3: Alternatives and mitigation** | **C** | **C** | **B** | **D** | **B** | **C** |
| 3.1 Alternatives | D | C | B | C | B | C |
| 3.2 Scope and effectiveness of mitigation measures | B | C | B | E | B | C |
| 3.3 Commitment to mitigation | B | B | B | C | B | C |
| **Review Area 4: Communication of results** | **B** | **B** | **B** | **C** | **B** | **C** |
| 4.1 Layout of the report | B | B | B | C | B | D |
| 4.2 Presentation | B | A | B | B | B | C |
| 4.3 Emphasis | B | B | C | C | B | B |
| 4.4 Non-technical summary | B | B | B | C | B | B |

The results of the review areas are largely satisfactory (*Table 4-2*)- apart from one D grade in Review Areas 2 (Identification and evaluation of key impacts) and 3 (Alternatives and Mitigation). Review Areas 1 (Description of the development, local environment and baseline conditions) and 4 (Communication of results) achieved the highest grades with B and C grades being the most frequent.

In spite of its greater complexity and its requirement of broad interpretation, Review Area 2 (Identification and evaluation of key impacts) was satisfactorily completed in most of the reports with 3Bs and 2Cs. This review area was however unsatisfactory in the Bright Source report which was allocated a D grade.

Review Area 3 (Alternatives and Mitigation) was the weakest performing with two of the reports achieving B grades, three recording C grades and one being allocated a D grade. This weak performance was also observed by Madlome (2016) where 60% of the reports achieved A-C grades and 40% achieved A-B grades. Boshoff's (2013) findings indicate that 27% of the reports were well performed while 57% were allocated satisfactory grades and 63% achieved borderline grades. Wood (2003) explains the poor contemplation of alternatives as a result of an EIA being conducted during the later stages of the development planning and design feasibility phases, resulting in the poor consideration of alternatives.

Review Area 4 (Communication of results) was the best performing with four of the reports achieving B grades and two achieving C grades. The results of Review Areas 1 and 4 signify a trend found in international and South African EIA reports where descriptive areas (Review Areas 1 and 4) perform better than the more practical ones (Review Areas 2 and 3) (Kabir & Momtaz, 2012; Sandham & Pretorius, 2008; Wood *et al*., 1996).

### 4.1.3. EIRQ results at review category level

The review category level is assessed based on the results found at sub-category level. As illustrated in *Table 4-2*, most of the review categories were satisfactorily performed with B and C grades being the most frequent grades. Some D grades were allocated to a few of the categories while the Kalkaar report was the only report with an E grade. These low grades suggest that the requirements at sub-category level were poorly completed and that the reports failed to meet the criteria in some of the sub-categories.

- **Review Area 1: Description of the development, local environment and baseline conditions**

The description of the development (1.1) (*Table 4-2*) was satisfactorily performed with 4Bs and 2Cs. The site description (1.2) illustrated good performance with 6Bs. The waste category (1.3) was the weakest performing with 1B, 1C and 4Ds. The description of the environment (1.4) achieved satisfactory grades of 3Bs and 3Cs while the description of the baseline conditions (1.5) also achieved satisfactory results with 4Bs and 2Cs.

- **Review Area 2: Identification and evaluation of key impacts**

A high proportion of B grades were assigned to the categories under Review Area 2. Categories 2.1 (Definition of impacts) and 2.2 (Identification of impacts) were the best performing with mostly B and C grades. A few D grades were allocated to Categories 2.4 (Prediction of impact magnitude) and 2.5 (Significance assessment). Scoping forms a fundamental part of the South African EIA system and this Category (2.3) was well performed in five of the reports with 1A and 4Bs. Scoping requirements were unsatisfactory in the Bright Source report because some tasks were poorly completed while others were not attempted at all.

- **Review Area 3: Alternatives and Mitigation**

The consideration of alternatives (3.1) was mostly satisfactory with 2Bs, 3Cs and 1D. The Humansrus report displayed the weakest performance with a D grade. Determining the scope and effectiveness of mitigation measures (3.2) was satisfactorily performed in five of the reports. The Kalkaar report was the weakest performing report in this category achieving an E grade. Commitment to mitigation (3.3) achieved satisfactory performance with 4Bs and 2Cs.

- **Review Area 4: Communication of results**

The way in which information is presented is an important aspect of EIRQ. This task was mostly satisfactory in these reports. A weakness was however observed in the layout (4.1) of the reports with the Kotulo Tsatsi report achieving a D grade. The information (4.2) was satisfactorily presented with 1A, 4Bs and 1C. Emphasis on key impacts (4.3) was also satisfactory with 4Bs and 2Cs. The category which requires a clearly written summary of the findings (4.4) performed satisfactorily in most of the reports-with 5Bs and 1C.

The categories under Review Area 4 generally perform well and this pattern is seen in findings from Madlome (2016); Sandham *et al*., (2008*b*); Sandham *et al*., (2008*a)*; Sandham *et al*., (2013*a*). According to Sandham *et al*., (2013*a*), a clear and effective communication of results in the EIA report does not guarantee good performance in the other review areas but- poor performance in Review Area 4 can weaken the quality of information provided in the first three review areas.

### 4.1.4 EIRQ results at sub-category level

The sub-category results (*Table 4-3*) determine the performance of the review categories and ultimately, the review areas. The sub-categories under Review Category 1.1 (Description of the development) were satisfactorily completed with mostly B grades. Sub-category 1.1.1 (Purpose of development) was well completed in the Kalkaar report which was allocated an A grade because as opposed to the other reports, it did not only justify the need and desirability of the development based on the country’s need to invest in alternative power supply but instead, the report clearly defined the desirability of the project in terms of the project site, the topographical gradient of the location, the results of the fatal flaw analysis and the Direct Normal Irradiance (DNI) of the project location.

Sub-categories 1.2.1 (Land area taken up by development) and 1.2.3 (Duration of different phases) were well performed with A and B grades. Sub-categories 1.2.2 (Demarcation of land use areas) and 1.2.4 (Number of workers/visitors on site) were mostly well performed in spite of a few C grades. Sub-category 1.2.5 (determining the transportation of raw materials to and from site) was satisfactory although D grades were observed in two of the reports. This sub-category has previously been presented as one of the weakest performing sub-categories under Category 1.2. Evidence has been observed in impact reports of projects affecting wetlands (Sandham *et al*., 2008*a*) and EIRs of the Northwest Province (Sandham & Pretorius, 2008).

Waste management (1.3) was allocated mixed grades ranging between A-C. Poor performance was observed in Sub-category 1.3.3 where methods of obtaining the quantity of residuals and wastes had to be described. The reports achieved 1F, 3Es, and 1D with a B grade being allocated to the Bright Source report because it defined different waste streams, the source of the waste, the type of waste generated and how the waste would be managed. The report also provided estimates of waste quantities and storage areas.

The sub-categories under Category 1.5 (Baseline conditions) were mostly satisfactory with a high proportion of A-B grades- but low grades were observed in Sub-category 1.5.1 (Identification of affected environment) where the Illanga report was allocated an E grade and the Paulpits report was allocated a D grade. Unlike the other reports, these reports failed to explain the role of the specialist reports in defining the methods used to identify and describe the important components of the affected environment.

Sub-categories 2.1.1 (Effects on the environment) and 2.1.2 (Effects on natural components) were amongst the best performing sub-categories with only A and B grades. The grades declined in Sub-category 2.1.3 (Impacts from accidents/adverse weather) which achieved 4Cs, 1D and 1E.

Sub-category 2.2.1 (Impact identification methodology) was well completed in four of the reports with A and B grades. The Kotulo Tsatsi report was allocated a C grade (satisfactory performance) while the Paulpits report was allocated a D grade because the impact significance rating methodology was not satisfactorily explained and substantiated.

**Table 6: EIRQ results at sub-category level.**

| Hum: Humansrus- BS: Bright Source- Illa-Illanga- KK: Kalkaar- PP: Paulpits- KT: Kotulo Tsatsi | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sub-category quality review results | | | | | | | | | | | | | |
| Review topic | Hum | BS | Illa | KK | PP | KT | Review topic/ Criteria description | Hum | BS | Illa | KK | PP | KT |
| 1.1.1 Purpose of development | B | B | B | A | B | C | 2.4.2 Methods predicting impact magnitude | B | B | E | C | B | C |
| 1.1.2 Dev. design and size | B | B | B | D | B | B | 2.4.3 Predictions of impact | C | C | A | D | A | C |
| 1.1.3 Physical presence of dev. | B | C | B | D | B | B | 2.5.1 Significance of impacts on community | C | B | A | B | A | B |
| 1.1.4 Nature of production processes | A | B | C | B | B | B | 2.5.2 Significance | B | A | A | D | B | B |
| 1.1.5 Nature & quantity of raw materials | B | B | B | D | B | C | 2.5.3 Significance assessment method | C | B | E | A | B | C |
| 1.1.6 Applicant identified | B | B | B | A | B | C | 3.1.1 Alternative sites | B | B | B | B | A | B |
| 1.1.7 EAP details | B | A | A | A | A | C | 3.1.2 Alternative processes | A | B | B | A | A | B |
| 1.2.1 Land area of development | B | B | B | B | B | B | 3.1.3 Severe adverse impacts | E | D | C | C | B | D |
| 1.2.2 Demarcation of Land use areas | C | B | B | C | B | B | 3.1.4 Alternatives identified | D | A | A | C | B | B |
| 1.2.3 Duration of different phases | A | B | B | A | A | B | 3.2.1 Mitigation of impacts | B | B | B | A | B | B |
| 1.2.4 No. of worker/ visitors | B | A | B | A | C | C | 3.2.2 Mitigation considered | B | C | A | D | A | C |
| 1.2.5 Transporting raw material | C | D | A | D | A | B | 3.2.3 Effectiveness of mitigation | B | C | A | D | B | D |
| 1.3.1 Types & quantities of wastes | C | B | B | A | C | D | 3.3.1 Commitment to mitigation | B | B | B | C | B | C |
| 1.3.2 Handling/treatment/disposal | B | B | D | B | C | C | 3.3.2 Monitoring arrangements in EMP | C | C | B | B | B | D |
| 1.3.3 Methods of obtaining waste quantities | E | B | D | E | F | E | 3.3.3 Commitment to mitigation | B | A | A | C | A | B |
| 1.4.1 Indication of affected area | B | B | B | A | B | C | 4.1.1 Introduction | B | B | A | B | B | C |
| 1.4.2 Effects occurring away from environment | B | A | D | C | C | C | 4.1.2 Arrangement of information | B | B | B | C | B | D |
| 1.5.1 Identification of affected environment | B | B | E | B | D | B | 4.1.3 Unless chapters are short | B | A | B | E | B | C |
| 1.5.2 Existing data sources searched | C | B | C | B | B | C | 4.1.4 External sources | A | A | A | A | A | E |
| 1.5.3 Local land use plans/policies | C | A | B | A | A | B | 4.2.1 Presentation of Information | B | A | B | B | B | C |
| 2.1.1 Effects on environment | B | B | A | A | B | B | 4.2.2 Technical terms, acronyms, | B | B | B | A | B | D |
| 2.1.2 Effects on natural components | B | B | A | B | A | B | 4.2.3 Statement presented as an integrated whole | A | A | A | C | A | C |
| 2.1.3 Impacts from Accidents/Adverse weather | C | C | E | D | C | C | 4.3.1 Emphasis to severe impacts | B | B | A | C | B | A |
| 2.1.4 Deviation from baseline conditions | B | B | A | B | B | C | 4.3.2 Statement must be unbiased | A | B | B | C | A | B |
| 2.2.1 Impact identification methodology | A | B | A | B | D | C | 4.3.3 Opinion on whether to authorized project | B | B | D | B | B | B |
| 2.2.2 Impact identification methods | B | B | A | A | B | D | 4.4.1 Non-technical summary of findings | B | B | A | C | B | B |
| 2.3.1 Public participation | A | E | A | B | C | C | 4.4.2 Main issues of summary | A | A | B | C | A | A |
| 2.3.2 Opinions and concerns of I&APs | B | D | A | A | B | B | | | | | | | |
| 2.3.3 Key impacts | B | C | A | B | A | B | | | | | | | |
| 2.4.1 Magnitude of main impacts and gaps in data | B | C | B | B | C | D | | | | | | | |

Genuine attempts to contact the general public and special interest groups to appraise them of the project (2.3.1) were satisfactorily completed in five of the reports with 2As,1B and 2Cs. The Bright Source development failed in this sub-category achieving an E grade. This low grade is due to the fact that the public participation appendix was not found in the report and the findings of the public participation process were not summarized as opposed to the other reports. The report was allocated a D grade instead of an E grade in Sub-category 2.3.2 (Opinions and concerns of Interested & Affected Parties) because although the public participation appendix was not attached, the report listed the public participation process as a primary source of data.

The Illanga report was allocated an E grade for Sub-category 2.4.2 (Methods predicting impact magnitude). In the other reports, impact magnitude was described as part of significance and the significance ranking methodology was defined using ranking scales and different criteria. This report rated the significance of the impacts but did not provide an explanation of how the significance was determined. It was therefore expected for the Illanga report to achieve a low grade in Sub-category 2.5.3 (Significance assessment methodology) since the significance ranking methodology was not described.

Alternatives (Alternative sites, 3.1.1 and Alternative processes, 3.1.2) were well contemplated in contrast to practice observed elsewhere (Boshoff, 2013; Madlome, 2016), with a majority of the reports achieving A and B grades. Impact mitigation (3.2.1) was well performed with most of the reports achieving A and B grades. Some D grades were observed in Sub-categories 3.2.2 (Mitigation considered) and 3.2.3 (Effectiveness of mitigation)- but the general performance of the sub-categories was satisfactory. In the contemplation of mitigation measures (3.2.2) and effectiveness of mitigation (3.2.3), the consideration of alternative sites or pollution control measures were unsatisfactory in the Kalkaar report and were therefore allocated a D grade.

Similar to practice observed in South Africa by Sandham *et al*., (2008*a*); Sandham *et al*., (2008*b*); Sandham *et al*., (2013*a*), sub-categories in Review Area 4 were the best performed with a majority of the grades ranging between A and B. Only a few E grades were allocated in Sub-categories 4.1.3 (Chapter summaries) and 4.1.4 (External sources). These findings contradict those of Boshoff (2013) where this review area reflected weak performance.

### 4.1.5 Section summary and conclusion

This section of the chapter presented the findings of Objective 1 which was to determine the EIRQ of Renewable Energy Projects. The results show a high frequency of mixed grades while some tasks achieved A and B grades. The results indicate that Review Areas 2 and 3 were unsatisfactory with weaknesses relating to methods of obtaining waste quantities (1.3.3), identifying impacts on the affected environment (1.5.1), impacts from accidents/adverse weather conditions (2.1.3) and severe adverse impacts (3.1.3). The requirements of Review Area 1(Description of the development, local environment and baseline conditions) and the information required in Review Area 4 (Communication of results) was satisfactory since the best grades were observed in these review areas. The best performed tasks include defining the purpose of the development (1.1.1) and land use development (1.2.1), commitment to mitigation (3.3.1), alternative sites (3.1.1) and alternative processes (3.1.2) as well as the mitigation of impacts (3.2.1). At the highest level of assessment (overall assessment), the reports achieved 2Bs and 4Cs. These results therefore lead to the conclusion that the EIRQ of Renewable Energy Projects is satisfactory.

The section that follows presents the results of the second objective which seeks to determine the extent to which the sustainability principles were considered in Renewable Energy Projects.

## 4.2. Results of the Sustainability Principles Review

The findings of the Sustainability Principles Review are presented at the review area, category and sub-category levels in *Tables 4-4* and *4-5*

### 4.2.1 Overall Consideration of the Sustainability Principles

Three of the reports indicate that the degree to which the sustainability principles were considered in Renewable Energy Projects is satisfactory while the other three indicate unsatisfactory performance (*Table 4-4)*. The reports achieved 1B, 2Cs and 3Ds with the Paulpits report illustrating the best performance with a B grade. The sustainability principles were satisfactory in the Humansrus and the Kotulo Tsatsi reports which achieved C grades while the weakest performance was observed in the Bright Source, Illanga and Kalkaar reports which were allocated D grades.

**Table 4-4: Consideration of the sustainability principles at review area and review category levels.**

| Review category | Review results | | | | | |
|---|---|---|---|---|---|---|
| | Hum | BS | Illa | KK | PP | KT |
| **Overall:** | **C** | **D** | **D** | **D** | **B** | **C** |
| **Review area 1: Socio-ecological system integrity** | **C** | **B** | **B** | **C** | **B** | **B** |
| 1.1 Natural resources | B | B | C | B | C | C |
| 1.2 Biodiversity | C | B | A | D | A | B |
| 1.3 Demographic | F | D | D | E | B | B |
| 1.4 Significance assessment | B | B | B | B | B | B |
| **Review area 2: Livelihood sufficiency and opportunity** | **C** | **D** | **D** | **D** | **B** | **C** |
| 2.1 Community share | F | F | F | F | D | D |
| 2.2 Employment | B | D | D | C | C | B |
| **Review area 3: Intragenerational equity** | **D** | **D** | **D** | **D** | **D** | **C** |
| 3.1 Social development | E | F | E | E | E | D |
| 3.2 Human and social health | C | B | C | C | D | B |
| **Review area 4: Intergenerational Equity** | **C** | **C** | **C** | **D** | **C** | **C** |
| 4.1 Pollution prevention | B | C | D | D | E | C |
| 4.2 Alternatives | B | B | B | B | B | B |
| 4.3 Project costs | F | F | E | E | F | E |
| **Review area 5: Resource maintenance and sufficiency** | **B** | **D** | **C** | **B** | **B** | **B** |
| 5.1 Waste | B | B | C | C | B | C |
| 5.2 Water use | B | B | B | A | A | B |
| **Review area 6: Socio-ecological civility and democratic governance** | **C** | **D** | **D** | **C** | **A** | **C** |
| 6.1 Knowledge transfer | D | F | E | D | D | D |
| 6.2 Participation | B | D | C | C | A | C |
| 6.3 Culture | B | D | B | B | B | B |
| **Review area 7: Precaution and adaptation** | **E** | **C** | **C** | **D** | **D** | **F** |
| 7.1 Alternatives | B | C | A | B | B | C |
| 7.2 Precaution | F | C | E | E | E | E |
| **Review area 8: Immediate and long-term integration** | **D** | **D** | **C** | **E** | **D** | **D** |
| 8.1 Monitoring and follow-up | D | B | D | E | E | D |
| 8.2 Integration | D | C | C | C | B | D |

*Hum: Humansrus- BS: Bright Source- Illa-Illanga- KK: Kalkaar- PP: Paulpits- KT: Kotulo Tsatsi

### 4.2.2 Consideration of the Sustainability Principles at review area level

The objective of Review Area 1 (Socio-ecological system integrity) is to understand how human actions affect natural resources and to seek measures to protect the long-term integrity of the natural environment. This Review Area was the best performed with 4Bs and 2Cs. This performance can be ascribed to the descriptive nature of the review area since descriptive areas have proven to perform better than practical ones (Wood *et al*., 1996).

Review Area 2 (Livelihood sufficiency and opportunity) was satisfactory in three of the reports and unsatisfactory in the other three. The Humansrus, Paulpits and the Kotulo Tsatsi reports were satisfactory with B and C grades. Unsatisfactory results were observed in the Bright Source, Illanga and the Kalkaar reports which were allocated D grades. Review Area 3 (Intragenerational equity) was amongst the weakest performing review areas with a high proportion of D grades.

Review Area 4 (Intergenerational Equity) is concerned with the well-being of future generations and requires pollution prevention measures, the consideration of different alternatives and projections of the costs of the development. Apart from the Kalkaar report which was allocated a D grade, the review area was mostly satisfactory with C grades.

The review area on Resource maintenance and sufficiency (Review Area 5) was the 2$^{nd}$ best performing after Review Area 1 with 4Bs, 1C and 1D. This review area focuses on waste management and water use and the results suggest that the requirements were largely satisfactory.

The performance of Review Area 6 (Socio-ecological civility and democratic governance) was mostly satisfactory with 1A, 3Cs and 2Ds. From a sustainability context, this review area requires information to be transferred between generations and for all affected individuals to be involved in project level decision-making.

Review Areas 7 and 8 were amongst the weakest performing review areas with a high proportion of E and F grades. Review Area 7 achieved 2Cs, 2Ds, 1E and 1F. The E grade was allocated to the Humansrus report and the Kotulo Tsatsi report was allocated an F grade.

Review Area 8 achieved 1C, 4Ds and 1E with the Ilanga report showing satisfactory performance (C grade). Weaknesses were observed in the Humansrus, Bright Source, Paulpits and the Kotulo Tsatsi reports which were allocated D grades. The poorest performance was observed in the Kalkaar report which achieved an E grade.

### 4.2.3 Consideration of the Sustainability Principles at review category level

The extent to which the sustainability principles were considered at review area level is reflected or explained by the findings at review category level (*Table 4-5*) which are discussed below.

- **Review Area 1: Socio-ecological system integrity**

Review Area 1 consists of four categories which were allocated a high proportion of B and C grades. All six of the reports were satisfactory in Category 1.1 (Natural resources) with mostly B and C grades. Category 1.2 (Identification of impacts on biodiversity) was well considered in four of the reports and satisfactory in one of the reports. The A grades were allocated to the Ilanga and the Paulpits reports while the B grades were allocated to the Bright Source and the Kotulo Tsatsi reports. The Humansrus report was allocated a C grade and the Kalkaar report was unsatisfactory with a D grade. Category 1.3 (Demographic structure) was the weakest performing with D, E and F grades while the category on the assessment of the significance of the impacts (1.4) was satisfactorily considered in all of the reports with B grades.

- **Review Area 2: Livelihood sufficiency and opportunity**

Although Review Area 2 was satisfactorily performed in three of the reports- the categories under the review area were however poor with a majority of the grades ranging between D and F. Category 2.1 (Community share in project) was poorly considered in most of the reports with 4Fs and unsatisfactory in two of the reports with Ds. Review Category 2.2 (Employment) performed better with 2Bs, 2Cs and 2Ds.

- **Review Area 3: Intragenerational equity**

The categories under Review Area 3 were poorly performed with a high proportion of E grades. Review Category 3.1 (Social development) was the weakest performing with 1D, 4Es and 1F. The category requires the development to indicate its contribution to the local and national social development of the country through existing or future investments or to encourage the local manufacturing/supply of CSP technology. This performance suggests that EAPs and proponents of Renewable Energy Projects overlook this requirement and therefore fail to promote transparency.

- **Review Area 4: Intergenerational Equity**

Category 4.1 (Pollution prevention) was satisfactory in three of the reports with 1B and 2Cs. D and E grades were allocated to the Illanga, Kalkaar and Paulpits reports. All six reports performed well under Review Category 4.2 (Alternatives) with B grades. Review Category 4.3 (Project costs) was identified as the weakest performing category under Review Area 4 with 3Es and 3Fs. This category requires the proponent to specify current project costs, to determine future capital costs of the development and to determine future investment costs which can be contemplated in future planning.

- **Review Area 5: Resource maintenance and sufficiency**

The categories under Review Area 5 were well performed with a high proportion of A and B grades. Category 5.1 (Waste) was satisfactory with 3B and 3C grades. Category 5.2 (Water use) was the best performing with 2As and 4Bs. This finding is significant because one of the sustainability concerns related to Solar CSP developments is water requirements and it has been documented that Solar CSP developments have more water requirements than the other Renewable Energy Developments (*Table 2-4*). This finding suggests that this aspect was considered and the sustainable use of water was well contemplated in Renewable Energy Projects.

- **Review Area 6: Socio-ecological civility and democratic governance**

Category 6.1 (Knowledge transfer) was one of the weakest performing categories with a high proportion of D grades. Poor performance was observed in the Bright Source and the Illanga reports which were allocated E and F grades.

The performance of the Illanga report was also poor in Review Category 6.2 (Participation) while the category was well performed in the Paulpits, Humansrus and the Bright Source reports which achieved A and B grades. The performance of the Kalkaar and the Kotulo Tsatsi reports was satisfactory with C grades. Review Category 6.3 (Culture) was satisfactory (B grades) in five of the reports and unsatisfactory (D) in the Bright Source report.

- **Review Area 7: Precaution and adaptation**

Category 7.2 requires the proponent to establish precautionary measures and plan for uncertainty. This was the most poorly performed category with a high proportion of E grades and accounts for the poor performance of Review Area 7. The Bright Source report was allocated a C grade while the Humansrus report was allocated an F grade. The E grades were allocated to the Illanga, Kalkaar, Paulpits and the Kotulo Tsatsi reports.

- **Review Area 8: Immediate and long-term integration**

Category 8.1 (Monitoring and follow-up) was poorly performed with a high proportion of D and E grades. The category on integration (8.2) was largely satisfactory with B and C grades. Weaknesses were observed in the Humansrus and Kotulo Tsatsi reports which achieved D grades.

### 4.2.4 Consideration of the Sustainability Principles at sub-category level

The grades allocated to the sub-category levels indicate the strengths and some of the concerns related to the consideration of the Sustainability Principles in Renewable Energy Projects. The category results above have summarised some of these strengths which include the identification of impacts on natural resources (1.1), significance assessment (1.4), water use (5.2) and alternatives (7.1). The identified weaknesses are concerned with demographic impacts (1.3), community share in project (2.1), social development (3.1), pollution prevention (4.1), future cost projections (4.3), knowledge transfer (6.1), precaution and adaptation (7.2) as well as monitoring and follow-up (8.1).

These strengths and weaknesses are illustrated in *Table 4-6* and it can be seen that the sub-category results leading to the strong categories (1.1, 1.4, 5.2 and 7.1) have a high proportion of A and B grades while the results leading to the weak categories (1.3, 2.1, 3.1, 4.1, 4,3, 6.1, 7.2 and 8.1) have more E and F grades.

**Table 7: Consideration of the sustainability principles at sub-category level.**

| Sub-category review grades | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Colour coding: A-Dark green; B-Green; C-Yellow; D-Pink; E-Maroon; F-Red | | | | | | | | | | | | | |
| **Review topic/ Criteria description** | **Hum** | **BS** | **Ila** | **KK** | **PP** | **KT** | **Review topic/ Criteria description** | **Hum** | **BS** | **Illa** | **KK** | **PP** | **KT** |
| 1.1.1 Water | B | B | B | B | B | B | 4.1.3 Hazardous material | A | - | C | - | E | - |
| 1.1.2 Soil | B | B | B | B | B | B | 4.1.4 Greenhouse gas emissions | D | C | E | A | E | C |
| 1.1.3 Land | B | C | A | B | B | B | 4.2.1 Cooling system alternatives | B | B | B | B | B | A |
| 1.1.4 Air | A | A | E | A | E | E | 4.2.2 Substantiation thereof | B | A | B | B | B | A |
| 1.2.1 Birds | A | B | B | B | B | B | 4.2.3 Water treatment | A | A | A | B | A | C |
| 1.2.2 Bird survey | F | B | B | B | B | B | 4.3.1 Project costs | F | B | E | E | F | D |
| 1.2.3 Anti-collision devices | B | B | B | E | B | B | 4.3.2 Future capital | F | F | E | E | F | E |
| 1.2.4 Fauna and flora | A | A | A | A | A | B | 4.3.3 Future investment costs | F | F | E | E | F | E |
| 1.2.5 Alien plant management | C | A | A | E | A | C | 5.1.1 Hazardous substances | B | C | C | B | B | E |
| 1.2.6 Plant rescue and protection | F | C | A | E | A | C | 5.1.2 Hazardous waste impacts | B | B | D | C | C | D |
| 1.3.1 Population structure | F | F | E | E | B | C | 5.1.3 Waste management | A | B | C | A | A | C |
| 1.3.2 Involuntary migration | F | A | B | E | B | B | 5.2.1 Water source | B | B | B | B | B | A |
| 1.3.3. Land loss | C | F | C | E | A | C | 5.2.2 Water source substantiation | B | B | B | B | B | C |
| 1.4.1 Ground & surface water resource | B | B | A | A | B | A | 5.2.3 Storm water management | D | C | B | A | A | B |
| 1.4.2 Soil erosion & contamination | D | B | B | B | B | B | 5.2.4 Water use requirements | B | C | A | A | A | A |
| 1.4.3 Land use | C | A | A | B | B | A | 6.1.1 Solar CSP workshops | F | F | E | E | E | E |
| 1.4.4 Air quality | A | B | B | B | D | D | 6.1.2 CSP training | C | F | E | C | C | C |
| 1.4.5 Birds | B | B | B | B | B | B | 6.2.1 Public participation | B | E | B | C | A | B |
| 1.4.6 Fauna & flora | B | B | B | B | B | B | 6.2.2 Presentation | B | E | D | C | B | D |
| 1.4.7 Reflective glare | D | B | B | B | B | C | 6.2.3 Documentation | A | E | D | A | A | B |
| 1.4.8 Noise | B | B | D | B | B | B | 6.2.4 Consideration of public views | B | D | C | C | B | C |
| 1.4.9 Traffic | D | B | C | B | B | B | 6.3.1 Heritage & culture | B | B | A | B | B | A |
| 1.4.10 Culture and heritage | B | B | B | A | B | A | 6.3.2 Heritage sites/cemeteries | B | F | A | B | B | A |
| 2.1.1 Economic empowerment | F | F | E | E | D | D | 6.3.3 Cultural beliefs/sites | C | F | E | E | C | E |
| 2.1.2 Community share in project | F | F | E | E | D | D | 7.1.1 CSP technology considered | B | B | A | B | B | D |
| 2.2.1 Number of local employees recruited | B | A | A | B | A | B | 7.1.2 Fuel for auxiliary facilities | B | F | - | A | E | A |
| 2.2.2 Remuneration packages (Benefits etc.) | B | F | E | E | E | B | 7.2.1 Overheating | F | C | E | E | E | E |
| 3.1.1 Stakeholder partnership | D | F | E | E | E | D | 7.2.2 Warning/monitoring systems | F | C | E | E | E | E |
| 3.1.2 National investments | D | F | E | E | A | D | 7.2.3 Response measures | F | - | - | - | - | - |
| 3.1.3 Skills and equipment | D | F | C | E | C | D | 7.2.4 Plumes | F | F | - | E | E | E |
| 3.1.4 Local CSP manufacturing | F | F | E | A | E | D | 7.2.5 Hazardous leaks | A | B | C | E | A | C |
| 3.1.5 Local supply survey | F | F | A | E | E | D | 7.2.6 Weather conditions | F | B | E | E | E | C |
| 3.2.1 Human health issues | D | B | E | C | E | C | 8.1.1 Project review | A | A | C | E | E | D |
| 3.2.2 Mitigate reflective glare | C | B | B | C | E | B | 8.1.2 Knowledge dissemination | F | B | E | E | E | D |
| 3.2.3 Noise | C | A | B | B | B | B | 8.2.1 Evidence of integration of first 7 principles in report (i.e. Silos) | D | C | C | C | B | D |
| 3.2.4 Traffic | C | A | A | A | A | B | | | | | | | |
| 4.1.1 Pollution types | B | C | C | C | C | D | | | | | | | |
| 4.1.2 Pollution control | B | F | E | E | - | E | | | | | | | |
| *Hum: Humansrus- BS: Bright Source- Illa-Illanga- KK: Kalkaar- PP: Paulpits- KT: Kotulo Tsatsi | | | | | | | | | | | | | |

The consideration of the sustainability principles at sub-category level indicates that impacts on water (1.1.1), soil (1.1.2) and land loss (1.1.3) were well addressed. The sub-category on air quality (1.1.4) achieved high grades in some of the reports and performed very poorly in others. The Humansrus report was one the best performing in this sub-category and was allocated an A grade because even though impacts on air quality were not identified as one of the potential impacts of the development, an air quality impact assessment was conducted to determine whether the project might impact air quality during the later stages of the development (e.g. construction or decommissioning).

The Ilanga report was allocated an E grade because it specified that the NEM: National Air Quality Act (39 of 2004) and the South African National Standards (SANS) 69 would be applicable during the operational phase of the development, but failed to provide evidence of an air quality impact assessment for the specified phase of the development.

Although the Humansrus report performed well in Sub-category 1.1.4, this report was the weakest performing in Sub-category 1.2.2 (Bird survey) because it failed to provide evidence of bird surveys while the other reports conducted bird surveys and acknowledged that the degree and significance of the impacts that the development would have on bird species depended on the amount of the species present in the area.

Weaknesses were also observed in the assessment of social impacts represented by Sub-categories 1.3.1 (Population structure) and 1.3.2 (Involuntary migration) which had a high frequency of E and F grades. The Paulpits report achieved the highest grade in Sub-category 1.3.1 (Population structure) because when describing the social impacts of the development during the construction phase, the report noted that the development is likely to change population structures since job seekers will be moving into the area and construction workers will be settling in. Sub-category 1.3.2 (Involuntary migration) was well considered in the Bright Source report because the report explained that since the proposed land was not occupied, the involuntary migration of communities was not identified as a potential impact.

Sub-categories 2.1.1 (Economic empowerment) and 2.1.2 (Community share in project) were amongst the weakest performing with grades ranging between Ds, Es and Fs. These reports failed to indicate the contemplation of local or regional ownership through economic empowerment programs as required by Review Area 2.

In Sub-category 2.1.2 (Community share in project), the performance of the Paulpits and the Kotulo Tsatsi reports was just unsatisfactory (D) and not poor (E/F) because unlike the other reports, these reports implied the allocation of a certain share of the development to affected communities. The Paulpits report noted that the proponent was required to develop a community trust that would be funded by the income from the power generation while the Kotulo Tsatsi report explained that a community trust would be established and some dividends would be allocated to the affected community. This report however failed to specify the projected amount that would be allocated to the community and was therefore allocated a D grade.

The reports performed well in Sub-category 2.2.1 (Number of local employees recruited) with grades ranging between As and Bs. The grades dropped in Sub-category 2.2.2 (Remuneration packages) which required the proponent to indicate the set amount for labour. This sub-category achieved 2Bs, 3Es and 1F. The Humansrus and the Kotulo Tsatsi reports were allocated B grades because they specified the amounts allocated for salaries and wages.

The requirements under Sub-categories 3.1.1. (Stakeholder partnership), 3.1.2 (National investments) and 3.1.3 (Skills and equipment) play an important role toward socio-economic development which is one of the main requirements of the REIPPPP. The results suggest that some of the objectives of socio-economic development were poorly considered in Renewable Energy Projects. This finding is also explained by the poor performance of Sub-categories 2.1.1 (Economic empowerment) and 2.1.2 (Community share in project). The results suggest that Renewable Energy Projects define socio-economic development through job creation instead of defining socio-economic development as a broad objective which ensures that local and national investments can multiply to ensure that communities are empowered and are less dependent on international investments.

The reports also failed to define the role of local companies in supplying equipment and undertaking construction activities. In Sub-categories 3.1.4 (Local CSP manufacturing) and 3.1.5 (Local supply survey), the reports failed to indicate measures to promote the local manufacturing of renewable energy technologies or a survey of local suppliers to establish material that can be sourced locally. The Stakeholder Consultation Workshop however provided an overview of renewable energy markets and deployment in South Africa (DOE *et al*., 2016) and revealed that local communities owned 11% of the share of Renewable Energy Projects, 51% of the construction content is accounted for by South African companies and that shareholding by South Africans amounts to 31%.

The sub-category results indicate that pollution and the management of hazardous substances is poorly contemplated in Renewable Energy Projects. The reports mostly illustrated satisfactory performance in the identification of pollution types (4.1.1) with 1B, 4Cs, and 1D while the contemplation of pollution control measures (4.1.2) was weak with 1B, 3Es and 1F. This sub-category was not applicable to the Paulpits report because the development used a central receiver instead of a parabolic trough power plant.

The reports performed well in Sub-categories 4.2.1 (Cooling system alternatives), 4.2.2 (Substantiation of cooling system alternative) and 4.2.3 (Water treatment) with grades ranging between As and Bs. Low grades were observed in the sub-categories which required the proponent to calculate project costs and future capital and investment costs (4.3.1, 4.3.2 and 4.3.3).

The sub-category on hazardous substances (5.1.1) was mostly satisfactory with 3Bs, 2Cs and 1E. Apart from the Kotulo Tsatsi report which was allocated an E grade, the other reports identified the brine released during water treatment as one of the hazardous substances that is likely to impact the environment. The impacts of the brine and oil/diesel substances (5.1.2) were satisfactorily identified in four of the reports while two of the reports achieved unsatisfactory grades (D grades). Sewer treatment is one of the most contemplated method of waste management (5.1.3) in Renewable Energy Projects and was well contemplated with 3As, 1B and 2Cs.

The sub-categories on water use were amongst the best performing with most grades ranging between As and Bs. The water source was identified (5.2.1) and substantiated (5.2.2). Storm water management (5.2.3) was well considered with most of the reports achieving A and B grades while water consumption estimates (5.2.4) were also well defined with most of the reports achieving A grades.

Concerns with addressing the objectives of socio-economic development were also evident in the sub-categories of the last three review areas. Sub-category 6.1.1 (Solar CSP workshops) indicates that the reports did not consider measures to transfer knowledge which can diffuse into local CSP markets. Sub-category 6.1.2 (CSP training) was mostly satisfactory with 4Cs, 1F and 1E. The Humansrus, Kalkaar, Paulpits and the Kotulo Tsatsi reports alluded to skills and development training before construction activities began and where therefore allocated C grades. The sub-categories on citizen participation (6.2.1, 6.2.2, 6.2.3 and 6.2.4) indicated satisfactory performance with mostly A, B and C grades.

Apart from the Bright Source report which was allocated a D grade, Sub-category 6.2.4 (Consideration of public views) indicates that the views of the public were satisfactorily considered during the project decision-making phase with 2Bs and 3Cs. The B grades were allocated to the Paulpits report and the Kalkaar report which mentions one of the farm owners expressing concerns related to visual impacts during the public consultation process. It was further observed that the Kalkaar report acknowledged the fact that the development would impact the sense of place in locations within 5km of the project area. The Paulpits report provides a summary of the concerns from land owners which include the impacts of dust on grazing areas. The report explained that dust impacts could not be avoided but would be reduced through relevant mitigation measures.

The sub-categories (7.1.1, 7.1.2, 7.2.1-7.2.6) on precaution and adaptation were poorly attempted with grades ranging between Es and Fs. The results suggest that the proponent did not consider response measures to overheating (7.2.1), establish warning or monitoring systems (7.2.2) or response measures (7.2.3). The Humansrus report was allocated F grades in all three sub-categories because it was the only report that used a wet cooling system and was therefore more prone to overheating and water shortages since it would require more water than the other developments which use a dry cooling system. Establishing response measures to water shortages during wet cooling is considered important since overheating may result in human and environmental harm.

Although the reports performed weak in this sub-category, it should be noted that some precautionary and response measures related to risk were identified in the reports. These were however overlooked in the review because they were not relevant to the specific review criteria.

The sub-categories in the last review area were poorly performed with more weaknesses than strengths. These findings indicate that Renewable Energy Projects fail to reflect on the strengths and challenges encountered during the scoping phase (8.1.1). The reports fail to transfer knowledge on lessons learnt or measures of improvement which can be considered in future developments (8.1.2). A significant finding is the way in which the first seven principles were integrated in the reports since integrated decision-making is at the core of Environmental Impact Assessment. Sub-category 8.2.1 (Integration of principles) was mostly satisfactory with 1B, 3Cs and 2Ds. These results signify that a decision was made based on a collective evaluation of the impacts identified in the reports.

#### 4.2.5 Section summary and conclusion

The findings of the second objective reveal that most of the sustainability principles requirements were poorly considered with main weaknesses related to the consideration of changes in population structures (1.3.1), definition of stakeholder partnerships (3.1.1) and national investments (3.1.2) in the project, the development of local skills and equipment supply (3.1.3), pollution control measures (4.1.2), future project (4.3.1) and capital costs (4.3.2), response measures to overheating (7.2.1), mitigation of plumes (7.2.4) as well as knowledge dissemination (8.1.2).

The requirements on the identification of impacts on water (1.1.1), soil (1.1.2), land (1.1.3), birds (1.2.1), waste management (5.1.3), definition of water source (5.2.1) and water use requirements (5.2.4), alternatives (4.2.1) and substantiation thereof (4.2.2) were the best performed with mostly A and B grades. These results indicate that the sustainability principles were satisfactorily considered in three of the reports and unsatisfactory in the other three. It is therefore concluded that satisfactory EIRQ in Renewable Energy Projects does not reflect a satisfactory consideration of the sustainability principles.

### 4.3. Chapter summary and conclusion

This chapter was a presentation of the EIRQ and the Sustainability Principles Review results. The findings indicate that the EIRQ of Renewable Energy Projects is satisfactory with a high frequency of B and C grades. Most of the strengths were observed in Review Areas 1 and 4 while the identified weaknesses included obtaining waste quantities (1.3.3), identification of affected environment (1.5.1), the identification of impacts from accidents/adverse weather (2.1.3), public participation (2.3.1) and the identification of severe adverse impacts (3.1.3).

Most of the requirements of the sustainability principles were poorly addressed with weaknesses related to the identification of demographic impacts (1.3), community share in project (2.1), socio-economic development (3.1), project cost projections (4.3), knowledge transfers (6.1), precautionary measures (7.1) and monitoring and follow-up (8.2). At the highest level of assessment, the results indicate that half of the reports evaluated for the consideration of the sustainability principles were satisfactory while the other half was just unsatisfactory and this suggests that satisfactory EIRQ does not reflect/guarantee a satisfactory consideration of the sustainability principles.

The relationship between EIRQ and the consideration of the sustainability principles in Renewable Energy Projects is better explained through a comparison of the EIRQ requirements and the sustainability principle requirements which is presented in Chapter 5.

# CHAPTER 5

# COMPARISON OF ENVIRONMENTAL IMPACT REPORT QUALITY AND THE CONSIDERATION OF THE SUSTAINABILITY PRINCIPLES

The aim of this chapter is to discuss the findings of Objective 3 which seeks to compare the Environmental Impact Report Quality (EIRQ) of Renewable Energy Projects and the degree to which the sustainability principles were considered in the reports. This is done by aligning the EIRQ Review Criteria with the Sustainability Principles Criteria. The categories are used instead of review areas and sub-categories because the category requirements are a summary of the sub-category requirements and allow for better alignment with the sustainability principles requirements as indicated in *Table 5-1*. These findings will define the link between EIRQ and the sustainability principles by illustrating the degree to which the sustainability principles were considered in EIA and the extent to which EIRQ is a surrogate for Sustainability Assessment.

## 5.1 Comparison of the EIRQ Requirements and the Sustainability Principles Requirements

To determine the extent to which the sustainability principles were considered in the EIRs, the criteria with similar requirements were aligned and a comparison was made based on the grades allocated for both the EIRQ and the Sustainability Principles Review (*Table 5-1*).

**Table 8: Comparison of the EIRQ requirements and the sustainability principles requirements.**

| Project | **Hum** | **BS** | **Illa** | **KK** | **PP** | **KT** | Project | **Hum** | **BS** | **Illa** | **KK** | **PP** | **KT** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Review category | **EIRQ Requirements** | | | | | | Review category | **Sustainability Principle Requirements** | | | | | |
| **1.3** | Wastes | | | | | | **5.1** | Waste Management | | | | | |
| | D | B | D | C | D | D | | B | B | C | C | B | B |
| **2.1** | Identify and define impacts | | | | | | **1.1** | Identify and define impacts | | | | | |
| | | | | | | | | C | B | D | C | B | B |
| | B | B | C | C | B | B | **3.2** | Identify impacts on human and social Health | | | | | |
| | | | | | | | | C | B | C | C | D | B |
| **2.3** | Scoping | | | | | | **6.2** | Citizen participation | | | | | |
| | B | D | A | B | B | B | | B | E | B | C | A | C |
| **2.5** | Significance Assessment | | | | | | **1.4** | Significance assessment | | | | | |
| | C | B | D | C | B | B | | B | B | B | B | B | B |
| **3.1** | Alternatives | | | | | | **4.2** | Cooling system alternatives | | | | | |
| | | | | | | | | B | B | B | B | B | B |
| | | | | | | | **7.1** | Alternatives | | | | | |
| | D | C | B | C | B | C | | B | C | A | B | B | C |
| **3.3** | Commitment to mitigation | | | | | | **4.1** | Pollution prevention | | | | | |
| | B | B | B | C | B | C | | B | C | D | D | E | C |
| **Hum**: Humansrus; **BS**: Bright Source; **Illa**: Illanga; **KK**: Kalkaar; **PP**: Paulpits; **KT**: Kotulo Tsatsi | | | | | | | | | | | | | |

### 5.1.1 Contemplated sustainability requirements in the EIRQ review criteria

Categories 1.3 (Waste) of the EIRQ and 5.1 (Waste management) of the sustainability principle criteria were aligned because they both require the contemplation of waste management measures. A difference in quality was observed since the EIRQ requirements were unsatisfactory with 1B, 1C and 4Ds and the sustainability principle requirements were satisfactory with 4Bs and 2Cs. The performance of the EIRQ requirements can be ascribed to the observation that four of the reports failed to define the methods of obtaining waste quantities as required by Sub-category 1.3.3 of the EIRQ criteria. The sustainability principles requirements include the identification of hazardous substances and their impacts as well as the contemplation of recycling and disposal procedures.

The requirements of Category 2.1 (Identify and define impacts) of EIRQ were aligned with those of Categories 1.1 (Natural resources) and 3.2 (Identify impacts on human and social health) of the sustainability principles criteria. All three categories require the identification and evaluation of impacts on the natural environment but Category 3.2 of the sustainability principles requirements puts more emphasis on human and social impacts since the National Environmental Management Act (Act 107 of 1998) defines society as part of the environment and requirement 2(h)(vii) of the 2014 EIA regulations requires social impacts to be amongst the emphasized impacts in EIA. A comparison between the grades indicates that the reports were satisfactory under all three requirements although the Illanga report was allocated a D grade in Sub-category (1.1) of the sustainability principles criteria and the Paulpits report was allocated a D grade for Sub-category (3.2) of the same criteria.

The requirements of the inclusion of the public in the decision-making process are illustrated by Categories 2.3 (scoping) of the EIRQ criteria and 6.2 (Citizen participation) of the sustainability principles criteria. The categories require the documentation of public views and opinions as well as evidence that the views and opinions were considered. The scoping requirements were better achieved than the citizen participation requirements with a higher occurrence of B grades. The Bright Source report was allocated a D grade for the scoping requirements because although the public participation appendix was not attached in the report, the public participation process was defined as one of the data sourcing processes of the specific project. The report was however allocated an E grade for the sustainability principle requirements because at sub-category level, the reports were assessed based on the simplicity of the public participation process (6.2.2) as well as evidence that the views and opinions of the public were documented (6.2.3), all of which were assessed from the public participation appendices of the reports.

The assessment of the significance of possible impacts is the heart of EIA. A sustainability driven EIA should emphasise the most important impacts so that methods for determining the significance of adverse impacts can be put in place (Ehrlich & Ross, 2015). The grades for the significance assessment (2.5) were lower in the EIRQ review with 3Bs, 2Cs and 1D while Category (1.4) was one of the best performed categories in the sustainability principle review with all B grades. The Illanga report achieved a D grade for the EIRQ review and a B grade for the sustainability principle review because it failed to justify the method used for assessing significance as required by Sub-category 2.5.3 of the EIRQ criteria.

The requirements of Category 3.1 (Alternatives) of EIRQ and those of Categories 4.2 (Alternatives) and 7.1 (Alternatives) of the sustainability principle criteria are aligned because they were derived from the regulation which requires the contemplation of alternatives during the scoping phase of a project (Regulation 2(h)(i) in Appendix 2 of the 2014 EIA Regulations). The requirements of Category 4.2 (Alternatives) were also driven the by the need to contemplate pollution prevention measures to ensure the protection of future generations as required by Review Area 4 of the sustainability principles criteria while Category 7.1 (Alternatives) was motivated by the need to prepare for uncertainty as required by Review Area 7 of the same criteria. The three set of results indicate that the EIRQ requirements performed slightly weaker than the sustainability principle requirements because Category 3.1 (Alternatives) of the EIRQ requirements was affected by the results of Sub-category 3.1.3 (Severe adverse impacts) which performed poorly with 2Bs, 2Cs, 1D and 1E.

Category 3.3 (Commitment to mitigation) of the EIRQ requirements was aligned with Category 4.1 (Pollution prevention and abatement) of the sustainability principles criteria because establishing pollution prevention measures is an indicator of commitment to mitigation. These requirements were satisfactorily completed in the EIRQ criteria with 4Bs and 2Cs while the sustainability principles criteria achieved 1B, 2Cs, 2Ds and 1E since the reports failed to identify the possible types of pollution (4.1.1), to contemplate the application of pollution control technologies (4.1.2) and to identify and address possible sources of Green House Gases (4.1.4) as required by Category 4.1 of Review Area 4 (Intergenerational equity).

### 5.2 Mismatch between EIRQ requirements and the sustainability principles requirements

The comparison between the EIRQ and the sustainability principles requirements indicates that some of the sustainability principles requirements are not addressed in the EIRQ criteria. These include the requirements from Category 2.1 (Community share) which require the contemplation of local and regional ownership through Economic Empowerment Programs (2.1.1) and the contribution of a certain share of the project to the affected community (2.1.2). The excluded requirements from Category 3.1 (Social development) include partnership agreements between international and national stakeholders (3.1.1), national investments in the project (3.1.2), the promotion of local companies in construction and equipment supply (3.1.3), the promotion of the local manufacturing of CSP equipment (3.1.4) and the survey of local skills and manufacturing (3.1.5).

The projection of development costs (4.3.1), the calculation of future capital costs (4.3.2) as well as the calculation of future investment costs (4.3.3) from Category 4.3 (Project costs) were also not addressed while knowledge transfer requirements (Sub-categories 6.1.1 and 6.1.2) from Category 6.1 were excluded. The requirements from Sub-category 8.1.1 of Monitoring and follow-up (8.1) are important since a reflection of the lessons learnt during the project planning and execution phases can be contemplated in future planning. These were however not addressed and this is highlighted by the poor performance of the sustainability principles requirements at category and sub-category levels with most of these categories being allocated a high proportion of D, E and F grades as follows:

- Community share (2.1) of the sustainability principles criteria- 2Ds and 4Fs
- Social development (3.1) of the sustainability principles criteria- 1D, 4Fs and 1E
- Project costs (4.3) of the sustainability principles criteria- 3Es and 3Fs
- Knowledge transfer (6.1) of the sustainability principles criteria- 4Ds, 1E and 1F
- Monitoring and follow-up (8.1) of the sustainability principles criteria- 1B, 3Ds and 2Es

These findings have not only highlighted the mismatch between the EIRQ review criteria and the sustainability principles review criteria but have also highlighted some of the sustainability principles criteria that should be considered in the EIRQ review package of Renewable Energy Projects.

### 5.3 Reflection of Sustainability Assessment objectives in the EIRQ requirements

The comparison between EIRQ and the sustainability principles requirements indicates that protecting the environment through waste management (1.3), impact identification (2.1), scoping (2.3), significance assessment (2.5), the development of alternatives (3.1) and commitment to mitigation (3.3) reflect the consideration of sustainability in the EIRQ criteria since these requirements are better aligned with some of the sustainability principle requirements as illustrated in *Table 5-1*. The waste management requirements contemplated in Category 1.3 of the EIRQ criteria were the worst performed with mostly D grades while impact identification (2.1) and commitment to mitigation (3.3) were satisfactory with mostly B and C grades.

The results suggest that a few of the requirements of Review Area 1 (Socio-ecological system integrity), Review Area 3 (Intragenerational equity), Review Area 4 (Intergenerational equity), Review Area 5 (Resource maintenance and efficiency), Review Area 6 (Socio-ecological civility and democratic governance) and Review Area 7 (Precaution and adaptation) were the most emphasised and contemplated in the EIA process while requirements of Review Areas 2 (Livelihood sufficiency and opportunity) and 8 (Immediate and long-term integration) were not reflected at all.

The category on waste management (1.3) reflects some of the requirements of Review Area 5 (Resource maintenance and efficiency)- the unsatisfactory performance of 1B, 1C and 4Ds however suggests that these requirements were overlooked in the reports. The EIRQ category on significance assessment (2.5) reflects requirements of Review Area 1(Socio-ecological system integrity) and were mostly satisfactory with B and C grades. The requirements of Review Area 1 were also seen in the EIRQ category on impact identification (2.1) which also reflects the requirements of Review Area 3 (Intragenerational equity). EIRQ Scoping (2.3) requirements reflect some of the requirements of Review Area 6 (Socio-ecological civility and democratic governance) and with the exception of the Bright Source report, these were mostly well considered. The EIRQ category on the contemplation of alternatives (3.1) reflects the requirements of Review Areas 4 (Intergenerational equity) and 7 (Precaution and adaptation) and were largely satisfactory apart from the Humansrus report which failed to contemplate alternatives in response to severe impacts as stipulated in Sub-category 3.1.3 of the EIRQ requirements. The requirements of Review Area 4 are also seen in Category 3.3 (Commitment to mitigation) which was satisfactorily completed with a high frequency of B grades.

### 5.4 Chapter summary and conclusion

This chapter has presented the comparison between EIRQ and the sustainability principles performance and the comparison of the EIRQ requirements with those of the sustainability principles shows that some of the objectives of Sustainability Assessment are achieved though EIA. The principle of Socio-ecological system integrity (Review Area 1) was the best performing with 4Bs and 2Cs (*Table 4-5*) and is reflected by the categories on significance assessment (2.5) and impact identification (2.1) from the EIRQ criteria. The EIRQ category on impact identification (2.1) also represents some of the requirements of the Principle of Intragenerational equity (Review Area 3) which were unsatisfactory with 1C and 5Ds.

Intergenerational equity (Review Area 4) was mostly satisfactory with 5Cs and 1D and some of its requirements were observed in the EIRQ categories on commitment to mitigation (3.3) and alternatives (3.1). Resource maintenance and efficiency (Review Area 5) was the 2nd best performing with 4Bs, 1C and 1D and is reflected by the EIRQ requirements for waste management (1.3) while EIRQ scoping (2.3) requirements represent some of the requirements of Review Area 6 (Socio-ecological civility and democratic governance) which was allocated 1A, 3Cs and 2Ds. These categories however reflect some of the requirements of the sustainability principles since most of the criteria from all eight sustainability principles were not contemplated in the EIRQ criteria- more specifically the criteria from Review Areas 2 and 8 which were not considered at all.

The comparison between EIRQ and the sustainability principles requirements shows that although some of the objectives of sustainability are reflected in EIRQ, the requirements that are most considered are those that are concerned with protecting the environment (i.e. impact identification, waste management, alternatives) while the social and economic requirements (i.e. socio-economic development contributions, cost projections and knowledge transfer) with the exception of scoping and job creation, are less represented in EIRQ.

An investigation of the EIRQ of Renewable Energy Projects and determining the performance of the sustainability principles in the EIRQ therefore leads to the conclusion that some of the sustainability principles requirements are not addressed in the EIRQ criteria and this is because Sustainability Assessment gives a wider view of the objectives of sustainability more than the traditional EIA.

# CHAPTER 6

# CONCLUSIONS

Sustainability Assessment is defined as a much broader approach toward achieving the objectives of sustainability in comparison to project-level EIA. The aim of Sustainability Assessment is to ensure that the objectives of sustainability are well contemplated in project planning and development. Sustainability Assessment requires a clear comprehension of sustainability and how it can be defined in different environments. The Sustainability Assessment process requires the formulation of context specific criteria in order to evaluate whether or not a proposed development is sustainable. Gibson's principles of sustainability are applied in Sustainability Assessment to better define the sustainability requirements of a particular project.

Sustainability Assessment evolved in response to the weaknesses of the Environmental Impact Assessment (EIA) process. The EIA process originated from the promulgation of the United States (U.S.) National Environmental Policy Act (NEPA) in 1969 and has since advanced as a potential tool for achieving sustainability. The process is however plagued by uncertainty and doubt on whether it is indeed obtaining sustainable outcomes. The efficiency of the EIA process is evaluated through Environmental Impact Report Quality (EIRQ) review which is an assessment of the quality of information documented throughout the EIA process.

The aim of this study was to determine how the EIRQ of Renewable Energy Projects and Gibson's principles of sustainability correspond. All three objectives of the study were met and the results are as follows:

- The first objective was to determine the EIRQ of Renewable Energy Projects and this was achieved through the application of the Lee and Colley Review Package to six EIRs of Renewable Energy Projects. The findings indicate that the EIRQ of Renewable Energy Projects shows the same satisfactory performance observed in previous studies. Most strengths were found in the descriptive areas (Review Areas 1 and 4) while the observed weaknesses were in Review Areas 2 and 3. These weaknesses were related to methods of obtaining waste quantities (1.3.3), the identification of affected environment (1.5.1), the identification of impacts from accidents/adverse weather (2.1.3), public participation (2.3.1) and the identification of severe adverse impacts (3.1.3).
- The second objective was to determine the extent to which the sustainability principles were considered in the reports. This was achieved through the development of Sustainability Principles Review Criteria which were applied to the EIRs of Renewable Energy Projects. The Sustainability Principles were translated into eight Review Areas while the categories and sub-categories were formulated to fit the context of Renewable Energy Projects as defined in Chapter 3. The results indicate that the consideration of the sustainability principles

is satisfactory in three of the reports and unsatisfactory in the other three. This finding suggests that satisfactory EIRQ does not necessarily guarantee a satisfactory contemplation of the sustainability principles.

The weaknesses that were observed in the reports were related to demographic impacts (1.3), community share in project (2.1), social development contributions (3.1), pollution prevention (4.1), project costs (4.3), knowledge transfer (6.1), precaution and adaptation (7.2) as well as monitoring and follow-up (8.1). These weaknesses were translated into Intragenerational equity (Review area 3), Precaution and adaptation (Review Area 7) as well as Immediate and long-term integration (Review Area 8).

Socio-ecological system integrity (Review Area 1) and Resource maintenance and efficiency (Review Area 5) were the best performed review areas with mostly A and B grades. Most of the strengths were related to the identification of natural resources (1.1), significance assessment (1.4), the contemplation of alternatives (4.2), waste management (5.1) and water use considerations (5.2).

- The third objective was to compare the EIRQ of the reports and the extent to which the sustainability principles were reflected in the reports. These results were obtained by comparing the EIRQ requirements with the Sustainability Principles requirements. The findings indicate that some of the objectives of sustainability are inherent in EIRQ, these include the identification of impacts, waste management, scoping, the development of alternatives, significance assessment and commitment to mitigation. This suggests that a significant part of Sustainability Assessment is conducted through EIA.

  These requirements were however considered to a lesser degree since some of the sustainability principles requirements were not reflected in the EIRQ criteria and those that were contemplated were more focused on biophysical impacts than social impacts. The requirements on social development contributions (1.3), project costs (4.3), knowledge transfer (6.1), precaution (7.2) and monitoring and follow-up (8.1) were poorly reflected in the EIRQ criteria while the identification and definition of impacts (1.1), significance assessment (1.4), the identification of human and social impact (3.2), pollution prevention (4.1), cooling system alternatives (4.2), public consultation (6.2) and precautionary alternatives (7.1) were the most contemplated.

The EIRQ of Renewable Energy Projects and the poor reflection of the EIRQ requirements in the sustainability principles criteria have confirmed that the contribution of project-level EIA toward

sustainability is to a lesser degree. Sustainability Assessment is therefore a wider and encompassing approach to meeting the objectives of sustainability. It is concluded that the correspondence between the EIRQ of Renewable Energy Projects and Gibson's (2006) Principles of Sustainability is poor, since the EIRQ criteria is not contemplative of the sustainability principles requirements. Therefore, in order to get a better reflection of Sustainability Assessment, it is recommended that the formulated sustainability principles criteria should instead be applied to the EIRQ review criteria of Renewable Energy Projects.

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## **ANNEXURE 1-** *The NWU EIRQ Review Package*

NWU®

| |
|---|
| **Review Area 1**<br>**DESCRIPTION OF THE DEVELOPMENT, LOCAL ENVIRONMENT AND BASELINE CONDITIONS** |
| **1.1 DESCRIPTION OF THE DEVELOPMENT** |
| 1.1.1 Purpose and objectives of development (Purpose, Objectives and Need and desirability of proposed activity) |
| 1.1.2 Design and size of development (Diagrams, plans, maps included) |
| 1.1.3 Physical presence and appearance of completed development within receiving environment (Indication thereof) |
| 1.1.4 Nature of production processes intended to be employed in completed development and expected rate of production (Production processes (where appropriate), Rate of production (where appropriate). |
| 1.1.5 Nature and quantity of raw materials needed during different phases (Construction phase: Nature of raw materials, Quantity of raw materials' Operational phase: Nature of raw materials, Quantity of raw materials |
| 1.1.6 Identification of applicant-Name, Address and contact numbers |
| 1.1.7 Declaration of independence; Expertise of EAP |
| **1.2 SITE DESCRIPTION: On site land requirements of development and duration of each land use** |
| 1.2.1 Land area taken up by development site (Property on which activity is to be undertaken (maps included), Location of activity on the property (maps included), Description of route of linear activity (if applicable), Coordinates of ocean-based activity (if applicable) |
| 1.2.2 Description of land uses to which this land will be put (Demarcation of different land use areas) |
| 1.2.3 Construction phase (Operational phase; Decommissioning phase (where appropriate) |
| 1.2.4 Estimated number of workers and/or visitors entering development site, access to site and likely means of transport (Number of workers: Construction phase, Operational phase' Number of visitors: Construction phase, Production phase |
| 1.2.5 Means of transporting raw materials/products to and from site and approximate quantities involved (Means of transporting, Approximate quantities) |
| **1.3 WASTES: Estimated types and quantities of wastes which might be produced and proposed disposal routes to the environment described** |
| 1.3.1 Residual process materials (Effluents, Emissions, Waste energy, Waste heat, Noise) |
| 1.3.2 Proposed handling/treatment, disposal and disposal routes to the environment (Handling, Treating, Disposal) |
| 1.3.3 Methods of obtaining quantity of residuals and wastes (Methods of obtaining quantity of wastes, Uncertainty acknowledged, Confidence limits given (where possible)) |
| **1.4 ENVIRONMENT DESCRIPTION: Area and location likely to be affected by development proposal** |
| 1.4.1 Indication of likely area to be affected by development (Description of direct environment to be affected, Map with location shown) |
| 1.4.2 Greater area to accommodate potentially significant effects occurring away from immediate affected environment (Dispersion of pollutants, Infrastructural requirements of project, Traffic) |
| **1.5 BASELINE CONDITIONS: Description of effected environment as it is currently, and as it could be expected to develop if project were not to be proceed.** |
| 1.5.1 Identification and description of important components of the affected environment (Disclosure of methods and investigation undertaken, Size and complexity in relation to assessment task, Uncertainty indicated) |
| 1.5.2 Existing data sources searched and utilized (Local authority records, Special studies carried out by/on behalf of conservation agencies/special interest groups) |
| 1.5.3 Local land use plans, policies consulted and other data collected to determine baseline conditions (Future state of environment – no go action) |

| **Review Area 2**<br>**IDENTIFICATION AND EVALUATION OF KEY IMPACTS** |
|---|
| **2.1 DEFINITION OF IMPACTS: Potential impacts of development on the environment** |
| 2.1.1 Description of all possible effects of project on environment (Direct, Indirect, Secondary Cumulative, Short term, Medium term, Long term, Permanent, Temporary, Positive, Negative) |
| 2.1.2 Identify and describe the effects and interaction of effects on Human beings, Flora and fauna, Soils, Water, Air, Climate, Landscape (Aesthetics), Material assets, Cultural heritage, Architectural heritage, Archaeological heritage |
| 2.1.3 Impacts arising from non-standard operating conditions due to Accidents, Adverse weather |
| 2.1.4 Impacts arising from deviation from Baseline conditions (Difference between conditions if development were not to proceed, those predicted to prevail as a consequence of it) |
| **2.2 IDENTIFICATION OF IMPACTS: Methods used for identification of all significant impacts** |
| 2.2.1 Impact identification methodology (Project specific checklist, Matrices, Panels of experts, Consultation, Supplementary methods to identify secondary impacts) |
| 2.2.2 Description of impacts identification methods (Method, Rational for using them) |
| **2.3 SCOPING: Key impacts should be identified, and main investigation centred on these.** |
| 2.3.1 Genuine attempt to contact general public and special interest groups to appraise them of project (Description of the advertisement, Notification: Relevant provincial gazette, Newspaper (local, regional, national Site, Advertisement of public meeting, Notification of availability of EIA report) |
| 2.3.2 Arrangements to collect opinions and concerns of I&APs (Steps undertaken in accordance with plan of study, List of identified I&APs: General public, Special interest groups, Government and public agencies, Arrangements made to collect opinions: public meeting, seminar, discussion group, etc. List of registered I&APs: Summary of comments received. Summary of issues raise, Date of receipt of comments, Response of EAP, Copies of any representations, objections and comments received from registered I&APs |
| 2.3.3 Key impacts (Identified and selected for intense investigation, Reasons why less important impacts require less detailed investigation, Summary of the findings and recommendations of any specialist report) |
| **2.4 PREDICTION OF IMPACT MAGNITUDE: Likely impacts should be described in exact terms where possible** |
| 2.4.1 Data used to estimate magnitude of main impacts and gaps in data clearly indicated (Should be sufficient for task, should be clearly described or sources clearly identified, Gaps in data should be clearly identified, Means used to deal with gaps in data should be explained) |
| 2.4.2 Methods predicting impact magnitude clearly described (Methods used clearly described, Methods appropriate to size and importance of projected impact) |
| 2.4.3 Express predictions of impact in measurable quantities with confidence limits (Measurable quantities, Qualitative descriptions should be fully defined) |

| Review Area 3 ALTERNATIVES AND MITIGATION |
|---|
| **3.1 ALTERNATIVES: Feasible alternatives should be considered** |
| 3.1.1 Main environmental advantages (Main environmental disadvantages, Reasons for final choice, Environmental implications investigated and reported) |
| 3.1.2 Consideration/description of alternative processes, designs and operating conditions (Environmental implications investigated and reported) |
| 3.1.3 For unexpectedly severe adverse impacts identified (Earlier rejected alternatives re-appraised) |
| 3.1.4 Comparative assessment of all alternatives identified |
| **3.2 SCOPE AND EFFECTIVENESS OF MITIGATION MEASURES: All significant adverse impacts should be considered for mitigation** |
| 3.2.1 Consider mitigation of all significant adverse impacts (Mitigation of al significant impacts considered, Specific mitigation measures put forward, Unmitigated impacts indicated and justified) |
| 3.2.2 Mitigation measures considered should include (Modification of project, Alternative facilities, Pollution control) |
| 3.2.3 Extent of effectiveness of mitigation when implemented (Expected effectiveness, Description of uncertainty, assumptions, gaps in knowledge) |
| **3.3 COMMITMENT TO MITIGATION** |
| 3.3.1 Clear record of commitment of developer to mitigation measures (Presented in report, Details of how mitigation measures will be implemented, Draft EMP must comply with regulations, any specific information required by competent authority) |
| 3.3.2 Monitoring arrangements to correspond with scale and deviations form expected impacts (Provisions to adjust mitigation measures) |
| 3.3.3 Commitment to mitigation |

| Review Area 4<br>COMMUNICATION OF RESULTS |
|---|
| **4.1 LAYOUT OF THE REPORT** |
| 4.1.1 Introduction (Briefly describing the project, the aims of the environmental assessment, how aims are to be achieved) |
| 4.1.2 Arrangement of information (Logically in sections/chapters, whereabouts of important data signalled in a table of contents or index) |
| 4.1.3 Unless chapters are very short (Chapter summaries to outline main findings of each phase) |
| 4.1.4 External sources (Original source must be acknowledged at that point in text and reference, full reference should be included) |
| **4.2 PRESENTATION: Information should be accessible to the non-specialist** |
| 4.2.1 Presentation of Information (Comprehensible to non-specialist, Appropriate tables, graphs and other devices, Unnecessary technical language avoided, Unnecessary obscure language avoided) |
| 4.2.2 Technical terms, acronyms, initials defined (When first used in text or in glossary) |
| 4.2.3 Statement presented as an integrated whole (Summaries of data presented in separately appendices should be introduced in main body of text) |
| **4.3 EMPHASIS: Information should be represented without bias** |
| 4.3.1 Prominence and emphasis to potentially severe impacts (Potentially severe and adverse impacts, Potentially substantially favourable environmental impacts) |
| 4.3.2 Statement must be unbiased (Should not lobby for any particular pint of view, Adverse impacts should not be disguised by euphemism or platitudes) |
| 4.3.3 Opinion as to whether the activity should/should not be authorized |
| **4.4 NON-TECHNICAL SUMMARY: Clearly written non-technical summary of main findings** |
| 4.4.1 Non-technical summary of main findings and conclusions (Potentially severe and adverse impacts, potentially substantially favourable environmental impacts, Technical terms, lists of data, detailed explanations, scientific reasoning should be avoided) |
| 4.4.2 Summary must cover all main issues (Description of project and environment, Main mitigation measures to be undertaken, Description of significant residual impacts, Methods by which data were obtained, Indication of confidence in methods to obtain data) |

# ANNEXURE 2- *Sustainability Principle Review Criteria*

**Review Area 1: Socio-ecological system integrity**

**1.1 Were impacts on natural resources identified?**

1.1.1 Were impacts on ground and surface water during and post construction identified and evaluated?

1.1.2 Were impacts on soil erosion and contamination identified and evaluated?

1.1.3 Were potential impacts on land use identified?

1.1.4 Were impacts on air quality identified?

**1.2. Were measures of biodiversity conservation established?**

1.2.1 Were impacts on bird communities identified?

1.2.2. Were bird communities in chosen location surveyed?

1.2.3. Were anti-collision devices (bird flappers) installed where powerlines cross avifaunal corridors?

1.2.4. Were impacts on fauna and flora identified?

1.2.5. Was an alien invasive management plan developed?

1.2.6 Was a plant rescue and protection plan developed?

**1.3 Were the demographic impacts of the project considered and evaluated?**

1.3.1 Were changes in population and demographic structures considered?

1.3.2 Was involuntary migration from (people living on land) or to the development site (workers) considered?

1.3.3 Were changes in indigenous lifestyle due to land loss considered?

**1.4. Was the significance of the impacts identified assessed?**

1.4.1 Was the significance of the impacts on ground and surface water resources assessed?

1.4.2 Was the significance of the impacts on soil erosion and contamination assessed?

1.4.3. Was the significance of the impacts on land use assessed?

1.4.4 Was the significance of the impacts on air quality assessed?

1.4.5. Was the significance of the impacts on birds assessed?

1.4.6. Was the significance of the impacts on fauna and flora assessed?

1.4.7. Was the significance of the impacts of reflective glare assessed?

1.4.8. Was the significance of the impacts of noise assessed?

1.4.9. Was the significance of the impacts of traffic assessed?

1.4.10. Was the significance of the impacts on culture and heritage assessed?

**Review Area 2: Livelihood sufficiency and opportunity**

**2.1. Was the intention to contribute a share of the project to the community contemplated or reflected?**

2.1.1 Was local or regional ownership promoted through Economic Empowerment Programs?

2.1.2. Was the distribution of a certain share of the project to local communities through community trusts etc. considered?

2.2. Were employment and income opportunities identified and considered?

2.2.1. Was the number of local employees to be recruited specified?

2.2.2. Were remuneration packages specified (Benefits, etc)?

**Review Area 3: Intragenerational equity**

**3.1. Were measures to contribute toward socio-economic development considered and established?**

3.1.1. Is there evidence of partnership agreements between foreign providers and South African Stakeholders?

3.1.2. Is there evidence of National Investments in the project?

3.1.3. Are local companies promoted/considered in Equipment Supply, Engineering, Installations, Transportation, Waste Disposal and Manufacturing?

3.1.4. Is there an Action Plan to promote local manufacturing of CSP components and equipment?

3.1.5. Are local suppliers/contractors surveyed to establish material that can be sourced locally?

**3.2. Were impacts on human health and society considered?**

3.2.1. Were human health issues identified?

3.2.2. Were measures to avoid/ mitigate reflective glare considered?

3.2.3. Were noise impacts identified and measures of mitigation established?

3.2.4. Were impacts of traffic and access roads on community considered?

**Review Area 4: Intergenerational equity**

**4.1. Were measures of pollution prevention and abatement established?**

4.1.1. Were possible types of pollution identified?

4.1.2. Were pollution control technologies considered/applied?

4.1.3. Was the management of hazardous material and pesticides for a parabolic trough power plant established?

4.1.4. Were sources of greenhouse gas emissions during construction phase identified?

**4.2. Were technology alternatives identified and considered?**

4.2.1. Were cooling system alternatives identified and considered? (Air cooling; Dry cooling (less water required; Hybrid cooling (less generation of waste)).

4.2.2. Was the type of cooling system used substantiated?

4.2.3. Was the preferred water treatment process defined and substantiated (ion exchange/reverse osmosis)?

**4.3. Were project costs projected?**

4.3.1. Where project costs calculated?

4.3.2. Where future capital costs of the development projected?

4.3.3. Where future investment costs projected?

**Review Area 5: Resource maintenance and efficiency**

**5.1. Was the management of waste defined?**

5.1.1. Were hazardous substances identified?

5.1.2. Were potential impacts of hazardous waste identified?

5.1.3. Were methods of recycling, disposing and re-using waste contemplated?

**5.2. Were water use considerations defined?**

5.2.1. Was the source of water for all water use requirements identified?

5.2.2. Was the reason for the chosen water source substantiated?

5.2.3. Is there evidence of storm water management?

5.2.4. Were water consumption requirements estimated?

**Review Area 6: Socio-Ecological Civility and Democratic Governance**

**6.1. Was there evidence of CSP knowledge transfer measures?**

6.1.1. Were workshops on local development of Solar CSP markets (Manufacturing, Installing and Engineering) defined or considered?

6.1.2. Was the training of local professionals on CSP Technologies considered?

**6.2. Was the participation of the public considered and planned?**

6.2.1 Was the public actively involved in the decision-making process?

6.2.2. Was the form of participation simple and easily comprehendible?

6.2.3. Were public views and opinions documented?

6.2.4. Was there evidence that the views and opinions of the public were considered/applied in the decision-making process?

**Review Area 7: Precaution and Adaptation**

**7.1. Were different alternatives considered?**

7.1.1 Was the reason for CSP technology considered substantiated (Parabolic trough, Linear, Power Tower or Dish/Engine?

7.1.2. Was the preference of fuel for auxiliary facilities defined (gas/diesel)?

**7.2. Were measures of precaution and adaptation considered and established?**

7.2.1. Were measures against overheating established in mitigation?

7.2.2. Were warning/monitoring systems considered in mitigation?

7.2.3. Were response measures to water shortages defined and established?

7.2.4. Were measures to mitigate plumes from boilers established?

7.2.5. Were response measures to diesel or fuel leaks or any other hazardous material established/considered?

7.2.6. Were response measures to adverse weather conditions considered?

**Review Area 8: Immediate and long-term integration**

**8.1. Were measures of monitoring and follow-up established?**

8.1.1. Was the monitoring, evaluation and dissemination of performance results with review to support future replicability (Lessons learnt; Measures of improvement; Challenges encountered) defined?

8.1.2. Were measures of knowledge dissemination established/considered?

**8.2. Was there evidence of holistic integration?**

8.2.1. Was there evidence that the first 7 principles were integrated in the report?

# ANNEXURE 3- *EIRQ Collation Sheet*

**Table 1: HUMANSRUS**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **1** | **B** | **2** | **B** | **3** | **B** | **4** | **B** |
| **1.1** | **B** | **2.1** | **B** | **3.1** | **B** | **4.1** | **B** |
| 1.1.1 | B | 2.1.1 | B | 3.1.1 | B | 4.1.1 | B |
| 1.1.2 | B | 2.1.2 | B | 3.1.2 | A | 4.1.2 | B |
| 1.1.3 | B | 2.1.3 | C | 3.1.3 | E | 4.1.3 | B |
| 1.1.4 | A | 2.1.4 | B | 3.1.4 | D | 4.1.4 | A |
| 1.1.5 | B | | | | | | |
| 1.1.6 | B | | | | | | |
| 1.1.7 | B | | | | | | |
| **1.2** | **B** | **2.2** | **B** | **3.2** | **B** | **4.2** | **B** |
| 1.2.1 | B | 2.2.1 | A | 3.2.1 | B | 4.2.1 | B |
| 1.2.2 | B | 2.2.2 | B | 3.2.2 | B | 4.2.2 | B |
| 1.2.3 | A | | | 3.2.3 | B | 4.2.3 | A |
| 1.2.4 | B | | | | | | |
| 1.2.5 | C | | | | | | |
| **1.3** | **D** | **2.3** | **B** | **3.3** | **B** | **4.3** | **B** |
| 1.3.1 | C | 2.3.1 | A | 3.3.1 | B | 4.3.1 | B |
| 1.3.2 | B | 2.3.2 | B | 3.3.2 | C | 4.3.2 | A |
| 1.3.3 | E | 2.3.3 | B | 3.3.3 | B | 4.3.3 | B |
| **1.4** | **B** | **2.4** | **B** | | | **4.4** | **B** |
| 1.4.1 | B | 2.4.1 | B | | | 4.4.1 | B |
| 1.4.2 | B | 2.4.2 | B | | | 4.4.2 | A |
| | | 2.4.3 | C | | | | |
| **1.5** | **C** | **2.5** | **C** | | | | |
| 1.5.1 | B | 2.5.1 | C | | | | |
| 1.5.2 | C | 2.5.2 | B | | | | |
| 1.5.3 | C | 2.5.3 | C | | | | |

**Table 2: BRIGHT SOURCE**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **1** | **B** | **2** | **B** | **3** | **C** | **4** | **C** |
| **1.1** | **B** | **2.1** | **B** | **3.1** | **C** | **4.1** | **B** |
| 1.1.1 | B | 2.1.1 | B | 3.1.1 | B | 4.1.1 | B |
| 1.1.2 | B | 2.1.2 | B | 3.1.2 | B | 4.1.2 | B |
| 1.1.3 | C | 2.1.3 | C | 3.1.3 | E | 4.1.3 | A |
| 1.1.4 | B | 2.1.4 | B | 3.1.4 | A | 4.1.4 | A |
| 1.1.5 | B | | | | | | |
| 1.1.6 | B | | | | | | |
| 1.1.7 | A | | | | | | |
| **1.2** | **B** | **2.2** | **B** | **3.2** | **C** | **4.2** | **A** |
| 1.2.1 | B | 2.2.1 | B | 3.2.1 | B | 4.2.1 | A |
| 1.2.2 | B | 2.2.2 | B | 3.2.2 | C | 4.2.2 | B |
| 1.2.3 | B | | | 3.2.3 | C | 4.2.3 | A |
| 1.2.4 | A | | | | | | |
| 1.2.5 | D | | | | | | |
| **1.3** | **D** | **2.3** | **D** | **3.3** | **B** | **4.3** | **B** |
| 1.3.1 | B | 2.3.1 | E | 3.3.1 | B | 4.3.1 | B |
| 1.3.2 | B | 2.3.2 | D | 3.3.2 | C | 4.3.2 | B |
| 1.3.3 | B | 2.3.3 | C | 3.3.3 | A | 4.3.3 | B |
| **1.4** | **B** | **2.4** | **C** | | | **4.4** | **B** |
| 1.4.1 | B | 2.4.1 | C | | | 4.4.1 | B |
| 1.4.2 | A | 2.4.2 | B | | | 4.4.2 | A |
| | | 2.4.3 | C | | | | |
| **1.5** | **B** | **2.5** | **B** | | | | |
| 1.5.1 | B | 2.5.1 | B | | | | |
| 1.5.2 | B | 2.5.2 | A | | | | |
| 1.5.3 | A | 2.5.3 | B | | | | |

**Table 3: ILLANGA**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **1** | **C** | **2** | **C** | **3** | **B** | **4** | **B** |
| **1.1** | **B** | **2.1** | **C** | **3.1** | **B** | **4.1** | **B** |
| 1.1.1 | B | 2.1.1 | A | 3.1.1 | B | 4.1.1 | A |
| 1.1.2 | B | 2.1.2 | A | 3.1.2 | B | 4.1.2 | B |
| 1.1.3 | C | 2.1.3 | E | 3.1.3 | C | 4.1.3 | B |
| 1.1.4 | B | 2.1.4 | A | 3.1.4 | C | 4.1.4 | A |
| 1.1.5 | B | | | | | | |
| 1.1.6 | B | | | | | | |
| 1.1.7 | A | | | | | | |
| **1.2** | **B** | **2.2** | **A** | **3.2** | **B** | **4.2** | **B** |
| 1.2.1 | B | 2.2.1 | A | 3.2.1 | B | 4.2.1 | B |
| 1.2.2 | B | 2.2.2 | A | 3.2.2 | A | 4.2.2 | B |
| 1.2.3 | B | | | 3.2.3 | A | 4.2.3 | A |
| 1.2.4 | A | | | | | | |
| 1.2.5 | A | | | | | | |
| **1.3** | **D** | **2.3** | **A** | **3.3** | **B** | **4.3** | **C** |
| 1.3.1 | B | 2.3.1 | A | 3.3.1 | B | 4.3.1 | A |
| 1.3.2 | D | 2.3.2 | A | 3.3.2 | A | 4.3.2 | B |
| 1.3.3 | D | 2.3.3 | A | 3.3.3 | A | 4.3.3 | D |
| **1.4** | **C** | **2.4** | **D** | | | **4.4** | **B** |
| 1.4.1 | B | 2.4.1 | B | | | 4.4.1 | A |
| 1.4.2 | D | 2.4.2 | E | | | 4.4.2 | B |
| | | 2.4.3 | A | | | | |
| **1.5** | **C** | **2.5** | **D** | | | | |
| 1.5.1 | E | 2.5.1 | A | | | | |
| 1.5.2 | C | 2.5.2 | A | | | | |
| 1.5.3 | B | 2.5.3 | E | | | | |

**Table 4: KALKAAR**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **1** | **C** | **2** | **C** | **3** | **D** | **4** | **C** |
| **1.1** | **C** | **2.1** | **C** | **3.1** | **C** | **4.1** | **C** |
| 1.1.1 | A | 2.1.1 | A | 3.1.1 | B | 4.1.1 | B |
| 1.1.2 | D | 2.1.2 | B | 3.1.2 | A | 4.1.2 | C |
| 1.1.3 | D | 2.1.3 | D | 3.1.3 | C | 4.1.3 | E |
| 1.1.4 | B | 2.1.4 | B | 3.1.4 | C | 4.1.4 | A |
| 1.1.5 | D | | | | | | |
| 1.1.6 | B | | | | | | |
| 1.1.7 | A | | | | | | |
| **1.2** | **B** | **2.2** | **B** | **3.2** | **E** | **4.2** | **B** |
| 1.2.1 | B | 2.2.1 | B | 3.2.1 | A | 4.2.1 | B |
| 1.2.2 | C | 2.2.2 | A | 3.2.2 | D | 4.2.2 | A |
| 1.2.3 | B | | | 3.2.3 | D | 4.2.3 | C |
| 1.2.4 | A | | | | | | |
| 1.2.5 | D | | | | | | |
| **1.3** | **C** | **2.3** | **B** | **3.3** | **C** | **4.3** | **C** |
| 1.3.1 | A | 2.3.1 | B | 3.3.1 | C | 4.3.1 | C |
| 1.3.2 | B | 2.3.2 | A | 3.3.2 | B | 4.3.2 | C |
| 1.3.3 | E | 2.3.3 | B | 3.3.3 | C | 4.3.3 | B |
| **1.4** | **B** | **2.4** | **D** | | | **4.4** | **C** |
| 1.4.1 | A | 2.4.1 | B | | | 4.4.1 | C |
| 1.4.2 | C | 2.4.2 | C | | | 4.4.2 | C |
| | | 2.4.3 | D | | | | |
| **1.5** | **B** | **2.5** | **C** | | | | |
| 1.5.1 | B | 2.5.1 | B | | | | |
| 1.5.2 | B | 2.5.2 | D | | | | |
| 1.5.3 | A | 2.5.3 | A | | | | |

**Table 5: PAULPITS**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **1** | **C** | **2** | **C** | **3** | **B** | **4** | **B** |
| **1.1** | **B** | **2.1** | **B** | **3.1** | **B** | **4.1** | **B** |
| 1.1.1 | B | 2.1.1 | B | 3.1.1 | A | 4.1.1 | B |
| 1.1.2 | B | 2.1.2 | A | 3.1.2 | A | 4.1.2 | B |
| 1.1.3 | B | 2.1.3 | C | 3.1.3 | B | 4.1.3 | B |
| 1.1.4 | B | 2.1.4 | B | 3.1.4 | B | 4.1.4 | A |
| 1.1.5 | B | | | | | | |
| 1.1.6 | B | | | | | | |
| 1.1.7 | A | | | | | | |
| **1.2** | **B** | **2.2** | **C** | **3.2** | **B** | **4.2** | **B** |
| 1.2.1 | B | 2.2.1 | D | 3.2.1 | B | 4.2.1 | B |
| 1.2.2 | B | 2.2.2 | B | 3.2.2 | A | 4.2.2 | B |
| 1.2.3 | A | | | 3.2.3 | B | 4.2.3 | A |
| 1.2.4 | C | | | | | | |
| 1.2.5 | A | | | | | | |
| **1.3** | **D** | **2.3** | **B** | **3.3** | **B** | **4.3** | **B** |
| 1.3.1 | C | 2.3.1 | C | 3.3.1 | B | 4.3.1 | B |
| 1.3.2 | C | 2.3.2 | B | 3.3.2 | B | 4.3.2 | A |
| 1.3.3 | F | 2.3.3 | A | 3.3.3 | A | 4.3.3 | B |
| **1.4** | **C** | **2.4** | **B** | | | **4.4** | **B** |
| 1.4.1 | B | 2.4.1 | C | | | 4.4.1 | B |
| 1.4.2 | C | 2.4.2 | A | | | 4.4.2 | A |
| | | 2.4.3 | A | | | | |
| **1.5** | **B** | **2.5** | **B** | | | | |
| 1.5.1 | D | 2.5.1 | A | | | | |
| 1.5.2 | B | 2.5.2 | B | | | | |
| 1.5.3 | A | 2.5.3 | B | | | | |

**Table 6: KOTULO TSATSI**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **1** | **C** | **2** | **C** | **3** | **C** | **4** | **B** |
| **1.1** | **C** | **2.1** | **B** | **3.1** | **B** | **4.1** | **D** |
| 1.1.1 | C | 2.1.1 | B | 3.1.1 | B | 4.1.1 | C |
| 1.1.2 | B | 2.1.2 | B | 3.1.2 | B | 4.1.2 | D |
| 1.1.3 | B | 2.1.3 | C | 3.1.3 | D | 4.1.3 | C |
| 1.1.4 | B | 2.1.4 | C | 3.1.4 | B | 4.1.4 | E |
| 1.1.5 | C | | | | | | |
| 1.1.6 | C | | | | | | |
| 1.1.7 | C | | | | | | |
| **1.2** | **C** | **2.2** | **C** | **3.2** | **C** | **4.2** | **C** |
| 1.2.1 | B | 2.2.1 | C | 3.2.1 | B | 4.2.1 | C |
| 1.2.2 | B | 2.2.2 | D | 3.2.2 | C | 4.2.2 | D |
| 1.2.3 | B | | | 3.2.3 | D | 4.2.3 | C |
| 1.2.4 | C | | | | | | |
| 1.2.5 | B | | | | | | |
| **1.3** | **D** | **2.3** | **B** | **3.3** | **C** | **4.3** | **B** |
| 1.3.1 | D | 2.3.1 | C | 3.3.1 | C | 4.3.1 | A |
| 1.3.2 | C | 2.3.2 | B | 3.3.2 | D | 4.3.2 | B |
| 1.3.3 | E | 2.3.3 | B | 3.3.3 | B | 4.3.3 | B |
| **1.4** | **C** | **2.4** | **C** | | | **4.4** | **B** |
| 1.4.1 | C | 2.4.1 | D | | | 4.4.1 | B |
| 1.4.2 | C | 2.4.2 | C | | | 4.4.2 | A |
| | | 2.4.3 | C | | | | |
| **1.5** | **B** | **2.5** | **B** | | | | |
| 1.5.1 | B | 2.5.1 | B | | | | |
| 1.5.2 | C | 2.5.2 | B | | | | |
| 1.5.3 | B | 2.5.3 | C | | | | |

## ANNEXURE 4- *Sustainability Principle Review Criteria Collation Sheet*

**Table 1: HUMANSRUS**

| **1 C** | **2 C** | **3 D** | **4 C** | **5 B** | **6 C** | **7 F** | **8 D** |
|---|---|---|---|---|---|---|---|
| **1.1 C** | **2.1 F** | **3.1 E** | **4.1 B** | **5.1 B** | **6.1 D** | **7.1 B** | **8.1 D** |
| 1.1.1 B | 2.1.1 F | 3.1.1 D | 4.1.1 B | 5.1.1 B | 6.1.1 F | 7.1.1 B | 8.1.1 A |
| 1.1.2 B | 2.1.2 F | 3.1.2 D | 4.1.2 B | 5.1.2 B | 6.1.2 C | 7.1.2 B | 8.1.2 F |
| 1.1.3 B | **2.2 B** | 3.1.3 D | 4.1.3 A | 5.1.3 A | **6.2 B** | **7.2 F** | **8.2 D** |
| 1.1.4 A | 2.2.1 B | 3.1.4 F | 4.1.4 D | **5.2 B** | 6.2.1 B | 7.2.1 F | 8.2.1 D |
| **1.2 B** | 2.2.2 B | 3.1.5 F | **4.2 B** | 5.2.1 B | 6.2.2 B | 7.2.2 F | |
| 1.2.1 A | | **3.2 C** | 4.2.1 B | 5.2.2 B | 6.2.3 A | 7.2.3 F | |
| 1.2.2 F | | 3.2.1 D | 4.2.2 B | 5.2.3 A | 6.2.4 B | 7.2.4 F | |
| 1.2.3 B | | 3.2.2 C | 4.2.3 A | 5.2.4 D | **6.3 B** | 7.2.5 A | |
| 1.2.4 A | | 3.2.3 C | **4.3 F** | 5.2.5 B | 6.3.1 B | 7.2.6 F | |
| 1.2.5 C | | 3.2.4 C | 4.3.1 F | | 6.3.2 B | | |
| 1.2.6 F | | | 4.3.2 F | | 6.3.3 C | | |
| **1.3 F** | | | 4.3.3 F | | | | |
| 1.3.1 F | | | | | | | |
| 1.3.2 F | | | | | | | |
| 1.3.3 C | | | | | | | |
| **1.4 B** | | | | | | | |
| 1.4.1 B | | | | | | | |
| 1.4.2 D | | | | | | | |
| 1.4.3 C | | | | | | | |
| 1.4.4 A | | | | | | | |
| 1.4.5 B | | | | | | | |
| 1.4.6 B | | | | | | | |
| 1.4.7 D | | | | | | | |
| 1.4.8 B | | | | | | | |
| 1.4.9 D | | | | | | | |
| 1.4.10 B | | | | | | | |

**Table 2: BRIGHT SOURCE**

| **1 D** | **2 D** | **3 D** | **4 C** | **5 B** | **6 D** | **7 C** | **8 D** |
|---|---|---|---|---|---|---|---|
| **1.1 B** | **2.1 F** | **3.1 F** | **4.1 C** | **5.1 B** | **6.1 F** | **7.1 C** | **8.1 B** |
| 1.1.1 B | 2.1.1 F | 3.1.1 F | 4.1.1 C | 5.1.1 C | 6.1.1 F | 7.1.1 B | 8.1.1 A |
| 1.1.2 B | 2.1.2 F | 3.1.2 F | 4.1.2 F | 5.1.2 B | 6.1.2 F | 7.1.2 F | 8.1.2 B |
| 1.1.3 C | **2.2 D** | 3.1.3 F | 4.1.3 - | 5.1.3 B | **6.2 B** | **7.2 C** | **8.2 C** |
| 1.1.4 A | 2.2.1 A | 3.1.4 F | 4.1.4 C | **5.2 B** | 6.2.1 B | 7.2.1 C | 8.2.1 C |
| **1.2 B** | 2.2.2 F | 3.1.5 F | **4.2 B** | 5.2.1 B | 6.2.2 B | 7.2.2 C | |
| 1.2.1 B | | **3.2 B** | 4.2.1 B | 5.2.2 B | 6.2.3 A | 7.2.3 - | |
| 1.2.2 B | | 3.2.1 B | 4.2.2 A | 5.2.3 B | 6.2.4 D | 7.2.4 F | |
| 1.2.3 B | | 3.2.2 B | 4.2.3 A | 5.2.4 C | **6.3 D** | 7.2.5 B | |
| 1.2.4 A | | 3.2.3 A | **4.3 F** | 5.2.5 C | 6.3.1 B | 7.2.6 B | |
| 1.2.5 A | | 3.2.4 A | 4.3.1 B | | 6.3.2 F | | |
| 1.2.6 C | | | 4.3.2 F | | 6.3.3 F | | |
| **1.3 D** | | | 4.3.3 F | | | | |
| 1.3.1 F | | | | | | | |
| 1.3.2 A | | | | | | | |
| 1.3.3 F | | | | | | | |
| **1.4 B** | | | | | | | |
| 1.4.1 B | | | | | | | |
| 1.4.2 B | | | | | | | |
| 1.4.3 A | | | | | | | |
| 1.4.4 B | | | | | | | |
| 1.4.5 B | | | | | | | |
| 1.4.6 B | | | | | | | |
| 1.4.7 B | | | | | | | |
| 1.4.8 B | | | | | | | |
| 1.4.9 B | | | | | | | |
| 1.4.10 B | | | | | | | |

**Table 3: ILLANGA**

| **1 B** | **2 D** | **3 D** | **4 C** | **5 C** | **6 D** | **7 C** | **8 C** |
|---|---|---|---|---|---|---|---|
| **1.1 B** | **2.1 F** | **3.1 E** | **4.1 D** | **5.1 C** | **6.1 E** | **7.1 A** | **8.1 D** |
| 1.1.1 B | 2.1.1 E | 3.1.1 E | 4.1.1 C | 5.1.1 C | 6.1.1 E | 7.1.1 A | 8.1.1 C |
| 1.1.2 B | 2.1.2 E | 3.1.2 E | 4.1.2 E | 5.1.2 D | 6.1.2 E | 7.1.2 - | 8.1.2 E |
| 1.1.3 A | **2.2 D** | 3.1.3 C | 4.1.3 C | 5.1.3 C | **6.2 E** | **7.2 E** | **8.2 C** |
| 1.1.4 A | 2.2.1 A | 3.1.4 E | 4.1.4 E | **5.2 B** | 6.2.1 E | 7.2.1 E | 8.2.1 C |
| **1.2 C** | 2.2.2 E | 3.1.5 A | **4.2 B** | 5.2.1 B | 6.2.2 E | 7.2.2 E | |
| 1.2.1 B | | **3.2 C** | 4.2.1 B | 5.2.2 B | 6.2.3 E | 7.2.3 - | |
| 1.2.2 B | | 3.2.1 E | 4.2.2 B | 5.2.3 A | 6.2.4 C | 7.2.4 - | |
| 1.2.3 B | | 3.2.2 B | 4.2.3 A | 5.2.4 B | **6.3 B** | 7.2.5 C | |
| 1.2.4 A | | 3.2.3 B | **4.3 E** | 5.2.5 A | 6.3.1 A | 7.2.6 E | |
| 1.2.5 A | | 3.2.4 A | 4.3.1 E | | 6.3.2 A | | |
| 1.2.6 A | | | 4.3.2 E | | 6.3.3 E | | |
| **1.3 D** | | | 4.3.3 E | | | | |
| 1.3.1 E | | | | | | | |
| 1.3.2 B | | | | | | | |
| 1.3.3 C | | | | | | | |
| **1.4 B** | | | | | | | |
| 1.4.1 A | | | | | | | |
| 1.4.2 B | | | | | | | |
| 1.4.3 A | | | | | | | |
| 1.4.4 B | | | | | | | |
| 1.4.5 B | | | | | | | |
| 1.4.6 B | | | | | | | |
| 1.4.7 B | | | | | | | |
| 1.4.8 D | | | | | | | |
| 1.4.9 C | | | | | | | |
| 1.4.10 B | | | | | | | |

**Table 4: KALKAAR**

| **1 D** | **2 D** | **3 D** | **4 D** | **5 B** | **6 C** | **7 D** | **8 E** |
|---|---|---|---|---|---|---|---|
| **1.1 C** | **2.1 F** | **3.1 E** | **4.1 D** | **5.1 C** | **6.1 D** | **7.1 B** | **8.1 E** |
| 1.1.1 B | 2.1.1 E | 3.1.1 E | 4.1.1 C | 5.1.1 B | 6.1.1 E | 7.1.1 B | 8.1.1 E |
| 1.1.2 B | 2.1.2 E | 3.1.2 E | 4.1.2 E | 5.1.2 C | 6.1.2 C | 7.1.2 A | 8.1.2 E |
| 1.1.3 B | **2.2 C** | 3.1.3 E | 4.1.3 - | 5.1.3 A | **6.2 C** | **7.2 E** | **8.2 C** |
| 1.1.4 A | 2.2.1 B | 3.1.4 A | 4.1.4 A | **5.2 A** | 6.2.1 C | 7.2.1 E | 8.2.1 C |
| **1.2 B** | 2.2.2 E | 3.1.5 E | **4.2 B** | 5.2.1 B | 6.2.2 C | 7.2.2 E | |
| 1.2.1 B | | **3.2 C** | 4.2.1 B | 5.2.2 B | 6.2.3 A | 7.2.3 - | |
| 1.2.2 B | | 3.2.1 C | 4.2.2 B | 5.2.3 E | 6.2.4 C | 7.2.4 E | |
| 1.2.3 E | | 3.2.2 C | 4.2.3 B | 5.2.4 A | **6.3 B** | 7.2.5 E | |
| 1.2.4 A | | 3.2.3 B | **4.3 E** | 5.2.5 A | 6.3.1 B | 7.2.6 E | |
| 1.2.5 E | | 3.2.4 A | 4.3.1 E | | 6.3.2 B | | |
| 1.2.6 E | | | 4.3.2 E | | 6.3.3 E | | |
| **1.3 D** | | | 4.3.3 E | | | | |
| 1.3.1 E | | | | | | | |
| 1.3.2 E | | | | | | | |
| 1.3.3 E | | | | | | | |
| **1.4 B** | | | | | | | |
| 1.4.1 A | | | | | | | |
| 1.4.2 B | | | | | | | |
| 1.4.3 B | | | | | | | |
| 1.4.4 B | | | | | | | |
| 1.4.5 B | | | | | | | |
| 1.4.6 B | | | | | | | |
| 1.4.7 B | | | | | | | |
| 1.4.8 B | | | | | | | |
| 1.4.9 B | | | | | | | |
| 1.4.10 A | | | | | | | |

**Table 5: PAULPITS**

| **1 B** | **2 B** | **3 D** | **4 C** | **5 B** | **6 A** | **7 D** | **8 D** |
|---|---|---|---|---|---|---|---|
| **1.1 C** | **2.1 D** | **3.1 E** | **4.1 C** | **5.1 B** | **6.1 D** | **7.1 B** | **8.1 E** |
| 1.1.1 B | 2.1.1 D | 3.1.1 E | 4.1.1 C | 5.1.1 B | 6.1.1 E | 7.1.1 B | 8.1.1 E |
| 1.1.2 B | 2.1.2 D | 3.1.2 A | 4.1.2 - | 5.1.2 C | 6.1.2 C | 7.1.2 E | 8.1.2 E |
| 1.1.3 B | **2.2 C** | 3.1.3 C | 4.1.3 E | 5.1.3 A | **6.2 A** | **7.2 E** | **8.2 B** |
| 1.1.4 E | 2.2.1 A | 3.1.4 E | 4.1.4 E | **5.2 A** | 6.2.1 A | 7.2.1 E | 8.2.1 B |
| **1.2 A** | 2.2.2 E | 3.1.5 E | **4.2 B** | 5.2.1 B | 6.2.2 B | 7.2.2 E | |
| 1.2.1 B | | **3.2 D** | 4.2.1 B | 5.2.2 B | 6.2.3 A | 7.2.3 - | |
| 1.2.2 B | | 3.2.1 E | 4.2.2 B | 5.2.3 E | 6.2.4 B | 7.2.4 E | |
| 1.2.3 B | | 3.2.2 E | 4.2.3 A | 5.2.4 A | **6.3 B** | 7.2.5 A | |
| 1.2.4 A | | 3.2.3 B | **4.3 E** | 5.2.5 A | 6.3.1 B | 7.2.6 E | |
| 1.2.5 A | | 3.2.4 C | 4.3.1 F | | 6.3.2 B | | |
| 1.2.6 A | | | 4.3.2 F | | 6.3.3 C | | |
| **1.3 B** | | | 4.3.3 F | | | | |
| 1.3.1 B | | | | | | | |
| 1.3.2 B | | | | | | | |
| 1.3.3 A | | | | | | | |
| **1.4 B** | | | | | | | |
| 1.4.1 B | | | | | | | |
| 1.4.2 B | | | | | | | |
| 1.4.3 B | | | | | | | |
| 1.4.4 D | | | | | | | |
| 1.4.5 B | | | | | | | |
| 1.4.6 B | | | | | | | |
| 1.4.7 B | | | | | | | |
| 1.4.8 B | | | | | | | |
| 1.4.9 B | | | | | | | |
| 1.4.10 B | | | | | | | |

**Table 6: KOTULO TSATSI**

| **1 C** | **2 C** | **3 D** | **4 C** | **5 B** | **6 C** | **7 F** | **8 D** |
|---|---|---|---|---|---|---|---|
| **1.1 B** | **2.1 D** | **3.1 D** | **4.1 C** | **5.1 C** | **6.1 D** | **7.1 C** | **8.1 D** |
| 1.1.1 B | 2.1.1 D | 3.1.1 D | 4.1.1 D | 5.1.1 E | 6.1.1 E | 7.1.1 D | 8.1.1 D |
| 1.1.2 B | 2.1.2 D | 3.1.2 D | 4.1.2 E | 5.1.2 D | 6.1.2 E | 7.1.2 A | 8.1.2 D |
| 1.1.3 B | **2.2 B** | 3.1.3 D | 4.1.3 - | 5.1.3 C | **6.2 A** | **7.2 E** | **8.2 D** |
| 1.1.4 E | 2.2.1 B | 3.1.4 D | 4.1.4 C | **5.2 B** | 6.2.1 B | 7.2.1 E | 8.2.1 D |
| **1.2 C** | 2.2.2 B | 3.1.5 D | **4.2 B** | 5.2.1 A | 6.2.2 D | 7.2.2 E | |
| 1.2.1 B | | **3.2 B** | 4.2.1 A | 5.2.2 C | 6.2.3 B | 7.2.3 - | |
| 1.2.2 B | | 3.2.1 C | 4.2.2 A | 5.2.3 D | 6.2.4 C | 7.2.4 E | |
| 1.2.3 B | | 3.2.2 B | 4.2.3 C | 5.2.4 B | **6.3 B** | 7.2.5 C | |
| 1.2.4 B | | 3.2.3 B | **4.3 E** | 5.2.5 A | 6.3.1 A | 7.2.6 C | |
| 1.2.5 C | | 3.2.4 B | 4.3.1 D | | 6.3.2 A | | |
| 1.2.6 C | | | 4.3.2 E | | 6.3.3 E | | |
| **1.3 B** | | | 4.3.3 E | | | | |
| 1.3.1 C | | | | | | | |
| 1.3.2 B | | | | | | | |
| 1.3.3 C | | | | | | | |
| **1.4 B** | | | | | | | |
| 1.4.1 A | | | | | | | |
| 1.4.2 B | | | | | | | |
| 1.4.3 A | | | | | | | |
| 1.4.4 D | | | | | | | |
| 1.4.5 B | | | | | | | |
| 1.4.6 B | | | | | | | |
| 1.4.7 C | | | | | | | |
| 1.4.8 B | | | | | | | |
| 1.4.9 B | | | | | | | |
| 1.4.10 A | | | | | | | |