DISCUSSION PAPER ON THE ROLE OF WATER AND THE WATER SECTOR IN THE GREEN ECONOMY WITHIN THE CONTEXT OF THE NEW GROWTH PATH

Report to the
Water Research Commission

by

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1. INTRODUCTION

The benefits of the GE and the need for more sustainable ways of operating have been very topical in South Africa. In his inaugural State of the Nation Address in June 2009, President Jacob Zuma stated, “It is my pleasure and honour to highlight the key elements of our programme of action. The creation of decent work will be at the centre of our economic policies and will influence our investment attraction and job creation initiatives. In line with our undertakings, we have to forge ahead to promote a more inclusive economy.” The GE is prioritised as one of the key economic drivers in the Medium Term Strategic Framework (MTSF) 2009-2014, Outcome 4 (Decent employment through inclusive economic growth), Outcome 10 (Environmental Assets and natural resources that are valued, protected and continually enhanced) and in the New Growth Path (NGP) announced by Cabinet in October 2010. The MTSF 2009-2014 priority 9 highlights the implementation of the 2008 cabinet approved National Framework for Sustainable Development (NFSD) to ensure that the country follows a sustainable development trajectory. The purpose of this framework is to enunciate South Africa’s national vision for sustainable development and indicate strategic interventions to re-orientate South Africa’s development path in a more sustainable direction. The implementation of the NFSD entails the finalization of the action plan and its institutional, monitoring and evaluation frameworks. The country’s sustainable development vision is outlined as “South Africa aspires to be a sustainable, economically prosperous and self-reliant nation state that safeguards its democracy by meeting the fundamental human needs of its people, by managing its limited ecological resources responsibly for current and future generations, and by advancing efficient and effective integrated planning and governance through national, regional and global collaboration”. The GE was further prioritised in the State of the Address and the Minister of Finance budget speech. All government departments need to develop implementation plans and align their programmes with the job creation imperative. A number of priority programmes were identified that effectively provide practical interventions for the environment sector contribution. If implemented, the programmes will have a significant contribution towards mainstreaming GE approaches within South Africa to the benefit of the environment, economy and society, promoting growth while reducing pollution and greenhouse gas emissions, minimizing waste and inefficient use of natural resources, maintaining biodiversity and strengthening energy security.

Further, South Africa is a signatory to the United Nations Framework Convention on Climate Change and has successfully hosted the 17th Conference of Parties (COP 17) event which took place in December 2011. The COP 17 conference resulted in a second commitment period for the Kyoto Protocol. This has largely been seen as the only internationally recognised binding mechanism to reduce global greenhouse gas emissions. In December 2009, South Africa conditionally agreed to effect a greenhouse gas emission reduction target of 34% by 2020, and 42% by 2025.

Achieving the NGP requires that government understand, accept and address key trade-offs affecting all sectors including the water sector. Although the NGP knits together the Industrial Policy Acton Plan (IPAP) 2 as well as policies and programmes in rural development, agriculture, science and technology, education and skills development, labour, mining and beneficiation, tourism, social development and other areas it fails to identify the significant role of resources in achieving the NGP. Various government departments have developed sector specific response strategies to the NGP such as the Green Economic Strategy.

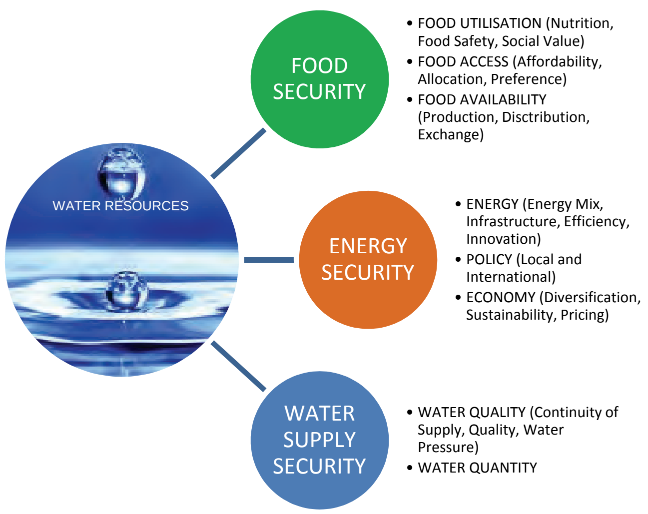
The environment sector in the initial implementation plan focuses contribution on 4 key focus areas: (1) Resource conservation and management, (2) Sustainable waste management practices, (3) Water management and (4) Cross-cutting focus area that will cover:

- Greening and legacy (2010 Soccer World Cup, COP17 flagship & Tourism); and
- Research, awareness, training, skills development and knowledge management.

Event greening is also one of the initiatives being implemented to promote responsible tourism.

This discussion paper looks to explore whether a GE, from a water sector perspective, will effectively assist in achieving the national development and job creation objections as outlined in the NGP. The outcome of this study will guide the activities of departments and municipalities in pursuance of a green agenda and its national obligations in terms of the NGP. What is clear from current research is that the present costs and future benefits of a green economy on the water sector are not clearly understood. Although this discuss paper will not determine those costs and benefits it will go a long way in identifying the factors and scope for a broader scoping study.

While water is a finite resource it is also a catalyst for economic growth. Various studies and common sense has shown that water is a key ingredient in industrial processes, the agriculture sector, good health, etc. Economic growth and development depends largely on water quality and availability which are affected by competing demands between people, industry, food security, the environment, development, etc. The interrelationship between these aspects must be considered in strategic planning particularly when there is a paradigm shift in economic growth. The Green Economy (GE) is seen by many Governments as an opportunity to meet growth projections and in turn reduce poverty and create much needed jobs. The South African Government has shown support for a GE as an alternative vision for growth and development which takes into account sustainable development and stimulating the triple bottom line approach to growth by responsibly advancing economic, environmental and social well-being.



However, the question remains, "What is the role of water in the GE in the context of sustainable and economic growth in South Africa? Can the water sector truly achieved economic growth by adopting a green approach" The discussion paper puts forward international arguments in support of a GE as well as examines the lessons learnt and challenges faced by those who have gone the green route in order to achieve economic growth.

Unlike other sectors such as the Electricity or the Agriculture Sector where a green approach is feasible, the water sector is constraint by a potential water crisis in the next 15-20 years. The International Water Management Institute has classified South Africa as a member of Group II: a country that does not have sufficient water to meet 2025 needs. According to this classification, South Africa will need to increase water supplies through creation of new storage, conveyance and regulation systems to over 25% more than 1995 levels to meet water needs of 2025 in time (ICID). According to the Water Resources Group, with current rates of expansion and efficiency, water demand is going to rise by between 40 and 50 % and this gap can only be closed by careful allocations of resources and encouraging innovation. With this in mind, the sector has little to no room for an untested approach such as a green economic approach.

Current international and national trends indicate that both public and private sectors are transforming towards greener and low carbon intensive economies. Examples include initiatives by the Industrial Development Corporation (IDC) to lead on investments in green industries, Eskom's intent to roll out one million solar water heaters by 2014 and the NGP that commits South Africa to taking steps towards the ultimate goal of developing a truly GE. Hence, unpacking what is meant by a GE in the context of the NGP is of strategic importance.

1.1 Aims of the Document

The general objective of the investigation is to define the concept of the GE in the context of the NGP and to examine the role of water in the GE. The objective of the research is as follows:

- Review literature on the role of water in a GE and in green growth;
- Provide a definition of the GE in the context of the water sector;
- Outline the role of water in achieving the NGP especially in terms of green growth;
- Identify the drivers in the GE that are reliant on water;
- Unpack the NGP objectives it terms of water dependencies;
- Unpack the growth targets and its implications on the water sector; and
- Compile a discussion paper on the significance of water in a GE and in achieving.

1.2 Assumptions and limitations

This report is generated largely from desktop analysis although some interviews were conducted with municipalities. As such we make the assumption that the authors of articles cited here are producing meaningful and accurate research that will inform the water sector of potential avenues of investigation for future initiatives.

1.3 Research Methodology

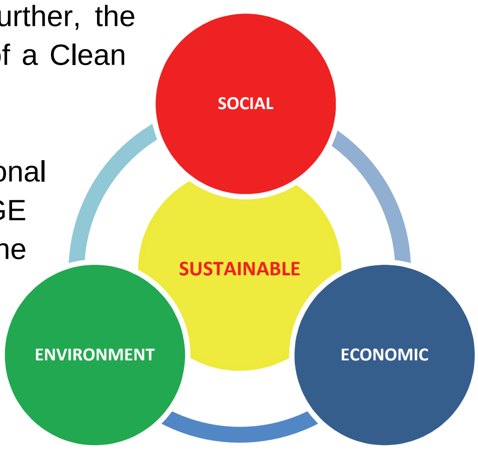
The research takes the form of a literature review to investigate patterns in national and international policy frameworks as well as to identify and document current relevant initiatives. This is followed by a baseline assessment of current GE initiatives to inform the water sector of potential avenues for research and development, and a gap analysis to identify future avenues for research and innovation in the water sector.

2. DEFINITION OF A GE

The GE was first introduced in the 1980s as an economic tool, to provide "economic underpinnings of the idea of sustainable development" and then implement aspects of sustainable development (United Nations, 2010). Since 1989, several definitions of the GE have emerged, as it has become less of a tool within sustainable development, and more an independent sector of the economy. The move towards the establishment of Green Economies is an international one, with each country facing its own set of unique challenges in this respect.

With this in mind it is essential to define the GE in the context of the NGP and examining the role of water in this definition. This definition could become the underlying strategy and implementing vehicle to green the water sector aligned to the NGP and international goals of improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities.

There are several definitions of the GE currently in use. Further, the concept of a GE is used interchangeably with the concept of a Clean Economy (CE) and a Low-Carbon Economy (LCE).



While the definition of a GE may vary, there is international agreement on common principles that should drive a GE leading to different perspectives or outcomes depending on the role the GE it is intended to fulfil. The common principles include a reduction in carbon emissions and pollution, promoting sustainable use of natural resources in a socially inclusive manner while achieving economic growth.

A further defining feature is that, compared to "traditional" economic regimes, the GE definition must lend itself towards the direct valuation of natural capital and ecological services as having economic value.

According to the UNEP any definition of the GE must foster growth in income and employment while still reducing carbon emissions and pollution, enhancing energy and resource efficiency, and preventing the loss of biodiversity and ecosystem services. The outcomes of the GE must result in improved human well-being, reduced inequalities and protecting future generations from environmental risks and ecological scarcities. According to the Department of Environmental Affairs (DEA), the GE is a growing economic development model based on the knowledge that aims to address the interdependence of economic growth and natural ecosystems and the adverse impact economic activities can have on the environment. The GE can create green jobs, ensure real sustainable economic growth and prevent environmental pollution, global warming, resource depletion and environmental degradation.

Below, is an overview of some definitions of a GE currently used.

No	Country/Organisation	Summary of the Definition
1	UNEP	Improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities.
2	Eco Canada	The aggregate of all activity operating with the primary intention of reducing conventional levels of resource consumption, harmful emissions, and minimising all forms of environmental impact
3	Gauteng Department of Economic Department	The GE has been defined as a series of actions rather than principles, namely: 1. Initiatives that protect the basic requirements of human beings (food, water, etc.); 2. Technology initiatives that make it possible to do more with less, including reduced energy input per unit of output, reduced carbon emissions and more efficient use of primary resources;
4	Green Economy Coalition	A GE is a resilient economy that provides a better quality of life for all within the ecological limits of the planet. The GE is founded on the principles of: • Sustainable development; • Equity and poverty alleviation; • Resilience; • Inclusiveness; and • Environmental limits.
5	New Zealand	An economy which mutually reinforces environmental, social and economic policy that makes the most of opportunities to develop new industries, jobs and technologies to clean up polluting sectors, seek efficiencies in resource use and transforms consumption patterns.
6	Japan	An economic system which promotes sustainable growth while improving human well-being, by pursing economic growth and the environmental conservation in tandem, properly utilizing and conserving natural resources and ecosystem services.
7	EU	Improve environmental justice and reduce inequalities, environmental scarcities and the stress on ecosystems by investing in and preserving natural capital, securing sustainable and efficient use of resources and addressing social concerns, while maintaining

No	Country/Organisation	Summary of the Definition
		competitiveness.
8	Kenya	GE must foster accelerated economic development, address poverty eradication and improvement of social welfare. It must be pro-poor and democratic, emphasise empowerment, social inclusion and participation in a holistic sense.
9	Philippines	GE is a people-centred development paradigm that promotes the people's role as steward of the natural resources and as owners of the country's domain, thus ensuring sustainability.
10	Republic of Korea	An economy of permanence, one which generates wealth and well-being, increases employment, reduces poverty and inequality, and does so without exhausting natural capital or creating ecological scarcities and climate risks.
11	USA	A GE or CE or LCE is the sector of the economy that produces goods and services with an environmental benefit.
12	South Africa	The Green Economy refers to two inter-linked developmental outcomes for the South African economy: • Growing economic activity (which leads to investment, jobs and competitiveness) in the green industry sector; • A shift in the economy as a whole towards cleaner industries and sectors with a low environmental impact compared to its socio-economic impact.

From the above it is clear that defining the GE can be a statement of expected outcomes and/or guiding principles. However, some countries and/or organisations have opted for a completed different approach to the definition of the GE. They have used a sector based approach to the definition and have identified six main sectors namely:

- Renewable energy;
- Green buildings;
- Clean transportation;
- Water management;
- Waste management; and
- Land management including the agricultural sector.

Yet others apply the triple bottom line approach, i.e. an economy concerned with being environmentally sustainable, socially just and with a locally rooted economic benefit through the exchange of goods and services.

While defining the GE may prove to be challenging it is nothing compared to the difficulty of having one definition that represents all sectors. The implications of a single GE definition and the implications of the SA definition of the GE on the water sector are discussed in Section 5 – Critical Analysis of the GE for the Water Sector of the paper.

3. WHAT DOES A GE PROMISE

In response to the international economic crisis, the SA government recognises the opportunities in the development of industries that combat the negative effects of climate change and urges South Africa to develop strong capacity in green technologies and industries. Accordingly it urges the development of incentives for investment in a programme geared at creating a large number of green jobs. About 300 000 jobs could be created in South Africa's renewable energy sector over the next 10 years, of which 20 000 is achievable in the next 2 years. Investments in both public and private sectors, provide the mechanism for the reconfiguration of businesses, infrastructure and institutions, and for the adoption of sustainable consumption and production processes. Such reconfiguration will lead to a higher share of green sectors in the economy, more green and decent jobs, reduced energy and material intensities in production processes, less waste and pollution, and significantly reduced greenhouse-gas emissions. Countries like Denmark have made tremendous strides in industrial energy efficiency. Brazil which is a developing country has set targets for the reliance on fossil power to be reduced by 2020. China has invested a large part of its fiscal stimulus package into clean energy. South Africa will implement nationally appropriate mitigation actions which will result in the reduction of emissions by 34% relative to our Business as Usual trajectory by 2020 and by 42% in 2025.

According to the report entitled The Business Case for the Green Economy: Sustainable Return on Investment businesses that have made the transition towards the GE have already reaped rewards worth hundreds of millions of dollars in savings and high return on investment, while benefiting consumers, communities and the environment. UN Under-Secretary General and UNEP Executive Director, Achim Steiner, said, "Business can no longer afford to ignore the benefits that switching to a Green economy will bring. Pioneers that are leading the market are reaping the rewards and positioning themselves for sustained success that benefits their customers and communities."

The report, produced by the UNEP in partnership with SustainAbility and GlobeScan, uses compelling economic and scientific data and a wide-ranging collection of real-life case studies to demonstrate the advantages of the GE in action. Below, is a summary of some of the success stories:

Organisation	Benefits of the GE
Unilever	Unilever's Sustainable Living Plan, which aims to integrate sustainability into business models, has led to savings of over US $10 million dollars annually. At the same time, their "one rinse" washing formulas, which save an average of 30 litres per wash, are now used across 12.5 million households worldwide – a 60 per cent increase over 2010.
Siemens	Siemens produces half of the installed capacity of offshore wind turbines worldwide (2,000 MW), saving about 4 million tonnes of CO_2 annually. It has recently announced investment of €150 million to offshore wind R&D and the expansion of its wind business.
Grupo Bimbo	Grupo Bimbo in Mexico saved approximately US $700,000 and 338,400 m3 of water in 3 years through its water reduction programme.

Organisation	Benefits of the GE
AVIVA	AVIVA, who launched its insurance product for Low-Carbon and Environmental Goods and Services in 2011, expects the sector to grow by an estimated UK £45 billion by 2015, supported by government decisions and financial incentives
PUMA	PUMA conducted the first Environmental Profit and Loss Account in 2010, in collaboration with PriceWaterhouseCooper and Trucost. The value of environmental impact was calculated at €145 million (seen as negative financial impact). Using the tool allows PUMA to reduce future financial loss while strengthening its operating margin by taking into account emerging risks. The company committed itself to having 50 per cent of its products made from sustainable materials by 2015.
The SEKEM Group	In Egypt, SEKEM Group's compost project helped save more than 300,000 tonnes of CO2 equivalent s between 2007 and 2011 and increased sales from EGP 788,400 to over EGP 10.5 million in 2010.
General Motors	General Motors saved more than US $30 million in 6 years through their resource productivity programme, they also reduced waste volume by 40 per cent.
The Zhangzidao Fishery Group	In China, the Zhangzidao Fishery Group saw revenues grow by 40 per cent annually between 2005 and 2010 (compared to the industry's 13 per cent average) through offering an alternative to monoculture methods. The integrated Multi-Tropic Aquaculture approach employed by the company provided for a more balanced ecosystem, taking into account local conditions and environmental quality.
The Colombian Coffee Growers Federation	The Colombian Coffee Growers Federation ensures a sustainable income for more than 27,000 coffee growers with its Rainforest Alliance certified coffee, as part of the Nespresso AAA Sustainable QualityTM program

Markets for biodiversity offsets are predicted to grow to US $10 billion by 2020. While in Europe employment in the wind sector is projected to grow to 150,000 by 2020 and to over 200,000 by 2030, while global revenues for companies involved in the renewable energy markets are projected to rise to more than US $300 billion annually by 2020.

South Africa's **unemployment rate** is now 37% if those "discouraged from seeking work" are included, and includes many of our most important resource: our young people. 2.8 million of people between the ages of 18 and 30 are neither engaged in jobs or any educational institutions. Job losses as well as casualisation are increasing.

At the same time we face a **deepening food crisis**. Almost half (40%) of South Africans are 'food insecure' and overall 42% of households in the City of Johannesburg are classified as food insecure. (Frayne et al., 2009:01). This increases to 70% of households in the poorest areas. (De Wet, 2007). ‘Food insecurity’ is a sanitized term for hunger.

This paper suggests that a just transition to a low carbon or green economy could provide such a new development path.

Decent, green jobs as the central pillar of a green economy have the potential to address all three crises – those of climate change, unemployment and food insecurity. However we need a transformative concept of the green economy. We need not just shallow change with new technology, green jobs, social protection, retraining and consultation, but an alternative growth path with new ways of producing and consuming and new ways of relating both to each other and to nature.

4. GREEN JOBS

In an era of high unemployment and economic uncertainty “Green Jobs” have become one of the latest buzzwords.

The transition to low-carbon and resource-efficiency will reshape the labour market by creating new opportunities for decent work (ILO & OECD, 2012). In the water sector where there is potential to adapt infrastructure in light of new understanding of the GE, there is also an opportunity for training and skills development in line with the NGP during the implementation phase. According to UNEP the GE will require new/re-allocated skills, create employment and result in more efficient products and services that require fewer resources than through conventional means. These jobs could be developed through adapting existing jobs by changing responsibilities or teaching new skills, or through creation of new industries and jobs associated with these industries. The initiatives of the GE can achieve significantly increased jobs, and also reduce carbon emissions without any reduction in GDP growth. In addition, it can be argued that these initiatives protect jobs that may otherwise be lost due to increasing resource constraints and energy costs (Spencer et al., 2010). In order to measure the contribution that green jobs are making to our economy we need to define them clearly in order to determine the measurable outcomes of the GE on the labour market in South Africa. But just as defining the GE has proved a challenge in light of the many different roles and forms it takes in different sectors, defining green jobs as well as how to create and measure the greenness of the workforce is a daunting task.

UNEP defines green jobs as those that contribute to maintaining or restoring the environment while avoiding future damage to ecosystems. In many sectors there is a distinction between green jobs and “greening jobs”. Green jobs are those directly associated with the GE. For instance, a green job in this context would be making solar panels, growing crops for biofuel, or installing rainwater collection tanks on houses. By separating these jobs are clearly green, we are not considering the role of other aspects of the GE. If we want the GE to be an integrated part of the economy in general then we have to include all contributions to the GE as part of our definition of green jobs. For example, the producer of biofuel can be said to be performing a green job, but so is the truck driver who is driving a vehicle powered by biodiesel. The producer of the oil is dependent on the driver and so the driver can be said to be as important for the development of the GE as the producer of the biodiesel in the first place. Meanwhile the driver may not even realise that he’s doing anything differently to any other truck driver. Just as the GE is an integral part of the economy in general, green jobs are a part of the workforce, and many people are contributing to the growth of a GE without even realising it.

A way to eliminate the confusion between green jobs and greening jobs is to view them on a continuum between jobs resulting in environmental degradation and jobs which enhance the environment (Bezdek et al., 2008). We can do this by defining green jobs as **those that are performed in a way that reduces emissions or energy consumption relative to the way that the same job was performed previous to 'greening'** (Bezdek et al., 2008). This is an excellent definition to use in the development of the GE as it means that traditional methods can be used as a baseline and increasing efforts to develop the green economy will always result in movement towards the GE without demanding a complete overhaul of each sector at the start. This is particularly useful as it provides a means to measure progress towards a GE, something that is traditionally very difficult to quantify (Rothwell et al., 2011). So by measuring the jobs that reduce the environmental impacts of economic activity (ILO, 2012), we are able to quantify the results of GE initiatives.

DEA has defined green jobs in various sectors and with specific outcomes as follows:

- Agricultural, manufacturing, research and development, 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; decarbonise the economy; and minimise or altogether avoid generation of all forms of waste and pollution.
- Greater efficiency in the use of energy, water, and materials is a core objective, i.e. achieving the same economic output (and level of well-being) with far less material input.
- Green jobs need to be decent work, i.e. good jobs which offer adequate wages, safe working conditions, job security, reasonable career prospects and worker rights. Peoples' livelihoods and sense of dignity are bound up tightly with their jobs.
- Green Jobs span a wide array of skills, educational backgrounds, and occupational profiles. They occur in: research and development; professional fields such as engineering and architecture; project planning and management; auditing; administration, marketing, retail, and customer services; many traditional blue-collar areas such as plumbing or electrical wiring; science and academia, professional associations, and civil society organizations (advocacy and community organizations, etc.)
- Green jobs exist not just in private business, but also in government offices (standard setting, policymaking, permitting, monitoring and enforcement, support programs, etc.),
- Not all green jobs can be identified as such. Some green jobs are easily identifiable – such as people employed in installing a solar panel or operating a wind turbine. Others, particularly in supplier industries, may be far less so. For instance, a particular piece of specialty steel may be used to manufacture a wind turbine tower without the steel company employees even being aware of that fact. Thus, some jobs come with a clear 'green badge,' whereas others—in traditional sectors of the economy—may not have an obvious green look and feel.

DEA has recognised that developments towards a GE are the nexus of the growing needs to develop and further elaborate the economic case for environmental management and sustainable development including scaling up labour intensive natural resources management programmes that contribute to decent work and livelihood opportunities. The department has emphasised the need for a Climate Change action and overall resource management and protection to accelerate the pace of green job creation and overall green investments in SA.

South Africa has a rich natural resource base and ranks amongst the top 3 in the world's most bio-diverse countries. The key sectors expected to drive job creation in the GE include:

- Agriculture;
- Green buildings;
- Greener transport including electric vehicles & bus rapid transit;
- Green cities;
- Forests;
- Energy supply including grid-connected solar, thermal, and large wind power projects, energy efficiency including demand-side management;
- Water;
- Fisheries;
- Industry and manufacturing;
- Tourism;
- Waste management;
- Retail;
- Natural resources; and
- Consultancy, policy, research and governance.

As green jobs work directly with the information, materials or technologies that minimize environmental impact, they require special skills, knowledge, training or exposure to these areas (ECO-Canada, 2010). This means that with the transition to a GE, capacity-building and training is essential (Strietska-Ilina et al., 2011). Historically trade unions were largely excluded from environmental initiatives, despite success or failure of green initiatives often depending on the unions and their members' commitment to sustainable practices. Some trade unions are historically dubious about environmental economies, as they may be concerned that conservation would impede growth, and jobs may be at risk as jobs are lost, changed or created (Räthzel & Uzzell, 2011). Several studies (e.g. Bezdek et al., 2008) have found that investing in environmental protection both displaces and creates jobs, but with a general net effect of increased employment. Often, the jobs created by promoting a GE may require additional training and skills, but they can also be standard jobs for accountants, engineers, clerks, factory workers, etc. The possibility of a GE creating new job opportunities is beginning to be recognised by major unions. In the General Secretary of COSATU's keynote address at the COSATU International Policy Conference, Zwelinzima Vavi suggested that investing in a GE is one of a suite of coordinated responses required to lay the basis for a transition away from large scale economic crises and towards economic democracy. The Global Jobs Pact notes the important contribution of green jobs to economic recovery through active change of policies and employment services. As the role of unions and their members is crucial in building a GE, lines of communication between labour and environmental sectors are a vital component in developing a GE.

Green jobs include opportunities across a broad range of skills, from scientists and technicians to rural populations and slum dwellers (UNEP et al., 2008). Despite the broad range of opportunities presented by the GE, in many cases skills shortages are reported as constraining factors on green growth. Skills shortages have been reported in the biofuels industry in Brazil, in the renewable energy and environmental industry in Bangladesh, Germany and the United States and in the construction sector in Australia, China, Europe and South Africa. This means that even with the technology and research available, the majority of engineers, architects and project managers are either unaware of green practices or not sufficiently trained to implement them. As Green initiatives are implemented it is important to ensure that training is provided to workers of all skill levels to ensure successful implementation (UNEP et al., 2008). Ad hoc training programs for potential skill upgrade could be used to adapt current education systems and vocational training to allow skills development to tie in with policies and investments (UNEP et al., 2008).

Besides skilled jobs in the development and maintenance of green infrastructure, due to the abundant natural resources found in South Africa, a large proportion of the jobs generated by the development of the GE in the water sector are likely to be labour intensive expanded public works programmes. This provides opportunities for relatively unskilled people to work for resource management (Maia et al., 2011).

5. CLIMATE CHANGE AND THE GE

The challenge of sustainable water management and use is exacerbated by challenges associated with global climate change. Impacts of global climate change on water include: changes in precipitation and evapotranspiration; changing drought and flood risk variability; changes in river base flow levels; and changes in temperature and rainfall which will cause increases in pollution and sedimentation of water bodies which will affect water quality and quantity. As a result of all of these challenges and changes the functions and operations of water infrastructure is affected. Institutions play an important role in both causing and coping with environmental change. By putting in place a series of measures to mitigate and adapt to changes in the environment it is possible to minimise the effects of these changes. Current water use practices will not be sustainable when affected by climate change, particularly if population growth remains at the current rate. The effects on the water sector will have far-reaching impacts, as water is linked to food production, energy, health and nature conservation. In addition, unpredictable weather patterns increase the risk of devastation from floods which are exacerbated by degradation of natural infrastructure that traditionally regulated floodwater such as wetlands, deltas and floodplains.

The relationship between energy and water is also of concern, as water is required in the production of energy, and energy is required to extract, process and transport water (World Energy Council, 2010).

With threats to water-security looming as the population increases and consumption exceeds replacement; it is worth understanding that water security and the GE are linked. The Global Water Partnership (GWP) suggests that the management of water security is integral for the development of the GE. There is significant overlap in the characteristics of green growth and the characteristics of water security as outlined below.

Characteristics of green growth	Characteristics of water security
More effective use of natural resources in economic growth	Ensure enough water for social and economic development
Valuing eco-systems	Ensure adequate water for maintaining eco-systems
Inter-generational economic policies	Sustainable water availability for future generations
Increased use of renewable sources of energy	Balance the intrinsic value of water with its uses for human survival and welfare
Protection of vital assets from climate related disasters	Harness productive power of water
Reduce waste of resources – and finance	Minimise the destructive power of water
	Maintain water quality and avoid pollution and degradation

(GWP, 2012)

Projections calculate that water will be the most important limiting factor in the growth of the South African economy in the twenty-first century. In the water sector where there is potential to adapt infrastructure in light of new understanding of the GE, there is also an opportunity for training and skills development in line with the NGP during the implementation phase. As the GE will result in more efficient products and services that require fewer resources than through conventional means (UNEP 2010) it can keep global water within sustainable limits while efficiency in agricultural, biofuel and industrial sectors improves (UNEP, 2011).

Action on climate-change will create significant business opportunities as new markets are created in low-carbon goods and services. This is a win/win process as development of the GE in response to climate change results in ameliorating the effects of climate change along with the creation of jobs and teaching skills to workers as well as saving money through use of renewable resources. Incentives to promoting the GE are built in – by promoting sustainability production costs should decrease, either through reduced waste management, raw material needed or reduced energy requirements (UNEP). While initial costs may be high in developing new infrastructure in order to meet the needs of the GE, once these costs are internalised improved capacity should more than compensate for initial investment (Chapple, 2008).

6 APPLICATIONS OF THE GE IN THE WATER SECTOR

Water plays a vital role in growth and development in South Africa (DWAF, 2004) and resilient and sustainable growth is more likely if use and availability of water is integrated into the planning process of all sectors (DST, 2011). Due to the vast degree in overlap between countries in terms of GE measures commonly used, this review takes a cross-cutting approach exploring GE initiatives by various sectors. The sections below are presented as a general overview of technologies and approaches used in the water sector and related industries, incorporating relevant case studies as examples.

6.1 Storm-Water Management

As areas become built-up there is an increase in the proportion of impermeable surfaces. This means that runoff patterns change considerably and storm-water management becomes necessary to ameliorate the effects of excessive storm-water such as erosion, scouring or pollution of natural water sources (EPA 2010). Newer techniques such as Sustainable Urban Drainage Systems (SUDS), Low-Impact Development (LID) technologies or Water Sensitive Urban Design (WSUD) focus on restoring natural flow regimes by slowing the flow of storm-water into the environment. This can include pervious elements of development such as rain gardens or porous paving, or strategies allowing harvest and reuse of rain water (Palla et al., 2011). Rainwater collection tanks are being used in many regions where the water collected can be used in lieu of expensive treated water (Gupta, 2012). One technique is the use of green roofs, where instead of contributing to storm-water run-off; roofs are covered in plants which promote evaporation and evapotranspiration as well as retaining water that would otherwise contribute to runoff (Palla et al., 2011).

In a South African context, runoff from informal settlements and townships can have vast consequences on the ecology of water-bodies in the area due to a lack of formalised sanitation, drainage and waste management (Owusu-Asante & Ndiritu, 2009). This can be addressed through structural means, such as reducing runoff through reducing paved surfaces, cutting off illegal storm-water connections, installing rainwater tanks and storm-water filtration systems and development of riparian vegetation and planting of vegetation to reduce erosion. There are also non-structural measures, such as reducing the amount of waste that can be washed away through a combination of education and cleaning by street-sweeping. While the settlements are being formalised, temporary measures can be put in place, such as systems to remove debris from water, and increasing permeable surfaces (Owusu-Asante & Ndiritu, 2009). A further benefit of green storm-water retention approaches is that it reduces the ‘urban heat island’ phenomenon, where rooftops and pavements absorb and radiate heat in built-up areas. Trees, green roofs and other storm-water retention measures create shade, increase evaporation and reduce the number of concrete surfaces that absorb and reflect heat (PWD, 2009). In some cases measures such as construction of artificial ponds or wetlands to collect excess storm-water for runoff management also provide recreational opportunities and improve the aesthetic value of an area (EPA, 2010).

In San Francisco where flooding often leads to sewage overflow as the system isn’t designed to deal with runoff at high volumes a decentralised system has been proposed. This will consist of two parallel systems with artificial wetlands, UV disinfectants and detention basins. One will work to process grey-water which can be used for irrigation and toilet flushing, which will work during the rainy season. The other will manage combined sewer discharges in wet weather when the system is overloaded by an influx of storm-water. While one system is operation at a time, the other will be maintained (Smith, 2009). They will also add to the aesthetic value of the area since the visual impact of a wetland is more pleasant than a sewage-works, which means it can also be introduced closer to urban areas which will reduce the cost of water transport. This innovative implementation of the GE is capitalising on existing legislation in San Francisco where all new buildings need to have dual-reticulation water supply pipes to eliminate combined sewer discharge (CSD) which saves water and prevents overload in rainy weather (Smith, 2009). This is a potential solution to combined sewage discharge in South Africa, where the volumes of water entering wastewater treatment works leads to overflow. The development of artificial wetlands to store the excess storm water and sewage would allow the facilities time to process the combined sewer discharge while nutrients are removed from the excess by plants in the wetland.

6.2 Grey-Water Management

Overuse of available water leads to reduction of stream-flow, depletion of aquifers and decline in water quality. High levels of development can have far-reaching detrimental effects on entire catchment areas (Anderson, 2003). Recycling wastewater is one way to reduce the pressure on natural resources. For example in Monterey, California there is a scheme to use recycled water for crop irrigation, as previous use of groundwater to irrigate crops led to seawater intrusion into groundwater reserves. Mexico City has used a similar scheme using recycled water for irrigation and since the start of the scheme there have been considerable changes in the environment, including creation of new aquifers and increased river flow. In Australia a new scheme has been constructed to transfer water from a sewage plant in Adelaide north to Virginia for irrigation of crops. In Israel water recycling is well established with over 60 % of wastewater generated in Tel Aviv being recycled and used for irrigation purposes (Anderson, 2003).

In Durban, recycling of water is carried out in partnership with wastewater treatment. The Southern Wastewater Treatment Works sends effluent to Durban Water Recycling, where it is treated to industrial standard. From there it is supplied to factories at a cheaper cost than potable water. This frees up potable water for domestic use and reduces the unnecessary cost of treating water to a higher level than is required for industry (e.g. paper mills and refineries (Friedrich et al., 2004)).

The separation of grey- and black (sewage)-water and processing grey-water to supplement irrigation during the dry season is not new, in fact the whole development strategy of Mallorca hinges on this as the only sustainable method of development for the island (Carrol & Turpin, 1997). In Ashford the water sector has implemented an integrated water management strategy that includes the use of treated industrial effluent as a non-mains water source, cooling of the treated effluent in constructed wetlands, establishing green roofs, combining of grey-water and storm-water in sustainable drainage systems and in-stream modifications to affect water velocity in a manner best suited for water quality and fisheries (Furey & Lutyens, 2008).

Wastewater recycling is vital for arid environments where available raw water is limited. The wastewater treatment plant of Marrakech processes wastewater from the city, which is then used for irrigation of golf courses and, in the near future, of the palm trees of “La Palmeraie”. It also generates biogas, which is used to generate a substantial fraction of the power used by the treatment facility (Sewilam & Liebe, 2012). Several towns in Namibia recycle wastewater for landscape irrigation and in Windhoek, the capital city; water is recycled to potable standards (AQUASTAT Namibia, 2005). In fact 35 % of the potable water used in Windhoek is provided through recycling (Du Pisani, 2006) and Windhoek has been practicing reclamation of wastewater for potable reuse since 1968 (AQUASTAT Namibia, 2005). This has two benefits: increasing the available water in a water-scarce country and also in reducing the amount of waste generated that would otherwise be released into the environment (Tarrass *et al*., 2008).

In metropolitan areas where large quantities of wastewater are produced, municipalities have major problems with capacity to treat wastewater due to constraints on available land for treatment and disposal facilities. Reuse of wastewater in irrigation and other ecosystem services can have a positive effect on the community and infrastructure. In agriculture the recycling of irrigation water has two benefits: reducing the load on wastewater treatment works, and providing nutrients that would otherwise have to be added through fertilizing. Wastewater can be used for purposes other than agricultural irrigation, such as in construction (both for construction processes and for spraying for dust control); landscaping of gardens, golf courses, parks and recreational areas, schools and sports facilities; aquaculture and recharging of groundwater (Hussain et al., 2002).

Care must be taken in using wastewater in irrigation that the quality of groundwater is not compromised as nutrient leaching can result in loss of land value and productivity as well as health problems for consumers (Hussain et al., 2002). In order to protect against this, groundwater should be monitored as well as the proximity of the wastewater application to tubewells and boreholes for domestic water supplies. Excessive nitrogen in groundwater has serious health implications for water-users both in productivity and in health, if wastewater use as irrigation leads to nitrate leaching remediation measures such as charcoal filters must be used (Israel et al., 2011). In some cases grey-water sludge can contain high levels of heavy metals such as cadmium, copper and nickel as well as organic pollutants, but the organic content of these wastes is more easily hydrolysable than in sewage sludge. While grey-water has multiple uses in irrigation and recycling care must be taken to measure the quality of the water before releasing it into the environment (Eriksson et al., 2010).

In an urban setting, some areas have been recycling water for decades, such as St Petersburg in Florida which has used recycled wastewater in homes since 1977 for landscaping, air conditioners and fire protection. Also in 1977 Irvine Ranch Water District in California initiated dual reticulation water systems to separate black- and grey-water. Recycled water is used for landscapes, crop irrigation, car washes, water features, industrial uses and toilet-flushing in high-rise buildings. In South Bay, also in California, legislation limited the volume of water discharged into the bay, and so the South Bay Water Recycling Scheme was put in place and implemented from 1998. In Australia new housing developments are designed with dual reticulation systems to redirect grey-water to toilet-flushing and garden-watering. Recycled water infrastructure was put in place in Australian sporting venues in preparation for hosting the Olympic Games (Anderson, 2003).

Recycled water has many applications in the industrial sector where water is required for cleaning and cooling and so high quality potable water is not necessary. Recycled water can be used in power-station cooling (as in Phoenix, Arizona), steam for power-station turbines (used in Australia) and a variety of points in the steel production process (also well-established in Australia). A benefit of recycled water being used in large-scale industrial processes is that the responsibility of filtration and purification can be given to the industry. For example the Port Kembla steelworks in Australia has its own recycling centre that processes and recycles large volumes of wastewater which reduces strain on natural resources and on the capacity of local waterworks. There is also a recycling plant in Brisbane which provides water to oil refineries. In some cases recycled water is purified to very high standards, such as semi-conductor and other high-technology industries in Singapore (Anderson, 2003).

Using recycled wastewater for recharging groundwater or aquifers is a well-established technique used in many areas including Orange County and Los Angeles in California, the Upper Occaquan in Virginia, El Paso in Texas and Windhoek in Namibia. In all of these cases long term studies have found the use of recycled wastewater to recharge groundwater or aquifers to be as safe (if not safer) than allowing discharged wastewater to percolate through the ground (Anderson, 2003).

In many cases recycled wastewater is discharged into streams and rivers and so forms a proportion of base flow. The incidental use of recycled water for domestic use encourages high treatment standards. In South Africa where treated wastewater is usually returned to the stream of origin (for example approximately 50% of the water flowing into Hartbeespoort dam is recycled wastewater).

6.3 Building Design and Maintenance

A Green Building is an energy efficient, resource efficient and environmentally responsible building which incorporates design, construction and operational practices to reduce its negative impact on the environment and its occupants (Green Building Council of South Africa). This includes water management, through water-efficient plumbing and fittings, wastewater reuse and rainwater harvesting. According to UNEP (2009) the built environment is responsible for 12 % of all freshwater consumption. Green building can reduce water consumption as well as reducing runoff to sewers and solid waste. Movement towards promoting green building initiatives in South Africa, where housing backlogs are being addressed through rapid construction of houses, could reduce the strain on water resources and waste-water infrastructure considerably.

In many cases the simplest method for implementing the GE is to maintain systems already in place, with a view of reducing water or energy requirements. For example in China, analysis of water-availability identified numerous avenues to make more water available, including reducing leaks and damaged water infrastructure. In some major cities leak reduction has led to an increase of up to 20 % available potable water (UNEP 2012). Water-efficiencies in building design include rainwater harvesting, waterless urinals, dual reticulation water systems, dual flush toilets, water saving showerheads and water-efficient appliances (Taviv et al., 1999). In some cities, such as Delhi, rainwater harvesting for groundwater recharge is mandatory for buildings with roofs larger than 100 square metres. In Austin, Texas tax rebates for water harvesting have been very successful in promoting the use of rainwater harvesting units (Taviv et al., 1999).

The more efficient a building is in terms of water use requirements, the more money is saved on potable water. While implementation of dual water reticulation systems would require intensive retrofitting in built-up areas, they could be implemented in developing regions such as low-cost housing. If all treated water is recycled and used as non-potable water then available water in an area will double. A feasibility study showed that it is possible to implement a dual water reticulation study in South Africa as long as there is the correct support from authorities (i.e. tarrif reduction for recycled water, legislation and capacity) to build support and willingness in the community (Ilemobade et al., 2009).

6.4 Energy Savings

The reuse of water has to be balanced against the energy costs for transporting and treating water, as it may be cheaper to treat waste-water than environmentally available water (such as brackish water or seawater (Novotny, 2011)). Treating groundwater for use in small communities is more energy-efficient than transporting water over large distances, particularly if sustainable methods, such as the use of charcoal filters to remove nitrates, can be established (Israel et al., 2011). An example of energy-saving through decentralised water provision is in Gujarat, India where solar water pumps are being commissioned in 260 villages which means that costly electrical infrastructure is not necessary to provide safe drinking water to the local communities (Gupta, 2012).

Water can also be used as an energy source, for example in the Sereng River Basin in Indonesia, the local community has harnessed hydropower from a local waterfall to provide electricity to the village for lights at night, while maintaining the use of the waterfall for recreation (Zakaria, 2012). Mini-hydro power from rivers and waterfalls are a viable and sustainable source of renewable energy for small communities (Adhau et al., 2012). This is much cheaper and simpler than expanding electrical grids from urban areas to rural communities, and may be a solution for rural communities of South Africans where electricity infrastructure has not extended to all communities.

6.5 Waste Management

Well-designed waste systems should allow for removal of waste as well as recovery of energy and nutrients (Chen & Cheng, 2005). Besides efficient and clean removal of waste there are uses for by-products (termed ‘sludge’) from water treatment works. For example, using a combination of dam sediment and water treatment plant sludge it is possible to make bricks which satisfy international quality standards (Huang et al., 2001).Sludge fluid bed incineration is becoming more efficient, with some sewage works in North America not requiring additional energy to manage their incinerators through using processes such as air preheating and cogeneration with steam and electricity production (Dangtran et al., 2011).

6.6 Industrial/Mine Effluent

South Africa is a leader in the use of sewage sludge to manage mine effluent. The sewage sludge is used as an electron donor and carbon source for the removal of sulphates for acid mine drainage (Poinapen et al., 2009). This process, knows as the Rhodes Biosure ® process is cost-effective, and requires special training to operate which means that new green jobs are created in implementing the system. The Rhodes Biosure ® process was launched at Ancor sewage works near Springs in 1995 (Ochieng et al., 2010).

6.7 Waste-To-Energy

Since wastewater is generated over a large geographic area it makes sense to use waste-recovery measures for on-site power. Sewage on the other hand is collected at water treatment works which allows for the potential of significant energy generation. This is a fantastic opportunity to improve energy security while reducing the amount of waste for disposal (Burton et al., 2009). The energy content of waste-water is considerable. One method of unlocking this energy is through the use of anaerobic digestion (reviewed in Chen & Cheng, 2005), Spiegel & Preston, 2000) to form methane which can be used as an energy source (Fytili & Zabaniotou, 2008).

An example of waste-to energy that shows the value of a multi-sector approach is in Honduras, where as a result of capacity building initiatives and international expert advice a textile factory was able to reduce energy and water requirements and improve the quality of waste water from the plant. This waste water is of a high enough standard that it can be used for irrigation of biofuel plants used to fuel steam generators in the factory (Bernaudat & Pavón, 2012).

After anaerobic digestion is complete, the by-products include liquid by-products and solid matter called digestate. After screening for pathogens, the nutrient-rich digestate can be used as fertiliser. If it not suitable as fertiliser it can be used in construction to make bricks and fibreboard (Burton et al., 2009). Energy from waste can be utilised on a small scale. For example household biogas units can convert household sewage into enough energy for cooking and heating. There are currently several thousand operational units in India, Nepal and China, and the people using them have reported improved health from using biogas compared to when they burned other substances such as wood for cooking.

On a larger scale South Africa has a biogas plant located near Mossel Bay which uses waste to convert industrial by-products to biogas. As organic matter decomposes naturally, methane is produces regardless of how waste is processed. By harnessing it for its energy potential it is possible to control methane discharge which has important environmental implications as uncontrolled methane emissions contribute to global climate change (Burton et al., 2009).

Incineration offers one possibility of recovering energy from waste. Another method is thermal degradation in either a vacuum or a controlled inert environment, termed pyrolysis. Pyrolysis breaks down sewage sludge and yields three products: non-condensable gas containing hydrogen, methane, carbon monoxide, carbon dioxide and other organic compounds; liquid tar and/or oil containing acetic acid, acetone, methanol and similar compounds; and char, an inert solid substance mainly made up of carbon. The gas and the char can be used as fuel, and the oil can be used either as fuel or as a raw material for chemical industry. Pyrolysis can be performed in a microwave if the raw sewage sludge is mixed with char. The microwave technique is more energy efficient than conventional heating methods such as furnaces or bed reactors (Fytili & Zabaniotou, 2008), and is an example of how the GE is not a fixed destination as continued research and innovation can improve efficiency and dematerialisation indefinitely.

Another option for extracting energy from sewage sludge is to convert it to combustible gas and ash in a reducing atmosphere. This process is called gasification, and it is more energy efficient than incineration as well as producing a cleaner end-product than classic incineration measures. If performed in steady conditions the gasification process can be self-sustaining with no additives or energy necessary to maintain chemical and thermal processes (Fytili & Zabaniotou, 2008).

Thermochemical treatment of sewage sludge yields a number of energy resources such as oil and fuel gas, and further refining processes can yield products such as gasoline and diesel, methanol and ammonia (Furness et al., 2000).

Due to the high proportion of lipids in sewage sludge, directly extracting and processing oils for biodiesel is also an option that is considerably cheaper than farming for high-oil plants (Siddiquee & Rohani, 2011). An alternative method for biodiesel from sewage is through using it as a growth-environment for microalgae. Algae fix carbon dioxide, and make significantly more oil than any plant currently used for biodiesel. Different alga can grow in any water source as long as there is sunlight, shallow ponds work best, so they can set them up with effluent from water-works, or if land is an issue existing sewage treatment ponds would also be viable albeit slower. Due to the extremely high yield of oil from biomass, algae is currently the most feasible option to replace the petroleum industry. The most productive oil product used thus far is from palms, which produce approximately 6000l/hectare, meanwhile at peak conditions algae can produce 90 000l/hectare. (Demirbas & Demirbas, 2011). The first commercial biodiesel production from plant material at waterworks is in New Zealand where a company called Aquaflow Binomic (http://www.aquaflowgroup.com/) grows and harvests micro-algae is grown from settling ponds at waterworks and then processes it to make oil.

Microalgae has very high rates of growth, and is significantly more productive than conventional crops. Some species of algae have a higher oil content than land-based oil crops which makes them incredibly productive, as well as removing nutrients from wastewater and requiring very little fresh water compared to land-based oil seed crops. The process of growing and harvesting algae can be carried out by unskilled labourers with minimal training and while the oil-extraction process requires somewhat more training it does not require highly-skilled personnel. Processing of oils into biodiesel requires skilled personnel but this could be centralised, limiting the number of skilled personnel required to run the process successfully (Burton et al., 2009). While the use of algae for biodiesel does look like a feasible option in China, where the demand for biodiesel is high, current technology is still new which means that the processing and refining of algal oils is still relatively expensive (Li et al., 2011). With increasing fossil fuel prices there is motivation to take this research further and maximize efficiency to lower costs. Most traditional algal biofuel projects work with developed strains of microalgae grown in artificial situations. There is a possibility that using ‘wild’ algae in waterworks settling ponds would be a more cost-effective solution despite yields potentially being lower than optimised strains.

Chlorella is a microalga which was applied to thickened sewage sludge for 14 days. Over the trial period it removed a considerable amount of measured nutrients (including nitrogen, phosphorous and ammonia) as well as producing a considerable amount of biomass that could be processed into biodiesel (Li et al., 2011b). While biodiesel from algae is viable, it requires a great deal more research before the process is cheap enough to be properly implemented (Khan et al., 2009). *Chlamydomonas* sp is even more effective at removing nutrients from waste than *Chlorella* (Wu et al., 2012).

Careful manipulation of light levels and exogenous CO_2 affect the removal rates of certain nutrients, for example low CO_2 levels promote the removal of phosphorous while high exogenous CO_2 promotes removal of COD and increase in biomass (Li et al., 2011c). This means that the processing of sludge can be tailored to the purpose if is geared for in each situation (Li et al., 2011c).

6.8 Agriculture and Food Security

Agriculture both contributes to and suffers from global climate change. It requires a substantial amount of water and causes a great deal of pollution. There is a potential for substantial greening of the agricultural sector through sustainable practices (UNEP et al., 2008). Considerable volumes of water are used in irrigation which evaporates more readily than water in storage due to the increase in evaporative surface area (Rockström et al., 2007). Rethinking the way in which water is used in agriculture would have resulting positive implications for other sectors, such as water available for other uses, food consumption and water security (GWP, 2012). As the agricultural sector in South Africa currently uses 62 % of total available water per year, it is highly vulnerable to water shortages (DST, 2011) which threaten food security.

The production of food is linked to water availability, and so there is also a link between water-availability and poverty reduction. Irrigation increases crop yields, which increases income and therefore increases demand for non-crop items which boosts GDP (Hanjra et al., 2009). Poverty levels tend to be elevated in areas where land and water distribution are inequitable and so making more water available at lower cost would have a favourable effect on poverty relief, provided that health and safety measures are properly considered and followed. While irrigation is not the sole factor required for poverty alleviation, it is an essential factor in a ‘package’ of intervention, including access to markets, education and incentives (Hanjra et al., 2009).

One way economists consider solving water shortages in production is to concentrate water-intensive processes in areas where water is plentiful. For example instead of water-scare areas needing to mobilise water to grow crops (through water conservation or interbasin transfers), crops can be imported from regions that are not under the same level of water stress. This is termed ‘virtual water trade’ as the water used to produce goods is a part of the trade of the goods themselves (Merrett et al., 2003). This is a contentious issue as, while it does reduce water demand in water-scarce areas, it also threatens the livelihood of farming communities. A potential avenue for the use of the concept of virtual water is to write it into the pricing of crops so that sustainable farming practices are given an economic incentive.

The reuse of urban wastewater for irrigation and other purposes frees up clean water for other sectors without limiting irrigation. There are several potential impacts of using waste for agriculture. UNEP (2011) stresses that recovering nutrients from organic waste for use as fertilizer is crucial in the development of the GE. As the cost of inorganic fertilizers rises with the depletion of phosphorus reserves it is expected that waste-management techniques will be encouraged and research will be accelerated to meet the needs of the agricultural sector (UNEP, 2011). Thermal drying is a method to transform sewage sludge into biosolids while removing pathogens to an extent that makes biosolids eligible for unrestricted use. Changes in legislation have limited the possible outlets for sewage sludge (dumping at sea is no longer widely allowed, landfill dumping is not sustainable and incineration is a publicly unpopular solution), as such it is essential that we find other outlets for sewage sludge. One of the primary uses is in agriculture/horticulture, which also retains significant nutrients and benefits from it (Smith, 2009). Recycling water and using nutrients from sewage as fertilizer are not only important suggestions for commercial farmers. In 2009 there were approximately four million subsistence farmers in South Africa, farming to either provide or supplement household food as well as to provide some income if work is erratic (Baiphethi & Jacobs, 2009).

There are potential negative impacts of using waste for agriculture, such as disease from pathogens in the waste material, chemical pollutants that may be toxic to plants, long-term negative effects on soil productivity through accumulation of excessive heavy metals, nitrogen, phosphorous, dissolved solids and salts. These nutrients and salts may leach into groundwater and affect its quality if factors such as drainage, depth of the water table and initial quality of groundwater are not taken into account. These polluting effects may be even more detrimental if they extend into local water bodies. While the use of waste-water in agriculture is a very attractive prospect of delivering nutrients and water in a cost-effective way, if these factors aren't considered and mitigated the temporary increase in agricultural yield may be counteracted by a long-term reduction in yield and loss in property values and risk to health and welfare (Hussain et al., 2002). The use of wastewater in agriculture, particularly in a peri-urban setting can free up potable water for nearby communities, while the wastewater from those communities assists with growing their food. This is of great importance as wastewater is generally costly to treat, and large quantities can slow down investment and development as resources are channelled towards treatment plants (Bahri, 2009).

A safer method of extracting nutrients from waste is through vermistabilization. Vermistabilization is the process of seeding sludge with earthworms and in doing, convert the sewage into worm biomass. This can be used as fertilizer on its own, or when mixed with sludges from pulp or paper-mills can also be converted into non-toxic fertilizer (Baldwin et al., 2000).

An example of wastewater in agriculture is Irvine, California, where reclaimed water makes up 20% of the Irvine Ranch Water District's local water supply. This reclaimed water provides irrigation for orchards and fields as well as landscaping of parks, schoolyards and some residential estate gardens. It is also used in some aspects of industry – such as in the dyeing process of a local carpet manufacturer, and as toilet-flushing water in some high-rise buildings.

Aquaculture has experienced an average growth rate of 6.6 per cent per year since the 1970s, and remains the fastest-growing animal food production activity in the world, accounting for nearly half of global food fish supply. Aquaculture practices are also becoming more sustainable (UNEP et al., 2012).

Cultural significance of aquaculture must be taken into account when considering the value of the industry. For example subsistence aquaculture in Rwanda seems counter-productive as it takes land and labour away from more productive sources of protein, such as soybeans. The high trading-value of fish (compared to vegetable protein) however, means that aquaculture can significantly improve the welfare of farmers as long as the yield is high enough to trade excess fish. This means that while subsistence aquaculture may be too costly and time-consuming, farming fish for profit may be a viable option for improving welfare of poor communities (Hishamunda et al., 1998). The high economic value given to fish makes aquaculture a valuable tool for poor communities.

In Thailand aquaculture has been used to supplement the harvest of wild fish in rice-fields, and despite various difficulties faced by farmers, the value placed on fish protein makes it a valuable source of income in Asia as well as Africa (Little et al., 1996).

There is a long history of aquaculture in South Africa, but unfortunately few projects are able to function at a high enough level to provide an income to local communities. A survey in 2004 found that small-scale commercial projects were more successful than food security projects, but these were not particularly lucrative, providing farmers with incomes of between R1000 and R2200 per year. Despite several public initiatives over several decades this sector does not seem to grow without ongoing technical support. A problem identified for aquaculture in rural areas is a lack of education and capacity building (Rouhani & Britz, 2004). In a move to revitalize the aquaculture industry in South Africa it was found that a combination of government and private sector (through community-private partnerships) was required to create aquaculture programmes that are sustainable in the long term. The private sector, with market-driven incentives can provide most of the day-to-day training and support, while government can provide other support such as veterinary support or providing fingerlings (Rouhani & Britz, 2011). With correct support and creation of infrastructure and training it is possible that aquaculture, whether for food or for ornamental fish, may provide sustainable income to rural communities. There are currently ongoing aquaculture development and support programs in rural areas and it is possible that this will become a sustainable and secure source of income (Rouhani & Britz, 2011). Aquaculture is still very much a viable option in Southern Africa (Brummett & Williams, 2000). Care must be taken to avoid exploitation of poor people by rich farmers or landowners, as well as to encourage and promote the inclusion on women in creating opportunities in aquaculture (Ahmed & Lorica, 2002).

6.9 Sanitation

Proper sanitation reduces disease and protects natural resources such as groundwater that could be contaminated from latrine systems. This aids the GE since water that is not contaminated requires less treatment at waterworks than polluted water (Strietska-Ilina et al., 2011). An innovative solution to improve sanitation was shown in three Asian cities where rather than installing sewage systems, Eco-tanks were installed. Eco-tanks are small-scale sewage-treatment systems use anaerobic bacteria to transform waste into non-contaminated effluent, organic waste into compost and can treat sewage from up to 750 people per day with no electricity requirement. The tanks provided immediate sanitation services without lengthy construction processes. In Negombo, north of Sri Lanka, the Eco-tank reduced sewage going into the canal network where local communities use outrigger canoes on trade-routes (Castro & Plouoviez, 2012).

In the Karoo region and along the west coast of South Africa conditions are too arid for sustainable use of groundwater and piping water to communities is prohibitively expensive. Mesh nets for fog harvesting have proved to be a successful and reliable source of water for these communities where current research is fine-tuning the structure and form of nets used in the region (Kotzé, 2012). Fog-harvesting is an established technique in several countries, such as Chile and the Dominican Republic (Mousavi-baygi, 2008; Shanyengana *et al*., 2002) as a low-cost solution to a shortage of potable water. In Chile fog-water is used extensively for domestic consumption and agricultural use (Eckardt and Schemenauer, 1998).

6.10 Natural Resource Management

An integral part of implementing the GE in the water sector would be in managing existing natural resources. Simply, if the quality of raw water is good, then treating it for consumption is cheaper and more efficient than treating polluted raw water. This treatment can be through natural resource management on various scales, from small-scale measures such as planting riparian vegetation to trap sediment, to large scale catchment management strategies (Coates & Smith, 2012). In addition to reducing treatment costs, natural resource management can contribute to economic growth in increasing property value near water bodies, and maintaining water reserves to enable growth and development in industry and agriculture. Proper resource management can also enable development of other aspects of the GE. For example in a badly-managed catchment area where rivers may run dry for part of the year, hydroelectric power would be an unreliable investment (Gouvea et al., 2012) and so managing natural resources makes power generation possible.

In an extreme example, the Meguro River in Tokyo was so polluted that residents began to leave the area. Through a treatment program a reclamation centre was established where water was sent through grit filter chambers, activated sludge processes and nutrient removal, sand and membrane filtration and UV radiation. The treated water was partially used for toilet flushing and partially discharged back into the river. Since the launch of the treatment process biodiversity has increased in the river system with plant, insect and fish populations becoming established in the area (UNEP, 2005). The possibility of a polluted water source becoming altered or polluted to the extent where the area becomes an undesirable living space is of particular concern to South Africa where housing is a complex and difficult issue. The use of GE initiatives to improve the aesthetic (and as a result the economic) value of an area is a valuable tool in social and economic development.

New South Wales has a policy of catchment management working in conjunction with an integrated urban water management policy that uses monitoring of water quality and flow conditions to facilitate urban planning (Anderson, 2003). In some cases it requires small changes, such as changing practices on local farms to have vast impacts on the health of the surrounding waterbodies. This was found in the Itaipu watershed in Brazil, where the Itaipu dam was filling with silt at a rate that predicted the dam would be useless in 60 years. This problem was solved by promoting non-tilling farming in the area (Coates & Smith, 2012).

A novel example of the GE in action is at Rietvlei dam where there was substantial growth of cyanobacteria. Solar-Bees – floating, solar-powered water circulators were used to disturb the water, thus preventing further growth of the cyanobacteria and providing an energy-efficient and effective method of weed control (Van Vuuren, 2012).

Land based water treatment such was wetland systems has two key disadvantages: firstly if land is in short supply (such as in metropolitan areas) it can become very expensive; and secondly there is a high degree of evaporative water lost from ponds. An alternative method is to use floating plants in constructed wetlands which feed on nutrient-rich waste and reduce pathogens and bacteria. This system has a low cost, high efficiency and requires very little land, making it ideal for small communities (Hussain et al., 2002).

In Egypt, Lake Manzala used to receive polluted water from the Nile delta. This contaminated water threatened food security as it affected fish in the region. Rather than treating the water before it went to local farmers, artificial wetlands were constructed to act as biofilters to water entering the lake. The cleaner water is then sent to farmers who use it to cultivate fish which are used to restock the lake. This is a prime example of the GE working as a cost-effective non-invasive method to improve natural resources as well as reducing the need for expensive chemical water treatments (Coates & Smith, 2012). They also provide opportunities for recreation, fishing and firewood collection.

In Taiwan, the Kaoping River Rain Bridge Constructed Wetland was designed to act as a non-point source pollutant remover, as well as providing wastewater treatment, habitat for wildlife and a location for education and recreation. The water entering the wetland is a combination of industrial, domestic and agricultural waste water. Studies showed that the wetland was capable of significant water quality improvement and pollutant removal before releasing water back into the river system. Besides water treatment the wetland was also credited with helping to rehabilitate the surrounding ecosystem as well as providing eco-gardens and green areas for residents to use (Wu et al., 2010).

The labour-intensive demands of natural resource management provide opportunities for the development of expanded public works programmes. In South Africa in 2009 alone, Working for Wetlands rehabilitated 95 wetlands in all nine provinces and in the process created employment for more than 1500 people and made use of 250 small businesses.

An important part of natural resource management is involving stakeholders and communities. PES schemes can be very effective in resource management. For example in some regions of Brazil, farmers are compensated for protecting the quality of headwaters that provide water to the cities. In Colombia there is a public-private partnership that pays for the maintenance of the Chingaza National Park to protect the quality of water delivered to Bogotá, the capital city. (Coates & Smith, 2012).

In Bolivia, farmers are paid to protect cloud forest areas which are essential for watershed protection as well as being habitat for 11 endangered bird species. They are paid by the government as well as water-users downstream that benefit from consistent water flow due to protection of water resources in the cloud forests (Asquith et al., 2008).

Costa Rica has a centralised PES-implementing authority that is able to negotiate new contracts based on past mistakes or inefficiencies (Pagiola, 2008). This works in conjunction with spatial planning which uses a site-selection tool has been that takes into account the environmental services provided by an area, the cost of losing those services and the cost of participating in a PES programme (Wünscher et al., 2008). The success of PES in Costa Rica inspired NGOs in Ecuador which has several PES schemes in place. These are decentralised and arranged by NGOs or municipalities rather than state-coordinated. These PES initiatives include watershed conservation in several districts and compensation for conservation in others. One example of PES in Ecuador is the conservation of the Palaurco River upper watershed. Following severe drought, water-users downstream of the watershed were happy to pay for its conservation in exchange for a stable and sustainable water supply. A 20% surcharge on water fees pays families in the Palaurco watershed for every hectare of forest conserved in the area (Wunder & Albán, 2009).

China uses a PES system to pay for farmers to convert cropland to forests. The scheme focuses particularly on sloping land which is as erosion risk. The scheme engages millions of rural households in conservation measures and could result in a 10-20% increase in national forest area (Bennett, 2008). Similarly in Mexico, forests are being destroyed for wood, farming and creation of pastures. The government identified areas that were important for watershed management and aquifer recharge and then paid forest owners to maintain the area rather than switching to agriculture. Amounts were calculated depending on the hydrological importance of the area and farmers who joined the program received annual payments once the government verified that no change in land use had taken place (Muñoz-Piña et al., 2008). This paid the farmers/landowners the opportunity costs incurred by not farming the forests, but saved the government the cost of establishing flood-protection and aquifer recharge programmes.

The USA has utilised a variety of programmes including PES programmes in agriculture since the 1930s, programmes such as retiring land from agriculture in order to protect the soil and change crop prices as well as co-funding measures of soil-protection such as terraces and grassed waterways. Besides the usual PES initiatives, farmers can also bid for financial assistance based on the characteristics of their land (including soil erodability, wildlife and water quality). For example areas that are prone to erosion can be put forward for assistance in establishing native grasses and trees to protect the soil (Claasen et al., 2008). In fact, an interesting comparison can be made between countries like China and the USA which focus on reducing the impacts of agriculture through PES schemes to limit farming, and Europe which focuses on ecosystem conservation concurrent to agricultural growth. In Europe, emphasis is placed on encouraging low-impact agriculture with high production of goods and low visual impact, while in the USA policies target reducing soil erosion through paying farmers the opportunity costs of reducing this in several ways, including not farming susceptible areas (Baylis et al., 2008).

In Eastern France, Vittel, a mineral water bottling company pays farmers in the catchment area where the water is obtained to maintain best practices in farming in order to maintain the quality of the aquifer in the area. They pay a combination of guaranteed funds, opportunity cost of clean farming as well as providing support and technical assistance and subsidising labour costs (Wunder et al., 2008).

In Victoria, Australia, catchment management to reduce salinity of groundwater involves paying members of the community who contribute to lessening of groundwater salinity. This is a pilot programme but social control is expected to play a large role in maintaining compliance in the region (Wunder et al., 2008). Similarly, a private foundation in Northeim, Germany, pays farmers to maintain low-impact farming practices that maximise biodiversity and aesthetic quality of the area (for recreational uses such as tourism) (Wunder et al., 2008).

Africa has more of a focus on ecotourism. For example the CAMPFIRE Programme in Zimbabwe allows communities to sell access rights to wildlife to safari operators. This encourages conservations, as ecotourism is not as lucrative in degraded as in pristine ecosystems. Where preciously wildlife was killed as pests due to threats on livestock or effects on crops, under the CAMPFIRE programme they become valuable assets to the community. The proceeds of the programme are used by local communities to build schools, clinics and water infrastructure (Frost & Bond, 2008).

In a South African context, in 1995 the Working for Water (WfW) initiative was started in South Africa, following the realisation of the threat that alien plants posed to water supplies. This initiative clears catchments and riparian zones of alien vegetation. This is paid for through a water resource management fee included in water tariffs. This management fee includes: control and eradication of alien plants, planning, implementation, pollution control and management, demand management and water use allocation. An interesting aspect of the programme is that it (like so many Green Economy initiatives) was not created purely for environmental reasons. In fact, it was largely begun as a poverty-alleviating measure. Once the hydrological benefits of the programme were realised, water catchment managers began to request restoration of catchments that affect water supplies (Turpie et al., 2008). The Working for Water programme in South Africa is another example of capacity building through training people to control and remove alien invasive plants. This programme provides jobs and training for women, young people and people with disabilities, while also restoring and maintaining natural resources in the water sector (Strietska-Ilina et al., 2011). The associated Working for Wetlands programme provides jobs and training to a large number of previously disadvantaged individuals while restoring wetlands around the country and aiding in water availability through the removal of invasive plant species and contaminants.

While there is debate over where Working for Water and CAMPFIRE programmes are legitimately considered to be PES schemes (Wunder et al., 2008), there is no doubt that they are incredibly effective and innovative ways to manage natural resources. Besides the benefits to the environment through these programmes, they also provide poverty alleviation and job creation, with members receiving additional benefits of employment and skills development as well as exposure to health programs and education programmes (Wunder et al., 2008).

Due to the abundance of natural resources in South Africa there are ample opportunities for job creation in natural resource management and conservation. An example of this are the 'Working for' programmes which supply jobs and training while making valuable contributions to resource conservation and restoration and improving the downstream economy (Israel et al., 2011). There are further innovative suggestions such as using the biomass from cleared alien invasive plants for the generation of energy (Maia et al., 2011) which would open a new sector for employment in the GE.

6.11 Energy

As natural resources are depleted and the population grows and develops, energy requirements increase dramatically. An Intergovernmental Panel on Climate Change (IPCC) study has explored five energy supply scenarios for satisfying the world's growing demand for energy services in the 21st century while limiting cumulative CO2 emissions. This includes using biomass as an energy source, which allows for use of low-quality farmland to produce biodiesel feedstock. These biomass crops can promote habitat and biodiversity on previously degraded land as well as providing income for the owners of the land (Herzog et al., 2004). Impacts on hydrology have to be determined at a local level – for example some crops may place significant demand on water supplies, while others may increase water retention in the system due to increased groundcover (Herzog et al., 2004).

The type of biomass used for energy generation can have a significant effect on the environment and on the people using it. In Ghana, 64 % of the primary energy supply is derived from firewood and charcoal. This results in deforestation and high emissions which lead to respiratory conditions in the local community. Studies have shown that the production of plant-derived biofuels would be beneficial in creating affordable energy, stopping land degradation and preventing further health problems while providing employment opportunities (Duku et al., 2011). While in this case, growing biofuels is an obvious solution to an energy-demand problem, biofuel feedstock requires a substantial amount of water (Bekunda et al., 2009). This means that without the support of the water sector, growing biofuels to meet the needs of the Ghanaian people will not be feasible.

The production of biofuels is encouraged as they are seen as sustainable, renewable, biodegradable and eco-friendly. The costs of biofuel production (both in growing plants and extracting oils) are still relatively high, but it is considered as an avenue worth exploring (Yusuf et al., 2011). While the concept of biofuels is often promoted as a way to reduce environmental footprint, it must be remembered that water is both a restrictor and an enabler to their production. Water footprints should be calculated before the start of biofuel crop production to determine the water footprint as well as the carbon footprint in a lifecycle analysis of the product.

South Africa's biofuel draft strategy aims to have 4.5% of liquid fuel used in road transport to be biofuel by 2013. The biofuels industry will receive incentives in the form of Fuel Levy reduction to encourage their production (Bekunda et al., 2009). This is a fantastic initiative to reduce reliance on fossil fuels in the transport sector, but only if sufficient water is available to enable this industry. Green initiatives could assist, for example by reallocating wastewater to biofuel irrigation, as long as the right GE strategies and infrastructure is in place. There is also the possibility of using unsuitable land for biofuel production in order to increase groundcover and reduce soil evaporation as well as limiting soil erosion (Bekunda et al., 2009).

Hydropower is the largest renewable energy producer currently worldwide. Over 150 countries use hydroelectric power to some degree. An important aspect of hydropower is the role that small, mini and micro hydro plants play in providing electricity to rural communities (Herzog, 2004). There are currently initiatives underway in South Africa underway to increase the use of hydropower by placing turbines inside large waterpipes across Gauteng.

6.12 Eco-Goods and Eco-Services

There is a growing global trend of increased concern and responsibility for society, which has resulted in increased demand for marketable environmentally-friendly products (Tsai, 2012). Recently, catchment management approaches and risk-based management and assessment has shown that while community 'buy-in' is vital to the success of projects, attitudes towards conservation have changed dramatically, revealing overwhelming public support for a more ecologically-centred set of urban values than traditionally employed in benefit-cost models (Everard, 2004). This is a considerable change since a report in 1997 found that the political and economic environment did not support the development of clean and sustainable product and services (Ulhøi, 1997).

Eco-goods and services create a market that takes advantage of the current positive attitude to environmentally friendly goods and services. Biotrade is the sustainable use and trade of biodiversity-derived products. This is a significant part of trade and industry, for example in Namibia, Biotrade is responsible for approximately 4.5 % of GDP. Promoting Biotrade can act as an incentive for biodiversity conservation and sustainable management of natural resources UNEP, 2012).

High-end Indigenous Natural Products require eco-certification/eco-labels to be marketable for the modern 'ethical green' consumer (UNEP et al., 2012). This consumer-awareness means that sustainable and fair-trade goods are actually more profitable than traditional goods and services, particularly in terms of recent market performance which has seen the cosmetics industry stagnate, while the fair trade 'green' cosmetics industry continues to grow at a substantial rate (UNEP 2012).

A particular area of interest has been the consumer-demand for natural pharmaceuticals and cosmetics. In one case The Body Shop has formed a partnership with Eudafano Women's Cooperative, which is made up of over 4000 women who harvest Marula fruits. The Marula oil produced from the fruits is used in the Body Shop's products, which can then be marketed as environmentally sustainable, taking advantage of current consumer preference (UNEP, 2012).

In South Africa, the use of indigenous medicinal plants has been part of the indigenous culture, both as part of longstanding culture and folklore, and also for the economically marginalized who cannot always afford formal healthcare. Recent global trends in 'eco-pharmaceuticals' has led to tremendous growth in the commercialisation and trade of these plants as they are being used in the development of new products in the cosmetic, pharmaceutical and nutraceutical sectors. In order to maintain the positive effects of this growth it is important to manage ecosystems sustainably, both preserving habitat and monitoring harvesting to avoid depletion of medicinal plants (Makunga et al., 2008). In some cases, medicinal plants are farmed specifically for the purpose of commercial trade, but these are generally not the demographic groups that traditionally used the plants. In this case richer farmers with access to water resources are able to use local indigenous knowledge without necessarily benefiting the original society (Makunga et al., 2008). It is important that the role of water as an enabler in the production of eco-goods and services is understood in order to empower local communities to produce and trade in a sustainable manner.

A further promotion of well-being for indigenous communities is to promote eco-tourism. For example greening the fishing industry will promote management of natural resources that can encourage scuba-diving which will create employment for local communities (UNEP et al., 2012).

6.13 Capacity Building

Coates and Smith (2012) consider capacity-building to be the 'missing link' required for successful and effective implementation of reforms in the water sector. For example in

Ecuador a large scale fog collection programme was in place for two years, but when it was handed over to the local population it degraded (Klemm et al., 2012). In Guatemala, fog collectors require maintenance due to damage from high winds, and with training, the local communities have maintained 35 collectors since the project was started in 2006, and strong community development has been identified as a major contributing factor to the success of the project (Klemm et al., 2012). The success of fog collecting programmes in Guatemala and failure in Ecuador demonstrates that in building a GE, there needs to be a significant element of capacity building in local communities.

Changes in technology are useless if they do not take place concurrently with involvement and training of the people affected by the change (Ardakanian & Jaeger, 2012). The transition to a GE requires interdisciplinary approaches, stakeholder involvement and empowerment, comprehensive action plans encouraging joint action between stakeholders and authorities and follow-up involvement and progress monitoring (Ardakanian & Jaeger, 2012). Systems and implementation have to be tailored to local conditions and policies, with materials, man-power and best-practices complementing training of the local people to ensure sustainable operations and maintenance (Blokland, 2012). Without specific attention given to developing local capacity, development of the GE will not be sustained unless the local community is trained and given ownership of the operation and maintenance of new services (Ardakanian & Jaeger, 2012).

A fascinating way to create a sense of ownership in GE initiatives was shown in Gujurat, India, where local communities or NGOs were charged ten per cent of the costs of constructing water infrastructure in small communities. They were allowed to pay this in physical labour, and many people chose to actively work on the project rather than paying for it. This increased the communities' sense of ownership of the resources as well as providing training for unemployed people in the community (Gupta, 2012). In a similar programme as NGO trained local communities in the Midnapore district to build sanitation systems (Strietska-Ilina et al., 2011).

The Working for Water programme in South Africa is another example of capacity building through training people to control and remove alien invasive plants. This programme provides jobs and training for women, young people and people with disabilities, while also restoring and maintaining natural resources in the water sector (Strietska-Ilina et al., 2011).

Capacity-building extends beyond training the local community to maintain green initiatives. In some cases developing the GE has empowering effects that lead to innovation in the community. An example is in the Sereng River Basin in Indonesia, following the implementation of natural resource management and green infrastructure. The local villagers developed a biogas scheme for cooking, using cow mature from the local farms. They also harnessed hydropower from a local waterfall to provide electricity to the village for lights at night, while maintaining the use of the waterfall for recreation (Zakaria, 2012). By building capacity in the community, the villagers were able to determine their own requirements and carry them out in a way that is sustainable.

6.14 Changing Perceptions

There are several tools that can be used in conjunction with the implementation of a GE that can assist with changing the attitudes of the public to water and water use. For instance PES schemes create awareness of the value of clean water. This is particularly relevant for South Africa where water is often seen as a free resource (DBSA, 2011). Industries paying communities in local catchments to preserve the quality of water in the environment will save money on treating water, while communities benefit from additional income. The community can also drive industrial attitudes to the GE with the development of consumer accreditation schemes. This means that any products or services that use water in any way are labelled according to their participation in the green economy. Another useful tool is the use of water-trading schemes such as trading of pollution credits or access rights to water. This maintains the message that water is valuable and should not be wasted, as well as incentivising pollution management innovation (Taviv et al., 1999).

There are widespread opinions in the public that a policy of protecting water reserve is directly competing with the interests of the public (Van Wyk et al., 2006), and so stakeholder education and involvement is of paramount importance in implementing the GE in South Africa where poverty and water-stress are of growing concern.

Australia has a policy to fix water over-allocation by raising prices of water to promote reduction in per capita water use while investing in recycling and developing 'smart water infrastructure.' This works in conjunction with catchment management and natural resource management to promote sustainable water use (Eltham, 2010).

Educational programs are of paramount importance to change the way the water is used, but it is not always successful. In an apartment complex in Malaysia water-saving technologies and techniques, as well as engaging residents to compete against each other in water-use reduction were successful in reducing water use substantially, but this was largely due to changes in infrastructure rather than human behaviour (Chan, 2012).

7. GE POLICY ENVIRONMENT

7.1 Overview of Global Policy Trends

The concept of a GE dates as far back as 2006 however, in 2011, UNEP produced the GE Report with the aims to debunk several myths and misconceptions about greening the global economy, and providing timely and practical guidance to policy makers on what reforms were needed to unlock the productive and employment potential of a GE. While many governments had accepted the concept and benefits of a GE, the global economic crisis caused a shift in focus towards more traditional economic principles. Hence, UNEP launched the Global Green New Deal to encourage governments to support economic transformation to a GE and turn the economic crisis into an economic opportunity to create green jobs, promote sustainable and inclusive growth and the achievement of the Millennium Development Goals (MDGs).

In response, governments developed GE policies and strategies for the implementation of GE initiatives. Particularly successful green initiatives have been noted in North America, England, Germany, some small Nordic countries, Denmark and China (Cooke, 2011).

Notable examples of current legislation include the Green Deal in the UK, where the government pays to retrofit house with energy-efficient mechanisms such as solar panels or insulation, and then uses the profits of improved efficiency to pay back the cost of the retrofit. The Energy Act was also revised to promote increased efficiency through enforcing high energy efficiency levels in any building to be rented for residential or business purposes (DECC, 2011).

Barbados plans to become the "most environmentally advanced, green country in Latin America and the Caribbean" (Moore et al., 2012) through a partnership with UNEP.

Taiwan relied almost solely on imported fossil fuels until 2009, when the 'Renewable Energy Development Act' was passed. The act includes incentives to promote the increase in generation of renewable energy according to the 'Sustainable Energy Policy Principles.' Research and development have been encouraged in hydroelectric power, solarthermal, photovoltaic and wind energy sectors (Liou, 2010). As a result, Taiwan became a world leader in solar-power technology (Liou, 2010b) and wind power technology (Liou, 2011). Due to the constraints of waste-management on an island, Taiwan is aiming to reach a zero-waste state. This means that new and revised legislation will create incentives for waste recycling as well as provide technical assistance. Everybody pays for recycling services, but only those who actually recycle receive incentives from the Resource Recycling Management Fund, which makes this a form of a Polluter Pays model (Tsai, 2007).

The Polluter Pays Principle has been implemented in the form of levies on polluting activities such as road transport, energy use and waste generation. These environmentally-motivated taxes have been established in Europe (notably Denmark, Sweden and Norway) since the early 1990s (UNEP, 2010d). Despite the positive environmental effect of these initiatives they are usually not environmentally motivated. Instead, they are seen as revenue-generating tools or, in the case of fuel and road-use levies, congestion control tools. Despite the motivation, these measures did reduce environmental impact with increased fuel taxes in Germany reducing fuel demand by 13 % over a decade (UNEP 2010d). Similarly, levies on waste water effluent and taxes on Landfill use in the Netherlands have significantly reduced waste volume in the country.

The Green New Deal in the USA plans to use green initiatives for the double-benefit of creating jobs and ameliorating the effects of climate change through investing in renewable energy and energy efficiency (di Peso, 2009). The US latest Energy Plan Bill calls for utilities to use 10 % energy from renewable sources by 2012 and 25% renewable energy by 2025 (di Peso, 2009). An interesting aspect of the American attitude to the GE is that it is largely state or local-government controlled due to previous administrations refusal to address the issue of the effects of global climate change. This is particularly evident in stormwater management legislation. In America climate change policy is largely governed at state level. Policies to reduce greenhouse gas emissions have been in place in several states since before the development of the Green New Deal. A benefit of state-level policy is that it allows for legislation to be tailored to the specific environmental needs of each area. For example, while energy may be the main national focus, water savings technologies that also reduce energy use and greenhouse gas emissions may be important opportunities in the arid western US (Peterson et al., 2006). For instance, coal based power production through advanced Integrated Gasification and Combined Cycle (IGCC) technology is estimated to save 30-50% of water needs compared to conventional coal technology (Herzog et al., 2004) where water is needed to enable power generation.

Although Australia has its own GE Strategy, the most notable change in policy towards a GE is seen in the water sector. The Australian Government's Water Resources Policy which promotes and supports initiatives towards higher valuing of water by consumers and partnership with the agricultural sector has a strong GE focus.

7.2 Overview of National Policy Trends

SA has a suite of legislation and policies in both the economic and environmental sectors to promote job creation and alleviate poverty such as the Accelerated Shared Growth Initiative for South Africa (ASGISA) which aims to halve poverty and unemployment by 2014. The National Strategy for Sustainable Development (NSSD) (2010) aims to promote effective stewardship of natural, social and economic resources. The vision of the NSSD is to be *"A sustainable, economically prosperous and self-reliant nation state that safeguards its democracy by meeting the fundamental human needs of its people, by managing its limited ecological resources responsibly for current and future generations, and by enhancing efficient and effective integrated planning and governance through national, regional and global collaboration."* In November 2010, the NGP was launched which aims to create five million jobs over the next 10 years through the vehicle of massive investment in infrastructure as a critical driver of jobs across the economy. The policy prioritises employment creation in all economic policies and has at its heart the reduction of inequalities.

In response to the UNEP call for governments to develop a GE approach, the DEA convened a GE Strategy Summit in May 2010 to gather valuable insights on key focus areas and issues requiring attention with respect to the GE and to see how existing policies and legislation can be amended to achieve the outcome of a GE.

The NSSD prioritised the development of a GE through a supporting framework of a National Green Economy Strategy and Sector Implementation Plan (which is currently in development). The NSSD highlights the growing concerns regarding water scarcity, oil price increases, electricity scarcity and increased emissions indicate that sustainable solutions are urgently required. The NGP proposes that by promoting the GE 300 000 jobs can be created, both in manufacturing and development of environmentally-friendly infrastructure, maintenance of new infrastructure and in targeted support to education, healthcare, research and development, pharmaceuticals and biotechnology. The NGP also aims to reach a target of 33 % of energy used in South Africa to be from renewable sources. In order to introduce and implement measures promoting the GE changes in the structure and the character of production are required to generate a more inclusive and greener sector.

At the COP17 talks in Durban in 2011, South Africa's GE Accord was launched. The Accord, one of the most comprehensive social pacts on green jobs in the world, builds a partnership to create 300 000 new jobs by 2020, in economic activities as diverse as energy generation, manufacturing of products that reduce carbon emissions, farming activities to provide feedstock for biofuels, soil and environmental management and eco-tourism. Specific commitments in the Accord include:

- Government will procure 3 725 megawatts of renewable energy for the national grid by 2016. That is more than the annual energy use of Cape Town, South Africa's second largest city. Eskom and business will also continue to work on technologies to further reduce emissions from its coal-fired plants.

- The solar and wind energy industries aim create at least 50 000 green jobs by 2020. They will develop a “roof-top” programme to install 300 000 solar PV power generation units for residential, commercial and industrial buildings by 2020. They will work with government to create local industrial capacity with an initial minimum target of 35% localisation as a first part of an aspirational target of 75% local content.
- Government will also support the installation of one million solar water heating systems by 2014, which will provide the basis for expanding local production of components and heating systems. The insurance industry will promote locally-manufactured solar water heaters to replace the 200 000 damaged every year. Organised labour will help establish and finance cooperatives to undertake installation and maintenance.
- All the parties will promote the manufacture and distribution of clean cooking stoves and heaters for the local and continental market.
- The state-owned Industrial Development Corporation will provide up to R25 billion (over US $3 billion) for investments in green economy activities over the next five years. The private sector will strengthen existing efforts by financial institutions to fund investments in the green economy and pursue investment opportunities in manufacturing linked to renewable energy initiatives. Organised labour will promote retirement fund investment in green investment vehicles that will create jobs and support the broader goals of the green economy.
- Business will work to expand investment in projects that enhance the environmental performance of existing production facilities. It will develop benchmarks for energy efficiency by industry as well as company energy-management plans.

At the World Environment Day celebrations held in Bloemfontein in June 2012, the Ministry of the Environment announced its intention to create 3000 Green Jobs by 2020. The Minister also mentioned that government’s environment sector GE Implementation Plan has received a boost of R800 million for the Green Fund over the next two financial years. This funding would be used to attract new and additional investments, to stimulate job creation and to lay the foundations for South Africa’s transition to a low carbon, job-creating and resource-efficient growth path.

Other national policies in place which prioritize the GE include:

- The 2009 Framework Response to International Economic Crisis, which prioritized incentives to encourage the creation of Green Jobs;
- 2009-2014 Medium Term Strategic Framework;
- Government Outcomes 4, 5, 6, 7 and 10 all involve aspects of the GE;
- IRP – prioritized the GE as a method to reach energy efficiency and renewable energy targets;
- Industrial Policy Action Plan: Promotes support of development of clean, low energy technologies and green jobs in the manufacturing sector;
- The Ten-year Innovation Plan aims to lead research in Africa on climate change, understanding impacts and mitigation measures; and
- Green Economy Summit Report.

On a regional level, the GE Strategy for Gauteng was developed with the of "*A province that embraces more innovative infrastructure choices, demand-side management and the principles of recycling and reuse, to its increase water capacity during times of plenty so that water is available in times of need, thereby ensuring residents and businesses can count on secure water resources into the future, and have access to safe, reliable and sustainable water and sanitation services.*" This was further clarified in the Green Strategic Programme for Gauteng (GCRO, 2011) where key areas of the water sector were identified as areas in which to grow the GE. These were:

- Long term water supply;
- Water demand management and groundwater resource management;
- Regulate and improve water quality;
- Ensure basic access to water;
- Funding mechanisms;
- Basic sanitation services/supply; and
- Mining water licenses & Acid Mine Drainage.

The SA government has made a noticeable shift towards prioritising GE in policy development and strategic planning to ensure an enabling environment for sustainable development and innovation.

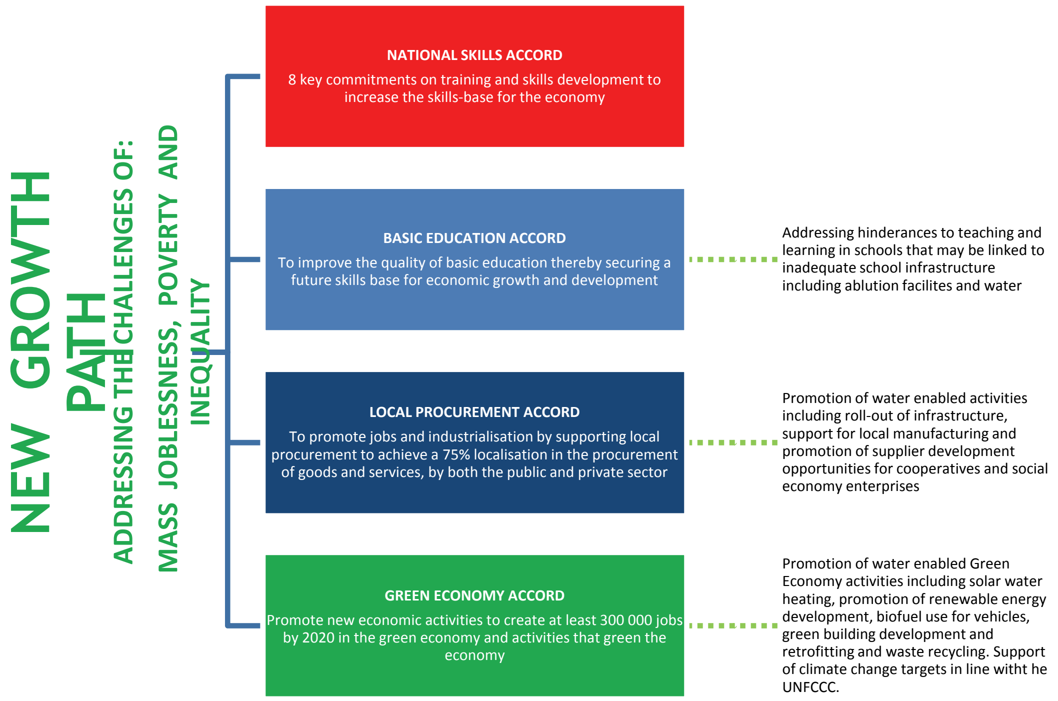
7.3 GE and the NGP

On 23 November 2010 the South African Minister, Ebrahim Patel released the *Framework of the New Economic Growth Path* aimed at enhancing growth, employment creation and equity. The main target of the policy is to create five million jobs over the next 10 years through the vehicle of massive investment in infrastructure as a critical driver of jobs across the economy. The policy prioritises **employment creation** in all economic policies and has at its heart the reduction of inequalities.

According to the 2012/2013 UN-Habitat Sate of the World's Cities Report, several South African cities are the most unequal in the world.[i] In the decade before 2011, despite experiencing strong economic growth, South Africa together with China, India and the Russian Federation, recorded steep increases in inequality levels.[ii] This is from an assessment of Gini coefficients which is commonly used as a measure of inequality of income or wealth. Gini coefficients range from zero to one where a coefficient of zero expresses perfect equality, where all values are the same, for example, where everyone has an exactly equal income and a value of 1 expresses maximal inequality among values for example, where only one person has all the income. The global income inequality Gini coefficient in 2005, for all human beings taken together, has been estimated to be between 0.61 and 0.68.[iii] The countries in Africa had the highest pre-tax Gini coefficients in 2008-2009, with South Africa having the worlds' highest at 0.7.[iv] For people in the age group 16-30 unemployment was at 40% in the first quarter of 2010[v] and amongst the employed, salaries were low with half of all employed people earning less than R2500 a month and over a third earning under R1000 a month I the third quarter of 2008.[v] Wages as a share of the national income dropped from 50% in 1994 to 45% in 2009; while profit as a share of national income soared from 40% to 45%.

This high level of inequality in South Africa is seen to pose a risk to South Africa as it can contribute to extreme levels of unemployment, violent crime, the proliferation of drug cartels, rampant corruption and general political instability[vi] and can breed growing discontent and resentment culminating in violent protest.

The aim of the NGP is to identify strategies that that will enable South Africa to grow in a more equitable and inclusive manner while attaining South Africa's developmental agenda.[vii] Five key areas for investment are identified viz., energy, transport, communication, water and housing. It is proposed that sustaining high levels of public investment in these areas will create jobs in construction, operation and maintenance of infrastructure.



The NGP identifies other priority areas for job creation in:

- Infrastructure through public investment in energy, transport, water and communications infrastructure and housing primarily through construction of new infrastructure; operation of the new facilities; expanded maintenance; and the manufacture of components for the infrastructure programme.
- Agriculture through addressing high input costs and up-scaling processing and export marketing. Small scale farmers will receive support by improved access to key inputs and government will explore ways in which working and living conditions for the country's 660 000 farm workers may be improved.
- The GE through the promotion of renewable energy technologies, clean manufacturing and environmental services
- Mining through increased mineral extraction and improving infrastructure and skills development as well as supporting beneficiation on the final manufacture of consumer and capital goods, which can create large-scale employment.
- Tourism and other high-level services through strengthening of measures to expand the tourism infrastructure and services, promote targeted marketing campaigns,

manage costs, quality assurance and logistics, improve training and identify employment and entrepreneurial opportunities for the youth.[v]

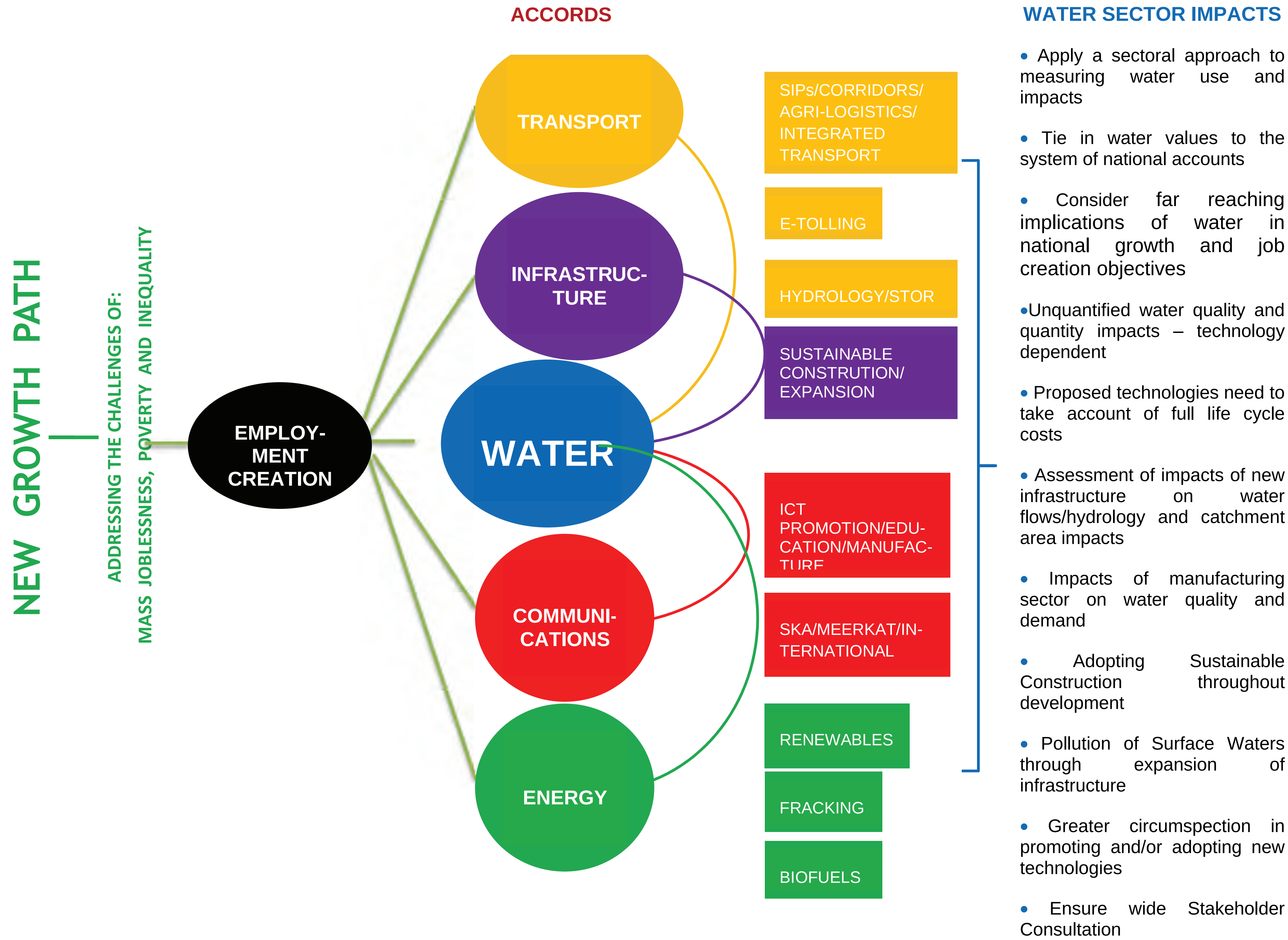
The main identified job drivers are[v]

1. "Substantial public investment in infrastructure both to create employment directly, in construction, operation and maintenance as well as the production of inputs, and indirectly by improving efficiency across the economy;
2. Targeting more labour-absorbing activities across the main economic sectors – the agricultural and mining value chains, manufacturing and services;
3. Taking advantage of new opportunities in the knowledge and green economies;
4. Leveraging social capital in the social economy and the public service; and
5. Fostering rural development and regional integration"[v]

In order to support the first jobs driver of the NGP which is infrastructure, the SA government has developed a single common, centrally driven infrastructure plan which contains more than 645 projects and has been adopted by Cabinet and the Presidential Infrastructure Coordinating Commission (PICC). A spatial mapping exercise was carried out to identify infrastructure gaps, population movement and economic performance and placed these in a framework in order to develop the required Strategic Integrated Projects (SIPs).

7.3.1 The NGP Objectives in Light of Water Dependencies

The overarching stated objective of the NGP is reduction in inequality through job creation and to where possible seize the potential for new economies, specifically the green economy. The water sector is identified as a separate sector for investment yet water dependencies may be identified in the remaining sectors energy, transport, communication, and housing. Below is an overview of the water implications.



NEW GROWTH PATH
ADDRESSING THE CHALLENGES OF:
MASS JOBLESSNESS, POVERTY AND INEQUALITY
EMPLOY-MENT CREATION
ACCORDS
TRANSPORT
INFRASTRUC-TURE
WATER
COMMUNI-CATIONS
ENERGY
SIPs/CORRIDORS/ AGRI-LOGISTICS/ INTEGRATED TRANSPORT
E-TOLLING
HYDROLOGY/STOR
SUSTAINABLE CONSTRUTION/ EXPANSION
ICT PROMOTION/EDU-CATION/MANUFAC-TURE
SKA/MEERKAT/IN-TERNATIONAL
RENEWABLES
FRACKING
BIOFUELS
WATER SECTOR IMPACTS
• Apply a sectoral approach to measuring water use and impacts
• Tie in water values to the system of national accounts
• Consider far reaching implications of water in national growth and job creation objectives
•Unquantified water quality and quantity impacts – technology dependent
• Proposed technologies need to take account of full life cycle costs
• Assessment of impacts of new infrastructure on water flows/hydrology and catchment area impacts
• Impacts of manufacturing sector on water quality and demand
• Adopting Sustainable Construction throughout development
• Pollution of Surface Waters through expansion of infrastructure
• Greater circumspection in promoting and/or adopting new technologies
• Ensure wide Stakeholder Consultation

7.3.1.1 The Energy Sector

In respect of the energy sector, the NGP identified several concerns and needs:[v]

- To address the existence of bottlenecks and backlogs in energy infrastructure
- To maintain high levels of public investment for the development of new industries to provide for renewable energy
- To ensure comprehensive support for energy efficiency and renewable energy as required by the IRP2, including appropriate pricing policies, combined with programmes to encourage the local production of inputs, starting with solar water heaters
- To strengthen regional integration on energy, including the Southern African Power Pool, linked to urgent improvements in electricity interconnectors, and to explore other opportunities for enhancing clean energy across central and southern Africa
- To identify viable new productive activities in the region, especially in the arena of renewable electricity (hydro and other green energy generation);
- To expand the existing public employment schemes to protect the environment, as well as in production of biofuels

Furthermore as per the NGP, it is anticipated that the government's Integrated Resources Plan 2 for the renewable energy sector will "open up major new opportunities for investment and employment in manufacturing new energy technologies as well as in construction."[v]

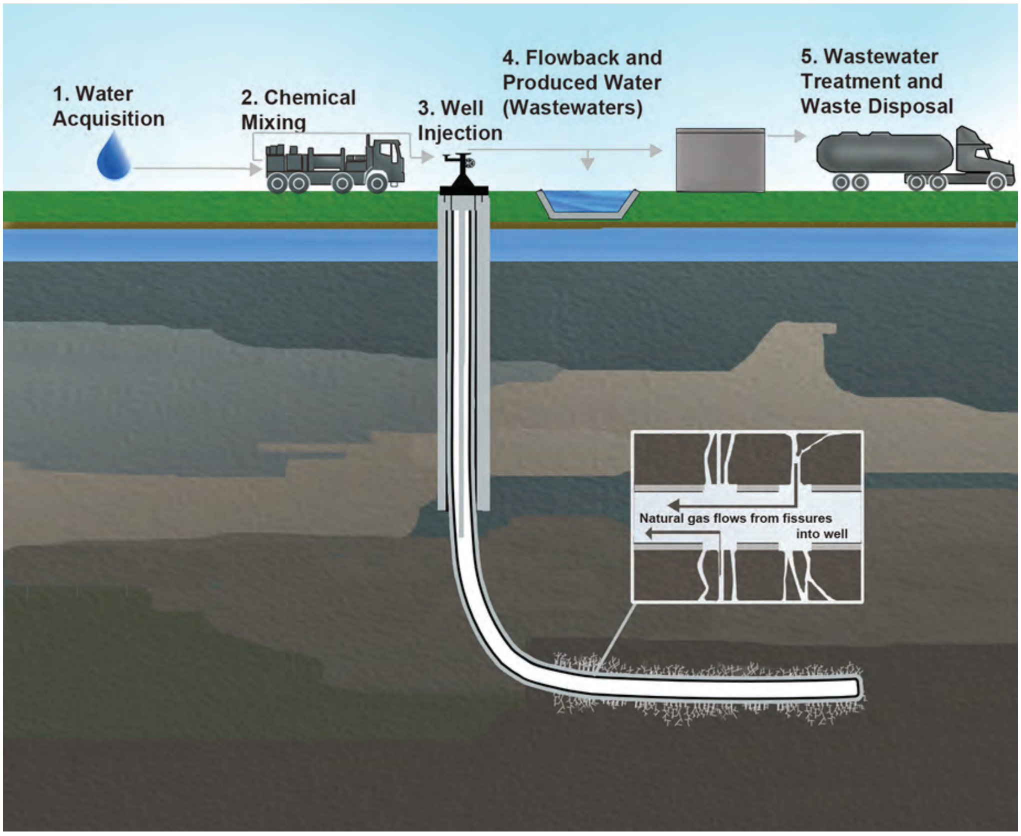
Gas Fracking

South Africa sits atop one of the world's largest shale gas reserves. A moratorium originally placed on shale gas exploration has been lifted by the South African government[viii] whilst the hydraulic fracturing technique, or 'fracking', is still restricted as the environmental costs are measured against opportunities for economic development. Whether exploration can happen without actual fracturing is another debate. If allowed to go ahead, it is estimated that the shale gas could cover South Africa's energy need for the next 400 years. It is further claimed that if only a tenth of the estimated gas can be extracted, potentially thousands of jobs could be created.[viii] However, fracking has been shown to have a very low employment to production ratio and the jobs created are unlikely to be new jobs but rather the reserve of qualified experts in the oil and gas industry and few will go to unskilled workers.[ix]

The fracking process is highly water intensive. Deep horizontal wells are drilled into the earth and pumped with water, sand and chemicals in order to burst open the shale containing natural gas. Gas flows naturally through the blasted hole via specialised tubing until the well needs to be re-drilled approximately two to three years later. Typical well creation requires about 20 million litres of water equating to a water use of about 4 billion litres of water/10 km^2 based on current proposal for fracking in the Karoo. Compare this against the entire water supply of the Western Cape Water Supply System servicing Cape Town and neighbouring cities which is approximately 511 billion litres.[x]

The fracking fluid used comprises water and other chemical substances which range from the relatively benign to the highly toxic not all of which are known to the public and which are often used in quantities and proportions unknown because this information is largely considered confidential business information.[xiii] Additionally, naturally occurring toxicants such as heavy metals, volatile organics, and radioactive compounds are mobilized during gas extraction and return to the surface with the gas/chemical mix (wastewater) not all of which remains underground.

The water quality and quantity impacts of fracking are still not clearly defined but concerns have been expressed over the possible long and short term health effects of air and water contamination and radiation exposure by gas production.[xi,xii,xiii] In a study of the impact of drilling on air and water water quality, animal owners who live near gas drilling operations were interviewed. The animals at these sites were tested and the findings illustrate that aspects of the drilling process may lead to health problems, specifically the wastewater production. The most commonly reported symptoms were associated with reproduction and in exposed animals; farmers reported an increased incidence of stillborn calves with and without congenital abnormalities (cleft palate, white and blue eyes). Other reported cases of exposure to drilling wastewater have led to the quarantine of beef cattle and significant uncompensated economic loss to the farmers.[xiv] In Louisiana, 17 cows died within one hour from direct exposure to hydraulic fracturing fluid largely from what appeared to be respiratory failure.[xv] At the request of the American Congress, the US Environmental Protection Agency is conducting a study on the impacts of fracking on drinking water resources. A final draft report is expected to be released for public comment and peer review in 2014.[xvi]



Hydraulic Fracturing Water Cycle[xvi]

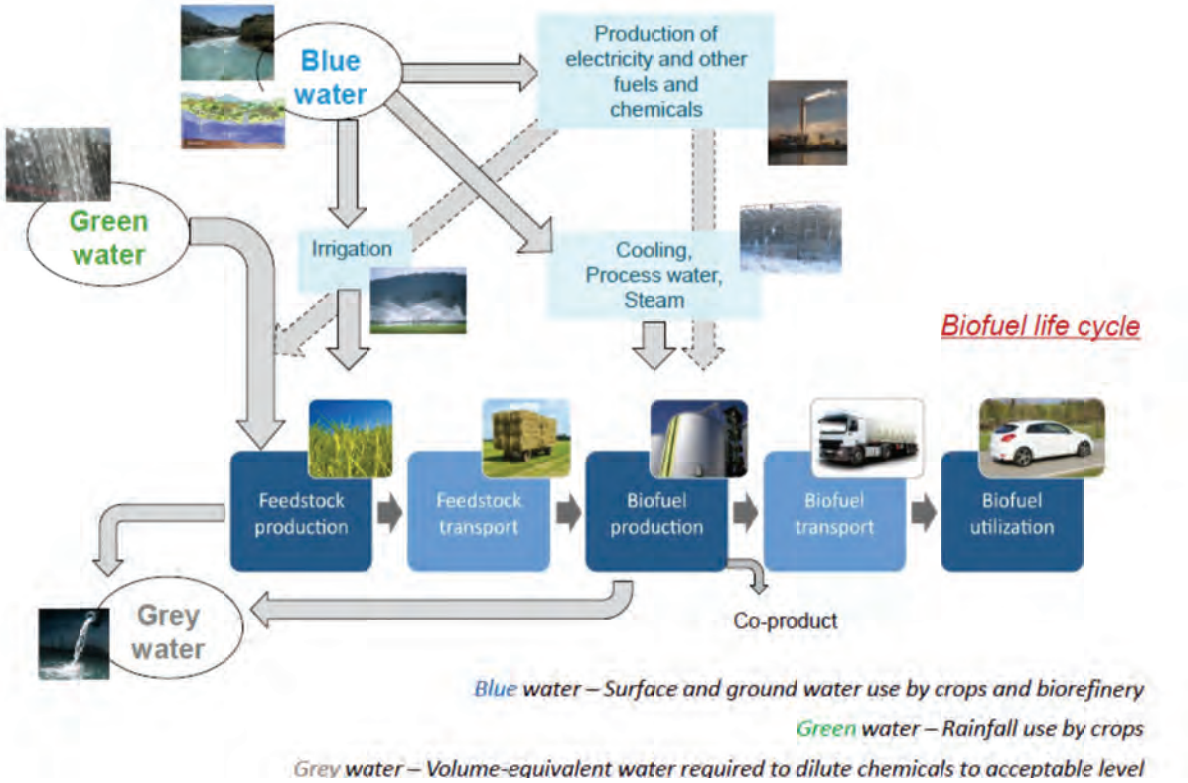
Renewable Energy

The uptake of renewable energy (RE) and what is referred to as clean energy in the NGP might mean “low carbon” but does not necessarily equate to “low water”. Certain RE, such as wind turbines and solar photovoltaic modules, may means generating electricity with essentially no water at all but the same cannot be said for all RE technologies and water usage varies widely depending on the particular technology. Particularly water intensive RE technologies include concentrating solar power (CSP) (cooling system dependent), bioenergy, geothermal, and hydroelectric.[xvii]

In terms of solar water heating (SWH), the promotion of the installation of these units in the NGP is welcomed as in the long term, once the original installation costs are covered, energy bills from heating water will be reduced. It is proposed in the NGP that uniform technical and performance standards for SWH be promoted both to support local manufacture as well as to facilitate the introduction of imported technologies for local manufacture. The proposed microeconomic strategy includes reforms in policies on competition, particularly the development of a competitive local industry. Regulatory constraints, costs and cheap imports were cited as the proximate causes for the threatened closure of SWH manufacturing facility Solardome in the Western Cape, a company established in 1969 with 21 employees.[xviii]

Biofuels

According to the NGP "Additional jobs will be created by expanding the existing public employment schemes to protect the environment, as well as in production of biofuels"[v] Biofuels are viewed as an attractive approach for producing fuel because the sources of biofuel are so readily available and may be easily produced. However the production of crops for biofuel production has a necessary water requirement, e.g. 28 litres of irrigation water are typically required to produce enough soybeans to propel an average vehicle 1 kilometre. Ethanol produced from maize has similar water demand requirements and a typical flexible-fuel vehicle running on E85 (85 percent ethanol fuel) produced from irrigated maize fields consumes about 26 l/km on average, assuming both the maize plant seed and stalks are transformed into ethanol.[xix]



Biofuel Life Cycle[xx]

South Africa has limited crop production potential with only about 16% (17 million ha) of the 122 103 700 ha being arable. Underutilised or poor arable land is being targeted as sites for production of crops that may be used for biofuel production. It is suggested that water use patterns for biofuel production under rainfed conditions are considered unlikely to impact on the "national water "picture", though small scale impacts might be significant under conditions of water stress. The DWA has made it clear that no water will be allocated for irrigation of biofuel crops and this is encapsulated in the DME biofuels licensing criteria document (DME, 2008) that "The production of feedstock under irrigation will only be allowed in exceptional circumstances and a detailed motivation will have to be provided".[xxi]

Researchers who assessed the Water Use of Crops/Trees for Biofuels in South Africa think it unlikely that irrigation will not be required when producing biofuel crops and highlighted schemes already planned for substantial production of sugarbeet under irrigation in the Fish River[xxi] though this project targeted for emerging farmers has stagnated. It is projected that by 2030 South Africa will be using 30% of irrigated water for biofuel production, and will be facing water stress.[xxii]

The biofuels market may have implications for transboundary water use impacts. Mozambique has several large irrigation developments driven by the biofuels market, and that several of these are planned for river systems that are shared with South Africa such as the Inkomati and Limpopo Rivers[xxi].

The ideal is to use crops that don't require any more water than what local rains provide as is the case for oil palms in Indonesia and sugarcane in Brazil where biofuels are produced on large scale without the crops requiring irrigation because they grow in regions receiving abundant rain. Water balance calculations have to take into account detailed water balances and contextually relevant life cycle analyses to determine water use patterns for biofuel crops. Serious consideration has to be given to whether it would make more sense to import biofuels from water-rich regions of the globe than to try to grow them where there's not enough water. Regardless, any feedstock considered for biofuel production will have to be viewed primarily within the context of how much water will be required to produce that crop. Another approach is to consider whether second, third and fourth generation feedstocks such as alien trees, algae and other feedstocks might not be considered preferentially over food crops.[xxiii]

7.3.2 The Transport Sector

As per the NGP, the transport sector is one of the sectors which can contribute to 250 000 jobs per year to 2015, projected to be created in the infrastructure sector:[v]

- Greater emphasis will also be placed on the expansion of rail transport, with more railway tracks and rolling stock, given the cost and logistics advantages for both commuters and freight transport
- Regionally, SA can be a leader behind the development of regional transport infrastructure through the development of transport hubs
- The infrastructure development must include construction of new infrastructure; operation of the new facilities; expanded maintenance; and the manufacture of components for the infrastructure programme.

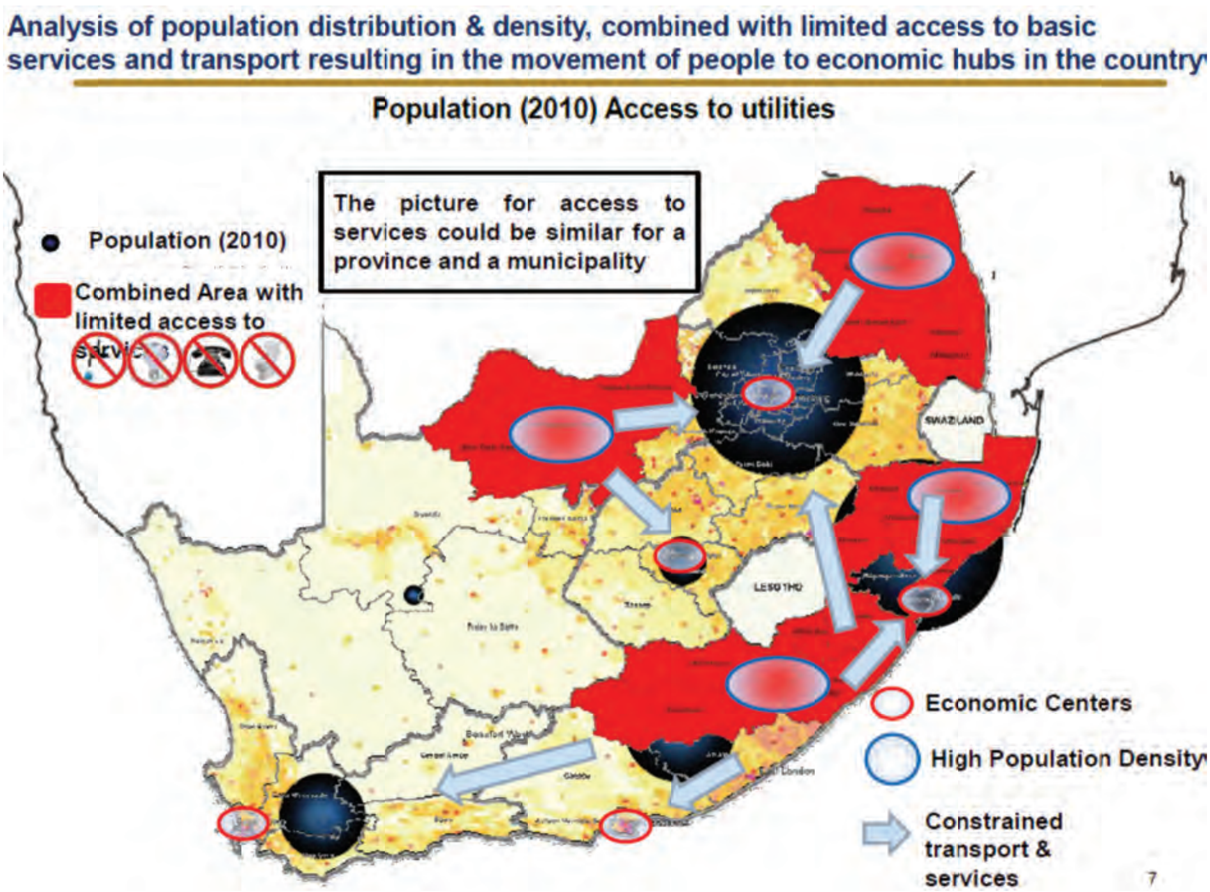
7.3.3 Strategic Infrastructure Plans (Sips)

Seventeen key projects or SIPs have been identified, several of which fall within the transport sector:[xxiv]

- *"Unlocking the Northern Mineral Belt with Waterberg as the Catalyst:* Investment in rail, water pipelines, energy generation and transmission infrastructure to catalyse unlocking of rich mineral resources in Limpopo resulting in thousands of direct jobs across the areas covered. Urban development in the Waterberg will be the first major post-apartheid new urban centre and will be a "green" development project.
- *Durban-Free State-Gauteng Logistics and Industrial Corridor*: Strengthen the logistics and transport corridor between SA's main industrial hubs; improve access to Durban's export and import facilities, raise efficiency along the corridor and integrate the Free State Industrial Strategy activities into the corridor and integrate the currently disconnected industrial and logistics activities as well as marginalised rural production centres surrounding the corridor that are currently isolated from the main logistics system.
- *South Eastern node & corridor development*: Promote rural development through a new dam at Umzimvubu with irrigation systems and the N2-Wildcoast Highway which improves access into KZN and national supply chains; strengthen economic development in PE through a manganese rail capacity from N Cape, a manganese sinter (NC) and smelter (EC); possible Mthombo refinery (Coega) and transshipment hub at Ngqura and port and rail upgrades to improve industrial capacity and performance of the automotive sector
- *Unlocking the economic opportunities in North West Province*: The acceleration of identified investments in roads, rail, bulk water and water treatment and transmission

infrastructure will result in reliable supply, meet basic social needs and facilitate the further development of mining, agricultural activities and tourism opportunities and open up beneficiation opportunities in the North West Province.

- *Saldanha-Northern Cape Development Corridor*: Develop the Saldanha-Northern Cape linked region in an integrated manner through rail and port expansion, back-of-port industrial capacity (which may include an IDZ) and strengthening maritime support capacity to create economic opportunities from the gas and oil activities along the African West Coast. For the Northern Cape, expansion of iron ore mining production
- *Integrated Urban Space and Public Transport Programme*: Improve investment in agricultural and rural infrastructure that supports expansion of production and employment, small-scale farming and rural development, including facilities for storage (silos, fresh-produce facilities, packing houses); transport links to main networks (rural roads, branch train-line, ports), fencing of farms, irrigation schemes to poor areas, improved R&D on rural issues (including expansion of agricultural colleges), processing facilities (abattoirs, dairy infrastructure), aquaculture incubation schemes and rural tourism infrastructure.
- *Agri-logistics and rural infrastructure*: Coordinate planning and implementation of public transport, human settlement, economic and social infrastructure and location decisions into sustainable urban settlements connected by densified transport corridors"



Mapping exercise Performed to set out key corridors of transport development[xxiv]

7.3.4 Stormwater Management

Transportation infrastructure is a major source of stormwater runoff that can alter hydrology and contribute significant quantities of pollution to surface waters.[xxv] Planning for expanding the transport infrastructure network must be done in conjunction with hydrologists as extensions to any transportation network render pervious layers less permeable or even impermeable resulting in an overall increase an increase in impervious surface areas. In road development, depressions may be raised to prevent ponding, surfaces and conduits are constructed to facilitate more efficient runoff, natural vegetation is often cleared and potentially results in increased erosion and natural water channels may be canalised to allow for routing through the development/s.[xxvi]

7.3.5 E-Tolling

The development of increased and expanded transport infrastructure may also impact on other NGP objectives. The proposed Freeway tolling commonly referred to as the e-tolling system, which is proposed for Gauteng's highways, has encountered strong resistance from the general public because of the additional charge it represents on road usage and the likely increase in the cost of living or working in the city, due both to the increase in direct travelling costs and the higher cost of goods (and services) transported into or leaving the city. This flies in the face of the NGP objectives "to minimise costs for business", "reduce cost drivers across the economy", "moderate price increases" and prevent gains in competitiveness being "eroded by rising domestic prices" and provide "appropriate and cost-effective infrastructure".[v,xxvii] This places a financial burden on the already burdened poorer sector of the populace.

7.3.6 The Communication Sector

Despite massive growth in finance and telecommunications, not much employment was created in the '00s. As part of the NGP:[v]

- The Bantustans are identified as suffering a backlog in communication technology rollout
- Stepping up education and skills development in communications is viewed as essential with proposals that computer skills form part of the secondary school and standard adult basic education and training (ABET) curricula.
- Proposals should be developed to improve telecommunications and internet connectivity across the region and from the region to Europe, Asia and the Americas

Seventeen key projects or SIPs have been identified, two of which fall within the communication and knowledge sector:[xxiv]

- *Square Kilometre Array (SKA) & Meerkat*
- *Expanding access to communication technology:*
    - Provide for 100% broadband coverage to all households by 2020 by establishing core Points of Presence (POPs) in district municipalities, extend new Infraco fibre networks across provinces linking districts, establish POPs and fibre connectivity at local level, and further penetrate the network into deep rural areas.

- While the private sector will invest in ICT infrastructure for urban and corporate networks, government will co-invest for township and rural access as well as for e-government, school and health connectivity.
- The school rollout focus initially on the 125 Dinaledii (science and math focussed) schools and 1525 district schools. Part of digital access to all South Africans includes TV migration nationally from analogue to digital broadcasting."

Square Kilometre Array

The Square Kilometre Array (SKA) is a : SKA is a global mega science project which entails building an advanced radio-telescope facility linked to research infrastructure and high speed ICT capacity & provides an opportunity for Africa and South Africa to contribute towards advanced science. South Africa together with Australia has secured the bid jointly to host the biggest radio telescope ever built. In the debate around fracking concerns were raised that the SKA could negatively impact on the SKA if sited within the same area. The science minister has the power to restrict or prohibit exploration and drilling under the Astronomy Geographic Advantage Act of 2007 in the event that impacts of drilling cannot be mitigated at close range.

Network Extension and promotion of ICT

Expansion of communication networks as well as promotion of ICT through educational initiatives. As part of the NGP manufacturing is being promoted and there is the potential for manufacturing of ICT components to have environmental impacts. The manufacture of semiconductors for example causes significant amount of air emissions in the form of acid fumes, volatile organic compounds and doping gases; as well as water emissions (solvents, cleaning solutions, acids, metals). Overall the manufacture of ICT equipment is energy intensive and uses large amount of water for rinsing and cooling.[xxviii]

7.3.7 The Housing Sector

As per the NGP, the housing sector is the sectors which can contribute the most to the 250 000 jobs per year to 2015, projected to be created in the infrastructure sector:[v]

- This trend was already in place in the 2000s, albeit poorly paid and insecure jobs.
- As per the NGP, government will step up its efforts to provide "public infrastructure and housing in rural areas, both to lower the costs of economic activity and to foster sustainable communities."[v]
- Government will also be "Reprioritising budgets for housing and social services to address rural backlogs"

The increased infrastructure build places pressure on water resources both during construction and after commissioning to provide occupants with access to potable water in a clean and secure environment. The housing sector ties in very closely with Green economy initiatives and efforts to improve water efficiencies in infrastructure development and retrofits. At the outset in water scarce areas, housing infrastructure rollout in rural areas can be developed in such a way as to address water scarcity issues.

Measures that might be adopted include adopting technologies and incorporation of low-flow faucets and low pressure showers, collecting rainwater from roofs and other impervious surfaces, collecting greywater from sinks and showers, washing machines, and other food sources that do not contain food or human waste and rerouting this water to toilet flushing use or for irrigation. Other measures might include promotion of xeriscape gardening that will require limited irrigation until establishment of the garden whereafter the irrigation system would no longer be required.

Sustainable Construction

In respect of actual construction activities, knowledge is limited of where water is used on construction sites and the volumes involved. Initiatives must be undertaken during planning stages of construction to identify water use on construction site by process/activity and to improve site water use behaviour, processes and technologies. The main activities/areas on construction sites where water is used include:

- Site cabins and temporary accommodation
- General site activities including tool washing
- Wet trades, such as brickwork, screeding, concreting and plastering
- Groundworks, including grouting and drilling
- Dust suppression, including road and wheel washing
- Hydro-demolition
- Cleaning of tools and plant equipment, lorry washing
- Commissioning and testing of building plant and services[xxix]

Assessments have to be made at the outset and during construction of those activities or processes where water waste is highest. The UK Strategic Forum for Construction has formulated an Action Plan for reducing water usage on construction sites. This includes the establishment of a baseline which includes all elements of water consumption associated with contractor's site activity.[xxix] A similar initiative might be adopted and implemented in South Africa. Where different building types are constructed, e.g. new domestic or new retail, the baseline might have to be adjusted. But in the rural housing sector it is likely that the residence type will be relatively uniform and that for that particular building type and its various phases of construction that baselines might reasonably be set. These may then be audited to ensure that the contractor complies with the baseline usage requirements. The knock-on effect of such an initiative is that a level of awareness is created both among contractors and by residents of the new infrastructure.

8. OVERVIEW OF CURRENT GE INITIATIVES IN THE WATER SECTOR IN SA

South Africa's metropolitan municipalities were researched and some visited to assess the level of awareness regarding the GE and identify, if any, GE initiatives undertaken by these municipalities in the water sector.

8.1 City of Cape Town Metropolitan Municipality

In November 2010, the City of Cape Town in conjunction with Western Cape Provincial government rolled out the Green Cape Initiative, a Sector Development Agency, aimed at unlocking the manufacturing and employment potential in the Green Economy in the Western Cape. Other partners in this initiative include WESGRO and academic institutions. Within the Western Cape, it was estimated that Green jobs stood at 3 000 people in 2010 and that through component manufacture for the energy sector, including the manufacturer of heat pumps for heating water, that this could increase to 20 000 by 2025.[xxx]

In June 2012, the Western Cape Government (WCG) launched "110% Green" initiative, aiming to bring both business and Government closer to achieving a healthier environment for future generations. Entrepreneurs are being challenged to innovate, attract investors and revolutionize the focus of industry The Premier of the Western Cape, Helen Zille, hosted the launch and asked organisations to lead by example and commit to flagship projects that support the growth of a green economy.[xxxi]

On the Water Resources front, the City of Cape Town (CoCT) is actively engaged in strategies to implement an effective Water Conservation and Water Demand Management (WC/WDM) Strategy with the aim of saving approximately 90 million m^3/annum of water by 2016/17. The main aim of the strategy is to "ensure the long-term balance between available Water Resources and water demand, to postpone the need for expensive capital infrastructure projects for as long as it is economically viable and to minimise water wastage."[xxxii] The strategy was initially implemented in 2007[xxxiii] and by 2010, the CoCT had set itself several targets including:

- A decrease in non-revenue water by 15% by the year 2010
- A decrease in wastage to less than 2% of demand
- The improvement of management systems and implement integrated water resource planning
- The adoption of the WC/WDM strategy as a key deliverable
- A decrease in the requirements for water to less than 1% per year.[xxxiv]

At that stage, the CoCT had already implemented a wide range of projects including both technical and social interventions. Included in this is the successful commissioning of a large scale pressure management projects. Analyses of the minimum nightflow into Khayelitsha in 2000 estimated losses through leaks of between 70 to 80%.[xxxv] And pressure management was introduced specifically to reduce leakage during off-peak periods in Khayelitsha. Since then, the city has extended these installations to Gugulethu, Atlantis, Mfuleni, Delft, and Mitchells Plain and new projects are currently underway in Belhar, Langa and Eersterivier.[xxxvi] Assuming a cost in 2009 of R6.20/m^3 to produce water, the water saved in Khayelitsha, Mfuleni, Gugulethu and Mitchells Plain, by the introduction of these devices, was 13.4 million m^3/year which represents a cost saving of approximately R80 million/yr.[xxxvi] Other benefits of pressure reduction include fewer pipe bursts and a reduction in wastewater volumes which for Khayelitsha alone is 20 Ml/day which results in an annual saving in sewerage treatment cost of R2.5 million/year.[xxxvi]

Lessons learned from the pressure management project included the following:

- Areas in which pressure management is implemented must be carefully selected to ensure that real savings might be achieved if implemented
- A greater proportion of the potentially obtainable savings may be achieved by the use of normal pressure reducing valves with smart pressure controllers used to realise the remaining savings
- All installed equipment must be regularly monitored and maintained to ensure optimal functioning and there is the potential for the creation of semi-skilled jobs

Pressure management has now been successfully implemented in more than 13 settlements, which includes pressure reduction devices at 49 schools.[xxxiv]

In 2005, the City implemented an Integrated Leaks Repair Project aimed at indigent households that were incurring debt arising from water leaks. Part of this included the development of a community empowerment programme to train local plumbers to play a role in on-going plumbing maintenance.[xxxvii] In the 2010/11 financial year:

- 60 Schools were visited and leaks repaired
- ± 100 Caretakers of schools were trained
- Awareness and Education campaigns were carried out with approximately 2 688 workshops;
- Approximately 200 households were visited for the Integrated Leaks Repair project[xxxiii]

The CoCT also promotes the use of treated effluent irrigation though this option has not been fully exploited. Current beneficiaries of the lower tariffs attached to such use include the majority of Golf Courses in the City, some parks and sport fields as well as a limited number of Industries. As at November 2011, approximately 12 823.16 Ml/month of treated effluent was used. This does not translate directly to a saving in water demand as some potable water is still used and a portion of the use replaces ground water use.[xxxiii]

Future interventions by the City include:

- Managing real losses through the expansion of the pressure management programme where feasible, leak detection and pipe replacement and pro-active maintenance
- Addressing apparent losses through unbilled and/or unauthorised consumption through meter audits and the replacement of broken or faulty meters
- Carrying out on-going public information and education campaigns

8.2 Gauteng and the City of Johannesburg Metropolitan Municipality

The Gauteng City-Region Observatory, in January 2010, published their report on a "Strategy for a Developmental Green Economy for Gauteng." The strategy is colloquially referred to as the 'green jobs' strategy but its main focus is on sustainable development.[xxxviii]

The overall strategic goal for the province is sustainable economic growth and sustainable job creation for Gauteng. And the Key initiatives within that strategy include:

- Food security: reducing food imports and (vastly) increasing local food production
- Energy security: reducing dependence on oil and coal-based sources of energy by increasing the supply of renewable energy and improving energy efficiency
- Water security: reducing total water consumption by 15% by improving efficiencies, introducing recycling, increased public education, and reversing pollution via more effective management of Gauteng's water resources and associated eco-system services
- Zero waste: by seeing all waste outputs as potential productive inputs, measures will be introduced to reduce, recycle and re-use
- Sustainable mobility: to reduce dependence on oil and limit carbon emissions, investments in public transport systems will be accelerated so that the number of trips in private vehicles can be reduced by 15%xxxviii

The City has several "green projects" in planning phase, and not much specific detail is available yet. Rand Water has several programmes, focussing on Education and Training initiatives, which promote, amongst others, the development of community gardens, water-conscious landscaping, promoting rainwater harvesting and use of grey water.[xxxix]

The City of Johannesburg ran a few advanced pressure control small pilot projects and progressed to a full-scale Johannesburg Pressure Management Project in 1995 by two different teams involving the design and commissioning of almost 100 advanced pressure control installations,[xl] which won a SAICE award. Since then similar initiatives have also achieved recognition such as the Sebokeng Pressure Management Project which won the prestigious International Water Association 2011 PIA – Development Award in the Drinking Water category. Since implementation, the actual measured savings are approximately 50 million Kℓ of water over a five-year period representing financial savings to the municipality of more than R150 million. Further, energy savings were conservatively estimated to be approximately 70 000 tonnes of CO_2 equivalent.[xli]

8.3 City of Tshwane Metropolitan Municipality

In July 2012, Tshwane metro launched a discussion document called "Tshwane 2055", a long-term strategy aimed at improving the quality of living across the Metro, revitalising the City, boosting economic development and attracting investment. Tshwane 2055 is a new city development strategy, which will articulate the City's vision, proposed strategic interventions, key indicators and expected outcomes.[xlii,xliii] Identified areas of focus include globalisation; climate change and environmental threats; the movement of people from rural to urban areas; the constraints of increasingly scarce resources; the need for ethical governance; growing the economy and alleviating poverty; building sustainable communities; and improving the quality of life of those in the City of Tshwane. One of the identified Key drivers of change and challenges that the city identifies in the discussion document is "the need for cities to drive green economies and city competitiveness in order to build '*resilient*' cities."[xliv]

8.4 Ekurhuleni Metropolitan Municipality

At the Growth and Development Strategy 2055 stakeholder engagement session on Environmental Sustainability and Climate Change, which took place in Germiston in May of 2012, the short and medium term goals of the Ekurhuleni Metro Municipality (EMM) were discussed.[xlv] Amongst others, these include:

- Identifying sectors vulnerable to the impact of climate change and to reduce its impact.
- Improving energy and water efficiency and reducing waste
- Encouraging alternative, environmentally-friendly cultivation of food sources
- Developing clean energy production mechanisms within Ekurhuleni to supplement the national supply utilising wind, solar or waste;
- Developing a water harvesting industry and ways to utilise other sources of water instead of relying on clean drinking water, even for industrial processes;
- Ensuring that principles of a green economy are carried through all aspects of service delivery; and
- imposing green building principals

Participants at the sessions emphasized the need to develop green by-laws and the necessity that these by-laws, once in place, be enforced.xlv Very importantly, the adoption and implementation of this strategy seeks to improve on the current growth and development status quo which has 27% of the EMM population living below the poverty line and 27% of its population unemployed.[xlvi]

As part of the Arbor Week activities, the EMM planted 1250 trees in Duduza, in remembrance of the tornado that hit the area a year ago. Approximately 280 fruit trees, 193 ornamentals at houses and 300 along the streets were planted with the rest donated to schools, nursery schools and clinics throughout the township.[xlvii]

8.5 eThekwini Metropolitan Municipality

The eThekwini Metropolitan Municipality (eTMM) has been extremely pro-active in activities, both at research and implementation level, that may be defined a “green economy” activities. The eTMM has established partners with research organisations, business, universities, donor funders (local and international, to explore and implement in excess of thirty projects relating to these projects. Spearheaded primarily by the Water and Sanitation Department of the Metro, the projects include, amongst others.

8.5.1 Decentralised Wastewater Treatment

The eThekwini Municipality in partnership with the Pollution Research Group in the School of Chemical Engineering at the University of KwaZulu-Natal are investigating a modularised Decentralised Wastewater Treatment System (DEWATS) plant for on-site waterborne sanitation. A technical evaluation plant was designed by BORDA, the Bremen Overseas Research and Development Association, which has extensive experience in both the design and implementation of such plants, having implemented over a thousand worldwide. BORDA have received recognition for this design by winning the International Water Association Technological Innovation Award in 2011.[xlviii]

The eTMM in conjunction with the South African Water Research Commission provided the land and financed the construction and the technical evaluation and funded the research. Domestic Wastewater from 86 residences in the Newlands-Mashu area is diverted to the test plant which comprises biogas/settler pre-treatment step, an anaerobic baffled reactor, two anaerobic filter chambers and effluent polishing in a constructed wetland. Tied to this project are other sub-projects including the microbial risk assessment of irrigating crops with treated effluent, the impact of nutrients on soil conditions and the harvesting of methane.

8.5.2 Mechanical Properties of Faecal Sludge from On-Site Sanitation Facilities

The Bill and Melinda Gates Foundation (BMGF) is funding several projects which address challenges of on-site sanitation. One aspect of this research is to determine the properties of faecal sludge from different types of onsite sanitation facilities. Chemical, mechanical, rheological and thermal properties will be measured to determine correlations, if an, between the quality and quantity of sludge and level of facility use. The data produced will be used to inform the design and sizing of mechanical pit-emptying devices, transportation and processing systems for the excavated sludge, and the design of future on-site sanitation facilities. The eTMM, the Pollution Research Group at the University of the KwaZulu-Natal and the eTMM are collaborating on this project.[xlix]

8.5.3 Sludge Management In Ventilated Improved Pit Latrines (Vips)

Two Water Research Commission funded projects, undertaken by the Pollution Research Group at the University of KwaZulu-Natal and Partners in development, added to the body of knowledge on the accumulation and quantification of sludge in pit latrines and disposal options for sludge dug out of pit latrines.[l,li]

8.5.4 Pre-Fabricated Sanitation Solutions

A PPP has been formed to tackle some of the issues around sanitation and in so doing, promote development and create sustainable improvements in the lives of people. In the Fraser's Informal Settlement in Durban, a containerised ablution block was installed for every 75 households while testing out different designs of prefabricated decentralized wastewater treatment plants (DEWATS) to determine the most suitable treatment process for the waste water from the ablution blocks. At the Sarasvati Primary School, the solution included waterborne toilet blocks, a wastewater treatment system with a biogas collection chamber, rainwater harvesting tanks and a garden for the school with no electricity requirement. Ongoing monitoring includes measurement of water consumption, [lii] performance of the wastewater treatment and the biogas collection.[liii]

Other areas where prefabricated communal ablution blocks (CAB) have been placed include the informal settlements in the eThekwini area, where 125 ablution blocks have been installed to date. The current goal is to install 2 200 by 2015. CABs consist of two prefabricated shipping containers modified to meet appropriate communal sanitation standards. The containers (serving male and female users respectively) service 50-75 dwellings at a maximum distance of 200 m from the facilities. Male blocks have two washbasins, two urinals two toilets and two showers. Female blocks have two washbasins, two or more toilets and two showers. Provision is made for a store room and for (two) external laundry basins.[liv] Jobs have been created by this initiative, as members of the community are hired to manage the CABs in their areas,.

8.5.5 Methane to Electricity

The eTMM Water and Sanitation Unit operates 28 wastewater treatment works (WWTW) which treat over 460 ML/day of sewage, producing the equivalent of 100 tons of sludge per day. At 10 of the 28 WWtW, sludge is treated by anaerobic digestion which yields methane gas. The project aims to maximise the generation of methane in digesters, to generate electricity from this methane and feed the electricity into the treatment works electrical system. By using methane to generate energy, methane can power at least 50 % of the energy requirements of each of the works with an anaerobic digestor. This will be piloted at the Northern WWTW which with an anticipated output of 350 kW..[lv]

8.5.6 Biodiesel from Microalgae

Biodiesel is typically produced from various types of oils including soybean oil, canola oil, animal fat, corn oil, waste cooking oil and jatropha oil. Utilisation of food crops for the production of biodiesel has come under a great deal of criticism because of food security issues. There is also much doubt cast on the whether the energy balance is favourable. Algae is seen as an ideal candidate for biodiesel production as microalgal yields can be between 15 and 300 times greater than that for oilseed crops, have demonstrably faster growth rates, can grow in saline waters, have greater photosynthetic efficiencies than higher plants, require minimal nutrient input and have moderate to high lipid content.[lvi] This is currently being piloted and optimised by eTMM in partnership with UKZN.

8.5.7 Industrial Effluent Impacts on Wastewater Treatment Plants

In conjunction with the Water Research Commission the eTMM has developed a methodology that enables the municipality to evaluate the ability of a receiving wastewater treatment plant (WWTP) to accept a factory's effluent and adequately treat it, together with the wastewater received from all other users of the sewer system in the WWTPs catchment, to a standard suitable for release to the environment.lvii This will allow for the development of a protocol to set limits on what may be discharged to sewer in the process of issuing an effluent discharge permit.[lviii]

8.5.8 System Optimisation

In the Durban municipality, potable water is distributed through a trunk main system to 265 reservoirs. In order to promote operational optimisation of the water distribution network, a model has been developed which simulates the water distribution network flows and also takes into account the minimum cycle times of some larger pumps and larger systems, with the aim of optimising flows within the network.[lix]It is estimated that in the trunk main system, water losses of 4% are incurred en route with even high losses incurred downstream due to an aging pipe infrastructure and water theft. A model is being developed that will assist in narrowing down the area of the leak to make maintenance easier, by overlaying "snapshots" of the network at a series of points in time, in order to progressively narrow down the part of the network which can commonly account for all observations.[lx]

8.5.9 Effluent Re-Use In Agriculture

The Decentralized Wastewater Treatment System (DEWATS), located at Newlands Mashu, Durban, uses anaerobic digestion processes to reduce the Chemical Oxygen Demand (COD) of the wastewaters. COD is a means of measuring the ability of wastewater to sustain aquatic life, essential for the preservation of the environment. The Chemical Oxygen Demand (C.O.D.) test gives an indication of the impact of discharge waters on aquatic life by measuring the oxygen depleting nature of the discharge water. It also enables proper assessment of treatment plant performance; the higher the COD, the less likely it is to sustain life. After passing through the DEWATS system, particulate components will have been solubilised and some pathogen reduction will have taken place. The anaerobic filter further reduces the COD of the wastewater as more pathogens and particulate material is removed by passing through a constructed wetland. A study is being carried out to assess the utility of ABR effluent in agriculture without negatively impacting soil properties. The risk of pathogen contamination to workers and potential consumers will also be assessed.[lxi]

8.5.10 Hydro-Power Major and Mini Stations

The eTMM plans to exploit excess pressure (currently dissipated by pressure reducing valves) present in the water distribution network arising from the difference in elevation between Durban Heights and the reservoirs. To this end, the plan is to install between two and four mini turbines fed by the city's Northern Aqueduct distribution system which supplies water from the treatment works at Durban Heights to the northern suburbs.[lxii] The turbines will take advantage of this pressure differential to generate electricity (120-180 kW) which will be fed to the municipal low tension grid. The eTMM is in the process of sourcing funding for the feasibility study.[lxii]

8.5.11 Water Reuse

In 2008, the Department of Water Affairs and Forestry (DWAF) concluded their *KZN Coastal Metropolitan Areas – Water Reconciliation Study, 2008* (Reconciliation Study). Included in this report was detail on the proposed further development for bulk water resources for the KZN Coastal Metropolitan area and concluded that the water supply needs in the eThekwini Municipality and surrounding areas currently exceed the reliable supply of local water resources. In order to meet the water demand several options are being investigated including treated effluent reclamation and re-use. The technology required to achieve this is well understood and the treatment process yields high water quality. After a series of studies conducted by the eTMM it was determined that the most feasible option for the eTMM is to reclaim treated sewage effluent from the KwaMashu and Northern WWTWs, and treat it to potable standard. An Environmental Impact Assessment (EIA) for implementation of this strategy is currently underway.

8.5.12 Rainwater Harvesting

Communities in the rural areas of eThekwini face high levels of poverty and unemployment. The eTMM has been working in these communities to encourage the planting of co-operative gardens coupled with the installation of rainwater harvesting tanks, to provide water for the irrigation requirements for the gardens as well as for domestic needs.[lxiii] Households targeted for this scheme must demonstrate a monthly income less than R1500/month.

8.5.13 VUNA (Valorization of Urine Nutrients in Africa)

In a collaborative project between the Swiss Federal Institute of Aquatic Science and Technology (Eawag) and eThekwini Water and Sanitation (EWS), the VUNA project focuses on three important aspects of a sanitation system with decentralized urine treatment.[lxiv] The aim of the project is to recover nutrients from urine and by doing so, improve the health of communities, incentivise the use of dry sanitation systems, produce a valuable fertiliser, foster entrepreneurship and reduce water pollution.[lxv] The addition of magnesium to urine results in the precipitation of struvite. Struvite (magnesium ammonium phosphate) can pose a problem in nutrient removal waste water treatment processes, where ammonium and phosphate from waste material is released, as it forms a scale on lines and clogs system pipes. The Recovery of phosphorus from wastestreams as struvite and recycling those nutrients into agriculture as fertilizer appears promising, particularly in municipal waste water treatment plants. . The VUNA project is currently in pilot phase. Urine diversion toilets have been installed in the test areas and the urine is collected weekly and transported to the test site at the University of KwaZulu-Natal and batch processed to precipitate out the struvite. The product is dried and weighed to determine yield and then used in pot trials[lxvi] to gauge efficiency as a fertiliser when growing maize hybrids.[lxiv] Running concurrently with the field and lab test is a social impact assessment to determine social acceptability and willingness of proposed participants to engage in urine collection schemes.[lxiv,lxvii,lxviii,lxix]

8.6 Mangaung Metropolitan Municipality

The Batho Greening Project, kicking off with the establishment of a Green Hub in Mangaung, is one of the projects drawing on government's funding for green job promotion. The project started with the establishment of a Green Hub in Mangaung, where several youth are already employed in labour intensive work such as cleaning the stream which flows from Dr Belcher road through Bochabela up to the Phahameng cemetery in Bloemfontein.[lxx]

8.7 Nelson Mandela Bay Metropolitan Municipality and Buffalo City Metropolitan Municipality

At the 17th Conference of the Parties (COP17) to the United Nations Framework Convention on Climate Change (UNFCCC), held in Durban, South Africa, the Eastern Cape Province launched the Eastern Cape Climate Change Response Strategy. The Spekboom Project is one of the identified projects under this strategy and is a subtropical thicket restoration project, i.e. restoring large tracts of the nearly 1,4-million hectares of spekboom-rich thicket that covered parts of the Eastern Cape a century ago with a corridor linking Baviaanskloof, Addo and Great Fish game reserves. The aim of the project is to restore biodiversity, protect water catchments, create jobs, increase CO_2 sequestering and create an opportunity for carbon trade.[lxxi, lxxii] The project has already been validated and registered through the Verified Carbon Standard and the Climate, Community and Biodiversity Alliance , making it a "blue-chip" voluntary carbon market credit.[lxxii] The benefits of the project in terms of job creation is estimated to be quite high with between 55000 and 70000 "person days" expected to be created if the full extent of the project, including reducing silt loads in dams and rivers and promoting greater ecosystem productivity and biodiversity, are realised.[lxxii]

Buffalo City Municipality contracted Amatola Water to implement the Nxamkwana Sanitation Project, which entailed the construction of 3510 compost toilets over a period of three years. After the successful completion of 410 toilets during Phase I, there were some delays in rollout due to funding constraints but in 2009 the second phase of the project was completed which resulted in 239 households receiving access to toilet facilities, and in March 2011 the rollout of the final phase of the project was announced. The compost toilets consist of two chambers: when one chamber is full it is left to dry while the household uses the other chamber. The full chamber is sprinkled with comfrey and yellow tea which accelerates decomposition and the dry matter can then be used as compost. Vent pipes contain odour and nets are in place to contain insects. During the rollout of this project a skills transfer component was incorporated into the work by the creation of ten learnerships during the construction of the toilets.[lxxiii,lxxiv]

8.8 Private Sector Initiatives

Globally, there has been much talk of private sector involvement in and support of a GE. At the biannual 7th World Chambers Congress, more than 1,000 business leaders agreed that the private sector has a key role to play in building a low-carbon, resource-efficient future.[lxxv] The Donor Committee for Enterprise development (DCED), the forum in which donor and UN agencies share their practical experience of Private Sector Development (PSD), sees PSD as the key driver for green growth.[lxxvi]

South Africa is one of the 30 driest countries in the world, but as recently as 2010, relatively few local companies have a formal management plan in place to tackle water-related issues. This was reported in the “The Environmental Handbook: A Guide to Green Business in South Africa” which reported on surveys of 100 major corporates, drawn from a database of publicly listed and large unlisted companies where 42% of respondents indicated that they had no specific policy on water management and a further 19% had a formal policy, but had no action plans developed to implement the policy.[lxxvii]

The Capital City Business Chamber (CCBC)[lxxviii], an organization representing the interests of Members and the Local Business community in the Pretoria/Tshwane region and surrounds, established a Green Economy Joint Venture that won the Mail & Guardian 2012 Greening the Future Award for Energy Efficiency and Carbon Management. The multi-pronged approach to improving efficiency included the use of Eco shower heads to reduce geysers’ energy use and water usage, combined with rain water harvesting by means of rain water catchment tanks and boreholes incorporating purification where required with the aim of reducing municipal water consumption by at least 50%.[lxxix] The implementation of electronic metering allows for users to manage and regulate their consumption. Scalability is addressed in that larger homes, guest houses, schools or business consuming more than

2,000 kWh per month may opt for hybrid energy modules with LPG operated generators, back-up batteries, inverter systems and PV solar panels for grid energy savings of up to 70% with an uninterrupted power supply to protect sensitive equipment from power surges caused by electricity blackouts or lightning.[lxxix] The project was rolled out at the Zuid-Afrikaans Hospital and expected gains include a reduction in municipal water consumption by, at least 63% (1 500 kL) and energy use by 21% (92 000 kWh) a month with expected savings of more than R400 000 on water and electricity during the first year, and up to R5-million over the next seven years.[lxxix]

In February 2012, the Ilembe Chamber of Commerce, Industry and Tourism (ICCIT) and King Shaka International Airport (KSIA) held the country's first ever 'Green Golf Day' at Simbithi Eco-Estate.[lxxx] The aim of this initiative was to foster awareness of the impacts human activities on the environment and encourage local businesses and communities to demonstrate responsible business practices. As part of the event, a waste management and recycling programme was introduced and to counteract the golf day's carbon footprint, 200 trees were planted at Simbithi Eco-Estate (some of these by the golfers themselves). Golfers were urged to make use of Eco-friendly, re-useable sports water bottles which were refilled on the course, biodegradable golf tees, and recycled scorecards.

The ICCIT is also investigating water supply shortages experienced in Ballito during the 2011/2012 festive season. The influx of tourists into the area during the holiday season places additional strain on the water supply system. The ICCIT is now part of a task team to look at ways of increasing efficiency and develop an operating plan to minimise risks while a new water pipeline from Hazelmere Dam is being built.[lxxxi] Medium-to-long term plans are being investigated and include supplying water south from the Tugela dam and the possibilities of a desalination plant.

In August 2012, Chris Whelan, the new CEO of Accelerate Cape Town, motivated for business to play a central role in developing a sustainable, inclusive economy, outlining a vision on how Accelerate Cape Town has worked on building partnerships to achieve this, and where the organisation plans to focus in the coming year.[lxxxii] Most of these initiatives are still in the planning stage.

9 THE GE FROM A RESOURCE ECONOMICS PERSPECTIVE

9.1 Implications of the GE on Current Resource Economic Practices

There is a great deal of debate over the value of water. While water is essential for many aspects of economic growth and development, it is not used often as a tradeable commodity, and prices (and therefore perceived value) do not often reflect the scarcity or intrinsic value of it as a resource (Hanemann, 2006). While water in itself is difficult to value, there has been a move to give it an economic value due to its competing uses and its role in industries that require water to perform. In developing and using water resources, priority has to be given to the satisfaction of basic needs and the safeguarding of ecosystems. Beyond these requirements, however, water users should be charged appropriately (Agenda 21, United Nations, 1992).

Understanding and quantifying the value of water is further complicated by the fact that it changes constantly. Water levels change over time, water evaporates or runs into rivers or is used by consumers, and so the supply of water changes depending on uses and environmental conditions. Demand for water also fluctuates – for example the agricultural sector will require more water during the planting season than during harvest. The cost of transporting water also means that in a time when there is an unexpected shortage (and so water would become more valuable in terms of what people would be prepared to pay for it), it is expensive to bring water into a water-scarce area, and also requires time and planning. Once the infrastructure for water is developed however, it typically lasts for decades, and so the cost of built infrastructure and of proposed infrastructure can be written into the price of water (Hanemann, 2006). The low cost of water affects its perceived value: for example in Nepal, all households in a survey had electricity, but not all had water or sanitation. In almost all cases, electricity is prioritised over piped water supply by people who cannot afford both (Hanemann, 2006), despite the fact that water is essential for survival and electricity is not.

Water is commonly provided free of charge or at a cost that does not accurately reflect the cost of providing the services (United Nations Statistics Division, 2007).In many cases the price charged for water is the cost of delivering it and of treating it. No consideration is given to the scarcity value of water, as water is given away for free, as long as the costs of treating and transporting it are covered (Hanemann, 2006). This is a concern as the current abstraction, treatment and transport costs may be covered, but as the demand for water increases, the pricing of water will need to cover replacement costs – i.e. the cost of new infrastructure to treat, transport or acquire water once the current supply is exhausted (Hanemann, 2006). This is not a fixed value and requires careful monitoring as technologies and innovations can reduce the price of infrastructure required to treat water. For example new biomembrane technology used in desalination plants makes desalination more economically viable than it has been historically (Hanemann, 2006).

Not having water can have huge economic impacts on industrial production and therefore on businesses, investors and producers (PWC, 2009). While the risk of not having water is greatest to industries that use large quantities of water – such as agriculture, beverage producers, electricity generators and mining sectors, lack of water will place any sector requiring water as part of their supply chains and product use at risk (PWC, 2011). PriceWaterhouseCoopers recommends using a combination of life cycle analysis and risk management to determine water availability problems, effects of industrial water use on local communities' access to water and sanitation and catchment management strategies in order to identify targets for water use reduction in industry (PWC, 2011). Companies that do not attempt to minimise water use are at risk of production being interrupted by water shortages, damage to reputation as conflicts arise through conflict between communities and businesses over water access, as well as reduction in investment as potential investors factor water-related uncertainties into investment strategies.

It is also suggested that human needs for water should be uncoupled from human demands for water. In developed countries per capita water use is significantly higher than in developing countries. Amenities such as appliances using water, water-based sewage removal systems and swimming pools have pushed water use in developed countries far beyond what is necessary for survival and sanitation. As countries without water and sanitation structures develop and water becomes available, it is likely that water use in developing countries will increase by a large degree as water-based amenities are adopted by developing societies. This means that the demand for water as well as an increase in water use will accompany the development of water supply and sanitation networks. To manage this demand for water, behavioural approaches concerning changing perceptions of the value of water are required to slow the impending water crisis, and also to project the future demands for water in developing countries (Hanemann, 2006). It must also be noted that the supply of water is uneven and the current situation where infrastructure needs to be developed, the quality and the value of water supplied must be taken into account to meet the needs of people without access to water, or without access to clean and safe water (Aguirre, 2006).

The need to understand the economic value of water can no longer be ignored. To advance the GE agenda it is imperative that the true value of water is understood or else it would be impossible to determine if an initiative falls within the definition of a GE. Determining the value of water will have an impact on current water sector practices. Below, is an overview of some of some of the potential impacts.

9.1.1 Economic Accounting for Water (EAW)

Prior to the promulgation of the National Water Act (Act 36 of 1998), there was no legislative requirement to take into account the economic value of water, i.e. the real cost of managing water, the cost of water supply and the scarcity value of water. However, since 1998 the government is responsible for ensuring that "water is protected, used, developed, conserved, managed and controlled in a sustainable and equitable manner, for the benefit of all persons". The implementation of the water resource management charges in 2002 did to a certain extent attempt to address the economic value of water however in light of GE expectations more needs to be done.

South Africa's pricing strategy for raw water use recognises the importance of pricing and requires that pricing policy must be structured to *"…*ensuring an efficient allocation of scarce water resources requires that the price of water is set to reflect its scarcity value, to ensure firstly that water is conserved and secondly that some water used for low-value purposes is redirected to alternative high value purposes however this is not reflected in the tariff structures.

The Southern African Development Community (SADC) has been active in developing frameworks and methodologies that might be applied to determining the basic principles of EAW. Whilst the prevailing legislation and many municipal initiatives acknowledge the need for such accounting it is not apparent that such accounting is being widely applied in a well-defined programmatic fashion.

Economic Accounting of Water is useful and necessary in that:

- *It allows for linkage with the System of National Accounts (SNA)*: national accounts typically do not include non-marketed goods and services provided by water, that might be vital for sustaining livelihoods in rural areas and ecosystems, and also underestimate the contribution of water to the economy through non-market services derived from water being omitted, or incorrectly attributed to other economic sectors
- *It allows for linkage with Integrated Water Resources Management (IWRM)*: EAW through acting as a practical tool for monitoring and evaluating the implementation of

an IWRM plan can generate useful information on whether water resources are allocated efficiently can link water availability with use and can ensure meaningful stakeholder engagement.

- *It is a Decision Support Tool for Effective Water Resources Planning and Management*: EAW application results in the generation of indicators that assist in decision making concerning the allocation of water among competing users and uses, benefit sharing in River Basins, setting tariffs that ensure financial sustainability of Water Utilities, while ensuring that the poor have access to basic water supply.[lxxxiii]

The baseline study report for the development of the EAW framework found that in the case of South Africa, little or limited information was available for water supply sources & returns to the environment, water financing & production costs and infrastructure. This has not however limited the move to assessing the true value of water and already South Africa has physical supply and use, asset and monetary accounts for water. In fact, the development standardised methodologies for EAW in SADC was informed in part by practical experience of water accounting especially in Botswana, Namibia and South Africa. Further, South Africa has attempted to implement the System of Environmental – Economic Accounting for Water (SEEAW) developed by the United Nations Statistics Division (UNSD).

The methodologies developed by SADC are a modification of SEEAW to be contextually relevant and reflect the policy priorities of SADC, the data availability situation as well as consider input from participants during the seven SADC regional workshops held in Gaborone in the development of this tool. For example, livestock watering, an important economic activity in the SADC region is additionally included under agriculture. Underserviced and/or unserviced areas are taken into account by applying the concept of Disability Adjusted Life Years (DALYs) to value the opportunity cost of time spent fetching water as well as the direct and indirect costs of water-borne diseases. The term “wastewater and pollutant account” is used in the standardised methodologies for SADC instead of “emission account” as applied in SEEAW and the legitimate use of water by the environment has been acknowledged by inclusion of Environmental Flow Requirements (EFR) in the calculations.

Through implementation of the SADC EAW tool policy direction may be obtained in respect of:

- Sustainability: sources of pressure on water resources may be more readily identified
- Pricing: Efficiency (cost recovery), equity (impacts of price levels on different users) and environmental sustainability (pricing policies impacts on behaviour, i.e. do they encourage water conservation and pollution prevention, or wasteful use and how this may be used to discourage high volume use).
- Financing: the tool allows for clear distinction between the units that bear the cost of producing water and sanitation services; and those that receive transfers from other economic units, Government or Development Partners to enable informed financing decisions going forward
- Pollution Control: through implementation of the tool, sources of pollution may be identified, wastewater discharge may be monitored and the effectiveness of applied penalties may be assessed.

- Water Allocation: water allocation and water use efficiency decisions may be informed by the model.
- Benefit Sharing: agreements may be reached in transboundary water sharing scenarios about optimising and equitably dividing the goods, products and services connected directly or indirectly to the watercourse, or arising from the use of its waters.
- Virtual Water: the tool allows for the measuring of virtual water, i.e. amount of water consumed in the production process of a product, and can yield important indicators, e.g.. relating to water productivity, which can inform policy on water allocation during periods of water shortage. This must of course be considered in the context of the source of water (not all sources are equal), the availability of this water for alternative uses were it not used in its primary activity and the impact of its use on the environment

9.1.2 Water Footprinting

The water footprint of national consumption is a measure of the total amount of fresh water that is used to produce the goods and services consumed by the inhabitants of the nation' i.e. the total amount of freshwater used directly and indirectly by consumers and manufacturers.

The concept of water footprinting was introduced in 2002 by Arjen Hoekstra at UNESCO-IHE, and has been developed further at the University of Twente and by the Water Footprint Network. The water footprint takes account of the local context by including information about the characteristics of the water used, including whether the water was rainwater or surface water, as well as the place of origin of the water and the time of use.

Three separate types of freshwater consumption are accounted for in a water footprint viz., green water use, which is consumption from rainfall; blue water use, which is consumption from groundwater or surface water; and grey water use, which would be the dilution water required to reduce pollutant concentrations to acceptable values in recognition of the fact that each of these distinctions have different associated economic costs and ecological impacts.

For example, the production of one kilogram of wheat bread requires 16 hundred litres of water (70% green, 19% blue, 11% grey water footprint). This is a global average and variation around this figure is introduced due to factors such as the type of production system and climate variations.

Much criticism has been leveled at the development and use of water footprints on the argument that it has been erroneously used as a resources economic tool when all it is, is an indicator of consumption which must be used in combination with environmental, social, institutional or economic indicators and insights to consider trade-offs and inform decision making. For water management and ensuring food security, the lack of linkages to environmental, social or economic impacts of the water footprint is thought to render the tool of little or no value. Much research effort is being expended on how to properly root a water footprint in a local context. The water footprint is also potentially misleading as it does not provide sufficient context regarding the water used and a perception might be created that a large footprint is bad and a small footprint is good which might not be the case in say an area of high water abundance where significant social and economic benefits are derived from that production. Other concerns include to what extent the opportunity cost of the water that is measured is considered and whether other inputs such as labour are taken into account. The utility of water footprinting is considered by Wicheln to be limited especially in policy development, though might be useful in enhancing public awareness and stimulating discussion regarding water resource issues.

In South Africa, water footprint may be applied as a useful intuitive concept which enables it to be used as a communication tool with people outside of the water sector. Much refinement and development of assessment tools is required first to address key questions relating to water footprinting in a local context. These include:

- Understanding Impact: A meaningful approach to understand impact in a local context is yet been developed, and is a key challenge for the applicability of water footprints
- Water Quality: the applicability of representing water quality as a volume of water remains to be answered and must be further developed or reconsidered to be useful.
- Integrating Complexity and Nuance: A water footprint is a number which represents a single consideration and must take account of a range of economic, social and environmental considerations in order for it to have utility in informing any decisions around water management.

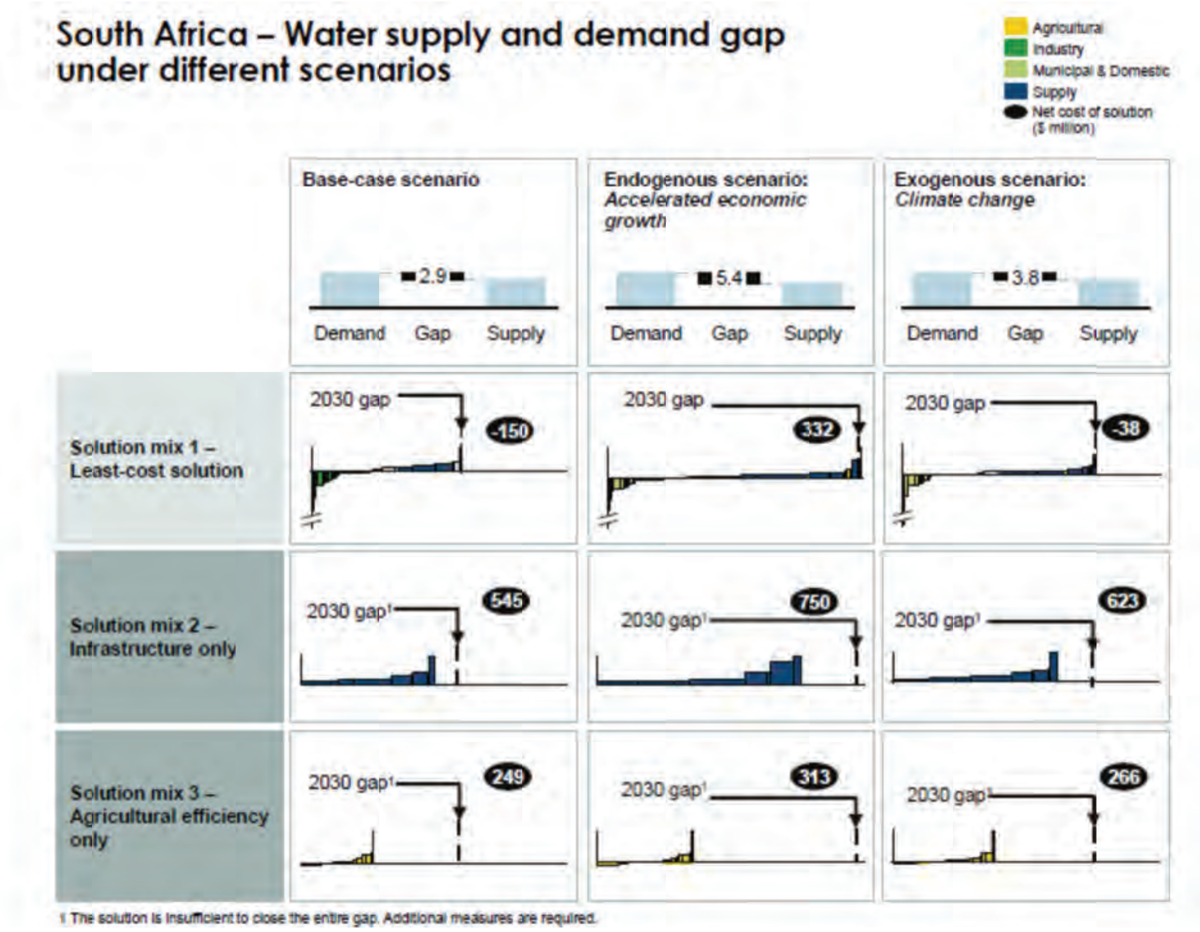
Within the South African context tools which can inform efficiency and raise awareness and create dialogue with people not previously involved in water debates are potentially very useful. Water footprints have the potential to contribute in this way, bringing new and important decision-makers into the water debate in a way that is intuitive and cuts across sectors. The Water Research Commission is in the process of developing a framework for measuring water footprints and assessing case studies for benchmarking across different sectors, and of particular relevance here, the mining sector.

9.1.3 Scenario Planning

South Africa's draft National Water Resource Strategy anticipates that closing the supply demand gap will require R670-billion over the next 10 years, with an anticipated funding gap of R338-billion. Inadequate financing and poor investment in maintenance and refurbishment of water infrastructure are identified as the main challenges that need to be tackled in the short term.

Scenario planning is one approach that might be used to make flexible long-term plans. Possible scenarios such as the water demand implications of rapid agricultural development or considering reduced water availability as a result of climate change might have to be plotted to represent relevant choices that might have to be made. The 2030 Water Resources Group have developed tools including the cost curve and gap models, which can be constructed for different scenarios and which allow for separation of different economic activities. For each scenario, a different cost curve can be constructed and can be used to define a set of technical solutions. Scenario planning allows decision-makers to separate the problem of choosing an appropriate mix of economic activities from ensuring that those economic activities are sustainable. Each cost curve may then be used to define a set of technical solutions whereafter, a full suite of options, with the water costs associated with them, can be laid out for decision-makers to compare and discuss. The cost curve can include measures that can be classified according to factors influencing their ease of implementation, such as low institutional capacity, policy and cultural barriers, and the high number of stakeholders from whom action would be needed.

This approach might avoid the pitfalls associated with adopting tools developed outside of a developing country context in that it allows for consideration of local conditions such as limited institutional capacity, poor governance and other locally relevant parameters. Other approaches to scenario planning can include scenarios to assess the impact of policy decisions on water demand or even to quantify the economics of adoption for end-users so that the planning process is transparent and decisions can be made about which measures to implement on the basis of how much the end-use can bear.



Scenario Planning for Water Supply and Demand in South Africa (DWAF, 2008)

There are several limiting factors to the application of a resource economic approach to planning in South Africa including:

- The young nature of the discipline in South Africa, coupled with a shortage of skilled practitioners;
- A shortage of good quality academic programmes and teachers at South African universities, compelling interested people to pursue these studies and interests abroad;
- Strong competition from other sectors for limited funding such as health and education); and
- Capability and capacity constraints within government departments, research councils and academic institutions (Treasury 2012).

9.1.4 Stakeholder Involvement in Resource Economics

Several stakeholders must be considered in resource economics planning. Within the public sector alone, several might be identified:

- *The Agricultural sector*: Highest water consumption (including irrigation) is attributed to agricultural use in South Africa, accounting for 60% of water used. Farmers, other agricultural value-chain players (e.g. food processors), and policymakers should be actively engaged to jointly address the implementation of any particular technical measure or policy decision in respect of water use.

- *Financial institutions*: Investment in infrastructure development and technical solution implementation in the water sector has often been viewed as a barrier to adoption in the water sector.
- *Large industrial water users:* Large industrial users such as metals, mining, petroleum, and energy companies, face both a water and an energy challenge and have to balance the requirements of ensuring sustainable practices along the value chain (including using water more efficiently) with the increasing energy costs that might accompany such measures. Industrial users must be cognisant of their exposure to risk in terms of water availability and how they might mitigate these risks.
- *Technology providers:* Technology providers have a very useful role to play in proposing innovative water technology solutions from water supply solutions such as desalination to proposing measures for reduced water use in agriculture such as crop protection and irrigation controls.

9.2 Tools to Assist in Determining the Economic Value of Water

From the above chapter is it clear that central to the concept of a GE is the economic value of natural resources. Historically, the economic value of natural resources was largely omitted from financial transactions. Hence, tools were required to assist in establishing these values. In recent years many such tools have emerged in the economic, water and environmental sectors. There is growing appreciation and use of these tools. For example educational programmes can change public perceptions, financial incentives such as rebates or funding allocation can encourage resource assignment to installing green infrastructure or using sustainable methods in production. Outlined below are some of the tools currently in use to promote the development of sustainable initiatives and grow the GE.

9.2.1 Corporate Ecosystem Valuation

Corporate Ecosystem Valuation (CEV) is a method of determining the true economic value of natural resources, both by the negative impacts of ecosystem degradation and through the financial benefit of having functional ecosystems (WBCSD, 2011). This is a system that can be used to make business decisions in a way that is inclusive of economics and environmental factors. For example, ecosystem services such as flood control, goods and products (such as timber, food or water) as well as aesthetic and recreational value of healthy ecosystems can be assigned values based on the cost to companies of providing these goods and services in the absence of ecosystem function. This has been used to great efficiency in Australia where people are charged the 'true' value of water rather than merely the cost of processing it for consumption. This includes the cost of building new infrastructure (such as dams or transfer schemes) should the current supply become unavailable. This has had a dramatic effect on water use as attitudes to water changed and consumers now appreciate water as a valuable resource. The reduction in water consumption also saved money as rehabilitation measures for over-utilized catchments were no longer required.

An example of the application of CEV in is in river deltas which provide an ecosystem service as they deliver sediments and nutrients from catchment areas to lowlands and estuaries as well as regulating existing land and new land formation and managing changes in water levels such as flooding. When deltas are depleted infrastructure has to be put in place to perform these services, often at exorbitant cost. The modification of delta hydrology through dam construction and water abstraction can result in degradation of natural ecosystem services. In fact the degradation of wetland systems has been recognised as a major contributor to the devastation of Hurricane Katrina in 2005. If natural infrastructure is treated as an asset in the same way as man-made structures (and using a comparable currency)it would be easier to make decisions regarding development around natural resources without compromising their function (Coates & Smith, 2012). Corporate Ecosystem Valuation provides a common ground to compare natural resource value with economic growth.

Another example of CEV in water resource management is the case of the degradation of the Mississippi delta. As a result of loss of ecosystem services infrastructure for sediment transfer, flood protection and water quality had to be put in place to replace natural ecosystem services. Studies showed that restoration of the delta would have an estimated net benefit of US$62 billion annually, through reduced vulnerability as well as through savings in running costs of infrastructure used to provide infrastructure services to replace those lost through degradation (Coates & Smith, 2012).

In Vietnam planting and maintaining mangroves cost US$1.1 million, but maintaining dykes for flood prevention cost US$8.4 million annually and so the initial investment was recouped almost immediately (Tallis et al., 2008).

CEV can also be used to determine when conservation is not the most lucrative solution to a problem. Concurrent benefits to the community and the environment are unusual (Tallis et al., 2008) and require careful planning and feasibility studies before expensive programmes are started. For example in the Maple River watershed in North Dakota, neither minor nor major wetland restoration provided sufficient protection to justify the cost of the restoration project (Schultz & Leitch, 2001). Economic feasibility studies for wetland restoration are quite rare (Schultz & Leitch, 2001) and should be incorporated into projects for effective implementation of the GE. In order to maintain and increase intensive growth all facets of the economy need to be considered prior to initiating projects affecting natural resources. For example the River Restoration Centre decided to reclaim prime agricultural land around London in order to create space for artificial wetlands to supplement existing flood-management infrastructure. It was decided that the heritage and tourism value of national monuments in London, as well as financial and residential areas were more valuable than the surrounding agricultural land in a city that is vulnerable to flooding, particularly in the face of global climate change (RRC, 2009). By using CEV, social, economic and environmental aspects can be compared and decisions can be made based on a comparable set of values for each facet of the situation.

9.2.2 Payments for Environmental Services (PES)

Although the fact that ecosystem services (ES) are valuable is well-known, some services are more measurable than others. This measurability makes them marketable. It has been argued that water services have enormous potential for PES schemes due to the fact that users are easily identify, receive clear benefits from clean water, and already have payment measures in place (Turpie et al., 2008). Linked to CEV is the development of Payment for

PES schemes. The formal definition of a PES system is a voluntary transaction where a well-defined ES (or a land-use likely to secure that service) is being ‘bought’ by a (minimum one) ES buyer from a (minimum one) ES provider if and only if the ES provider secures ES provision (conditionality) (Wunder, 2005).

In other words, the PES is where those who use an ES pay those who assist in providing it. This can also be used in offset programmes, for example one company may pollute water more than is acceptable, but then pay a company upstream to keep their systems clean, or pay conservation areas that do not use water for maintaining the integrity of the natural hydrology of the system. In Colombia, electricity providers who generate hydroelectric power pay a portion of their profits to river conservation and maintenance.

PES isn’t a one-size-fits-all approach, but rather a tool that can be tailored to specific situations. Special consideration must be given to the services, the identities of ‘buyers’ and ‘sellers; as well as the cost and benefits of the services in question (Engel et al., 2008). In general, user-financed programs are more effective, better suited to the situation and better organised and monitored than government-sponsored programmes (Wunder et al., 2008).

A related concept is the Polluter Pays principle whereby heavy users or polluters of ecosystem services are financially penalised.

9.2.3 Payments for Watershed Services (PWS)

Payments for watershed services (PWS) is a subset of PES which has the potential to improve resource management. The rationale behind PWS is that downstream service users benefit from the upstream land use practices that ensure the supply of services such as protection from erosion and sedimentation, and stream flow stabilization. However, if upstream service providers are to take appropriate land use decisions, and provide downstream users with such services, they likely need to be compensated for their opportunity costs, i.e. the economic gains they would have made if they had continued with their first land use plan. The concept of conditionality is an important theoretical difference between PWS and other watershed management tools—downstream water users pay for watersheds services if, *and only if*, lands are managed in such a way to provide the desired service. In contrast, traditional tools such as integrated watershed management (IWM) have not had the same degree of conditionality. IWM interventions have sometimes involved rewards and investments, e.g. building a local school, but these have not been contingent, i.e. the school would not be closed if providers failed to comply with agreed-upon land use measures.

In practice, two generic PWS types are being implemented around the world. The first one is user-financed PWS schemes, the conditions of which have usually emerged from the negotiation process between buyers and sellers (often through intermediaries). Such schemes are typically carried out at the scale of one or more targeted watersheds, and are thus small-to-medium sized in terms of contracted areas. Most are designed in ways that bring them close to the five theoretical PES principles. Examples include the Vittel watershed scheme in France and municipal water programs in Heredia (Costa Rica), Pimampiro (Ecuador) and Los Negros (Bolivia).

The second generic type is government-financed PWS schemes, where the state acts on behalf of service users across a number of targeted watersheds or regions, using tax revenues or obligatory user fees for payments. Here, service users cannot directly decide to stop the payments if they do not get what they paid for. Correspondingly, service providers normally cannot influence scheme design or payment rates, which tend to be offered by the state as a fixed menu. Payment rates and other modalities are typically more uniform and less customized to local conditions, and side objectives such as poverty alleviation and regional development typically play a large role. Such schemes thus tend to be "PWS-like", less-than-fully conforming to the five PES principles. On the other hand, these schemes are normally much larger in size, thus exploiting economies of scale in setup and ongoing administrative costs. Some state run schemes are at least nominally focused on watershed protection, such as the Chinese Sloping Land Conversion Program (7.2 million ha land retired; 4.9 million ha planted with trees), or Mexico's national watershed protection program (126,000 ha).

Other schemes buy not only watershed protection, but also other environmental services that are provided from contracted areas. Examples here are Costa Rica's PES scheme (600,000 ha), and the United States Conservation Reserve Program (about 14.5 million ha).

9.2.4 Water Banking

Water banking is the use of water, or access rights to water as a tradeable commodity. This can be on a short-term basis, where acquiring water rights is not necessary but water is required temporarily, or on a long-term basis, where water rights are bought and the water is set aside for times of drought (Pratt, 1994). Water banks can provide a reliable source of water through dry years, insure water supply for future needs, promote water conservation by providing financial incentives (where water can be sold) as well as providing avenues for water storage (as an alternative to a use-it-or-lose-it fixed abstraction right). There are many mechanisms for storing banked water, from surface storage to aquifer storage. In some cases banking of surface water is used in exchange for the use of groundwater while surface water is used in other sectors (O'Donnell, 2011)..

Water banking is a powerful tool in influencing agricultural production – for example a farmer may decide to plant drought-resistant crops or install efficient irrigation systems in order to sell additional water, while in the urban environment, trading for water leads to a more realistic price which means that water is considered a valuable commodity. This has been used widely in Australia as a technique for maintaining a realistic water price in agricultural and industrial sectors (O'Donnell, 2011).

In California, a water bank was used to assist a drought-stricken region by transporting to the area and then using a banking system to allocate it. The water allocations were also decided according to a structure where critical needs were addressed first (O'Donnell, 2010). The idea of using water banks as a tool in the trade-off between industry, agriculture and urban use could be very effective in South Africa where interbasin transfers are common creating the framework for water trade as long as critical needs and equitable access are considered first.

9.2.5 Integrated Water Resource Management (WRM) and Systems for Environmental-Economic Accounting for Water (SEEAW)

Integrated water resources management (IWRM) looks to protect water resources in order to maintain water availability and aquatic ecosystem function. This resource management is required to satisfy human needs for water as a resource in social and economic spheres while maintaining water as an integral part of the ecosystem. IWRM takes into account the quality and quantity of water available and the effect that this supply has on the nature of its use. In order to meet the needs of present and future generations, IWRM calls for sustainable management of water resources. This approach requires coordination of water, land and associated resources without compromising ecosystem function. This requires coordinated development of ecosystems related to water such as land and water, surface and groundwater, river basins, coastal and marine environments and upstream and downstream water users and ecosystems (Global Water Partnership, 2004).

For IWRM to be effective, policies and priorities have to take water resource management into account. This requires cross-sectoral approaches to policy development, stakeholder engagement and understanding the relationship between economic policy and water development. Broad social, economic and environmental goals must be integrated with national objectives and water-related decisions made at catchment or local level (Global Water Partnership, 2004).

The System of Environmental and Economic Accounting for Water (SEEAW) provides a systematic framework for the organization of water information to study the interaction between the economy and the environment. It is a further elaboration of the Integrated Environmental and Economic Accounting 2003 (SEEA-2003) framework focusing exclusively on water resources. As the SEEA, the SEEAW expands the 1993 System of National Accounts (1993 SNA) (CEC et al., 1993) by separately identifying information related to water in the 1993 SNA and linking physical information on water with economic accounts.

The SEEAW is a tool that can be used in support of IWRM to provide a framework to organise hydrological and economic information in a consistent manner. This makes it possible to study the interactions between the economy and the environment. SEEAW provides guidelines that can be used by any country, region or river-basin to determine the economic and environmental pressures on water and to understand the implications of water use on the resources available. This can be used to inform policy decisions as it integrates available information on hydrology, economic aspects, natural resource management and social factors. This is important as decisions, particularly those pertaining to development of water-intensive industries; need to be informed by the long-term implications of those decisions on water.

The SEEAW involves integrating the following groups of information:

- Stocks and flows of water resources within the environment;
- Pressures of the economy on the environment. This includes water abstraction and emissions released to the environment;
- The supply of water to industries and households;
- Reuse of water within the economy;

- The costs of providing water: collection, purification, distribution and treatment. The service charges paid by water users are also included;
- The financing of the costs of providing water and sanitation;
- Payments for access to water or to discharge wastewater;
- Hydraulic stock in place and investments in hydraulic infrastructure;

This information allows policy-makers to analyse the quantity of water used by various industries, the waste generated and the value added by the activity and use this to inform decisions regarding policy regarding certain sectors. It also allows for efficient investment in water infrastructure as the information provided from the SEEAW makes it possible to analyse the costs and benefits of installing new infrastructure.

In Southern Africa, the SADC-EAW project has used the SEEAW infrastructure to develop pilot projects in four countries and two river basins. Initial results presented in 2010 found that while some aspects were relatively simple, such as quantifying assets and physical supply accounts, others were complex and required significant time allocated for data collection. SADC-EAW has also raised the issue that besides cooperative governance within a country, international cooperation is also necessary since economic and environmental boundaries do not always match (SADC Economic Accounting of Water Use Project, 2010).

The table below shows some of the preliminary results from the SADC-EAW project:

Country/ region	Malawi	Mauritius	Namibia	Zambia
Relevant policy	Malawi Growth and Development Strategy prioritises agriculture and food security, both dependent on water	Currently institutionalising EAW at national level	EAW institutionalised at national level. National Water Resources Management Act treats water resources as having economic value	Integrated Water Resources Management and Water Efficiency (IWRM/WE) Plan promotes EAW to measure productivity and promote water use efficiency
Economic contribution of water	Agriculture accounts for 83 % of workforce and 40 % GDP	Agriculture uses 68% of water but contributes only 6% of GDP	Agriculture accounts for 31 % of employment and 12% GDP	Agriculture accounts for 72 % of the workforce and contributes 22 % of GDP
Opportunity cost of poor water supply/ sanitation	17 % of GDP lost each year due to illness from poor water supply and sanitation	Coverage is good, with only 0.1 % of GDP lost each year	Coverage is good, with 1.2% of GDP lost each year to illness from poor water quality and sanitation	6.84 % of GDP is lost each year to illness from poor water supply and sanitation coverage

10. CRITICAL ANALYSIS OF THE GE FOR THE WATER SECTOR

Below, is an overview of some key issues that require further debate and/or discussion when considering the impact of the GE on the water sector in SA.

10.1 Definition of the GE for the Water Sector

In Chapter 2 of the discussion paper, various definitions of the GE are present and yet, when asked, “what does the GE mean for the water sector” it remains difficult to explain. It is almost as though the GE remains an enigma: hard to assess. Green activities and jobs related to environmental aims is a cross cutting issue affecting almost all sectors in SA because our legislative framework is very pro sustainable development within the limits of our natural resources. Therefore, the concept of a GE and green jobs should not, in theory be anything new to SA. In fact, many still find it difficult to differentiate between the outcomes of the GE and the old sustainable development concept.

It is only when trying to assess this new economic driver that we realise the complexities in defining, isolating and measuring its contribution. The GE in the water sector remains elusive in part because, in the absence of standard definitions and data, strikingly little is known about its nature, size, and growth at the critical regional and local levels.

According to DEA, the GE is a growing economic development model based on the knowledge that aims to address the interdependence of economic growth and natural ecosystems and the adverse impact economic activities can have on the environment. The GE should create green jobs, ensure real sustainable economic growth and prevent environmental pollution, global warming, resource depletion and environmental degradation. While this definition may apply to the agricultural and biodiversity environment it does have its limitation for the water sector. It is very difficult to relate current water sector contributions to the GE within the context of the above-mentioned definition.

It is possible that each sector needs to create its own working definition of the GE and green jobs within the ambit of the DEA definition. This approach will go a long way in allowing the water sector to provide its own guidelines and criteria for green jobs, green initiatives, green processes and green outcomes.

It may also emerge that a definition of the GE for the water sector is not necessary instead, the sector may find most value in aligning itself with well-established guidelines and principles that allows the sector to measure its gain and contribution to the national GE in a meaningful way.

It cannot be overemphasised the importance of agreeing the definition/principles/outcomes of the GE for the water sector. This clarity it needed if the contribution of the water sector to the growth of the GE is to be measured and monitored. The US found that it was not possible to size the GE without first creating its own working definition without straying from the national guideline.

10.2 Measuring the Sustainability of the GE wrt the Water Sector

In the absence of defining current green initiatives in the water sector it is difficult to determine the true sustainability of such green initiatives. For instance, the Expanded Public Works Programmes (EPWP), Working for Water, Working for Wetlands, Working on Fire, etc. are considered job creation mechanisms within the definition of a GE. However, if one has to work out the economic value of the jobs created verses using other approaches that maybe less job intensive but still meets the environment outcomes of a GE it is possible that these jobs make no financial sense. In other words, it may cost more to create the job than if less job intensive methods were used. In this case, the EPWP may be green jobs and contribute to the GE however they may not be economically sustainable

Green technology was supposed to be Spain's path to more jobs and a cleaner more prosperous future however it wasn't because the economic sustainability of the jobs were never tested. The Spanish public were recently outraged when they realised that the new sector, in the renewable energies, that would create a sort of new economy with new jobs, green jobs, so called GE as promised by politicians was a colossal failure.

The Spanish found that a lot of taxpayer money went down the drain in trying to create green jobs. A detailed economic review of Spain's green technology program found that each green job created in Spain cost Spanish taxpayers $770,000. Each Wind Industry job cost $1.3 million to create. The study found that for every four jobs created by Spain's expensive green technology program, nine jobs were lost. Electricity generated was so expensive that each "green" megawatt installed in the power grid destroyed five jobs elsewhere in the economy by raising business costs. Some green technologies implemented were untested but because it was contributing to the GE it was considered reasonable to implement. Marta

Sabina who lives on the outskirts of Barcelona in one of Spain's new green technology apartment buildings explained that her toilet used recycled water with chemicals in it which turned out to be a health hazard for her three young children. She also had to heat her family's hot water on the stove because the building's solar water heater didn't work for three years which ended up costing more than heating the water using conventional methods.

Spain's green technology dream cost the nation more than $15 billion a year before the government had to slash it because it had failed and Spain was going broke.

On other hand Germany has found that the GE has sustainably expanded its economy largely in the renewable energy sector. Through a focused approach which included creating new legislation such as the Renewable Energy Sources Act in 2000, Germany was able to introduce a feed-in tariff program that guarantees electricity produced from renewable energy sources (including hydropower, wind, solar PV, concentrated solar, biomass, geothermal, and landfill or sewage gas) would receive an above-market rate of return for 20 years. In 2004, the renewable energy industry employed 160,000 people but by 2009 the number had jumped to more than 300,000. While the German success is limited to the Energy Sector the question remains, “can this be applied to the SA water sector and how do we duplicate the German success story and not the Spanish disaster?” There are many factors to be taken into account such as German standards of excellent, German efficiency especially at an institutional level, an enabling environment and financial instruments to support such development, etc. but most importantly the German approach to the GE is based entirely on economic principles which benefit the environment. Job creation was not the focus instead producing cost effective and clean electricity was the driving force. Jobs were created as an outcome of the process. The local demand for clean energy has driven the growth of an export base for clean energy. Investment returns on renewable energy projects in Germany has been so success that many American companies like Google, First Solar, and Good Energies decided to invest there. The clean energy investments in Germany reached $41.2 billion in 2010.

10.3 Quantifying and Measuring the Contribution of the Water Sector Towards a GE

In order to measure the success and contribution of GE initiatives by the water sector as outlined in Chapter 8 of the discussion paper it is imperative to (1) have a common understanding of the GE and (2) be able to quantify/measure/size the existing GE in the water sector. Further, in quantifying the number of green jobs created it is important to establish the following:

- Are new jobs being created;
- Are we significantly changing the work or worker requirements of existing jobs; and
- Are we simply increasing the demand for workers in existing jobs.

These distinctions are essential for locating, describing, and forecasting potential workforce consequences of the GE and in quantifying the size of the existing GE.

The need for better indicators and means of progress towards the GE must become a priority for the water sector. Many countries are looking at alternative metrics to Gross Domestic Product or other economic indicators to stress that national objectives and human wellbeing should not be measured in economic terms alone. Examples from Asia-Pacific such as Gross National Happiness (Bhutan) or the self-sufficiency economy (Thailand) are promising attempts to redefine the meaning of national progress. While these may simply be indicators of a willingness to explore alternatives to GDP, they do serve as a positive basis to the emerging global research agenda and possible new policy directions. In the Rio+20 process the proposal by some countries to develop Sustainable Development Goals to follow on from, or merge with, the Millennium Development Goals was strongly supported by many participants from member states, major groups and others, with emphasis on earth system boundaries, poverty eradication, sustainable consumption and production patterns, renewable energy, and reduced vulnerability, improved risk management, and increasing resilience. In the absence of national or international indicators, the water sector must consider a mechanism to measure the GE that aligns with international best practices.

Further, given that water is a key ingredient in GE initiatives of other sectors such as the renewable energy sector, the agricultural sector and the manufacturing sector it is imperative that the method used to size the GE wrt to the contribution from the water sector takes into account the far reaching implications of water in national growth and job creation objectives.

Currently no national or local database exists on the spatial geography of the GE and its sub industries. While this remains the responsibility of the DEA and the Department of Economics, the water sector will benefit from creating such a database specific to the GE initiatives in the sector.

In the United Sates the Metropolitan Policy Program at Brookings worked with Battelle's Technology Partnership Practice to develop a national and regional green jobs assessment database with the explicit aim of sizing the GE. The study was necessary in that it gave better direction to the national GE programmes because for the first time there was quantitative data to dispel speculation and inform leaders on the direction that national GE policies should take. The study found:

- The clean economy, which employs some 2.7 million workers, encompasses a significant number of jobs in establishments spread across a diverse group of industries;
- The clean economy grew more slowly in aggregate than the national economy between 2003 and 2010, but newer "cleantech" segments produced explosive job gains and the clean economy outperformed the nation during the recession.
- The clean economy is manufacturing and export intensive.
- The clean economy offers more opportunities and better pay for low- and middle-skilled workers than the national economy as a whole.
- Scale up the market by taking steps to catalyse vibrant domestic demand for low-carbon and environmentally-oriented goods and services.
- Strong industry clusters boost metros' growth performance in the clean economy.
- The clean economy permeates all of the nation's metropolitan areas, but it manifests itself in varied configurations.
- Focus on regions, meaning that all parties need to place detailed knowledge of local industry dynamics and regional growth strategies near the centre of efforts to advance the clean economy.

- Ensure adequate finance by moving to address the serious shortage of affordable, risk-tolerant, and larger-scale capital that now impedes the scale-up of numerous clean economy industry segments.
- Drive innovation by investing both more and differently in the clean economy innovation system.
- Focus on regions, meaning that all parties need to place detailed knowledge of local industry dynamics and regional growth strategies near the centre of efforts to advance the clean economy.

From the above, it is clear that a detailed database of GE industries is necessary to meaningfully advance the GE agenda in the water sector. If the true sustainability of the GE is to be tested, accurate information on the economic value connected to supply and demand in competitive markets, rather than just voluntary business philanthropy is required. There must be a clear understanding on whether the GE is creating new jobs and not moving people from one sector to another at a greater cost. Anything less would expose SA to the same risks as the Spanish GE Programme.

10.4 Implications for Water Sector Policies

Going forward, the success in terms of progress towards a GE for the water sector would be judged by its ability to transform current policies that take the following into account:

- Recognition of the value of the benefits provided by good water management and costs (negative value) of not doing so;
- Evidence of increased investment in the water supply and sanitation sector that gives consideration to the environment;
- The formal definition of rights to use water and its allocation to users and the environment;
- Legislative recognition of the important role that ecosystem services can play in supporting an economy;
- Investment in the development of institutional capacity to manage water resources on a sustainable basis;
- The removal of policies that discourage ecosystem conservation and/or have perverse effects on water use and investment;
- Progress towards arrangements that reflect the full costs of resource use in ways that do not compromise the needs of disadvantaged people in a community; and
- Addressing ecosystem degradation by increasing efforts for restoring and protecting ecosystems critical to supply of water quantity and quality.

This approach will have a dire impact on existing water sector policies such as the existing tariff structure, the water allocation process, transfer schemes and national growth and development objectives.

Many countries have implemented various mechanisms to support a sector based approach for instance the United States passed the Cleans Jobs Act which provided a focused approach to creating green jobs. While this level of intervention is best placed at a DEA level, the water sector is encouraged to research the implications of the GE on existing policies.

The study underway by the WRC to determine the water footprint of various sectors and activities will be critical to determine the water allocation going forward. This will influence policy decisions and impact on sector partners.

Finally, the move towards a GE could create new industries which will require additional policy and regulatory guidance from the water sector.

10.5 Impact on Sector Partners

International research has shown that industries and/or sectors most likely to benefit from green jobs are:

- Agriculture and natural resources conservation;
- Education and compliance;
- Greenhouse gas reduction;
- Environmental management and recycling; and
- Renewable energy.

Water is the driving force in at least 4 of the above sectors. Any change in current water sector policies will have an effect on the above mentioned sector partners. The outcome of the water footprint study by the WRC will play a pivotal role in determining which activities and sectors contribute towards sustainable and green returns on water investments.

10.6 Skills Development, Capacity Building and Institutional Efficiency

At the heart of GE activities is technology. The GE in developing countries is highly dependent on the transfer of applicable technologies. Technology transfer, however, is not only a process of supplying capital equipment from one entity to another but also includes the transfer of skills and know-how for operating and maintaining the hardware, and understanding the technology so that further independent innovation is possible by recipient. Thus, understanding the development and application of various green technologies can help to depict the potential workforce implications of GE activities.

In the DWA study on the Water for Growth and Development, skills development and lack of technical skills in the water sector were highlighted as one of the main concerns in moving the sector forward. Hence, institutions may be burdened by a further technical skills crisis if the green agenda does not take cognise of the skills shortage in the sector.

Much of the success of the German GE is attributed to a skilled workforce and extremely efficient institutions. The US found that current attitudes at existing institution, skills levels and policy gaps weaken the US GE market.

The skills base of the existing water sector must be tested against the skills required to implement green projects, initiatives and processes.

10.7 Financial Incentives

Almost all the success stories of the GE are hinged on rebates, incentives, rewards and grants. The water sector would need to consider the long term financial implications of green initiatives on existing schemes such as the free basic water allowance.

The sector would need to agree on incentivised approaches to get the public and the private sector to buy into a green approach.

The IDC, DBSA, DEA and Treasury all manage and/or administer green funds for green investments and projects. No information exists on the success of the expenditure of the green funds in creating sustainable green jobs. Further, the funding has strong bias towards the energy sector and renewable energy projects which is not very encouraging for the water sector.

10.8 Community Acceptance of the Green Approach

Central to the success of GE in the water sector is public and community acceptance. The installation of water meters in Phiri, Soweto created green jobs in a GE but it was not accepted by the local community. Similarly the De Hoop Dam in Steelpoort was met with great resistance from the land-based communities. The delays in the project has increased the cost of water from the dam which raises the question of whether the project created green job and contributed to the GE.

International NGOs have raised concerns that rather than reducing pollution and consumption, protecting the territorial rights of land-based peoples, and promoting local initiatives that steward resources for future generations, the approach is doing the opposite: promoting monoculture tree plantations, trade in pollution credits, and the establishment of speculative markets in biodiversity and forests, all of which threaten to displace land-based communities.

A report by Ecosystem Marketplace, the leading purveyor of "Payments for Ecosystem Services," lays out the GE argument: "Ecosystems provide trillions of dollars in clean water, flood protection, fertile lands, clean air, pollination, disease control. ... So how do we secure this enormously valuable infrastructure and its services? The same way we would electricity, potable water, or natural gas. We pay for it."

The United Nations Environment Program (UNEP), among the chief proponents of the green economy, says this approach will result in "improved well-being and social equity while significantly reducing environmental risks and ecological scarcities." The World Bank, also promoting the GE, says, "Natural capital accounting would add to our national GDPs the wealth stored in our natural resources: minerals before they are mined, forests before they are felled, water while it is still in the rivers." But, for social movements, land-based communities, and indigenous peoples, the question is, who really pays? For what are they paying? And, most poignantly, since when has nature, the source of all life, been reduced to a service-provider? One concern is that this new GE is a form of "disaster capitalism"—a global effort to put the "services" of nature into the same hands that caused the global financial meltdown. The reforestation plan in Mozambique has peasant farmers planting industrial monocultures of African palm for biofuel production, not native forest. The Kenyan farmers of the Green Belt Movement, while initially receptive to a World Bank-backed scheme that would pay them to protect agricultural soils, became discouraged when they realized the payments would add up to less than 15 cents per acre per year, and that they would have to wait many years for payment. In Brazil, the "green basket" of food staples adds up to 100 Reales per family per month — but cooking gas alone can cost 50 Reales a month, leaving families without access to the forest hungry and dependent on paltry state support. And in Chiapas, where families in the Lacandon community are paid to protect the forest against their neighbours, the struggling *campesinos* from the Tzeltal, Tzotzil, Chol, and Mam ethnic groups are forced off the land and into prefab peri-urban settlements, where their customs and traditional livelihoods will be forever lost.

All of these initiatives are based on carbon offsetting—essentially, permission slips purchased by corporations and governments to allow them to continue dumping CO2 into the atmosphere in exchange for the ecosystem service provided by forests and agricultural soils in the Global South, which act as carbon sinks. But, as Nigerian activist Godwin Ojo says, “Forests are not carbon sinks, they are food baskets.” Ojo tells of a rubber plantation near his home that has deprived hundreds of farmers of their livelihood under the auspices of the United Nations Collaborative Initiative on Reducing Emissions from Deforestation and Forest Degradation, a pillar program of the green economy.

The main concern raised by NGOs and communities is that the GE does not question the current economy based in extraction and fossil fuels, nor the patterns of consumption and industrial production, but extends this economy into new areas, feeding the myth that economic growth can be infinite.

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THE 'GREEN ECONOMY': Problems and prospects for an alternative development path in South Africa.

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