

**REVIEW OF TWO SUSTAINABILITY  
LEARNING PROGRAMMES FOR  
INDUSTRIAL SETTINGS IN  
RELATION TO EMERGING  
GREEN LEARNING  
ASPECTS**

**Marba Visagle. Thesis for MEd Environmental Education. Rhodes University  
Graphic © Michael Mc Sweeney. Waves at Kalk Bay, South Africa, illustrate the effect of rising sea levels**

REVIEW OF TWO SUSTAINABILITY LEARNING  
PROGRAMMES FOR INDUSTRIAL SETTINGS IN  
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ASPECTS

Half-thesis submitted in partial fulfilment of the  
requirements for the degree of Master of Education  
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## ABSTRACT

Driven by the needs of growing populations, industrial and governing powers are successfully accelerating the rate of industrial consumption, production and employment as if the earth's resources are in unlimited supply. In contrast, a range of international sustainable development forums, inspired by visionary individuals, have made significant progress in creating awareness that the footprint of human activity is exceeding the earth's sink and source capacity; and educating people in government, workplaces and communities to slow down industrial consumption and clean up production.

Turning around conventional and short sighted 'business as usual' logic, and directing economies toward greener, long-term sustainability outcomes, still meet with resistance and hidden unsustainable agendas. The 'green economy' drive nevertheless since 2008 attracts financial and human resources and bold action in favour of more sustainable management of human-nature relations. The sustainable development movement for example advocates a 'triple bottom line' approach, holding that socially and ecologically responsible economic development would be sustainable. The sustainability movement has attained significant buy-in among governments and business communities. It forms the under-labouring philosophy of the programmes reviewed in this case study.

The thesis reviews social-economic events paving the way for a global green economy. Taking a leadership role in the sustainable development movement the United Nations (UN) and the Organisation for Economic Co-Operation and Development (OECD) concurred to respond to the 2008 world-wide economic meltdown with a two-pronged 'Green New Deal' (UNEP, 2008). The Green New Deal financial package helps restore multi-national economic growth, employment and markets while re-shaping economies to follow an ecologically and socially responsible growth trajectory. South Africa implements green economy principles as part of the 2010 The New Growth Path overarching policy framework, with an implementation strategy embedded in the 2011 National Development Plan (NDP) (RSA. The Presidency, 2010; 2011).

The New Growth Path emphasises that the transformation of South Africa's un-sustainable economic and educational legacy to a more sustainable future is not expected to follow a

smooth, linear process. The transition to a green economy is rather expected to be an event of “... noisy, healthy democracy” (RSA. The Presidency, 2010).

A green, low carbon economy particularly constitutes a pledge to slow down and turn the human induced climate change trajectory around. McKinsey (2009) argues that this pledge is attainable on a world-wide scale, as sufficient and suitable environmentally sound techniques and technologies are already in place. Attaining buy-in from business stakeholders toward re-thinking and amending an economy’s self-defying large environmental footprint (inclusive of carbon, water and waste footprints) however requires education starting with awareness-raising followed by educational programmes and official curricula aimed at implementation and continuous improvement of green practices in day to day ‘doings and beings’ (Sen, 1997). This study at implementation level reviews two green economy training programmes and their emergence in South Africa around this rationale.

The awareness generation and training programmes elected as case study examples are the ‘Resource Efficient and Cleaner Production’ (RECP) and ‘Industrial Energy Efficiency’ (IEE) programmes, of the hosting agency National Cleaner Production Centre of South Africa (NCPC-SA). The RECP and IEE teams reach out to decision makers, engineers and artisans at industrial workplaces and workplace related events to add green competences to their business-as-usual skill sets. Implementing green options in industry typically slows down industrial scale resource consumption, pollution, waste generation and green-house gas (GHG) emissions while optimising resource productivity and enterprise excellence. Optimised supply side systems allow industry to reduce energy and material intensity of products thus reducing cost and producing more with less. In transitioning to a ‘Green GDP’ economy South Africa is awakening to the reality that natural resources constitute the original, albeit limited feedstock for growth and employment. The RECP and IEE approach also contribute to reduction of industrial waste, waste-to-landfill, and energy and resource security.

Literature reviewed for this research provides evidence that the green economy’s triple bottom line philosophy is quantifiable thus manageable. A range of green economy management tools are emerging, including guidelines for carbon, water and environmental footprinting and the green-house gas abatement cost curve (see section 2.2.5) (McKinsey and Company, 2009). Transitioning from business as usual to ecologically sustainable industrial

sectors however requires visionary, educated leadership, willing and capable of introducing modern and more efficient techniques and technologies.

The boundaries of this half thesis embrace the globally and historically significant Tbilisi Declaration and other education and sustainable development agreements produced by United Nations and OECD mechanisms. Participating nations like South Africa incorporate the essence of these agreements into domestic policies and strategies, and align industries to remain competitive in international markets, which are increasingly enforcing green standards like ISO 14001 and ISO 50001.

The focus of this case study guided by inductive, abductive and retroductive inference is to understand how the two sustainability learning programmes for people in industrial workplaces, supported by the United Nations Industrial Development Organisation (UNIDO) and relevant donors, and overseen by the South African Department of Trade and Industry (**the dti**), relate to emerging green learning aspects. Producing a review of this nature requires a framework of laterally understanding emerging green learning aspects, for which I have reviewed green economy literature and also green learning and conventional education and training literature respectively. Themes emerging from the literature review informed an analytical instrument (questionnaire) in Phase One. In Phase Two the questionnaire was applied through nested case study methodology to show how the educational content and approaches of the RECP and IEE programmes relate to emerging green learning aspects and as such is suitable for mainstreaming in the national educational system. From an explicit educational perspective potential partners for collaboration include the Department of Higher Education and Training (DHET) the South African Qualifications Authority's (SAQA's) Quality Council for Trades and Occupations (QCTO) and the Sector Education and Training Authorities (SETAs) representing the training needs of the industrial workforce but affiliated to QCTO and SAQA. In the extended scenario the NCPC-SA as a **dti** programme recognises the Department of Environmental Affairs (DEA) as lead agency guiding implementation of South Africa's green economy, and specifically DEA's National Environmental Sector Skills Planning Forum (NESPF), a national leader in green skills development in South Africa, as conduit for productively mainstreaming relevant RECP and IEE content and approaches toward green skills development for the green economy.

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## KEY PHRASES

Applied competence; energy and resource efficiency; Energy Management System (EnMS); energy system optimisation (ESO); Environmental Sector Skills Plan (ESSP); green gross domestic product (green GDP); green learning; Industrial Energy Efficiency (IEE); job creation and retention; National Environmental Skills Planning Forum (NESPF); Quality Council for Trades and Occupations (QCTO); Resource Efficient Cleaner Production (RECP); sector skills plans (SSP); skills for the green economy; South African Education and Training Authorities (SETA); South African Qualifications Authority (SAQA); sustainability capacity building; tacit knowledge.

## LIST OF ACRONYMS

CSIR	Council for Scientific and Industrial Research	RECP	Resource-Efficient Cleaner Production
DANIDA	Danish International Development Agency	Rio	Rio Earth Conference held in Rio de Janeiro in 1992
DEA	Department of Environmental Affairs, South Africa	Rio+10	Tenth anniversary of the 1992 Rio Earth Conference, termed ‘World Summit on Sustainable Development (WSSD), held in Johannesburg (2002)
DEAT	Department of Environmental Affairs and Tourism, South Africa	Rio+20	Twentieth anniversary of the 1992 Rio Earth Conference, termed ‘Global Green Economy Conference’ held in Rio de Janeiro in 2012
DFID	UK Department for International Development	SAQA	South African Qualifications Authority
ELRC	Environmental Learning Research Centre, Rhodes University	SECO	Swiss State Secretariat for Economic Affairs
EnMS	Energy Management Standard	SETA	Sector Education and Training Authority
ESO	Energy System Optimisation	<b>The dti</b>	Department of Trade and Industry, South Africa (branded acronym)
ESSP	Environmental Sector Skills Plan for South Africa	TIPS	Trade and Industrial Policy and Strategy
GDP	Gross Domestic Product	UNEP	United Nations Environment Programme
GHG	Greenhouse gas (emissions)	UNESCO	United Nations Educational, Scientific and Cultural Organization
IEE	Industrial Energy Efficiency	UNIDO	United Nations Industrial Development Organization
IPAP	Industrial Policy Action Plan		
NBI	National Business Initiative		
NCPC-SA	National Cleaner Production Centre of South Africa		
NESPF	National Environmental Skills Planning Forum		
NQF	National Qualifications Framework		
QCTO	Qualifications Council for Trades and Occupations		

# CHAPTER ONE. OVERVIEW OF THE STUDY

*Chapter 1 provides an overview of the study, the study context, the research questions and the research methodology. It includes insight into how data was generated and analysed for the study. It also explains my motivation for undertaking the study and how I was positioned in relation to the selected case study and study topic.*

## 1.1 OVERVIEW OF THE CHAPTERS, RESEARCH CONTEXT AND RATIONALE

### 1.1.1. Overview of the chapters of the thesis

This study responds to the need for green skills development initiatives for the South African green economy. As captured by the research title the study involves a review of two green economy training programmes, namely the Industrial Energy Efficiency (IEE) and the Resource Efficient Cleaner Production (RECP) programmes in relation to emerging green learning aspects.

Initiatives to develop skills and knowledge to meet South Africa's green economy needs are currently emerging while the RECP and IEE programmes have been running for over ten and over four years respectively originating from concerns around human-nature relations. They therefore offer good cases to review in an emerging green economy where a wider range of training programmes are likely to be needed in future (see section 1.2.2).

**Chapter One** introduces the RECP, IEE and the host programme, the National Cleaner Production Centre of South Africa (NCPC-SA).

**Chapter Two** comprises a green economy and green learning literature review, providing theoretical lenses for looking into the content and green learning approaches used by the two programmes that form the empirical basis of the review; and concludes with the analytical instrument.

**Chapter Three** presents the programme descriptions and a nested case study of the two programmes. The analytical instrument provides a template for the study's inductive, abductive and retroductive inferences as part of nested case study methodology.

**Chapter Four** serves as platform where I display and interpret the key research findings and formulate conclusions and recommendations.

### **1.1.2. Context**

The programmes examined are the RECP and IEE, with hosting programme the National Cleaner Production Centre of South Africa (NCPC-SA). Institutional arrangements are outlined insofar as they clarify context, positioning, sources of funding, mandates, scope and magnitude of operations and implicitly reveal power relations.

Funding and therefore authority the programmes report to are as follows: While the NCPC-SA receives core funding from National Treasury through the Industrial Development Division of the national Department of Trade and Industry (**the dti**), additional funding for the IEE programme is provided by donor agencies through the United Nations Industrial Development Organisation (UNIDO). UNIDO and the NCPC-SA are recognised for co-implementing the IEE in industry (UNIDO, 2009). The South African Centre for Scientific and Industrial Research (CSIR), an agency of the Department of Science and Technology, acts as host agency, strategic and managerial advisor and administrative and legal entity for the NCPC-SA.

My interest in the NCPC-SA and its training programmes hinges on the kind of agency generally known as voluntary pursuance of non-egocentric goals to serve a bigger cause. In terms of National Treasury Directives ‘agency’ however refers to an organisation or enterprise that is established in terms of special legislation and with independent identity and administration. The latter definition is also applicable to UNIDO, a United Nations (UN) institution operating across the world in many countries (UNIDO, 2012), to the CSIR and to NCPC-SA.

### **1.1.3. My involvement in the National Cleaner Production Centre of South Africa**

As member of the Industrial Development team I was closely involved in the NCPC-SA’s establishment, strategic planning, reporting and annual budgetary process for around a decade while employed at **the dti**. I assumed general governing responsibilities, established co-operative working relations between **the dti** sector desks and NCPC-SA managers. In the course of annual planning, reporting and budgeting events I presented the cleaner production

business case in **dti** language to motivate for funding. My interest in examining the educational component of the programmes stems from experience as observer-participant in green learning events over these years of involvement. However, I am no longer employed by **the dti**, having retired from service before starting this study.

Establishment of the NCPC-SA, located at the Industrial Development Division of **the dti**, was announced at the 2002 Johannesburg World Summit on Sustainable Development (WSSD), in the spirit of the partnership theme of the event. Executing their commitment to financial and technical sustainability assistance to developing countries (UNEP, 1992; UNCED, 1993), the Swiss and Austrian governments through UNIDO partnered with **the dti** of South Africa to replicate the internationally tried and tested ‘National Cleaner Production Centre’ model promoted jointly by the United Nations Environmental Programme (UNEP) and UNIDO (ECOSOC, 2002). This study recognises NCPC-SA’s progress since establishment as a Cleaner Production awareness-raising pilot project, to its current status as **the dti’s** main industry greening programme. This is significant to the green economy transition as Hohnen (2012) views industry greening as the pivotal driver of green economy transition because, in an emerging economy like South Africa, industry represents the bulk of employment, investment, consumption and production (see section 1.1.4).

In national industrial context the RECP and IEE programmes have relatively small budgets, staff components and therefore reach. The value of the programmes is vested in their recognition of the role of industry in ‘Our Common Future’ as described by the World Commission on Environment and Development (WCED) (WCED, 1987) and since verified by economic leaders for example at the Rio Earth Summit (UNCED, 1993), Rio+10 (ECOSOC, 2002) and Rio+20 (UNEP, 2012b). Along with various other initiatives the international drivers which have influenced the two programmes under review (RECP and IEE), and the programmes themselves within their institutional framework, have been key to the spearheading of Cleaner Production (CP) in South African industrial enterprises. The multiplication effect resulting from this approach reaches across participating industry sectors, building green awareness, competences and a demand for green technologies. RECP and IEE have thus participated with other initiatives in preparing the way for industry greening as key component of South Africa’s green economy and ‘The Future We Want’ (UNIDO, 2009; UN, 2012).

#### **1.1.4. RECP and IEE historical context**

Soon after the 1992 Rio Earth Summit, UNEP and UNIDO in partnership developed the CP template as operational guide for a number of National Cleaner Production Centres (NCPs) in developing countries. UNIDO and UNEP in 2006 refined the cleaner production concept and termed the new template ‘Resource Efficient Cleaner Production’ (RECP). The Centres are intended to create sustainability awareness among industry sector leaders and managers, educate, train, assess cleaner production needs on an individual enterprise basis and encourage implementation of suggested sustainability solutions. On the premise that waste and pollution as result of in-efficient design, process and equipment constitute a preventable loss of resources, the RECP concept advocates efficient, non-wasteful energy and resource utilisation (UNIDO, 2012).

The IEE programme was initiated by means of a project proposal by UNIDO, inviting South African industry leaders, **the dti** and the Department of Energy to embark on an industrial energy efficiency improvement programme. Key attributes of the programme include a South African National Energy Efficiency Strategy (NEES) as legal baseline, the ISO 50001 energy management standard (EnMS) as backbone to the programme and technical and financial support from Swiss and UK agencies. At commencement of the IEE programme the NEES and ISO 50001 only existed in draft form and their finalisation was included as a deliverable of the programme (UNIDO, 2009).

#### **1.1.5. My interest in examining the programmes’ green learning alignment**

Sustainable access to nature-produced resources is imperative to sustaining life on earth. Productivist (Anderson, 2009) value systems however promote extraction of natural resources on an industrial scale, depleting the earth’s resource pool and the systems securing climate resilience. An example in case would be industrial-scale extraction and consumption of fossil-based minerals to the detriment of climate stability, water quality, energy security and overall health of the mega ecology (IPCC, 2014).

South Africa recently committed to green economy transitioning, punctuated by events like The New Growth Path policy framework (RSA. The Presidency, 2010), the Green Economy Conference (UNEP, 2011a; 2011b; Tshangela and Roman, 2012) and the National Development Plan (NDP) (RSA. The Presidency, 2011).

Incorporated into the green economy, the notion of sustainability directs social, environmental and economic policies to create less wasteful consumption and production patterns toward securing current and future generations' access to natural resources and a clean and healthy environment. My understanding is that green learning constitutes a major element of the sustainability challenge. Availing citizens, including people in workplaces, to quality green learning opportunities has the potential to provide individuals with the freedom and confidence to challenge un-sustainable productivist and consumerist behaviour as if long-horizon access to resources such as potable water, nourishing food and a human-friendly climate actually matters. Environmentally educated citizens clearly understand how actions taken or neglected today, matter now but even more in the long term (UNCED, 1993; RSA, 1996). Drawing on Lotz-Sisitka, Ramsurup, Gumede, Togo and Rosenberg (2012) the meaning of 'green learning' in this study comprises how education and training programmes oriented towards green skills development are set up and mediated in green economy and social learning context (see section 2.1).

Drawing on Eisner's (1994) educational imagination model, green economy discourses appear to be **explicit** about environmental risks, green-house gas reduction goals, and the intellectual capacity of humans to direct economic development toward more sustainable outcomes, *inter alia* by means of new technologies and reflexive approaches to consumption and production. **Implicit** systemic interrelations between energy generation, use and security on the one hand and climate resilience on the other, interwoven with human settlement and food security and both the access to and integrity of water and other resources is recognised. An interactive international system of appropriate reflexive approaches to sustainable management of these complex interrelations are however only beginning to emerge and remains largely implicit. The **null or silent green economy** discourse includes vast uncertainties around cost and benefit, new definitions of winners and losers and how power relations, for example around access to employment and resources, might play out.

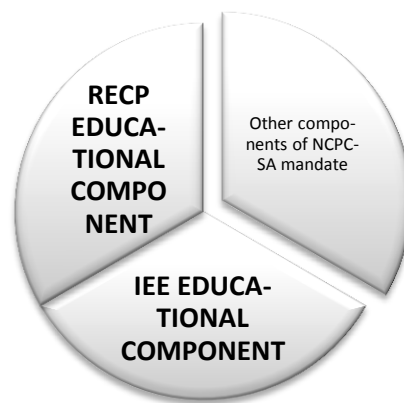
The interest of this research is the educational component of the NCPC-SA programmes and its relation to other emerging green learning aspects. The educational imagination model suggests that the green learning context may be more complex than which is noted at face value in programmes such as the RECP and IEE.

As is often the case with workplace-oriented training programmes, the teaching component of the RECP is not clearly defined by means of a curriculum or similar statement. The IEE

programme however explicitly offers learning events in the form of lectures, in-course tasks, demonstrations, and implementation, captured in a curriculum statement for each respective course. The estimated magnitude of the education and training component might be placed in context as illustrated below in Figure 1.1.

The mandate of the NCPC-SA extends beyond education and training and for example includes hosting of special events and provisioning of practical and technical support to industry. This study is however focused on examining the educational component of the programmes in relation to emerging aspects of green skills development (UNIDO, 2009; see section 2.2).

**Figure 1.1. Illustration of educational component of the NCPC-SA mandate**

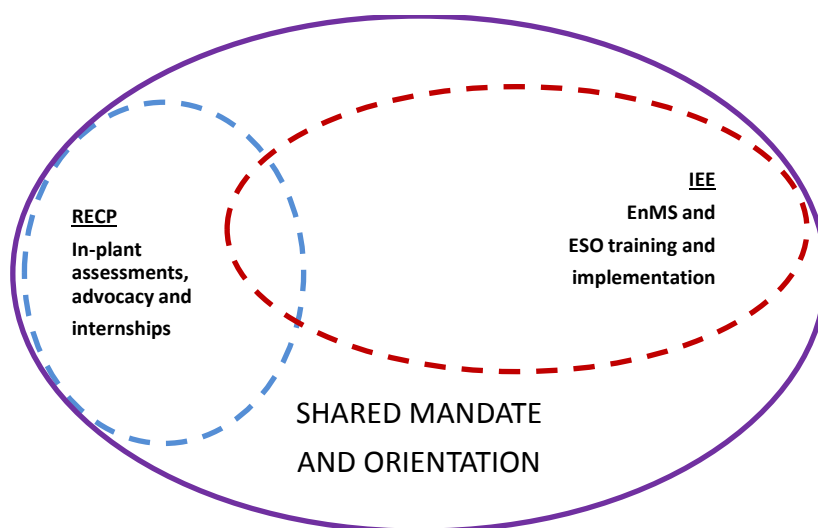


To this end, I utilised emerging green economy literature and policies and associated green learning principles and approaches to inform the contents of an analytical instrument (questionnaire) for conducting the review of the two NCPC-SA programmes. This instrument was used to interpret the two programmes in what I have termed a nested (combined) case study. This approach represents my interpretation of the building blocks of sustainability learning as green economy transition catalyst (UNCED, 1993; Fien, Maclean and Park (Eds), 2009; Hohnen, 2012). The questionnaire provides an instrument through which I could examine the programmes against what is said about the green economy transition, social learning theory and praxis, and about green learning. A key part of this thesis was therefore to produce the analytical instrument, as no such instrument was available to me prior to the study. As there is a general dearth of analytical tools for underpinning research into green learning and how it relates to green economy thinking and praxis, or to

educational thinking and praxis, the questionnaire is designed to be generalizable in the event of follow-up and further research.

Interesting too for the ongoing application of the research findings in the context of the NCPC-SA, is the fact that both programmes are implemented under the NCPC-SA mandate. Analysis of the programmes in green learning context may therefore help to facilitate an understanding of the mutual benefits and alignment of orientation of the two programmes (see figure 1.2).

**Figure 1.2. Merging of the RECP and IEE programmes within the NCPC-SA**



I declare subjectivity in electing to focus on a case study (the NCPC-SA's two training programmes as sub-cases or nested cases) that I am familiar with. I also declare subjectivity in relation to the sustainability values I believe in. I have, however, sought to manage the preference of examining familiar examples by means of an open minded and rigorous approach to research and by maintaining professionalism in all interactions with the data, management and staff of the example cases. Guided by Maxwell (2008) I have made use of respondent validation and member checks to glean feedback with the aim of ruling out misinterpretations. The effect of subjectivity is further minimised by self-reflectiveness about researcher 'bias' and admitting, accepting, understanding and balancing the inevitable effects of the research process and researcher on setting and/or participants (Maxwell, 2008). In this sense I have sought to be reflexive in the research process.

### **1.1.6. Research rationale**

There is no doubt in international policy framings and literature that current un-sustainable industrial practice needs mediation (UNCED, 1993, ECOSOC, 2002, UNEP, 2012, Elliot, 2007, DEA, 2009). In all discussions and discourses around sustaining the earth as host for human existence it clearly transpires that new understandings of human-nature relations, actioned by means of innovative, reflexive and applied green competences, need to replace productivist business-as-usual practices. The paragraphs below deliberate the industry greening measures disseminated to industrial enterprises by means of the RECP and IEE programmes' training and educational interventions.

Sustainability forums (UNCED, 1993; ECOSOC, 2002; UN, 2012), green economy authors (Elliot, 2007) and policy documents such as the Environmental Sector Skills Plan (ESSP) developed by the Department of Environmental Affairs' (DEA) National Environmental Skills Planning Forum (NESPF) (RSA. DEA, 2009), unanimously confirm that transition to a low carbon green economy requires integrated educational intervention across the economy.

Sustainability education requires deconstruction and reconstruction of conventional educational practice in order to incorporate equal consideration of economic, ecological and social realities in education (Fien, Goldney and Murphy, 2009). Basic and higher training and education institutions are expected to feed industry with new green-skilled generations of decision makers and workers in due time. Generating timeous and adequate competences for the industry greening difference required as if the planet and its people really mattered, however calls for immediate and direct educational intervention in industrial workplaces (Fien et al., 2009).

In the South African context, this also requires engagement with the wider system of education and training, or the National Qualifications Framework (NQF) as argued by Lotz-Sisitka et al., (2012), but there is as yet little work focussing on moving the green economy-green learning interface forward.

Text box 1.1 below summarises the research rationale.

### **Text box 1.1. Research rationale**

**A variety of green learning aspects are emerging, re-shaping workplace education and training to meet green economy objectives (RSA. DEA, 2010b; 2011; SAQA, n.d).**

**The research rationale is to reveal valuable content and approaches of the RECP and IEE programmes that relate to emerging green learning aspects and, in conclusion, to depict how the programmes' content and approaches are suitable for mainstreaming into the NQF system.**

## **1.2 HISTORICAL CONTEXT OF THE GREEN ECONOMY**

### **1.2.1. Events paving the way for a global green economy**

The international context of this research is the global green economy initially introduced by Pearce (Pearce, Markandya and Barbier (Eds), 1989) and proposed in updated form by UNEP as the 'Green New Deal' (UNEP, 2008) to simultaneously lift economies out of a looming economic depression and set development on a more sustainable trajectory. The emergence of the green economy is substantiated by other literature resources inclusive of Cartwright (2010), Nhamo, Shava and Togo (2011) and AtKisson (2012) (see section 2.1.1).

Events like the establishment in 1961 of the World Wildlife Fund (WWF) (now World Wide Fund for Nature) and the publication by Rachel Carson of "Silent Spring", (1962) followed by the United Nations (UN) Stockholm Convention on the Human Environment (UNEP, 1972) and the Tbilisi Conference on Environmental Education (UNESCO and UNEP, 1977) culminated in the Brundtland Commission's ground-breaking report, "Our Common Future" (Comune di Rovereto, 1987). A visionary paper "Blueprint for a Green Economy" (Pearce, Markandya and Barbier (Eds), 1989) further contributed to the critical mass of research that inspired the United Nations (UN) series of World Summits on Environment and Development, commencing with the 1992 Rio Earth Summit and its declaration termed 'Agenda 21'.

Rio (1992) is recognised as the occasion that marks the advent on a global scale of the 'environmental awareness' movement with a combined focus on environmental and developmental concerns. The Rio+10 summit (2002) confirmed the relationship between environment and development through the Johannesburg Implementation Plan, and most recently the Rio+20 (2012) conference focussed in more depth on the Green Economy and its potential for bringing environment and development goals closer together (UNCED, 1993; ECOSOC, 2002; UN, 2012). While this has been the case, there are many different ways of interpreting the relationship between environment and development as represented in these and other related policy discourses.

Sanctions were lifted and the South African democratic government became signatory to Agenda 21 in 1996, a few years after the 1992 Rio Earth Summit. This commitment resulted in incorporation of the principle of sustainable development into the new South African

Constitution (RSA, 1996). Johan Hattingh (1999) calls for reorienting the dualisms that separate humans and nature. He appreciates apparent tensions between the diversity of trends, philosophical perspectives and debates as virtual spaces in which new and stronger environmental values emerge. Head (2000) advocates rethinking cultural landscapes and human-nature interaction as basis for better ways of managing the earth.

Showing further commitment to the goals of sustainable development, South Africa hosted the 2002 World Summit on Sustainable Development, also known as Rio+10. The summit declaration, entitled 'Johannesburg Plan of Implementation', encourages developing nations to form partnerships toward achieving 'triple bottom line' sustainability, also expressed as 'people, planet, prosperity' partnerships (ECOSOC, 2002; see section 1.1.2). At the 2012 Rio+20 Summit participating nations in principle committed to implement a global green economy (UN, 2012).

The United Nations Framework Convention on Climate Change (UNFCCC) appointed the Intergovernmental Panel on Climate Change (IPCC) with a mandate to research, monitor and report regularly on damage to climatic systems also known as 'climate change' and 'global warming' caused by CO<sub>2</sub> and related emissions. IPCC reports also suggest mitigation measures and reports on implementation thereof. The IPCC's Fourth and Fifth Review Reports unequivocally link the alarming current global warming phenomena to human activity like industrial consumption and production. A range of security and life-threatening risks is associated with global warming (IPCC, 2007; IPCC 2014). The need to mitigate and minimise green-house gas emissions has given greater impetus to the 'low-carbon' element of the green economy, and in 2011 South Africa produced a 'National Climate Change Response White Paper' that contains the following statement:

The climate change response will attempt to reduce the impact of job losses and promote job creation during the shift towards the new green economy. The NGP is a clear policy signal of the intention to develop South Africa's economy in a manner that harnesses our natural resources whilst developing and expanding less carbon-intensive sectors towards a 'greener' economy (RSA, 2011b, p. 38).

However, there is also debate about what constitutes a 'greener' economy. In the statement above, the South African government uses the term 'greener' economy, without defining its full meaning, and this is giving rise to debate at a national level (Death, 2014). This debate reflects international deliberation on the meaning of green economy. AtKisson (2012) outlines green growth indices and use them to position respective economies on a scale of

progressive green growth frameworks. The frameworks range from mainstream ‘Growth-as-Usual’ to radical ‘De-Growth’, for which the indicator is ‘Gross National Happiness’, a concept described in concrete and measurable terms. South Africa’s NDP expresses economic growth targets in terms of Gross Domestic Product (GDP). This signifies that the green economy transition South Africa is in its fledgling stages and may be categorised as an ‘Emerging Green GDP Economy’ emerging from ‘growth-as-usual’ to a Green GDP, with scope for further greening (see section 2.1.2). Death’s (2014) analysis of the emergence of the South African Green Economy holds a similar interpretation. In comparison to AtKisson’s ‘gross national happiness’ objective, Death however argues towards a green economy that underpins social justice principles.

UNEP in partnership with the International Labour Organisation (ILO), International Organisation of Employers (IOE) and the International Trade Union Confederation (ITUC) researched the green-job creation potential of a world-wide green economy. Noting that there are ‘shades’ of green and that green jobs will evolve over time, the authors define green jobs as:

... work in agricultural, manufacturing, research and development (R&D), administrative and service activities that contribute substantially to preserving or restoring environmental quality. Specifically, but not exclusively, this includes jobs that help to protect ecosystems and biodiversity; **reduce energy, materials, and water consumption through high efficiency strategies; decarbonize the economy; and minimize or altogether avoid generation of all forms of waste and pollution** (UNEP/ILO/IOE/ITUC, 2008, p 24, my emphasis).

From a conceptual perspective the green transition affects employment in four ways:

- i. In some cases, additional jobs will be created - as in the manufacturing of pollution-control devices added to existing production equipment;
- ii. Some employment will be substituted - as in shifting from fossil fuels to renewables, or from truck manufacturing to rail car manufacturing, or from land filling and waste incineration to recycling;
- iii. Thirdly, certain jobs may be eliminated without direct replacement for example discontinuation of production of excessive packaging materials; and
- iv. Fourthly it would appear that many existing jobs (especially such as plumbers, electricians, metal workers and construction workers) will simply be transformed

and redefined, as day-to-day skill sets, work methods and profiles are greened (UNEP/ILO/IOE/ITUC, 2008, p.25).

This scenario justifies openness to workforce participation in green economy strategy formulation and implementation.

### **1.2.2. South Africa's green economy context**

As indicated above, South Africa incorporated principles of sustainable development into the 1996 Constitution in its Bill of Rights (see section 1.2.1). The National Water Act (RSA, 1998a), National Environmental Management Act (NEMA) (RSA, 1998b), the National Strategy for Sustainable Development (NSSD) (RSA.DEA, 2007) and most recently the National Climate Change Response White Paper (RSA 2011) referred to above, followed on this in-principle commitment to sustainability.

South Africa's New Growth Path (RSA, The Presidency, 2010; see section 2.1.2) introduced a systemic green economy comprising a framework of policies, strategies and policies under construction inclusive of the

- i. National Water Act (RSA, 1998a);
- ii. National Environmental Management Act (NEMA) (RSA, 1998b) and a number of subsidiary NEMA acts and regulations;
- iii. National Climate Change Response Strategy for South Africa (RSA. DEAT, 2004);
- iv. National Strategy for Sustainable Development and Action Plan (NSSD) (RSA, 2007);
- v. Innovation Towards a Knowledge-based Economy: Ten-Year Plan for South Africa 2008 –2018 (RSA, 2008);
- vi. Medium Term Strategic Framework (MTSF) 2009-2014, inclusive of Objective 9: Sustainable Use of Resources (RSA. The Presidency, 2009);
- vii. Green Fund (RSA, 2013);
- viii. South African Green Economy Modelling Report (UNEP, 2013);
- ix. Discussion Document on Carbon Tax (Donnelly, 2014);
- x. National Development Plan -Vision 2030 (NDP) (RSA. The Presidency, 2011);
- xi. Industrial Policy Action Plan (IPAP and IPAP2) (RSA. **The dti**, 2010; 2011); and
- xii. National Climate Change Response White Paper (RSA 2011).

The green economy drive also includes a number of government-labour-private sector Accords, for example the Green Economy and National Skills Accords (RSA. The Presidency, 2011), representing a re-think of mandates, powers and responsibilities with respect to green employment and workplace oriented green skills development. The Accords hold potential for new green jobs, which need to resonate in education and training strategies and actions toward generating and supplying green skills required for the green economy transition.

## 1.3 LEARNING CONTEXT

### 1.3.1. Environmental education context

The 1977 Tbilisi Declaration on Environmental Education is credited as being the first international policy statement on environmental education and training. It emphasises both **learning about the environment and learning from the environment**, and sets out a set of internationally agreed upon principles to guide environmental education internationally. One of the principles for environmental education captured in the Tbilisi Declaration requires that "Special attention should be paid to understanding the complex relations between socio-economic development and the improvement of the environment" (UNESCO and UNEP, 1977).

The 1992 Rio Earth Conference's Agenda 21 recognises the Tbilisi Declaration on Environmental Education (ibid) as particularly significant to sustainable development. Chapter 36 of Agenda 21 calls on the industrialised international community to establish mechanisms for environmental education in developing countries. In the spirit of Tbilisi, Agenda 21 recommends learning **from the environment** (understanding **how** the ecology as a comprehensive system sustains life on earth) to shape education **about the environment** and adds the important notion of **education for social and environmental sustainability**. With this approach Agenda 21 foregrounds the social and environmental responsibilities of economies, giving substance to the rapidly growing sustainability movement, which in less than two decades evolved to become the green economy movement. The green economy *inter alia* requires critical changes in the approach to policy making and implementation (UNEP, 1992; UNCED, 1993; see section 1.2.1).

The obligation to strengthen national capacities is shared by all countries. Drawing on Agenda 21, this study views sustainability capacity building as a continuous process of enhancing the ability of citizens to evaluate and address crucial policy choices relating to development options and modes of implementation. Sustainability capacity building implies technical and financial assistance that includes education and training towards an understanding of how needs as perceived by the people of the country concerned might be met within environmental potentials and limits.

Agenda 21 emphasises the critical role of education in sustainability capacity building:

**Education**, including formal education, public awareness and **training** should be recognised as a process by which human beings and societies can reach their fullest potential. **Education** is critical for promoting sustainable development and improving the capacity of the people to address environment and development issues (UNCED. 1993, chapter 36, par 3, my emphasis).

Rio (1992) participants through Agenda 21 explain that the ability of a country to take charge of crucial sustainability challenges to a large extent hinges on the capacity of its people and its institutions as well as by its ecological and geographical conditions. Specifically, capacity-building encompasses the country's human, scientific, technological, organisational, institutional and resource capabilities (GDRC, 2012).

Specifically, capacity-building encompasses the country's human, scientific, technological, organisational and institutional and resource capabilities. A fundamental goal of capacity-building is to enhance the ability to evaluate and address the crucial questions related to policy choices and modes of implementation among development options, based on an understanding of environmental potentials and limits and of needs as perceived by the people of the country concerned (UNCED. 1993, chapter 37, par 1).

The Tbilisi Declaration and Agenda 21 call for environmental education and training as complimentary streams of teaching, firstly to bring understanding why sustainability is important and secondly to develop skills toward minimising environmental impact, restoring damaged ecosystems and sustaining the ecology and economy in a symbiotic relationship. Jickling (1991) and Jickling and Wals (2008), substantiate this principle and caution that education *about* the environment should not be superseded by education *for* the environment. Concoran (2010) on the other hand argues that education *for* the environment, evolving as 'training to develop green or sustainability skills' is equally important as it is crucial to human life on the planet.

The Rio+10 Johannesburg Plan of Implementation (ECOSOC, 2002; see section 2.1.1) in chapters III, IX and X encourages change-oriented capacity building, education, training and knowledge transfer by means of sustainability projects and partnerships. The Rio+20 declaration termed ‘The Future we Want’ (UN, 2012) reconfirmed education as imperative to the green economy transition. In South African National Qualifications Act context, Blom (2012) affirms that training and education in general are mutually supportive in learners’ progression along the qualifications ladder and should therefore not be dichotomised.

Green economy transitioning and training are dependent on structural changes. Venturing into modern, greener practices and technologies with the aim of efficiency improvements implies re-thinking and re-design of products, production plants and processes. In addition, investment in structural and institutional changes is equally important.

A competent workforce equipped with tacit knowledge is required to implement efficiency and system optimisation measures and to handle unintended distortions and other consequences of sustainability changes in a way that prevents production losses (Kahn, 2009). Obstacles to the transition to a green economy and green learning system however fail to transpire clearly at policy and ideological levels. For example, Kahn (ibid) argues that chief executive officers (CEOs) lacking confidence in workers’ tacit knowledge of modern practices might tend to hold on to ‘business as usual’ albeit inefficient practices. It is in this regard that UNEP/ILO/IOE/ITUC (2008) argue for up-skilling programmes for production teams and providers of energy services in order to add green competences to conventional skill sets, as these may go a long way in overcoming management’s low confidence in the workforce’s capacity to take charge of green practices (UNEP/ILO/IOE/ITUC, 2008). The relationship between training, and structural aspects of change in the form of new green and clean technologies, implies also a focus on the education and training of those in the workforce, which in turn implies an understanding of the centrality of tacit knowledge and the learning of green practices (Gamble, 2006; see sections 2.2.2; 2,2,3).

The value of programmes directed at upskilling of people in workplaces indicates the importance of the two training programmes under review in this study.

### **1.3.2. Social learning context**

South Africa’s first democratic government adopted the White Paper on Education and Training (RSA, 1995a), by which the South African Qualifications Authority (SAQA) was

established with the responsibility of developing and implementing the National Qualifications Framework (NQF) toward transforming the South African educational system. A particular SAQA focus is on integrating education and training, which were dichotomised by previous governments. The objective of enhancing skills development is a core issue for ongoing national policy, and the 2009-2014 Medium Term Strategic Framework - Objective 9: Sustainable Use of Resources (RSA. The Presidency, 2009) called for a balanced education over the broad spectrum of learners, inclusive of engineering and artisanal education. The National Development Plan (NDP) (RSA. The Presidency 2011) also emphasises the importance of education, training and skills development for South Africa's future sustainable development. As suggested by Lotz-Sisitka et al. (2012), creating a 'green economy learning system' as envisaged by the NDP requires an adequate collection of "... pro-active programmes, system elements and skills development processes ..." (Lotz-Sisitka et al, 2012, p. 23).

The green skills development challenge is being taken up at different levels, for example by business schools of higher education institutions. Christelle Weybrecht (2010) examines management perspectives on sustainability in her book *The Sustainable MBA. The Manager's Guide to Green Business*. Rhodes Business School (2012) in turn published *Leadership for Sustainability*. An equally important human capital resource to be empowered with green skills is the artisanal workforce, also known as the Technical Vocational Education and Training (TVET) occupations. The book, *Work, learning and sustainable development: Opportunities and challenges* (Fien, Maclean and Park (Eds.) 2009) with the 2005 Bonn Declaration as baseline, is introduced as:

... the first that provides a comprehensive overview of the way education systems and institutions in a wide range of countries have responded to the call for an integration of learning for work, citizenship and sustainability ... Discussions at both the Seoul and Bonn conferences led to the conclusion that a new paradigm of both development and technical and vocational education and training was needed (Maclean, 2009, p.iii).

Educational institutions for artisanal occupations, historically known as 'technical' or 'industrial' colleges, tend to foster 'productivist' educational content and approaches, narrowly focused on sector specific technical training for production maximisation (Anderson, 2009). A narrow productivist orientation would seem to contradict the NQF Act and the Human Capital Development Strategy for the Environmental Sector 2009-2014 (RSA, DEA, 2009) which both emphasise a stronger systemic approach to integrating

environmental education and training into the national system of education and skills development in South Africa. Quality technical education and training would also need to be more holistic, cultivating students' understanding of ecosystems, values, new practices and technologies in addition to teaching specific green skills for cleaner production, as these all underpin the transition to a green economy. By implication, quality green workplace training provides the workforce as a whole, but specifically production engineers and artisanal learners, with competences to appreciate and sustain access to finite resources (see section 2.2.3).

A range of donor-supported agencies regularly engage in sustainability capacity-building initiatives in South Africa. NCPC-SA's sustainability learning programmes enjoy financial and technical input from foreign development agencies through UNEP and UNIDO as noted in section 1.1.2. above. The donor agencies also function as conduits of sustainability knowledge and skills.

### 1.3.3. Research Questions

For case study purposes the title: Review of two sustainability learning programmes for industrial settings in relation to emerging green learning aspects is translated to the main question:

**“How do the RECP and IEE programmes relate to emerging green learning aspects (or not)?”**

The main question is broken down into four researchable questions.

- Research question 1-(RQ01): *Which* green economy and green learning aspects are relevant to the RECP and IEE programmes? RQ01 informs an analytical instrument comprising three categorised questions derived from the respective green economy and green learning literature reviews.
- Research question 2 - (RQ02): *How* do the IEE and RECP programmes relate to green economy policies (or not)?
- Research question 3 - (RQ03): *How* do the IEE and RECP programmes relate to social learning aspects (or not)?
- Research question 4 - (RQ04): *How* do the IEE and RECP programmes relate to emerging green learning aspects (or not)?

Findings are derived by deductively and abductively examining descriptive programme data, guided by RQ02, RQ03 and RQ04.

## 1.4 METHODOLOGY

### 1.4.1 Theoretical framework

This study is based on an understanding of social learning theory as underpinned by, and informed by Critical Realism, which explains that social learning processes emerge from generative mechanisms that shape social interactions and agency for change (Danermark, Ekström, Jakobsen and Karlsson, 2002; Wals, 2007; O'Regan, 2011). The study is also based on an understanding that green learning aspects as understood with social learning theory and the under-labouring of critical realism are emergent from social contexts and generative mechanisms that operate at a structural level. For example, the emergence of the green economy is related to significant problems of environmental degradation, the generative mechanisms of this environmental degradation are located in the structure of the modern industrial economy, and this problem is driving attempts to re-orient and change the functioning of the economy. This in turn shapes social interactions, social learning and green learning aspects as outlined and identified in this study (see section 1.1.5).

The social learning principle of life-long (career-long) learning is for example evident in mechanisms that emerge within this wider societal re-orientation and transitioning process and which influence green learning mechanisms such as conformity to the environmental and energy management standards ISO 14001 and ISO 50001. These quality management standards have been framed to shape the emergence of a green and energy efficient industrial sector, and these inspire the notion of a continuously upward spiral of green learning and improvement.

It is necessary to introduce some of the basic tenets of critical realism here to explain the way in which generative mechanisms at the level of the real (such as environmental degradation, poverty and transformation imperatives in developing countries, available technology etc.) influence events (such as the signing of Agenda 21 by the South African government, the development of sustainable development policy, the signing of a Green Economy Accord), and social-interactive experiences of these (such as learning processes and methods in the RECP and IEE programmes of the NCPC-SA). Bhaskar (1998) suggests that it is difficult to attribute causality especially when “causal laws are not the pattern of events that enable us to identify them” (p. 33). To explain causality, Bhaskar suggests that there is a need for “... a non-anthropocentric ontology of structures, generative mechanisms and active things” (ibid).

He suggests further that generative mechanisms are independent of the events that they may or may not generate, and that they may remain unrealized. An example may be the generative mechanism of environmental systems and how they react to human intervention (e.g. too much CO<sub>2</sub> in the atmosphere). Such a mechanism may or may not give rise to events that will lead to a green economy. He also states that generative mechanisms cannot be predicted, as they operate in open systems, and they can therefore only retroductively or abductively be identified (see below). We cannot say therefore that the generative mechanism of environmental systems functioning will lead to green economy development and green learning; this depends on a range of other interacting mechanisms, for example political will, degradation practices, or technology availability. He says that “it is only under closed conditions that there will be a one-to-one relationship between the causal law and the sequence of events” (p. 34). As such Bhaskar (1998) argues:

... there is a distinction between the *real* structures and mechanisms of the world and the *actual* patterns of events that they generate ... The world consists of mechanisms not events. Such mechanisms combine to generate the flux of phenomena that constitute the actual states and happenings of the world ... knowledge of mechanisms depends on a rare blending of intellectual, practico-technical and perceptual skills (p. 34; 35).

By developing this ontological frame for interpreting human experiences, Bhaskar suggests further that “a sequence of events may provide empirical *grounds* for the hypothesis of the existence of the mechanism” (p. 36), but that this may not always be the case as generative mechanisms endure even when they are inactive. He therefore puts forward an argument that the “causal structures and generative mechanisms of nature [e.g. earth systems and how they function] must exist and act independently of the conditions that allow men to access them, so that they must be assumed to be structured and intransitive” (p. 41).

Structures and mechanisms are real and distinct from the patterns of events they generate; just as events are real and distinct from the experiences in which they are apprehended. Mechanisms, events and experiences thus constitute three overlapping domains of reality, viz. the domains of the *real*, the *actual*, and the *empirical* (Bhaskar, 1998, p. 41, emphasis original).

Bhaskar (1998, 41) provides this diagram (Table 1.1) to make the relationships between the real, actual and empirical clearer.

**Table 1.1. The real, actual and empirical domains and their relationship to mechanisms, events and experiences in critical realist research (Bhaskar, 1998, p. 41).**

	Domain of Real	Domain of Actual	Domain of Empirical
Mechanisms (e.g. Earth System Functioning)	□		
Events (e.g. Green Economy Accord)	□	□	
Experiences (e.g. experience in IEE or RECP training)	□	□	□

For this study, it is therefore important to see that there are underlying generative mechanisms that shape the emergence of events leading to the Green Economy’s emergence, and that these are experienced in and via various training programmes in different ways, since these take place in open systems. As indicated above, Green Economy interpretations also differ, but the fact that these are emerging across the planet indicates that there are underlying generative mechanisms that are shaping the emergence of the Green Economy approaches and events, and how they are experienced in various social learning situations and contexts.

To interpret the educational *experiences and how the educational programmes are structured and play out* in the context of the two programmes, I also needed to draw on learning theory. Curriculum content such as workshops and demonstration projects illustrate *how* the RECP and IEE programmes relate to theoretical concepts such as ‘zone of proximal development’ (ZPD) (Vygotsky, 1978) and ‘scaffolding’ (Bruner, 1990), contributing to concepts of quality of learning, and democracy in the learning process (Sen, 1999). I have therefore drawn on these theories of learning to provide further explanation and insight into the green learning dynamics of this study (see Chapter 2).

As indicated by Danermark et al, (2002) critical realism can use deductive and inductive approaches to analysis, but these are often complemented by abductive and retroductive modes of inference in interpreting reality in ways that are consistent with Bhaskar’s (1998)

ontology (see Table 1.2 below). In this thesis I worked mainly with inductive and abductive modes of inference, but also with retroduction, as this helped me to identify the underlying drivers of sustainability and the emergence of the green economy, as well as the way in which the green economy was emerging via events and approaches, and also the experiences and ways in which the RECP and IEE were shaped and experienced. This serves to extend what is said about the green economy to theoretical lenses illustrating *how* the programmes relate to green economy generative mechanisms such as damage to the functioning of the earth system, resource security and the need for accelerated green employment in a country where unemployment rates are very high.

**Table 1.2. Deductive, inductive, abductive and retroductive modes of inference**  
(Adapted from Danermark et al., 2002, pp. 80, 81)

	<b>Deduction</b>	<b>Induction</b>	<b>Abduction</b>	<b>Retroduction</b>
Fundamental Structure	To derive logically valid conclusions from given premises.	To see similarities in a number of observations and draw the conclusions that these similarities also apply to non-studied cases.	To interpret and recontextualise individual phenomena (e.g. the RECP and IEE programmes) within a conceptual framework or set of ideas (e.g. green learning principles).	From a description and analysis of concrete phenomena (e.g. the two training programmes), to reconstruct the basic conditions for these phenomena to be what they are.
Central issue	What are the logical conclusions of the premises?	What is the element common for a number of observed entities and is it also true of a larger population?	What meaning is given to something interpreted within a particular conceptual framework? (e.g. how can the green economy training programme be interpreted from Sen's view of human capabilities?).	What qualities must exist for something to be possible? (e.g. for a green economy training programme to exist there must be an emerging green economy and structural factors that shape the emergence of the green economy in certain ways).

### 1.4.2 Interactive qualitative design

The above theoretical orientation was actualised using Maxwell and Loomis' (2002) interactive research model, which helped me to design this qualitative research project. Interactive research implies the development of an underlying scheme to govern aspects of order, system and consistency of planning and to guide the process of under-labouring that utilises theoretical lenses and research instruments to derive findings and conclusions from raw data.

An interactive research model is "... a model *of* as well as *for* research..." incorporating

- i. the original view of the problem;
- ii. the research process; and
- iii. the interactive relationship between theoretical and methodological commitments.

Interactive research models therefore "... represent the design-in-use of a study; the actual relationships among the components of the research; as well as the ... reconstructed design." (Maxwell and Loomis, 2002, p. 248).

Reflective qualitative research design as applied in this study is typically interactive as it examines and makes meaning of the collaboration of objectives, theoretical concepts, methodology and methods. Qualitative research design by no means resembles replicable, off the shelf patterns but rather represents custom-built and 'choreographed' designs.

In contrast to research that would 'test' a hypothesis, this study is an example of qualitative research as a 'test' of how uniquely combined data sets relate and articulate. A common attribute among the many varieties of qualitative research is that data is examined inductively, producing findings that are grounded in and faithful to the data. (Maxwell, 1996). As indicated above, in critical realist research, which under-labours this study, there is also need to use abductive and retroductive approaches to making inferences during the analytical process.

The literature review undertaken for this study reveals that 'social learning' is a well-researched learning theory while concepts like 'green learning' and 'skills for the green economy' constitute an emerging educational knowledge field. Considering that the educational principles of green learning are related to social learning (as outlined in section 1.3.2 above), the study draws on social learning theory directly to provide tools for abductive interpretation. Social learning theory, for example, outlines notions of 'scaffolding' and

‘quality learning’, which elegantly extends to green learning in workplaces (see Chapter 2). As indicated above, a key contribution of this study was to develop a framework for interpreting the green economy – green learning relation, as there was little available to work with in this specific area at the start of this study. This required me to engage with interactive research design, as outlined above that included ongoing deepening of theoretical understanding of sustainability issues at a deeper level, green economy emergence, social learning and green learning as it is positioned within green economy thinking and praxis.

### **1.4.3 Inductive and abductive interpretive case study design**

Wilson (2011) contends that

Methodology deals with philosophical assumptions underlying a research process e.g. positivism, phenomenology or interpretative approaches, while a method is a specific technique for data collection under those philosophical assumptions (Wilson, 2011, p. 2).

The chosen methodology for the study is critical realist inspired inductive and abductive interpretive case study research, using a nested case study research design (see below).

According to Yin’s (1989) definition, a case study is an empirical inquiry that:

- investigates a contemporary phenomenon within its real-life context; when
- the boundaries between phenomenon and context are not clearly evident; and
- using multiple sources of evidence.

As shown in Table 1.2 above, inductive analysis allows me to consider ‘what is inside’ the sustainability learning programme and to take a tentative approach, allowing key issues, patterns and themes to emerge from the data naturally. An abductive approach to analysis of phenomena involves re-contextualising the data according to theory and/or context (Danermark et al, 2002). Abductive interpretation allows me to critically analyse IEE and RECP data in relation to what is said about learning for the green economy. Additionally, I also sought to identify some of the generative mechanisms shaping green learning in an emerging green economy context, involving retroduction as outlined in Table 1.2 above.

Case study research generally answers one or more questions which begin with "how" or "why." The questions are directed at a limited number of events or conditions and their inter-relationships. A further motivation for using case study methodology is found in Yin’s (2003) definition:

... the distinctive need for case studies arises out of the desire to understand complex social phenomena ... because ... the case study method allows investigators to retain the holistic and meaningful characteristics of real-life events, such as organisational and managerial processes, for example. Case studies seem to be the preferred strategy when "how" or "why" questions are being posed, when the investigator has little control over events and when the focus is on a contemporary phenomenon within some real-life context (Yin, 2003, pp. 2-10).

Soy (1997) observes that case study provides a proven methodology for studying complex issues and has the potential to flexibly re-contextualise multiple events from rich and multiple data sources to create new perspectives on events and experiences. In this study case study methodology is regarded to be suitable for reviewing project events as 'real life cases', constituted within industrial workplace settings in the wider societal context of industry as the green economy's engine of growth and employment (Hohnen, 2012; see sections 1.1.3; 1.1.5).

Patton (2002, p. 297) explains that while fieldwork can take place in the context of one case such as the NCPC-SA in this study, the single case is likely to be made up of smaller cases, as in the case of the NCPC-SA which has the two training programmes – RECP and IEE – which I have studied. Patton describes this as 'nested' or 'layered' case study research, where case studies of specific bounded activities, such as the two training programmes, may also be presented within the larger case of the NCPC-SA training programmes. Thus, in this study I adopted this 'nested' approach to case study research. As explained by Flyvberg, (2011, p. 301) making the choice to use case study is not so much about making a methodological choice, but it is rather a choice about what is to be studied. He suggests that the individual unit may be studied qualitatively or quantitatively, and that qualitative data can be represented in different ways (e.g. using graphics, or thick description). What is decisive about case study research is the 'boundary of the case' not the type of methods used to construct the case, or the way in which the data is represented.

As indicated above, the selection of the nested cases (the two training programmes) within the case (of the NCPC-SA) was based on my previous knowledge of, and experience of working with the NCPC-SA, and my knowledge and experience of the two training programmes. Another criteria for their selection was that they were focussed directly on green economy development in the industrial sector, and they had been running already for a few years, and therefore were established training programmes. I also selected this nested

case set up for its links to international green economy initiatives (UNEP/UNIDO), as outlined in the introduction in section 1.1.4 above.

#### **1.4.4 Generating, organising and analysing the data**

Multiple data generation sources and techniques, including interviews, discussions, document analysis and observation were used in this study to generate data, and I used different forms of representation of the data (graphics and textual descriptions; see section 3.2.4). Case study research is often characterised by rich and thick description, and hence qualitative data is often used in case study research as it provides for detailed insight into the case and phenomenon under study. In this study I used a combination of data generation processes, including

- a. Interviews and personal conversations
- b. Document analysis
- c. Observation
- d. Managing and organising data
- e. Data analysis and processing

##### ***A. Interviews and personal communications***

Patton (2002, p. 341) explains that the purpose of interviewing is to “allow us to enter into the other person’s perspective”. He goes on to say that “Qualitative interviewing begins with the assumption that the perspective of others is meaningful, knowable, and able to be made explicit” (ibid). The quality of an interview is dependent on the interviewer and how he or she approaches the interview. There are different ways of approaching interviewing; it can be in the form of informal conversations (i.e. the informal interview), or it can be conducted in a slightly more formal way (i.e. using a semi-structured format and an interview guide). This approach allows you to have guiding questions, but to also allow for more open ended responses. There is also a more structured, formal approach to interviewing in which respondents are limited in their responses by strict adherence to the interview schedule, often requiring less complex answers.

In this study I used mainly personal communications but also conducted and transcribed an interview, summarised in the Communication Memo. The Communication Memo contains a list of 26 individuals from which I obtained data by means of personal communications and interviews (Appendix Section A). I made handwritten notes in order to keep track while

maintaining the flow of conversation and at a later stage collated the notes in a single Communication Memo.

### ***B. Document analysis***

Patton (ibid) explains that documents are a particularly rich source of information about programmes or organisations, as organisations tend to produce many different kinds of documents that can serve as records of their activities. For example, the NCPC-SA's annual and quarterly reports, strategic plan and materials for the different training programmes that it offers, are useful sources of information. Patton (ibid) goes further to say that "documents prove valuable not only because of what can be learned directly from them, but also as a stimulus for paths of inquiry that can be pursued only through direct observation and interviewing".

The Document Analysis Memo (Appendix Section B) lists the documents analysed. Against the backdrop of green economy and social learning information I searched a range of RECP and IEE documents with two objectives in mind: (1) to reveal the programmes' significance with respect to industry greening (or not) and (2) to reveal that the approaches followed are aligned with generally accepted social learning practices (for example scaffolding and participation); and with emerging aspects of skills development for industry greening (or not), for example the focus on engineering and TVET (technical or artisanal) skills and the practical and participatory approach to green workplace learning (or not).

Themes emerged explicitly or implicitly; or in some cases not mentioned at all (silent or null text) but were noted in a secondary related research paper. A sterling example of silent text is Kahn's (2009) insight that industrial modernisation is often impaired due to industry's productivist ('business-as-usual') focus and lack of confidence in the workforce's tacit knowledge and competence to master modern technologies. This served to clarify the reluctance of some CEOs to implement RECP despite incentives and clear evidence of the improvements and savings to be gained through RECP.

Themes transpired, drawing the study to findings and a conclusion (see sections 1.4.4; 2.2.3; Appendix Section D).

### ***C. Observation***

Patton (ibid, pg. 295) states that “Observing activities, interactions, what people say, what they do, and the nature of the physical setting is important in a comprehensive approach to fieldwork”. He also suggests that it is important to observe what does *not* happen. Stake (1995) suggests that observations of this nature require experience, and also an informed perspective. Thus, it would be possible to observe if cleaner production principles were not being appropriately employed in a workplace, if one had experience of these principles or if one was theoretically informed using a set of guidelines to structure one’s observation for example. The Observation Memo (Appendix Section C) contains the following sub-sections, compiled from what I remember from career experiences, in addition to photographs and written notes compiled as participant-observer:

- C.1. Career related observation and experiences
- C.2. Industry greening through the NCPC-SA
- C.3. RECP implementation
- C.4. Sustainability value beyond financial savings
- C.5. IEE observations
- C.6. IEE Students
- C.7. Workshop to plan IEE Phase 2, commencing 2015.

### ***D. Managing and organising data***

As indicated above, this study generated and worked with a range of different data sets. It was therefore also important to organise and manage the data for systematic analysis. In this research I indexed and managed data by means of the electronic file management and indexing systems provided by MSWord 2010 and XCel 2010 (Appendix Section D). The research process included documented classification, coding and indexing of literature and programme material to generate an integrated and traceable system of information. Critical reading and observation, bearing in mind the research purpose and questions, allowed themes and patterns to emerge (Schudel, 2012, Communication Memo A.1). Planning grids and summaries contributed to focus and logical sequencing in discussions and overall data management (Soy, 1997).

Themes that transpired from the data were incorporated in the analytical instrument. Use of the analytical instrument for the case study produced findings, which confirmed that themes

transpiring from the literature review were present in the content and approaches of the programmes. Themes include:

- Awareness raising, capacity building, environmental education and training as a constellation of educational initiatives in pursuit of sustainability (See sections 2.1.3.4; 2.2.3);
- green skills educational needs, challenges and optimal approaches (see section 2.2);
- programme content, approaches and implementation challenges (See section 3.2);
- NESPF as platform for possible mainstreaming of programme material and approaches (see section 2.2.4).

### *E. Data analysis and processing using an analytical instrument*

Overall, the research was a dynamic journey over time involving an iterative analytical process. Maxwell (2008) outlines a typical dynamic research process as:

The activities of collecting and analysing data, developing and customising a theoretical foundation, elaborating or refocusing the research questions and identifying and dealing with validity threats are usually going on more or less simultaneously...The aspects of this dynamic process are interactive e.g. the researcher might have to reconsider or modify a range of decisions with every change in the design (Maxwell, 2008, pp. 214-253).

A key part of this research was also to generate the analytical instrument in Phase One (see section 1.4.5). Creating the analytical instrument was deemed necessary as the literature review did not produce a suitable analytical instrument for reviewing sustainability learning programmes in relation to emerging green learning aspects. Designing and creating the analytical tool comprised a dynamic research process that relied on rigorous literature review work, cross-referencing between sections and updating the literature selection while maintaining progress and focus. The uniquely combined data sets generated for the research instrument produced a new, flexible, re-usable conceptual framework for reviewing the sustainability learning programmes (see section 2.3).

I used the conceptual framework thus generated to produce a draft analytical tool or instrument (see Table 2.1). The draft instrument was iteratively applied to review the NCPC-SA's RECP and IEE programmes, initially in a pilot run that shed light on the usefulness as a review tool for the nested case study (see section 1.4.6). The pilot stage provided an opportunity to critically assess, refine and finalise the tool to become a **mechanism for**

**reducing, organising and translating selected data for meaning-making, retaining richness and quality in the reduced and processed data and producing findings that feed into a useful conclusion** (Schudel, 2012 - Communication Memo section A.1). The analytical tool was thus developed and tested through inductive and abductive analysis and used for reviewing the training programmes, formulating the findings and arriving at the conclusion. This analytical process was enriched through retroductive analysis, which sheds light on the generative mechanisms shaping new green learning programmes in the context of the emergence of a green economy in South Africa and elsewhere.

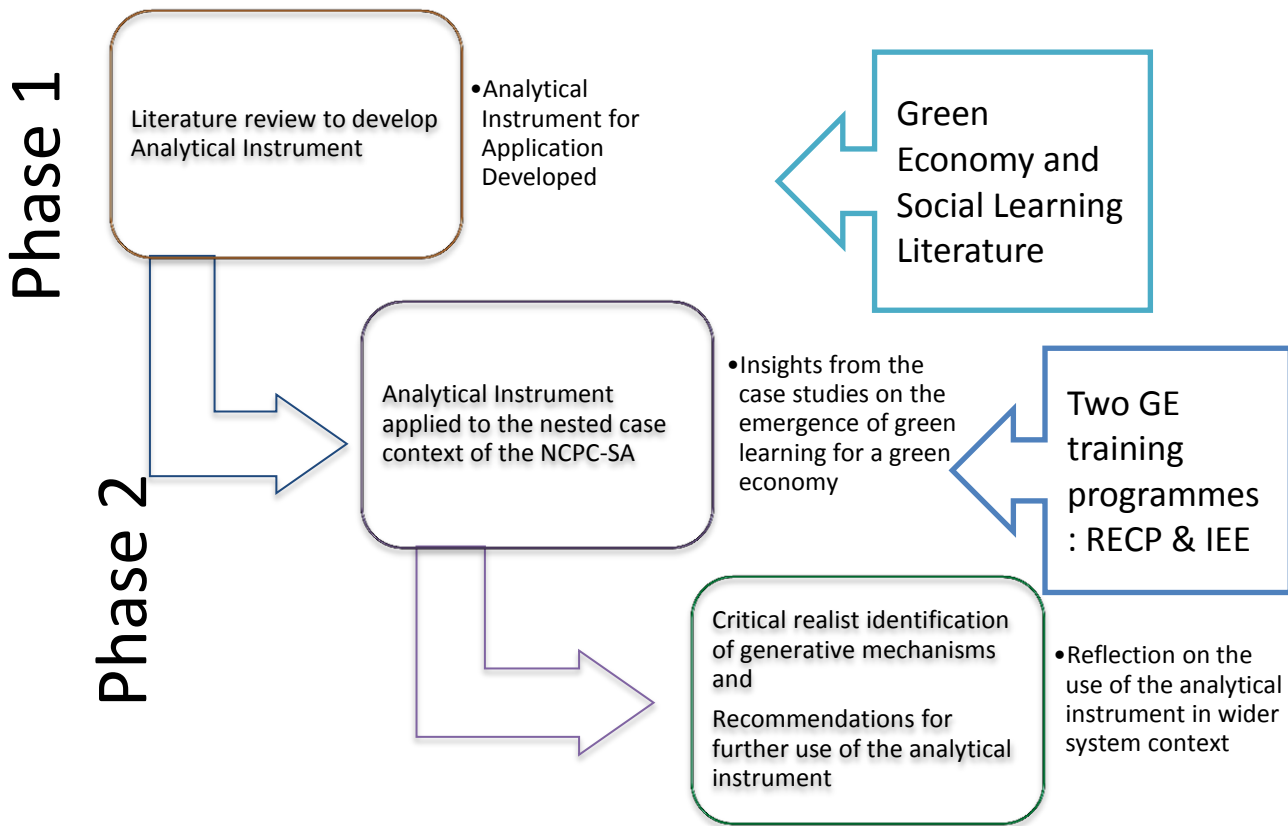
Danermark et al. (2002) suggest that it is possible to generalise in critical realist research at the level of the generative mechanism. In this research, critical refinement and productive utilisation of the analytical tool resulted in a useful review instrument that is provided as a contribution from this study, for wider testing, application and further use in the emergent green economy, where green learning approaches are still being worked out. In critical realist context generative mechanisms shaping the RECP and IEE training programme emergence and play out, may also be shaping and influencing the emergence and play out of other green economy training programmes. Future use of the analytic instrument as a generalised tool may thus provide a useful framework for wider analysis of green economy training programmes, building on what was possible in the context of this study (see Chapter 4).

#### **1.4.5 Study phases**

As outlined above via the analytical description and in Figure 1.3 below, the study was conducted in an iterative way, which can essentially be seen to be in two phases. The first phase involved generation of the research instrument which was based on respective green economy and green learning literature reviews, feeding into a questionnaire comprising three categories of ‘how’ questions as outlined in Research Questions 2, 3 and 4 above (see Chapter 2).

In Phase Two the questionnaire was applied as research instrument in a combined nested case study context using deductive and abductive inference to examine how the sustainability learning programmes relate to emerging green learning aspects (see Chapter 3). Combining phases one and two in a final analytical review helped to identify generative mechanisms shaping the green learning emergence in the context of an emerging green economy (see Chapter 4).

**Figure 1.3. Study design showing the analytical process**



#### **1.4.6 Triangulation, validity and ethics**

To ensure validity and reliability or trustworthiness in this qualitative research, data was generated systematically, keeping an auditable track of actions in accordance with research design. Strategies for data validity and quality include multiple data collection techniques in order to generate rich (thick) data. Patton’s (2002) path of systematic collection, recording and management of data was followed in this study to create an audit trail allowing for access and tracking of the origins of findings for verification purposes. Data was collected and analysed reflexively while bearing in mind the research questions, theoretical framework, goals and methodological constraints (Maxwell, 2008).

In interviews and discussions participants were invited to describe realities that they and only they can construct. Along this trajectory I followed Cho and Trent’s (2006) holistic

framework, aligning research purpose, questions and processes in an interactive, procedural approach and also used member checking as a validation method.

Maxwell (2008, p. 243) contends that 'Ethical considerations should be prominent in every aspect of research design.' Ethical considerations involve respecting the rights and interests of participants and respondents, showing appreciation of work load and time management, and maintaining privacy. Anonymity and confidentiality rules were agreed upon at the outset of each discussion. None of the respondents however chose to be anonymous. NCPC-SA director and the co-ordinators of the two training programmes endorsed the research and I regularly provided them with feedback (Communication Memo section A.3). I requested NCPC-SA members' and training presenters' permission to observe training and interview students. None of the participants or presenters hesitated or declined.

In accordance with Maxwell, self-reflectiveness about researcher bias and subjectivity was also considered in this study, admitting, accepting and minimising the inevitable effects of the research process and researcher on setting and participants.

Drawing on Meyers (1997), I used diverse qualitative research methods in relation to each other. This approach helps to rule out misinterpretation and minimises the effect of bias. In this study I used triangulation of the different data sources mentioned above to construct the case and to produce the findings. I also used member checking to get feedback on my interpretations of the cases from presenters and students that attended the training at the NCPC-SA.

I conducted a number of pilot runs to try out and optimise the data generation and analysis methods, inclusive of trying out different techniques, identifying and removing barriers and simplifying complicated areas (see section 1.4.4). Careful preparation and managerial endorsement preceded interaction with programme and project managers. I made short interim reports to keep management informed of progress.

# CHAPTER TWO. GREEN ECONOMY AND LEARNING THEORY PILLARS OF THE STUDY INFORMING AN ANALYTICAL TOOL

*As briefly introduced in Chapter 1, green learning for industrial settings, also termed ‘skills development for the green economy’ is equally rooted in green economy policies and social learning theory. This chapter generates green economy and green learning perspectives in response to RQ01 – Which green economy and green learning aspects are relevant to the RECP and IEE programmes? This chapter informs the design of the analytical instrument used in the study and provides useful insights for induction and abduction (Chapter 3) and critical realist retrodution (Chapter 4), which are the means of making inferences in this study.*

## 2.1. GREEN ECONOMY DESCRIPTIVE SUMMARY

### 2.1.1. Green economy mechanisms

This section reflexively learns from green economy related texts what is said about *actualising* envisaged green economic growth and green employment. Drawing on The New Deal rescue package lifting America out of an economic depression in 1933 (Hiltzik, 2011) and on ‘Blueprint for a Green Economy’ (Pearce, Markandya and Barbier (Eds) 1989), UNEP suggested a rescue package oriented to the emergence of the green economy to counter the global financial meltdown of 2008.

Conventional GDP’s failure to secure future generations’ sustained access to natural resources impelled UNEP to commission a team headed by Edward Barbier, one of the “Blueprint for a Green Economy” (ibid) editors, to prepare a strategic Global Green New Deal Policy Brief (UNEP, 2012a). The strategy proposes a world-wide green stimulus programme supporting implementation of economy greening policies. The twofold purpose of the **financial injection** is to move participating economies forward in terms of **sustainable development** and the generation of **new green jobs** to counter **job losses** resulting from the global economic crisis.

UNEP suggests deliberate, interrelated steps towards turning the vision of a sustainable economy and green employment into a reality. The steps may include;

- i. Assessing the potential for green jobs, taking action to realise it and monitoring progress;
- ii. Closing skills gaps;
- iii. Mobilising the greening of workplaces as a dormant source of green employment; and**
- iv. Political resolve in the form of systemically integrated policy driven incentives and disincentives (ibid, my emphasis).

The Global Green New Deal Policy Brief points out how environmental sustainability and economic progress are complementary and suggests three concrete and measurable long term green economy objectives, captured in Text box 2.1.

**Text box 2.1. The Global Green New Deal Policy Brief suggests three concrete and measurable long term green economy objectives**

**GLOBAL GREEN NEW DEAL CONCRETE AND MEASURABLE OBJECTIVES**

- i. Economic recovery by means of a stimulus programme linked to sustainable views on wealth, growth and investment underpinned by intensified sustainability measures;
- ii. Poverty reduction by creating additional jobs through green goods and services, retaining but greening existing jobs, preparing learners at all levels for green lifestyles and green employment and green up-skilling of people in workplaces; and**
- iii. Legal measures inclusive of monetary penalties to turn around climate and ecosystem degradation by embedding the full cost of economic activity in the activity itself. (UNEP, 2009a, my emphasis)

The green economy transition is characterised by a deep shift in economic thinking and the way business is conducted. **In concrete terms greening implies decoupling industry from in-efficient and energy intense practices by implementing cleaner, more efficient techniques and technologies.** Long term economic objectives of this ‘green revolution’ include continued access to resources into the future.

Cartwright notes that

...decoupling will involve a reorganising of the global economy with a new set of “winners” and “losers”. For South Africa decoupling could provide the basis for precisely the economic reform that it requires....the economic success stories of the coming century are likely to be defined by those regions, cities and companies that **are best able to transition to renewable energy sources and energy efficient economies** (Cartwright, 2010, p. 9, my emphasis).

While economies may independently set green economy priorities and customise international best practices for a green economy transition, science is clear about the systemic connectedness of nature, society and the economy and the sensitive interrelatedness of energy, climate, atmosphere, water, pollution and waste (see section 2.1.3.4). In its Green Economy Report UNEP (n.d.a) recognises the systemic interconnectedness of economy, society and nature and points out the under-valued status of natural resources as economic assets.

The joint UNIDO and UNEP Green Industry Platform poses but one example of agencies offering developing countries technical and financial assistance with the green economy transition (Hohnen, 2012; see section 2.1.1). The Green Industry Platform pursues two inter-linked and mutually supporting developmental outcomes with employment and business development in mind:

- i. Growing economic activity (which leads to investment, jobs and competitiveness) in the green industry sector, supplying commercialised technological applications, and green businesses providing environmental services; and
- ii. A revolutionary industry greening process, constituting a deep shift in the economy towards cleaner industries and sectors characterised by a low environmental impact compared to its socio-economic impact (UNEP, 2013).

### **2.1.2. Positioning South Africa in relation to the global green economy**

Divergent green economy theories depicted by Nhamo, Shava and Togo (2011) range from anthropocentric (technological) or weak green economies at the one end of the spectrum to eco-centric, biological or strong green economies at the other end. Anthropocentric green economies may seek to trade in cleaner technologies but incompletely engrain sustainability in the aspirations of organisations and the lifestyles of citizens. Eco-centric green economies on the other hand achieve more than trade in environmental goods and services, inclusive of

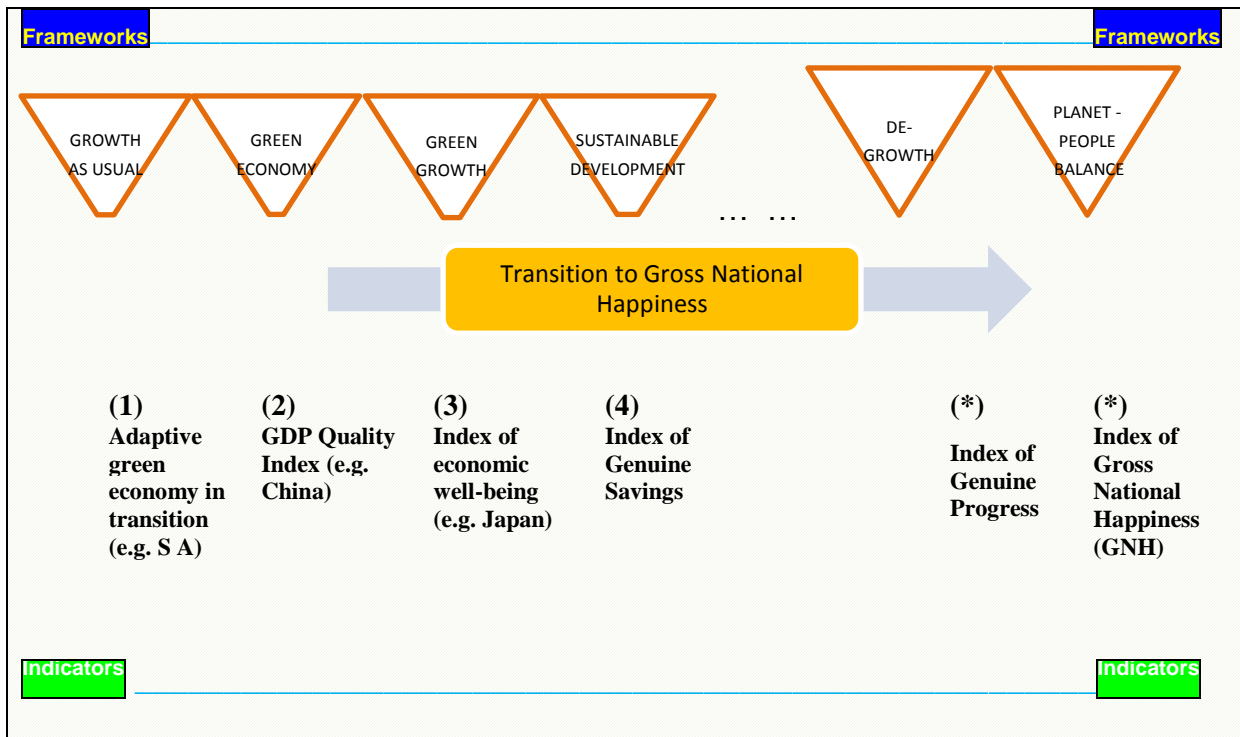
maintaining and growing human wellbeing and natural capital over the long term (Nhamo, Shava and Togo, 2011).

In a report termed 'Life Beyond Growth', commissioned by the Tokyo-based Institute for Studies in Happiness, Economy and Society (ISHES), AtKisson, (2012) puts forward similar indicators to distinguish between 'adaptive green economies in transition', 'GDP Quality Index' (e.g. China), 'Index of Economic Well-being (e.g. Japan)', 'Index of Genuine Saving', 'Index of Genuine Progress' and 'Index of Gross National Happiness (GNH)'.

The 'Life Beyond Growth' report augments the conventional GDP equation with concepts to express the systemic connectedness of nature-society-economy, for example sustainability, quality, planet wellness and measurable and verifiable gross national happiness.

AtKisson (ibid) outlines a spectrum of approaches to growth, ranging from radical 'De-Growth', to mainstream 'Growth-as-Usual' (see diagram below). The author advocates growth for the sake of human happiness, underscored by clearly outlined indicators contained in a 'National Happiness' index, such as enough-ness and sufficiency. Setting 'respect for the limits of the earth as a system' as realistic concrete basis for transformation to sustainable human, social and economic development, AtKisson cautions that growth for the sake of power is not sustainable. He suggests a typology based on indicators of sustainability that represent incremental steps toward a sustainable world, which he defines with a simple equation: "Green Economy + National Happiness = Sustainable World" (see Figure 2.1 below) AtKisson (ibid, p. 66).

**Figure 2.1. Spectrum of green economy frameworks and indicators (after AtKisson, 2012).**



At a national green economy summit held on 20 May 2010, followed by announcement of The New Growth Path, South African participants representing labour, government and private sector (tripartite stakeholders) resolved to embark on a green growth path and to systemically develop a resource efficient, low-carbon and labour absorbing green economy (Tshangela and Roman, 2012; PSETA, 2011, see section 2.2.2). The 2012 Medium Term Economic Framework deliberates on the New Growth Path target of 5 million new jobs by 2020. Government pledged support to the network of sectors responsible for pursuing the target, as shown by the National Treasury statement below:

Cabinet endorsed the New Growth Path in October 2010 and set a target for the generation of 5 million new jobs by 2020 in order to significantly reduce unemployment. Among the job drivers, the New Growth Path identifies the following key sectors to support employment creation: infrastructure; agriculture, rural development and agro-processing; mining and beneficiation; manufacturing, with emphasis on implementing the Industrial Policy and Action Plan II; the green economy and the tourism, creative industries and business service industries (RSA. National Treasury, 2011, p. 610).

The NDP comprises a US\$7.5 billion green economy stimulus package and a Green Economic Accord, which aims to create 300,000 green jobs in the next 10 years. The Green Economy Accord and National Skills Accord form part of the delivery agreements giving substance to the Programme of Action for implementation of the NDP. By implication the delivery agreements constitute society and private sector's commitment to share with government the responsibility and financial burden of developing both green employment opportunities and the matching skills required (RSA. The Presidency, 2010; 2011). The Green Fund, set up with R800 million and expanded by a further R300 million in 2013, is intended to provide catalytic finance to facilitate investment in green initiatives that will support South Africa's transition towards a green economy (Gordhan 2013; Green Fund 2012).

Overarching South Africa's green economy policies, The New Growth Path and National Development Plan (NDP) allocate the role of lead agent for the green economy transition to DEA (RSA. The Presidency, 2010; 2011). Montmasson-Clair (2012) however suggests that the complex interconnectedness of sustainable development mandates may result in incoherent allocation of green economy roles and responsibilities.

The National Strategy for Sustainable Development and Action Plan (NSSD) is the responsibility of the Department of Environmental Affairs (DEA) but the National Planning Commission (NPC), a department of sustainable development in all but name, resides in the Presidency (it however have advisory powers only).

The Economic Development Department (EDD) includes the green economy under its formulation of a New Growth Path (NGP) for the country but EDD only has direct control over the two main state-run development finance institutions: the Development Bank of Southern Africa (DBSA) and the Industrial Development Corporation (IDC).

Support for green industry falls under the Department of Trade and Industry (**the dti**) but **the dti** has to rely on other departments to implement measures aimed at green industries. Environmental fiscal reform (green taxes and subsidies which support both green industries and the greening of the economy as a whole) is under the mandate of the National Treasury (NT).

The DEA is responsible for the protection and restoration of ecosystems and the setting of environmental standards (e.g. for pollution or emissions). The Department of Energy (DoE) is in charge of issues relating to fossil fuels and renewable energy. The Department of Water Affairs (which [until early 2014] falls under the same ministry as the DEA is responsible for issues relating to

water and technology policy and research and development (R&D) are under the Department of Science and Technology (DST). Other departments (including for mining, agriculture, forestry, fisheries, transport, housing and local government) all contribute to green economy activities and thereby to green jobs at the sectoral level (Montmasson-Clair, 2012, p. 6).

The lack of coherence revealed by Montmasson-Clair's case study resonates with Death's (2014) concerns around South Africa's national green economy challenges, which may not be limited to the absence of a concerted strategy for a green economy transition. Citing Dual Citizen (2012), Death (2014) notes that The Global Green Economy Index in 2012 ranked South Africa overall 21st out of 27 countries surveyed. South Africa was given low scores on indicators such as policy and clean-tech investment, however scored high on green tourism. Similarly, the Environmental Performance Index (EPI) rated South Africa's green economy 128th out of 131 countries.

Reflecting the prominence of climate change and conservation in South African foreign policy and 'nation branding' (Death 2011) the EPI however granted South Africa the first position out of the 27 countries listed for leadership performance on the green economy (EPI 2012). Barbier (2010) and ILO (2013) recognise South Africa as an economy that puts the concept of 'sustainability' into practice, as the country for example hosted the 2002 Johannesburg World Summit on Sustainable Development and the 2011 Durban COP17 climate change conference. South Africa's 'Long Term Mitigation Scenarios' attracted positive attention nationally and internationally (Raubenheimer, 2011).

Being one of the most carbon intensive economies in the world South Africa made a high-profile commitment prior to the 2009 Copenhagen COP15 conference to reduce national emissions to 34% below business-as-usual levels by 2020 and to 42% below business-as-usual levels by 2025 provided financial, technology and capacity-building support were received from industrialised countries (Death 2011; Never 2012).

Death (2014) cautions that the South African green economy seems an unlikely candidate to be leading developing countries' transition to a green economy, considering the political and practical challenges facing the country. A large portion of all South Africa's electricity needs is met by fossil fired power stations, with Medupi and Kusile, the third and fourth largest coal-fired power plants in the world, still under construction and struggling to meet environmental standards. Sasol's Secunda plant producing liquid fuel and gas from coal, is

one of the largest point sources of CO<sub>2</sub> emissions anywhere on the planet (Resnick, Tarp, and Thurlow 2012, 219; Yeld 2011).

On basis of projections by different sources, revealing the exponential growth of the world-wide demand for environmental goods and services (EGS), the pursuit of green jobs is a common denominator found in South Africa's green economy discourse (RSA. The Presidency, 2010; 2011; see section 1.2.2):

- i. In 2004 the international EGS market was conservatively calculated at US\$548bn, estimated to reach US\$688bn by 2010 and US\$800bn by 2015 (UK Treasury, 2004 cited in du Plooy, 2009);
- ii. Another study however calculates the international EGS market at US\$1370bn in 2008 and an expected US\$2740bn by 2020 (UNEP/ILO/IOE/ITUC, 2008);
- iii. A more recent projection foresees a £4.3 trillion EGS market by 2015, sustaining tens of millions of jobs (Death, 2014).

Du Plooy (2009) in a presentation to **the dti** notes that South Africa yet has to achieve her full potential market share of about 1% of the international EGS market. He cites NEDLAC (2006), which reveals that South Africa's actual EGS market share had reached a mere tenth of the potential US\$5.5bn. by 2007.

Death (2014) reflects on South Africa's green economy utilising a set of green economy discourses, notably 'green revolution', 'green transformation', 'green growth', and 'green resilience'. The progressive trend emanating from green economy discourses articulates with the reference earlier in this paragraph to Nhamo, Shava and Togo's (2011) green economy categories ranging from 'anthropocentric' to 'eco-centric' and AtKisson's (2012) green economy indices ranging from 'adaptive green economy in transition' to 'gross national happiness'.

Death (2014) concludes that, rather than reflecting a balanced combination of green economy discourses, the South African green economy prioritises job creation and new markets, which reflects domination of a conventional GDP oriented 'green growth' discourse. A deep rooted sustainable Green GDP would for example include Environmental Resource Economics in the GDP equation, recognising the value and scarcity of the earth's sink and source functions (AtKisson, 2012; Death, 2014).

The green economy recognises ‘sustainable access to resources’ as lifeblood of supply chains, employment and economic growth. Regulation and education plays a critical role in bridging the divide between this simple logic and human activities that choose to deny it. Tariffs and taxes, often utilising standards conformity as criteria for legality, are one of the instruments used to direct potentially damaging activities toward green objectives. South Africa’s authorities for standardisation (South African National Standards (SANS)) and accreditation (South African National Accreditation System (SANAS)) enjoy recognition as members of the system of world-class standards and accreditation entities. Of particular significance to the green economy is international recognition (provided by SANAS accreditation), of certification to the SANS ISO 14001 environmental management standard (EMS) and the SANS ISO 50001 EnMS. In practical terms this means that certificated ISO 14001 or ISO 50001 compliant products meet the environmental requirements of trade counterparts in developed countries and are accepted without penalty at foreign border posts. Continuation of certification involves continual review and improvement.

World Trade Organisation (WTO) rules conditionally allow countries to apply environmental penalties and restrictions to imports, also known as technical barriers to trade (TBT), for example the so-called border tax, penalising imports based on measure of conformity to ISO 14064 and ISO 14067 (carbon foot-printing) and ISO 50001 (energy management). Long distances to most export destinations in combination with dependence on fossil fired electricity and fossil fuelled mobility contribute to South African products’ carbon vulnerability.

Some industries do not regard voluntary eco-labelling as a feasible industry greening option due to affordability concerns. A counter-argument is that Eco-labelling improves enterprise and sector viability, product image and market access. An example in case is energy efficiency labelling for domestic appliances that has been established as regulatory requirement for the sub-sector. Measureable and verifiable energy efficiency measures open up manufacturing companies’ access to incentive schemes such as the 12i Tax Incentive (RSA, 2011a). Competences developed to ensure design and manufacturing conditions meet the requirements, have up-scaled workers’ skills levels.

SANS mostly adopt standards developed by the international standards organisation (ISO), for example ISO 14064 and ISO 14067 for improvement of corporate and product carbon foot-printing respectively. The large carbon footprint of most South African products, due to

our dependency on a coal fired power supply system, compromises the international marketability of energy intensive products. Ways to overcome this challenge include reduction of a product's carbon footprint by improving energy efficiency and increasing the renewable energy percentage in the energy mix, used during manufacturing (Maia et al, 2011). The demand for renewable energy stimulates green jobs and grows the manufacture and supply of green technologies such as solar panels, heat exchangers, wind turbines, equipment for pyrolysis, bio-digesters and electronic devices that display the electricity consumption of individual pieces of equipment.

### **2.1.3. Stakeholders' green economy options and expectations**

#### **2.1.3.1. Employment seekers**

In response to social-economic pressures to elevate employment rates, and the reality of prevailing unemployment levels around 25% (Statistics South Africa, n.d), South Africa's NDP prioritises expanded investment, GDP growth and creation of decent green jobs. In NDP context, the term 'green jobs' refers to activities involved in protecting, restoring and sustaining the ecology, be it directly or indirectly (RSA. The Presidency, 2011).

Green industries, also known as environmental goods and services (EGS) industries, comprise technological applications and services and may make a direct or indirect contribution to the green economy (see section 2.1.1). Direct green services for example include activities of people working in the 'Groen Sebenza' and 'Working For' programmes and indirect green services include green policy formulation, implementation services, green education, enforcement, science, engineering, trade and consultancy towards achieving environmental standards conformity (Sanbi, 2013). Green 'goods' refer to technologies for improved sustainability, which may be supplied by a variety of industrial sectors in the form of modern, environmentally preferable products e.g. energy and water efficient appliances. Office printers are for example a conventional technology but paper, energy and toner-efficient office printers represent green technology, as do electric vehicles, solar and induction cookers, solar water-heaters and photo-voltaic equipment for electricity generation.

Maia et al (2011), in a study commissioned by the Industrial Development Corporation (IDC), Development Bank of Southern Africa (DBSA) and Trade and Industrial Policy and Strategy (TIPS), synthesise best available estimates of green employment projections for the

South African economy. Green skills development is conditional to actualising the green employment projections (see Table 2.1 below).

**Table 2.1. Employment estimates by green economy categories and segments (Maia et al, 2011).**

Broad green economy category	Projected long-term net employment
Energy generation (includes renewable (non-fuel electricity), fuel-based renewable electricity, liquid fuels.	130 023
Energy and resource efficiency	67 977
Emissions and pollution mitigation	31 641
Natural resources management (biodiversity and soil and land management)	232 926
<b>TOTAL</b>	<b>462 567</b>

Hawken, Lovins and Lovins (1999) envisage a world-wide ‘re-industrial-revolution’ through systems optimisation and minimisation of energy and resource consumption. According to Industrial Development Corporation (IDC) senior economist Nico Kelder a significant increase in our international environmental goods and services (EGS) market share is regarded pivotal to generating the green economy’s promised 5 million green jobs by 2020. Based on 2007/8 best available figures, including water related work (but excluding local government and water utility enterprises), approximately 12,000 green jobs existed in the South African public sector in 2010 (Kelder, 2013; see section 2.1.3.3).

### **2.1.3.2. People in workplaces**

People in conventional jobs may experience employment insecurity in events where employers remain stuck in a productivist ‘business as usual’ mode, neglecting the development of their workforces’ green potential and failing to implement green measures. By resistance to change, productivist oriented organisations eventually find themselves facing penalties and marketplace challenges. In contrast, South Africa’s NDP recognises the importance of an enabling environment for a knowledge intensive and labour-rich green economy offering new careers and business opportunities (Almond and Solomon, 2011).

NDP objectives signify a need for green education and for recognition of green education achievements. All employers have an obligation to avail employees to green skills development opportunities, thus elevating job retention and continued employability of green-competent workers (RSA. The Presidency, 2011).

The EU Single Market's principle of 'free movement of professionals' (European Commission, 2014) may be extended to artisanal (TVET, technical) occupations, thus recognising green training achievements as a way of cultivating ecosystem custodianship and employment security.

Drawing on Canadian and other green learning examples, Almond and Solomon (2011) propose recognition of green achievements to cultivate ecosystem custodianship and foster a sense of security among employees. The authors also advise governments to promote green jobs by linking incentives to job growth in green industries. This argument resonates with UNIDO and UNEP's Green Industry Strategy, which offers policy support in the form of a mechanism developed to guide, teach and educate people working in government by means of practical technical assistance, streamlining industry greening while maintaining investor certainty and worker security (UNIDO, n.d).

In South African context the NQF system encompasses sector skills plans (SSPs) for various sectors. Up-scaling of workforce skills levels is for example a typical SSP responsibility (SAQA, n.d). The SSP system therefore provides a possible platform for developing educational mechanisms and practical technical assistance directed at streamlining industry greening, similar to mechanisms developed by UNIDO and UNEP's Green Industry Strategy. SSPs are discussed in more detail in the section on green learning analysis (see section 2.2.2).

### **2.1.3.3. Business owners (investors)**

Transition of conventional industries to low carbon, efficient and clean industries implies **departure from conventional energy and resource intensive extraction, consumption and production practices**. Energy intensive industries hold the key to green-house gas reduction as they represent opportunities to improve energy efficiency. An accelerated transition to non-fossil energy generation, underpinned by technology development and a knowledge rich workforce are of critical importance toward achieving South Africa's carbon reduction commitments over the short term and contribute to long term climate stability (RSA. National Treasury, 2012; see section 2.1.2).

The possibility of access to IDC loans and government grants, for example the 12i Tax incentive based on verifiable energy efficiency improvements, encourage investors to implement green technologies. Further motivation is found in spiralling energy prices, which have reduced the period for recovering funds invested in industry greening technologies. In the case of energy and water saving devices, return-on-investment (ROI) savings are visible on utility bills immediately.

Resource efficiency is a key factor, as efficiency gains in the use of all resources contribute individually and synergistically to climate resilience. When less materials and water are used, less energy is required to pump, heat, cool and/or process these, lowering net green-house gas reductions, while also relieving the pressure on water and other resources that might become less available as a result of changing weather patterns (UNIDO, UNEP and SECO, 2010).

The IDC considers ROI in designing custom-made loans for financing energy efficient technologies in industrial operations. Kelder points out that care is taken by IDC to match loan repayments to the savings profiles of specific technologies in order to limit out-of-pocket expenses for the implementing company (Kelder, 2013, See section 2.1.3.1).

Industry organisations, along with labour and government representatives, at occasion of adopting the NDP, formally agreed to an employment and knowledge rich green economy transition, underpinned by the National Skills Accord; Basic Education and Partnerships with Schools Accord; Local Procurement; the Green Economy Accord and the Youth Employment Accord. By implication government, private sector and labour adopted green economy mandates and obligations that require revision of organisational establishments to embrace greening of current jobs and creation of new green jobs, thus becoming the green economy and shaping the 'future we want' (RSA. The Presidency, 2011; UN, 2012).

Howells and Laitner (2005) underline the role of industry as driver of economy greening. Industry greening expressed as resource productivity and profitability through efficiency, determines the character and pace of the green economy transition. South Africa's 2011 Budget and the 2012-2013 Estimates of National Expenditure (ENE) correspondingly prioritise government's support to efficiency improvements, for example energy efficiency, as a measure to reduce green-house gas emissions (RSA. SARS, 2011; RSA. National Treasury, 2012; see section 2.1.2).

#### 2.1.3.4. Systemic approach to industry greening

The prioritisation of green jobs distinguishes a Green GDP economy from a conventional GDP oriented economy. The term ‘emerging green learning aspects’ as used in this study gives expression to aspects of teaching and learning directed towards the skills and knowledge required to competently take charge of the 5 million green jobs promised at announcement of the green economy. Drawing on an internationally recognised definition of green jobs used in a recent survey of skills in South Africa, RECP and IEE management and project manager jobs clearly qualify as green jobs as they “... de-carbonise the economy and minimise ... generation of waste and pollution (UNEP/ILO/IOE/ITUC, 2008, p. 25). Green jobs imply workplaces to be populated by green skilled people, for example skills to ensure that the generation and utilisation of energy is sustainable, along with an understanding of the implications of success and failure in this regard.

Nobel laureates and climate change leaders participating in the 2007 interdisciplinary symposium: “Global Sustainability: A Nobel Cause” in Potsdam, Germany, deliberated the direction in which the ‘industrial metabolism’ is heading by asking: ***“Does a ‘third way’ exist between environmental destabilisation and persisting underdevelopment?”*** The symposium concluded that a ‘third way’ exists but it has to bring about, rapidly and ubiquitously, a thorough re-invention of the industrial metabolism, which they view as the ‘Great Transformation’. Schellnhuber (2007) notes that the challenge is ‘awesome’ but the one comparative advantage of the current generation over all previous generations is an incredibly advanced system of knowledge production that can be harnessed, in principle, to co-generate such transformation, involving committed and courageous political leaders, enlightened business executives and civil society at large.

The joint UNEP-UNIDO Green Industry Initiative, launched at the Rio+20 Summit, underscores the significance to the green economy of both industry greening and the green industry (UN, 2012). The Green Industry Initiative provides governments, business and civil society with a co-operative framework for driving industry greening and developing strategic road maps and partnerships. Drawing on success stories created through UNEP-UNIDO National Cleaner Production Centres in many countries (see section 1.1.2), the Initiative offers practical solutions toward implementing environmental agreements, securing low-carbon growth and creating green and decent jobs (UNIDO, n.d; Hohnen, 2012).

Leaving behind the conventional economy, also known as ‘business as usual’, where economic growth is measured in terms of conventional GDP, green economy policies pursue a re-invention of the industrial metabolism and appreciates natural resources as economic assets. The green economy model seeks to measure growth in terms of Green GDP, which takes into account additional indicators such as food, water and energy security and the percentage of waste streams re-introduced in production. Strategies need to be implemented to secure long term sustainable access to resources (Schellnhuber, 2007; UNEP, 2009a; see section 2.1.2).

Mia et al. (2011) hold that a country’s response to the synergy that exists between poverty eradication (food, water and energy security and access to education and health services) and enhanced conservation is evidenced by its investment in implementation of the green economy and in particular by prioritising carbon reduction while growing the green economy.

Sustaining a greener industry sector requires systemic provisioning of techniques, technology, knowledge and skills for incrementally improving resource efficiency, waste minimisation and low-carbon energy generation and utilisation. It requires the provisioning of a systematic approach to providing for quality green education and training programmes for all sectors of the economy (Lotz-Sisitka et al., 2012). The systemic approach straddles the green economy and green learning sections of this study and is further deliberated as part of the green learning literature review (see section 2.2.2).

The RECP and IEE host programme, the NCPC-SA, holds a key position in South Africa’s systemic industry greening approach. NCPC-SA has on more than one occasion expressed a need for a national cleaner production strategy to clarify government, labour and private sector’s industry greening objectives and to provide for adequate resourcing of the industry greening trajectory (Mthente, 2013).

## **2.2. GREEN LEARNING LITERATURE REVIEW**

### **2.2.1. Learning theory for quality learning**

#### **Educational quality**

Green learning has the potential to equip people in workplaces and the communities they belong to with capacity to progress from inadequate short-term thinking to long-horizon

sustainability values and behaviour. The systemic integration of economic, social and environmental considerations evidenced by green thinking, being and doing requires knowledge and skills development in the spirit of life-long learning for sustainability (UNESCO, 2009).

The UNESCO *Education for All Global Monitoring Report* draws attention to issues of educational quality. The report reveals that physical access to education does not by default lead to quality education and effective epistemological access to knowledge. In the foreword to the assessment of educational quality issues, UNESCO Director General Koïchiro Matsuura states that

... although much debate surrounds attempts to define educational quality, solid common ground exists ... Quality must be seen in light of how societies define the purpose of education...(UNESCO, 2005, p.1).

Quality education implies cognitive development and creative and emotional growth of learners to help learners acquire values and attitudes for responsible citizenship. Significant to South Africa, where many have historically been denied access to education, particularly access to quality education and training, he pointed out that ‘quality must pass the test of equity’ (ibid).

Graca Machel in her opening plenary speech at the first World Conference on Education for Sustainable Development in 2009 said about quality of education:

I want to see education that empowers young people to question, to develop their minds and skill sets, to make choices, to find meaningful employment and to play constructive roles in their families, their communities and their nations. I want to see education that enables young people to value other human beings, encourages them to understand the importance of equality and equity and helps them to recognise the importance of collective responsibility and action. I want to see education that produces young people who will not tolerate their peers living in abject poverty in the midst of plenty; young people who will be outraged by inequality and impatient to bring about change (UNESCO, 2009, p.1).

The German Federal Ministry for Economic Co-operation and Development Report: *Capacity Building in the Education Sector* holds that education for sustainable development forms an important aspect of educational quality. Education for sustainable development (ESD) is seen to empower children, adolescents and adults to shape their mind-set and actions for a sustainable future. ESD is also seen to form an important aspect of educational

quality as it enables people to understand their own as well as the global contexts and to shape their actions accordingly. The German Ministry states that ESD conveys sustainable development values and principles to society and the economy and underpins people's understanding of the complexity and interdependence of society, the economy and the environment (German Government, 2010), a narrative which is widely shared and promoted by UNESCO at a global level (UNESCO, 2009). UNESCO is accordingly mandated to lead implementation of the UN Decade of Education for Sustainable Development, which was promulgated as part of the Johannesburg Plan of Implementation in 2002, and launched in 2005.

Sen (1997) illuminates how quality, meaningful learning can bring about freedoms in everyday beings and doings (functionings). Green learning holds potential as learning experience that might overcome some of the ontological constraints and inadequate prior knowledge attributed to under-resourcing of workplace related skills development in the past. Inherent to green learning is a culture of life-long learning towards continual up-scaling of green measures. By leaving the capability framework under-specified and refraining from proposing a list of desirable capabilities, Sen centralises the participation aspect of epistemology – **by participation the learners in a society decide which capabilities are to count as 'valuable' in the particular collective or society**. This approach both requires and creates the freedom to choose valuable beings and doings and is significant to this research as it offers the potential to enrich a potentially narrowing 'technical' interpretation of green economy skills (Elliot, 2007).

Sen (1997; 1999; 2010) utilises the philosophical concepts 'freedom' and 'capability' to reconceptualise the relationship between society and economy in the context of a transition to sustainable development. Sen's (1997) Capability Theory can offer a view of learning that incorporates values of social freedom and quality of life through learning, thus extending learning to include purpose or answering questions about the philosophical and societal intent and value of education. Sen (ibid) holds that an individual's capability to change through learning is determined by valued freedoms in making purposeful choices. The notion of 'change through learning' gives rise to concepts like 'change oriented learning' (UNEP, 2012b). Elliott (2007) supports Sen's (1997) capability approach as it broadens the (worker-) learner's orientation to also include real choices and a consciousness and deliberate engagement with choice-making with respect to green functionings.

Rosenberg's utility principle (City of Cape Town, 2004) requires pedagogy to recognise and reinforce participants' freedom to make reflective, informed choices, thus being useful to participants. This principle validates Sen's (1997; 1999; 2010) and Elliot's (2007) views that quality education creates capability and freedom and resonates with Bradshaw's (2012) notion that learning events meeting learners' needs in 'practical and applicable' ways have a better chance of securing learners' willingness to assimilate the knowledge and skills offered. Rosenberg (2008) maintains that quality environmental education contains meaningful learning experiences, creating opportunities for change and encouragement to re-imagine reality, venture into new ways of thinking and doing and completing assignments.

Capability acquired through learning allows people to enunciate valued beings and doings and establish new workplace cultures and new forms of competence (e.g. minimising the energy and resource intensity of economic practices); and finds expression in a culture of becoming over and over again through life-long learning (e.g. constantly updating knowledge and competences in ongoing cycles of learning and change). In this context, the nature of sustainability as multi-faceted core element of the green economy and the undesirable prospect of un-sustainable development "... requires a fundamental change of epistemology and therefore education. Changes are necessary in curricula, pedagogy, policy and institutional structures" (Concoran, 2010, p. xiii).

Concoran 'epistemological reform' argument is reminiscent of Sen's capability theory and Rosenberg's utility principle, in maintaining that education for sustainability should support democratisation of the educational process through respecting people's capabilities and their abilities to express valued beings and doings, in and through experiential and applied learning opportunities where change is both possibility and reality.

To SECO the rationale for supporting energy efficiency initiatives across the world is the conviction that such technical and financial support serve to promote green conduct, human development and quality of life (SECO, 2011).

In leveraging green industry knowledge in practice, the sustainability practitioner would be guided by principles of social learning. Wenger explains this complex but unavoidable challenge:

The success of organisations depends on their ability to design themselves as **social learning systems** and also to participate in broader learning systems

such as an industry, a region or a consortium (Wenger, 2000, p. 225, my emphasis).

The authors Pór and Brown, (2001) caution that the business community's poor understanding of how to **create and leverage knowledge in practice** constitutes an epistemological crisis, as knowledge is recognised as a key source of competitive advantage, yet it is not always effectively shared or co-constructed in the workplace. This challenge has also been highlighted by authors advocating a departure from technician approaches to training in the business and industry context and devising transformative, reflexive and change-oriented models of workplace learning (Rosenberg, 2004; Lotz-Sisitka and Raven, 2009; Engeström and Sannino, 2010).

### **Zone of Proximal Development**

Insight into the importance of social learning in the context of interacting activity systems in the workplace might be gained from Engeström and Sannino's (2010) review of expansive learning – a methodology developed to strengthen change-oriented learning in workplaces. The concept of change-oriented learning **values contradictions within activity systems, for example in workplaces, as a source of learning**, as such contradictions provide frames for constructing 'zones of proximal development' (ZPD) (see section 1.4.1).

Engeström and Sannino's (ibid) work draws on earlier Vygotskian theory which indicates that **learning leads development**. Vygotsky emphasises the need for assessing learners' ZPD as it signifies the difference between what people currently know and what is possible to know.

In a green learning context in industry, workers would for example know how to operate technologies from a procedural perspective, but may not know (yet) how to operate the same technologies from an energy saving and resource efficient perspective. In this context, the sustainability concern or 'content' provides a new ZPD (yet to know content) for the learners. As a measure of evaluation to determine if learning has occurred it is important to re-assess ZPD (Rieber and Robinson, 2004).

Newman and Holzman (1993) argue that ZPD located in material reality and in the social processes that produce it, meets the *principle* of "explaining the interaction between individual and society" (p. 79). Engaging with complex objects such as sustainability in social contexts, where ZPD is "understood to represent the fundamental social historical characteristic" ZPD allows for conceptualizing the possible scope of green learning (Newman

and Holzman, 1993, p. 80) that links what is currently known in socio-cultural / socio-historical context, to what can be known with the introduction of new knowledge via various supportive education and learning processes. Human capital development programmes for workplaces need to consider worker-learners' educational history, inclusive of the quality of such education and new possibilities for learning, as outlined in the example above. From this important insight about the socio-cultural and socio-historical nature of learning, it is possible to deduce that learning material adapted to learners' prior knowledge and experience, has a better chance to be understood, assimilated and implemented in the workplace, leading to new development of activity and practices, as also confirmed in the extensive review of research in this area by Engeström and Sannino (2010).

### **2.2.2. South African realities**

Based on the notion of ZPD green education practitioners need to take into account South Africa's historical and current educational and training conditions. South Africa's general lack of energy related competence can for example be traced back to historical factors like exploitation of fossil reserves (coal) to provide large energy consumers like industry and mining with cheap, subsidised electricity, diluting the need for energy efficiency. Moreover, the 1994 democratic government inherited an educational system characterised by deep seated historical inequalities. In line with world-wide trends prevalent at the time separate systems also existed for training and education, which reduced occupational learning to a narrow productivist-focused experience. This approach also limited career progression and marginalised the employability of a section of the population (Lotz-Sisitka and Raven, 2009; Anderson, 2009).

The impact of ontological disparity and variation in prior learning needs to be managed bearing in mind Vygotsky's (1978) notion of ZPD and the role of a more knowledgeable other in scaffolding as approach to teaching (Bruner, 1990). In the beginning stages of green learning there may be a shortage of more experienced or knowledgeable others and an intensive programme of 'training the trainers' would be required. Variation in prior learning may also restrain learning in and across communities of practice and activity systems (Rogoff et al., 1996; Wenger, 2000; Engeström and Sannino, 2010). A thorough assessment of potential learners' prior learning and also what learning is already taking place in workplace

communities of practice could be helpful as part of situation analysis to ensure successful green learning in industrial workplaces.

### **2.2.3. Systemic approach to green skills development**

Re-conceptualisation of the relationship between economic development and society constitutes a subtle but important (re)orientation of Sen's capability approach, enriching the orientation of educational policy and practice, to also include real choices that people have and a consciousness and deliberate engagement with such choices. In a green economy education and training context worker-learner's freedom to make choices in accordance with quality of life values, can potentially invite innovative learning and improvement of production processes. In contrast to workers treated as 'merely means of production' worker-learners empowered with green skills and knowledge demand recognition as sustainability partners (Sen, 1997; 2010; UNESCO, 2005; Elliot, 2007; see section 2.1.2).

Illeris (2011) views modern day workplace learning as 'competence development', referring to what an individual worker is able to accomplish or the tasks the person would be able to perform, based on personal attributes in combination with skills and qualifications acquired with respect to a specific achievement. Illeris emphasises the value of competence in specific areas of work, in managing uncertain, unforeseen and unpredictable situations in the same or related area of work. The notion of 'uncertain, unforeseen and unpredictable situations' in workplaces resonate with Beck's (1992) view of modernity as a risk society. Investors would be reluctant to implement green techniques and technologies in workplaces where workers lack competence and tacit knowledge of modern technologies (Kahn, 2009). Drawing on Illeris, evidence of green learning achievements may serve to overcome such reluctance. Quality green industry learning would be situated in apprentice-like context and focused on up-scaling the employability of people in workplaces (Illeris, 2011).

The IISD webpage 'What is Sustainable Development?' (IISD webpage, n.d) notes that the concept of sustainable development is rooted in 'systems thinking'. Learning to understand the world as a system-over-space facilitates understanding of how air pollution from North America affects air quality in Asia and how pesticides sprayed in Argentina could harm fish stocks off the coast of Australia. Learning to understand the world as a system-over-time brings knowledge of how the decisions our grandparents made about farming the land, continue to affect agricultural practice today and how the economic policies we endorse

today might in future cause urban poverty. Sustainability learning based on ‘systems thinking’ brings us self-insight and insight into our world and how to innovate for a healthy and meaningful future (ibid).

Sustainability learning projects and programmes have over the past two decades been commissioned in South Africa by developed country and international agencies such as UNEP, UNIDO, UNICEF, Swiss State Secretariat for Economic Affairs (SECO), Danish International Development Agency (DANIDA) and the UK Department for International Development (DFID). In accordance with National Treasury regulations the conditions for allowing such projects include endorsement and governance by an overseeing government authority – in the event of the case studies **the dti**. National Treasury also requires the projects to leave a legacy by transferring knowledge and skills to South African participants (UNIDO, 2009; NCPC-SA 2011; 2012).

The systemic approach coined by the Agenda 21 theme of ‘environmentally and socially sustainable development’ (UNCED, 1993) transpires at international green economy forums and also in South Africa’s New Growth Path and NDP as discussed in Chapter 1, see also section 1.2.2). The New Growth Path’s micro-level drivers for change appropriately cover ‘stepping up education and skills development’ (RSA. The Presidency, 2010, p. 20). Critical to achievement of this goal is the training of 30 000 engineers by 2014 and 50 000 additional artisans by 2015. The central role of the Sector Education and Training Authorities (SETAs) in achieving this goal is emphasised. The NDP’s National Programme of Action (RSA. The Presidency, 2011) reflects commitment to a new jobs-rich growth trajectory as mentioned above, which is gradually becoming visible in policy and strategic frameworks like the recent revisions of the Industrial Policy and Action Plan (IPAP), providing for green industries and industry greening and prioritising energy efficiency (RSA. **The dti**, 2010; 2011). The second Industrial Policy and Action Plan contains several green objectives, for example a ‘Green Industries’ subsector, an ‘Industrial Energy Efficiency Framework’, an ‘Industrial Waste Management Strategy’ and significant to this study, the expansion of the NCPC-SA (RSA. **The dti**, 2010; 2011).

These macro level policies however leave it to micro level strategies to ensure that skills development mechanisms equip new engineers and artisans with environmentally sound skills to meet green economy requirements. The Environmental Sector Skills Plan for South Africa (DEA, 2010) showed that there is often poor alignment between the different levels of

micro-organisation that is required for the skills development that is needed. It emphasises the alignment of sector policies; and in this regard education and training system policy and practice is particularly important for mediating and facilitating skills development towards a green economy (Lotz-Sisitka et al., 2012).

At a broad level it is encouraging that the White Paper on Education and Training includes guiding principles for environmental education that are relevant to all phases and levels of the education and training system, including occupationally directed education and training:

... environmental education, involving an interdisciplinary, integrated and active approach to learning, must be a vital element of all levels and programmes of the education and training system, in order to create environmentally literate and active citizens and ensure that all South Africans, present and future, enjoy a decent quality of life through the sustainable use of natural resources (RSA 1995a, p.18).

As argued by DEA (2010), and by Lotz-Sisitka et al., (2012), a government-supported educational system is required for meeting the green economy's multiple skills demands and maintaining the quality of qualifications. The mandate of the national Department of Higher Education and Training includes the responsibility to oversee implementation of the NQF by SAQA, which oversees three quality councils: the Council for Higher Education (CHE), UMALUSI and the Quality Council for Trades and Occupations (QCTO) (SAQA, n.d).

The NQF provides for seamless articulation, movement and progression between qualifications, based on an innovative system of credits and recognition towards redressing South Africa's sub-optimal skills development legacy. One of the problems, however, is that the NQF system has not been easy to implement, and it has since been reviewed, with significant structural changes, especially the transferring of qualifications development to professional communities working under the three quality councils (ibid).

The SETAs, overseen by the QCTO and informed by enterprises' workplace skills training plans and reports, develop, implement and regularly update sector skills plans (SSP). The SETAs also conduct research into new areas such as green skills, but experience to date has shown that the SETA system is slow to respond to the Green Economy trajectory, as SETAs also struggle to obtain adequate green skills research capacity. This reflects the finding in the Environmental Sector Skills Plan for South Africa that the national system of skills development is largely *re-active* (DEA, 2010).

Business leaders, as co-signatories of the Green Economy and National Skills Accords, are affiliated to industrial SETAs such as the merSETA and CHIETA and contribute to their work by means of the training levy system for workplace related skills development. The RECP and IEE programmes share industry as customer base with the SETAs. SETAs deliver training through a body of recognised training providers that are guided by the Sector Skills Plans in proposing training courses for SETA recognition.

Some green economy components of SETA related sector skills plans (SSP) recently published, tend to focus more on extended business and job opportunities in recycling and manufacturing of basic environmental goods (electric cars, equipment for wind and solar energy generation and solar water heating) than on resource and energy efficiency and greenhouse gas reduction.

Newly published Sector Skills Plans that reflect these contents include:

- i. Public Sector Skills Plan (PSETA, 2011);
- ii. merSETA Sector Skills Plan (merSETA, 2011); and the
- iii. Chemical Industries Education and Training Authority (CHIETA) Sector Skills Plan (CHIETA, 2012).

Bearing in mind government's green economy objectives, it would seem that there is a need for Sector Skills Plans to put forward indicators for green skills to guide training providers' process of developing recognised training courses. Indicators for green skills however need to equalise a complex set of requirements, for example labour-intensity, productivity of people and resources and competence in modern techniques and technologies towards a resource efficient, low carbon economy.

Recently published Sector Skills Plans recognise the need for green skills, admitting that implementable plans are still being constructed (merSETA, 2011; PSETA Sector Skills Plan, 2011; CHIETA, 2012).

The merSETA in its strategic planning for the metals sub-sector for example takes a tentative and reactive stance that needs refinement to meet the entire set of requirements for a resource efficient, low carbon economy.

In the long-term, initiatives that are being considered under the green economy strategy will expand opportunities of growth in the sub-sector. Currently, these are still in the planning stage and include the recycling of scrap metal and solar water heating manufacturing. However, the sub-sector can begin to consider the

impact of these initiatives on skills development, and prepare foundations to respond to demand once the initiatives are ready to be implemented (merSETA, 2011, p. 127).

Clarity of communication necessitates distinction to be made between at least three different contexts in which the term ‘sector’ is used in this research. (a) The ESSP is organised around environmental sectors such as water, biodiversity and climate; (b) The Industrial Policy and Action Plan (RSA. **The dti**, 2010; 2011), and therefore the NCPC-SA’s sustainability programmes, are organised according to industry sectors, for example the clothing and textiles, the metals and the chemical sectors (in some literature referred to as sub-sectors); (c) Sectors represented by the SETA system includes sectors of the macro economy and may be categorised in groups (own categorisation): The cross-cutting energy and water sectors are combined in one SETA, governance sectors are divided among four SETAs; manufacturing, engineering and mining industrial sectors are categorised in four groups, services sector is categorised as a single group and the standalone construction sector is categorised on its own. This makes for a complex context for green skills planning in South Africa.

#### **2.2.4. Emerging mechanisms for green skills development**

Neglecting green skills development poses the risk of technology driven industry greening, compromising the NDP vision of a competent, knowledge-rich, employment intensive national workforce. Creating a comprehensive set of appropriate green skills indicators is seen as a gateway to South Africa’s challenge of shaping an educated, employment-rich, sustainable future (see section 1.3.2).

It is significant to note that the mandates of lead agent for both the **environmental sector** and **economy greening** are assigned to the Department of Environmental Affairs (DEA) (RSA. DEA, 2010; RSA. The Presidency, 2011). As such DEA

... is mandated to ensure that South Africa efficiently manages the environment for the benefit of current and future generations, according to the Bill of rights in Section 24 of the Constitution ... and to provide leadership, policy and institutional frameworks to facilitate effective service delivery ... in relation to environmental mandates ... (RSA. DEA, 2010, p.5).

As no dedicated SETA exists for the environmental sector, DEA established the National Environmental Sector Skills Planning Forum (NESPF). Through the NESPF DEA put forward the Environmental Sector Skills Plan (ESSP), published along with a number of supporting documents (DEA, 2010). The ESSP feeds into Sector Skills Plans developed by

SETAs and Human Capital Development (HCD) strategies developed by subsectors. On the basis of DEAs mandate as lead agent for the green economy the ESSP explicitly requires SETAs to integrate the environmental driver in sector skills plans (DEA, 2010). The ESSP provides broad guidelines for developing knowledge-rich professional green skills in order to respond to complex challenges, for example analysis and conservation of water catchment areas, creating software for co-ordinating country-wide industrial symbiosis systems and maintaining ambient air quality. As the ESSP is not only a green economy strategy (but is oriented towards all forms of environmental activity and also includes public sector environmental occupations), the ESSP is less explicit on the view shared by Barbier (1978), Agenda 21 (UNCED, 1993), Howells and Laitner (2005) and Hohnen (2012) that industry holds the key to economy greening (see section 2.1.1).

The ESSP's requirement to integrate the environmental driver into Sector Skills Plans supports the NDP's notion that all socio-economic sectors need a basic understanding of the limited supply of and increasing demand for food, energy, water, open spaces and other life-sustaining resources. The NDP requires green learning to be systemically integrated in basic, higher and technical training. The role of the National Environmental Sector Skills Planning Forum NESPF is to ensure co-ordination and an efficient, synergistic incorporation of the environmental driver into sector skills plans and other skills development planning processes and activities in South Africa (RSA. DEA, 2010; RSA. The Presidency, 2010; 2011; see sections 2.1.2; 4.3.1 and 4.3.3).

The ESSP by means of an incorporated underpinning study prepared by Lotz-Sisitka, Rosenberg, Ramsarup and Vallabh (2010): *'Integrating the Environmental Driver into Sector Skills Plans in South Africa: An Enabling Document for all SETAs'* explicitly spells out green economy skills needs and the sustainable development qualifications the SETAs should provide for as a minimum. In response to the green economy's low-carbon focus, energy security and climate change mitigation through efficient energy use and renewable energy generation take centre stage but due emphasis is put on reduced water consumption and conservation of water quality as South Africa is a water scarce country. Skills and knowledge needs at this point in time by far exceed South Africa's capacity to keep pace of world-wide implementation of 'sustainable development innovations', replacing the previous cycle of 'mass production' innovations (Montavaldo, 2009; Lotz-Sisitka et al., 2010).

UNEP/ILO/IOE/ITUC (2008) points out the need to alleviate skills shortages in industry in South Africa and particularly green skills shortages. The green skills focus of this report and follow-up investigations into the shortage of green skills in South Africa alludes to the poor ability of the workforce to practice techniques for efficient utilisation of energy and resources, to minimise waste and to optimise energy systems. Kahn (2009) expresses concern that developing economies fall short of the tacit knowledge required for industrial modernisation, for example to implement more efficient (green) techniques and technologies. Recent reports addressing the state of skills development in South Africa (UNEP/ILO/IOE/ITUC, 2008; South African - German Development Co-operation Programme, 2011) state that skills shortages in South Africa inhibit potential green growth. The reports emphasise the need for extensive skills improvement among industrial engineers and artisan occupations in South Africa. A more recent report reveals that, although South Africa has evolved in the environmental field at strategic level, little improvement has occurred in green skills levels since the 2008 survey (UNEP 2012a).

Recent research towards developing a co-ordinated system of change-oriented green learning includes:

- i. *Human Capital Development Strategy for the Environmental Sector 2009 – 2014. A systems approach to skills development to support the ESSP.* (RSA, DEA, 2009);
- ii. *The Environmental Sector Skills Plan for South Africa (ESSP).* (South Africa. DEA. (2010a). The ESSP intends to ensure that the government’s Medium Term Strategic Framework goal ‘Sustainable Use of Natural Resources’ is included in national skills planning and development processes. (RSA. DEA, 2010b);
- iii. A paper by Lotz-Sisitka, Rosenberg, Ramsarup and Vallabh (2010), underpinning the ESSP: *Integrating the Environmental Driver into Sector Skills Plans in South Africa: An Enabling Document for all SETAs* (RSA. DEA, 2010b);
- iv. A paper advocating a systems approach to green skills, developed as a partnership comprising Rhodes University Environmental Learning Research Centre, South African Qualifications Authority (SAQA) and the Green Matter and National Environmental Sector Skills Planning Forum: *Green Skills Development in South Africa. System perspectives for the shaping of learning pathway possibilities for sustainable development, the green economy and climate resilient development.* (Lotz-Sisitka, Ramsarup, Gumede, Togo, and Rosenberg, 2013); and

Having agreed to the Green Economy and National Skills Accords, investors and business leaders have an obligation to upskill staff and manage human capital with due recognition of green criteria for specific areas of work. In accordance with the ESSP the terms ‘skills’ and

‘green skills’ as used in this study, refer to the occupational categories required to fulfil green economy mandates, inclusive of the knowledge, values and competences needed to fulfil such mandates (RSA. DEA, 2010). South Africa’s well-developed NQF system differentiates between levels of qualifications, with emphasis on flexibility of learning paths and career progression based on the principle of articulation between and along qualification ladders. Entry level workplace related skills, for which an Adult Basic Education and Training (ABET) level 4 or Basic Education Grade 9 qualification is required, are differentiated as NQF level 1. NQF levels 2-6, categorised as intermediate skills, require Basic Education Grade 9, Further Education and Training (FET) or diploma qualifications and are also known as technical, artisanal or Technical and Vocational Education and Training (TVET) skills. High level skills range between NQF levels 7 to 10, representing Bachelors and further degrees up to PhD level, attained within an articulating system of mutually recognised higher education institutions. Engineering training belongs in the category of high skills (RSA, 1995b; SAQA, n.d).

### **2.2.5. Skills and knowledge for efficient and optimised energy consumption**

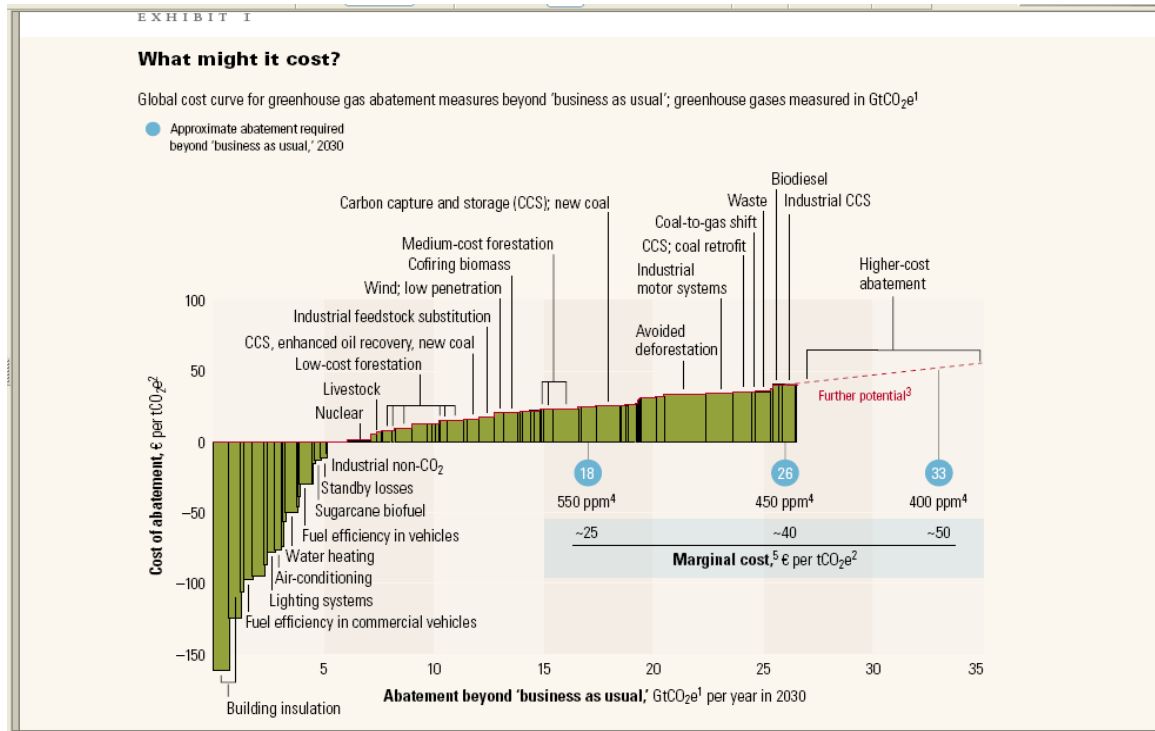
Efficient and optimised energy consumption, in combination with generation from renewable resources, counters oil price fluctuations and bolsters energy security. Optimised energy consumption requires managers, engineers and artisans to develop applied competence in implementing guidelines for energy management systems (EnMS) and energy system optimisation (ESO) (UNIDO, 2009). ESO is

...one of the most cost-effective measures to help supply-constrained developing and emerging countries meet their increasing energy demand and loosen the link between economic growth and environmental degradation. The Industrial Energy Efficiency (IEE) project is anticipated to bring about a sustainable transformation of industrial energy usage practices in South Africa and possibly in the southern African Region. ... It has been estimated that industry has the technical potential to **decrease its energy intensity and emissions by between 26 per cent and 32 per cent, providing a striking 8.0 and 12.4 per cent reduction in total global energy use and CO<sub>2</sub> emissions respectively** (UNIDO, n.d.a, p.1, my emphasis).

McKinsey and Company (2009) holds that energy system optimisation is one of the most cost effective measures to help supply-constrained developing and emerging countries meet their increasing energy demand and loosen the link between economic growth and environmental

degradation. The authors' green-house gas abatement cost curve shows that the cost of green-house gas abatement by means of building insulation and energy system optimisation inclusive of lighting, air conditioning, water heating, fuel efficiency in vehicles, sugarcane biofuel, minimising standby losses and industrial use of non-CO<sub>2</sub> energy is actually negative. Based on many examples of this reality energy system optimisation is generally accepted as one of the most cost effective green-house gas abatement measures available.

**Figure 2.2. McKinsey green-house gas abatement cost curve. McKinsey and Company (2009).**



Mohr-Swart on Environmental and Sustainability Solutions Homepage (n.d.) notes that carbon management and reporting will be mandatory, with carbon taxes expected to become a reality for South Africans from 2016 onwards at R120/t CO<sub>2</sub>e. The South African Chapter of the National Business Initiative (NBI), supported by the University of Cape Town's Energy Research Centre, since 2005 administers the South African Energy Efficiency Accord, an international initiative of the World Business Council for Sustainable Development (WBCSD). In contrast to regulatory carbon footprint minimisation measures such as carbon taxes and border adjustment trade tariffs the Energy Efficiency Accord constitutes voluntary carbon minimisation. Executive Guides on Climate Change and Energy Efficiency training are used by Accord signatories and were taken into account in developing IEE courses (Environmental and Sustainability Solutions Homepage. n.d; Energy Research Centre Homepage, n.d.; NBI, 2005; UNIDO, 2009).

The Energy Efficiency Accord is but one example to illustrate the reality that green skills do not exist in isolation but constitutes a ‘greening’ of conventional skill sets. The greening of conventional industrial skill sets occurs with respect to engineering and artisanal curricula vested in education institutions but also in structured and incidental re-skilling of people in the course of everyday functionings at work. Lotz-Sisitka and Raven’s review of the notion of ‘applied competence’ (used in the South African NQF) as guiding framework for sustainability education similarly acknowledges that workplace competences are developed over years of conventional artisanal and engineering praxis (Lotz-Sisitka and Raven, 2009).

The focal area of this study is sustainability requirements and more specifically energy and resource efficiency, waste minimisation and energy systems optimisation. Extending the notions of quality learning and applied competence to industry greening situations, unlocks the elevation of conventional competences to a level of applied green competence, integrating sustainability requirements in conventional praxis. Practitioners oriented to career-long learning can reach levels of skill where practical, foundational and reflexive competences interact and combine in applied competence (Lotz-Sisitka and Raven, 2009), serving to resolve industry greening challenges. Applied green competence for example empowers industrial practitioners to detect and skilfully manage unintended effects of efficiency and optimisation improvements, maintaining production flow and quality.

#### **2.2.6. Green training of people in artisanal occupations**

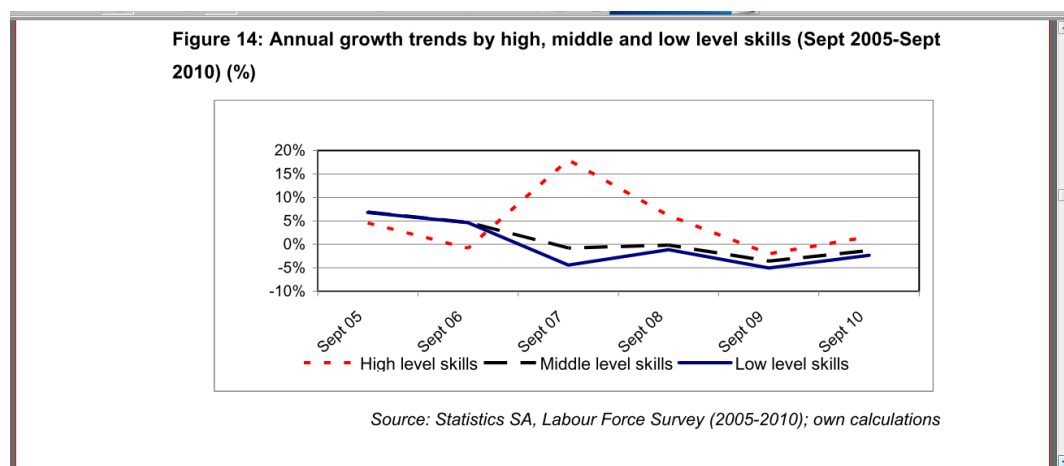
People are an organisation's most valuable resource. On basis of this fact, Wenger challenges organisations to recognise the communities of practice through which individuals often develop and share knowledge (Wenger, n.d.; 2000). Engeström and Sannino (2010) takes a similar approach by encouraging organisations to understand the importance of learning from contradictions within and across workplace activity systems, as this is central to the development of new human activity in workplaces. These approaches have also been explored in environmental education research that is oriented towards change-oriented learning in workplaces and community contexts (Lotz-Sisitka, Belay and Mukute, 2012).

The obligation to upskill staff and manage human capital with due recognition of green criteria particularly involves engineers and technical occupations. UNESCO emphasises the role of technical education also known training and education for artisanal or TVET occupations:

We have ... concluded that Technical and Vocational Education, as an integral component of lifelong learning, has a crucial role to play in this new era as an effective tool to realise the objectives of a culture of peace, environmentally sound sustainable development, social cohesion and international citizenship (UNESCO, 1999, p. 61).

Drawing on UNESCO (1999), Fien and Maclean (2009) consider TVET a priority in green skills development. Gough (2009), drawing on Park (2009) and Anderson (2009), supports the notion of a ‘capital approach’ to sustainable development. Gough points out that education, and TVET in particular, is prominent in adding value to and leaving as legacy, sustainable human, social and natural capital towards securing an ecologicistic future. In South Africa, there is a massive skills development crisis, as discussed below.

**Figure 2.3. Share of high, intermediate and artisanal skills to overall employment 2005 – 2010. (RSA. The dti, 2011)**



South African leaders such as Pravin Gordhan recognise the skills development backlog as a binding constraint to the green economy transition, dampening green employment expectations (RSA. National Treasury, 2012). Gordhan by this statement confirms **the dti’s** report to the Economic Sectors and Employment Cluster, revealing a declining ratio of trade and vocational skills, also known as artisanal skills, in comparison to overall employment. While there has been an increase in the share or percentage of high skills to overall employment, the share of intermediate skills has remained static and there has been a decline in the share of artisanal skills (see figure 2.3 above). This implies that the current size and trends in the skills profile of the labour force do not support the growth and technological

opportunities arising from the second Industrial Policy and Action Plan in the foreseeable future (Statistics SA, Labour Force Survey (2005-2010); cited in **the dti** Report to Economic Sectors and Employment Cluster (RSA. **The dti**, 2011).

A collection of authors publishing in Fien, Maclean and Park (Eds) (2009) focus on greening technical and vocational (TVET) curricula associated with lower and intermediate level artisanal skills. 'Productivism' in TVET institutions world-wide, however, may represent powers that oppose industry greening (see section 1.3.2). While the productivism contradiction can be expected to evolve as a driver of change (Engeström, 2004) it currently has the potential to erode the NDP's promise of 500,000 new green jobs (RSA. The Presidency, 2011).

Drawing on Sen's theory, a participative approach allows for learners' own assessment of which capabilities are to count as 'valuable'. This approach both requires and creates the freedom to choose valuable beings and doings and is significant to this research as it offers the potential to enrich a potentially narrowing 'technical' interpretation of green economy skills and competences. Whether or not in an industrial setting, effective green learning requires epistemologically sound quality teaching, confirming learners' freedom to live their valued functionings (doings and beings) (Sen, 1997; 1999; 2010; Elliot, 2007).

Rogoff, Matusov and White (1996) found communities of learning, based on *participative transformation* as epistemological model to be an effective, sustainable and thus preferred learning model, where learning is about transforming the nature of one's participation in a collaborative endeavour in contrast with adult driven models facilitating 'transmitting' of knowledge or learner driven models facilitating 'acquiring' knowledge. Learning through participative transformation implies interpretation of events and problem solving in a 'real life' context as *members of a transforming community*, comprising both learners and more experienced members, or members of diverse communities in the workplace. To illustrate this in the cleaner production context, individual practitioners such as engineers sharing a concern or passion often form a circle of peers that participate in troubleshooting and solving difficult challenges across different business units as is often the case in workplaces (Wenger, 2000; Engeström and Sannino, 2010). Social learning theorists like Rogoff et al., (ibid), Engeström and Sannino (ibid) and Wenger (n.d., 2000) argue that by focusing application of principles in a variety of situations communities of practice generate dynamic knowing, adding value to members' tacit knowledge and competence. In the case of Engeström and

Sannino (2010) and Wals (2007) the authors suggest that engaging with contradictions and dissonance is also an important part of this process as it opens up enquiry towards new learning, hence the increasing popularity also of problem-based learning approaches in business and industry training.

Katherine Bradshaw (2012) notes that for learning to be effective the content and experience need to be practical and applicable to learners' lives, creating meaningful learning experiences. What does this mean for workplace oriented sustainability learning? By implication Bradshaw suggests that sustainability learning approaches trusted by workers to meet their own short term concerns like job satisfaction, increased employability, career path advancement and qualification progression in an applicable and practical way may have a better chance of securing worker-learners' willingness to assimilate and act out the sustainability knowledge and skills offered by the programme.

Quality education and training in workplaces would reflect the freedom to question and re-imagine conventional practices and convert valued beings, doings and resources into new functioning and capabilities oriented towards a low carbon green industry. As outlined above, Sen's (1997; 1999; 2010) notions of freedom and capability provide a mechanism for engaging with future concerns, potentially also securing future generations' right to exert the freedom of choosing and living their own 'valued functionings, beings and doings'. Elliot (2007, p. 142) notes that "The major thrust of Sen's work is to use philosophical tools to reconceptualise the relationship between economy and society in the context of development".

### **2.3. CONCLUSION: THE ANALYTICAL TOOL**

Finance Minister Pravin Gordhan announced in his 2012-2013 budget speech that 'industry greening is imminent' (RSA. National Treasury, 2012). Realisation of a labour-intensive, green, low carbon future, however requires substantial education and training interventions to generate the necessary knowledge, skills and technology intensity required to green the economy through industry greening (UNEP/ILO/IOE/ITUC, 2008).

This study aims to reveal how the programmes under review meet green economy and green learning criteria and thus possess content and approaches that are suitable to be considered as contribution to current mainstream initiatives developing skills for the green economy.

Theoretical lenses for the nested review of the green skills programmes were derived from social learning theory and emerging aspects of green economy and green skills development. As shown earlier in this chapter, educational and development authors, inclusive of Sen (1997; 1999; 2010), Vygotsky (1978), Engestrom and Sannino (2010), Rieber and Robinson (2004), Bradshaw (2012) and Blom (2012) shaped my understanding of how people in workplaces acquire skills and knowledge. This chapter also shows that champions of sustainability and green economy, such as UNEP and UNIDO, stand out as agencies showing green economy leadership and supporting governments and cleaner production centres worldwide with capacity building that forms part of a constellation of green learning mechanisms.

Learning for sustainability implies that the valued choices of worker-learners are balanced between job security feeding into career progression, clean and healthy ecological systems, and sufficient enterprise prosperity for securing jobs and creating more jobs.

The ‘continual improvement’ requirement put forward by the Environmental Management Standard, ISO 14001 and the Energy Management Standard ISO 50001 resonates with the notion of lifelong learning (SAQA, n.d), innovation, implementation, assessment and new learning as the eco-innovation curve increasingly substitutes inefficient, resource-depleting practices (Elliot, 2007; UNIDO, UNEP and SECO, 2010; Montavaldo, 2009).

This chapter provides background for the design of a ‘triple bottom line’ case study of the sustainability learning programmes.

**Table 2.2. Analytical tool used for case analysis of green learning in green economy training programmes.**

<b>ANALYTICAL QUESTIONS</b>	<b>Sub-focus areas considered</b>
<p><b>i. How do the programmes relate to green economy policies (or not)?</b></p>	<p>International and national Green Economy policy alignment Retention and creation of jobs Interests and policy concerns of industrial stakeholders</p>
<p><b>ii. How do the programmes relate to social learning approaches (or not)?</b></p>	<p>Commitment to and reflection of quality education Commitment to and reflection of career-long learning Reflects engagement with Zone of Proximal Development (ZPD), scaffolding, participation and demonstrations in the training approaches and methods</p>
<p><b>iii. How do the programmes relate to emerging green learning aspects (or not)?</b></p>	<p>Reflection of skills development for the triple bottom line Multiple sector engagement Commitment to incremental improvement (ISO 14001 and ISO 50001) Focus on engineering and artisanal skills Organisational institutionalisation of training and materials used in training</p>

The analytical tool included above will be used in Chapters 3 and 4 to guide a ‘triple bottom line’ case study and to analyse the nested cases in NCPC-SA context.

### 3. CHAPTER THREE. CASE STUDY ANALYSIS

*In Chapter Three the NCPC-SA case example programmes, the RECP and IEE, are firstly described and then analysed by means of abductive and inductive modes of inference within a case study approach. The description and subsequent analysis draws on the multiple sources of data produced for the study, and the analytical approach described in Chapter 1, using also the analytical tool presented at the end of Chapter 2 which is based on the literature review of green economy trends, social learning theory and green learning emergence.*

#### 3.1. HOST PROGRAMME CONTEXT

Sections 3.1 and 3.2 draw largely on document analysis of NCPC-SA documents, and documents that are related to the RECP and IEE programmes (which are referenced throughout). The case descriptions are complemented with some observational data and interview conversational discussions.

Reporting to the Industrial Development Division (IDD) of the national Department of Trade and Industry (**the dti**) as mandating authority, and CSIR as hosting legal and financial control entity, NCPC-SA administers the RECP and IEE programmes with industry as customer base. NCPC-SA has offices at three CSIR campuses (Pretoria (head office), eThekweni and Cape Town) enjoying legal, managerial and financial management services from CSIR, an agency of the Department of Science and Technology (see section 1.1.2). The mandating IDD division is also responsible for implementing the IPAP, the industrial policy component of the national green economy. As such the IDD determines the NCPC-SA's mandate, which in broad terms implies improving the competitiveness of industrial enterprises by improving energy, water and materials efficiency (RSA. **The dti**, 2010; 2011; NCPC-SA 2011; 2012; 2013).

As pointed out in section 2.1.2 South Africa can be classified as an economy in transition from a conventional GDP to a Green GDP economic model, with employment a top priority.

In executing its mandate to support the viability of conventional industries as employers, NCPC-SA takes a three-pronged approach:

- i. Greening and retaining existing jobs;
- ii. Creating new green jobs as leaders effecting RECP in enterprises; and
- iii. Advocating procurement of cleaner technologies and green services, which stimulates employment in the environmental goods and services (EGS) subsector also known as green industries.

NCPC-SA has since inception as a small pilot project evolved into a green-job intensive employer, rolling out two main programmes and a number of smaller projects. The main programmes comprise the RECP programme that originated from the Cleaner Production template and the flagship IEE programme which has recently been granted funding for another four-year period. In contrast to conventional training institutions linked to the NQF system, the NCPC-SA's unique services act as catalyst to spearhead sustainability awareness and teaching in industrial settings, in the process also generating green jobs and business opportunities for South Africans (NCPC-SA, 2011b; 2014b).

NCPC-SA by means of two main programmes and a number of smaller projects assumes the task of spearheading sustainability learning in South African industry by introducing cleaner production best practices as they emerge internationally. Relations with SETAs and their monitoring authority SAQA, part of the NQF system, have strengthened since the advent of South Africa's green economy in 2010. NCPC-SA does however not aspire to convert to a conventional training institution delivering SETA recognised training.

The fact that the RECP and IEE programmes share industry as customer base with conventional training institutions might justify a dedicated communication effort to clarify the different services and pricing structures offered by the respective entities. The communication might also be a starting point for identifying areas of overlap and information exchange opportunities.

## **3.2 EDUCATIONAL CONTENT AND APPROACHES**

### **3.2.1. RECP objectives and content**

In the context of different orientations to nature-culture relations as put forward by Martinez-Alier (2002) who suggests three dominant approaches viz-a-viz: the cult of wilderness

(emphasising conservation and preservation of nature); sustainable development (emphasising eco-efficiency and ecological modernisation); and environmentalism of the poor (emphasising environmental justice and resource inequalities / political ecology), the NCPC-SA programmes relate mainly to the sustainable development paradigm as described by Martinez-Alier: The gospel of eco-efficiency represents a belief in new technologies, the 'internalisation of externalities', the sustainable management or 'wise use' of natural resources and pollution control as instruments for ecological modernisation (Martinez-Alier, 2002).

Existing green technologies and techniques have the potential to minimise green-house gas emissions and industry's environmental impact in general. McKinsey and Company holds that most of the carbon abatement needed between 2009 and 2030 is achievable with simple, everyday measures such as building insulation, electricity and fuel efficiency and switching to concentrated chemicals to reduce packaging and transport costs (McKinsey and Company, 2009; see section 2.2.2).

Learning from experience, both RECP and IEE teams realise that educational is imperative to moving stakeholders from 'business as usual' practices to cleaner techniques and technologies. Intensive educational intervention generates the skills, knowledge and confidence required to move Chief Executive Officers and engineers from awareness to implementation of efficiency measures. Continued learning underpins achievement of further levels of improvement such as optimisation of systems and eventually closing carbon, water and waste loops. Project managers with a technical or engineering background deliver RECP, EnMS and ESO training in partnership with consulting engineers, which may in some cases also hold positions as higher education lecturers.

*Resource productivity through energy and resource efficiency* stands out as the RECP's programme's core objective since inception in South Africa in 2001 as a cleaner production pilot project. RECP training content and basic approaches are guided by UNEP/UNIDO templates, while detailed approaches are customised to the specific sector and to South African conditions (UNEP, 2009b).

On the premise that inefficient practices and technologies result in waste and pollution, RECP interventions train process engineers and technical staff in water, energy and materials efficiency and waste minimisation. Training is presented in the form of introductory presentations, in-plant assessments, workshops and road shows. At commencement of an assessment, all workers in the business unit are requested to attend an introductory briefing to

create internal buy-in to findings and amendments that might be recommended. The educational component of the RECP comprises a participative technical efficiency assessment and advocacy, matching options for specific efficiency improvements to challenges identified in the course of in-plant assessments.

Enterprises participate on a voluntary basis. Assessments comprise physical inspection, measurement and calculation to quantify consumption and possible wastage of energy, water, feedstock and consumables. Findings are recorded and reported to management but treated confidentially. The consultant, an RECP trained engineer which is also a sector expert, applies generally accepted equations such as input-output models, resource balancing and costing to determine the nature and cost of wastage due to inefficiency. In the assessment feedback report calculations show the estimated cost and savings due to efficiency changes, inclusive of return on (cleaner technology) investment (ROI). The overarching approach is to close waste and pollution loops in consumption and production patterns, which implies re-use of resources, for example by treating and re-using process water and by generating energy from waste.

### **3.2.2. IEE objectives and content**

The IEE programme's core objectives comprise to *improve energy efficiency and to step up climate change mitigation in industry by reducing the rate of green-house gas emissions through improved EnMS and ESO*. On a national scale industry greening increases energy margins for economic growth and climate resilience. Trained energy users influence a wider circle of users by communicating energy related programmes, for example carbon disclosure and integrated reporting programmes.

Learning from experience with rolling out the RECP programme, the team of IEE programme designers under UNIDO leadership realises that equipping Chief Executive Officers and production engineers with efficiency awareness does not by default move enterprises from un-sustainable practices to sustainability. The fact that no-cost low-cost low-technology efficiency suggestions are often implemented points to budget, skills and knowledge as areas of constraint delaying full implementation of suggested efficiency measures.

IEE courses equip multiple levels of people in workplaces with low-carbon energy management skills. The programme is strongly focused on a reflexive approach to implementation as an integral part of training. IEE training includes (1) introductory courses

for Chief Executive Officers and vendors, (2) high level and expert energy management training of project managers and engineers and (3) training of technical energy practitioners, also known as TVET or artisanal occupations.

Against its green-house gas reduction commitment government in 2009 gave UNIDO a mandate to allow experts of their choice to implement the IEE programme in industry through NCPC-SA as host programme. In contrast to the world-wide trend of reducing occupational education to narrow productivist-focused technical training (Anderson, 2009) the IEE meets some of the guiding criteria set by the White Paper on Education and Training for quality environmental education (as outlined in Chapter 2). By linking energy and cost savings to climate change mitigation and calculating the green-house gas reduction effect of different system optimisation options, IEE awareness raising and training contribute to environmental literacy of citizens as required by the White Paper on Education and Training (RSA 1995a; UNIDO 2011).

### **3.2.3. Categories of IEE Courses**

The high level and expert EnMS curricula are informed by the National Energy Efficiency Strategy (NEES) and the ISO 50001 Energy Management Standard. ESO energy system optimisation courses, covering a range of energy systems, are NEES and EnMS compliant but focus on detailed technical aspects relevant to optimising energy use of the systems (UNIDO, 2009). Individual course curricula include the overarching EnMS and ESO courses for respective fan, pump, compressed air, motor and steam systems. A representative piece of course material is selected to inform this review: 'Development Framework for UNIDO Training Package on Pump System Optimization. Draft. 30 April 2011' (UNIDO, 2011).

Introductions, in-course discussions and shared exercises contribute to knowledge exchange, bringing participants to a common level of understanding. Terminology is clarified throughout the lectures (UNIDO, 2011).

The expert level EnMS course comprises an in-depth knowledge of the framework for energy management encapsulated in the ISO 50001 EnMS Standard. An engineering degree or diploma combined with completion of the EnMS short course is requisite to enrolling for the expert level EnMS, equipping candidates with applied competence in energy management and detailed assessment and optimisation of energy systems (UNIDO, n.d.a; n.d.c; 2009).

The range of different ESO courses covers application of SANS ISO 50001 EnMS principles in the respective energy consuming systems in industry. Different ESO courses specialise in typical industrial energy-consuming systems such as pump, fan, motor, boiler, compressed air and heat-ventilation-air-cooling (HVAC) systems. Training workshops include practical exercises, for example calculation of savings, energy consumption and green-house gas emissions; and reductions as a result of optimisation. ESO means to ensure that each component is working efficiently while the optimal working of the whole system is regularly tested, quantified and adjusted to continually minimise consumption while improving reliability. Course content for example includes equations that empower engineers to calculate potential savings and compare different options. ESO students receive software to assist with calculation. A high ESO implementation rate is experienced. Enterprises keep record of their energy and financial savings. The records are used for feedback to the IEE, and for carbon and integrated reporting.

At the Two-day Motor system Optimisation Course for engineers Dr Hugh Falkner, Chief Sustainability Engineer at Atkins Environmental Services, Oxford, UK, trained engineers to calculate and compare the environmental and financial implications of different optimisation options. In a classroom example the energy consumption by a system for a week pre- and post-optimisation are compared. The difference of 146 kW savings for the week is converted to financial savings on basis of electricity rates and to a carbon saving of  $146 \text{ kW} \times 70.4\text{g} = 103 \text{ kg}$  per week. At 103 kg per week a single system saves approximately 5 tonnes of carbon emissions per week, which amounts to significant carbon reductions for sectors and whole economies. The lecturer furthermore points out that the energy consumption in fan system loads is sensitive to speed, to such an extent that the user can achieve significant savings with even modest speed adjustments. For example, a 100 kW motor driving a load continuously throttled to 50 percent in contrast to 100 percent of output will save almost 18000 Euro per year (assuming 6000 hours per year @ 0.06 Euro/kWh) (De Almeida, Fong and Falkner, 2012, p. 40; Observation Memo section C.5.2).

The ISO 50001 EnMS that informs IEE courses prescribes continual incremental improvement and review of energy systems. The IEE's emphasis on continual cycles of learning and change is confirmed by the NCPC-SA Sector Review (2012), which reports that incremental rather than 'earth moving' changes bring about meaningful and sustained energy optimisation results (see sections 2.1.1; 2.2.2).

### 3.2.4. RECP and IEE interrelatedness

NCPC-SA extends its services to enterprises via business associations and **dti** sector desks in several industrial sectors identified by the Industrial Policy and Action Plan as strategic drivers of growth and employment including:

- i. Agro-processing
  - ii. Automotive
  - iii. Chemicals, cosmetics, plastics fabrication and pharmaceuticals
  - iv. Fibres, textiles, clothing, footwear and leather
  - v. Green industries including utilisation of waste
  - vi. Metals fabrication, capital goods and transport equipment
  - vii. Pulp and paper
  - viii. Tourism and hospitality
  - ix. Mining (in relation to the IEE only)
- (RSA. **The dti**, 2010; 2011; NCPC-SA, 2012b)

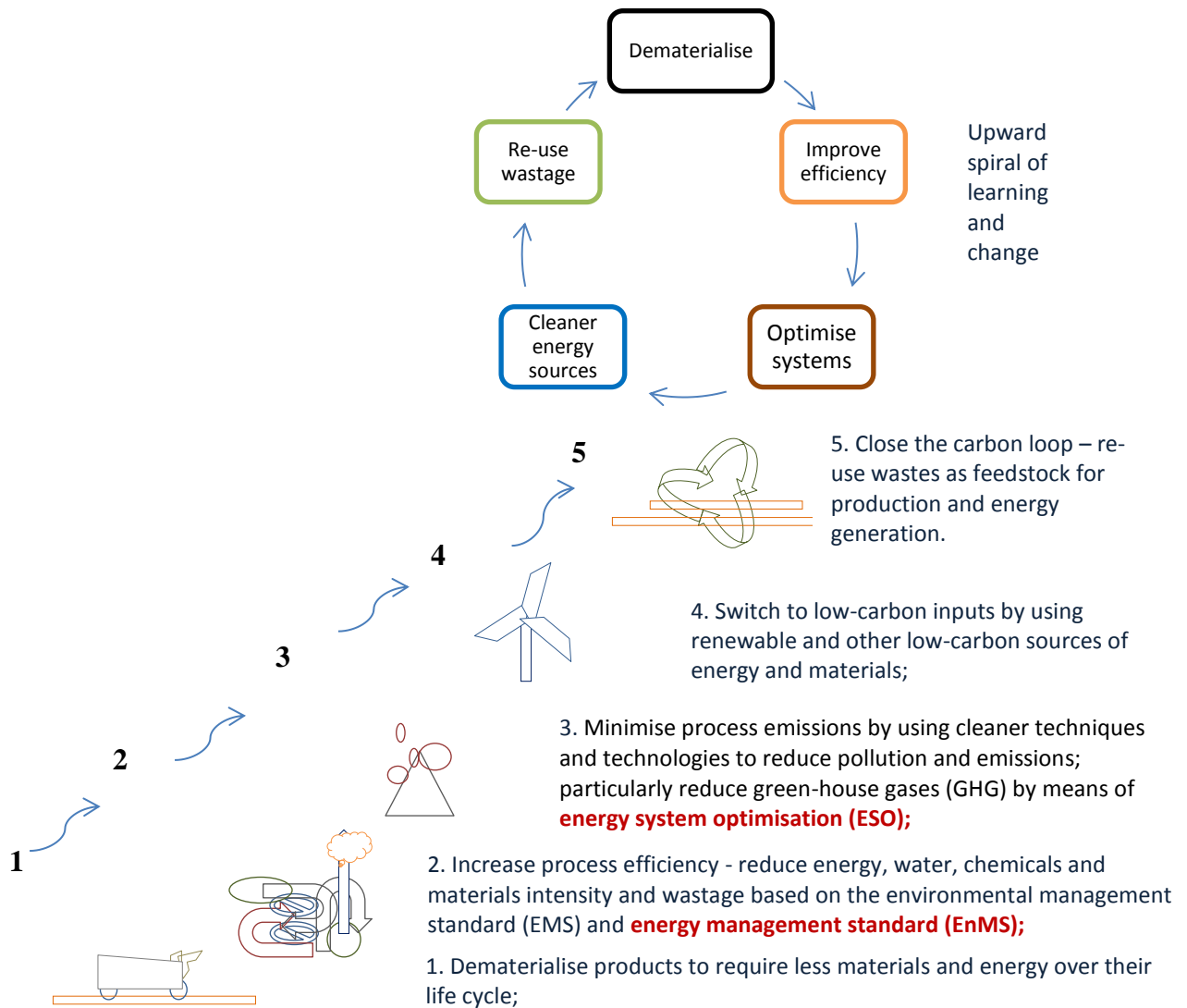
Figure 3.1 below illustrates the RECP and IEE's interrelated functioning within a cross cutting matrix.

**Figure 3.1 Matrix of sector-specific and resource-specific operational level approaches**

		<p style="text-align: center;"><b>SECTOR ORIENTED APPROACH</b> Resource Efficiency and Cleaner Production (RECP)</p> <p style="text-align: center;"><b>CROSS CUTTING RESOURCE ORIENTED APPROACH</b> Waste Minimisation (**) Water Quality and Efficiency (*) Energy System Optimisation (IEE)</p>								
		<p style="margin: 0;"><b>Sector Oriented Sustainability Learning (RECP)</b></p>								
000. Sectors and subsectors inadequately attended to		1. Agro-processing	2. Automotive	3. Chemicals, pharmaceutical, cosmetics and plastics	4. Fibres, textiles, clothing, footwear, leather	5. Green industries including utilisation of	6. Metals fabrication, capital goods and transport	7. Tourism and Hospitality	8. Pulp and paper	9. Mining
<p><b>Resource Oriented Sustainability Learning (IEE); (Water to follow)</b></p>	A			Waste & pollution minimisation & management dealt with under green industries, forms part of the RECP approach						
	B			Water quality and efficiency - business plan (tentative) for proposed water accord implementation						
	C			Energy efficiency - IEE (EnMS + ESO) based on Energy Efficiency Accord, NEES and ISO 50001						

UNIDO, UNEP and SECO (2010) point out that resource productivity and climate change mitigation are closely interlinked. The five fundamental dimensions of the RECP curriculum begin to close the carbon loop by using wastage for renewable energy generation, as shown in Figure 3.2 below.

**Figure 3.2. IEE incorporated in RECP closes the carbon loop (Adapted from UNIDO, UNEP and SECO, 2010).**



UNIDO et.al. (ibid) illustrates how the five fundamental dimensions of the RECP curriculum interlock with IEE dimensions to continue improving energy efficiency in upward spirals of learning and change toward closing the carbon loop (see figure 3.2).

RECP dimensions include

- i. Dematerialise products to require less materials and energy over their life cycle;
- ii. Increase process efficiency - reduce energy, water, chemicals and materials intensity and wastage. Implement EMS and interlocking EnMS;
- iii. Minimise process emissions by using cleaner techniques and technologies to reduce pollution and emissions. Particularly reduce green-house gas emissions by means of ESO, optimising energy efficiency;
- iv. Switch to low-carbon inputs by using renewable and other low-carbon sources of energy and materials;
- v. Close the carbon loop – re-use wastes as feedstock for energy and production.

The IEE programme's green-house gas abatement measures are focused on energy as industrial resource utilised by all sectors including mining. At a strategic level the programmes function as an intersecting matrix with industry sectors the columns and natural resources the cross cutting streams that need to be managed sustainably. Figure 3.1 also alludes to un-serviced environmental sectors such as services, which may benefit from RECP intervention (United Nations, 2004).

The value to industry, society and the environment of the RECP and the IEE programmes is vested neither in typical training offerings nor in the magnitude of interaction but rather in spearheading green practices in industries caught up in un-sustainable practices.

### **3.2.5. Education that promotes cleaner technologies**

In preparing RECP assessment reports project managers and consultants take cognisance of relevant regulations and enterprises' possible preparation towards ISO 14001 certification. Sharing green knowledge with decision makers however focuses on efficient resource use and waste minimisation.

Enterprises tend to implement no-cost and low-cost options, for example stepping up shop-floor practices, also known as 'low hanging fruit', right away to attain immediate waste reduction benefits and savings. Areas where costly or substantial wastage may require financial investment are identified as priority action steps for medium term efficiency improvements. Medium term improvements often involve investing in modern, cleaner technologies. Project managers, supported by consulting engineers take care to advise an

improvement path that will maintain and improve production flow, profitability and job security. Feedback presentations with improvement suggestions as far as possible involve the whole management team in order to secure buy-in and clarify financial, technical and legal questions. Generic best available technologies are advised without reference to specific suppliers or manufacturers (Observation Memo section C.3).

RECP feedback presentations encourage implementation of the full set of recommendations flowing from assessments. Little leverage however exists to exert pressure on enterprises to implement RECP recommendations. To encourage implementation of efficiency improvements project managers share information on possible financing in the form of loans or **dti** grants, to mediate out-of pocket expenses when investing in cleaner, modern and more efficient technologies (RSA, 2010).

In her introduction at the launch of the White Paper on Energy Policy (1998), Ms Pumzile Mlambo-Ngcuka, then Minerals and Energy Minister, noted that the energy intensive industrial and mining sectors account for more than two-thirds of national electricity usage therefore pose great savings and green transformation potential. She emphasised the role of education in industry greening and the value of replacing old technologies with more efficient new plant and equipment (RSA, 1998c). Procurement of green equipment (technology) supports green jobs in manufacturing and provisioning of green technologies, the so called green industries also known as the EGS (environmental goods and services) sector (UNIDO, 2011).

The UNIDO Regional Office Southern Africa recognises the IEE programme's energy awareness campaign. It attributes South African business' readiness to endorse the Green Economy Accord and the National Skills Accord to business leaders' appreciation of the benefits of industry greening and green skills development facilitated by the IEE programme (UNIDO Regional Office Southern Africa, n.d.).

The IEE programme also contributes to innovation for sustainability through the Cleantech Small and Medium Enterprises Acceleration programme, assisting individuals with starting small enterprises and converting cleaner production innovations into sellable technologies. The new 'green industry sector' often comprises of inventors of green technology applications (engineers) having a presence in other sectors for example in electrical and electronic equipment but typically lacking the complete set of skills to start their own businesses. The IEE team partners with CSIR's technology transfer and other services in

hosting Cleantech competitions and accompanying finalists along the learning and articulation curve in acquiring skills in costing, marketing and management of intellectual property, equipping the innovators to start their own green businesses (NCPC-SA, n.d.).

An example of green technology acquisition subsequent to learning from the RECP team relates to a poultry abattoir's quality challenges. Water analysis conducted in the course of an in-plant assessment revealed a chain of un-sustainable water management practices. Without prescribing a specific product the poultry abattoir was advised to purify borehole water before using it in the processing plant. The enterprise was furthermore advised to treat and re-use production wastewater. The waste extracted might be land filled or, as a carbon loop tightening option, used as feedstock for electricity co-generation by means of a bio-digester. The abattoir's technology procurement as a result of the RECP intervention comprises:

- i. Reverse-osmosis (RO) filter for purifying pre-process borehole water;
- ii. Custom built filter for treating end-of-process water; and
- iii. Bio-digester as a renewable energy resource to produce energy from wastewater.

Green jobs in the environmental goods and services (EGS) sector are supported with each cleaner technology transaction (Observation Memo section C.4; Communication Memo section A.2).

The IEE website, newsletters and interaction with Chief Executive Officers clearly communicate the carbon reduction and cost saving benefits of replacing energy intensive plant and equipment with energy efficient technologies (IEE Newsletter, 2013).

### **3.2.6. Recipients of training: Project managers and interns**

Given industry's low awareness of the value of energy efficiency as climate-care and energy saving instrument the IEE budget provides for full subsidisation of **awareness** workshops for industry and vendor Chief Executive Officers and government representatives and partial subsidisation of EnMS and ESO **technical, expert and advanced level workshops and demonstration projects** (ILO, 2010; Wallander, 2011). Project manager positions and competences are of critical importance to rolling out the programmes in industry. Mthente (2013, p.7) verifies that training of RECP and IEE staff forms a large component of the NCPC-SA's work as it is critical to achieving its goals of " ... helping companies improve

their competitiveness through identifying areas of savings in energy, water and materials efficiency and waste minimisation”.

According to a recent management report (NCPC-SA, 2012) the two programmes support 10 interns in industry in addition to employing 21 project managers, seven administrative staff, communications and skills development managers and the director. In contrast to former 3-year contracts NCPC-SA members now have ‘permanent’ CSIR contracts. Interviews conducted by Mthente (2013) recognise increased job security as a result of this development. By adding RECP, EnMS and ESO skills to their engineering qualification, project managers also add to their employability.

Trained RECP project managers’ responsibilities are focused on **in-plant interventions** in industrial plants. Each intervention is managed as a project and takes at least two months to complete, which might pose a challenge as annual targets set by the business plan need to be met. In broad terms the intervention comprises:

- i. Raising RECP awareness as the first phase of RECP education-presentations to Chief Executive Officers and at sector seminars and road shows;
- ii. Recruiting Chief Executive Officers for participation in enterprise assessment;
- iii. Project-managing the legal, financial, technical, relational and reporting aspects of enterprise participation within timelines and targets; and
- iv. Monitoring implementation and continual improvement. (NCPC-SA, n.d.; 2008).

Trained IEE project managers support students with practical tasks and ESO implementation in workplaces. Project managers also assist enterprises in preparing for (voluntary) EnMs certification.

Objectives of the studentship programme include enhancing the employability of unemployed graduates, which are mostly youths from previously disadvantaged communities, integrating them into the mainstream economy (NCPC-SA 2010, p.19). Participation in the Internship Programme avails engineering graduates an opportunity to add a six-month (or longer) internship to their CVs. Participating engineering graduates are placed in host companies for a period of six months or more, situated in the production unit of a manufacturing enterprise and mentored by RECP and IEE experts working in the sector. Interns’ brief is to report on energy, water and material usage and, with mentor and production manager consent,

demonstrate efficiency practices. Knowledge is cemented and competences deepened by innovating and demonstrating cleaner production solutions. The internship programme originated in the RECP programme but also embrace EnMS and ESO. Host companies enjoy direct benefit from having onsite individuals dedicated to identifying resource and cost saving opportunities and resolving challenges. Addition of scarce and critical green skills to their skill sets empowers interns to contribute to industrial sustainability and increase their employability. Over and above the RECP and IEE training, interns also gain core workplace skills such as project management and business communication skills (NCPC-SA, n.d.c). Interns' increased employability subsequent to internship is confirmed by the NCPC-SA 2009-2010 management report. In 2011 NCPC-SA once again reports that all the interns participating in the programme have received job offers (NCPC-SA, 2010; 2011).

### **3.2.7. Recipients of training: Consulting engineers – advanced and expert levels**

At commencement of the cleaner production programme in 2002 the Funders' Board and **the dti** agreed to take a business development approach, which means that South Africans will be trained in 'train the trainers' events to take over from international consultants that initially conducted training and assessments (see section 2.2.2). Upon successful completion of the prescribed training courses, commercial engineers qualify as IEE or RECP experts and apply for inclusion in the body of RECP and IEE consulting engineers. NCPC-SA regularly hosts training events for consulting engineers, project managers and production and energy engineers from industry.

The IEE project is building a legacy within industry of energy efficiency, EnMS and ESO services, which is recognised as international best climate change abatement practice. The task of multiplying the numbers of engineers trained in EnMS and ESO and to embed EnMS and ESO as standard energy management practice in industry is assigned to project staff and consulting engineers trained at advanced and expert levels of IEE. This assignment constitutes the IEE project's instrument towards creating a legacy of sound energy management in the country.

As a legacy of sound energy management is crucial to filling the energy optimisation knowledge gap, government and donors have agreed to extend the IEE programme into the future. The national project manager confirmed that the IEE project is designed to permanently change energy usage patterns in southern Africa and effect transformation of

energy systems towards a low-carbon economy. The approaches used include intellectual intervention encouraging worker-learners to re-think real practices at real workplaces. Permanent change comes with practical implementation (Wallander, 2011).

Consultants interviewed by Mthente (2013) commented ‘... now we also train specialists in the different systems. We have trained a fan specialist and a steam specialist.’ Training is open to both consulting engineers and engineers employed in industry as both groups have the potential to extend ESO skills and knowledge to suppliers, peers and customers (NCPC-SA, 2011a; 2013).

The UNIDO (2011) development framework for an IEE pump system optimisation (PSO) course on page 7 explains that the purpose of the ‘One-Day PSO End User Training’ is to introduce PSO to managers and (senior) staff of enterprises, with the further purpose of inviting the managers to enrol energy teams for the intensive training which includes implementation in trainees’ own workplaces (UNIDO, 2011). IEE expert trainees interviewed in the ten-year review report testifies that benefits of the IEE expert training programme extend to their colleagues, suppliers and customers in the course of business (Mthente, 2013).

The comprehensive strategy for a combined RECP and IEE programme provides for a helpline service supporting re-optimisation of resource-using systems. Changes in product design, mix and volumes and also the introduction of new equipment typically cause energy systems to loose efficiency therefore require systems to be regularly re-assessed and re-optimised. RECP and ESO systems, even if custom made for a specific operation, therefore requires continual learning and change (NCPC-SA, 2012; 2013).

UNIDO (2011) confirms that end user PSO training introduces energy engineers and technical (TVET) members of energy teams in industry, to basic principles for energy efficient design of systems. Incumbents learn how to successfully sell PSO projects to management and how to select a PSO service provider. Also included is training in the use of software tools (i.e. PSAT) to quantitatively assess pump systems, identify potential improvement opportunities and achieve cost savings. An IEE brochure relates that the “The Two-Day Pump System Optimisation (PSO) End User Training is targeted at facility engineers and technical staff such as operators and maintenance staff”. It is designed to teach the PSO end user how to regularly assess pump systems, identify potential

improvement opportunities and achieve cost savings through proper operation and controls, system maintenance and appropriate use of pumps (NCPC-SA, 2011b 2012).

The NCPC-SA 2010-2011 annual management report emphasises the implementation component embedded in IEE courses for engineers as an experience in designing and installing optimised systems and developing competences for solving practical challenges.

RECP assessments start with an introductory workshop to ensure participants are at the same level of prior knowledge, followed by participation in the assessment, securing critical changes towards sustainability. In contrast to a narrow technical approach to assessment the participation approach ensures that RECP assessments are hands-on industry greening learning experiences, with participation by process and energy engineers and technical (artisanal) staff (NCPC-SA, 2011a; Observation Memo section C.2.1).

The UNIDO IEE project document (2009) in the terms of reference stipulates a pragmatic approach to teaching, ensuring practical, re-usable training experiences that build competence and contribute to job satisfaction. Meaningful in-course tasks pose challenges and encourage participants to find practical and feasible solutions based on new ways of thinking and doing. A key challenge for the expert level incumbents is re-designing energy systems at their own workplaces and integrating ESO measures in everyday work-life.

The Compressed Air System Optimisation Training workshop, among many other training courses, provides a sound example of practical solutions for real challenges. In April 2014 the IEE green skills unit invites energy managers, maintenance managers, plant engineers and engineering consultants who have a basic understanding of compressed air systems to a two-day Compressed Air System Optimisation Training workshop. The short description says the workshop helps evaluate the performance of compressed air systems and looks for ways to optimise such performance by means of hands-on training experiences inclusive of group exercises and problem solving. The course promises to deliver practical solutions for improving system performance, reducing energy and maintenance costs and improving operational reliability and control. The (subsidised) R1500 course fee includes VAT, training material, lunch and refreshments.

Practical topics include:

- v. Taking measurements;
- vi. Developing a system profile;
- vii. Meeting requirements for air quality, pressure and transient high volume;
- viii. Optimising existing equipment;
- ix. Understanding various controls;
- x. Balancing supply and demand;
- xi. Heat recovery; and
- xii. Taking a systems approach instead of component approach (NCPC-SA, 2014a).

The IEE programme has trained around 2200 engineers at the advanced level comprising a two-day workshop. 80 of these also completed the one-year course for EnMS experts. The expert training runs over months and includes theoretical and in-plant practical training and an actual implementation project at the incumbent's workplace. Expert graduates are awarded an UNIDO certificate (Industrial Energy Efficiency Project in South Africa Brochure, 2014).

### **3.2.8. Recipients of training: People in industrial workplaces**

The RECP and IEE offer training to people in industrial workplaces inclusive of (1) awareness-raising among CEOs and plant and equipment vendors and (2) technical training of engineers and people in technical occupations.

While owners and directors are legally responsible to ensure that industrial operations are run in a sustainable manner, this responsibility is delegated to CEOs. The power to deny or sanction green amendments to products and processes is thus vested in CEOs advised by production managers. CEOs advised by financial managers hold the key when it comes to making a financial investment in cleaner technologies.

Recognising the responsibilities and power relations embedded in everyday industrial practice, NCPC-SA managers have developed a successful approach to introducing efficiency as a measure to achieve both increased profitability and a greener product. Generating awareness of the benefits of RECP and IEE is directed at CEOs. This intervention is followed by an **offer** to advise management teams on basis of an in-plant assessment (RECP) or an **invitation** to enrol energy managers in IEE training.

The South African industry sector at occasion of the Johannesburg Rio+10 (2002) in principle accepted the RECP programme, which was inaugurated as a Cleaner Production (CP) pilot project. Interventions commenced with six projects in Hammarsdale to align industrial enterprises with pollution prevention requirements. Over 150 companies received RECP awareness training and assessments between 2003 and 2010 (ECOSOC, 2002; NCPC-SA, 2008; 2012).

According to **the dti** the IEE programme is rolled out among energy intensive industries on a national scale with the overarching purpose of conveying energy efficiency skills to industrial participants (RSA, 2010b). UNIDO (n.d.a) states that the IEE programme is anticipated to bring about a transformation of industrial energy usage practices in South Africa and possibly in the Southern African Region. UNIDO (2009) claims that the IEE curriculum goes beyond the basic energy efficiency approach to energy systems optimisation and replacing inefficient technologies with efficient, modern plant and equipment.

Awareness training is also provided to national and provincial government officials. Five **provincial road shows** were presented in Gauteng, Kwa-Zulu Natal, Limpopo, Northern Cape and Mpumalanga and three **detailed awareness workshops** in the Mpumalanga, Kwa-Zulu Natal and Western Cape provinces to increase governmental awareness and understanding of CP (NCPC-SA, 2008; 2012).

In an impact survey workers in participating enterprises frequently mention environmental benefits, reduced input costs and skills development "... not referring specifically to the training courses offered by the NCPC but more broadly to ... skills development that resulted from interacting with the NCPC and participating in (an) assessment" (Mthente, 2013, p.12).

The IEE National Project Manager relates that

the energy engineering profession has become pivotal in appreciating the climatic impacts of energy efficiency and in-efficiency, spreading knowledge and skills toward energy system optimisation (Communication Memo section A.2.2).

The Department of Minerals and Energy with UNIDO advocacy initiated the IEE programme in direct response to low awareness and limited understanding of energy efficiency in South Africa, compromising industry's ability to implement climate change abatement measures and counter national energy shortages (UNIDO, 2009).

The UNIDO (2009) IEE project proposal cites a survey that reveals general trends of inefficient industrial energy management and limited understanding of energy efficiency among southern African industries. Industry was clearly unprepared for rising energy prices and carbon tax discourses. A serious lack of capacity to mitigate green-house gas emissions was reported.

Wallander (2011) states that enterprises affiliated to Business Unity South Africa (BUSA) committed to participate in IEE training events as an appropriate measure toward both filling the skills and knowledge void and implementing energy efficiency in a feasible, practical and affordable way. The UNIDO Regional Office Southern Africa (n.d.) shares that BUSA committed its members to participate in IEE training events and implement energy system optimisation, as part of industry's response to the Energy Efficiency, Green Economy and National Skills Accords.

The NCPC-SA (2012) annual management report shares that companies receiving IEE assistance with ISO 50001 conformity, participate as demonstration projects. Participating demonstration plants form part of the IEE's 'scaffolded' (Vygotsky, 1978; Bruner 1990) approach to green learning, where worker-learners in reality experience how actual optimised energy systems perform while operators point out areas of challenge and innovative solutions.

The suite of incentives schemes available to enterprises includes:

- |   |   |
|---|---|
| i. The manufacturing Competitiveness Enhancement Programme (MCEP) | iv. Production Incentive                                      |
| ii. The 12 I Tax Allowance Programme                              | v. Clothing and Textile Competitiveness Improvement Programme |
| iii. The Automotive Investment Scheme                             | vi. The Green Energy Fund                                     |
|   | vii. Incentives offered by Eskom (NCPC-SA, n.d).              |

Efficiency implementation implies a pre-calculable and financially lucrative return on investment (ROI). Industry needs savings as a result of cleaner technology investment to balance with and preferably exceed the amount invested in training, system components and installation within one year or less. NCPC-SA management report relates that the ROI argument is emphasised in marketing the IEE, as investment in energy system improvements

may be made up by means of savings on electricity in less than a year, particularly if access to incentives contributed to reducing out of pocket expenses (NCPC-SA, 2011a).

Industry's participation in RECP assessments and implementation is voluntary. Enterprises gain from participation by receiving a subsidised in-plant efficiency-improvement needs assessments and written reports. Three funding agreements underpin UNIDO's support to the IEE, National Treasury via **the dti**, Swiss SECO and UK Aid. The IEE spent R100 million on workshops, lectures and demonstration events over the first four-year period. An in-kind contribution of R113m pledged by the South African business sector through BUSA, materialised in the form of technology investments and employee time spent in IEE training (UNIDO, 2009; DFID, 2011; NCPC-SA 2011; 2012).

IEE and RECP teams build and maintain good relations with sector associations, sector desks at **the dti** and individual enterprises (NCPC-SA, 2012). In contrast to regulation driven legal-driven inspections and reporting the assessment, training and presentation of suggested improvement measures give rise to suggestions for voluntary implementation and include advice on access to incentives. Senior project managers often assist incentives committees in adjudication of applications. Incentives range from cash grants, a reduction of the enterprises' income tax payable through loans. The rationale is to minimise the enterprises' out of pocket expenses when installing energy efficient systems and equipment.

The IEE budget provides for full subsidisation of introductory workshops for industry and vendor Chief Executive Officers and government representatives and partial subsidisation of EnMS and ESO technical, advanced and expert level workshops and demonstration projects (Wallander, 2011).

ISO 14001 Environmental Management standard and ISO 50001 Energy Management Standard are enforced in the international trade regime. RECP indirectly and IEE directly supports enterprises in preparing for certification to these standards. EnMS and ESO provide footprint calculation and target-setting options for countering energy scarcity, green-house gas driven climate change and carbon tax pressures (UNIDO, 2009, see sections 1.3; 2.2).

RECP, EnMS and ESO records provide valuable content for inclusion in integrated waste management reports required in terms of the NEMA National Waste Management Act (RSA, 1998b) and anticipated carbon reporting - expected to be legislated at R120/t CO<sub>2</sub>e by 2016 (Environmental and Sustainability Solutions, n.d).

Plans, baselines and other information generated in the course of ESO implementation are of the essence to carbon reporting and ensure relevant, substantiated and effective reporting. Companies listed on the Johannesburg Stock Exchange (JSE) are obliged to participate in Integrated Reporting. The King III guideline for sound corporate management suggests voluntarily commitment of all enterprises to Integrated Reporting (Integrated Reporting Committee, 2011). Some Chief Executive Officers declared willingness to pay for the assessment and efficiency improvement report were it not subsidised (Mthente, 2013).

Vulnerability to environmental barriers to trade and legal penalties erodes government's efforts to encourage employment through industrial growth. Turning around energy inefficiency to optimised efficiency commences with reaching people's minds through environmental education and technical training of people in workplaces. The 'Introductory Course for Fan Systems' manual for example explains optimisation firstly in cost-benefit terms and secondly in terms of the contribution to minimising the climate change implications of negligent and wasteful energy practices (UNIDO, 2011).

In addition to market access the ISO50001 EnMS provides business with certainty and pragmatic measures for energy system optimisation and sustainable energy management. IEE objectives include services to assist enterprises in preparing for and demonstrating ISO 50001 conformity. The IEE programme also supported South African National Standards in adopting the Danish EnMs as 'SANS 879: Energy System Optimisation'. South African National Standards furthermore adopted SANS ISO 50001 soon after release by ISO (Reynolds, 2008; UNIDO, 2009; NCPC-SA, n.d.).

### **3.3 ANALYSIS OF THE TRAINING PROGRAMMES USING THE ANALYTICAL TOOL TO ESTABLISH GREEN LEARNING**

As reported in Chapter 2, and as shown in the analytical instrument included at the end of Chapter 2 (Table 2.2), three analytical questions guided reflexive inductive and abductive case study analysis of programme data in relation to emerging green learning aspects. The analysis recognises social learning theory and green economy as essential green-learning building blocks therefore commencing examination of how the programmes relate to social learning theory and green economy policies and texts.

The three sections below draw on the insights presented above on the two training programmes, their goals and how they operate as green economy training programmes within the NCPC-SA.

### **3.3.1 QUESTION 1: HOW DO THE PROGRAMMES RELATE TO GREEN ECONOMY POLICIES (OR NOT)?**

#### **3.3.1.1. RECP and IEE programmes are rooted in green economy policies**

The RECP and IEE's green economy orientation aims to reduce the rate of resource and energy consumption towards climate stability and planet sustainability (UNIDO, 2009). Achieving more with less and sustaining future access to natural resources by minimising energy and resource consumption, directly respond to the objectives of a green, low carbon economy. These objectives are envisaged by the 'Global Green New Deal' policy brief, 'The Future We Want' declaration and South Africa's New Growth Path and the NDP (UNEP, 2009a; UN, 2012; RSA. The Presidency, 2010; 2011; UNEP, 2008, see section 2.1.1).

The RECP and IEE programmes are up-scaling previously inadequate efficiency, EnMS and ESO skills, which are required to green the industry sector but are poorly supplied in South African industry (ILO,2010; South African – German Development Cooperation, 2011; NCPC-SA, 2012, see sections 2.2.2; 2.2.3).

Learning by optimising energy systems upgrades production facilities and facilitates improvements to make consumption and production patterns more sustainable as advocated by Agenda 21 (UNCED, 1993; NCPC-SA, 2014c) and reflected in this quote: "Managing the interrelatedness of correct motor sizing, technology transfer, harmonised electric motor specifications is essential ..." from the training (Prof Aníbal De Almeida from Coimbra University in an ESO lecture). He furthermore explains the potential of motor system optimisation to save up to 1.25 Mega tonnes (Mt) of carbon dioxide per year on a national scale. Saving green-house gas emissions directly contributes to South Africa's green, low carbon economy (RSA. National Treasury, 2011, p. 610; 2012; De Almeida, Fong and Falkner, 2012, p. 40; see Observation Memo section C.5.2; see sections 2.2.2; 2.2.3).

The programmes' teaching approaches account for industry's financial and marketing considerations by promoting highly effective, affordable industry greening measures, aligned

with environmental standards enforced by international markets (McKinsey and Company, 2009). ‘Train the trainer’ courses for IEE and RECP project managers and engineers teach how the notion of efficiency reduces environmental impact while saving costs. RECP and IEE improve energy and resource productivity and product marketability and reduce carbon and environmental footprint (UNIDO, 2009; NCPC-SA, n.d.a; see sections 2.1.1; 2.2.3).

Cost savings help convince Chief Executive Officers to enrol their engineers and technicians for learning events. Incentives encourage Chief Executive Officers to invest in green technologies (UNIDO, UNEP AND SECO, 2010; NCPC-SA, 2011a; 2012; Kelder, 2013; see section 2.2.4).

Both programmes subscribe to the complex South African framework of green economy policies and express a need for a national cleaner production strategy dedicated to industry greening (Cartwright, 2010; Montmasson-Clair, 2012; Mthente, 2013). The programmes’ learning content serves the systemic interconnectedness of people, planet and prosperity (ECOSOC, 2002; NCPC-SA, 2010, UNIDO, UNEP AND SECO, 2010; see sections 1.1.5; 2.1.1).

UNIDO, confirmed by NCPC-SA, reports how the IEE programme was instrumental to finalising the South Africa’s National Energy Efficiency Strategy (NEES) and is using the strategy as legal basis for EnMS and ISO 50001 conformity training (NCPC-SA, n.d;). The IEE team was also supportive to the process of incorporating the ISO 50001 EnMS standard in **the dti** technical infrastructure agencies SANS and SANAS (NCPC-SA, n.d; RSA, 2004; Reynolds, 2008; UNIDO, 2009; **The dti**, 2011; see sections 2.1.1; 2.2.3).

### **3.3.1.2. The programmes retain and create jobs**

Each RECP and IEE employee represents a new green job that meets the definition of green jobs as activities that “... de-carbonise the economy and minimise ... generation of waste and pollution” (RSA. The Presidency, 2010; UNEP/ILO/IOE/ITUC, 2008, p. 25). According to the 2011/2012 Management Report the two programmes maintain permanent positions for 20 project managers, one IEE national project manager, two communications managers, seven administrative staff, a skills development manager and the director. 10 interns hold temporary positions (NCPC-SA, 2012; see section 2.2.2).

The IEE programme has trained around 2200 engineers in the advanced level course, which comprises a two-day workshop. 80 of these candidates progressed to the next level,

graduating as EnMS experts after one year. The expert training runs over months and includes theoretical and in-plant practical training and an actual implementation project at the incumbent's workplace. Expert graduates are awarded an UNIDO certificate. The experts qualify to be utilised by IEE as ESO and EnMS lecturers and in-plant ESO assessors (Industrial Energy Efficiency Project in South Africa Brochure, 2014; NCPC-SA, 2011b; 2014b; see section 1.1.4).

Industrial process engineers and artisanal (TVET) workers add green skills to conventional skill sets, thus retaining conventional jobs as they become 'greener' jobs. Reflexive and applied competences developed during up-skilling increase employability (RSA, 1995b; Lotz-Sisitka and Raven, 2009; UNIDO, 2009; Anderson, 2009; see section 2.2.3).

The programmes in RECP and IEE implementation encourage procurement of cleaner, more efficient technologies. Trade in cleaner technologies also supports green jobs in the environmental goods and services sector (EGS) (NEDLAC, 2006; NCPC-SA, n.d.c; 2012). The Cleantech SME Acceleration project represents a combined expression of the business development and cleaner technology approaches. The IEE team provides scaffolding to small and medium enterprises (SME) in converting cleaner production innovations to sellable technologies (NCPC-SA, n.d; see section 3.3.1.3).

The RECP programme facilitates creation of (temporary) green jobs by means of the Internship Programme. A NCPC-SA brochure relates that participating engineering graduates conduct assessments and implement efficiency measures in host plants, gaining confidence in putting to practice the theoretical knowledge attained (NCPC-SA, n.d.c). NCPC-SA reports that interns develop green competence in real industrial workplaces (NCPC-SA, 2010). The programmes indirectly facilitate green employment as all the interns thus far have received employment offers (NCPC-SA, 2011a; see sections 1.1.5; 3.2.5).

### **3.3.1.3. The programmes recognise interests and responsibilities of industrial stakeholders**

NCPC-SA reports on industry's voluntary RECP implementation in exchange for subsidised in-plant efficiency needs assessment and a written report (NCPC-SA, 2011a). Moreover, since 2010 **the dti** offers incentives to encourage plant and equipment modernisation including upgrading to cleaner and energy efficient technologies (NCPC-SA, 2012). The programmes inform Chief Executive Officers of a suite of eight incentive and loan schemes

available to mediate out-of pocket expenses on new and retrofit cleaner technologies (NCPC-SA, n.d.; RSA, 2010). Mthente reports that Chief Executive Officers interviewed declared willingness to pay for in-plant RECP assessments were it not subsidised (Mthente, 2013; see section 1.1.5).

The IEE budget provides for full subsidisation of awareness workshops for industry and vendor Chief Executive Officers and government representatives and partial subsidisation of EnMS and ESO technical, expert and advanced level workshops and demonstration projects (Wallander, 2011).

RECP, EnMS and ESO implementation reduces waste and carbon emissions through reduced consumption, which results in a financially lucrative return on investment (ROI) in the event of procuring green technologies as part of the optimisation plan (NCPC-SA, 2011a).

Kahn (2009) interprets the chief executive officers' reluctance to modernise and the holding on to 'business as usual' albeit inefficient practices, as a symptom of low confidence in workers' competence and tacit knowledge of modern techniques and technologies. Green up-skilling contributes to confidence in the workforce's capacity to take charge of green practices (UNEP/ILO/IOE/ITUC, 2008; see section 1.1.4).

Mthente surveyed the impact of NCPC-SA among workers in participating enterprises and notes frequent reference to environmental benefits, reduced input costs and skills development '... not referring specifically to the training courses offered by the NCPC but more broadly to any type of skills development that resulted from interacting with the NCPC.' (Mthente, 2013, p.12).

Energy System Optimisation is seen as '...one of the most cost-effective measures to help supply-constrained developing and emerging countries meet their increasing energy demand and loosen the link between economic growth and environmental degradation' (UNIDO, n.d.a., p.1; McKinsey and Company 2009; see section 2.2.3).

Enterprises affiliated to Business Unity South Africa (BUSA) embrace RECP, IEE and the Energy Efficiency, Green Economy and National Skills Accords, as all these mechanisms contribute to meeting NEMA and NEES obligations (RSA, 2004; UNEP/ILO/IOE/ITUC, 2008; UNIDO, 2009; Wallander, 2011; see sections 3.2.3; 3.2.4; 3.2.7; 3.2.8).

RECP, EnMS and ESO records provide valuable substance for inclusion in the integrated waste management reports required in terms of the NEMA National Environmental

Management Act (RSA, 1998b) and anticipated carbon reporting to underpin carbon taxes - expected to be legislated at R120/t CO<sub>2</sub>e by 2016 (Environmental and Sustainability Solutions, n.d; Integrated Reporting Committee, 2011; see sections 3.2.2; 3.2.3; 3.2.8).

The ISO 14001 Environmental Management standard and ISO 50001 Energy Management Standard are enforced in the international trade regime. RECP indirectly and IEE directly supports enterprises in preparing for certification to these standards (UNIDO, 2009; see sections 1.1.4; 1.4.1; 2.1.2).

### **3.3.2 QUESTION 2: HOW DO THE PROGRAMMES RELATE TO SOCIAL LEARNING APPROACHES (OR NOT)?**

As argued in Chapter 2, successfully conveying knowledge and skills to industry participants require project managers and engineers to apply educational principles in industry interventions. This section of the analysis looks into the programmes' teaching approaches in relation to social learning theory. Orientation to learning theory is not formalised and might be identified as an area for improvement.

#### **3.3.2.1. The programmes offer quality learning**

IEE training provides quality learning opportunities as it empowers decision makers to make reflexive, informed sustainability choices that bring job satisfaction because it improves product marketability and company viability (see section 2.2.1).

Typically required by sustainability standards, for example the ISO 50001 Energy Management Standard referenced in the NEES (RSA, 2004), continual improvement reflects the social learning culture of life-long learning toward quality of work life (Sen, 1997; 2010; Elliot, 2007). The continual re-optimisation of systems (UNESCO, 2005) forms an upward spiral of learning and improving, for example reaching a point of zero waste by re-using waste either as input material or as resource for energy generation (Sen, 1997; 2010; UNESCO, 2005; Elliot, 2007; see sections 2.2.2; 2.2.3).

The internship programme constitutes quality learning in the form of shop floor situated practical learning experiences. Solutions-based learning experiences are generated by means of scaffolding by RECP and IEE experts, availing interns to valued beings and doings such as certainty with respect to the success of efficiency measures, which facilitates work satisfaction and the development of new activity in the workplace (Vygotsky, 1978; Bruner,

1990; Sen, 1999; Engeström and Sannino, 2010; NCPC-SA 2010, p.19; Observation Memo section C.2.4).

The UNIDO IEE (2009) terms of reference stipulates a pragmatic approach to teaching, ensuring practical, feasible and re-usable training experiences that build competence. Skills competence generates confidence in the workforce's green capability and contributes to job satisfaction by facilitating implementation mandates. Worker-learners experience in-course tasks as meaningful because participants find practical and feasible solutions based on new ways of thinking and doing within conventional workplace limitations. The expert level training course is for example completed with an assignment to re-design an energy system at the students' workplace, thus integrating ESO in everyday work-life. The NCPC-SA 2010-2011 annual management report accordingly emphasises the implementation component embedded in IEE courses as an experience in designing and installing optimised systems and developing competences for solving practical challenges (ECOSOC, 2002; Rosenberg, 2008; NCPC-SA, 2011a; Bradshaw, 2012; see section 2.2.2).

Similar to the other courses, a Compressed Air System Optimisation Training workshop provides a sound example of practical solutions for real challenges. Practical exercises include:

- i. Taking measurements;
- ii. System profiling;
- iii. Meeting requirements for air quality;
- iv. Pressure and transient high volume;
- v. Optimising existing equipment;
- vi. Understanding various controls;
- vii. Balancing energy supply and demand; and
- viii. Heat exchange and recovery (NCPC-SA, 2014a; see section 3.2.2).

### **3.3.2.2. The programmes subscribe to career-long learning**

In the spirit of life-long learning, project managers for the duration of their careers regularly undergo up-skilling. Mthente (2013, p.7) verifies that training of RECP and IEE staff forms a large component of the NCPC-SA's work as it is critical to achieving its goals of "... helping companies improve their competitiveness through identifying areas of savings in energy, water and materials efficiency and waste minimisation" (see section 2.2.1). Continuous improvement is covered in section 3.3.3.3.

### **3.3.2.3. Training approaches include ZPD, demonstration, scaffolding and participation**

RECP interventions in an enterprise as a rule starts with an introductory workshop to align participants' level of prior knowledge in accordance with approaches that work with the theory of ZPD (Vygotsky, 1978). The introduction is followed by comprehensive participation in the assessment, securing an understanding of critical efficiency changes needed for the specific operation, identifying possibilities for new activity formation (Engeström and Sannino, 2010) through workplace learning.

ZPD is, for example taken into account in an April 2014 invitation directed at incumbents having a basic understanding of compressed air systems, for enrolment in the Compressed Air System Optimisation Training Workshop (NCPC-SA, 2014a).

The NCPC-SA (2012) annual management review reports that companies receive IEE assistance with ISO 50001 conformity in exchange for availing their operations as demonstration projects to underpin the scaffolding approach (Vygotsky, 1978; Bruner 1990). NCPC-SA (2012) concurs with UNIDO (2011) that classroom learning is strengthened by in-course assignments, demonstration experiences and the challenge of implementing optimisation measures in the workplace, showing the integration of learning and the creation of new forms of practice / activity in the workplace as described by Engeström and Sannino (2010) (NCPC-SA, 2012; see sections 2.2.1; 3.2.1; 3.2.2).

### **3.3.3 QUESTION 3: HOW DO THE PROGRAMMES RELATE TO EMERGING GREEN LEARNING ASPECTS (OR NOT)?**

#### **3.3.3.1. The programmes develop skills that recognise the 'triple bottom line'**

Drawing on Agenda 21 (UNCED, 1993), Howells and Laitner (2005) and Barbier (2010) view education for industry greening as the nucleus of the green economy transition. Hohnen (2012) recognises guidance provided by the Green Industry Platform for promoting competitive capabilities and safeguarding jobs while softening the impact of industry on the ecology.

The RECP and IEE programmes similarly transfer efficiency skills and knowledge while taking the three dimensions of sustainable industry into account:

- i. Production efficiency and competitiveness (optimising the productive use of natural resources, including materials, energy and water);
- ii. Environmental management (minimising impacts on the environment and nature by reducing wastes and emissions); and
- iii. Human capital development (minimising risks to people and communities and supporting the development of communities and individuals) (NCPC-SA, 2012; see sections 1.1.5; 2.2.2).

### **3.3.3.2. The programmes cover multiple sectors**

RECP and IEE training gives expression to the energy-efficiency and skills-for-the-economy objectives contained in the second Industrial Policy and Action Plan (IPAP2), which forms part of the green economy framework (RSA, 2011a). The national project manager confirms that the IEE programme is designed to effect transformation of energy systems across a range of sectors towards a low-carbon economy (Wallander, 2011; see section 3.2.2; Communication Memo section A.2.2).

The National Environmental Sector Skills Planning Forum (NESPF) resolved that green learning cuts across all sectors of the economy (UNIDO, 2009; RSA. DEA, 2010; UNIDO, n.d.c; Lotz-Sisitka, Rosenberg, Ramsarup and Vallabh, 2010). RECP and IEE skills development therefore involves as many sectors as limited resources allow. This approach also recognises general skills shortages and a dire absence of green skills in South African industry revealed by a 2008 UNEP/ILO/IOE/ITUC Skills Report and affirmed by ILO (2010) and the South African - German Development Co-operation Programme (2011) (see sections 2.1.2; 2.2.2).

In response to the green economy's low-carbon focus (RSA. The Presidency, 2010) each IEE training event involves large groups from a range of sectors. The IEE programme's offering of ESO and EnMS advanced courses enrolled 2200 trainees over four years, of which 80 graduated as experts after completing the second phase (NCPC-SA, n.d.c; 2014; see sections 1.1.3; 2.1.1).

### **3.3.3.3. The programmes pursue continual incremental improvement through green learning and change**

The integrated RECP and IEE 'closing the carbon loop' philosophy has potential to inspire continual cycles of learning and change, characterised by incremental rather than 'earth moving' changes that bring about meaningful and sustained energy optimisation results

(UNIDO, UNEP and SECO, 2010; NCPC-SA, 2012). Unfolding eco-innovations allow organisations to assertively plan and strategize for such continual improvement (Lotz-Sisitka et. al., 2010; Montavaldo, 2009). The notion of continual incremental improvement as expressed by the IEE project document, the RECP template and the ISO 50001 Standard resonates with dynamics embedded in Lotz-Sisitka and Raven's (2009) notion of 'applied competence' as guiding framework for sustainability education. Energy managers at the expert level would for example display applied competence by detecting and skilfully managing unintended effects of efficiency adjustments, maintaining production levels and flow (UNIDO, 2009; see section 2.2.3).

The strategy for a combined RECP and IEE programme provides for a helpline service, supporting and scaffolding re-optimisation of resource-using systems as they typically loose efficiency over time (Communication Memo section A.3). Changes in product design, mix and volumes and introduction of new equipment require re-assessment and re-optimisation. RECP and ESO systems, even if custom made for a specific operation, therefore requires continual learning and improvement (NCPC-SA, 2012; Lotz-Sisitka et al, 2010; see sections 2.1.1; 3.3.1).

#### **3.3.3.4. The programmes develop engineering and technical (TVET) green skills**

In contrast to the world-wide trend of reducing occupational education to contain only narrow productivist-focused technical training (Anderson, 2009), and in line with Agenda 21 Chapter 37, the IEE 'Introductory Course for Fan Systems' manual offers education both about and for the environment. Lecturers should diligently maintain this balance (UNCED, 1993; UNIDO, 2011; see sections 1.1.3; 1.1.6).

The RECP and IEE meet guiding criteria for quality environmental education set by the White Paper on Education and Training. Contribution to environmental literacy improves employability of interns and course participants (RSA 1995a; UNIDO, 2011; see sections 1.3.2; 2.1.1).

The IEE acknowledges the NBI's Executive Guides on Climate Change and Energy Efficiency developed by the WBCSD and utilised by signatories to the Energy Efficiency Accord. The Executive Guides are directed at production and energy engineers (NBI, 2005; UNIDO, 2009; see section 2.2.3).

The level of IEE skills is comparable to NQF level 7 and higher. As it constitutes up-skilling of conventional skills the duration of workshops is however mostly two days only except in the event of expert level training, which lasts several months (RSA,1995b; SAQA, n.d; De Almeida, Fong and Falkner, 2012; see section 2.2.3).

### **3.3.3.5. The programmes are positioned to institutionalise course material**

The programmes' objectives include institutionalisation of course material into national higher educational curriculums and with professional bodies while training continues. The programmes do not compete in the commercial market for training, nor do they use the SAQA SETA system for accreditation, preferring to work with professional bodies for wider acceptance of the training. At a recent IEE planning workshop options for mainstreaming EnMS and ESO training programmes were discussed. According to a UNIDO presentation training manuals and more individual curricula for EnMS and ESO courses are planned as basis for standardising the learning materials (Observation Memo section C.7).

Different options are available for programme administrators to collaborate with higher education and private training institutions with view to institutionalisation of course material. One-on-one collaboration with higher education institutions might be considered but will be time and human resource intensive. The same constraint applies to collaboration with individual SETAs. SAQA as authority overseeing research to inform development of the NQF, thus influencing SETAs, might be a suitable counterpart for collaboration toward wider institutionalisation, as SAQA interacts with the DHET, the QCTO and the CHE all of which may want to consider content and quality of green economy training as it expands in scope.

Another option for consideration may be the **National Environmental Sector Skills Planning Forum (NESPF)**. The NESPF was established by DEA to ensure co-ordination and an efficient, synergistic incorporation of the environmental driver into sector skills plans as directed by the New Growth Path and the NDP (RSA. DEA, 2010; RSA. The Presidency, 2010; 2011). This would seem to be a likely option as the NCPC-SA serves on the NESPF and, as this thesis was being finalised, the NESPF has had a large grant approved by the Green Fund to systematise green skills development in South Africa (Communication Memo section A.1).

The ESSP put forward by the NESPF cuts across sectors and as such is not driven by the SETA system. As national authority for skills development for the green economy (see section 1.1.6) the NESPF might consider UNIDO's plans to develop and refine IEE curriculums and training manuals, as discussed at the 2014 IEE planning workshop (see section 3.3.3). The curriculum refinement exercise might pose a useful area of common interest and a possible starting point for formalising NCPC-SA – NESPF collaboration.

## **4. CHAPTER FOUR. SYNTHESIS AND CONCLUSION**

*This chapter briefly summarises the study, and provides a synthesis. It returns to the point made that critical realism can help to explain the emergence of phenomena such as green learning in a changing and transitioning societal context. The chapter makes recommendations for expanded use of the analytical framework produced and used for this study, and points to limitations of the research.*

### **4.1. SHORT SUMMARY OF THE STUDY**

As noted in Chapter 1, this study sets out to produce insight into the status quo of green learning in the context of the emerging green economy in South Africa, where the focus is on industry's pivotal role in the emergence of the green economy. However, early reading into the research topic showed that there was little available in terms of research frameworks for understanding green learning in this context. Thus, a literature review was used to develop an analytical tool to provide inductive and abductive interpretations of green learning in training programmes for the green economy that serve the industry sector, as reported in Chapter 2. The literature reviewed, synthesised key trends towards green economy development internationally and also in South Africa, drawing on history, current policy and programmes, as well as international influences and discourses of the green economy. From here, it was necessary to develop a perspective on what would constitute good quality education and learning within a transforming system towards a more holistic view of green economy that is transformative and not just productivist in orientation. Following on from this, it was necessary to review how green learning is emerging from a systems perspective, and this required review of existing initiatives in this direction.

As the study's core interest is green learning in an industry context, it was important to identify a case study that could be examined, which supports and services a range of industries with training. I selected to work with the National Cleaner Production Centre of South Africa (NCPC-SA) as it is a leading institution supporting the emergence of a green economy in South African industry using training, and I chose to focus on its two key training programmes, the IEE and RECP, respectively focussing on energy management

systems and on resource and energy efficiency in a transformation of practices that include new technology development and new management approaches, guided by international standards.

To interpret these two training programmes from a green learning perspective, it was first necessary to describe them. I used document analysis, observations and informant discussions to produce data on the two programmes and the NCPC-SA, producing a description of the two programmes within a nested case study design. The programmes were described in some detail in the first part of Chapter 3, and in the second part of Chapter 3 I applied the analytical tool developed from the literature to establish the way in which the two programmes were representative of green learning for a green economy (or not). Key findings showed that the programmes were progressive in their implementation and design, and that they were not only improving green economy practices in the participating industries, but also creating green jobs and setting a model example of how green economy training can be developed in ways that are not productivist, but are more holistic. Some critiques of the training programmes may be that they have an unquestioned adherence to the dominant discourses of green economy, and that with further engagement these can also be expanded. Additionally, the training programmes are not integrated into the national system of skills development, and further engagement with institutions such as SAQA and the NESPF may help to upscale the practice, content and approaches of the training programmes to further expand the green economy in South Africa, which is still in its infancy.

In conclusion it is said that the programmes' practice, content and approaches, with customisation if and where necessary, may be suitable for mainstreaming into NQF related green learning for people in workplaces.

## **4.2. SYNTHESIS ANALYSIS**

As discussed in the previous chapters, environmental learning encompasses learning about, from and for the environment. Environmental learning emerges from the environmental movement, which has evolved into an expansive social and policy movement, to drive change in response to environmental degradation. The broad landscape of education for the environment ranges from trade, regulatory and business policies, design, techniques, technologies and performance, explicitly involving product, process, plant and equipment, and people. The implicit green education curriculum however involves all practices, from

human capital management, resource exploration, beneficiation, transportation, trade, land and water use, biodiversity, atmosphere, energy use and generation, and waste management to services and financial decisions and gains, in favour of improved environmental performance. While these disciplines are equally important the focus of the RECP and IEE programmes is on awareness of and skills for financially sustainable techniques, technologies and waste management practices for improved environmental performance of industry. Upscaling energy and resource efficiency techniques and technologies and optimising energy systems, construct the way for a generalised approach to optimised resource utilisation in production of goods and services. By foregrounding these, it may exclude other approaches such as reduction of production, or de-materialisation which are more radical approaches to green economy development.

RECP and IEE programmes' rootedness in the dominant green economy discourse as found in international policy and in national policy responses, transpires through its resource efficiency focus resulting in more sustainable consumption and production patterns, but not necessarily in a fundamental restructuring of industrial enterprises, although there are signs that such a restructuring could emerge with higher levels of participation and engagement.

Secondly, and influenced by the socio-economic context of South Africa, the programmes subscribe to 'job creation' as a key objective of South Africa's New Growth Path green economy policy. The RECP and IEE sustainability teaching retains and greens conventional jobs, for example by up-skilling artisans and engineers in workplaces responding to a lack of skilled people in these key occupations. The programmes also create green jobs for project managers, facilitate employment for interns and generate business opportunities for consulting engineers. In support of job retention and economic growth RECP and IEE interventions contribute to energy and job security in industry while upgrading industrial operations to greener, low carbon investments. As such they provide a good case example of how training combined with workplace intervention (e.g. new technology, management support, subsidised activity etc.) can drive a re-orientation of the economy to achieve two key goals at the same time (jobs and cleaner production).

Aspects of the educational component of the programmes include subsidised in-plant assessments, training, demonstrations and scaffolding of practical assignments and certification to the ISO 50001 EnMS. This shows evidence of the programmes' recognition

of industrial stakeholders' interests and responsibilities, and a situated approach to learning in workplace communities.

An understanding of how people get to know is imperative to conveying skills and knowledge in the course of RECP and IEE interventions. Extending the concept of quality education to quality of green learning in workplaces and quality of work life, requires learning approaches to include ZPD, demonstration, scaffolding and participation, and as shown in this study, the two programmes are working with this approach, although the Engestrom and Sannino (2010) paper shows that this could also become an ongoing process of expanding and changing work activities with expanded use of this approach over time.

As discussed in section 3.2 the RECP and IEE systemic context may differ as far as accreditation and SETA recognition is concerned. The programmes have however developed a successful approach to skills development for the green economy, which might add value to the SAQA related skills development system and prevent a metaphoric 're-invention of the wheel' as far as green skills for industrial settings are concerned (see section 3.2). The analysis detects a measure of utilisation of these approaches and also shows up the relation to social learning as a possible area of improvement. The programmes for example require project managers and consulting engineers to make learning experiences happen but their training does not involve teaching skills. Written programme curricula are also not explicit on how lecturers might utilise social learning approaches to optimise learning events. While some lecturers have an educational background as they hold lecturing occupations it is not necessarily the case with local engineers that complete the expert level training to qualify as assessment leaders and lecturers. Thus further investment in training of trainers could also help to expand this dimension of the programmes.

The analysis meets the research rationale by providing examples of **how the programmes relate to emerging green learning aspects**. In contrast to conventional productivist training and education of engineers and technicians the programmes incorporate green learning to achieve an ecologic balance. The programmes provide learning experiences that recognise and respect the 'triple bottom line' of environmentally sustainable economic and social development. Given the cross cutting nature of green learning the programmes work in multiple sub-sectors of industry, acknowledging **the dti** sector desks and respective industry associations in the course of presenting green learning experiences.

The programmes do not explicitly recognise the ESSP or the need to engage with the wider education and training systems landscape in South Africa, which potentially reduces upscaling possibilities. However, they appear to be working with professional associations who are now more powerful in the defining of standards for occupationally directed education and training following the revision of the NQF Act in 2008. There exists an opportunity to expand the work done by the NCPC-SA into the sphere of qualifications development for green economy training. A cooperative relationship exists between the NCPC-SA and the DEA with respect to the UNEP Sustainable Consumption and Production (SCP) programme but this relationship does not yet form an integral and productive part of the RECP and IEE programmes. A further cooperative relationship exists between the NCPC-SA and the DEA with respect to the NESPF but as yet the relationship has not been maximised to carry forward and upscale the experience of the NCPC-SA in offering workplace-based training of a high quality and relevant content (as shown in this study) for expanding green economy outcomes. These would therefore seem to be key areas for further development emerging out of this study, which has sought to reflect on the potential of these programmes within a wider ‘green learning for a green economy’ framework.

In Chapter 1 I also noted that critical realism helps to explain how social learning and green learning emerge in society. I provided a review of Bhaskar’s (1998) ontological framework that differentiates between the real, the actual and the empirical and which explains that generative mechanisms can be identified via retrodiction to help explain phenomena and their emergence. In Figure 4.1 below, I summarise some of the dynamics of the real, the actual and the empirical as identified in this study. Figure 4.1 shows that there are a range of interacting generative mechanisms that are shaping the emergence of a green economy, and that this is leading to a range of interacting events at the level of the actual. These in turn, have influenced the orientation, approaches, assumptions, design and outcomes of the two training programmes that were reviewed in the NCPC-SA context. This analysis is helpful for expanding the findings of this study, as Bhaskar also indicates that it is possible to generalise at the level of the real, or to see that the generative mechanisms that have shaped the events and experiences in the case of the two programmes, may well also be shaping the emergence of other green learning programmes for the green economy in similar ways.

While this would require further empirical testing, it may well be possible to suggest that it is the combination of **interacting generative mechanisms including** industry interests; culture

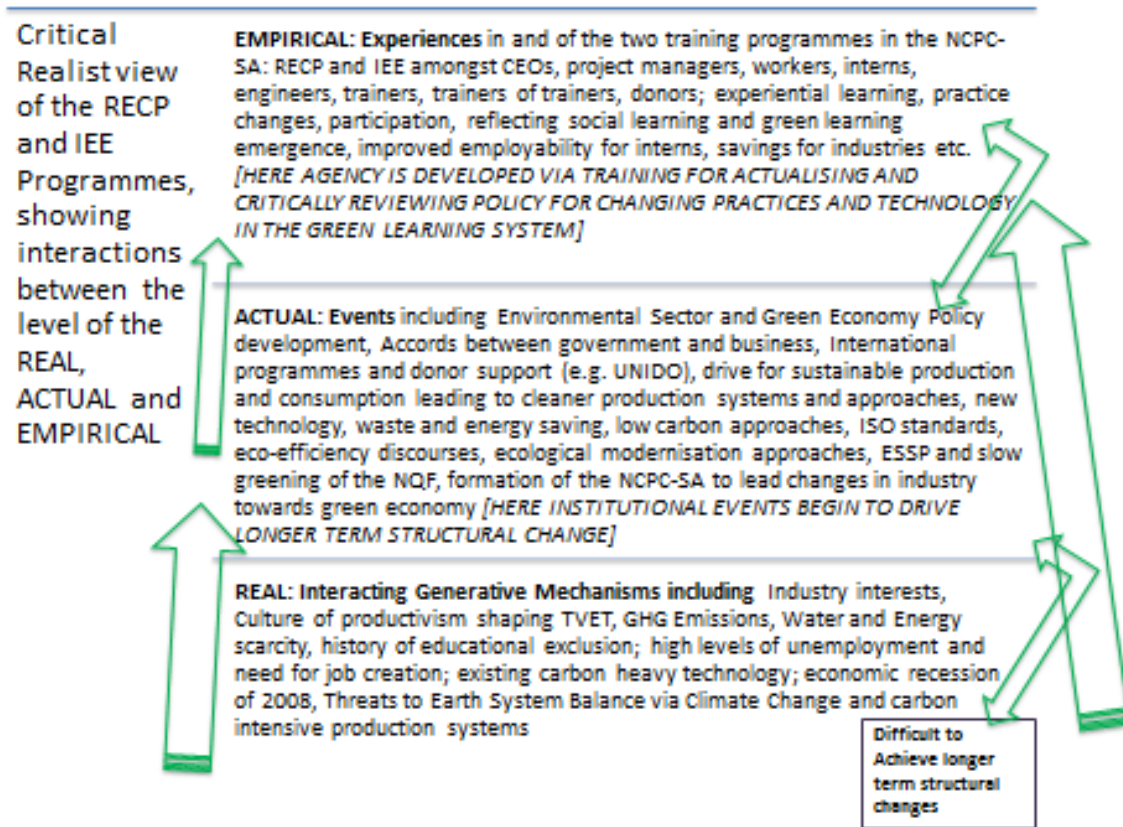
of productivism shaping TVET; water and energy scarcity; history of educational exclusion; high levels of unemployment and need for job creation; existing carbon heavy technology; economic recession of 2008; threats to Earth System balance via GHG driven climate change and carbon intensive production systems that is driving the emergence of green learning.

In turn, it is possible to suggest that a range of diverse events occurring over time at different time-space configurations (local industry level, national level, international policy level etc.) are occurring that also shape the emergence of green learning. These include (but are not limited to) **events** including Environmental Sector and Green Economy Policy development, signing of accords between government and business, development of international programmes and donor support (e.g. through UNIDO and UNEP), the emergence of cleaner production systems, centres and approaches and new technology development that are oriented towards waste minimisation, water and energy saving and low carbon approaches to production. These are being influenced by new guidelines and standards, such as ESO and the ISO standards (EMS and EnMs) identified in this study. They are in turn shaped by a dominance of eco-efficiency discourses and ecological modernisation approaches in conceptualizing the global Green Economy. From a skills system perspective, key events shaping green learning and its emergence are for example the development of an ESSP, slow greening of the NQF, formation of the NESPF all of which can further shape the emergence of green learning.

These shaping factors lead to various **empirical experiences** as shown via the two training programmes. Significant to this study is the real experience of changes in practice, and new forms of employment, all of which are realizing the green economy in practice via training programmes and other interventions. This shows that there is power in green learning for supporting and enabling a green economy as practiced and experienced by people in industries in South Africa at diverse levels: management, project and operations levels and artisanal and engineering levels, all of which are important for realizing an ecologic approach to implementation of the green economy. It is at this level that agency is developed not only for green economy implementation, but also for critical analysis and review of green economy policy and green learning programmes, as shown in this study. This level of agency in turn is important for re-shaping, and the shaping of new events that can further the goals of the emerging green economy and, over time, contribute to the deep structural transformations that are necessary at the level of the real for a global green economy to be realized. Agency

for sustainability includes adequate responses to the issue of earth system balance to sustain human and all other forms of life, as advocated by future looking authors such as Nhamo et.al. (2011), AtKisson (2012) and Death (2014), who suggest ongoing striving for improved and more ecologic approaches to the green economy (see section 2.1.2).

**Figure 4.1. A critical realist view of the RECP and IEE programmes**



## **4.3. RECOMMENDATIONS**

Although not originally part of the rationale of this study, a few areas of possible improvement of the programmes' operational features in relation to emerging green learning aspects transpired. Other recommendations offered here relate to further development and use of the research framework produced for this study.

### **4.3.1. Institutionalisation**

To prevent confusion around green learning agencies, industry as shared customer might appreciate clarification of the difference between the RECP and IEE programmes on the one hand and on the other hand conventional training institutions for industrial settings. This clarity is specifically needed in the near future with the incorporation of green aspects in conventional training curricula.

The ESSP put forward by the NESPF cuts across sectors and as such is not driven by the SETA system. The NESPF is recognised as national authority for skills for the green economy. The development and refinement of curriculums and training manuals as discussed at the 2014 IEE planning workshop might prove to be useful as basis for collaboration. Consolidation of curricula for individual courses into a single curriculum might be worth considering and this could be used as a model for expanding into other areas of training in South Africa perhaps via the NESPF's engagement with SETAs and the wider education and training system.

### **4.3.2. Inclusion of a social learning component in training of project managers and experts**

Project managers are typically recruited from technical or engineering backgrounds. Project managers and consulting engineers may not by default possess the teaching skills to convey their knowledge and skills to participants in assessment or workshop situations. Inclusion of an appropriate component of social learning theory in the training of project managers and consulting engineers might contribute to enhanced learning events, accelerating implementation of RECP, EnMs and ESO (see section 3.2).

### **4.3.3. Focus on green skills for artisanal occupations**

The programmes develop green skills at engineering and technical levels. Training needs of people in technical occupations, also known as artisanal or TVET occupations are differentiated from training of engineers although not less important. Under supervision of engineers, artisanal occupations work at the coal face of resource utilisation in production facilities. Artisans thus have potential to influence the successful implementation and maintenance of efficiency and optimisation measures in the interest of sustainability. Considering the importance of green skills for technical occupations, a dedicated effort might be made to infuse RECP and IEE content into the curricula of institutions for technical training (see section 4.2; Observation Memo section C.7). This is especially potentially helpful as these training institutions are currently under-resourced from a conceptual / curriculum development perspective for the green economy (Lotz-Sisitka et al. 2012).

### **4.3.4. Further testing and use of the analytical tool and framework developed for this study**

As explained across the study, there was little available in the form of analytical tools at the start of this study for guiding a review of the relationship between green learning and green economy. This is understandable as it is an emerging arena of skills development in South Africa and elsewhere. The literature review undertaken in this research provided a useful analytical tool which I was able to apply to the two training programmes of the NCPC-SA via the nested case study design using inductive, abductive and retroductive analytical approaches. The critical realist analysis shows that there are underlying generative mechanisms that are shaping the emergence of a range of events associated with the emergence of the green economy in South Africa and elsewhere and that these are shaping the development of green learning events and programmes. The potential therefore exists to combine further use of the analytical tool to other cases, and to underlabour the analysis with a critical realist perspective to test a) whether the generative mechanisms as identified in the context of the NCPC-SA case is more widely applicable, and b) how these and a range of associated events may be shaping green learning in other contexts, bearing in mind that the generative mechanisms operate in open systems. One would therefore not be looking for comparative ‘matching up’, but rather for cross-sectoral nuance and understanding of how green learning emerges and plays out across the system. I would therefore recommend

further development of the research framework produced for this half thesis study, and its application in other contexts. The fact that I was only able to use the tool in one case, is a limitation of the study, but at the same time, was consonant with the expected scope of a half thesis study.

## **4.4. CONCLUSION**

The research rationale holds that,

Examining how the educational content of the RECP and IEE programmes relate to emerging green learning aspects by implication reveals valuable content and approaches that might be mainstreamed into the NQF system. (see section 1.1.6).

As reported on in Chapter 3, significant common ground was found between the programmes and emerging green learning aspects as the educational interventions are explicitly focused on minimising waste, pollution and green-house gas in particular by means of efficient and optimised energy and resource use. The programmes generate green jobs, improve enterprise financial viability and are making a measurable green learning impact in industrial workplaces in South Africa. The programmes' social achievements include job retention and improved employability by adding green skills to the conventional skill sets of learners in workplaces. The programmes' approaches resonate with social learning theory and with green learning dynamics. They therefore would seem to have potential for upscaling and for the dynamics of the programmes to be expanded into formal qualifications which can be offered more widely. Recommendations as to how this can be done have been provided above.

The findings of this study underpin objectives expressed at a recent IEE planning workshop. Instead of competing with conventional training institutions the programmes' objectives include institutionalisation of course material into national higher educational curriculums. Options for this exercise include possible direct collaboration with SETAs. As pointed out above, a feasible platform might however be the existing SAQA/NESPF green skills development drive in collaboration with professional associations and the QCTO. The NESPF for example offers assistance in integrating the environmental driver in specific skills plans, and works with other stakeholders to expand green skills development within the national system of skills planning and development (RSA. DEA, 2010a; see section 2.2.3).

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## APPENDIX

### A. COMMUNICATION MEMO

#### A.1. LIST OF INDIVIDUALS APPROACHED FOR DISCUSSIONS

In this study the type of interview I used mainly comprised short personal communications. Individuals involved are listed below with topics and dates. The research process included generation of understanding through background information, literature reviews and discussions with individuals. This appendix includes synopses of elect discussions.

1. Buckley, Chris. Researcher and Waste Minimisation Project Manager, KZN University, Department of Chemical Engineering, University of KwaZulu Natal. Topics: landfill scarcity and waste minimisation. Location: iSithebe. 2011, March 05.
2. Harzenburg, Alfred. Manager Studentship Programme, RECP; National Project Manager, IEE Programme. Topics: Implementation of RECP and IEE. Locations: Durban 2011, March 18; NCPC-SA offices Cape Town, 2010; Pretoria, 2012-2014.
3. Hattingh, Elize. M Student, Stellenbosch University. Topic: Green Jobs. Location: Cape Town 2011, January 20.
4. Lotz-Sisitka, Heila. Professor Murry & Roberts Chair of Environmental Education; Director, Postgraduate Studies Centre, RHODES UNIVERSITY; Supervisor for this research; Member of the National Environmental Sector Skills Planning Forum (NESPF). Topics: Environmental education, matters relating to the study as a MEd thesis, NESPF. Locations: Pretoria, 2010; Grahamstown, 2011-2014; OR Tambo International Airport 2013.
5. Maepa, Podesta. RECP project manager for the agricultural processing subsector. Topic: RECP. Location: NCPC-SA, Pretoria, 2012.
6. McKuur, Gerswynn. National Project Manager, IEE. Topic: IEE. Location: NCPC-SA, Pretoria, 2011-2014.
7. Mdlalose, Zakhele. Director Green Industries, Department of Trade and Industry (**the dti**). Topics: Industry greening, EGS. Location: **The dti**, Pretoria, 2009-2014.
8. Morden, Cecil. Chief Director Tax Instruments, National Treasury. Topics: Tax incentives, green taxes. Locations: Midrand, Pretoria, 2010.
9. Naidoo, Vinessa. Marketing Manager, Tshwane University of Technology. Topic: green skills. Location: Sandton. (Future Leaders event) 2011, March 31.
10. Ndaba, Faith. Project Manager, IEE. Topic: project managers' role in IEE training, assessment and implementation. Location: NCPC-SA, Pretoria, 2011.
11. Raphulu, Ndivhuho. Director NCPC-SA. Topics: NCPC-SA strategy for the green economy, SCP. Locations: Durban, Cape Town, 2010-2014.
12. Schudel, Dr Ingrid. Lecturer, ELRC, Rhodes University. Topics: environmental education, analytical tool. Location: Grahamstown, 2012 -2013.
13. Steyn, Dr Elsabe. Director Technical Infrastructure at **the dti**; Manager-SANAS **The dti**, Topics: standards and accreditation. Location: Pretoria. 2011.
14. Van der Merwe, Wynand. Manager Green Training, NCPC-SA. Topics: green skills development, curriculums, matters relating to SETAs. Location: Pretoria. 2010-2014.

## A.2. EXAMPLES OF INTERVIEWS AND PERSONAL COMMUNICATIONS

### A.2.1. RECP programme.

#### Project manager Podesta Maepa



**Figure A.2.1.1. RECP Project manager for the agro-processing sector: Podesta Maepa**

Synopsis of personal communication with Podesta Maepa, RECP project manager for the agricultural processing subsector, at NCPC-SA offices in Pretoria during 2012. Tel. 0128413754

#### Acronyms

PM Podesta Maepa

MJV Marba Visagie, researcher

RECP Resource Efficient Cleaner Production

**MJV:** Thank you for your time and for inviting a colleague to participate in this communication. I have prepared a few questions to take us forward but please feel free to skip questions you are not comfortable responding to, add relevant information and to ask me to explain my interpretation of certain terms that may come up. To be transparent I want to explain to you the purpose of the research and the meaning of critical analysis – it means we look at the programme to examine critical factors that make the programme what they are and which make them successful or not. I also need to be comfortable with the whole discussion and need to know if I may quote you or would you alternatively prefer to be anonymous.

**PM:** Transparency is important to me. Transparency is about appropriate behaviour. It is a human issue and how I perceive myself and the organization. So please use my name and write down as we progress.

**MJV:** Thank you. Shall we work through the questions?

**PM:** Yes, we can start.

**MJV:** *Can you explain what you understand a green economy to be. What is a green economy?*

**PM:** You get these ambiguous words. Green economy to me is to be responsible in production, to make sure there is less impact, you are sustainable, you prevent hazardous impact, to look at the waste we dispose. There are many variables. Perhaps green economy means doing the right thing from beginning to end including industry and society. Responsible in how we do things otherwise all will collapse. Make more with less. For example food security is an important issue in agro-processing. The IPAP it is linked to agro-processing and poverty. There must be sufficient production to ensure affordability to the poor but the price must be viable to farmers. I am also talking to agricultural co-ops about sustainability.

**MJV:** *What implications does the green economy have for RECP?*

**PM:** RECP is about systems, integration of resources and variables into a system. There is a strong relation with the green economy. It is about the way we produce things. Anything about production is about resources, how we utilise them and how we treat waste before disposal. Produce more with less resources, people must be responsible - reduce volumes of resources utilised and minimise wastage. Systems are not always working well. We want profit but do not invest in technology. In South Africa we innovate but do not implement. For example the SKA – SA has the knowledge and expertise but we don't implement.

**MJV:** *Why is that, what do you think is the reason?*

**PM:** Budget is always given as the constraint. Actually it is attitude, what we believe is appropriate. Companies could for example earmark the savings made on water and energy bills to start their own 'investment fund'.

**MJV:** *Should RECP respond to the green economy? And the reason for your response?*

**PM:** If we get policy questions from **the dti** we need to show we are up to date, responding to the green economy, understanding implications for RECP. We just need to package what we are doing in a way that will show we are in a green economy mindset, we are up to date. RECP is already doing the right things in accordance with our current mandate. Our vision goes beyond mandate. As a soldier on the ground I am concerned about food security, water issues – we live in a water scarce country.

**MJV:** *Considering dti and industry expectations, and RECP capacity: Which green economy objectives are relevant to RECP?*

**PM:** I tried to reach companies via **the dti** sector desk. I asked **the dti** how we could support their objectives (by implication green economy objectives) and if they would help us in return as our biggest challenge is always to recruit companies and keep their interest to go through with the assessment and implementation. The response from **the dti** was inadequate.

Recruiting companies for RECP assessment is like building public relations, only a deeper intervention, human to human. You sell yourself, must be confident to gain customer's

confidence. To negotiate you must have knowledge about the RECP concept and about the sector.

I take a holistic approach, combining energy, water, material and waste as separate issues in one system. I look at entirety of process, one value chain. I have also through experience learnt to read people's culture, beliefs and body language, which helps me interpret the responses I get from them. This helps me to understand to what extent I need to prepare people until they would be receptive to RECP. The human element plays an important role in what I do. We invest in people. When I start negotiations with a CEO I read their behaviour, their response to basic questions, their mood and attitude and whether they are happy. From this baseline I know what to emphasise in my presentation of RECP.

**MJV: *How might RECP respond to the green economy?***

**PM:** The green economy requires us to engage in measuring of variables, implementation and monitoring and evaluation. It should actually be a continuous follow up, as manufacturing plants change all the time. Implementing RECP means continuous improvement. Change does not occur just because people have the skill. Attitude, culture, and leadership are required ... it starts with the big bosses, the CEO.

**MJV: *Is the RECP's response to the green economy sufficient?***

**PM:** No. For example insufficient use is made of follow-up visits, which would complement marketing. RECP could lead by example, use success stories to counter the same song we hear every time about financial barriers. We can do better by getting more staff and the best consultants in the market. We need to increase our budget by better packaging what we do and sharing knowledge. We need a mindset shift and align with the green economy. Package, show and refine our contribution to the green economy.

**MJV: *What are industry expectations from RECP with respect to the green economy?***

**PM:** I have not researched industry's expectations. As I have mentioned **the dti** was asked but has not communicated it to me yet. I suggest industry needs RECP, it helps enterprises and sectors to achieve and showcase efficiency (environmental/sustainability) improvements and it reduces cost.

**MJV: *What are dti and NCPC-SA management's expectations of RECP with respect to the green economy?***

**PM:** Again I am not sure. What is emphasised is value for money – the RECP has to meet quantified targets with respect to numbers of assessments to be done per year. Also to contribute to green industries, but the kind of contribution is not specified.

**MJV:** *Could these expectations feasibly be met? Why or why not?*

**PM:** Targets are usually met or RECP performs close to targets. Our green economy contribution is the greening of existing industries.

**MJV:** *In your view, is the RECP developing green skills for the green economy?*

**PM:** Yes we are developing skills and we are greening enterprises.

**MJV:** *Which green economy skills are developed?*

**PM:** I trained hard to improve my own skills. I did the CP Toolkit training. It teaches how to do the CP (RECP) assessment. You learn to link the variables and also consider that industry needs profit. Resources and impact on environment can be quantified – what you can measure you can manage. In one example spending and quantities of lubricant purchases indicate overusing of lubricant. When you check it physically you see it leaking from machines.

Measuring also helps set targets for change. RECP teaches you to become observant. That is how you improve housekeeping within the factory, like how they use cleaning materials, how they store materials ...

**MJV:** *Does the CP Toolkit or any other training award a certificate?*

I think a CP Toolkit certificate is available if you would conduct an assessment, which one can find on the Internet. You can do it on your own and submit the report. I have not done that. I don't think consultants go for the certificate. Maybe the senior project managers do.

Eco-Inspector is something different. It helps you with the routine of assessments.

When I started I was willing to make myself vulnerable and ask the consultant to teach me that I can better understand CP. Nobody is born to know everything. Project managers learn a lot from consultants.

**MJV:** *What is the educational approach – how are green economy skills developed?*

**PM:** Through capacity building. We advocate, we demonstrate.

**MJV:** *What is the relation between training and capacity building?*

**PM:** For each in-plant assessment we do a half day or one-day training with employees. The consultant presents the training.

The whole workforce of the enterprise is involved in the training of employees. Implementation would be compromised if only part of the workforce understood RECP and

committed to implement. The financial manager is particularly important as they are in charge of budgetary work.

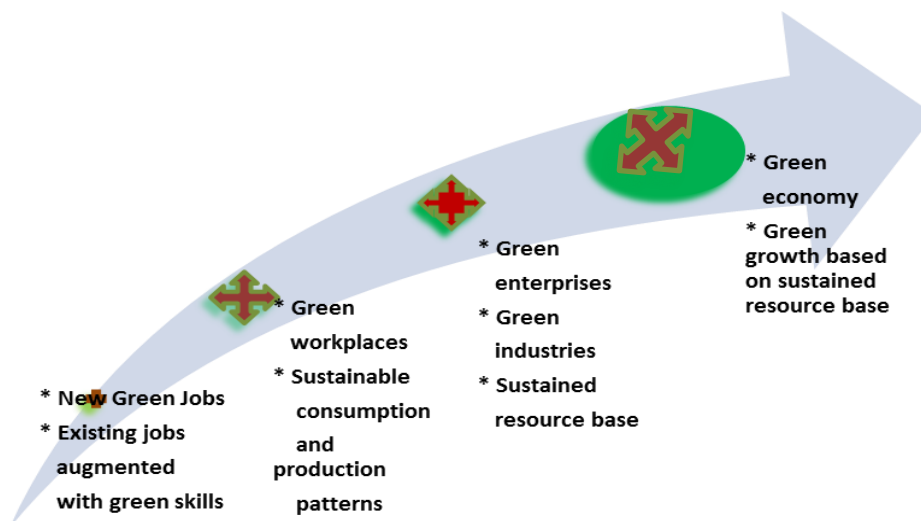
**MJV:** *Are all the consultants used by RECP competent educators?*

We hope so but we don't know. It is trial and error before we know. (PM names two consultants who are perceived to be good educators.)

**MJV:** *According to your view how are green enterprises developed?* (MJV explains the question by drawing a diagram on the whiteboard)

This is a possible path how green skills development might bring about industry greening, asking 'Do you think green economy skills could contribute to green industry / enterprises in this way; and what else might be involved?'

**PM:** I agree skills contribute in this way. But the green economy is not skills only – more than skills are required. If the enterprise for example have budget constraints implementation will for example not go beyond housekeeping efficiency improvements and low hanging fruit (no cost and low cost improvements).



**Figure A.2.1.2. How green skills contribute to green enterprises within green industries and a green economy**

It is important that financial managers record and separately show the savings incurred through RECP. Recording the savings helps to show decision makers that RECP as a package generates funding that puts investment in cleaner technologies within reach. Considering technologies in isolation will however show that payback time might be long in some instances.

Capturing actual savings as part of the assessment is not feasible although it would make an assessment more complete and provide quality success stories. In reality it will however be too expensive to extend the consultant's contract to record actual savings as some savings take months or even years to become evident. Not all companies implement right away and not all savings are evident right away.

Project managers talk about monitoring and evaluation (*follow up to monitor level of RECP implementation*) but we do not follow a standardised monitoring and evaluation process. We also do not use a standardised set of indicators and formulas to quantify savings.

We also don't know how successful our skills development efforts are. Only if we find success stories after six months or some years do we know whether skills development were successful. Only after six months or more and only in some instances do we know whether RECP suggestions were implemented.

**MJV:** *Have (1) 'green economy skills development' and/or (2) development of green enterprises' appeared as an agenda item in strategic planning sessions and other meetings that you have attended? Please provide detail.*

**PM:** 'Green industries' do come up in discussions, not as an agenda item, more like "... we are now in the green industries division so we must start doing green industry things." We are thinking how to align with green economy but I have not been informed about options yet.

**MJV:** *How (in which manner) is (1) and (2) reported in quarterly and annual reports?*

**PM:** Green economy does not feature in reports.

**MJV:** *If you regard it desirable would you have any suggestion how the RECP programme might strengthen its response to the green economy?*

**PM:** RECP must step forward into the GE mindset. In the agro-processing sector I deal mostly with water related issues. I would like to do more intensive work and more water quality analyses and demonstrations of the efficiency solutions we want companies to implement.

Demos were done in the course of 'Ten CP' project. The consultant built up a bio-digester on site for one enterprise and kept modifying it until it performed optimally. This was necessary as bio-digesters work differently for every type of effluent it uses as fuel. The consultant also demonstrated a reverse osmosis water purifier thus convincing another enterprise to acquire one. Another example of intensive assistance (*scaffolding*) was the pioneering and creative thinking that led to bio-digesting of potato skin waste to generate renewable energy. This solved the problem of the skins filling up the enterprise's landfill space. The limited time available for conducting assessments is often a constraint and it limits the assistance that can be given to enterprises.

**MJV:** *Any other relevant information you wish to share?*

**PM:** We need to set targets in terms of green skills and green economy indicators, monitor results and report it to make it tangible. It involves analysis, stronger marketing of success stories and follow-up work to try again in the event of inadequate implementation. The additional work load will require a separate division with adequate staff and resources.

An example of green technology acquisition subsequent to learning from the RECP team relates to a poultry abattoir's quality challenges. Water analysis conducted in the course of an in-plant assessment revealed a chain of un-sustainable water management practices. Without prescribing a specific product the poultry abattoir was advised to purify borehole water before using it in the processing plant. The enterprise was furthermore advised to treat and re-use production wastewater. The waste extracted might be land filled or, as a carbon loop tightening option, used as feedstock for electricity co-generation by means of a bio-digester.

The abattoir's technology procurement as a result of the RECP intervention comprises:

- i. Reverse-osmosis (RO) filter for purifying pre-process borehole water;
- ii. Custom built filter for treating end-of-process water; and
- iii. Bio-digester as a renewable energy resource to produce energy from wastewater.

Green jobs in the environmental goods and services (EGS) sector are supported with each cleaner technology transaction.

**MJV:** *I remember the TEN CP project that you have done in 2009. You achieved a high rate of implementation. Would you perhaps have that report or any other document available that you wish to share with me?*

**PM:** It worked well because the terms of reference were good. I will share the terms of reference with you.

**MJV:** Thank you very much for your time and valuable contribution.

(see main text 3.2.1).

~~~~~

## **A.2.2. IEE programme. Communications with the National Project Manager, Gerswynn McKuur**



**Figure A.2.2. National Project Manager Gerswynn McKuur**

Synopsis of discussions with **Gerswynn McKuur**, National Project Manager, Industrial Energy Efficiency Project (IEE). Tel (012)8412403

Date: between 2011 and 2014

### **Acronyms:**

GM Gerswynn McKuur

MJV Marba Visagie, researcher

ESO Energy system optimisation

IEE Industrial Energy Efficiency

(Introduction was similar to A.2.1. above)

### **GM:**

The IEE is a training project running for four years between 2010 and 2014. UNIDO proposed the project to provide training in industrial energy systems optimisation in South Africa. Donor funding from SECO and DfID was secured by UNIDO. National Treasury also contributes funding. The business community through BUSA is committed to contribute in kind by participation and investment in ESO where necessary.

The IEE short history is that UNIDO and **the dti** in 2009 allocated the IEE programme to the NCPC-SA with recognition to UNIDO as implementing agency. The Department of Energy participates as contributing Department. The business community through BUSA committed to participate in EnMS and ESO training and implementation.

Energy System Optimisation (ESO) training courses cover a range of topics for example fan, motor, pump, boiler and compressed air systems. The range of training events for each topic includes:

- One-day introductory course for vendors and management (CEOs), confirming the value of IEE for environmental performance and operational bottom lines;
- Two-day managerial level energy management system (EnMs) course, focused on the day to day running of industrial plants and the tools available for efficient energy management, targeting management level production managers;
- Two-day technical level courses, i.e. energy system optimisation looking at energy consuming systems such as steam, compressed air, pump, motor and fan systems respectively, targeting plant level engineers and energy managers;
  - For engineers wishing to become lecturers there is an opportunity to complete the expert level EnMS course over a period of months.

The fan system invitation for example invites industrial end-users, operators, maintenance staff, energy managers, supervisors, facility and consulting engineers who have fan system responsibilities in industrial and institutional plants.

The IEE National Project Manager relates that

- the energy engineering profession has become pivotal in appreciating the climatic impacts of energy efficiency and in-efficiency, spreading knowledge and skills toward energy system optimisation (see main text 3.2.2 to 3.2.8).

### **A.2.3. IEE Project Manager Faith Ndaba**



**Figure A.2.3. Discussion with IEE Project Manager Faith Ndaba, energy engineer.**

## **Extract**

IEE project managers provide practical assistance (scaffolding) during in-course tasks and particularly in the course of implementing ESO and EnMS in workplaces. Training of IEE project managers includes completion of the high level EnMS short course and preferably also the expert level EnMS. IEE project managers also attend ESO training and demonstrations to equip them with the tacit knowledge and competence required as advisors of participants from industry (see main text 3.2.2).

### **A.3. Communication with the NCPC-SA director**

NCPC-SA director, Ndivhuho Raphulu, endorsed the idea of a critical analysis of the RECP and IEE programmes by approving the NCPC-SA's financial contribution to my student fees. He was kept updated throughout the research period and the letter below will be delivered as covering letter for a copy of the research results. A copy of the feedback letter is included below.

**Ndivhuho Raphulu**  
Director NCPC-SA  
CSIR  
Pretoria, South Africa  
0001

Reference: (001)01\_NCPC-SA  
Enquiries: M J Visagie  
Cairncroft Estate, Die Wilgers  
Tel: +27729592777

Dear Mr Raphulu

REVIEW OF TWO SUSTAINABILITY LEARNING PROGRAMMES FOR INDUSTRIAL  
SETTINGS IN RELATION TO EMERGING GREEN LEARNING ASPECTS

This letter and copy of the research results serve as feedback on the above research project endorsed and supported by you. The research set out to achieve the following:

- Substantiate the RECP and IEE programmes' relevance to the **green economy transition**, as envisioned in the New Growth Path (RSA, 2010) and the National Development Plan (RSA. The Presidency, 2011); and
- Assess the suitability of the NCPC-SA's programmes to be considered for **contributing to national green learning initiatives** that aim to develop skills for the green economy.

The study has been completed and submitted to my supervisor on 13 January 2015 for examination. As co-funding agency, NCPC-SA will be informed of the outcome.

Please be assured of my sincere gratitude for granting me the right of way to source data from NCPC-SA managers and project managers as required for the research.

You are invited to read through the four chapters and view NCPC-SA and its programmes from a green education perspective. In the event of time constraints you are urged to at least engage Chapter Four, which may inspire strategic strides for NCPC-SA in context of skills development for the green economy inclusive of SCP.

Kind regards

**M J Visagie**

2015-01-13

## B. DOCUMENT ANALYSIS MEMO

### **B.1. Types and sources of documents analysed**

This annexure contains a list of documents reviewed. As explained in section 1.4.3, I obtained documents on a needs basis, inclusive of slide presentations, from NCPC-SA (main source of documents) **the dti** and my lecturers at the Environmental Learning Research Centre (ELRC). The slide show presented to **the dti** by the late Peet du Plooy is a precious possession received from him directly.

Ample references were available in libraries, the Internet and generously donated from Prof Lotz-Sisitka's collection to substantiate the literature reviews pertaining to social learning, green economy and industry greening in particular. A huge chunk of literature served as background and does not appear in the reference list at the end of the main text. When it came to critical information on emerging aspects of green learning and EGS activities, options were however significantly reduced. I was in a number of events notified of newly completed documents as they came available and kindly supplied by senior researchers and peer students. In a few events I had to refer to secondary text cited in documents as the original could not be accessed. With respect to the content and approaches of the programmes in particular, I relied on NCPC-SA internal documents, reports and minutes, augmented by observations and discussions with project managers.

### **B.2. Themes**

Section 1.4.3. explains the objectives of the document analysis and the themes that emerged explicitly, implicitly or as silent text, illuminated by the experience of non-related researchers, for example Kahn's document on CEOs' lack of confidence in workers' tacit knowledge. The Kahn paper was broadcast by Nimrod Zalk to members of the Industrial Development Division of **the dti**. In our follow-up email correspondence Kahn asserted that this document has not been published as yet but was to become a chapter in a book (see Data Management Memo).

### B.3. List of documents

Documents cited in the report are listed below. They are also listed in the main reference list, among the other references.

1. De Almeida, A., Fong, J. and Falkner, H. 2012. Manual for Energy Efficient Electric Motor Systems. Vienna: UNIDO
2. Du Plooy, P. 2009. Presentation as chairperson of the EGS Forum to Deputy Director General: IDD. **Dti** Internal Document.
3. Mthente. 2013. *National Cleaner Production Centre (NCPC-SA) Impact Review 2013. Final Executive Summary October 2013*. Pretoria: NCPC-SA.
4. NCPC-SA. 2008. Terms of Reference for cleaner production Projects to develop case studies, benchmarks and capacity building. Unpublished internal document. Pretoria: NCPC-SA.
5. NCPC-SA. 2010. Road map for the review of NCPC-SA business plan and mandate in line with IPAP2. Unpublished internal document. Pretoria: NCPC-SA.
6. NCPC-SA. 2011a. National Cleaner Production Centre - South Africa: Management Report 2010-2011. Pretoria: NCPC-SA.
7. NCPC-SA. 2012. A Decade of Industry Greening Through Resource Efficient and Cleaner Production. 2002–2012. NCPC-SA internal document.
8. NCPC-SA. 2014a. Compressed air system optimisation training. Flyer disseminated among industry associations, sector desks and the existing IEE customer base.
9. NCPC-SA. 2014b. National Cleaner Production Centre South Africa. Business Plan 2014/15. Pretoria: National Cleaner Production Centre SA
10. NCPC-SA. 2014c. Industrial Energy Efficiency Project in South Africa. Results and Impact in the Automotive Sector. Pretoria: NCPC-SA.
11. NCPC-SA. n.d. National Cleaner Production Centre South Africa. Pretoria: NCPC-SA. (Brochure).
12. Schudel, I. 2012. Developing data generation tools for your research project. Unpublished slide presentation. Grahamstown: Rhodes University Environmental Learning Research Centre.

## C. OBSERVATION MEMO

### C.1. Career related observation and experiences

My observations include company visits, events and meetings attended and work experience gained during 19 years in the industrial sustainability field. I utilised my work experience to enrich this research.

#### C.1.1. International observations

Heading the small Environment unit at **the dti**, part of the rich learning trajectory equipping me for this new portfolio was to partake in conferences and working sessions as member of the South African delegation to international sustainability events. Events included conferences of the United Nations Commission on Sustainable Development (UN CSD) in New York and the World Trade Organisation's (WTO) Commission on Trade and Environment (CTE) in Geneva and elsewhere. At these occasions I had contact with UNEP and UNIDO and became aware of their programmes and projects carrying the concept of sustainability into economies world-wide. Their joint initiative to establish national cleaner production centres (NCPCs), mostly in developing countries, struck me as a feasible platform for economy and environment to generate mutually beneficial sustainable development outcomes. International observations served to put the study in context of international pressures, powers and most encouragingly, technical and financial assistance available.

#### C.1.2. NCPC-SA established in 2002

Establishing a South African UNIDO office coincided with preparations to host the 2002 Johannesburg World Summit on Sustainable Development (WSSD), project-managed by the Department of Environmental Affairs and Tourism (DEAT). As participant by default, UNIDO expected **the dti** to put forward ideas for meaningful input to the event. As Deputy Director: Environment I was instrumental in promoting the establishment of the NCPC-SA as one of the outcomes of the WSSD, a UNIDO / **dti** partnership, piloting CP, (now RECP) in South Africa. I was also part of the team partnering with UNIDO, industry and the Department of Energy (DoE) in establishing the Industrial Energy Efficiency (IEE) programme as a four-year pilot project, evolving as a programme entering its second phase in

2015. My experience, firstly as learner and then as mentor, in developing fundable CDM projects contributed to useful experience in identifying IEE success factors in context of legal and industrial frameworks in South Africa. NCPC-SA drives roll out of the two programmes and recognition by industry and other government departments such as the DEA has been affirmed by NCPC-SA's potential role in greening the industry towards a green economy (see main text 1.3).

### **C.1.3. Donor assistance**

UNIDO and UNEP act as agencies spearheading green projects in many countries, with local NCPCs as implementing agencies. UNIDO and UNEP negotiate co-funding agreements with government departments and secure funding and technical assistance from more advanced green economies such as Austria, the UK, Denmark and Switzerland, for RECP, IEE and other projects.

### **C.1.4. Sustainability factored into South African policies**

#### **C.1.4.1. Participation in aligning national policies with the sustainability drive**

It was a once-in-history privilege to witness the development of South African environmental policies from a fragmented conservationist approach to embracing sustainability as overarching principle, on basis of the environmental right enshrined in the Bill of Rights in the Constitution (RSA, 1996, section 24). I represented **the dti** at policy formulation forums to align national policies and standards with multilateral environmental agreements (MEA). In instances where **dti** policy on sustainability matters needed to be formulated or reconsidered I initiated and project-managed studies to inform **dti** policies and strategies. The studies resourced and monitored by the National Economic Development and Labour Council (NEDLAC) Fund for Research into Industrial Development, Growth and Equity (FRIDGE) are available on the NEDLAC website, including respective studies on the environmental goods and services (EGS) sector and the recycling industry.

## **C.2. Industry greening through the NCPC-SA**

NCPC-SA on a limited scale contributed to industry greening in terms of government's commitment to sustainable development. My role in the first decade of the NCPC-SA included representing **the dti** at planning and reporting meetings. **The dti** mainly required quantified reporting: numbers of companies assessed, implementation statistics, energy and water saved and financial savings. As part of embracing the green economy since 2010 **the dti** eventually extended incentives programmes to encourage green technologies, which elevated implementation of RECP and IEE to new levels.

### **C.2.1. RECP approach in general**

I attended preparation, mid-assessment and closure feedback meetings with enterprises. Introduction of RECP training includes securing buy-in and involving the whole management team. The RECP team responds to questions, for example the following frequently asked questions from management and unions:

- How can RECP help the company in meeting waste and municipal regulations (in some cases the companies experienced regulatory challenges).
- Will information be shared with the municipality or the Green Scorpions?
- How will the assessment and possible implementation affect production flow;
- Financial implications of the assessment and costs incurred by implementation;
- Impact on job security.

RECP assessments start with introductory workshops. This approach brings staff on the same level of cleaner production awareness. The mode of assessment is observation by means of a walkabout, providing incidental learning through discussion of improvement options.

Intensive education and training are however required to create a thorough understanding of RECP. The RECP team strictly adheres to the confidentiality agreement (see main text 3.2.7).

### **C.2.2. Observation of RECP assessments**

The following paragraphs summarise a preparatory meeting for RECP assessment of the headquarters of a commercial bank in 2010, in which I participated as observer. The RECP project manager and consulting engineer worked directly with the division manager and a number of section managers in assessing the resource efficiency of the division. The meeting

occurred as an interim milestone, to consider the quick scan report and determine focal areas for the in-depth assessment.

Efficiency options considered, covered energy use, waste minimisation and recycling of waste, including re-use and external recycling. A strategy was proposed to minimise production of printed material and in particular the use of high-cost material such as letterhead paper and paper rolls used at ATMs (see main text 3.2).

### **C.2.3. Visit to a garment factory - 2009**

A small clothing factory in Cape Town was visited while a RECP assessment was ongoing. I accompanied the RECP project manager and consulting engineer. The product (soccer shirts) was manufactured in terms of a tender. RECP options focused on high-cost input items such as compressed air and imported knit fabric. The RECP team informed company management about IEE training in energy system optimisation of Compressed Air Systems. The assessment focused on small but significant measures such as leaks in the compressed air system. It was calculated that about R6900 might be saved per month on the energy bill by diligently maintaining the compressed air system and training to ensure compressed air is used only at prescribed points in the production process. A re-think of cutting layout saved on fabric (see main text 3.2).

### **C.1.2.4. Presentation by intern – 2010**

A lingerie factory was visited. The visit included attending the feedback meeting at which an intern made her presentation to management, upon completion of internship. The incumbent was allowed to make substantial improvements in the course of her internship. Her presentation to management displayed savings already incurred during the pilot period:

- i. Less expensive paper was used to line cutting tables;
- ii. The intern sorted a disorderly stock shelf containing half-used rolls of thread according to colour and coding, making it accessible for re-use;
- iii. Attention was given to layout of patterns, which allowed more items to be cut per metre, minimising wastage of fabric and producing more with less;
- iv. It was planned to centralise all processes using heat and install a heat exchange system. This energy saving solution required investment in green technologies, training of staff to calculate energy use and re-planning of the production layout system; and

- v. The intern suggested costing of compressed air per division, for tighter control.

A RECP senior project manager acted as mentor to the intern and assisted her in identifying no-cost and low-cost RECP opportunities. The presentation balanced financial investment with RECP savings.

Cognisance is taken that the intern's success story continued beyond the internship assignment, as she received a job offer as Cleaner Production Manager, which is recognised as a green industrial job.

### **C.3. RECP implementation**

In presenting efficiency improvement options the RECP team suggests generic technologies without recommending a specific brand name (see main text 3.2.5).

Companies often start with implementing no-cost and low-cost options eg. shop-floor and housekeeping practices (low hanging fruit). Efficiency improvements requiring investment are often postponed to next budget year.

Poor continuity of management may be a cause for weak implementation as the new management team lacks awareness of the benefits of RECP. RECP and enforcement of environmental regulations work hand in hand.

### **C.4. Sustainability value beyond financial savings**

The programmes' value in terms of saving of environmental resources yet has to become part of reporting requirements but transpires in the form of units of electricity, water and material saved. The programmes stimulate growth of the environmental goods and services (EGS) sector with each transaction to procure cleaner technologies (see main text 3.2.5).

## **C.5. IEE observations**

### **C.5.1. Observation of training events: Two-Day Motor System Optimisation Course For Engineers on 2012-07-16**

The Presenters were Prof. Anibal de Almeida, ISR - University of Coimbra, Portugal ([www.sustainablebuildingscentre.org](http://www.sustainablebuildingscentre.org)); and

Dr Hugh Falkner, ETSU; Chief Sustainability Engineer at Atkins Environmental Services, Oxford, UK (<http://uk.linkedin.com/pub/hugh-falkner/b/76a/774>).

Book: *Energy Efficiency Improvements in Electronic Motors and Drives*. Eds. Dr. Paolo Bertoldi, Prof. Anibal T. de Almeida and Dr Hugh Falkner. Berlin, Heidelberg: Springer

### **C.5.2. Content notes**

De Almeida focused on energy optimisation of electrical motor systems. He emphasised that improvements in the efficiency of electric motor systems could save up to 1.25 Mega tonnes (Mt) of carbon dioxide per year, with systems comprising medium and large scale motors.

He noted the importance of harmonization of electric motor efficiency standards; technology transfer; correct motor sizing and full analysis of the systems in which electric motors are installed eg. conveyor belts. Prof de Almeida frequently challenged the class with questions. At tea break, students showed keen interest and approached the lecturers with questions.

Falkner focused on calculations, for example to identify the most efficient combination of motors in the system. Maximise output, minimise electricity use. Engineers calculate and compare the GHG and financial implications of different optimisation options.

Classroom example: energy consumption by a system for a week pre- and post-optimisation are compared. The difference of 146 kW savings for the week is converted to financial savings on basis of electricity rates and to a carbon saving of  $146 \text{ kW} \times 70.4\text{g} = 103 \text{ kg}$  per week. At 103 kg per week a single system saves approximately 5 tonnes of carbon emissions per week, which amounts to significant carbon reductions for sectors and whole economies.

Energy consumption in fan system loads is sensitive to speed. Eg. , a 100 kW motor driving a load continuously throttled to 50 percent in contrast to 100 percent of output will save almost 18000 Euro per year (assuming 6000 hours per year @ 0.06 Euro/kWh,). Significant savings are incurred with even modest speed adjustments (see main text 3.2.3).



**Figure C.5.2.1. Prof de Almeida and Dr Falkner responding to questions at Motor Efficiency ESO course, 2012-07-16.**



**Figure C.5.2.2. Students (energy engineers) completing an in-course assignment – calculation of projected GHG energy savings as a result of ESO**

## **C.6. IEE Students**

IEE students were motivated to attain IEE knowledge and skills, and participated in a focused way. They were challenged by in-course assignments but managed to master the engineering-type equations and calculations.

I had brief interviews with (1) Barry Winter, production engineer at an SME, who attended to build capacity in installing an optimised motor system; and (2) Lindha Mntambo, an engineer

working on improving energy efficiency at Eskom power stations. Linda shared that he was also an instructor at his workplace and it was assigned to him to transfer the skills and knowledge gained to his colleagues at Eskom.

#### **C.7. 2014 workshop to plan IEE Phase 2, commencing in 2015**

International IEE project agency UNIDO plans has secured a new round of funders, which includes the Global Environmental Facility (GEF), for the next phase of IEE. Plans for the second phase include institutionalisation of IEE courses into NQF related curriculums and with professional bodies. At a 2014 planning workshop for further phases of IEE, options for mainstreaming EnMS and ESO curricula were discussed. UNIDO's objectives for the second phase include development of EnMS and ESO training manuals (see main text 4.3.3).

## D. DATA MANAGEMENT MEMO

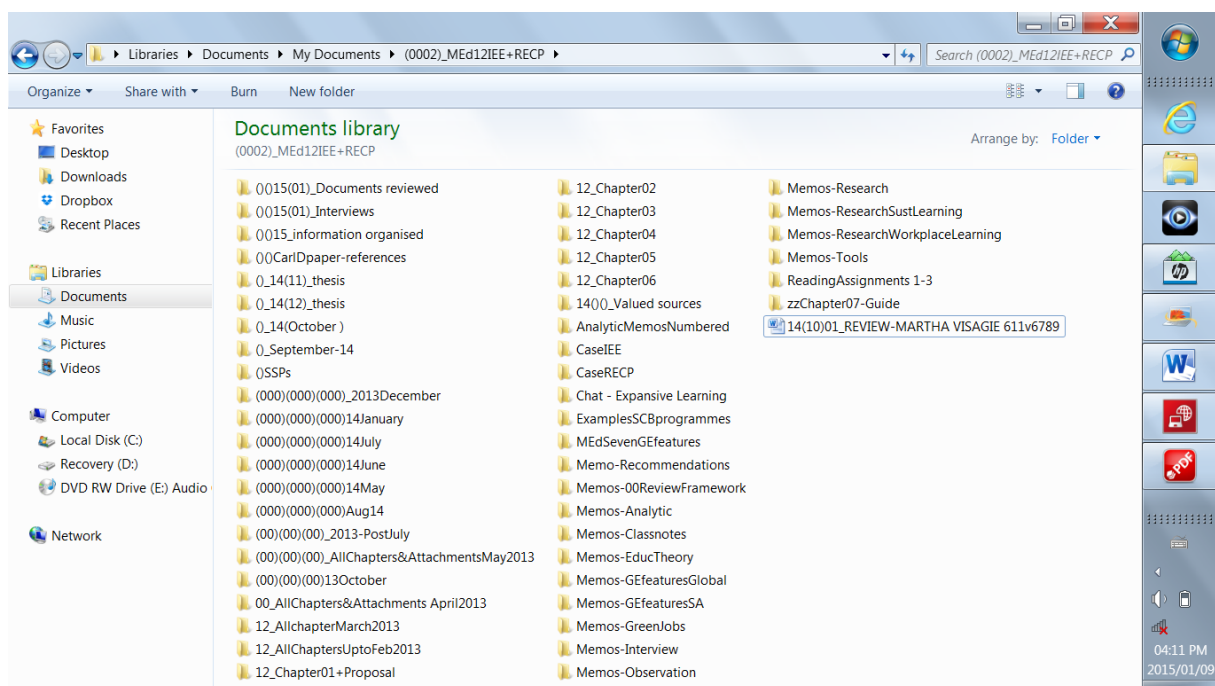
### *Managing and organising the data*

As indicated above, this study generated and worked with a range of different data sets.

It was therefore also important to organise and manage the data for systematic analysis.

I used the MSWord 2010 searchable electronic system of folders and files arranged in a system that first lists files numerically, then alphabetically. The system allowed me to initially work on chapters separately and at the right stage combine them into a single document seamlessly.

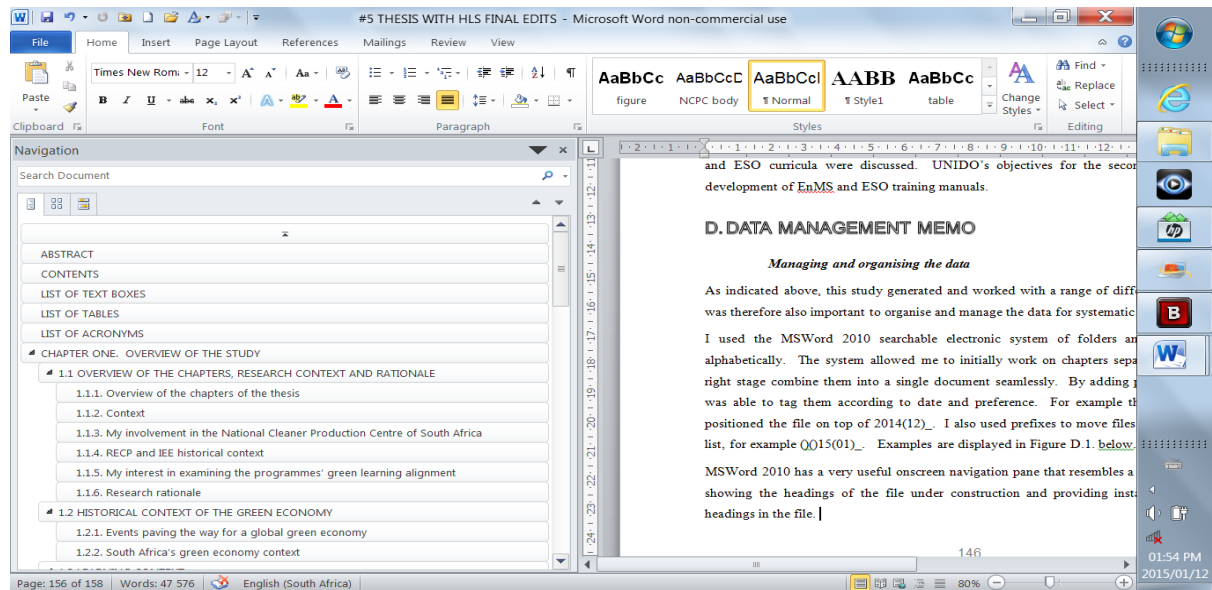
By adding prefixes to files it was able to tag them according to date and preference. For example the prefix 15(01)\_ positions the file above 2014(12)\_. I also used the prefix ‘()’ to keep files at the very top of the list, for example ()()15(01)\_XXX Like-prefixed files will be positioned together. Examples are displayed in Figure D.1. below.



**Figure D.1. Example of how files were organised**

MSWord 2010 also has a very useful onscreen navigation pane that resembles a table of contents, showing the headings of the file under construction and might be used either independent of the text on the right hand side or for instant access to elect sections in the file. The navigation pane in combination with the internal search function that can find specific

words of phrases in the text, helped with cross referencing, which I did manually after electronic cross-referencing was found to inconsistent.



**Figure D.2. Example of navigation pane linked to text but also used independently**

I used the powerful search function of MSWord 2010 as virtual indexing mechanism. The search engine can find words in file names and also inside all the documents in a selected data section.

The search function also helped to weed out duplication in the text, which may occur when working on a paper with frequent and lengthy interruptions as was the case with this study.

Appreciating how the electronic system of folders, files and search function articulate is of the essence when using the search function as virtual indexing mechanism. For example file and folder titles may be changed but the correct procedure must be followed in order to allow the overview to keep track of files and folders.

I also generated a planning grid and a register of references on Xcel spread sheets. Xcel is searchable, can arrange entries alphabetically and number entries. Insertion or deletion of rows in the correct way does not impair the integrity of the numbering or alphabetical system. The example below shows how Xcel displays a large volume of information on one screen when two files are viewed simultaneously.

The image shows a screenshot of a Microsoft Excel spreadsheet titled "15(01)\_LiteratureLog - M". The spreadsheet is divided into two main sections. The top section, labeled "Keywords", contains a list of themes and their corresponding literature references. The bottom section, labeled "Top 25 Literature Log. Med. Environmental Education. M.J. Visagie 6116789", contains a table with columns for "Nr", "Author", "Keywords", "Date (yr)", "Title", and "Publisher". The "Keywords" column in the bottom table lists terms like "competence development as workplace learning", "modernity; risk", "dialectic: the pulse of freedom", and "situated cognition; culture of learning". The spreadsheet interface includes the Microsoft Office ribbon (File, Home, Insert, Page Layout, Formulas, Data, Review, View, Add-Ins) and a taskbar at the bottom showing the system clock as 02:25 PM on 2015/01/12.

**Figure D.3. Examples of literature register displaying a large volume of information on one screen with a searchable list of themes in the column termed ‘keywords’**

Themes that transpired from the literature review were incorporated in the analytical instrument (see main text 2.3). More themes emerged from the case study and they were documented in the synthesis analysis, recommendations and conclusion (see main text Chapter 4).