Analysis of green occupations: The local government sector perspective.

Research Report

To

The Local Government Sector Education and Training (LGSETA)

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Executive summary

The idea of green economy (GE) has gained an increasing international focus, with new strategies, policies and discussions aimed at ways of restructuring the economy in a direction that is environmentally friendly, which is currently taking place in several countries. Green economy can be defined as one that results in improved human wellbeing and social equity, while significantly reducing environmental risk and ecological scarcities. Green occupations, which result from GE, are jobs that promote preservation or restoration of environmental quality. A transition to GE therefore, offers an opportunity for economic renewal, environmental protection and the potential for job creation. Creation of green occupations from the greening of technologies and economies is imperative in responding to the high global unemployment rate and towards improving the working conditions of the already employed. South Africa's workforce is faced with two major challenges: high unemployment and significant differences in the welfare and income between the highly paid and low-skilled employees. Under South Africa's new development policy (the New Growth path), of importance is the target of job creation. Despite the large number of GE strategies and policies in place, the country does not report green occupations individually in any of its surveys or statistics of employment.

A study was carried to analyse existing and potential green occupations, and identify green qualifications and skills necessary for the development of green economy practices. The study was carried out within the context of the role of local governments in the adoption of green economy strategy, leading to the creation of green jobs in the water and wastewater treatment sector, in selected local governments across the Republic of South Africa (RSA). The study assessed the capability of local governments to effectively play the role of creating access to training and skills development. The research was conducted across all the provinces of the RSA within a period of six months by a team of researchers from the Vaal University of Technology. Both qualitative and quantitative approaches were implemented, and both national and regional data were used. A total of 96 water and wastewater treatment plants in 55 different local and metropolitan municipalities were surveyed. The strides made in creating green occupations in local governments both locally and globally were analysed from available literature and comparisons made. This project identified green occupations in the local government sector, and carried out a green skills audit of employees in various wastewater

treatment plants. This study brought into perspective the concept of green occupations in local government, with focus on jobs in water and wastewater treatment.

Key findings: Many wastewater treatment (WWT) plants did not have any green related occupations/jobs in place due to the lack of green technologies within the plants. The highest uptake of green technologies and practices leading to green jobs creation was in metropolitan and large local municipalities. Small local municipalities in some provinces like Northern Cape, Eastern Cape and Limpopo had the lowest number of green jobs. For the few plants that had green jobs, a clear definition of the job descriptions was not available. The key challenges to green jobs creation are lack of funds and required green skills. Installation of green technologies requires huge capital cost, which cannot be easily raised by most local municipalities, especially the smaller ones.

Green jobs were predominantly found in the larger municipalities and metropolitans that had the financial capability for implementing green technologies and practices. However, sufficient individuals with the requisite green skills base were not readily available to be employed by these municipalities. The current training for water care is mainly focused on skills that are aligned to conventional treatment approaches and technologies. Most training institutions are yet to incorporate green skills in their programs. There was a low level of formal qualifications for most employees at the plants, especially in the smaller municipalities. Many employees did not have matriculation certificate or formal qualification on water care. This was evident from the low level of awareness on green jobs as observed during the survey.

Intervention strategies: Some of the potential strategies that can be used to spur green jobs creation include implementation of green technologies and practices such as:

- Reuse of treated water for irrigation and potable use with the introduction of tertiary treatment such as ultrafiltration and reverse osmosis
- Conversion of sludge into dry sludge compost
- Installation of anaerobic sludge digesters capable of electricity production from biogas
- Installation of solar energy to supplement the energy requirements of the treatment processes

Most of the WWT plants visited are very old and in poor condition. When they are upgraded, green technologies such as anaerobic digestion need to be incorporated. It is recommended that the level of communication between WWT plant employees and senior management be improved. As the green economy policies are cascaded down to the municipality levels, in-

house training on green technologies need to be initiated. Courses need to be designed to equip employees of WWT plants with green skills. There is a concern with the succession planning at most of the WWT plants. It is recommended that while green skills are introduced in the learnership program, the employees on the learnership program should be retained as part of the succession plan.

To meet the demand for skilled workers in the water and wastewater treatment sector, environmental protection should be adapted in the existing training. New training and studies with environmental specialization should be introduced at the institutions where training on water care is offered.

The efficient implementation of green economy requires the application of new technologies to help in addressing emerging environmental challenges. It is therefore recommended that plant operators be given short courses on emerging challenges in the water sector

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Abbreviations

BNR	Biological Nutrients Removal
BOD	Biochemical Oxygen Demand
BRICS	Brazil, Russia, India, China and South Africa
BRT	Bus Rapid Transport
BTF	Biological Trickling Filters
COD	Chemical Oxygen Demand
DEA	Department of Environmental Affairs
DWA	Department of Water Affairs
DM	District Municipality
EDD	Economic Development Department
EC	Eastern Cape
ERWAT	East Rand Water Care Association
FS	Free State
GDC	Gross Dealer Concession
GDP	Gross Domestic Product
GDS	Global Distribution System
GE	Green Economy
GETS	Green Economy Target Scenario
GHGs	Greenhouse Gases
GP	Gauteng Province
HEI	Higher Education Institution
ILO	International Labour Organisation
KZN	KwaZulu Natal
LEGDP	Limpopo Employment Growth and Development Plan
LGSETA	Local Government Sector Education and Training Authority
LM	Local Municipality
LP	Limpopo Province
MBR	Membrane Biological Reactor
MP	Mpumalanga Province
MM	Metropolitan Municipality
NC	Northern Cape
NCCASP	National Climate Change Adaptation Strategy and Plan

NGOs	Non-Governmental Organisations
NGP	New Growth Path
NQF	National Qualification Framework
NRM	Natural Resource Management
NW	North West Province
SA	South Africa
SAGEM	South African Green Economy Modelling
SAQA	South African Qualification Authority
SETA	Sector Education and Training Authority
SWH	Solar Water Heaters
TIEP	Tshwane Integrated Environmental Policy
UCT	University of Cape Town
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Convention on Climate Change
UV	Ultraviolet
VUT	Vaal University of Technology
WC	Western Cape
WWT	Wastewater Treatment
WWTWs	Waste Water Treatment Works

CHAPTER 1

1. Introduction

1.1. Green occupations

Green occupation or job is any work in sectors such as manufacturing, agriculture, administrative, research and development, and service delivery that promotes preservation or restoration of environmental quality. Examples of green occupations include those that are aimed at protecting the environment, energy reduction through high efficiencies, economy de-carbonisation, and minimisation or elimination of pollution and waste generation. A growing number of green occupations will be created as countries transform businesses towards GE, with green innovative companies and regions more likely to create and retain green occupations. Green occupation creation and greening of current occupations are indispensable means for attaining development that is sustainable and providing decent work for all. With proper design and management, green occupations can foster gender equality and social inclusion, and eradicate poverty. For national and local governments to achieve transition to green occupations, programs or policies that provide opportunities for employees to build capacity and develop skills for green practices should be put in place. As the SA economy becomes greener, employment will be affected in four major ways including:

(i) Creation of additional jobs such as manufacturing of pollution control devices
(ii) Technology re-orientation such as change from fossil to renewable energy
(iii) Job elimination, and
(iv) Redefinition of many jobs existing as day-to-day work procedures, profiles and skills such as plumbing and construction are greened

With the current high unemployment and underemployment, the net creation of green occupations for low income earners will reduce the significant income divergence between the low-wage and highly paid workers. In fact, the creation of decent work and livelihoods that are sustainable, lies at the heart of South Africa's national strategy for sustainable development and action plan. Local governments being closest to local businesses, job seekers, and the disadvantaged communities in local labour markets, are expected to play a major role in the creation of green occupations amid limited capacity and skills at local level. Waste management, a major mandate of municipalities, is one of the key sectors expected to facilitate

transition to GE in the RSA. To create green occupations in this sector, municipalities must therefore employ green technologies and processes in sectors such as energy, water, and with a focus on wastewater treatment, which is a dominant prerogative of local governments. It is therefore important for local governments to identify the skills needed for the implementation of green technologies in wastewater treatment, in addition to the examination of green occupational requirements.

Attaining green economy occupations does not depend only on employing green technologies and practices in treating the waste that has been deposited at the door step of the local governments. Instead, it requires proactive steps that promote green practices aimed at preventing or minimising the production of waste in the first place. To do this effectively, the municipal staff should be equipped with critical skills to manage modern infrastructure, and scientific data to help formulate policies to enhance green occupations for effective waste management. Such kind of data can come from research units with expertise in renewable energy and water management.

1.2. Research motivation and expected outputs

The valuable research on green occupations, resulting from transitioning to green economy in SA and in other parts of the world, is gradually being carried out as evident from several reports on the jobs that are already created and prospective ones. However, research that focuses on green occupation skills and qualifications is far less prevalent now and, where available, is rarely country or sector specific. The aim of this research was to assess the scarce and critical green skills in local governments spread out in different provinces of SA, through the analysis of green occupations needed, and identification of green qualifications necessary for the development of green economy practices in the wastewater management sector.

1.3. Objectives

The specific objectives of the green occupation study were to:

a. Identify and unlock the future skills requirements for the green economy occupations in the local government sector
b. Conduct a skills audit on the green economy occupations in the local government sector
c. Provide an analysis and comparison between green economy occupations in the local government sector locally and globally
d. Propose possible interventions on the skills gap for the green economy occupations
e. Identify green economy qualifications necessary for employees in the wastewater management sector

CHAPTER 2

2. Literature review

South Africa's economy is faced by several challenges including inequality, high unemployment and poverty, in addition to being energy intensive as compared to her international peers. South Africa's greenhouse emission was ranked 12th globally, despite being the 28th largest economy by total GDP in the world as of 2012 (SALGA 2013). To spur on economic growth and reverse the adverse environmental impacts of past industrialisation systems, South Africa, just like other countries, has identified transition to green economy (GE) as a sustainable development route that can address a myriad of economic challenges. GE is defined as a system that entails holistic remedial initiatives including social, economic and environmental challenges that can reduce or halt factors hindering economic growth and activities (UNEP, 2013). At the heart of GE, as defined by the United Nations Environmental Programme (UNEP), is the desire to improve the standard of living of populations and social equity, while significantly reducing environmental risk and ecological scarcities.

In SA, GE is viewed as a route to sustainable development given its potential to address inclusive interdependence among social protection, economic revival and natural systems. GE consists of economic activities aimed at producing, distributing, and consuming goods and services that will result in long term improved human well-being without affecting the sustainability of the future generations. GE has the potential to accelerate economic growth with the creation of new green occupations. A transition to GE therefore presents a great opportunity for addressing unemployment through creation of green occupations (Kaggwa et al. 2013). In order to achieve social inclusiveness through creation of green occupations, the created jobs need to be decent, provide adequate income, social protection and respect for workers' rights (ILO 2009).

For SA to effectively participate in the transition to GE, there is an urgent need for sector capacity building especially in the local government that is tasked with implementation of GE policies on the ground (African Centre for a Green Economy 2015). Local governments play an important role in planning and guiding developments that are compatible with the climate in rural and urban areas. Key functions of the local government such as provision of water, infrastructure, energy and waste management, make it a key player in the transition to GE that will lead to creation of green jobs (Moyo 2015). Green initiatives will create green jobs thereby

having a direct impact on the local labour market and livelihoods of the local citizens through improved access to services and reduced environmentally negative impacts.

As SA transits to GE, new technologies are progressively and simultaneously introduced, improved, developed or commercialised. The full economic merit of the new green technologies and systems may only be established in the long-term period. The 2010 South Africa's New Growth Plan identified creation of new green jobs in the fields of green energy generation and efficiency, greenhouse gas mitigation, and natural resource and waste management. Moreover, the Industrial Policy and Action Plan (IPAP2) by the Department of Trade and Industry (DTI), identified industries linked to green energy production such as wind energy, solar water heaters (SWH), waste management and energy efficiency as the key drivers for green job creation. A revision of IPAP2 in 2011 included detailed targets in six sub-sectors (Sustainlabour and TIPS 2013):

- Solar and wind energy
- Biomass
- Multi-energy clean stoves
- Energy and water efficient materials and appliances
- Efficient motors
- Waste treatment including wastewater

The GE already employs several South Africans mainly in the sectors of recycling, conservation, eco-tourism and renewable energy. Current analysis of the potential of the unfolding GE in SA reveals the creation of approximately 98 000, 255 000 and 462 000 direct jobs in the short, medium and long term, respectively, in the formal economy as shown in Table 2.1 (Maia et al., 2013). However, there is still limited data available directly relating specific green initiatives to green jobs creation in SA (Moyo 2015). In Spain, by 2009, an estimated 530 947 green jobs had been created with 58 264 created in wastewater treatment and another 140 000 in waste management and treatment. In Brazil, 2 653 059 green jobs had been created by the year 2008 representing 6.7% of total formal jobs (ILO 2013).

Table 2.1: Potential South Africa's green jobs (Maia et al. 2013)

Net direct jobs	Short term (2012)	Medium (2017)	Long term (2025)
Energy generation	13 365	57 142	130 023
Energy efficiency	31 569	70 193	67 979
Pollution control	8 434	13 189	31 641
Natural resources	44 512	114 842	232 926

As the economy becomes greener, several jobs are affected, thus there is a need to train/re-train the workforce and equip them with new skills to meet the demands of a green economy. Apart from technical skills, awareness should be raised with the aim of changing the mindset of both the workforce and the citizens. Within the context of sustainable development and dignified working conditions, GE can only be achieved if people fully embrace the idea, possess the required green skills and practically apply them. Some of the relevant new skills required for a smooth transition to green jobs include (UNEP, 2011):

- Good understanding of the impact of any job on the environment
- Good knowledge of ways to contribute to cleaner environment and reduced environmental damages at work places
- Knowledge and skills on efficient resource and energy use, waste minimisation, re-use or recycling
- Mindset change resulting in the ability to be liable to the outcome of one's work

Just like in other countries, the shortage of skills has been identified as being critical in the GE industries. A shortfall in managerial, professional and technical skills such as engineering and artisan, has the potential of greatly hindering green industries' growth, thereby delaying the creation of green jobs (Sustainlabour and TIPS 2013). Green job opportunities can be created in several sectors of the GE with the sectors having the most employment opportunities being renewable energy, energy management, low carbon transportation, energy efficient building, environmental protection and waste management (Katz 2012).

It is the responsibility of municipalities in their respective local governments to promote creation of green occupations by employing green technologies in their operations including but not limited to wastewater, water and energy management. This forms a major part of the green economy movement and green jobs creation. According to Hammer et al. (2011) local

government and cities are the key drivers to economic growth since they have an advantage in identifying opportunities and deficits. Local governments are the "closet" entity to the job seekers, disadvantaged citizens, and are prepared to respond to the needs of the locals, although quite a number of municipalities are confronted with several challenges, including corruption, water scarcity, environmental degradation, lack of skills and, poor service delivery, to name but a few. Alternative strategies, goals and implementation plans for the environment are aimed at greening the local government and have been developed for the past few years to improve the living conditions of the society.

2.1. Northwest province

Creation of green occupations in North West Province (NWP) has been pegged on the Renewable Energy Strategy (RES) for North West Province. RES is driven by several international, national and provincial forces including economic growth, environmental protection, and universal access to energy and job creation. The potential of job creation by RES lies mainly in the manufacturing of relevant technologies rather than in the operation and maintenance of energy facilities. The number of jobs created per unit of renewable energy produced is much higher as compared to conventional energy production. Moreover, the manufacturing of renewable energy technologies, which requires appreciable workforce, is expected to spur job creation in NWP. The localisation of global value chain elements for wind and solar power could establish NW and particularly South Africa as a regional hub for renewables' manufacturing.

For NWP to become the regional renewable hub it desires to become, the creation of industries for manufacturing renewable technologies must be undertaken. This will also help in avoiding the limitation of job creation by refocusing the workforce towards the maintenance and operation of implemented renewable technologies. In the Renewable Energy Independent Power Producer Programme launched in 2011, a total of 36 498 green jobs were expected to be created in the construction phase as compared to 2 245 jobs created for operation (DEDECT, 2012). The application of the following renewable energy sources is expected to spur green job creation in NWP:

i. Solar energy – NWP with a good solar potential averaging 8 000 MJ/m^2 per day, has the opportunity for installation of solar generators namely Solar Water Heaters, Concentrated Solar Power and Solar Photovoltaic

ii. Waste to Energy – Municipal solid waste in NWP contains a potential energy of 169 to 304 MWth, which if harnessed through application of technologies such as anaerobic digestion, will lead to both energy generation and job creation

iii. Biofuels – Energy crops such as maize, sunflowers and Jatropha tree with wide production in NWP, makes the production of biofuels viable

iv. Fuel Cell Technologies – There is a potential for NWP in the application and local manufacturing of catalytic metals used in fuel cells. South Africa and NWP in particular contain 75% of the world's platinum group of metals used as catalysts. The use of fuel cells dubbed 'hydrogen economy' by NWP is aimed at achieving eight goals. The goals include improved health, job creation, poverty alleviation, pollution reduction, improved competitiveness, reduced CO_2 emissions, energy security and delayed construction of new power plants

v. Wind Energy – Wind use is mainly expected in wide utilisation of wind pumps for irrigation and domestic use in rural areas

2.2. Northern Cape province

The Northern Cape Province (NCP) is a regional leader in renewable energy sources development leading to the creation of several green jobs. NCP is endowed with close to 300 days of natural sunlight per year making it ideal for electricity generation from solar-based technology. With several solar projects being implemented and a plan of a 5 GW solar park in NCP, there is a potential for green jobs creation. Local production of the solar components such as mirrors, control systems, turbines, generators and heaters, is expected to further contribute to job growth. Solar energy production is expected to create 3 000 green occupations including 3 000 in operation and maintenance which is the long term, and 600 in manufacturing (NC Provincial Review. 2016).

Power generation from photovoltaic, which is relevant to SA, is expected to create 8 500 direct green jobs in the NCP in the long term (Sustainlabour and TIPS 2013). Table 2.2 gives a breakdown of the potential green jobs' creation in the solar photovoltaic sector. Solar water heating (SWH), another source of renewable energy, has the potential to create green jobs in NCP. SWH, being labour intensive creates employment in its entire supply chain, including manufacturing, installation and maintenance. Currently more than 700 people are employed in SWH with 400 on installation and 200 on manufacturing. Apart from solar energy generation, NCP had also created an estimated 404 green jobs in the waste management sector

during the 2013/2014 financial year. This was achieved through the implementation of waste recycling projects in Namaqua, Frances Baard and ZF Mgcawu districts. Through recycling projects, community members have been able to generate income by selling waste material in addition to the creation of permanent green jobs for the operators.

Table 2.2: Green jobs potential in solar photovoltaic (Maia et al., 2013)

Activity	Short term (2012)	Medium term (2017)	Long term (2025)
Construction	1 057	2 142	2 794
Operation and maintenance	71	777	2 284
Manufacturing	2 688	6 048	8 463
Total	3 816	8 967	13 541

2.3. Limpopo province

South Africa (SA) is at risk of negative impacts of climate change due to increased frequency and magnitude of extreme events such as floods and droughts. Furthermore, environmental challenges leading to human vulnerability are air and water contamination, the deterioration of rivers and land degradation. The country's path to a green economy is therefore a response to these impending environmental threats. Unlike countries that show a strong urban bias in greening the economy, social equity constituents are key features of national plans in SA (Musyoki, 2012). The Limpopo province (LP), for example, is dedicated to supporting sustainable development through (amongst other things) the promotion of green economy and creation of green occupations.

Limpopo is the most northerly province in SA and the persistent problems of poverty and inequality are key constraints to rural development in this province (De Swardt, 2003). Limpopo's leading economic sectors include agriculture, tourism and mining, all of which are reliant on natural resources. Mining experienced most growth in the period between 1995 and 2002 (Musyoki, 2012). The province aims at providing services to all, but the actual performance has not met expectations in rural areas where many dwellings have no access to water within their houses. Despite the high quality of water in SA, some municipalities do not meet the required standards. There is also a gap in terms of affordability of electricity, with many rural residents only accessing limited electricity through government subsidies (LPG,

2009). Transition to a green economy is therefore seen as an opportunity to overcome some of these persistent problems.

The green economy occupation opportunities of the LP province to address these challenges include creating jobs and improving environmental quality. Thus, based at different district and local municipalities, this will be implemented through specified initiatives in the following key focus areas:

a. Sustainable production and consumption
b. Water management
c. Sustainable waste management practices
d. Clean energy and energy efficiency
e. Agriculture, food production and forestry
f. Green municipalities

In Limpopo province, providing jobs and addressing poverty issues will require interventions at both local and regional levels to bridge the gap between policy and implementation. For proper policies to work there must be concerted efforts to direct resources to sectors where poor people are employed, locations where they live and to producing food that they consume. Unskilled labour needs to be valued and remunerated accordingly.

2.4. Western Cape province

The West Coast provincial government leads among the top local governments in that it has strong strategies and policies towards sustainable development for the green economy initiative in the country. This province is referred to as a home of scenic beauty following its unique biodiversity hotspots. However, the Western Cape (WC) province is subject to crises as far as climate change estimation is concerned (Rebelo et al., 2011; Pasquini et al., 2013). The solution to such threats requires a proactive and integrated approach between all the Western Cape entities, non-governmental organisation and residents in their respective municipalities. Several programmes, projects and action plans are put in place for the green economy transition, with the focus to create green jobs and opportunities for low-skilled citizens (WCG 2013).

Creating an alignment and collaboration with different sectors in the local governments and municipalities is very essential in effecting a possible investment for the WC vision for green economy. Green investment in five sectors including water, ecotourism and waste was

expected to increase green occupations by an average of 69.78% between year 2014 to 2016 in the WC province (King 2014). Currently various intervention programmes and projects are running focusing on previous strategic enablers. The province has significantly improved in merging the current system to support the green economic growth; installation of modified meters called "smart meters", the import of Liquefied Natural Gas (LNG), and wastes projects, are some of the projects that were carried out in the last three years. However, no reported projects on development of green skills and quantitative data were recorded for green occupations in the green economy report 2014.

The "Five-year term Provincial Strategic Plan" is aligned with the development goals for the province which is a collective vision for the province that incorporates the following strategic goals as key guidelines to contribute towards implementing the green growth vision:

a. The creation of job opportunities

b. Improvement of opportunities for education and youth development

c. Increasing protection and healthy resources for the society

d. Enabling inclusive growth and sustainable living conditions and

e. Lastly to form partnerships to fix the integration of the local government management and their delivery services to the society

The strategic plan includes some important priorities that give direction to future development of green occupation for the province. All these strategic plans, framework and goals set important key parameters for the province's green occupation opportunities. The goal to create green occupations and opportunities will aid in addressing and resolving some of the major issues in the current provincial system such as mismatch of skills in the existing employment system, high unemployment rate especially youth, and the aging of water and energy infrastructure. This will be accomplished by prioritising on proper management of water, greening of industrial services with focus on replacing fossil-fuel-based technology with renewable innovative methods. The Western Cape government has identified resources and substantial investment sectors such as water, energy, waste and ecotourism that will assist in creation of green occupations. In addition, five enablers have been identified as support structures that will create new economic opportunities. According to Ge & Zhi, (2016), a green

economy is one that focuses on growth in income, sufficient skills and has a positive effect on employment and creation of green occupations.

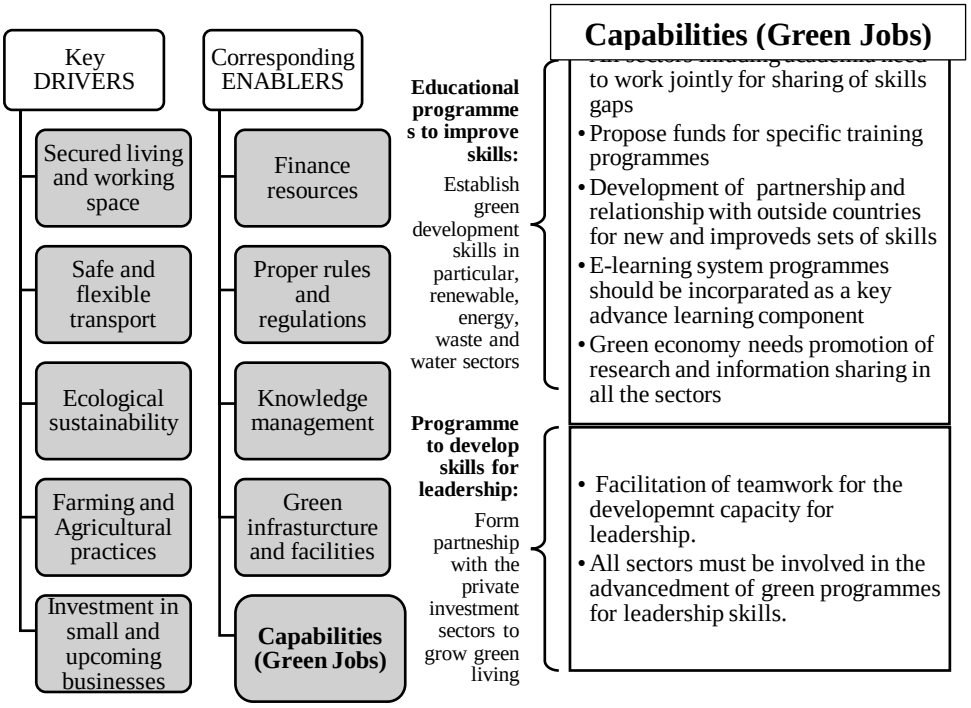

Figure 2.1: Key principles and broad actions for skills empowerment.

The training technology center for renewable energy is the first of its kind in South Africa, situated in the WC province. It offers training for both the theoretical learning and practical side of wind turbine and solar farms. Figure 2.1 shows key principles elaborated in the strategic framework and broad action plans to implement green occupations and skills programmes for green growth. The municipalities in the Western Cape region heavily rely on coal for energy. Thus, there are several key areas that need intervention in order to meet the current energy demands for the local customer and to incorporate the municipal management and operating systems in terms of making profits through energy that is renewable and efficient. These challenges can only be resolved if all the stakeholders (municipalities, private sector, residence and academia) play their roles and take responsibilities.

2.5. Gauteng province

Gauteng is referred to as the economic heartland of South Africa that has strong green policies and local strategies in place to improve green economy performance (Götz and Schäffler 2015). However, this province has constantly encountered setbacks going forth, due to its historical

past industrial activities involving greenhouse gas emissions. The increasing illegal squatter camps, energy scarcity, water security and environmental pollution are some of the challenging issues in the local municipalities in this region. The creation of green occupations is one of the drivers in all strategic plans and visions for all local government and municipalities within the province. The GP has intended to address environmental issues, promoting clean renewable energy technologies that will reduce carbon footprint, and addressing the importance of preserving water, by focusing on creating green decent occupations and skills empowerment.

One of the "low-carbon economy" implementation projects in the province is the current public transportation system that became a success in the past few years. Up to date, this project has improved the bus rapid and transit railway transportation systems, which is now a flexible, easily-accessible and cost effective way of reducing congestion for all good reasons. The Rea Vaya and Are Yeng bus rapid transit systems (along with the Gautrain railway) are currently operating in the two metropolitan municipalities namely City of Johannesburg and City of Tshwane, respectively. The City of Johannesburg seeks to promote other replacements for fuel use in its transportation systems including private transport. This renewal will be achieved by the introduction of biofuel energy techniques. On the other hand, City of Tshwane will commence first with 30% gas fuel for its fleet vehicles. However, green occupations created are not reflected in these projects (Moyo 2015).

2.6. Eastern Cape province

The Eastern Cape Province is home to close to 6.7 million of the total 52.9 million South African population (Statistics South Africa, 2014**).** Eastern Cape (EC) province has several district municipalities (DM) such as Amathole DM and Joe Gqabi DM that are the designated Water Services Authorities (WSA) for its local municipalities (Easter Cape Socio Economic Consultative Council, 2012). The district municipalities often regulate water services, management of waste and water treatment plants. Though poverty has struck this province, the provincial government has implemented several industrial development strategies to address poverty in the field of automotive, agro-processing, green economy, tourism, capital goods, and petrochemicals (Eastern Cape Development Indicators, 2012). The main purpose of green drop is to encourage municipalities to strive for continuous improvement of services towards its citizens, compliance with legislation and creating jobs while protecting the environment. In 2011, Statistics South Africa indicated that the province had the highest total

unemployment and youth unemployment rates of 37.4% and 47.3%, respectively, in the country.

Wastewater services delivery is performed by seventeen (17) Water Services Authorities in Eastern Cape via an infrastructure network comprising 123 wastewater collector and treatment systems (Department of Water Affairs, 2011). From the 2014 Green Drop Progress Report, it is reported that EC achieved 72.9% cumulative risk rating (CRR) as shown in Figure 2.2. This rating was based on national risk analysis score of Water Service Institute of South Africa under department of Water and Sanitation (DWS). Nevertheless, there has been a significant improvement from 67% in 2013 of the operations since the inception of green drop development policy by the government. Green Drop score rating assists management of the municipalities to implement strategies that will progressively improve operations of water treatment works.

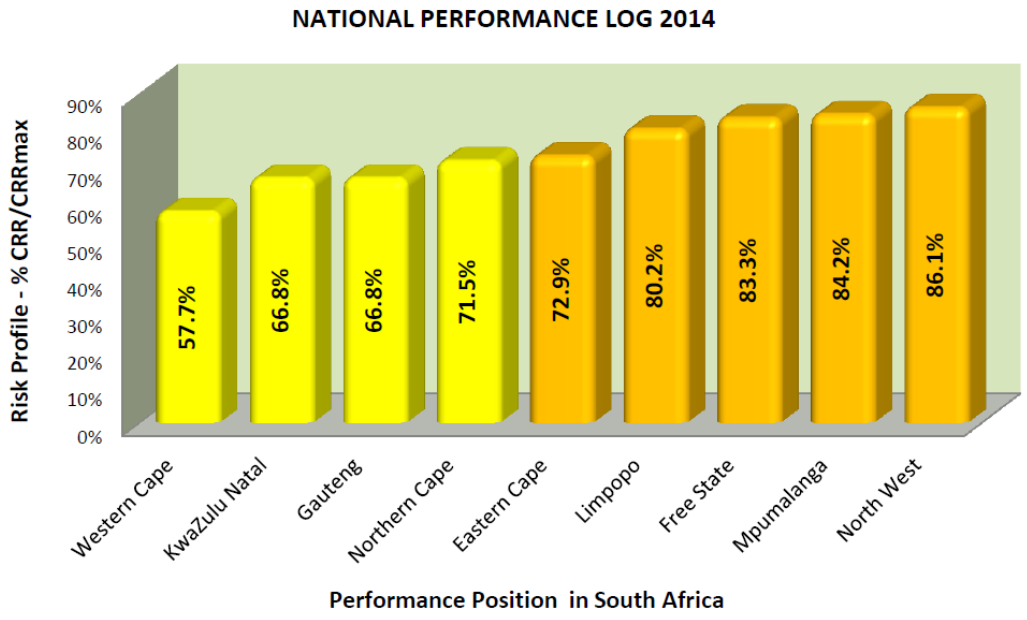

Figure 2.2: 2014 National Green Drop Performance (DWS report, 2014)

The 2014 risk analysis score suggests that the EC province is one of the high-risk provinces (Figure 2.3) that should be given attention to improve treatment works operations (Department of Water Affairs 2014). Nelson Mandela Bay municipality was the municipality in the EC with the lowest risk abatement score and has been commended for such outstanding work. There are several main factors that contributed towards the digression of the provincial cumulative risk rating score of the treatment works. These include inadequate technical skills in treatment works, poor effluents compliance according to WSD standards, inadequate treatment works maintenance and operation, and over-capacitated treatment works.

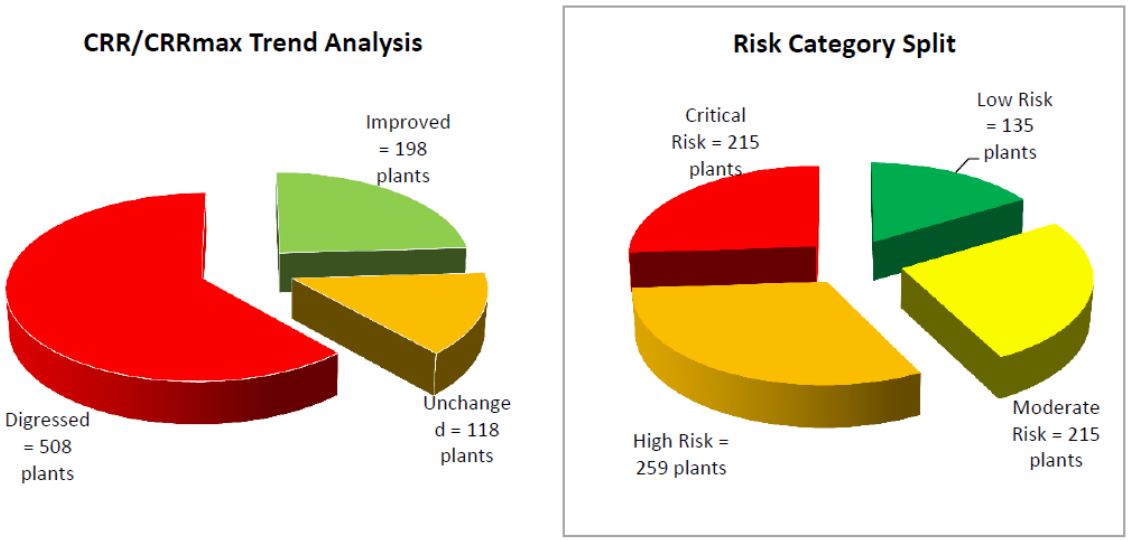

Figure 2.3: Green Drop Risk Chart (DWS, 2014)

Furthermore, the EC province has the potential for green jobs creation with abundant renewable energies from solar, wind, hydropower, biomass, and waste materials according to renewable energy independent power producer procurement (REIPPP) report of March 2015 (Figure 2.4). Currently the EC province has the largest wind farm in SA known as Cookhouse Wind farm and this farm provides alternative green energy to the Eskom power grid in the province. The wind farm contributes ±130 megawatts of wind power to Eskom network (REIPPP, 2015) and there are other wind farms currently under construction, such as Amakhala Emoyeni wind farm and Jeffreys Bay, that will contribute ±200 megawatts to the provincial power grid leading to significant green jobs creation.

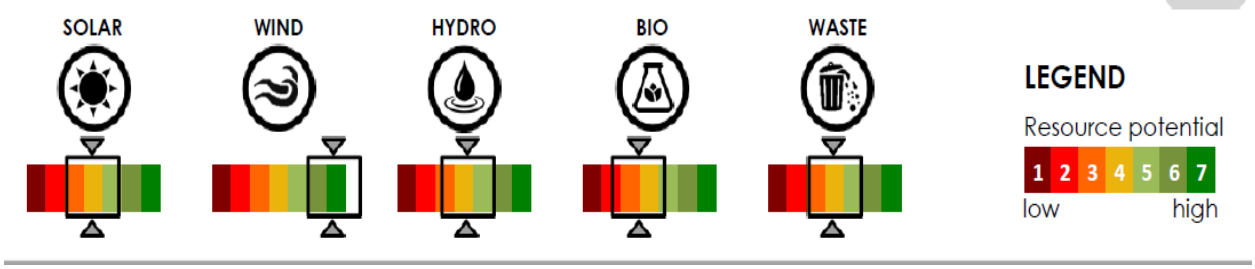

Figure 2.4: Renewable Energy Independent Power Producer Procurement in Eastern Cape (REIPPPP, 2015)

2.7. Free State province

Free State (FS) Province is home to ±2.78 million of the total 52.9 million South African (SA) population i.e. 5.2% of SA population (Statistics South Africa, 2014). In the Free State province, wastewater services delivery is currently performed by twenty (20) Water Services Authorities through an infrastructure network comprising 95 wastewater collector and treatment systems (DWA, 2011). The current risk analysis score of FS is 83% and this implies that the province is not yet fully compliant with the guidelines provided by WSD green drop plan. Furthermore, it was noted that in 2013 the province achieved 77% GD risk analysis score as compared to 83% of 2014. The cumulative risk rating score (CRR) indicates that the province must take urgent remedial action in the water treatment works to address compliance according to the green drop program outlines. Transition to green technologies in wastewater treatment will enable the province to meet the set guidelines and in the process, creating green jobs.

There are several main factors that contributed towards the digression of the provincial cumulative risk rating score of the treatment works. These include inadequate technical skills in treatment works, poor effluent compliance per WSD standards, inadequate treatment works maintenance and operation, and over-capacitated treatment works. Furthermore, some of the treatment works might have not submitted their progress assessment tools (PAT) before the GD report was released and this also contributes towards low CRR scoring. The only municipality which had an outstanding performance in the province in terms of risk abatement plan and risk management practice for 2014 is Tokologo (Green Drop Progress Report, 2014).

There are several renewable energy technologies that the province has adopted to reduce greenhouse gases and fossil fuel reliance. Solar power plants, such as Boshoff, contributes 57 megawatts to the provincial power grid (REIPPP, 2016), while Pulida solar power plant currently under construction in Letsemeng local municipality will contribute 82 megawatts of the provincial power grid (Pulida solar park public hearing, 2016). Some of the renewable energy projects the province has executed includes Letsatsi Solar Photovoltaic Park and Stortemelk Power Plant (Small hydro power plant). These are some of the projects the province has committed to in order to encourage green environment, reduce carbon emissions and create green jobs.

2.8. Mpumalanga Province

Mpumalanga province lies in eastern South Africa, bordering Swaziland and Mozambique. It constitutes 6.3% of South Africa's land area. It shares borders with Limpopo, Gauteng, Free State and Kwazulu-Natal. This province is divided into three district municipalities (i.e. Ehlanzeni, Gert Sibande, and Nkangala District Municipality). These district municipalities are further subdivided into 18 local municipalities. There is an abundance of coal reserves in the Mpumalanga province. About 83% of South Africa's coal production is from this province. The coal is mainly used in the production of fuels and electricity. Twelve out of seventeen of Eskom's coal fired power generation plants (Arnot, Camden, Duvha, Grootvlei, Hendrina, Kendal, Komati, Kriel, Majuba, Matla and Tutuka) are based in Mpumalanga Province. Currently the construction of a new power station, Kusile Power station, is ongoing. Moreover, the Sasol Plant using coal for coal gasification and in coal fired boilers to generate synthetic fuels, electricity and other products, is situated in this province. For this reason, most the carbon dioxide emitted in South Africa is from Mpumalanga Province.

The use of coal for energy production results in adverse environmental impacts associated with the mining and removal of coal for use in coal fired power stations as well as the impacts resulting from burning or gasification of coal for energy production. Coal intensive activities contribute to large-scale water and air pollution. This includes carbon dioxide emissions that contribute to global warming. Mpumalanga province needs to develop green energy to reduce the large-scale water and air pollution. This will include solar energy, biomass, hydropower and municipal waste (human waste and biological waste) treatment in biogas digesters for bioenergy recovery. Implementation of such green initiatives will create massive green employment opportunities.

Currently, there is a biomass power project in Ngodwana, the Ngodwana Energy Project, with a planned commissioning in 2018 and an installed capacity of 25 MW. There are other existing green energy sources such as hydroelectricity (Friedenheim Hydroplant - 3MW capacity, Lydenburg hydroplant - 2.6 MW capacity, Badplaas Hydroplant - 0.17 MW and Lomati hydropower plant - 0.6 MW). There are currently no wind farms, concentrated solar power and solar photovoltaic power stations in Mpumalanga. Mpumalanga province recently held a meeting on the 25th - 26th of August 2016 at the Nkangala District Municipality Offices in Middleburg to discuss the green economy issues. These discussions were led by the MEC for

Finance, Economic Development and Tourism, Mr Sikhumbuzo Eric Kholwane. The theme of this discussion was "The green economy as a driver of sustainable development and job creation in Mpumalanga" and the key points discussed were:

- To position Mpumalanga as the main point of focus for green economy activities in South Africa
- To gather inputs on potential provincial priority actions for the green economy (Green Economy Sector Development Plan)
- To confirm the key elements of a green economy path (15 years horizon) in Mpumalanga's context and
- To start building provincial consensus on the green economy path as an innovative way towards sustainable consumption and production patterns.

There were many presentations from private sector and academia. BiogasPro presented the option of biogas digesters to treat human and biological waste. The bioslurry can be used as an organic fertilizer while the biogas can be used for cooking, heating and lighting. The green sector outlined in the Mpumalanga Economic Growth and Development Path (MEGDP) includes energy, infrastructure, transport, waste, agro-ecology and eco-construction. The green economy is identified as a sector that will assist in job creation and reduce the emission of greenhouse gases. The MEGDP will incorporate relevant green economy projects over the next ten years. The starting point will be to develop an integrated Clean and Green Development Strategy, which will be anchored around job creation. The green strategy will assist the Province to determine its existing baseline with regards to the seven green sectors and the most feasible green projects based on Mpumalanga's developmental needs.

The Green Economy Sector Plan for Mpumalanga has been drafted. The plan aims to provide an integrated approach towards developing the green economy in Mpumalanga by 2030. Specific objectives include:

a) Developing a sector plan based on the province's strength in natural resources endowments
b) Expanding the economic, green and environmental initiatives that are already underway in the province to facilitate quick wins
c) Support the Department of Economic Development and Tourism's drive in sustainable economic development
d) Develop an action plan for implementation

e) The green economy will be mainstreamed to ensure that economic growth is sustainable (i.e. creates green jobs and reduces the emission of greenhouse gases)

In the Green Drop performance, which reflects the level of mastery that the municipality has achieved in terms of its overall municipal wastewater business, MP received a score of 44%, the worst performance by any province (DWA, 2013).

2.9. KwaZulu-Natal province

KwaZulu-Natal province lies in the southeast of South Africa, bordering Swaziland, Lesotho and Mozambique. It constitutes 7.7% of South Africa's land area. It shares borders with Mpumalanga, Free State and Eastern Cape provinces. It is divided into eleven district municipalities (i.e. Amajuba, Zululand, uMkhanyakude, uThungulu, uMzinyathi, uThukela, uMgungundlovu, iLembe, eThekwini, Ugu and Harry Gwala Municipality). There is no operating coal fired power stations in KwaZulu-Natal. There are two gas turbine power plants, viz. Newcastle cogeneration plant and Avon peaking power in Shakaskrall. Newcastle Cogeneration Plant was commissioned in 2007 and is operated by IPSA Group with an installed capacity of 18 MW. The Avon peaking power was commissioned in July 2016 and is operated by International Power with an installed capacity of 670 MW.

In terms of green energy, there are hydroelectric activities within the province. The Ingula pumped storage scheme is located 22 kilometers southwest of Van Reenen (Uthukela District Municipality), in the escarpment of Little Drakensberg between the border of the KwaZulu-Natal and Free State provinces. The pumped-storage hydroelectric scheme consists of an upper and lower dam, 4.6 kilometers apart, and connected to a power station by tunnels. This is a joint venture between Eskom and CMC Impregilo Mavundla. Construction began in 2005 and the first two generators were commissioned in March 2016 while the third one was commissioned in August 2016. The remaining generators are expected to be commissioned in 2017. The planned installed capacity is 999 MW. There are currently no wind farms, or concentrated solar power and solar photovoltaic power stations in KwaZulu-Natal.

There are two Landfill Gas Power stations in the eThekwini Metropolitan Municipality, the Mariannhill landfill gas to electricity and the Bisasar road landfill gas to electricity. The Mariannhill landfill gas to electricity was commissioned in 2006 and has an installed capacity of 1 MW. The Bisasar Road landfill gas to electricity was commissioned in 2009 and has an

installed capacity 6.5 MW. The Department of Economic Development, Tourism and Environmental Affairs in KwaZulu-Natal formulated the draft provincial Green Economy Strategy. They also established a Green Economy Unit that launched a Green Growth website in 2012 (currently not active - http://www.kzngreengrowth.co.za). The Green Economy Technical Assistance Fund was also established in partnership with Trade and Investment in KwaZulu-Natal. According to the Department of Economic Development, Tourism and Environmental Affairs KwaZulu-Natal Strategic Plan 2014-2019, the key initiatives that have been implemented so far as part of this strategy include the development of Solar and Wind Resource Maps for the province, Municipal Waste to Energy Protocol and Technical Assistance Program. A Green Economy Technical Assistance Fund worth R2,5 million was established to enhance the green economy initiatives.

In 2012, the provincial Department of Economic Development and Tourism hosted its first Green Economy Research Conference at the Durban ICC, with the aim of promoting economic activities that promote sustainability whilst protecting the environment. A range of knowledgeable speakers from civil society, government, business and academia gave presentations. In addition, presentations on renewable energy, carbon tax, waste management, and agriculture provided much information and initiated discussions. The KwaZulu-Natal provincial government has a vision that by 2025, the province will have an economy that provides for all its residents to prosper, and where the natural resources are enhanced and used sustainably in supporting basic needs as well as green economic growth.

The main aim of the KwaZulu-Natal Green Economy Strategy is to support and direct the re-orientation and growth of the KwaZulu-Natal economy to become increasingly competitive and resilient by:

a) Increasing efficient use of business and government infrastructure and development
b) Increasing the supply of renewable energy
c) Securing the supply of ecosystem services from the province's natural assets
d) Reducing environmental and climate related risks
e) Creating sustainable jobs for local people
f) Reducing poverty and
g) Addressing social equity throughout the province

In 2010, a situational analysis of the province was undertaken to better understand the green economy opportunities. The goals outlined in the draft Green Economy Strategy are:

- To leverage the green economy through greening provincial government investments, activities and operations
- To create 'Enabling Conditions' for the development of the green economy
- To unlock the green economy through turnkey/pilot projects in the green economy

A wide range of economic opportunities to grow the green economy in the province has been identified. These include management of natural resources, subsistence fisheries and coastal recreation and leisure, organic farming, green tourism accreditation, wind and biomass energy, development of green building materials, alternative road materials and fuels, and foreign investment in greening initiatives in the retail and manufacturing sectors.

The eThekwini Metropolitan Municipality has an Energy Office, which is a small unit situated within the Treasury Department. The Energy Office is responsible for conceptualizing and initiating projects in the following areas within the municipality:

- Renewable Energy (generating energy from renewable sources such as the sun)
- Energy Efficiency (using less energy)
- Climate Change Mitigation (reducing greenhouse gasses)

In the Green Drop performance, which reflects the level of mastery that the municipality has achieved in terms of its overall municipal wastewater business, KZN received a score of 81.5%. They were on top 3 and they received a total of 19 green certificates (DWA, 2013).

CHAPTER 3

3. Methodology

South Africa consists of nine provinces, all of which were part of this survey. This study employed the use of a descriptive method with a quantitative approach for data collection. Respondents were obtained from selected wastewater treatment (WWT) plants visited. A survey method was used as a research instrument for data gathering. In this study, two types of questionnaires (plant information and employee information contained in the Appendix section) were used as data collection tools. In addition to the questionnaires, surveyors carried out a tour of the visited plants to gather more information to back up the data obtained and adjust where necessary, thus ensuring the accuracy of the report. Predetermined probing questions specific to the plant under survey were asked during the plant tours.

3.1. Research design

In this study, questionnaires were developed taking into consideration the objectives and relevant literature study. The questionnaires consisted of closed ended questions designed to capture more in-depth information. The questionnaire tools used are given in the Appendix section. The tools had the following sections:

a) Awareness of green jobs (direct and indirect) – This was aimed at assessing the level of employees' awareness about green occupations/jobs. Direct green occupations include jobs involving classification and sale of dried sludge as manure and operation of biodigesters responsible for bioenergy production. Indirect green jobs are those that transcend both green and non-green activities such as a plant operator responsible for process monitoring, and sludge drying and classification.
b) Green jobs plan – Aimed at identifying whether wastewater treatment plants are intended to create green jobs, and whether the employees are aware of such plans
c) Challenges to green jobs creation – This section was designed to identify some of the major challenges faced by municipalities in their quest for green jobs at wastewater treatment plants. The challenges were identified from the employers' and employees' perspectives
d) Measures to overcome the challenges – This was aimed at identifying the measures regarding skills development that would help facilitate the shift to green jobs

e) Demographic profile – This section considered the employees' relevant qualifications, age and gender. The demographic information was obtained based on the company records and responses given by interviewed individuals
f) Company information – Aimed at gathering information of the capacity and efficiency of treatment plants visited

In addition to the use of questionnaires, surveyors (researchers) carried our oral interviews with the operators and managers at the visited plants, asking questions that were plant and province specific.

3.2. Sampling method and size

The survey was carried out across Limpopo, Mpumalanga, Free State, Gauteng, Northern Cape, Western Cape, Eastern Cape and North West provinces of South Africa. A random sampling method was used in identifying the plants to be surveyed. The sampling took into consideration the geographical location, size and type of municipalities for surveyed thus ensuring the capturing of an inclusive non-biased data. In each province, at least three district municipalities were selected based on their population size and geographical location to ensure good representative data. In every district municipality selected, a further two local municipalities were selected and visited for the data collection. At the local municipalities, at least two WWT plants were visited where the interview questionnaires were distributed to the plant employees. For the local municipalities that had less than two WWT plants, the survey was carried out at the potable water treatment plants. A coding system for identification of the plants visited was developed for confidentiality purposes. A file showing the identity and codes used for the plants was developed and submitted separately to the LGSETA. In the discussion contained in this report therefore, codes have been used to refer to the plants and municipalities (local, district and metropolitan) visited. Table 3.1 gives the total number of visits made per province.

For data collection purposes, a total of 96 treatment plants spread across the 9 provinces of SA were visited by the researchers from VUT. Primary data were collected using direct observation and semi-structured questionnaires comprised structured and open-ended questions. Before answering any questions, all employees were informed about the study and had to verbally consent to their participation. To support the data obtained in the investigations and to limit biases in the research process, a semi-structured in-depth interview with plant managers was conducted based on company information. As the questionnaire comprised

structured and open-ended questions, quantitative data from the closed questions were analysed using Microsoft Excel.

Table 3.1: Selected samples

Province	Number of DMs selected	Number of LMs/Metros selected	Number of WWT plants selected
Gauteng	1	4	8
Western cape	4	6	14
Northern Cape	3	5	7
Eastern Cape	2	5	12
North West	4	6	10
Free Sate	3	5	10
Limpopo	3	6	8
Mpumalanga	3	8	11
KwaZulu Natal	7	10	15

Key: DMs – District Municipalities, LMs – Local Municipalities, WWT – Wastewater treatment

3.3. Data analysis

Excel spreadsheets were generated for plotting of graphs and tables. Great care was taken during data collection to minimize error. Trends were compared across provinces, municipalities and plants.

3.4. Study limitations

This study, despite having been designed with the aim of accurate data capturing and interpretation, was still subject to the following limitations:

- Biasness – There were some cases of discrepancy between information provided by operators and managers. In some cases, respondents did not provide all the required information.
- Language barrier – Some respondents were not well conversant with the language of instruction/questioning. Furthermore, as a result of this language barrier, some distortion in the capturing of the information could have resulted during translation
- Difficulty in obtaining data – It was challenging to obtain data on the number of existing green jobs as most municipalities did not have such records.

CHAPTER 4

4. Northwest Province

4.1. Company information

There are about 42 WWT plants spread across NW Province employing various technologies for wastewater treatment. Out of the 42 plants, a total of 10 plants were visited across 4 district municipalities. A questionnaire (Company Information) contained in Appendix 1, together with oral interviews carried out during plants tour, was used in generating information about the plants visited. The information of interest included size of plant (capacity and number of employees), technologies in use, green jobs uptake and the challenges thereof. Table 4.1 shows the number of plants visited and the technologies employed.

Table 4.1: Summary of Northwest visits

DM visited	No. of LMs visited	Number of plants visited	Technologies used for treatment
NW-DM1	1	3	Oxidation ponds, Activated sludge and BNR
NW-DM2	1	1	Oxidation ponds, Activated sludge and BNR
NW-DM3	2	4	Oxidation ponds, activated sludge and BNR
NW-DM4	1	2	Oxidation ponds, activated sludge and BNR

Key: DM- District Municipality, LMs – Local Municipalities, BNR – Biological nutrient removal

In District Municipality 1 (NW-DM 1), two WWT plants (NW-DM1-LM1-Plant1 and NW-DM1-LM1-Plant2) and a portable water treatment plant (NW-DM1-LM1-Plant3) were visited. One of the plants (NW-DM1-LM1-Plant1) employed oxidation ponds for treatment while the other WWT plant (NW-DM1-LM1-Plant2), which was out of operation at the time of visit, employed activated sludge and AD for nutrient removal. The failure to operate was occasioned by drought experienced at the time of the visit, which caused water shortage in most households, thus preventing generation and flow of wastewater stream to the plant. Moreover, most households in the small local municipalities in NW still use septic tanks and pit latrines for sanitation. At the time of visit, there was poor distribution of water to households from the

portable water treatment plant (NW-DM1-LM1-Plant3). High cost of operation and inadequate water supply infrastructure, were some of the reasons mentioned to have caused the poor water supply.

To overcome challenges such as the low volume of wastewater streams occasioned by drought, more households should be connected to the sewer line. Also, measures should be put in place to ensure adequate water supply to households especially during dry seasons. Portable, decentralized water treatment should utilize new technologies and treatment systems that can reduce the cost of water treatment and supply. The use of oxidation ponds for treatment was also observed for the other remaining sparsely populated municipalities in NW-DM4-LM2-Plant1 and NW-DM3-LM1-Plant1 treating less than 5 Ml/day. For the populated municipalities, BNR was employed for treatment in NW-DM3-LM2-Plant1, NW-DM3-LM2-Plant2 and NW-DM4-LM2-Plant2 plants.

The cumulative demographic information for the visited plants in Northwest province is given in Table 4.2. All the WWT plants visited in NW were categorised as small size, having less than 50 employees (Table 4.2). Most of the plants have been operational for more than 10 years with some being as old as 30 years. Only 10% of the plants visited have been in operation for less than 10 years. Such plants are newly built to accommodate the increased wastewater inflow arising from an increasing population size in the populated municipalities. This is a sharp contrast to the observation made in the sparsely populated municipalities where decreased wastewater inflow occasioned by drought at the time of visit, had led to suspension of treatment operations in NW-DM1-LM1-Plant2. Plant upgrade and construction of new treatment plants (referred to as new units by the interviewees) was observed in NW-DM2-LM1-Plant1 plant in NW-DN2 district municipality. Generally, and per the company responses, most employees at the wastewater plants were found to lack formal qualification with 41% having no matriculation. Another 28% had certificate qualifications that in most cases were attained after undergoing on-the-job training.

Whereas many employees lacked formal qualifications, majority had knowledge and skills acquired from work experience. Some of the employees, despite being employed without any formal qualification, could obtain formal certification from the Department of Water Affairs (DWA) after undergoing recommended training programmes on water care. Employees with high formal qualifications such as diplomas and degrees were few with only 2% and 11% reported, respectively. The few that were reported are in most cases in the management

positions and had to monitor operations at more than one treatment plant. Many companies, 43%, did not have any green related occupation in place. Only 20% of the companies had direct green occupations with the remaining 37% having indirect green jobs.

Table 4.2: Demographic profile of plants visited in NW province

		Percent
Size of plant	Small (less than 50 employees)	100
	Medium (50–100 employees)	0
	Large (more than 100 employees)	0
Age of plant (years)	0 -10	20
	10 – 25	40
	More than 25	40
Plant employees' qualifications	Lower than matric	41
	Matric	28
	Certificate	18
	Diploma	2
	Degree/Postgraduate	11
Employee occupation type	Direct green occupation	20
	Indirect green occupation	37
	Occupation unrelated to green jobs	43

4.1.1. Barriers to uptake of green occupations

The low number of employees at the treatment plants directly involved in green occupations was attributed to the lack of green technologies in place. Moreover, it was noted that lack of training on green skills for the already employed operators is also a great contributor to the low uptake of green jobs (Figure 4.1). The current training in place, which is not sufficient, is only aimed at equipping the present employees with conventional skills for wastewater treatment process control, thus enabling them to attain NQF ratings. Also of interest is the high number of employees lacking the conventional skills as seen by the 28% who recognised shortage of skilled employees as being a barrier to uptake of green jobs. Whereas green skills are needed for effective wastewater treatment, employees should be equipped with the conventional skills as a prerequisite for training on green skills and technologies. To address the skill gap,

companies/municipalities can employ already skilled individuals. However, the unavailability of such individuals was a hindrance to 28% of the companies surveyed in NW.

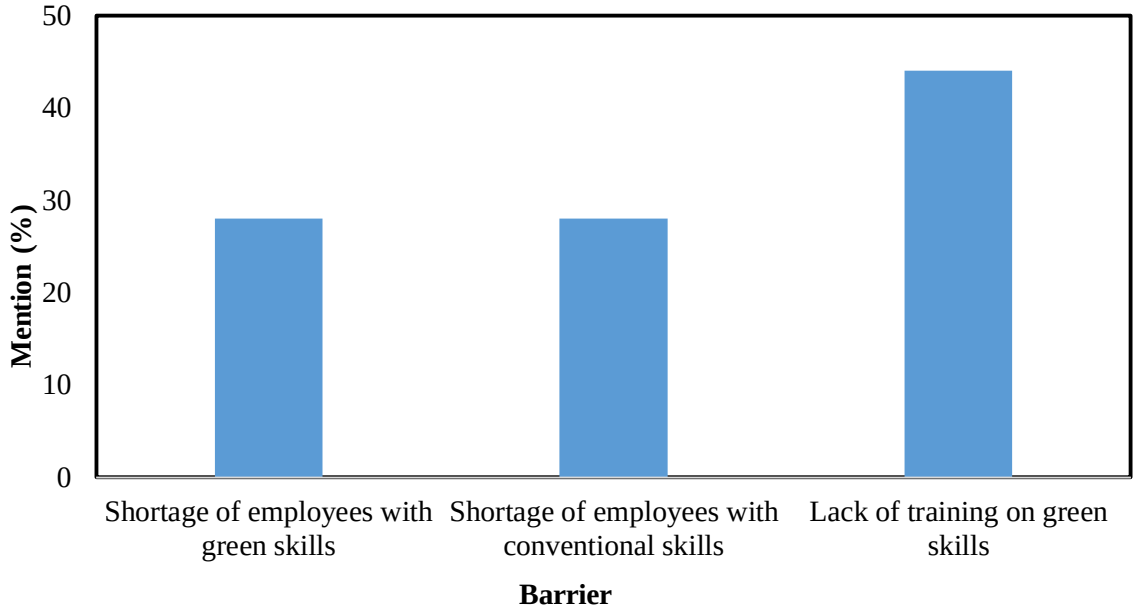

Figure 4.1: Barriers to green occupations in wastewater treatment in NW Province

4.1.2. Training required to meet the skills shortage

In-house training is the most preferred method for addressing the shortage of both green and conventional wastewater treatment skills (Figure 4.2). Most companies visited would like to have a trainer on site to facilitate skills development. Similar to the need for in-house training, on-the-job training is also a preferred method for skills development. These two training methods are ideal to most plants as they allow the employees to undergo training while working, hence no need to look for stand-in operators. It was observed that university training is the least preferred qualification for skills development by most companies. This is due to the low number of employees with formal qualifications that would allow for enrollment for degree courses. Moreover, due to the low accessibility to higher learning institutions in NW province, the qualified employees who would have loved to further their studies, are hindered by the inability to register for part time studies. Technical training despite not being highly preferred (18%) by the surveyed companies in NW, can be very appropriate for equipping the already employed individuals with the necessary conventional and green skills. Unlike universities, plant employees with matriculation (comprising 28% in Table 4.2), can easily get admission into technical colleges offering short courses on water care. The duration of such training can be reduced in recognition of prior learning and work experience.

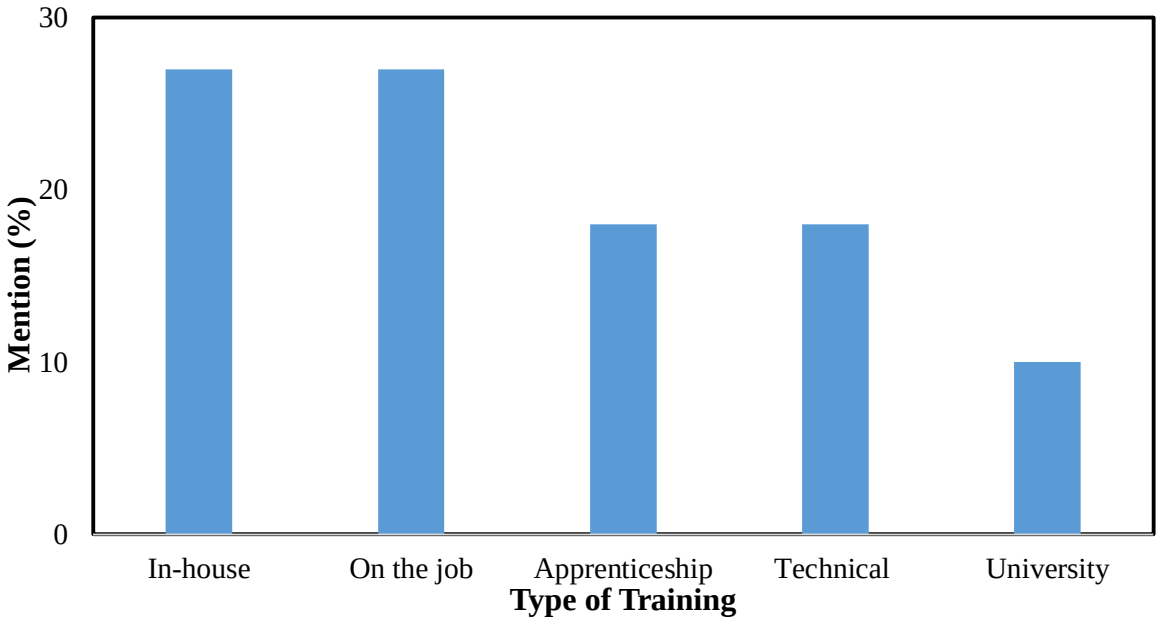

Figure 4.2: Preferred training by WWT plants in NW Province

4.2. Potential for green jobs creation in NW Province

NW Province, being endowed with natural renewable sources of energy such as sunshine, has the potential to create green jobs in wastewater treatment by incorporating renewable energy in the treatment process. Moreover, the agricultural sector of the province could benefit from the adoption of a green treatment process by the various treatment plants. Some of the potential strategies that could spur on green jobs creation include:

- Reuse of treated water for irrigation of farms close to the plants such as NW-DM2-LM1-Plant1 and NW-DM3-LM2-Plant3.
- Conversion of sludge into dry sludge compost for use in farms and gardens
- Installation of anaerobic sludge digesters capable biogas production. The biogas can then be harnesses into electricity and used in supplementing the energy requirements.
- Installation of solar energy to supplement the energy requirements of the treatment processes.

With domestic waste water and abattoir effluents being the major sources of wastewater for most WWT plants in NW (Figure 4.3), the generation of bioenergy from biodigesters is a viable technology for plants with high volume of inflows. The remaining technologies are implementable in all the treatment plants, irrespective of the amount of influent.

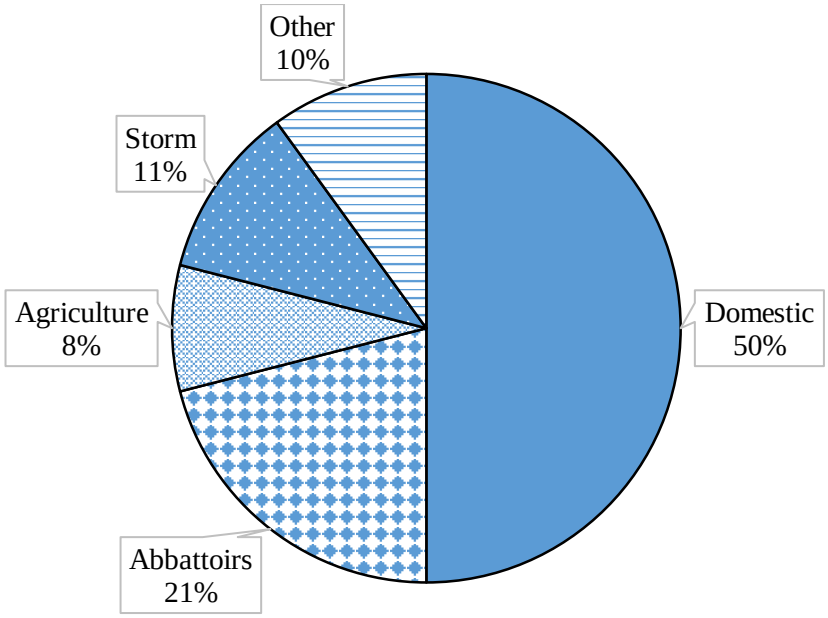

Figure 4.3: Sources of wastewater in NW province

4.3. Employee information

It was also of importance to interview the individual employees at the WWT plants to obtain their view on matters such as green occupation awareness as well as their demographic profile. The cumulative information gathered from all the plants visited in NW Province is given and discussed in the sections that follow.

4.3.1. Employees awareness of green occupations

Many respondents did not know what green occupations are, but upon elaboration from the surveyors, they could identify green occupations with several sectors such as renewable energy, transport and agriculture (Figure 4.4). The concept is, however, still foreign as evident from the several employees who still could not identify green occupations with most sectors, even after the elaboration. A high percentage of employees identified both waste management and water treatment as the sectors most likely to have green jobs. Tourism was least associated with green jobs, probably due to lack of knowledge of this sector by most employees interviewed. The foreignness of the concept of green economy/jobs is not only limited to employees of local municipalities, but also observed among the general population.

Governments, industries and institutions are still grappling with the GE concept. Moreover, since there has not been a significant uptake of GE in SA, a good percentage of the population

including the interviewed operators are thus expected to struggle in identifying green jobs and sectors. As South African municipalities respond to the climate change in transitioning to the green economy field, all stakeholders including plant operators should be brought on board. This will enhance the understanding and ease the transition to GE (SALGA 2013).

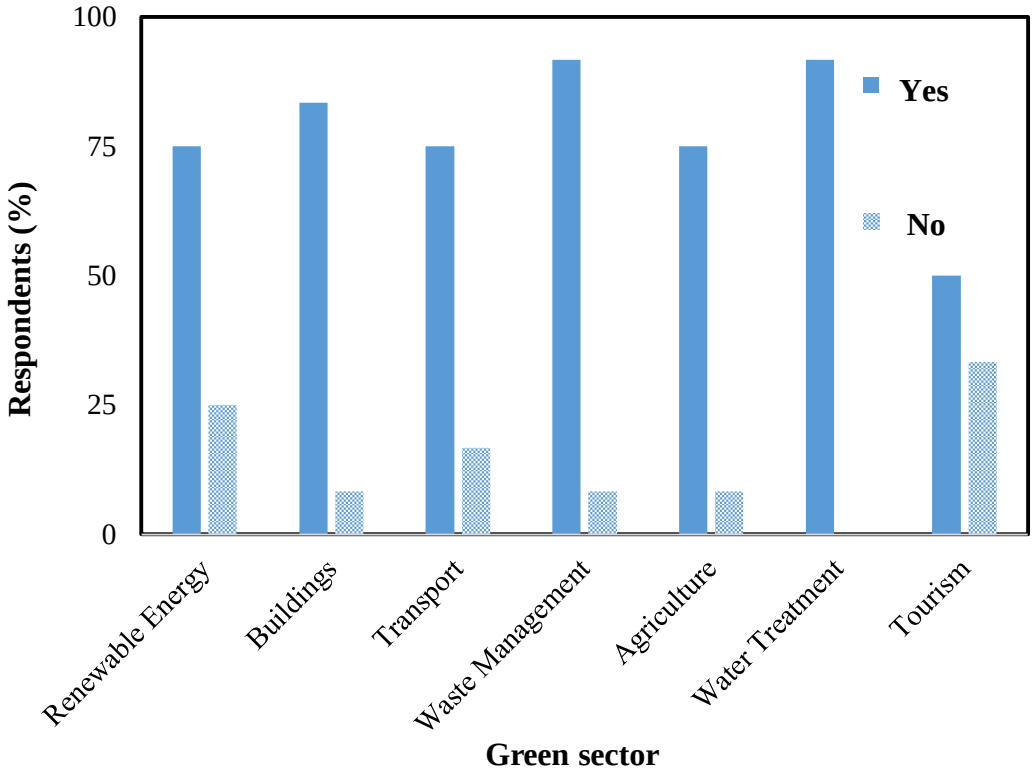

Figure 4.4: Sectors associated with green jobs as per water and wastewater treatment employees in NW Province

After the identification of sectors that can potentially create green jobs, the employees were further assessed to determine their level of awareness of green occupations. A distorted response from the respondents (Figure 4.5) was obtained. Whereas some of the respondents could easily link green occupations with most of the sectors (see Figure 4.4), the overall understanding of green jobs by all employees was limited. The limited understanding could be due to the low level of formal qualifications by most respondents. The concept of green economy and jobs thereof, is still new and has not penetrated most industries. Moreover, there is very little training on green economy and skills offered to most employees.

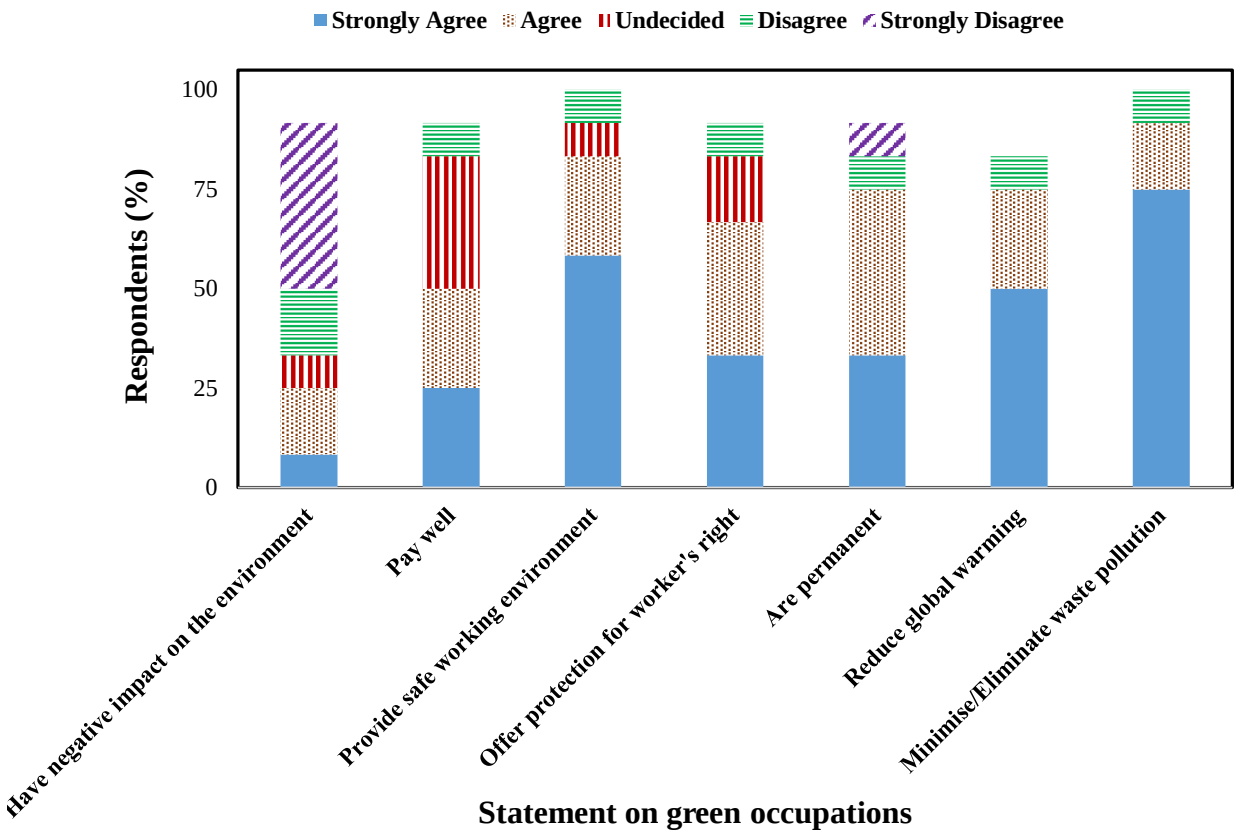

Figure 4.5: Green occupations awareness level

4.3.2. Employees awareness of company plans for green occupations

A transition to green economy leading to creation of green occupations is a process that should involve all the relevant stake holders including the wastewater employees. It was thus important to find out if the interviewed employees were well informed of their company's plan to create green occupations. From Figure 4.6 it was evident that most employees were not aware of their company's green economy plans. This could be due to the fact that most companies do not have clear plans for green occupation creation. There is also poor communication between the employees and the senior municipal officials responsible for initiating developments such as installation of green technologies. The employees are therefore in most cases caught unaware when new developments are rolled out.

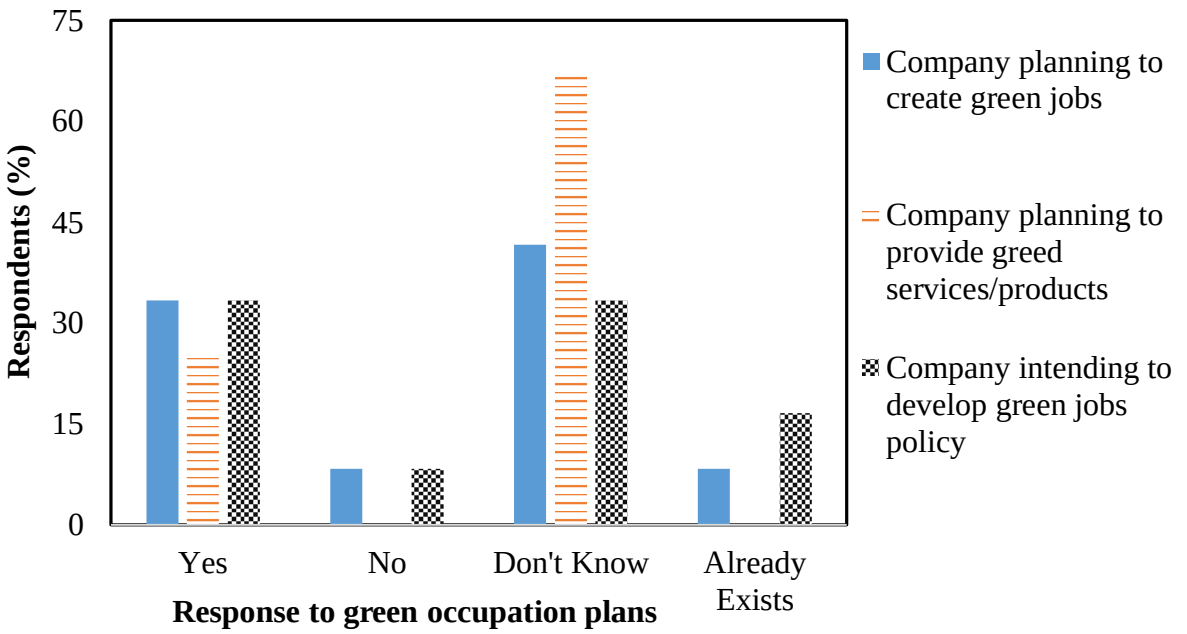

Figure 4.6: Employees awareness of company's green occupations plans

A further probing of the employees awareness of any existing green technology/occupation was done (Figure 4.7). Most respondents could easily identify the activities that they were engaged in, but were unaware whether the activities were green related or not.

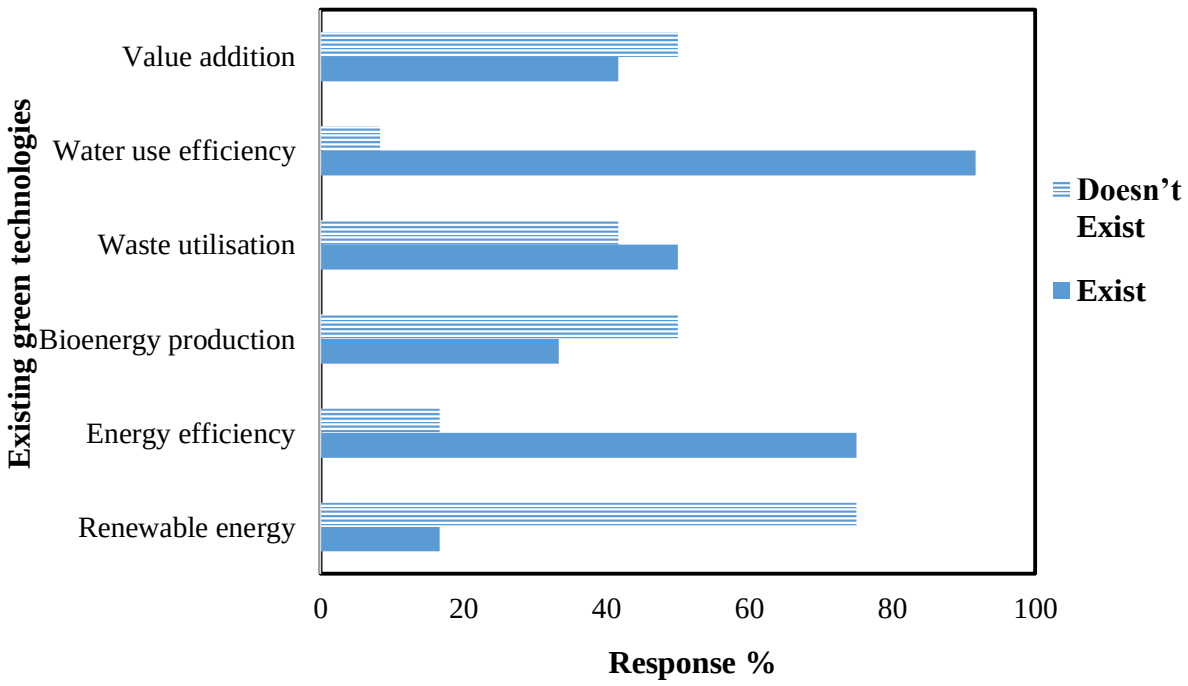

Figure 4.7: Employees' awareness of existing green technologies and processes

The most widely identified existing green related practice was water use efficiency, followed by energy efficiency. These practices, however, do not lead to any meaningful green job creation, but contribute to lowering cost of operation. Other technologies with potential green occupations creation such as renewable energy, biogas production from biodigesters and value addition, were the least identified by the respondents.

4.3.3. Demographic information of the interviewed employees

Many respondents (73%) were male with the remaining 27% being female (Figure 4.8). The few female respondents were mostly employed as general workers while their male counterparts are mainly responsible for the process and pump station control. This trend was observed in the other provinces as well. The physical work involved in the treatment plants could be a major factor in the imbalanced gender distribution, as traditionally physical work has been reserved for males. Moreover, due to unmaintained treatment grounds leading to overgrown grass, the conditions at some of the visited plants seemed inhabitable to female employees. A transition to green treatment system, through the development of safe working environment and conditions, would ensure equal job opportunities for males and females, in addition to attracting potential employees to the treatment plants.

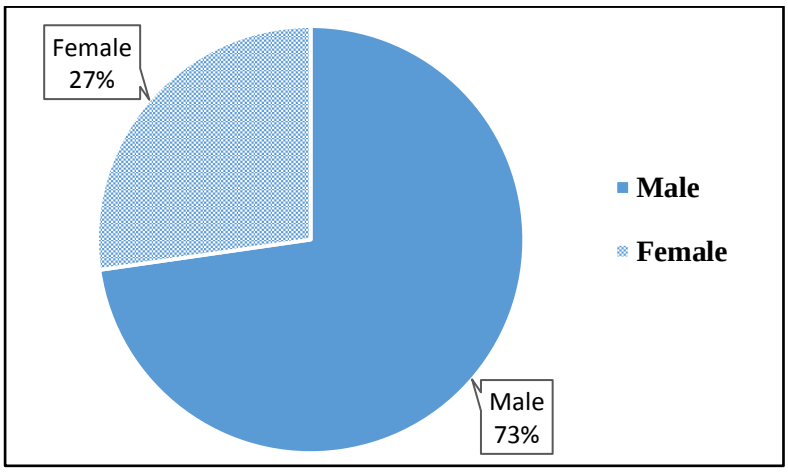

Figure 4.8: Gender distribution of respondents

Most respondents were aged between 30-39 years (63%). Another 18% were aged between 40-49 with the remaining 18% being either less than 30 or more than 50 years (Figure 4.9).

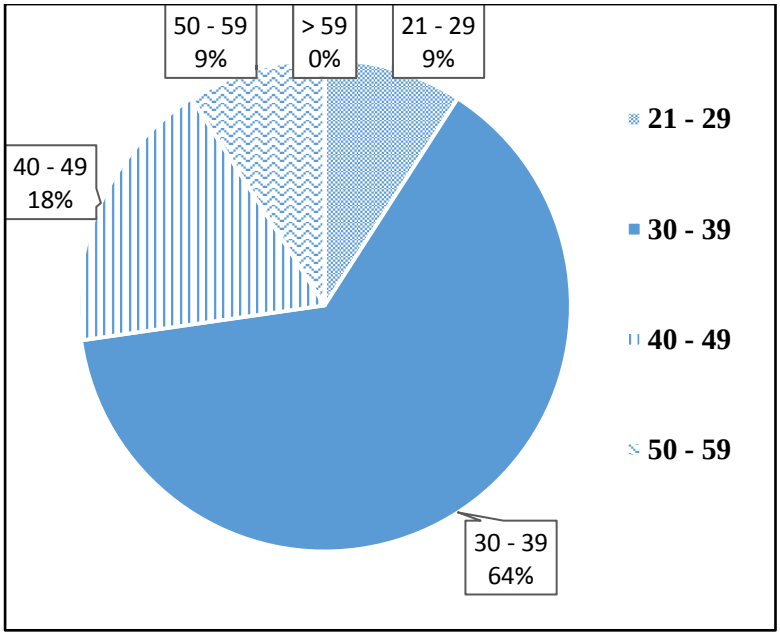

Figure 4.9: Age distribution of respondents

The occupational distribution of the respondents was determined too (Figure 4.10). Most of the respondents were operators, labourers and those in learnership and, were the most likely to be found at the treatment plants during the visits. Respondents undergoing learnership were unlikely to have a good understanding of the green economy practices or plans in place, thus having an influence on the trend observed in Figure 4.6. The formal qualification distribution of the respondents is given in Figure 4.11. The highest number (34%) had matriculation qualifications closely followed by 25% with lower than matriculation qualifications. The low qualification of most respondents is responsible for lack of in-depth understanding of green economy and occupations observed earlier in Figure 4.5.

Figure 4.10: Respondents' occupational distribution

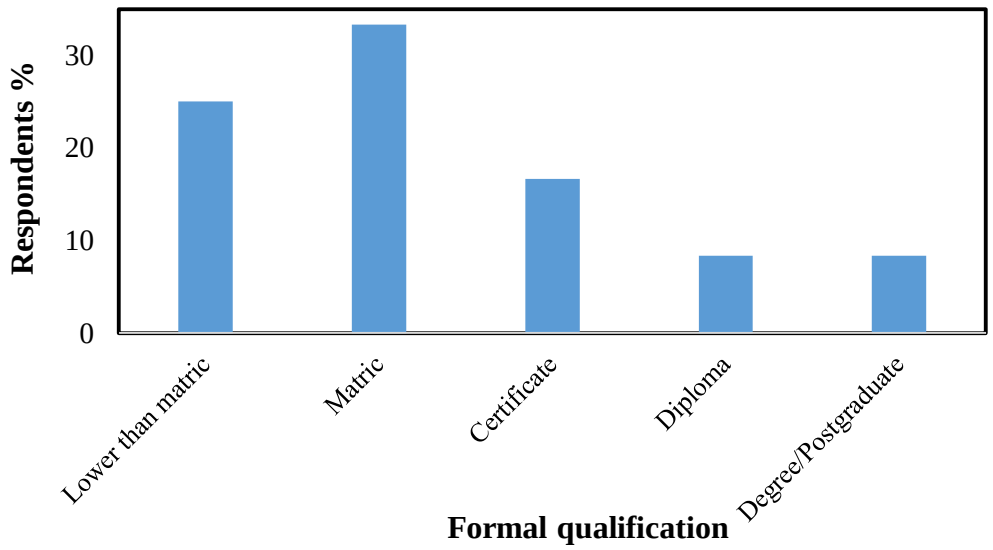

Figure 4.11: Respondents' formal qualifications

4.4. Conclusion

The uptake of green economy practices leading to green jobs creation in the water and wastewater sector is still very low in NW. Small municipalities were the least likely to implement green initiatives such as the use of solar energy, waste utilisation and bioenergy production. It was also observed that the small municipalities were the most affected by adverse weather conditions such as drought. Most plants employ the conventional activated sludge and BNR systems for treatment, and oxidation pond system mostly used by the small municipalities. Whereas a potential exists in utilising energy from renewable sources such as solar and biogas, the initiative to harness such energy is yet to be taken. This has greatly contributed to the low number of green jobs in NW. For NW to create good and an adequate number of jobs, the transition to green economy should be sped up. The wastewater treatment sector is faced with shortage of green and conventional skills that are necessary for effective wastewater treatment and management. Thus, in some of the plants visited, discharge standards set for wastewater effluent was not met. The lack of green skills and knowledge also, hinders transition to GE. Partnership with appropriate training organisation and other relevant organizations is important in providing the needed training to the already employed, but unqualified operators.

NW has a lot of agricultural activities for which effluent water and sludge can be used for irrigation and as manure respectively. This can create more green occupations and encourage green practices. In addition, the fact that a significant proportion of influent to WWT plants is

from abattoirs, a potential for biogas production from the wastewater treated in such plants exists. This is because abattoir wastewater has high methane production potential.

CHAPTER 5

5. Northern Cape Province

Of all the nine provinces surveyed, the Northern Cape (NC) had by far the smallest economy and population. There is no metro municipality in NC with only one secondary city (Sol Plaatje) out of the 32 municipalities. About 20% of the province population resides in Sol Plaatje hence, the sparse population in the other municipalities (Provincial Review, 2016). According to the Department of Water Affairs, there are twenty-seven Water Authorities in NC providing wastewater services through 71 wastewater collector and treatment systems. In this study, three district municipalities were visited for data collection. In all the district municipalities visited, at least two local municipalities were visited except for one district municipality (NC-DM3) as shown in Table 8. Most of the treatment plants visited were of small and medium sizes, treating up to 10 Ml/day. This is because of the sparse population of most of the local municipalities visited. Moreover, uptake of septic tanks for sewage treatment is still very high in the NC, especially in the rural and semi-urban areas. Most of the small size treatment plants operate under-capacity due to the low volume of wastewater influents, as most households are yet to be connected to the sewer line. In some of the populated towns however, large size treatment plants treating up to 25-35 Ml/day are used.

5.1. Company information

The most common methods of treatment employed by the plants visited are activated sludge, biological nutrient removal (BNR) and oxidation ponds (Table 5.1: Summary of Northern Cape visits). The oxidation ponds are mainly employed by small size plants treating 0.5 Ml/day or less of wastewater as was observed in NW. The medium and large size treatment plants mainly use the activated sludge and BNR systems, with a few using oxidation ponds for treated effluent maturation. Some of the plants (such as NC-DM2-LM1-Plant1) have more than two units consisting of old and new treatment works. The two-system treatment is mainly found in populated towns where increase in wastewater influent necessitated plant upgrades. Many of the plants are thus operating within capacity and in some instances under capacity. In one plant visited (NC-DM1-LM2-Plant1), however, the upgrading activities at the time of visit had brought major treatment operations such as clarification and chlorination to a stall leading to discharge of poorly treated effluent to the receiving stream. Moreover, it was reported that due to acute shortage of operators, the plant would sometimes remain unattended.

Table 5.1: Summary of Northern Cape visits

DM visited	No. of LMs visited	Number of plants visited	Technology used for treatment
NC-DM1	2	5	Oxidation ponds, Activated sludge and BNR
NC-DM2	2	1	Oxidation ponds, Activated sludge and BNR
NC-DM3	1	1	Activated sludge and BNR

Key: DM- District Municipality, LMs – Local Municipalities, WWT – Wastewater treatment BNR – Biological nutrient removal

The demographic profile of the wastewater treatment plants visited in NC is given in Table 5.2. Since most of the plants were of small or medium size, a majority (85%) as expected, employed less than fifty employees/operators for the running and maintenance of plants. Most plants visited (70%) were commissioned more than 25 years. Given the sparse population and low rate of urbanization, most of the plants have operated under-capacity since commissioning, hence there has been no need to construct new plants or upgrade existing ones. This scenario is expected to remain so, however, most of the plants would fail to cope with an abrupt increase in wastewater influent. This is because of poor and inadequate maintenance coupled with operational deficiencies observed at the small sized plants.

Table 5.2: Demographic profile of plants visited in NC Province

		Percent (%)
Size of plant	Small (less than 50 employees)	85
	Medium (50–100 employees)	15
	Large (more than 100 employees)	0
Age of plant	10 – 25	30
	More than 25	70
Plants' employees' qualifications	Lower than matric	12
	Matric	61
	Certificate	23
	Diploma	2
	Degree/Postgraduate	2
Employees' occupation type	Direct green occupation	7
	Indirect green occupation	35
	Occupation unrelated to green jobs	58

Most of the employees/operators (62%) at the plants visited had the highest qualification of matriculation, with no other formal qualification on water care. A few (23%) had some formal qualification (certificates and diplomas) on water care or related courses. The low number of qualified operators was associated with the poor remuneration offered by most local municipalities in NC, leading to poor retention of skilled personnel. Most operators, after obtaining the right qualification, migrate to other municipalities or organizations that remunerate better. The poor remuneration also means that the local municipalities cannot attract skilled and experienced operators. There were few green practices/technologies employed by the visited municipalities, hence the low number (7%) of employed directly involved in green jobs. At NC-DM2-LM1-Plant1 in NC-DM2 district municipality, the treated wastewater effluent is supplied to a neighbouring mine company for reuse. The uptake of green economy and related technologies for wastewater treatment is very low in NC despite the existing potential for GE.

5.1.1. Barriers to uptake of green occupations

The greatest barrier to uptake of green technologies and practices (Figure 5.1) at the plants visited was lack of appropriate training on green skills. Most of the employees lacked any formal training on water and wastewater treatment and only operated based on experience obtained from on-the-job training under the supervision of senior operators. The lack of conventional water care skills by most employees make it even harder for the introduction of and training on green treatment systems and technologies, respectively. Understaffing is also a major challenge faced by municipalities in NC particularly smaller ones. Some of the plants (such as NC-DM1-LM2-Plant1) visited had very few operators onsite with only a single shift of operation against the recommended two shifts or more, based on the size of the plant. As companies adopt green technologies, adequate number of employees will be needed for the successful implementation and running of such technologies.

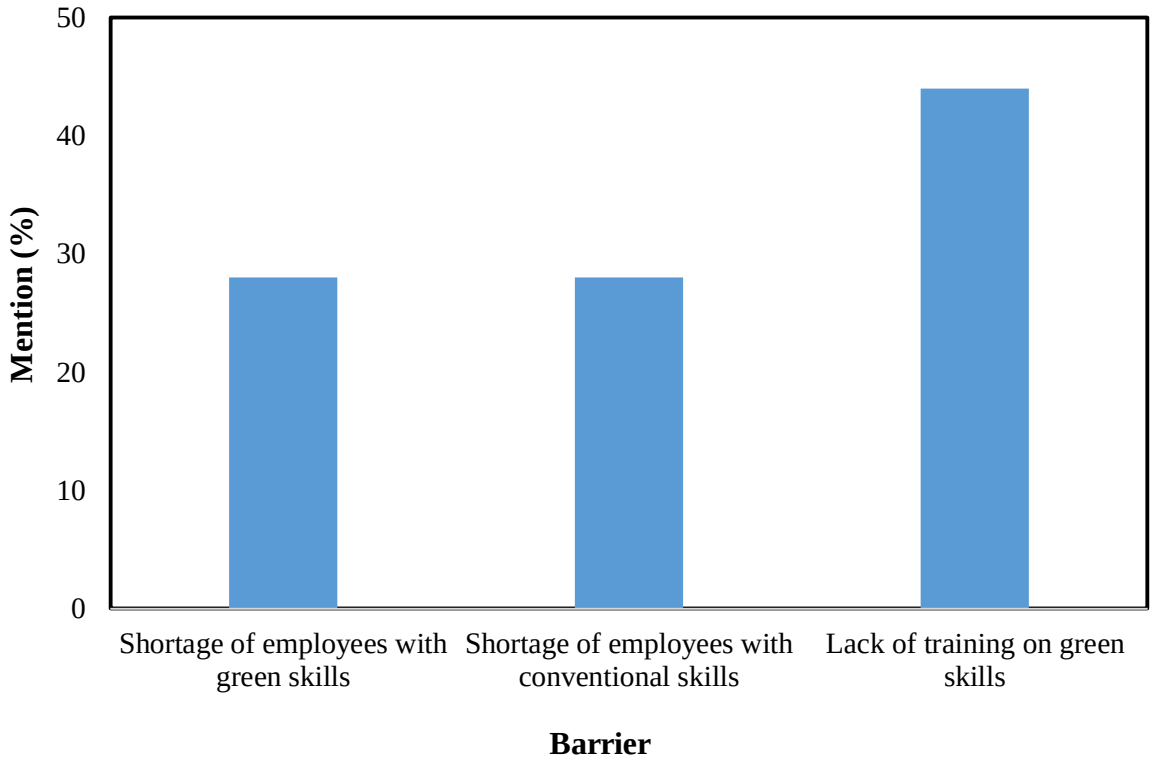

Figure 5.1: Barriers to green occupations in wastewater treatment in NC Province

5.1.2. Training required to meet the skills shortage

To meet the skills shortage gap, most of the plants would prefer in-house or on-the-job training for the already employed operators (Figure 5.2). Like observed in NW, this would allow the operators to undertake their operational duties while undergoing training. It is also expected that such an arrangement would allow for personnel retention. University training was the least preferred possibly because on completion it would be very difficult to retain the trained individual given the poor remuneration of WWT operators by most of the municipalities visited in NC. The problem of lack of university training has been compounded by the fact that, for many years, NC did not have a university. However, universities and technical colleges outside of NC can play an important role in designing and offering short training courses, that can equip the already employed and experienced operators with necessary skills on green wastewater treatment.

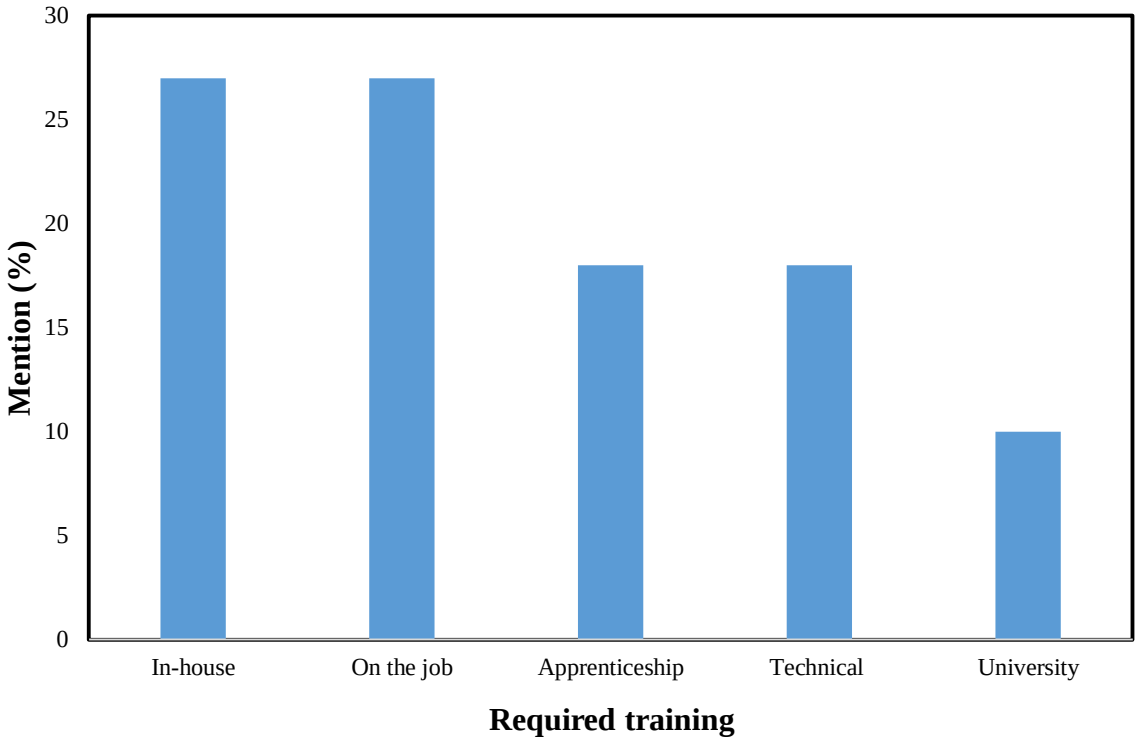

Figure 5.2: Preferred training by WWT plants in NC Province

5.2. Potential for green jobs creation in NC Province

Given the low capacity of most of the treatment plants, despite having domestic waste as the largest source of wastewater (Figure 5.3), application of anaerobic digesters for biogas production is not feasible. However, for the few large sized treatment plants, anaerobic digestion of the waste active sludge can be carried out in the process producing bioenergy. The sludge from the anaerobic digesters can then be dried, classified and then sold as manure. NC is endowed with a lot of sunshine, hence, the installation of solar energy to supplement the energy requirement of the treatment plants should be considered. Another potential for green jobs and practices creation is by applying the treated effluent for reuse in agriculture for irrigation. Such reuse of effluent was observed at NC-DM2-LM1-Plant1 as discussed in section 5.1. The dried sludge (Figure 5.4), a common product in most plants visited can also be utilized as manure in farms after appropriate processing and classification, instead of being disposed of.

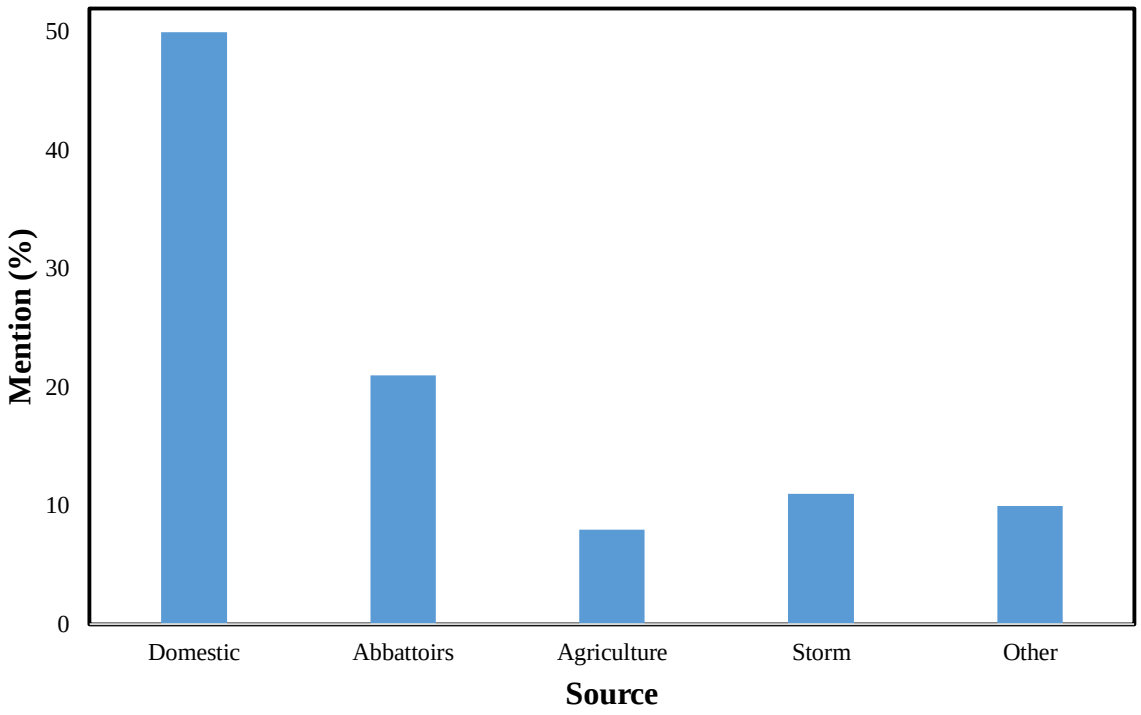

Figure 5.3: Sources of wastewater in NC Province

Figure 5.4: Unutilized dried sludge at NC-DM2-LM1-Plant1 that could be sold as manure after classification

5.3. Employee information

The individual employees at the respective treatment plants visited were interviewed to obtain their view on matters such as understanding of green jobs, awareness plans for green jobs put in place by the companies, their demographic profile and work experience. The cumulative information gathered from all the plants visited in NC was analysed and is given in the sections that follow.

5.3.1. Employees awareness of green occupations

Most of the employees interviewed could associate green jobs with several sectors of the economy except for tourism. In waste management, all the employees (Figure 5.5) were aware that green jobs existed or could be created. This could be because of the ease of creation and several green jobs already created in waste management such as waste plastic recycling. A minority could not associate green jobs with sectors such as renewable energy, construction and agriculture, indicating that the employees were not entirely conversant with the concept of green jobs and technologies. The high association of waste management with green jobs provides a suitable ground for introduction of such jobs and green technologies. The employees were already aware of the potential waste management has in green job creation and therefore are likely to be receptive to green initiatives. Renewable energy leads to the creation of green jobs. However, some of the employees (15%) identified the renewable energy sector as having no green jobs. This could be attributed to a lack of clear understanding of either what renewable energy or green jobs entail.

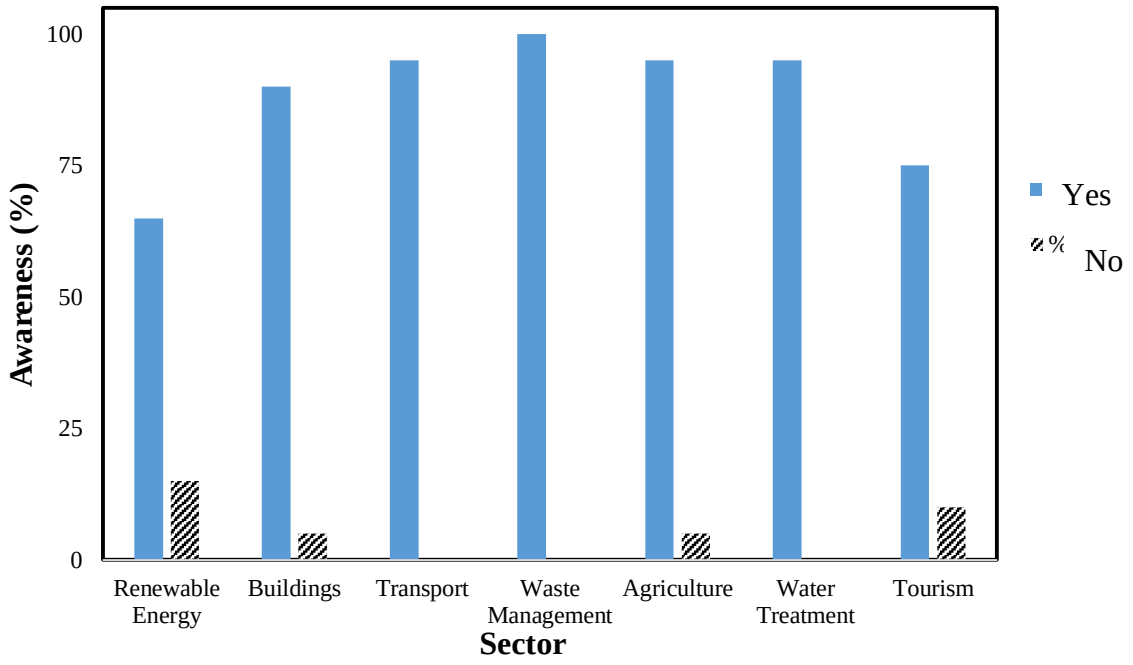

Figure 5.5: Sectors associated with green jobs as per water and wastewater treatment employees in NC Province

Green jobs are mainly aimed at protecting the environment and providing safe working conditions to the employees and communities involved. Green jobs also provide quality career level opportunities. It was therefore important to gauge the employees understanding of the

advantages of green jobs. It was noted that while most employees knew where green jobs could be found or created, they did not really understand what green jobs entail as shown by the diverse feedback (Figure 5.6). However, a majority agreed that green jobs can provide safe working conditions, provide a safe working environment and reduce pollution. The lack of in-depth understanding is also seen from very few respondents who either strongly disagreed (5%) that green jobs have negative impacts on the environment, or strongly agreed (30%) that green jobs reduce global warming. Green jobs are intended at protecting the environment and creating safe working conditions. Any individual with an in-depth understanding of green jobs is therefore, expected to strongly affirm to the statements associating green jobs with environmental protection.

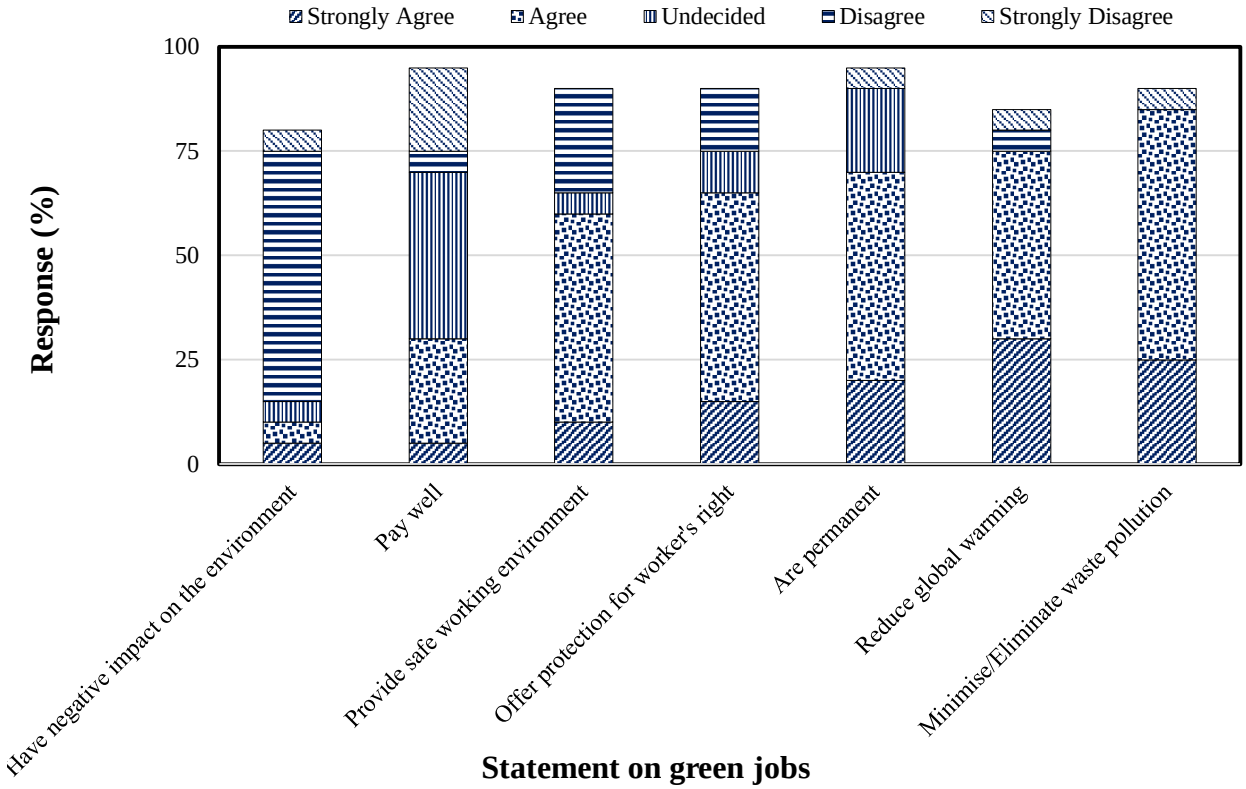

Figure 5.6: Green occupations' awareness level

5.3.2. Employees awareness of company green occupations plans and practices

The employees were further interviewed to gauge their awareness of green jobs plans and programs existing in their companies. From Figure 5.7, it can be seen that the majority did not have any idea of their company's green jobs plan. This could be attributed to poor communication between the management and the operators. Many of the operators interviewed could therefore not respond adequately to the questions on green jobs plan due to lack of

information. The minority that could give conclusive answers comprised largely senior operators or plant managers. The uncertainty on green jobs plan could also be linked to the poor understanding of green jobs.

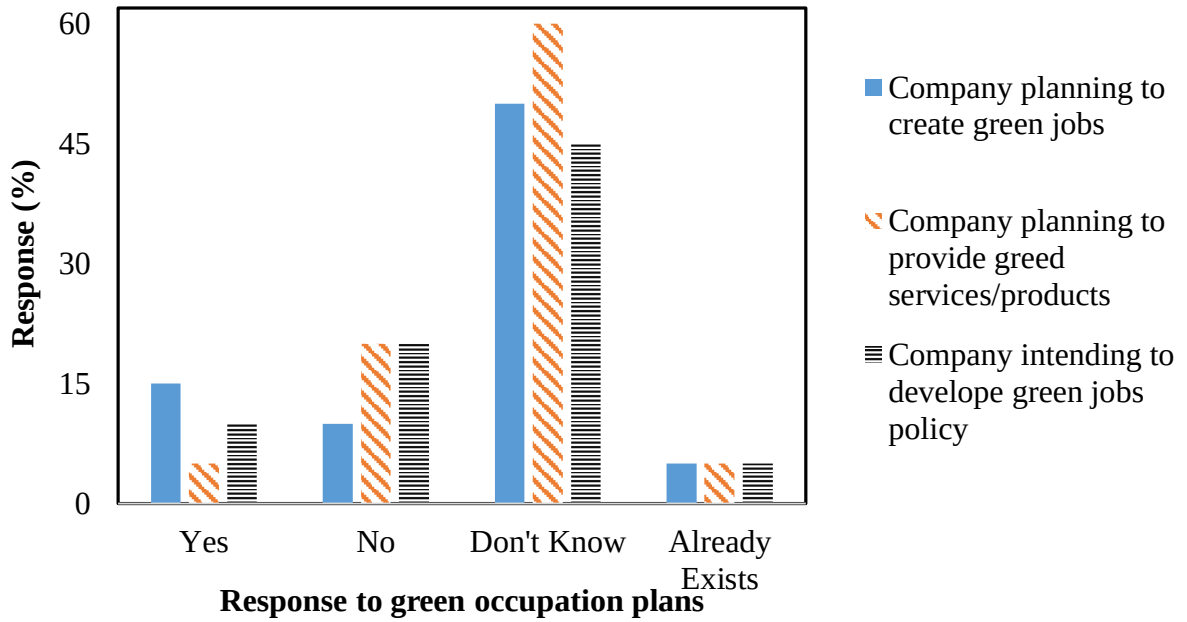

Figure 5.7: Employees awareness of company green occupation plans in NC

Figure 5.8 shows the employees' awareness of existing green jobs and technologies at their respective places of work. Green technologies such as value addition through manure classification and bioenergy production in form of biogas were non-existent according to the interviewed employees. Other activities such as water use and energy efficiency, and waste utilisation were reported to exist. These activities can be classified as green though not necessarily leading to green job creation. The interviewed employees could easily identify the existence of these technologies as they are in most cases directly involved in such activities.

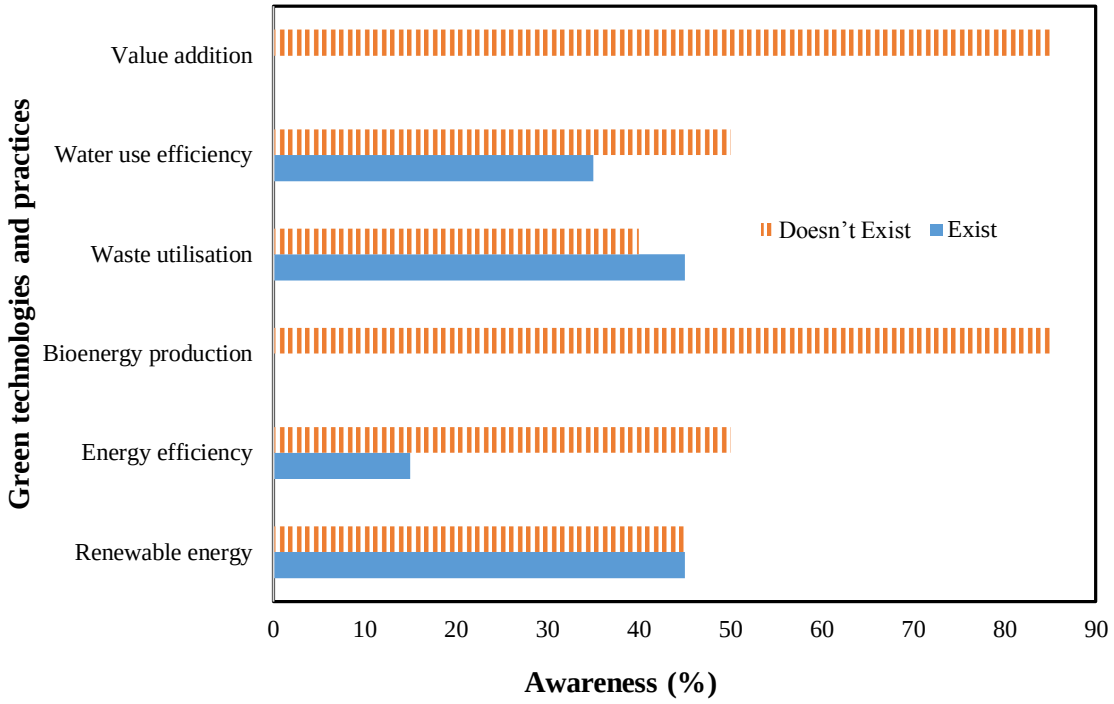

Figure 5.8: Employees' awareness of existing green technologies and processes

The major challenge to green jobs creation as identified by employees, was lack of green skills (Figure 5.9). Green jobs creation is a relatively new idea in South Africa. Most training providers do not equip their trainees with the necessary skills for green practices and technologies. This therefore leads to lack of qualified personnel with green skills required for transitioning to green technologies and practices. Moreover, most wastewater treatment employees in NC lack post matriculation qualifications, thus limiting their knowledge of both conventional and emerging green skills. Lack of funding, inadequate training and the cost of installing green technologies were other major challenges. Most green technologies or equipment used have high initial capital cost that is out of reach of the sparsely populated NC municipalities.

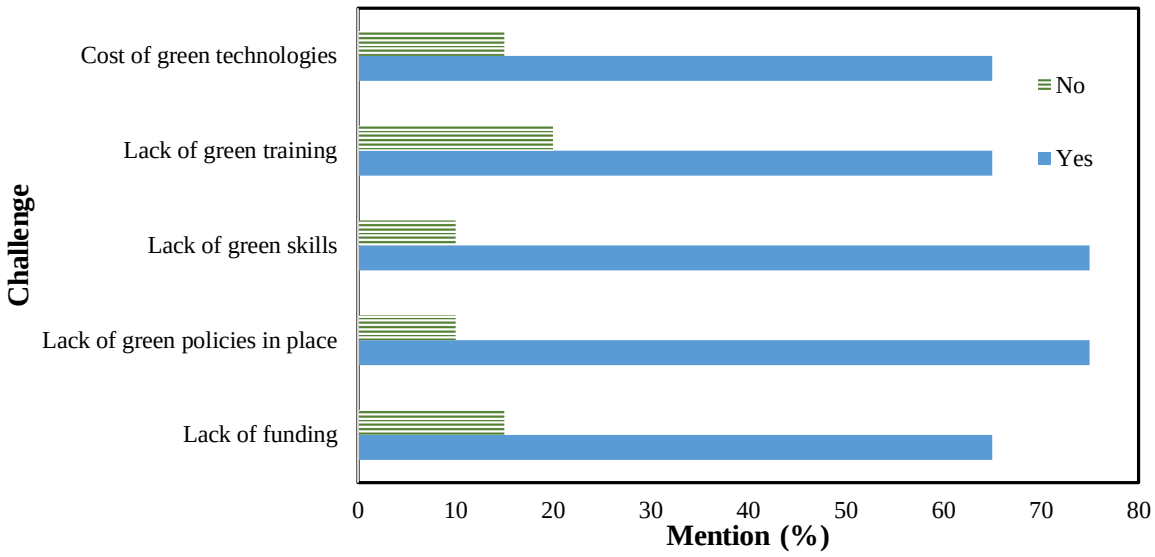

Figure 5.9: Challenges to green jobs creation in NC

5.3.3. Demographic information of the interviewed employees

Unlike other provinces, a good number (47%) of the employees interviewed in NC were women. The women employees were employed as plant managers, operators and general workers, just like their male counterparts. In plant NC-DM2-LM1-Plant1, gender distribution trend different from that of the province was observed, as most employees of the plant at the time of the visit (80%) were females. Figure 5.10 and Figure 5.11 give the gender and age distributions of the respondents, respectively. Of all the employees interviewed, 50% were aged between 30 and 39 years while 28% were aged in the range of 40-49. The 50% have gained enough experience on the job but with little training to upgrade their skills. A potential, therefore, exists for the training of the current staff to equip them with new skills necessary for transition to green jobs and technologies.

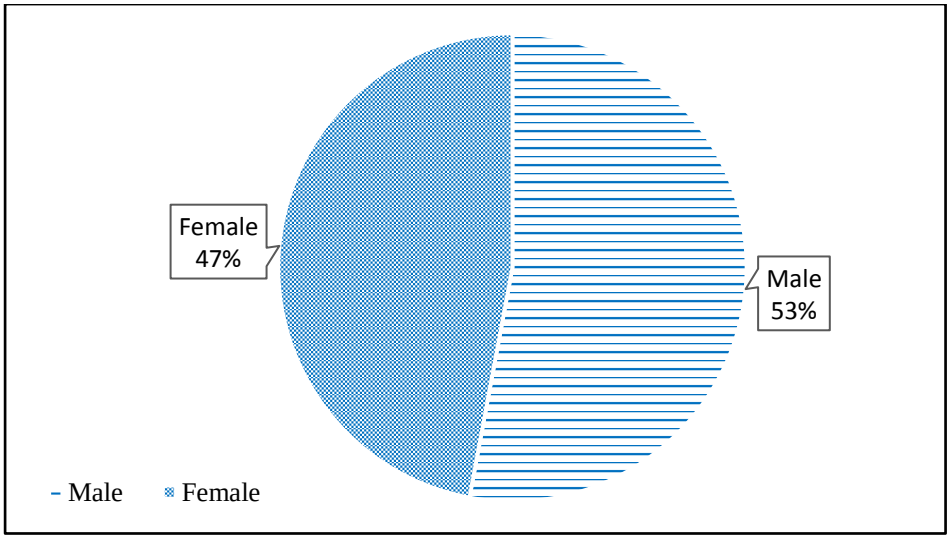

Figure 5.10: Gender distribution of respondents

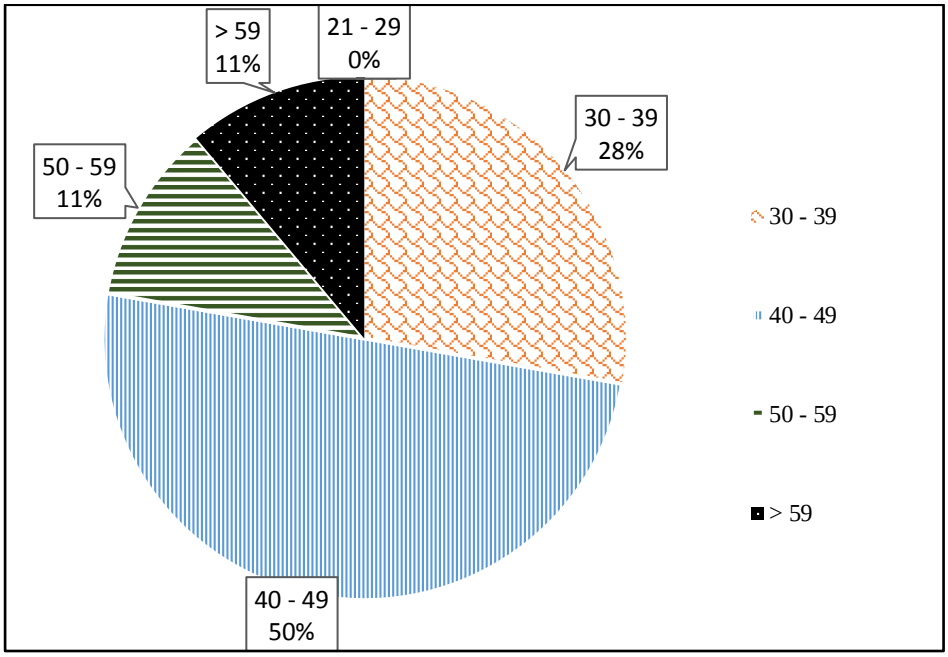

Figure 5.11: Age distribution of respondents

The occupational distribution of the interviewees (Figure 5.12) shows that a significant proportion (44%) was majorly employed as operators followed by labourers at 38%. These two categories are likely to be found at the treatment plants as compared to management and technical staff who are likely to oversee operations at more than one treatment plant. A low number (5%) of the employees was on a learnership program in a few of the plants visited. Being far from organizations such as Rand Water and technical colleges, the NC treatment plants are unlikely to receive students on learnership programs, hence the low number.

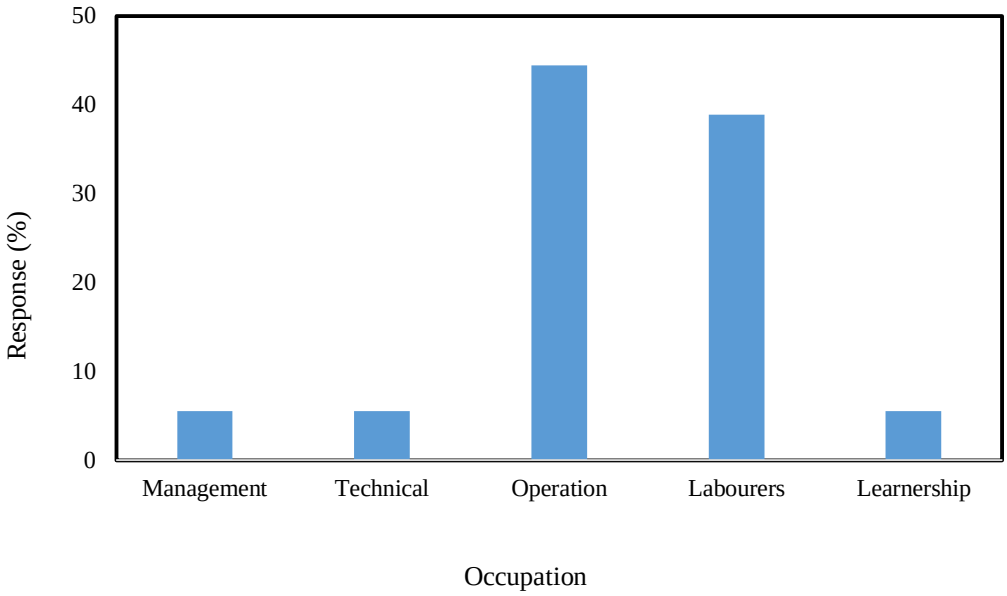

Figure 5.12: Occupational distribution of respondents

The highest formal qualifications of employees play a significant role in the overall performance and ease of further training and learning. According to Figure 5.13, most of the employees interviewed (47%) had not attained matriculation certification. A further 23% had only matriculation certification. This shows that a majority (70%) did not have formal qualification on water care and related training. The low qualifications of the employees could be due to the brain drain experienced by most municipalities in NC, and lack of regular training for the already employed. The few who had formal qualifications appropriate to wastewater treatment were mainly employed as managers or senior operators. The low qualifications observed could explain the lack of in-depth understanding of green jobs by most employees.

Through continued on-the-job training and introduction of refresher courses, the unqualified employees can be equipped with necessary skills for effective wastewater treatment. Green skills and technologies can be introduced to the employees during such trainings. On-the-job training would be very appropriate for skills development given that most of the employees interviewed had gained enough work experience as shown in Figure 5.14. The knowledge already gained would easily facilitate the skills training in terms of practical experience.

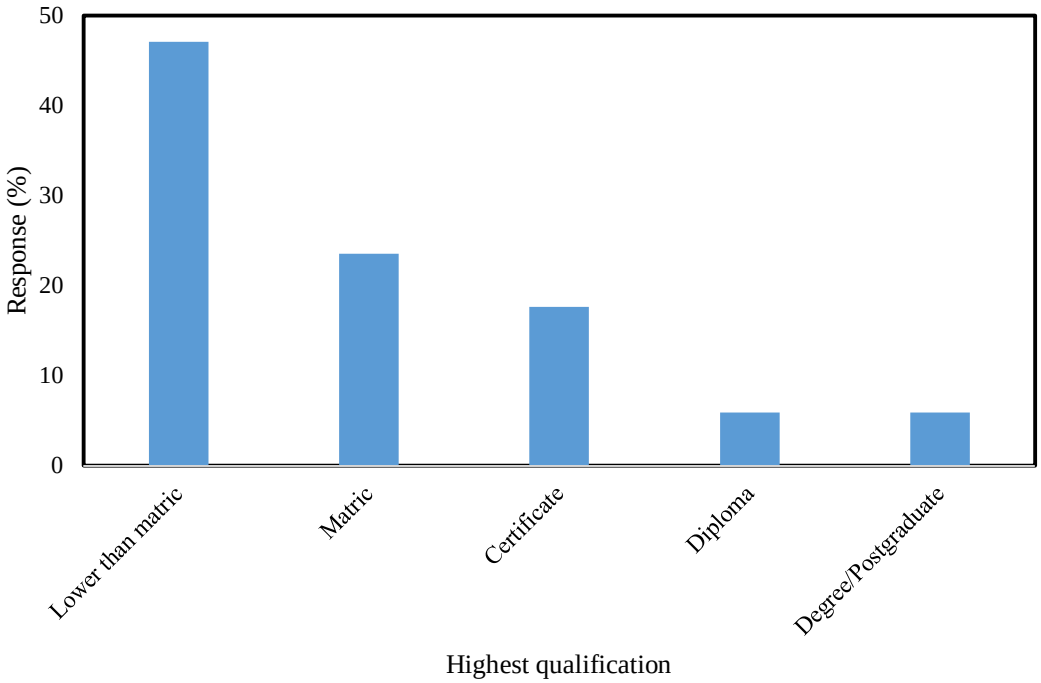

Figure 5.13: Formal qualifications of respondents

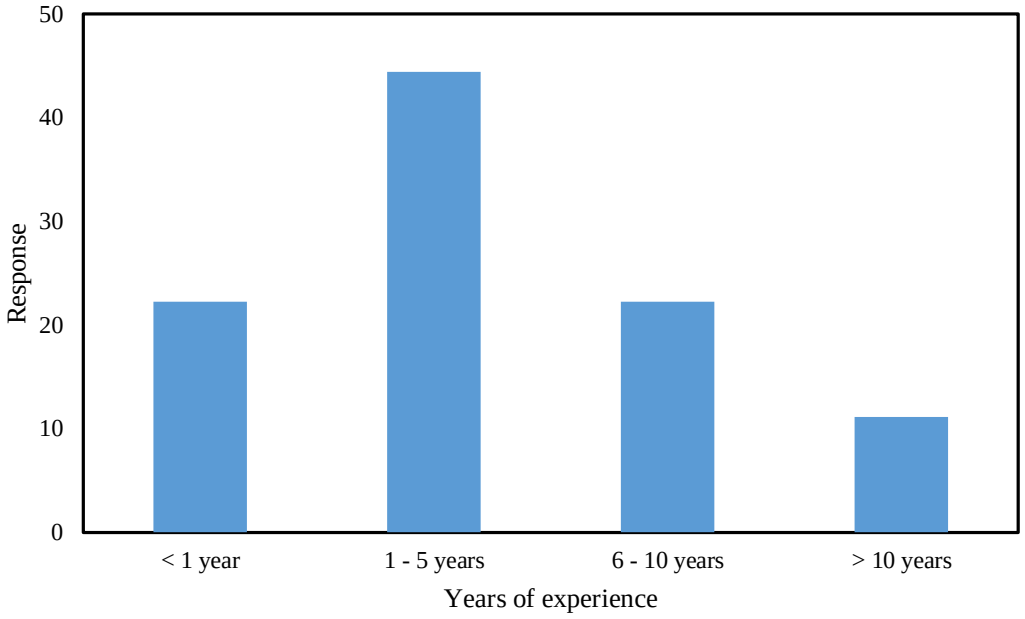

Figure 5.14; Years of experience of respondents

5.4. Conclusion

Of the nine provinces surveyed, NC had the least populated local municipalities as signified by the high number of small WWT plants. Uptake of green economy in the water and wastewater treatment sector was very low in NC despite the high potential for solar energy production and

re-use of treated effluent for irrigation purposes. The low uptake could be due to the small size of the treatment plants and the sparsely populated local municipalities. Most small size municipalities are unlikely to implement green technologies and processes at WWT plants due to financial constraints.

Results show that many plants in NC operate below capacity. This can be an opportunity given the fact that the problem of system overload does not exist, consequently the treated wastewater is expected to be low in substrate. Such kind of wastewater can easily be managed both in anaerobic and aerobic systems to produce effluent with low pollution load. In the context of GE, such kind of effluent can be further treated for domestic use. Given that NC is very dry, there is a great demand for clean water which can be obtained from the WWT plants if effective technology systems are installed. Unlike many provinces, NC had a high percentage (47%) of women employees. By capacitating these municipalities through GE initiatives. The problem of gender equity observed in the other provinces will be addressed since a good proportion of the beneficiaries will be women. It was further observed that there is acute problem of brain drain as most highly qualified professionals move to cities like Johannesburg and Cape Town. Green occupations will help reverse this trend.

CHAPTER 6

6. KwaZulu-Natal Province

6.1. Company information

A total of 15 wastewater treatment plants were visited in the selected six district municipalities and one metropolitan municipality of KwaZulu-Natal (KZN). The questionnaires together with oral interviews carried out during plant tours, were used to obtain information about the plants visited. The information of interest included size of plant (capacity and number of employees), technologies in use, green jobs uptake and the challenges thereof. Table 6.1 shows the number of plants visited and the technologies employed.

Table 6.1:Summary of KwaZulu-Natal visits

District Municipality	Number of LMs visited	Number of WWT plants visited	Technology used
KZN-DM1	1	2	Activated sludge and BNR
KZN-DM2	2	3	Oxidation ponds, Activated sludge and BNR
KZN-DM3	1	2	Oxidation ponds, Activated sludge and BNR
KZN-DM4	2	2	Oxidation ponds, Activated sludge and BNR
KZN-DM5	2	2	Activated sludge and BNR
KZN-DM6	2	2	Oxidation ponds, Activated sludge and BNR
KZN-MM		2	Oxidation ponds, Activated sludge and BNR

Key: DM- District Municipality, LMs – Local Municipalities, MM-Metropolitan Municipality, WWT – Wastewater treatment, BNR – Biological nutrient removal

The demographic profile of WWT plants visited in KZN is summarized in Table 6.2. All of the WWT plants visited had less than 50 employees (Table 6.2). All the WWT plants visited in KZN have been operational for more than 10 years, varying between 23 and 52 years in operation.

The management of the WWT plants was asked to provide the formal qualification information for their employees. Many employees had no matriculation/grade 12 qualification (48%), and only 19% of the employees had matriculation. Some of the employees had undergone on-the-job training in order obtain the national qualification framework (NQF) certificates (25%). Technicians supporting the WWT plants and managers had high formal qualifications such as diplomas (6%) and degrees (2%).

Table 6.2: Demographic profile of plants visited in KZN province

		Percent
Size of plant	Small (less than 50 employees)	100
	Medium (50–100 employees)	0
	Large (more than 100 employees)	0
Age of plant (years)	Less than 10	0
	10 – 25	9
	More than 25	91
Plant employees qualifications	Lower than matriculation	48
	Matriculation	19
	Certificate	25
	Diploma	6
	Degree/Postgraduate	2
Employees occupation type	Direct green occupation	27
	Indirect green occupation	33
	Occupation unrelated to green jobs	40

In the fifteen WWT plants visited in KZN, 40% of the employees engage in functions unrelated to green activities. This is mainly due to the limited green technologies currently in place. About 27% of the employees had direct green occupations. This includes operation of anaerobic digesters for manufacturing of biogas, classification of dried sludge and distribution as manure to local farmers. The remaining 33% had indirect green jobs that include primary functions of the plant and green related tasks such as normal running of the plant, drying of sludge and analyses of effluent water before being discharged to the river and to farmers for irrigation purposes.

6.1.1. Barriers to uptake of green occupations

The major barriers to green activities in the WWT plants visited in KZN were shortage of employees with green skills (35%) and lack of training on green skills (32%) as shown in Figure 6.1. There are currently limited green technologies in the WWT plants visited in KZN and this results in fewer employees involved in green jobs. There was no training previously offered on green skills and this results in fewer employees with green skills. The shortage of employees with conventional skills was also identified as a barrier (26%). This type of training is supposed to equip employees of the WWT plant with skills such as the operation of the plant, sample taking and dealing with deviations from normal working procedures. Employees were complaining that even this type of training is very limited due to budget constraints experienced by the Skills Development Facilitators. Employees should be well trained in conventional ways of running the WWT treatment plant as a prerequisite for the training of green skills. A small number of the respondents (6%) thought that the lack of government policies was one of the barriers. The respondents were not aware that the green economy policies have been rolled out at provincial level.

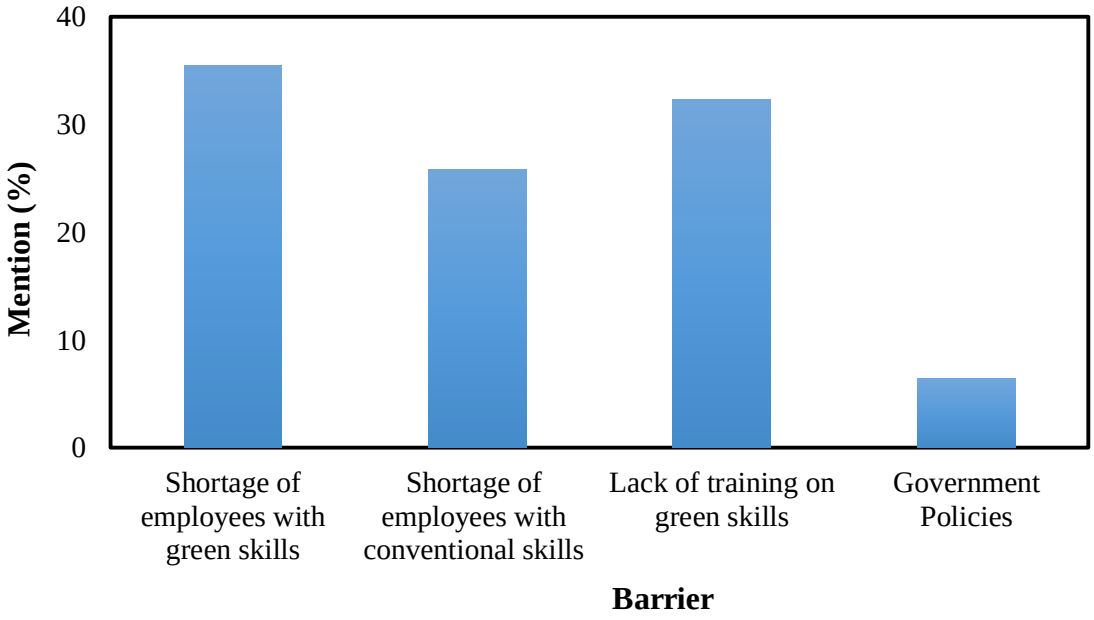

Figure 6.1:Barriers to green occupations in wastewater treatment in KZN Province

6.1.2. Training required to meet the skills shortage

The concept of green technologies/occupation was foreign to most of the employees of the WWT plants visited. There was no training previously offered to them in terms of green

economy, green technologies or green occupations. The training that they have been attending was on the conventional methods of running the WWT plants. The training required in addressing the shortage of green skills (Figure 6.2) as identified by the employees and management of the WWT plants were on the job training (28%), in-house training (24%) and apprenticeship (16%). The WWT plants visited would like to have a trainer on site to facilitate the green skills development. As observed in other provinces, university (8%) and technical college training (12%) were the least preferred skills development methods because it would mean that the WWT plant operators must be on study leave for extended periods yet there is a limited number of employees on site. University and technical college training would be ideal for future employees on the learnership-training program since a high number of current employees do not have grade 12 and will not qualify for the university programs. Some 12% of the respondents felt that hiring employees in the future with green skills would address the shortage of green skills in the WWT plants. This will be an ideal case when the green technology/skills have been incorporated in the tertiary education training programs.

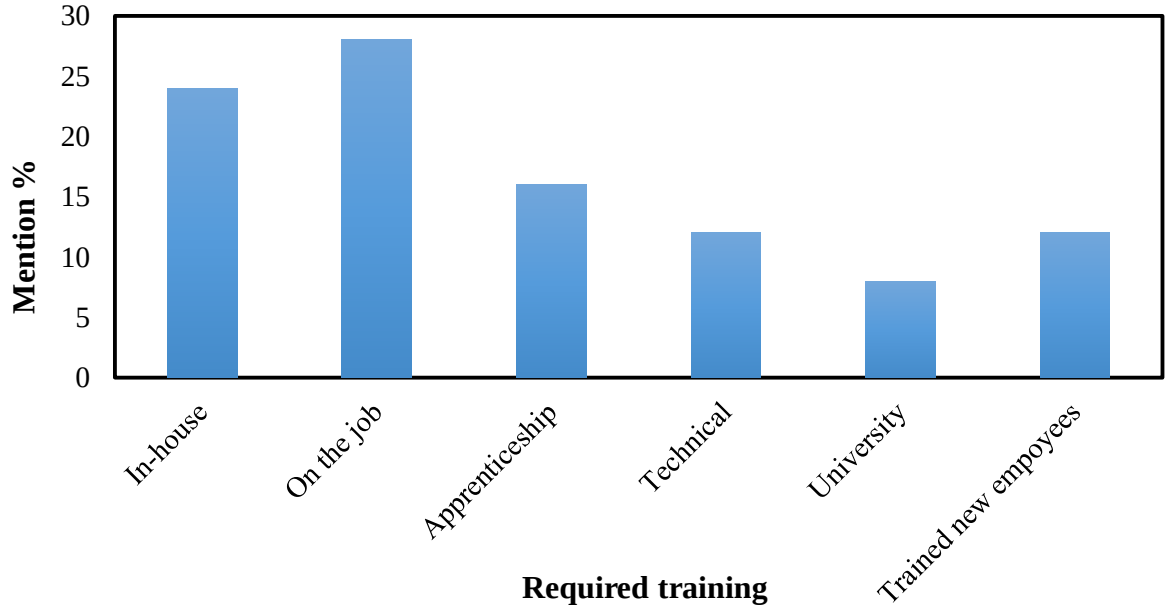

Figure 6.2:Preferred training by WWT plants in KZN Province

6.2. Potential for green jobs creation in KZN Province

Since KZN is one of the hottest provinces in South Africa, it has the potential to create green jobs in wastewater treatment by incorporating solar energy into the treatment process. The agricultural sector of the province could benefit from the adoption of a green treatment process by the various treatment plants. Some of the plants already have anaerobic digesters where biogas is vented into the atmosphere (KZN-DM4-Plant1, KZN-DM4-Plant2, KZN-MM-Plant1

and KZN-MM-Plant2), while in some plants the digesters were not in operation at the time of the visit (KZN-DM2-Plant1, KZN-DM5-Plant2 and KZN-DM6-Plant1). These digesters can be repaired and the harvested biogas used for electricity generation. Some of the potential strategies that could spur green jobs creation include:

- Reuse of treated water for irrigation (KZN-DM2-Plant2 and KZN-DM6-Plant2 are already doing this)
- Conversion of sludge into dry sludge compost
- Installation of anaerobic sludge digesters capable of electricity production from biogas. Some of the WWT plants visited already have anaerobic sludge digesters but the gas is vented into the atmosphere. The biogas should be harvested and used for electricity generation
- Installation of solar energy to supplement the energy requirements of the treatment processes

About 50% of the WWT plants visited are very old and are not functioning properly. It is recommended that some of these potential strategies be incorporated when these WWT plants are upgraded to increase green jobs. The main sources of wastewater (Figure 6.3) in the WWT plants visited in KZN were domestic wastewater (33%), storm water (30%) and small industrial wastewater (17%). There was limited wastewater from abattoirs (10%) and agricultural sector (10%). Most of these WWT plants were built around communities to process domestic waste.

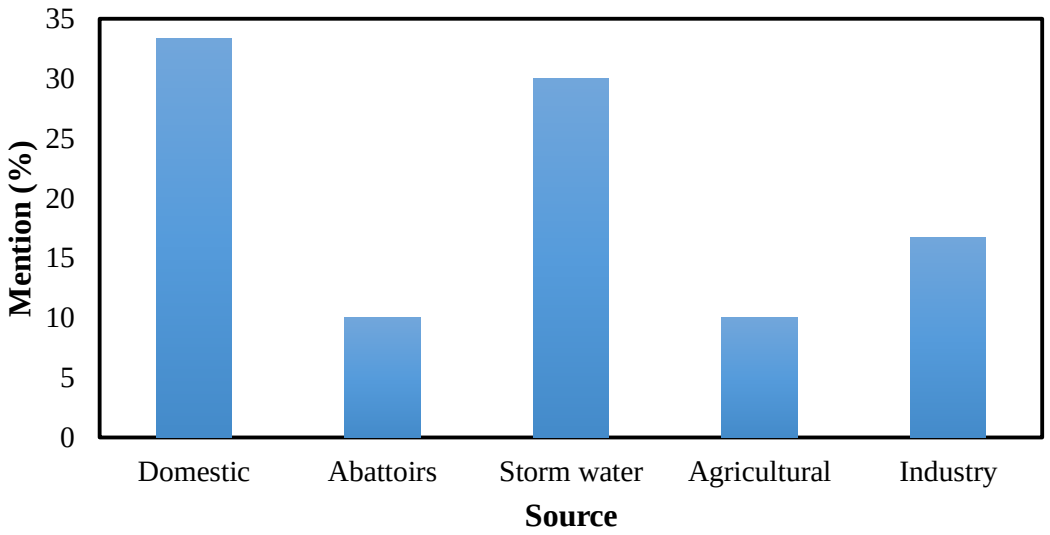

Figure 6.3:Sources of wastewater in KZN province

6.3. Employee information

The employees and management of the WWT plants were interviewed and asked to fill in the questionnaire on the employee information in Appendix 2. This was done to determine the level of green occupation awareness and to identify the challenges to green jobs creation.

6.3.1. Employees awareness of green occupations

The respondents were asked to identify different sectors that have green occupations. Most employees and management of the WWT plants were not aware of what green technologies/occupation are. After the concept of green occupation was explained, they could easily identify sectors such as renewable energy (98%), waste management (98%), agriculture (92%), water treatment (88%) and buildings (82%) as having green occupations (Figure 6.4). Transport and tourism were the least associated with green occupations. This could be due to the limited knowledge of these sectors by the respondents. Most of the respondents are not involved with the tourism activities.

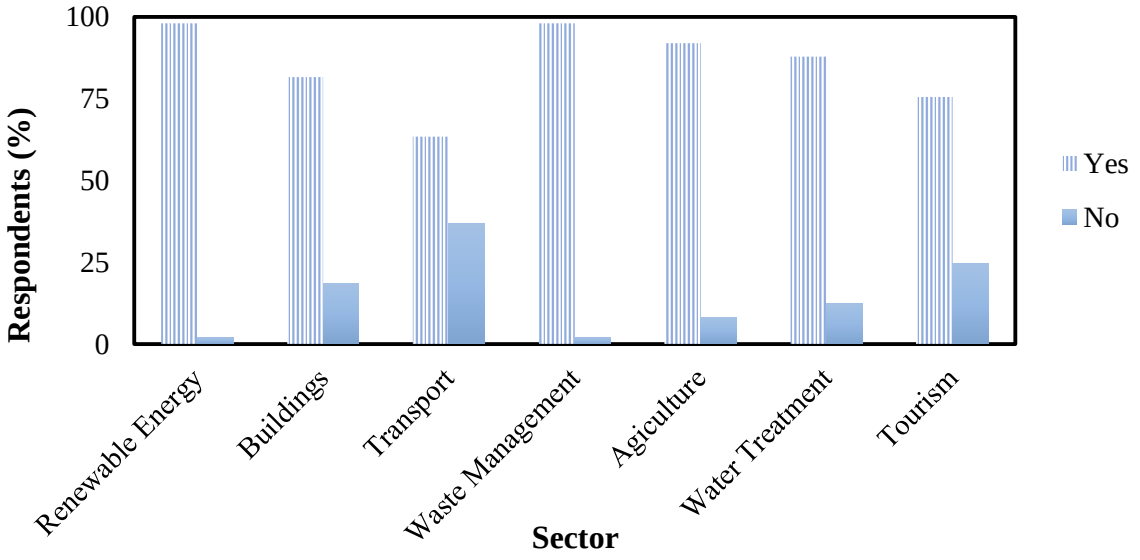

Figure 6.4:Sectors associated with green jobs as per wastewater treatment employees in KZN province

The level of green occupation awareness was further assessed by asking the respondents to give their views on certain statements about green occupations. More than 70% of the respondents agreed that green occupations provide a safe working environment, offer protection of workers' rights, are permanent, reduce global warming and eliminate/minimize waste pollution (Figure 6.5). This shows that the respondents understood these positive aspects

of green technology/green jobs. Even after a detailed explanation of what green occupations are, some of the respondents were still struggling to grasp these concepts about green occupation. This can be seen by 24% of the respondents that still thought that green occupations would have a negative impact on the environment yet green occupations are aimed at protecting the environment. The difficulty in understanding the green concepts might be due to the low level of formal qualification by some of the respondents. The other contributing factor to the limited understanding of green technologies and occupations was that there was no training on green technologies and skills that has been offered to the respondents in the past. Most of the respondents were undecided on the statement that green jobs pay well (45%). This is mainly due to the limited information that the respondents are exposed to in terms of green jobs.

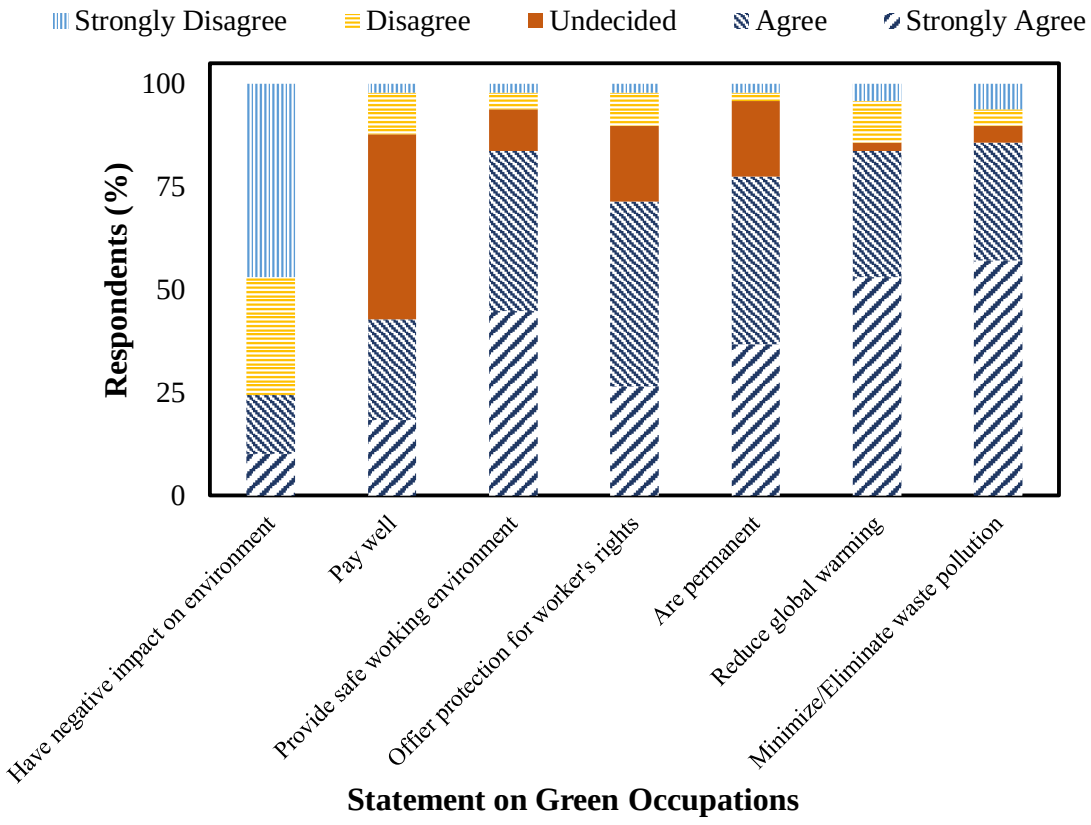

Figure 6.5:Green occupations awareness level

6.3.2. Employees awareness of the WWT plant green occupation plans and practices

It is important for the employees of the WWT plants to be aware of the plans from management for the creation of green jobs because this will directly impact their day-to-day operations. The awareness of employees on future green occupation plans is shown in Figure 6.6. It was evident

that most employees were not aware of the green economy plans from their WWT plant. Even though the green economy has been rolled out at the provincial level, this information has not been cascaded down to the employees of the WWT plants. This can be seen from Figure 6.6 where some of the employees were not aware of the municipal plans for green occupations. Those employees and management that responded "yes" to the municipality occupation plans, when they were further asked the reason for responding "yes", they said it was mainly because of this research that was conducted by VUT/LGSETA on green occupations. They assumed that since this research was conducted the municipality was planning to create green jobs and green products. This lack of awareness is mainly due to poor communication between the employees and management. Even some of the superintendents in the WWT plants were not aware of the green economy that has been rolled out at provincial level because it was not communicated to them.

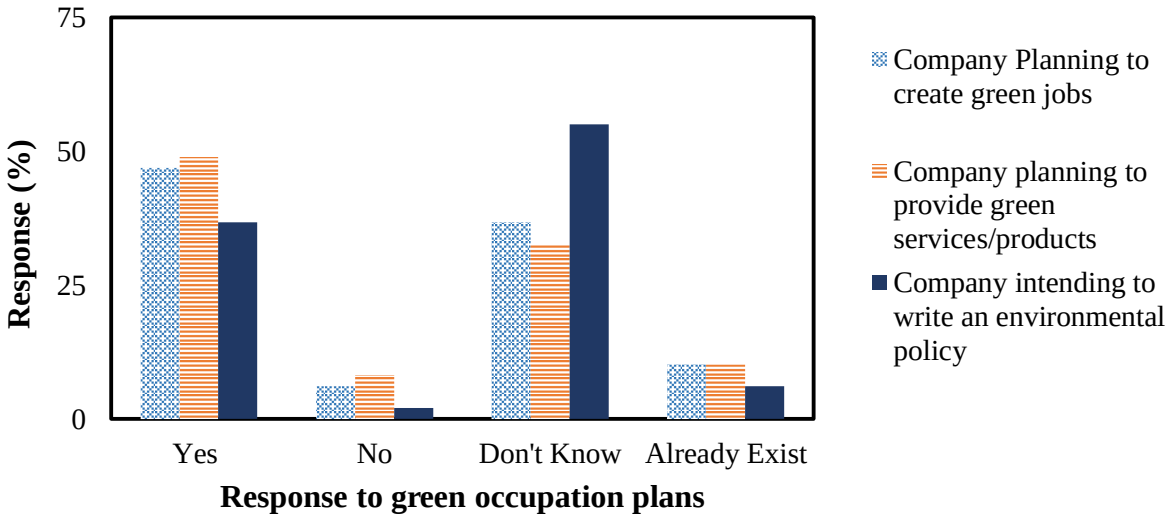

Figure 6.6:Employees awareness of company's green occupations plans

The respondents were further asked to identify green practices and processes that currently exist in their WWT plants (Figure 6.7). The existing green technologies that were most selected by the respondents were water use efficiency (80%), waste utilization (67%) and energy efficiency (61%). Some of these processes will mainly contribute to the reduction of operating cost, but offer limited green occupations. The main technologies with high potential for green occupations such as bioenergy production, renewable energy and value addition currently do not exist in most of the WWT plants visited and were the least identified by respondents. Biogas produced from anaerobic digesters will be used to generate electricity and renewable

energy, e.g. solar panels to generate electricity will reduce the amount of electricity the municipality must buy from Eskom. These methods of generating electricity are friendly to the environment.

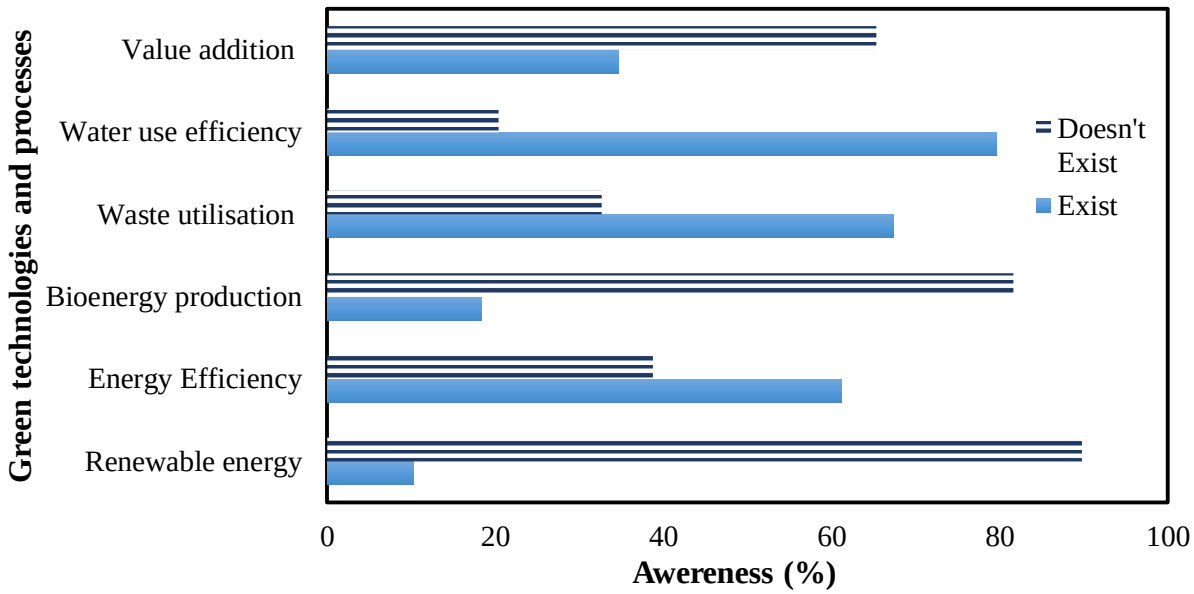

Figure 6.7: Employees awareness of existing green technologies and processes

The respondents were then asked to identify the challenges to creating green jobs in their WWT plants (Figure 6.8). The main challenges to green jobs creation are the lack of green skills, cost of green technologies, lack of green training and lack of funds. The lack of green technologies was observed during the visit to the WWT plants. Most of the WWT plants were old and some of the sections were not working properly due to poor maintenance. Poor maintenance was attributed to the lack of funds and poor prioritization at municipality level. If municipality is still struggling to maintain the existing infrastructure due to lack of funds, it might be a challenge to channel funds towards green technologies. The conventional WWT plant training is also lacking due to limited funds and it will be a problem to initiate the green skills training.

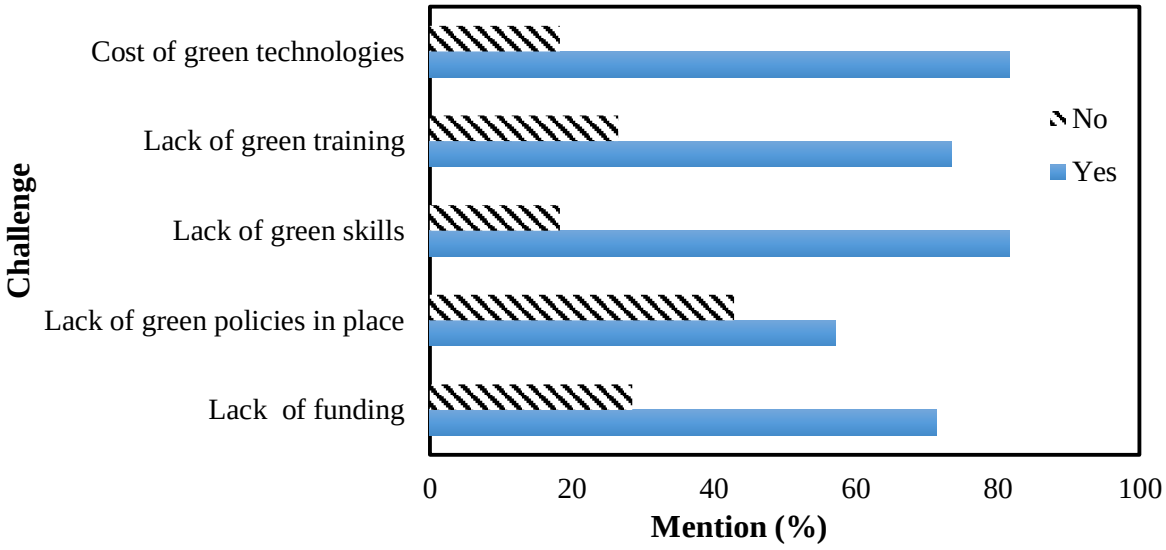

Figure 6.8:Challenges of green jobs creation

6.3.3. Demographic information of the interviewed employees

The last section on the questionnaire was on the demographic information of the respondents such as age group, gender, highest qualification, role in the organization and the number of years in their current position. Most respondents (71%) were male with the remaining 29% being female (Figure 6.9). There is currently a high intake of females on the learnership-training program. Most of the female respondents were labourers (cleaners) while most males were operators.

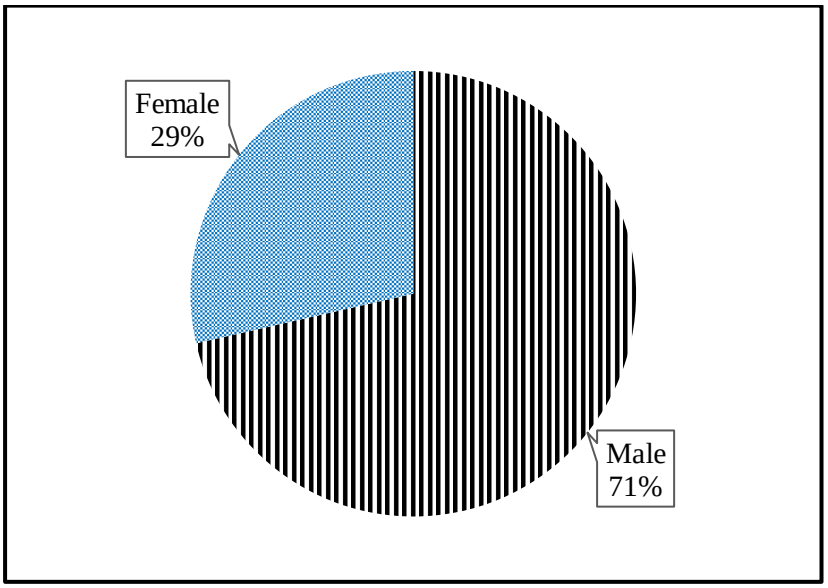

Figure 6.9: Gender distribution of respondents

Most respondents were aged between 30-39 years (33%), 20% were aged between 40-49 years while another 16% were aged between 50-59years (Figure 6.10). About 2% were older than 59 years old. The younger respondents (aged 29 and less) were 28%. The majority of the younger generation are on the learnership programs as part of preparation to take over from the older generation (succession planning). About 43% of the workforce has been in their current position for more than 10 years (Figure 6.11). If there is no good succession plan the knowledge and skills will be lost when these employees retire or resign.

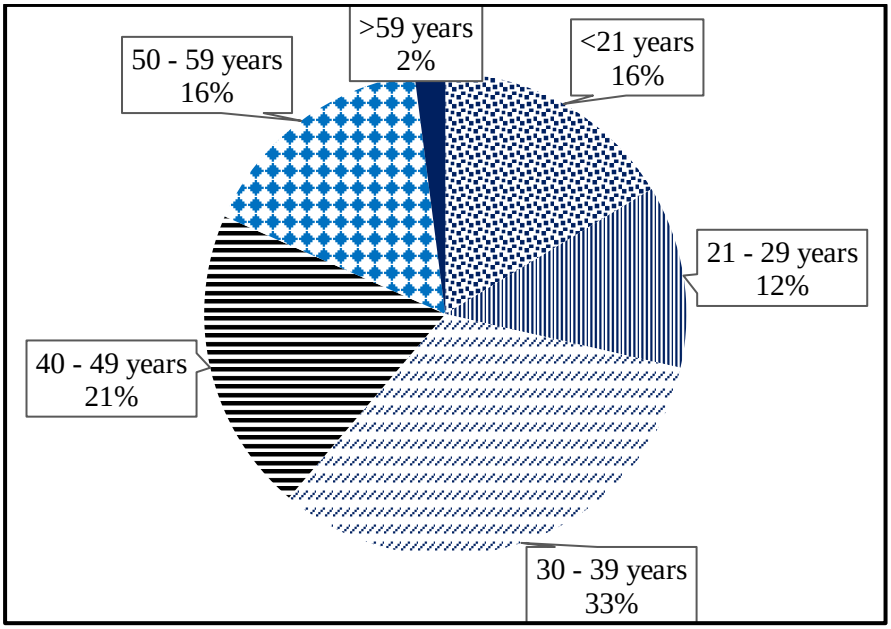

Figure 6.10: Age distribution of respondents

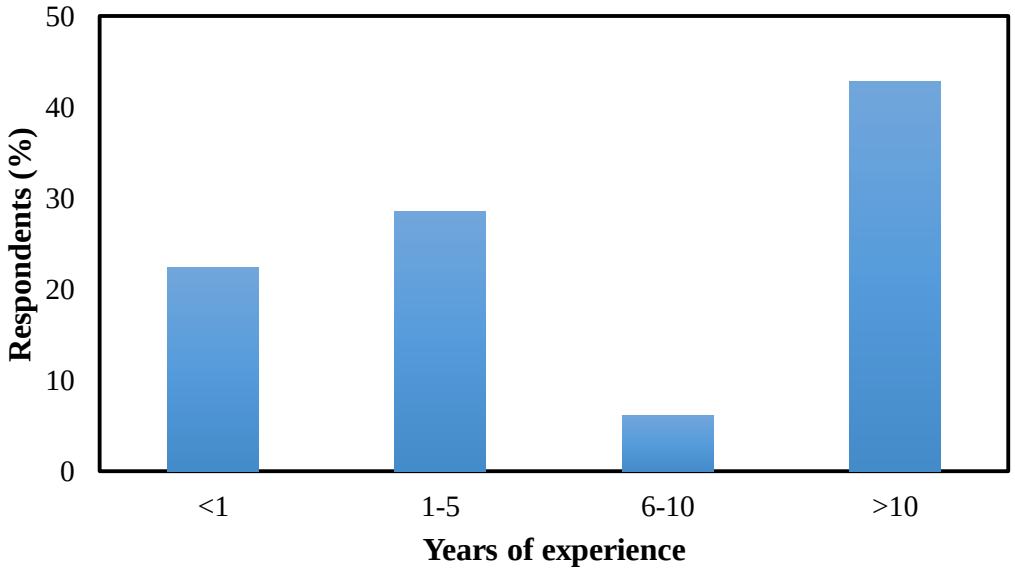

Figure 6.11:Respondents number of years in current position

The roles of the respondents in the WWT plants visited in KZN are shown in Figure 6.12. Most of the respondents were operators (41%), labourers (22%) and managers (14%). Respondents on learnership-training programs were 8% and those in administration positions 4%.

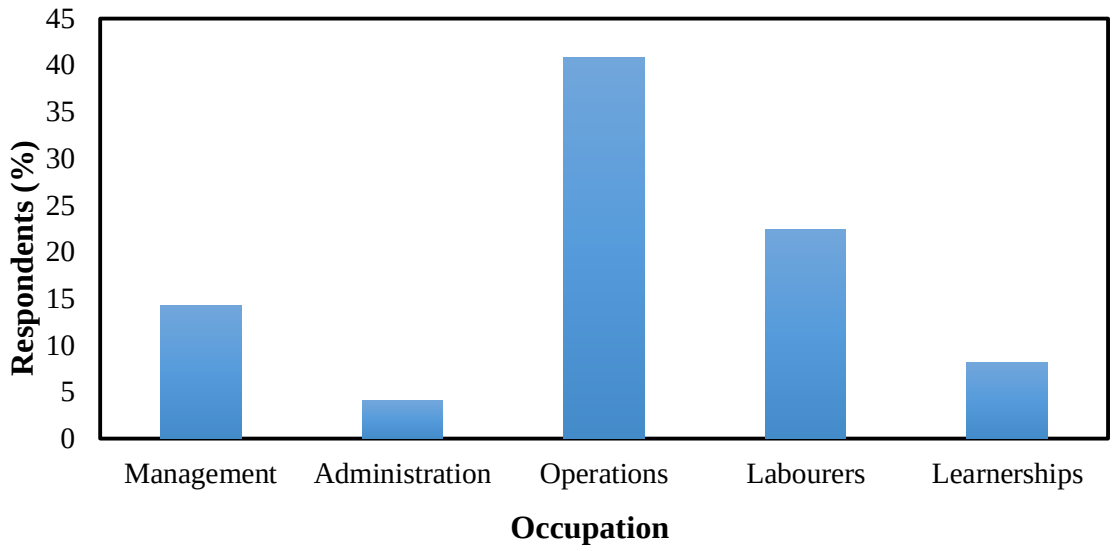

Figure 6.12:Respondents occupational distribution

The highest formal qualification distribution of the respondents is shown in Figure 6.13. The highest number (31%) had matriculation qualification, closely followed by 29% with lower than matriculation qualification. About 26% of the respondents had NQF certificates. Some of the respondents with NQF certificates did not have matriculation qualifications. The lack of understanding of green technologies and occupations is attributed to the level of education (lower than matriculation) of most respondents and lack of technologies and training on green skills. The qualification reported by management (Table 6.2) did not correspond to the one reported by employees in Figure 6.13. This might be due to some of the employees not telling the truth about their qualifications when they were completing the questionnaire. Some may be referring to the qualifications that were still in progress.

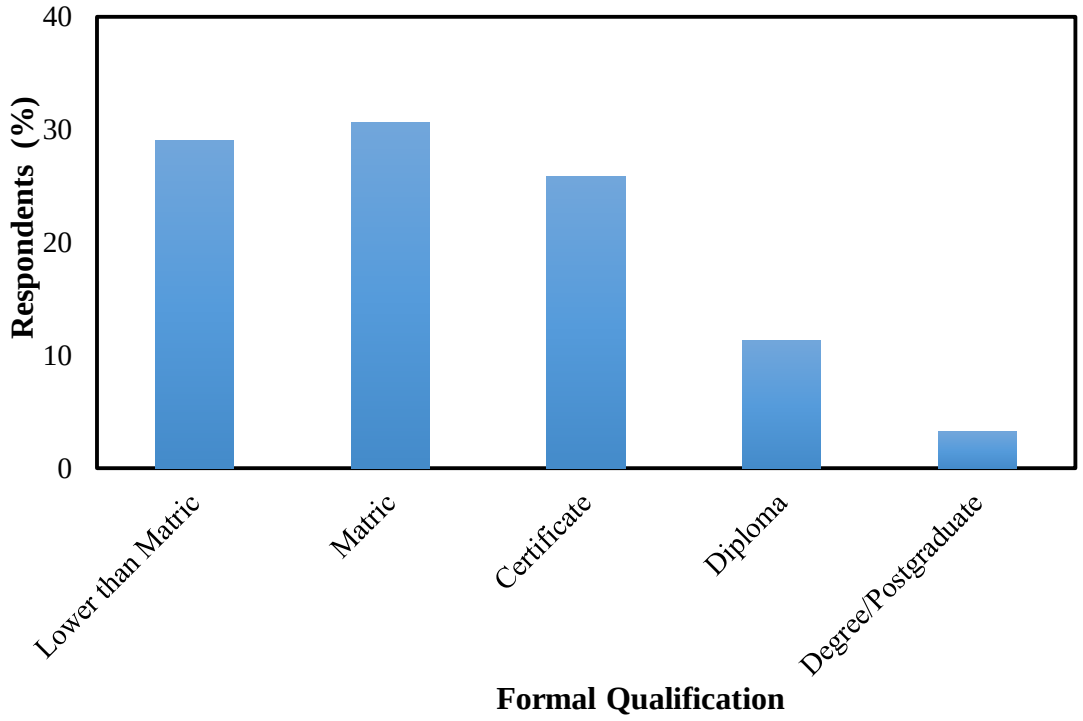

Figure 6.13: Respondents formal qualification

6.4. Conclusion

The general conditions of the WWT plants visited were better as compared to WWT plants in MP, NC and NW provinces. However, there is currently lack of green technologies in place in most of the WWT plants visited, which has resulted in the lack of green occupations. It is recommended that when these plants are upgraded, the green technologies need to be implemented. This will include the installation of anaerobic digesters with the possibility of electricity generation from biogas. The plants that are currently venting biogas into the atmosphere, should harvest the biogas and used it for electricity generation. About 48% of the employees that were interviewed had no matriculation. Future employees should have at least grade 12. If employees have at least grade 12 they can be sent to technical colleges for training.

There was poor communication between WWT plant employees and municipal officials responsible for initiating developments such as transitioning to green technologies. It is recommended that the level of communication between WWT plant employees and senior management be improved. The employees should always be aware of new developments taking place. The visibility of government's green economy policies as well as the flow of information on green technologies should be improved. If the management increased

communication on green plans, the employees would be well prepared for the transition to green technologies and occupations. Strategies such as reuse of water for irrigation and conversion of sludge into compost for use by local farmers should be implemented. This will empower the local communities and reduce the carbon footprint of the plants. The succession plan in the WWT plants in KZN is better than several other provinces. About 61% of the employees are younger than 39 years. KZM municipalities should continue employing the younger generation on the learnership training program to take over when the older generation retire or resign.

In the case of KZN, the most feasible approach to create green occupations could be the use of treated wastewater in sporting facilities. The high volume of storm water dilutes the substrates in the WWT facilities and this is likely to create problems to AD systems and thus, affecting the methane production potential. Abattoir wastes are known to have high methane production potential, but in the case of KZN WWT plants, amount of abattoir effluent reported was very low. The reason for this is not obvious. It could be due to the eating habits of the inhabitants in the region or other reasons, such as the disposal method used. Some of the abattoirs may be discharging untreated waste illegally into the Indian Ocean. This would have a negative impact on tourism. This is an area that needs further investigation.

It was reported that infrastructure maintenance and replacement rate is low in KZN. This is likely to cause problems in the near future if no action is taken immediately. In light of this respondents reported that maintenance is a priority over green economy.

CHAPTER 7

7. Mpumalanga Province

7.1. Company information

Mpumalanga province (MP) has three district municipalities. A total of eleven WWT plants were visited in the selected 8 local municipalities. The management of the WWT plants was interviewed and requested to complete the company information questionnaire with relevant information applicable to their WWT plants. The company information questionnaire and the interview questions were created with an aim to establish the involvement of the WWT plant in terms of green occupations. The number of WWT plants visited per local municipality and the technologies employed are shown in Table 7.1.

Table 7.1: Summary of Mpumalanga visits

District Municipality	Number of LMs visited	Number of WWT plants visited	Technology
MP-DM1	4	5	Oxidation ponds, Activated sludge and BNR
MP-DM2	2	4	Oxidation ponds, Activated sludge
MP-DM3	2	2	Oxidation ponds, Activated sludge and BNR

Key: DM- District Municipality, LMs – Local Municipalities, MM-Metropolitan Municipality, WWT – Wastewater treatment, BNR – Biological nutrient removal

The demographic profile of WWT plants visited in MP is summarized in Table 7.2. All the WWT plants visited had less than 10 employees. The plants have been operational for more than 10 years, varying between 23 and 52 years in operation. The management of the WWT plants was asked to provide information on the formal qualification of their employees. Most of the employees had matriculation/grade 12 (44%) and only 28% of the employees had no matriculation. Some of the employees had undergone on-the-job training in order to obtain the national qualification framework (NQF) certificates (23%). Technicians supporting the WWT plants and managers had high formal qualification such as diplomas (3%) and degrees (2%).

There was one employee in one of the WWT plant who had a postgraduate degree and is currently an operator because of the limited jobs in her area of expertise.

Table 7.2: Demographic profile of plants visited in MP Province

		Percent
Size of plant	Small (less than 50 employees)	100
	Medium (50–100 employees)	0
	Large (more than 100 employees)	0
Age of plant (years)	0 -10	0
	10 – 25	10
	More than 25	90
Plant employees qualifications	Lower than matric	28
	Matric	44
	Certificate	23
	Diploma	3
	Degree/Postgraduate	2
Employees occupation type	Direct green occupation	18
	Indirect green occupation	27
	Occupation unrelated to green jobs	55

In the eleven WWT plants visited in MP, 55% of the employees engage in functions unrelated to green activities. This is mainly due to the limited green technologies currently in place. About 18% of the employees had direct green occupations. This includes operation of anaerobic digesters for manufacturing of biogas, classification of dried sludge and distributing this as manure to local farmers. The remaining 27% had indirect green jobs that include primary functions of the plant and green related tasks such as normal running of plant, drying of sludge and analysis of effluent water before it is sent to the river and to local farmers for irrigation purposes.

7.1.1. Barriers to uptake of green occupations

The low number of employees at the treatment plants directly involved in green occupations was attributed to the lack of green technologies in place. Moreover, it was noted that lack of training on green skills is also a great contributor to the low uptake of green jobs (Figure 7.1). The current training in place is only aimed at equipping the present employees with conventional skills for wastewater treatment process control, thus enabling them to attain NQF

ratings. There were low numbers of employees with the conventional skills as seen by the 24% who recognized shortage of skilled employees as being a barrier to uptake of green jobs. Whereas green skills are needed for effective wastewater treatment, employees should be equipped with the conventional skills as a prerequisite for training on green skills and technologies. A small number of the respondents (12%) thought that the lack of government green economy policies was one of the barriers. This is due to the lack of information to the respondents that the green economy policies have been rolled out on provincial level.

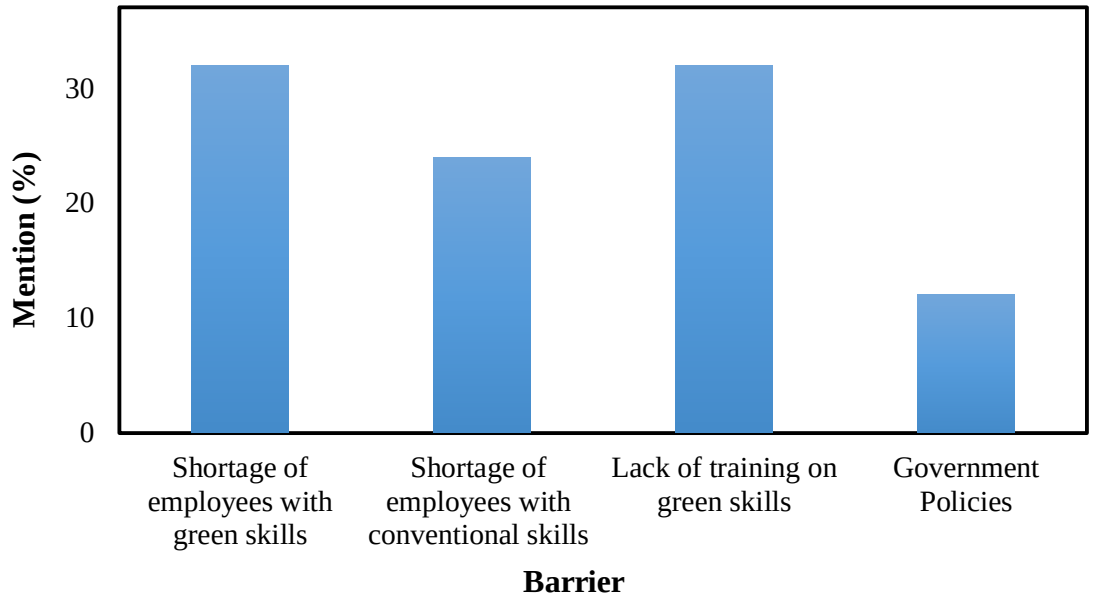

Figure 7.1:Barriers to green occupations in wastewater treatment in MP Province

7.1.2. Training required to meet the skills shortage

The concept of green technologies/occupation was foreign to most of the employees of the WWT plants visited. There was no training previously offered to them in terms of green economy, green technologies or green occupations. The training that they have been attending is on the conventional methods of running the WWT plants. The training required to address the shortage of green skills (Figure 7.2) as identified by the employees and management of the WWT plants were in-house training (27%), on the job training (21%) and technical college training (18%). The WWT plants visited need a trainer on site to facilitate the green skills development. There are currently some employees sponsored by municipalities to undergo training at nearby technical colleges to gain skills on the conventional WWT treatment, and that is the reason technical college training was in the top three most preferred methods of training. University training (12%) and apprenticeship (6%) were the least preferred skills

development method. As reported in the case of KZN, the university training was low because it would mean that the WWT plant employee must be on study leave for extended periods yet there is a limited number of employees on site. Some 15% of the respondents felt that hiring employees in the future with green skills will address the shortage of green skills in the WWT plants. This will be an ideal case when the green technology/skills have been incorporated into the tertiary education training programs.

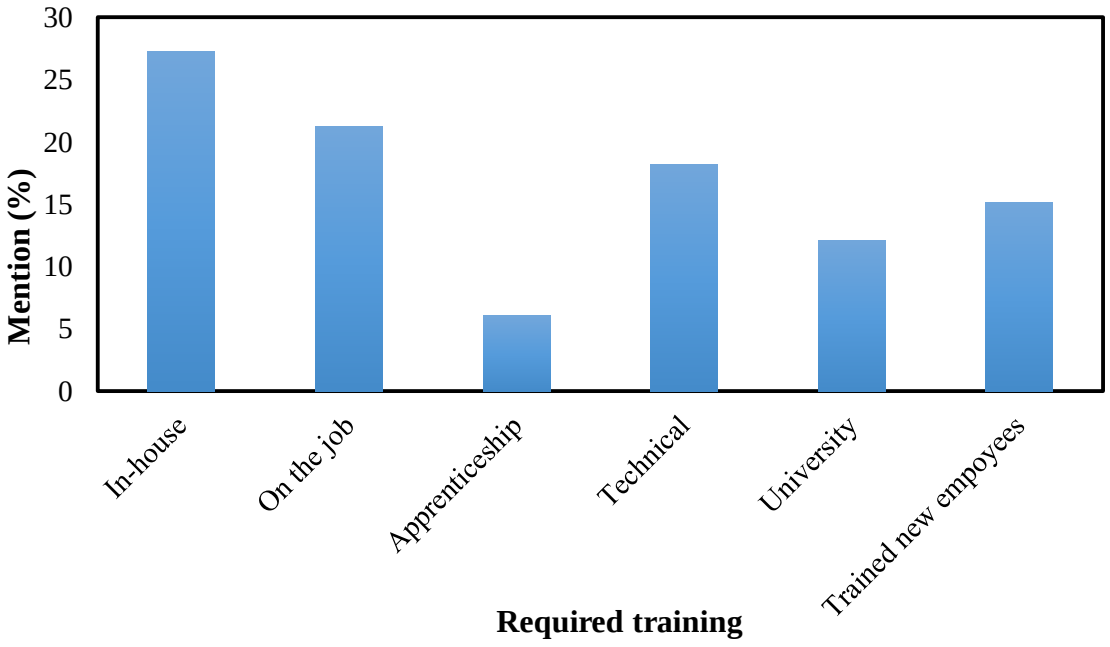

Figure 7.2: Preferred training by WWT plants in MP Province

7.2. Potential for green jobs creation in MP Province

Mpumalanga province is the largest producer of coal used to produce most of the electricity used in the country. MP has the potential to create green jobs in wastewater treatment by incorporating solar energy into the treatment process and thus reducing the carbon footprint of electricity generation. The agricultural sector of the province could benefit from the adoption of a green treatment process by the various treatment plants. Some of the potential strategies that could spur on green jobs creation include:

a) Reuse of treated water for irrigation
b) Conversion of sludge into dry sludge compost (MP-DM1-LM2-Plant1 was using the dried sludge as compost in one of the nearby farms owned by the municipality)

c) Installation of anaerobic sludge digesters capable of electricity production from biogas. MP-DM2-LM2-Plant1 has 10 bio-digesters. There is a project currently in the pipeline to get solid waste from the nearby WWT plants and feed it into these bio-digesters. The increased biogas produced will be used to generate power from the power generation plant that is going to be constructed

d) Installation of solar energy to supplement the energy requirements of the treatment processes

e) Most of the WWT plants in MP are very old (MP-DM1-LM1-Plant1, MP-DM2-LM2-Plant1, MP-DM3-LM1-Plant2 and MP-DM3-LM2-Plant1) and some are in very bad condition (MP-DM2-LM1-Plant1, MP-DM2-LM3-Plant1, MP-DM2-LM4-Plant1). They are in serious need for an upgrade. Green technologies must be incorporated when upgrades are done such as anaerobic digesters

The main sources of wastewater (Figure 7.3) in the WWT plants visited in MP were domestic wastewater (34%), storm water (31%) and small industrial wastewater (17%). There was limited wastewater from abattoirs (10%) and agricultural sector (7%). The distribution of main sources of wastewater in MP is almost similar to the one in KZN due to similar sources of wastewater in both provinces.

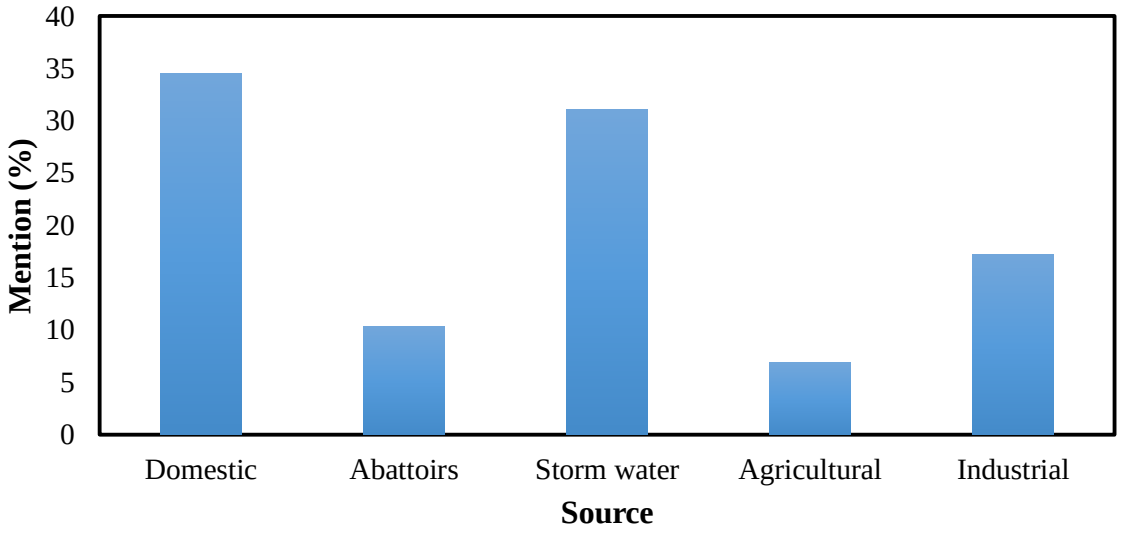

Figure 7.3: Sources of wastewater in MP Province

7.3. Employee information

The employees and management of the WWT plants were interviewed and asked to fill in the questionnaire on employee information. This was done to determine the level of green occupation awareness and to identify the challenges to green jobs creation.

7.3.1. Employees' awareness of green occupations

Majority of the employees and management of the WWT plants were not aware of what green technologies/occupation are. After the concept of green occupation was explained, they could identify sectors (Figure 7.4) such as agriculture (85%), renewable energy (84%), water treatment (84%), waste management (81%) and transport (70%) as the sectors associated with green occupations. Buildings and tourism were the least associated with green occupations. This could be due to the limited knowledge of these sectors that the respondents have. Most respondents were not exposed to the new green building technologies.

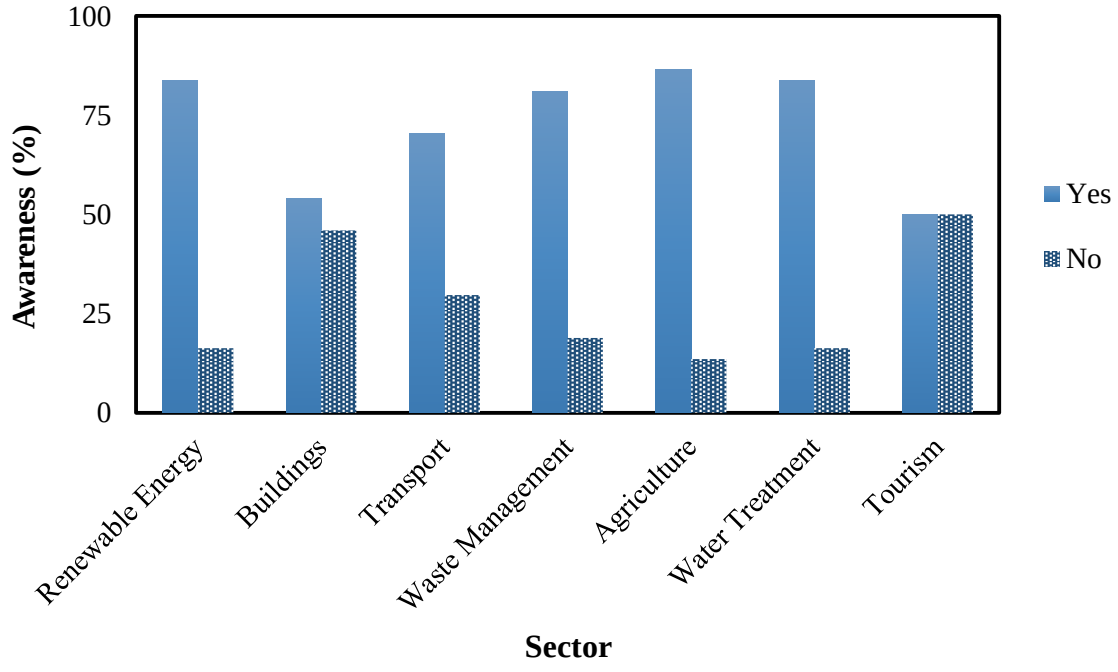

Figure 7.4: Sectors associated with green jobs as per water and wastewater treatment employees in MP Province

The level of green occupation awareness was further assessed by asking the respondents to give their views on certain statements about green occupations (agree or disagree). More than 76% of the respondents agreed that green occupations provide a safe working environment, offer protection of workers' rights, are permanent, reduce global warming and

eliminate/minimize waste pollution (Figure 7.5). This shows that the respondents understood these positive aspects of green technology/green jobs. Some of the respondents were struggling to understand the concepts of the green occupations even when it was explained to them. This can be seen by 35% of the respondents that still thought that green occupations would have a negative impact on the environment whereas green occupations are meant to protect the environment. This limited understanding might be due to the low level of formal qualification and lack of training on green technologies and occupations. Some 38% of the respondents were undecided on the statement that green jobs pay well, mainly because of the limited information that the respondents are exposed to in terms of green jobs.

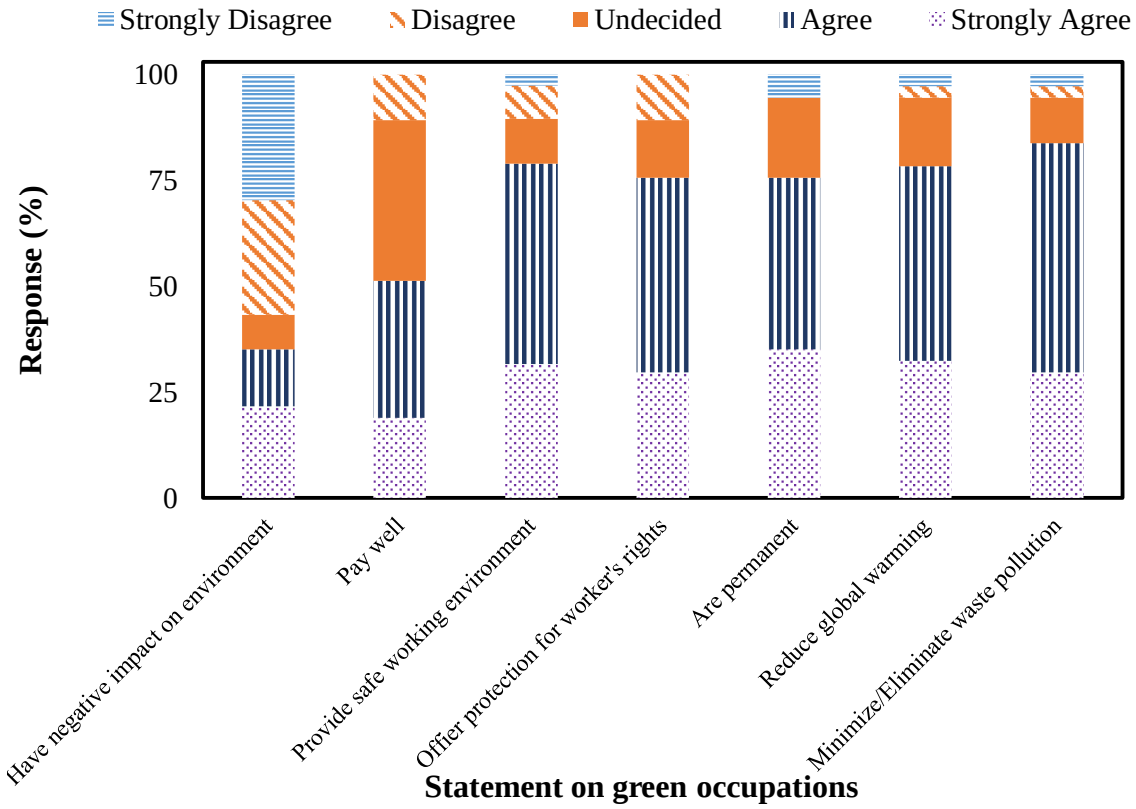

Figure 7.5:Green occupations awareness level

7.3.2. Employees awareness of the municipality green occupation plans and practices

The awareness of employees on future green occupation plans is shown in Figure 7.6. There was a lack of communication of the green economy plans that have been rolled out on the provincial level. The employees of the WWT plants were not aware of these plans.

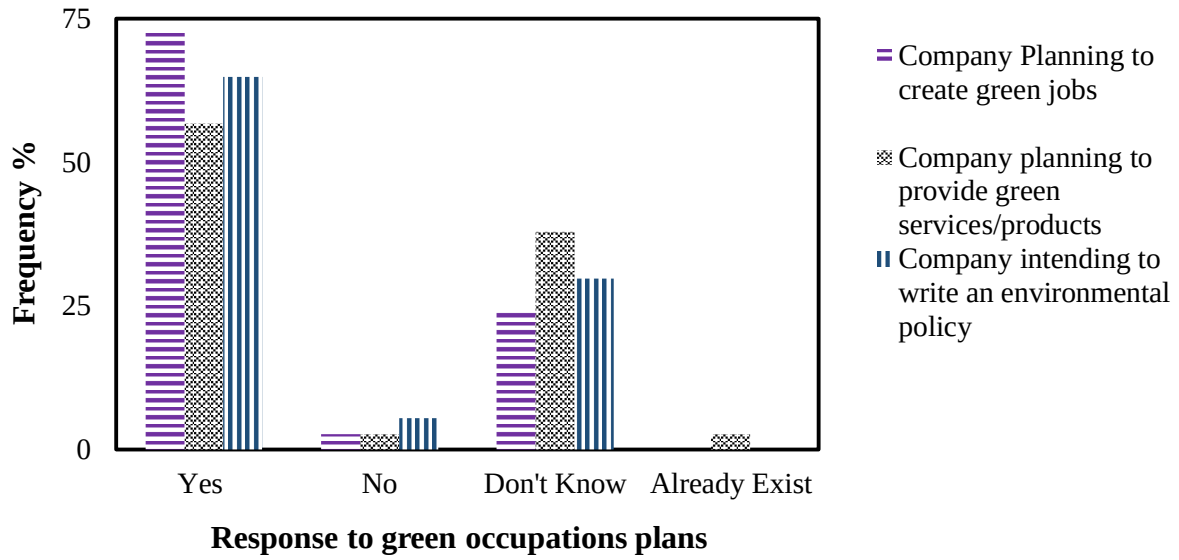

Figure 7.6: Employees awareness of company's green occupations plans

The respondents were further asked to identify green practices and processes that currently exist in their WWT plants (Figure 7.7). The water use efficiency (84%), energy efficiency (54%) and waste utilization (51%) were the most selected existing green technologies that are already in place. These processes offer limited green occupations while they mainly contribute to the reduction in energy and water use. The least identified technologies by the respondents were the bioenergy production, renewable energy and value edition. These technologies currently do not exist in most of the WWT plants visited. The water use efficiency and energy efficiency received the highest scores in both KZN and MP because of the programs that are run by municipalities in these provinces to educate people to save water and electricity.

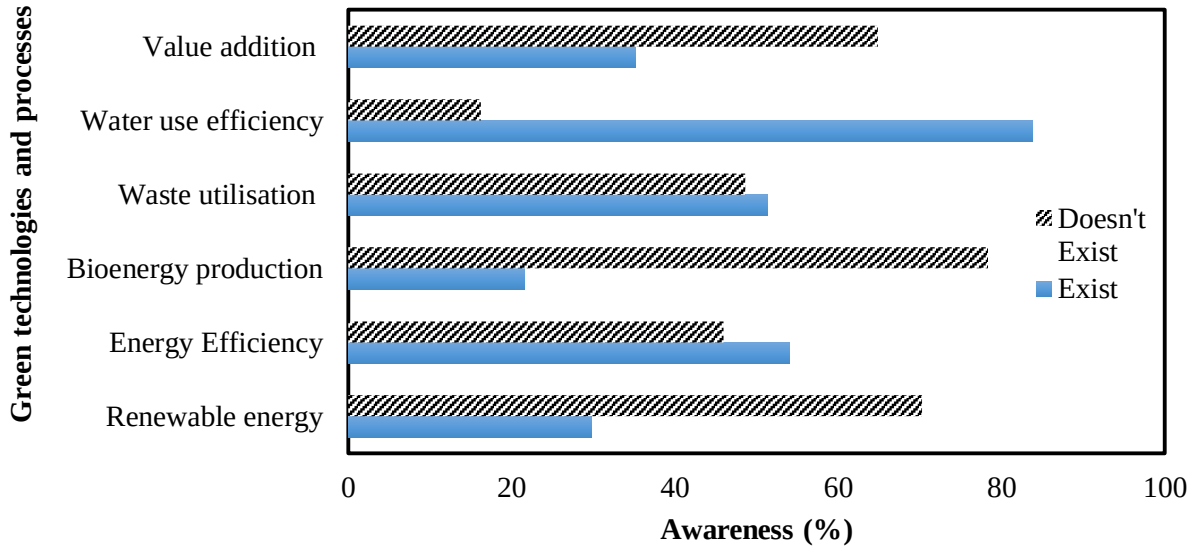

Figure 7.7:Employees awareness of existing green technologies and processes

The identified main challenges to green jobs creation were the cost of green technologies, lack of funding, lack of green training and lack of green skills. The lack of green technologies was witnessed during the visit to the WWT plants. Most of the WWT plants were old and some of the sections were not working properly due to poor maintenance (MP-DM2-LM1-Plant1, MP-DM2-LM3-Plant1 and MP-DM2-LM4-Plant1). Maintenance was lacking due to the funds prioritization. There was a long waiting period when the request for maintenance was submitted.

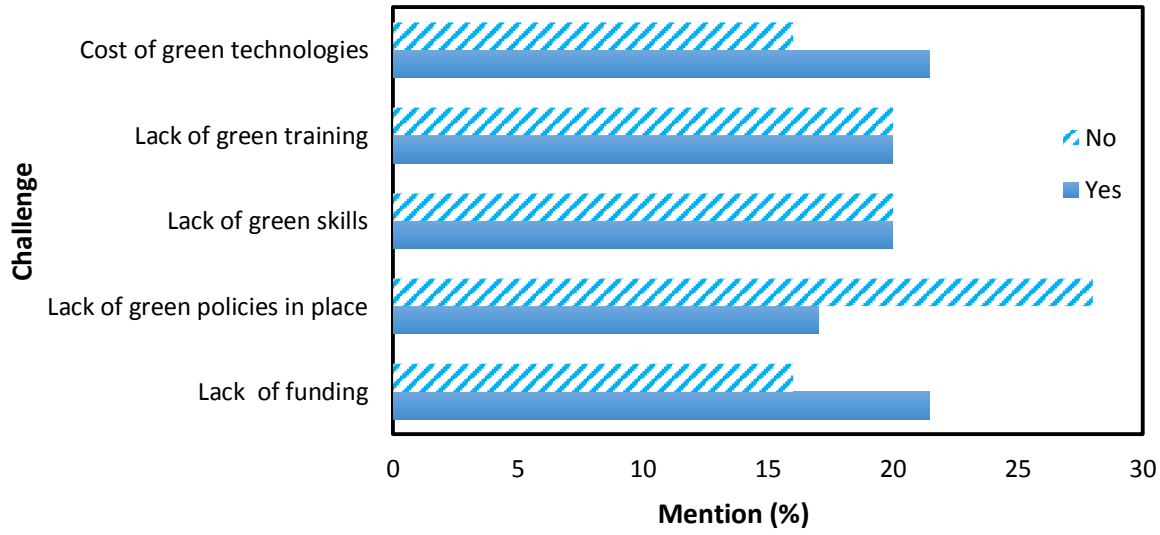

Figure 7.8:Challenges of green jobs creation

7.3.3. Demographic information of the interviewed employees

The demographic information was requested from each respondent. This included age group, gender, highest qualification, role in the organization and the number of years in their current position. The majority of the respondents (73%) were male with the remaining 27% being female (Figure 7.9). The majority of the responded in MP were between 40-49 years (41%), 32% were aged between 30-39 years while another 22% were aged between 50-59 years (Figure 7.10). The younger respondents (aged 29 and less) contribute only 5%. There is a serious concern with succession plan in MP. Based on the interviews conducted, they normally do not employ the younger generation on learnership-training programs after they finish their training program. About 56% of the workforce have been in their current positions for more than 10 years (Figure 7.11). The gender distribution in KZN and MP was almost similar. WWT plant positions were previously for males and based on the cultural background in these two provinces, working was previously only for the current and future heads of the home (males). The few that were employed were only doing housekeeping and cleaning jobs. This is starting to change as the transformation is witnessed on both these provinces by an increased the number of women employed through the learnership programs and as labourers.

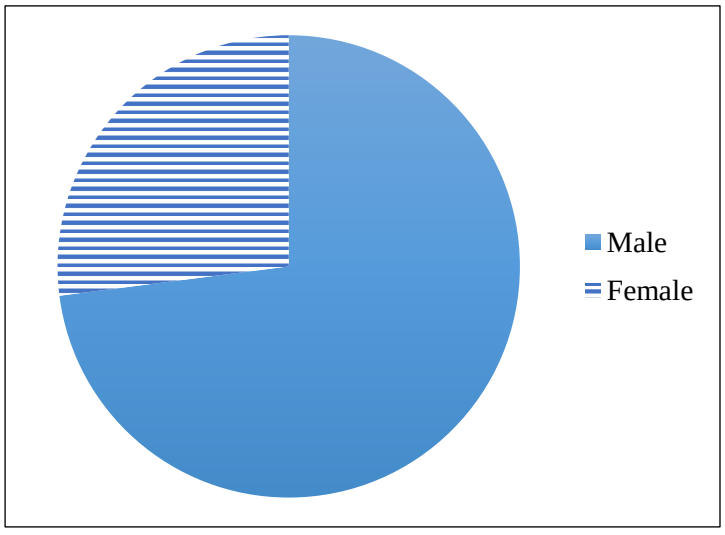

Figure 7.9:Gender distribution of respondents

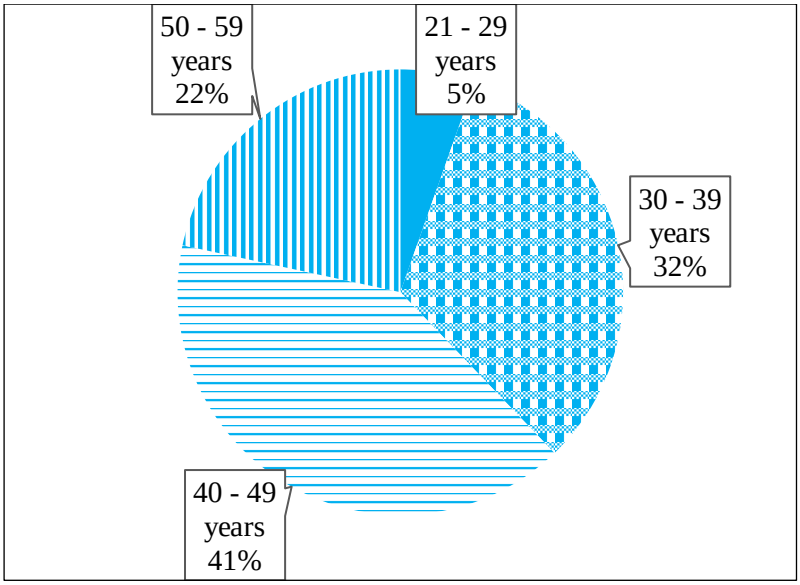

Figure 7.10:Age distribution of respondents

The roles of the respondents in the WWT plants visited in MP are shown in Figure 7.12. Most of the respondents are operators (41%), labourers (24%) and managers/supervisors (14%). Respondents in learnership-training programs were 11% and those in administrative positions 5%. The roles distribution in MP is almost similar to the one of KZN. This was mainly due to the ratio of operators to the laborers, which was almost similar, depending on the size of the plant. There was one operator and one laborer for small plants while this number was more than doubled for bigger plants.

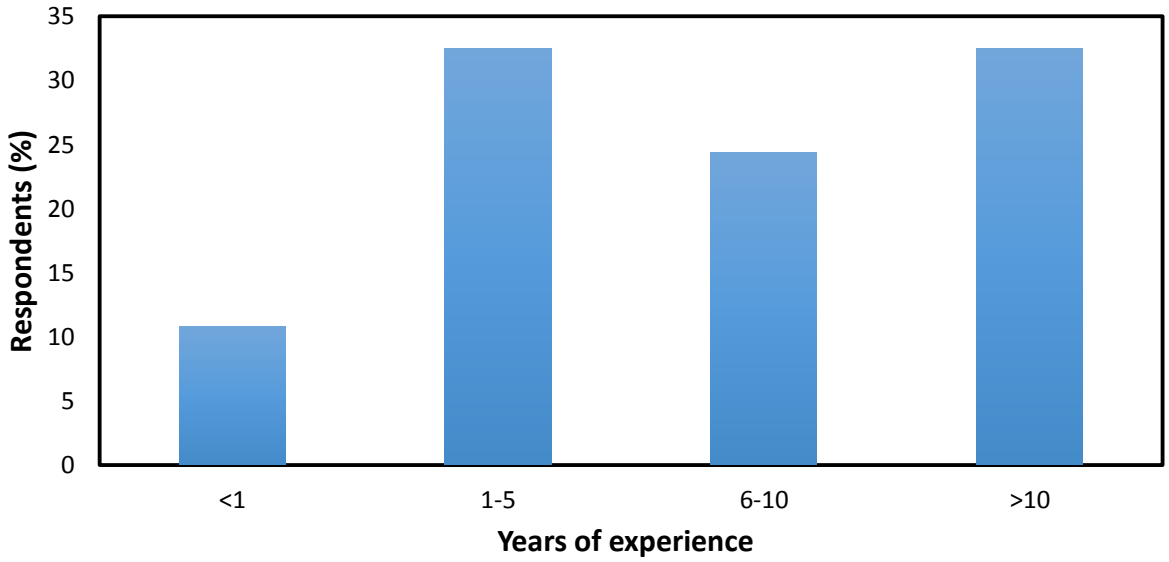

Figure 7.11:Respondents number of years in current position

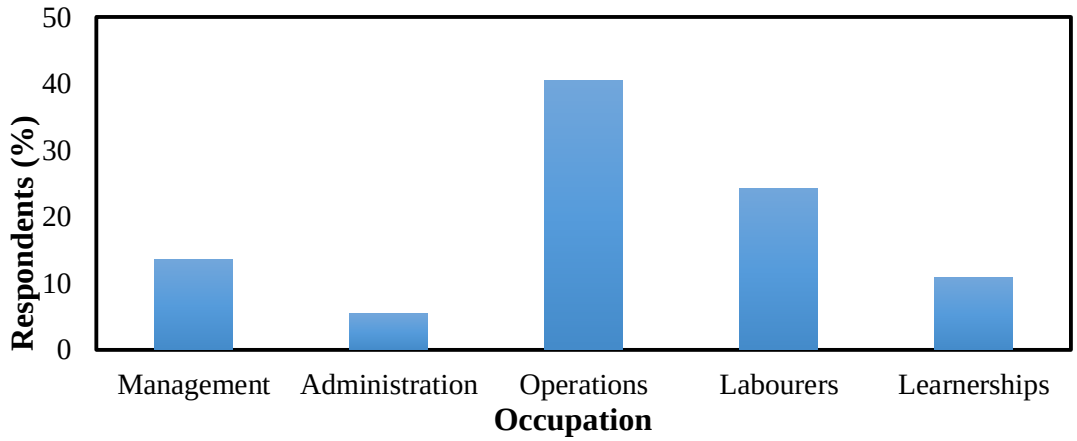

Figure 7.12:Respondents occupational distribution

The highest number of employees (40%) had matric qualification, see Figure 7.13 below, while the other 30% had matric qualifications. About 20% of the respondents had NQF certificates. The high percentage of responded that does not have matric may be an attributing factor to the lack of understanding of green technologies and occupations. As it was reported in KZN, the qualification reported by management (Table 2) does not correspond to the one reported by employees in Figure 7.13. This might be due to the respondent reporting on the training that they are currently undergoing. The 2% percent of the respondent had a degree qualification was involved in the supervision of the WWT treatment plant.

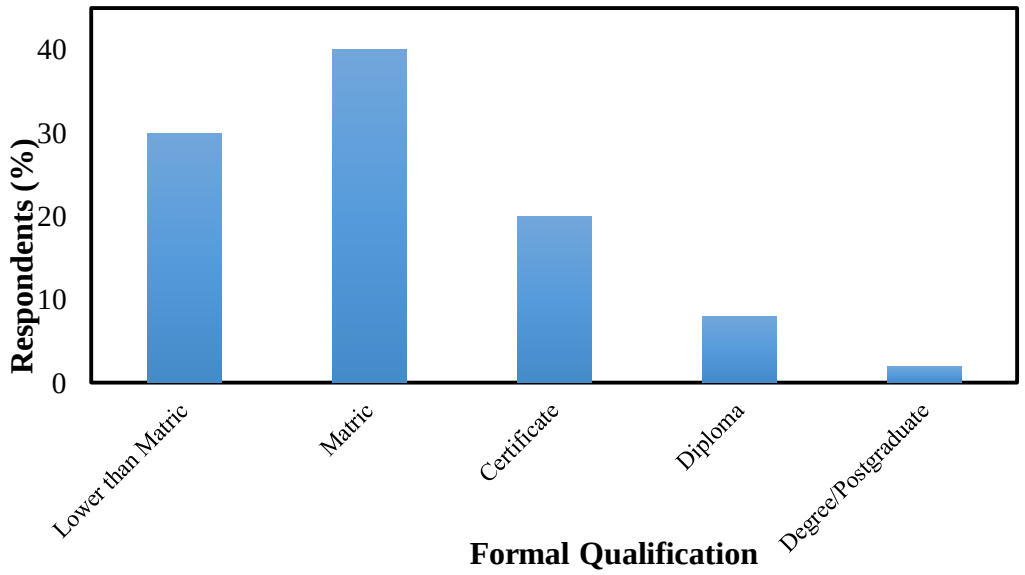

Figure 7.13: Respondents formal qualifications

7.4. Conclusion

MP province was the worst performing province in the Green Drop performance report (DWA, 2013). This was probably due to the very old infrastructure observed at most of the WWT plants visited. Some of these plants were in poor conditions with no maintenance and analyses done (MP-DM2-LM1-Plant1, MP-DM2-LM3-Plant1 and MP-DM2-LM4-Plant1). Lack of funds and poor prioritization is the main contributor to the problem of plants deterioration. It is recommended that maintenance and water analysis should be prioritized to minimize discharging of off-specification water to the rivers which will end up harming the aquatic life. The infrastructure at most of the WWT plants visited in MP needs to be upgraded. Green technologies must be incorporated when upgrades are done (anaerobic digesters, gas to power generation facilities and solar panels).

There is currently lack of training on green skills and a shortage of employees with green skills. As the green economy policies are cascaded down to the municipality levels, in-house training on green technologies should be initiated. Courses need to be designed to help increase the level of skills for the WWT plant employees. An external service provider (e.g. VUT) should be identified to design and deliver these courses. Once the senior operators have been trained they can pass the knowledge to the junior ones. MP is currently training some of their employees in the local technical colleges on conventional WWT plant skills. Most of the employees interviewed are aged 40 years and above, and have been in their current position for more than 10 years. Most of the employees on the learnership programs are not employed at the end of their training programs. There will be a loss of critical skills when the older generation retire or resign if the younger generation have not been well trained and retained. It is recommended that while the green skills are introduced in the learnership program, the employees on the learnership program should be retained as part of the succession plan. Since there are a lot of agricultural activities in MP, the province will benefit from the reuse of effluent water for irrigation purposes and the conversion of sludge into compost.

Results show a huge skills shortage in MP and this mitigates against the green economy initiative that requires highly skilled human capital. Further, it was observed that MPO has a robust agricultural sector that can benefit from irrigation water originating from WWT plants. Further. One of the emerging green technologies is the co-treatment of acid mine drainage and municipal wastewater. This would be an important technology for MP where acid mine drainage pose a great challenge.

CHAPTER 8

8. Western Cape Province

8.1. Company Information

One metropolitan municipality, three district municipalities and five local municipalities were visited in WC. In total, fourteen wastewater facilities were surveyed in the selected municipalities. Table 8.1 highlights the wastewater facilities surveyed and different technologies employed at the facilities.

Table 8.1; Summary of Western Cape visits

DM visited	No. of LMs visited	Number of WWTWs visited	Technologies used for treatment
WC-MM 1	1	4	Modified UCT BNR system, Old BNR system, MBR system, Anaerobic digester, Oxidation ponds, and Activated sludge.
WC-DM 1	1	2	BNR system, Oxidation Ponds, Activated sludge, and odour disinfection system.
WC-DM 2	2	4	BNR system, Oxidation Ponds, and Activated sludge
WC-DM 3	2	4	Modified UCT BNR system, Old BNR system, Oxidation Ponds, Activated sludge, and MBR system.

Key; DM - District Municipality, LMs - Local Municipalities, MM - Metropolitan Municipality, UCT - University of Cape Town, BNR - Biological nutrient removal, and MBR - Membrane Biological Reactor, WWTWs – Wastewater Treatment Works.

Most WWTWs in this province used biological nutrient removal and activated sludge systems which lies at the heart of the treatment operations. The new technique which has gained attention in this area, was a newly developed and a modification of the old BNR system from UCT known as modified UCT system. Other commonly used systems were oxidation ponds and Ultraviolet (UV) light disinfection systems. Almost all the wastewater works in this province had a minimum of two oxidation/maturation ponds in their final disinfection treatment. Most of the wastewater plants in one Metropolitan Municipality (WC-MM1) were being upgraded and the municipality was adopting new techniques. However, it was unclear if the new technology will be green compliant in terms of the green economy initiative and green jobs creation.

Only one (WC-MM1-Plant3) of all the plants visited was producing biogas from sludge received from other WWTWs. The plant was producing 40% to 45% methane gas from 3×

600 cubes biodigesters and the methane gas was being used in boiler burners. It was also found that at least 30% of the plants visited were conducting manure classifications, but only one plant (WC-DM3-LM1-Plant1) was utilising the dried sludge as fertilizer for agricultural purposes both for grass and crops. The remaining plants which performed manure analysis and classification, had great potential as fertilizer-producers and suppliers to farmers. However, this has not been realised due to some constraints including lack of funds to install some of the technologies required to produce good quality compost. The local government in this case can join forces with both the private and agricultural sector to raise funds and investment in the green initiatives.

Membrane technology has been proven to be an effective wastewater treatment method, especially for municipal wastewater treatment works, since it is economically feasible. Only two plants (WC-MM1-Plant2 and WC-DM3-LM1-Plant1) visited were found to use membrane systems. The high-quality effluent obtained from the plants has proven the effectiveness of this technology. The application of this process has benefited the plants in the following ways:

- Effluent from the membrane system was used as cooling water in nearby industries
- Final effluent was used for irrigation and was also recycled back into the treatment process for reuse in activities such as cleaning

The information given in Table 8.2 summarises the cumulative demographics of the site visits in the WC Province. The category from which the information was obtained from the visited plants was classified per the scale of the plant ranging from small, medium to large. It was found that half of the plants visited had less than 50 employees. This might be because most of the plants visited in the 3 districts were medium treatment works with the operating capacities less than 50 ML/day. Unlike other provinces, it was also found that 33% of the plants visited in this province had more than 100 employees. These types of plants were mostly being upgraded to accommodate new structural developments. It was also found that 70% of the wastewater treatment plants had been operational for more than two and a half decades, and most of these plants were still in good structural conditions and with only few newly upgraded modules.

Table 8.2; Demographic profile of plants visited in WC Province

		Percent (%)
Size of plant	Small (less than 50 employees)	50
	Medium (50–100 employees)	17
	Large (more than 100 employees)	33
Age of plant (years)	Less than 10	20
	10 – 25	10
	More than 25	70
Plants employees qualification	Lower than matric	51
	Matric	25
	Certificate	5
	Diploma	11
	Degree/Postgraduate	8
Employees occupation type	Direct green occupation	37
	Indirect green occupation	44
	Occupation unrelated to green jobs	28

Furthermore, Table 8.2 highlights the formal qualifications that all the employees including the management possessed. Most employees in the wastewater plants lacked formal qualifications at the time of the visit. Although most of them had more knowledge and experience about the wastewater system gained on the job, 51%, which is approximately half of the employees, had no matriculation. The minority of employees working as process controllers had obtained certificates through training from the Department of Water Affairs (DWA). The second highest percentage of 25% employees interviewed had matriculation. Employees with high formal qualifications such as diplomas and postgraduate degrees were a rare find with only 11% and 8% reported, respectively. The few that were reported are in most cases in management positions and must monitor the operations of more than one treatment plant.

In general, as per the companies' responses in the WC province, only 37% of the employees at the wastewater treatment plants were found to perform jobs that are directly green related. It was also found that the highest portion of the employees' jobs of 44% are indirectly related to green practices. Non-green related practices are only 28 percent of the total employees' occupation types. These results show that most activities carried out by employees in this

sector were indirectly related to green jobs and at least some of these plants are currently moving towards green practices, even though most of these employees were not aware of this concept.

8.1.1. Barriers to uptake of green occupations

The challenges that are currently faced by most local governments in adopting green technologies or green occupations creation in the wastewater treatment works, are lack of green knowledge and skills (Figure 8.1). No green related trainings were offered to the employees, with most having skills suitable for the traditional operating systems of treatment. The introduction of new green technologies and practices in the existing wastewater treatment systems, will result in generation of entirely new jobs that require provision of specific trainings and skills development programmes. Moreover, this transition will enable employees to be equipped with skills that will influence greening the existing occupations. As mentioned in the literature, in response to the governments green skills growth, the WC government has developed a training centre specifically for improving theoretical and practical skills on renewable energy. Such initiatives will address green skills shortages that may prevent the creation of new green occupations in this province.

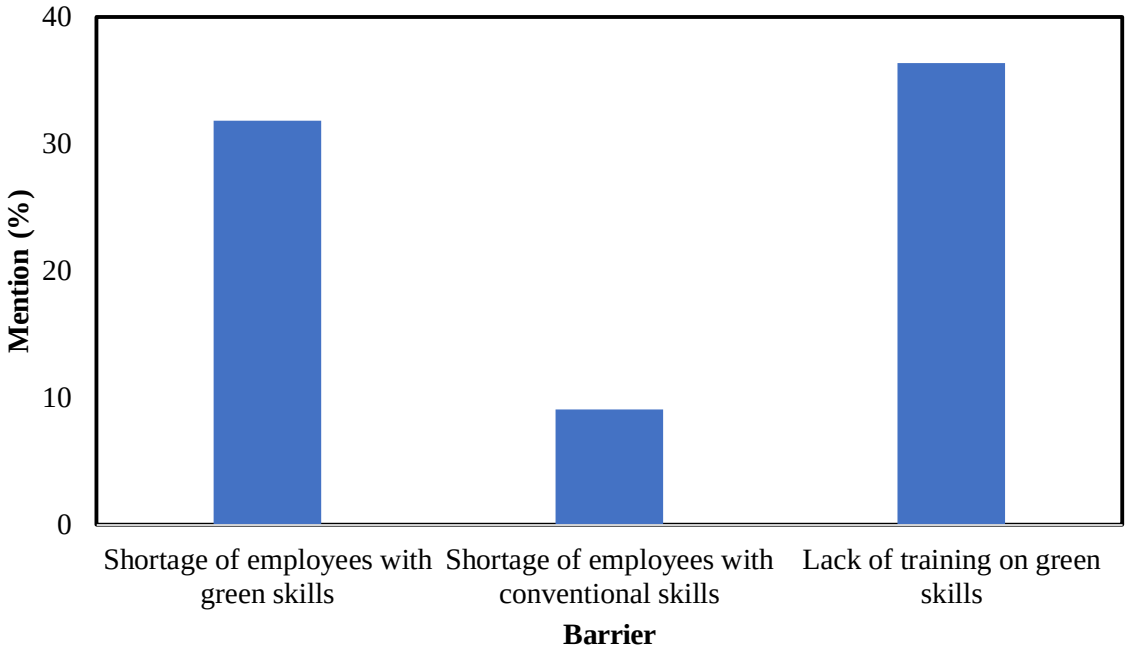

Figure 8.1; Barries to green occupations in wastewater treatment in WC Province

8.1.2. Training required to meet skills shortage

The issue of training is one of the main drivers needed to mitigate the green skills shortages. First, it was of importance to identify the necessary training needed for employees in the WC in order to meet green skills shortage, more especially for those 51% of employees that did not have any formal qualification. From the data shown in Figure 8.2, most of the companies identified technical training and obtaining university training as two important methods required to meet new green skills demand. This will lead to massive changes to the employees' formal qualifications. The quality of the new training will provide changes in greening the existing occupations, create more green jobs and consequently close the gap between the low-wage, skilled and highly-paid employees because of misplacements of skills. The least recommended training activities by most companies were on-the-job, apprenticeship and in-house training. Most of these methods are currently being employed in the current system in various wastewater treatment works, however, these types of trainings do not improve the skills needed for green related occupations.

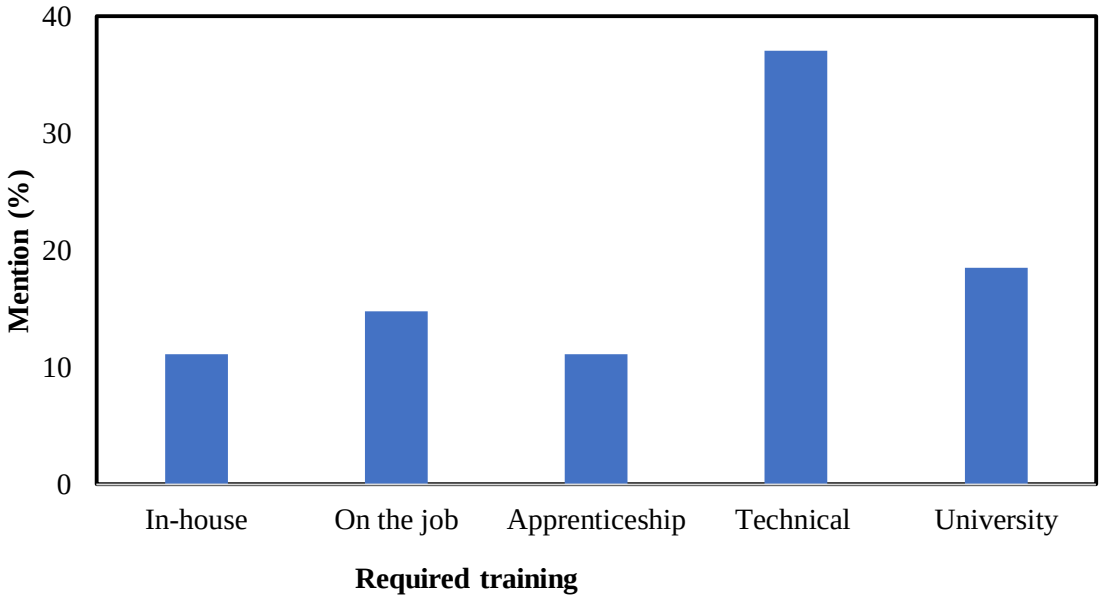

Figure 8.2; Preferred training by WWTWs in WC Province

8.2. Potential for green occupations in the WC Province

The WC Province is the second largest economic contributor in South Africa, with agriculture being one of the drivers for economic growth in this province. Unfortunately, due to the water crisis taking place across SA, the province needs urgent intervention strategies to resolve this

crisis. Most of the WWTWs were operating accordingly as shown by the high-quality effluents generated. A high percentage of wastewater sources for the treatment works in WC were domestic and storm influent (Figure 8.3). It was found that plants situated in the industrial region of this province, where a constant increasing population is a major challenge, were operating over capacity to accommodate the bulk inlet flows from domestic activities (37%), storm water (23%), and other industries and factories (14%).

The province is focusing on projects that will develop green technologies including in wastewater and water management sectors. Within this province, the potential to create more green jobs in the water and wastewater sector includes:

- Using the dried sludge to produce green products such as fertilizer and supply to farmers as depicted in Figure 8.4
- Reusing the good quality effluent for process operation and irrigation as shown in Figure 8.5
- Production of potable water by the treatment of secondary using ultrafiltration and reverse osmosis. The secondary effluent is currently being discharged into the ocean in some plants
- Generating methane gas using anaerobic digestion process to supplement the energy requirements of the process units

Even though agriculture is one of the fast-growing sectors in this province, especially in the three districts visited where plants are situated in farms, wastewater from the agricultural activities contributed only 9% of the total wastewater sources. This might be due to the water scarcity in most rain-fed farming in this region which had significant effects on the overall agricultural activities. The effluent outflows of most of the plants in this province were of good quality, hence can be utilised by the farms for irrigation. The WC government can consider the possibilities of using intensive technology to further treat the wastewater effluent to drinking water quality standard. This will help in solving the water crisis issue and will also have a positive impact on the creation of green employment. In most cases, the production of bioenergy from small treatment plants cannot be successfully implemented currently due to the low influent inflows.

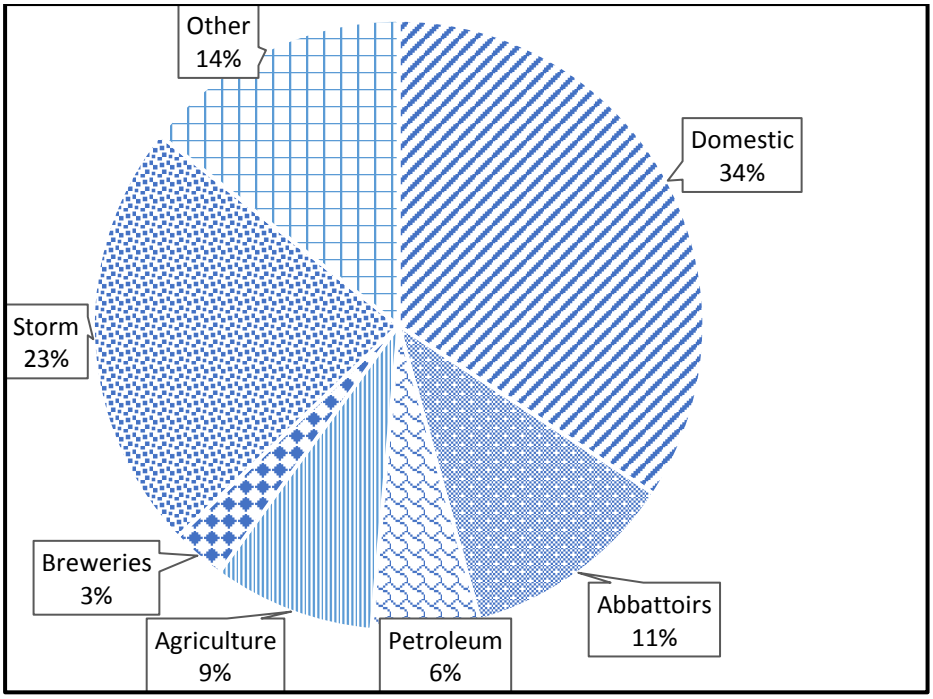

Figure 8.3; Sources of wastewater in WC Province

As mentioned in the literature section, the WC province has identified water and energy as other potentials for green job opportunities. The majority of the wastewater treatment plants already have the possibilities to develop towards producing good-quality compost and renewable energy from sludge. However, the challenges most plants were currently facing includes, limited funds to carry out manure classification and installation of biodigesters. Out of the 14 plants visited, only three (WC-MM1-Plant4, WC-MM1-Plant2 and WC-DM3-LM1-Plant1) had dewatering plants which were operating accordingly and carried out value addition process. The rest of the plants disposed the sewage sludge to landfills, drying beds, stored in ponds or dumped to the water bodies. Figure 8.4 shows one of the plants which employed belt filter press dewatering method for desludging and processing the dried sludge into compost after manure analysis and classification. This shows that sludge management is an important part of any wastewater treatment plant and has high potential to create more green job opportunities in the water sector.

Figure 8.4; Dried sludge processing into manure

In most cases, the treatment and handling of sludge is neglected by plants as compared to effort placed on ensuring high quality effluent is obtained. Figure 8.5, shows one plant (WC-DM3-LM1-Plant1) which cultivated a small garden to grow crops such as mealies, green peppers and tomatoes. The small garden was dependent on the good quality fertilizer produced from the dried sludge and the good effluent for irrigation.

Figure 8.5; Reuse of good quality effluent for irrigation

8.3. Employee Information

This section analyses the information obtained from the employees in response to green occupations and technologies in their line of work. The focus was particularly on the awareness of green occupations currently available in each of the municipal wastewater works. For this purpose, interviews and questionnaires were specifically developed for employees, working onsite; the data obtained were to provide key feedback on the awareness of green economy in terms of jobs creation.

8.3.1. Employees awareness of green occupations

Many employees working onsite did not know what green economy or occupations were, instead they were very much informed on what "Blue Drop" and "Green Drop" initiatives were. Based on the questionnaires and interviews, much of the respondents identified green jobs to be available in the following sectors: renewable energy (75%), agriculture (85%), waste management (90%), water treatment (90%) and buildings (80%). The results in Figure 8.6, show that tourism and transport sectors were least identified as having green employment. Similar results were obtained in the province of KZN. Nevertheless, these provinces have the potential to develop natural systems for wastewater treatment in their tourism facilities. The development of such natural systems such as the Atlantis green technology park in the WC province, will attract more tourists and create opportunities for green jobs. The Atlantis Park is an initiative established by the City of Cape Town and Department of Economic Development and Tourism (DEDT) to increase green renewable technologies in WC province (Moyo 2015).

The WC province has significantly improved its green transport system especially in the City of Cape Town. The public transport has been integrated with other modes of transport including rail, Integrated Rapid Transit (IRT) and cycling systems. However, majority of the respondents had little or no knowledge about green jobs in both sectors (Tourism and Transport). The government in this region needs to invest more in green programs to raise green transport and tourism awareness for all employees working in various sectors. It is essential for all sectors including government and private bodies to participate in the creation of green awareness.

The findings show that most employees identified sectors with potential for green jobs creation as being waste management (90%), agriculture (85%) and water treatment (90%) as shown in

Figure 8.6. Similar results were observed in many plants visited and in other provinces as well. This could be because the employees could only relate green economy to their line of work, which is waste management.

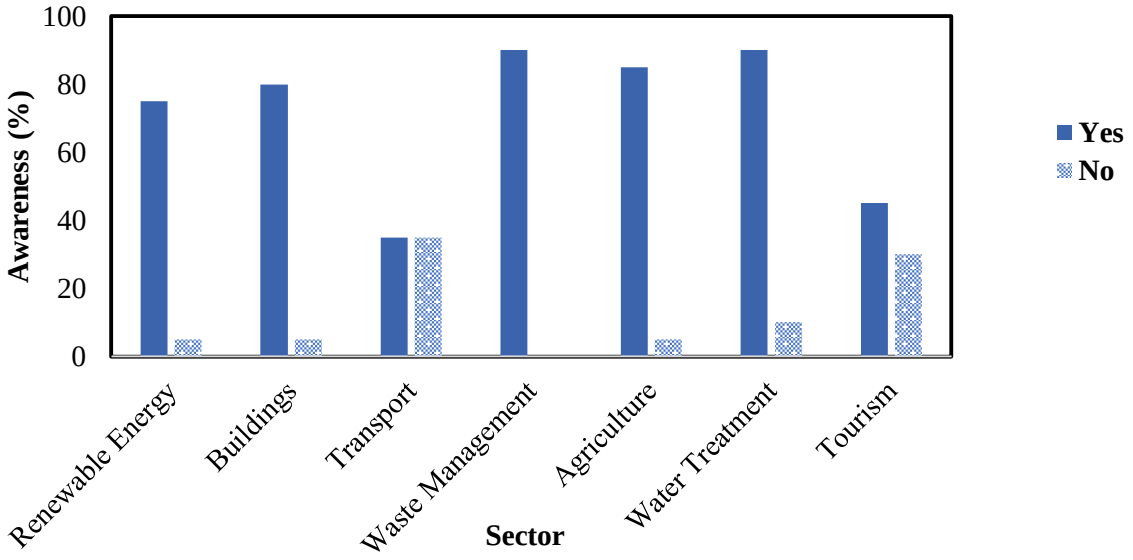

Figure 8.6; Sectors associated with green jobs as per water and wastewater treatment employees in WC Province

From Figure 8.7, it was evident that most of the respondents had an in-depth understanding of green occupations. The majority could associate green jobs with some of the known benefits such as environmental protection, reduced global warming, and a safe working environment. A minority, however, did not have a clear understanding of what green jobs entail. In general, moving towards the milestones of the whole green economy initiative, skills for green jobs are very crucial. All workers involved in the operation at the treatment plants should be able to explain and understand what green economy is, and what roles and contributions their company might potentially have on the greening of the economy. It is of importance that employees should be capacitated in terms of knowledge, skills and abilities for the benefit of the company. This will bring change towards applying relevant skills in greening their workplace. Transforming the wastewater sector in line with the concept of green practices, technologies and occupations is only possible if employees from all levels are involved and informed of the companies' strategies and plans.

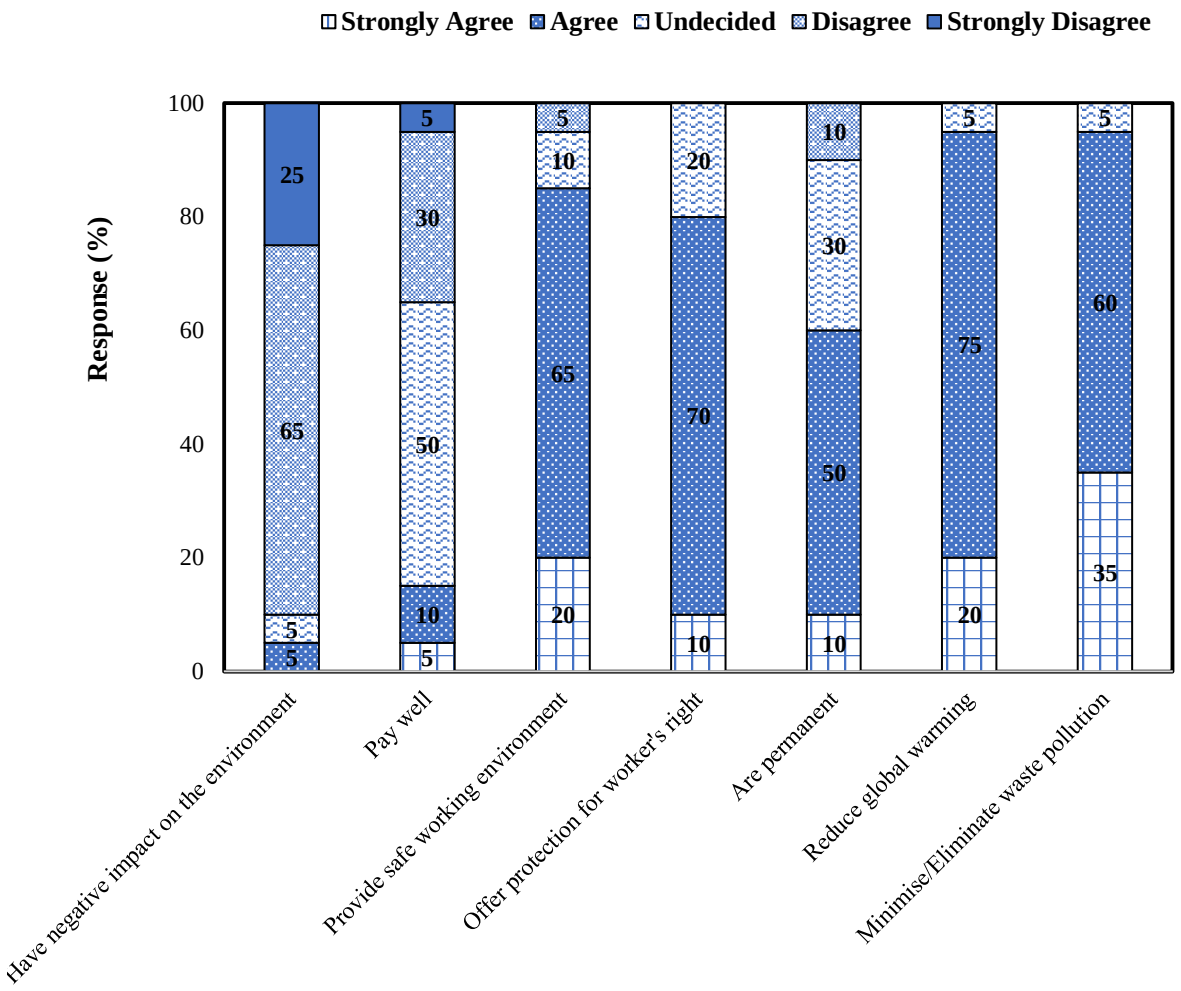

Figure 8.7; Green occupations awareness level in WC Province

8.3.2. Employees awareness of company's green occupations plans and practices

Figure 8.8 shows that most employees working on site, especially process controllers, did not have much knowledge about their company's plans and strategies on green economy. However, senior process controllers and plant managers seemed to have a little knowledge about some of the plans. The results therefore reflect how information is distributed in the work place. Only employees who are in higher positions are exposed to such information.

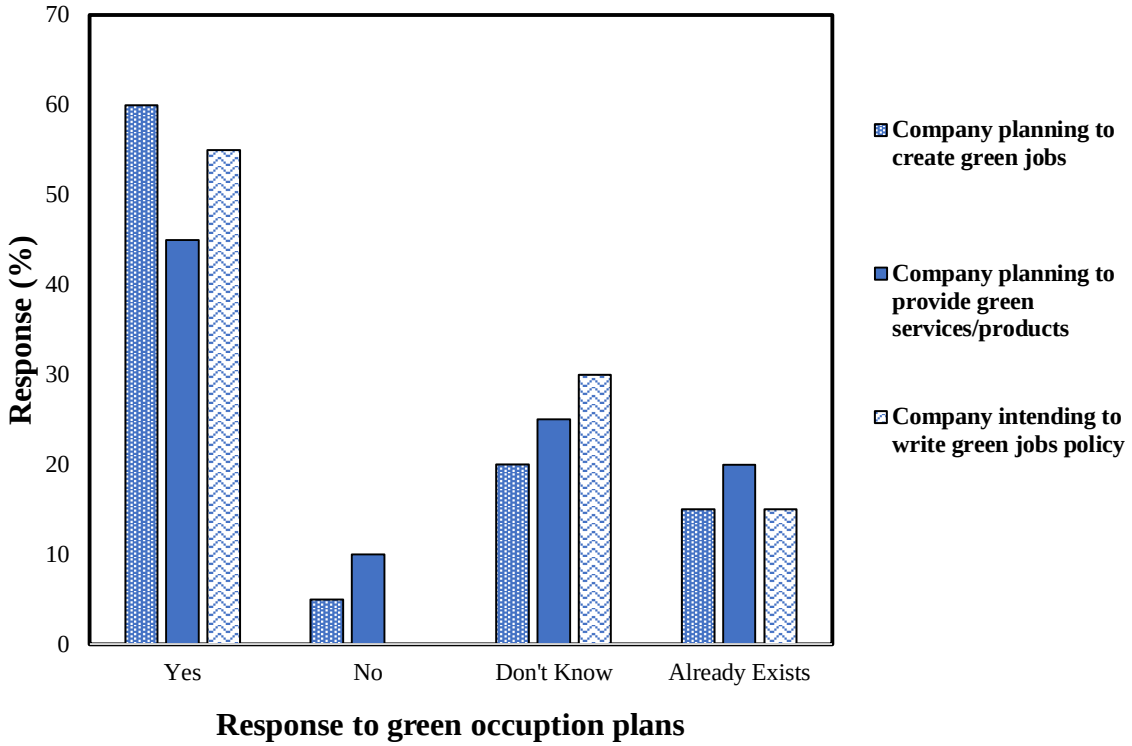

Figure 8.8; Employees' awareness of green occupations plans

Figure 8.9 further assessed the awareness of employees on the existing green technologies at their workplace. The possibilities of greening the conventional water and wastewater sector lie in creating job opportunities in bioenergy production, utilizing green waste for compost and a shift away from energy intensive technologies to promoting energy efficiency.

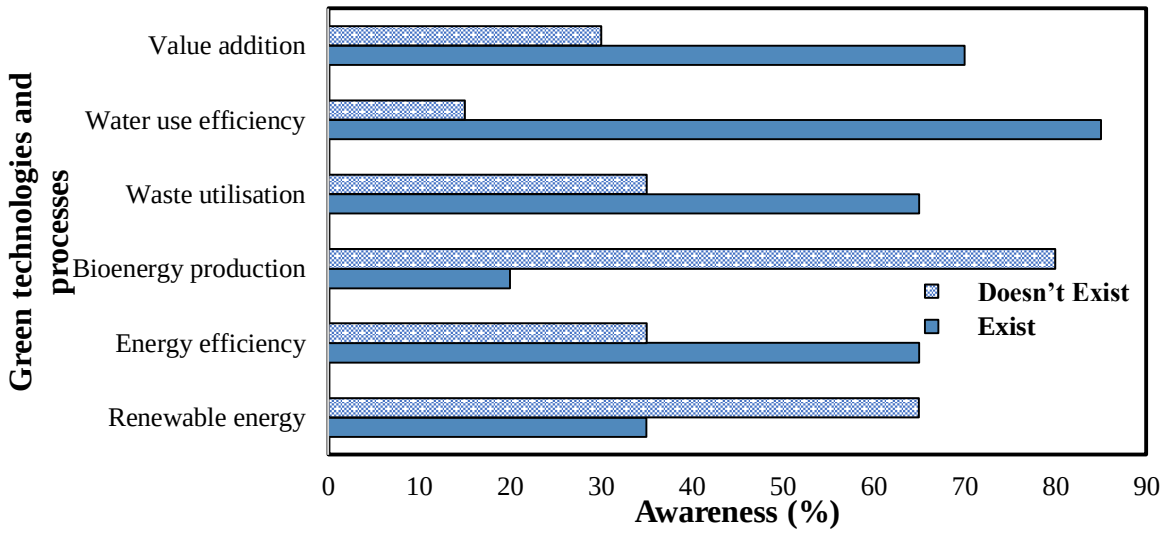

Figure 8.9; Employees' awareness of existing green technologies and processes

Most the employees have identified value addition (70%), waste utilisation (65%), water use and energy efficiency, 85% and 65%, respectively, as green technologies currently existing in their plants. However, the least identified green practices were the production of bioenergy and renewable energy. Given these results, it is evident that bioenergy, which is a renewable energy, is not present in most wastewater works even though it has been reported to potentially create green jobs. As outlined previously, many plants visited were treating small waste inflows of less than 50ML/day, which is not enough to generate sludge required to produce bioenergy production. Furthermore, most of the plants that dispose sludge to drying beds do carry out manure analysis occasionally, hence, value addition has been identified as a green technique available in most plants by a high percentage of the employees

8.3.3. Demographic information of the interviewed employees

The transition to green economy will not only increase job creation, conserve the environment, but it also focusses on promoting equity including gender equity in the workplace. Within the current economic system, majority of the employees working in the water treatment industry are males as reported for all the visited provinces. Figure 8.10 shows that most plants are dominated by one gender, with 85% males and 15% females. Most male respondents are permanently employed as senior process controllers, whilst most of the female respondents were employed as general workers and cleaners, and only few were holding process controller positions.

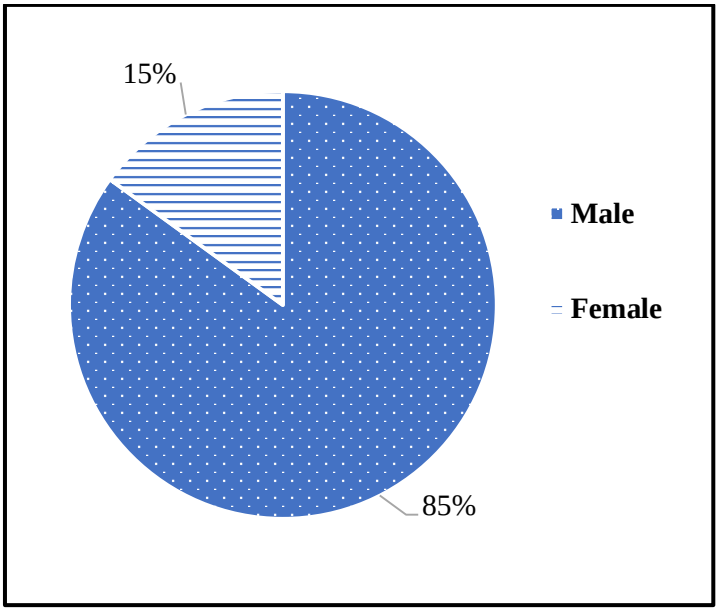

Figure 8.10; Gender distribution of respondents

The results in Figure 8.11 show that majority of the employees working onsite in the visited plants were between the ages of 30 to 39 years. It was also found that a significant percentage of the interviewees were aged between 40 and 59 (40%). The age group distribution results show that there were no employees working in the plants who were aged below 21 years or above 59 years. From these results, it was seen that most young people, just like in the other provinces, do not form a significant percentage of WWT employees.

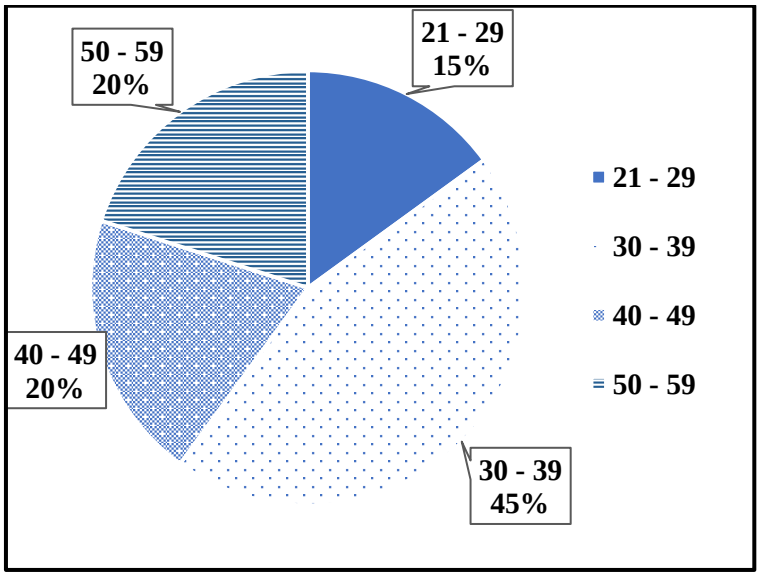

Figure 8.11; Age distribution of respondents

The findings in Figure 8.12 suggest that most employees interviewed are based on the operational site and are mostly likely to perform most direct green jobs. Most employees were either process controllers or general workers with few (10%) being on learnership or apprenticeship temporary contract programmes. The minority of the respondents were employed as professionals and administrators, and were not directly involved in the daily plant operations onsite.

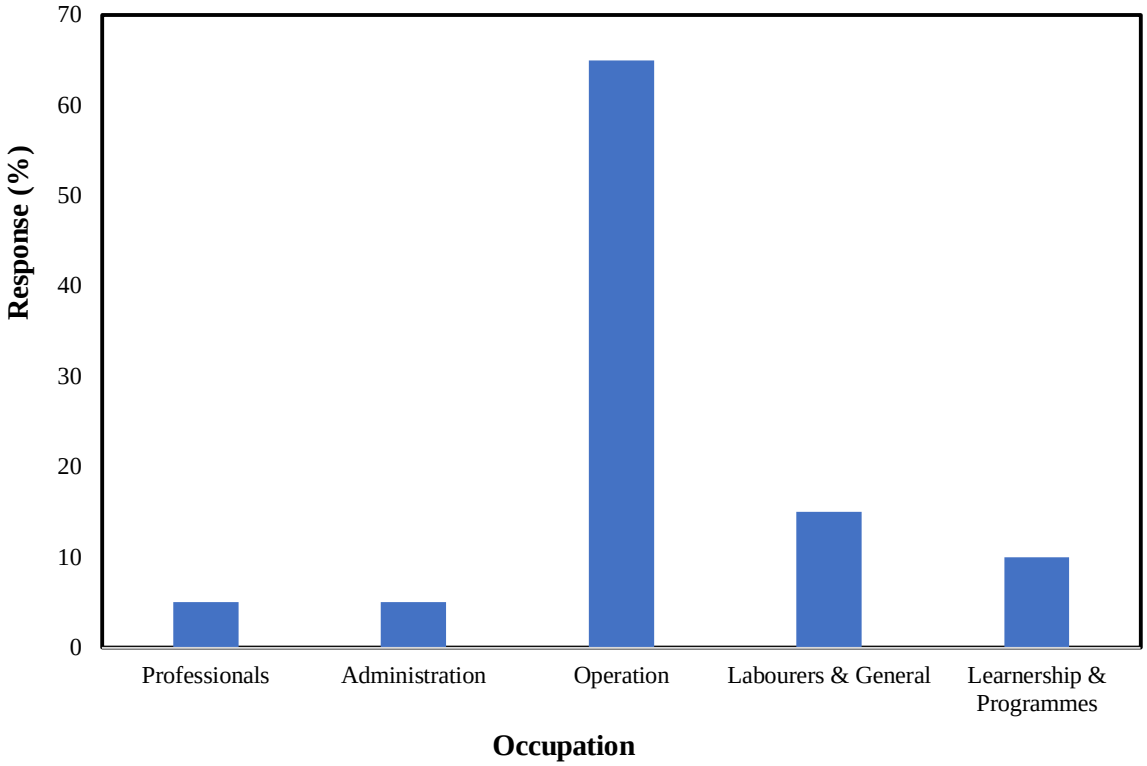

Figure 8.12; Respondents' occupational distribution

During the interviews, it was found that most employees working onsite had no formal tertiary qualifications, except for certificates awarded from either in-house or on-the-job training (Figure 8.13). The minority of the interviewed employees who were either plant managers or senior process controllers, had diplomas (15%) and degrees (5%). It should be noted that employees who possess formal qualification still lacked green skills and knowledge. It is of importance that as most governments implement strategies to improve sustainable developments, the need for upgrading existing skills and retraining employees on green skills is a matter of urgency that all municipalities should focus on. Moreover, the focus should also be channelled in addressing low-skilled employees and employees who have no formal education, by introducing basic education in line with the green economy. This will also assist in enabling the employees to adjust to learning new green technical skills.

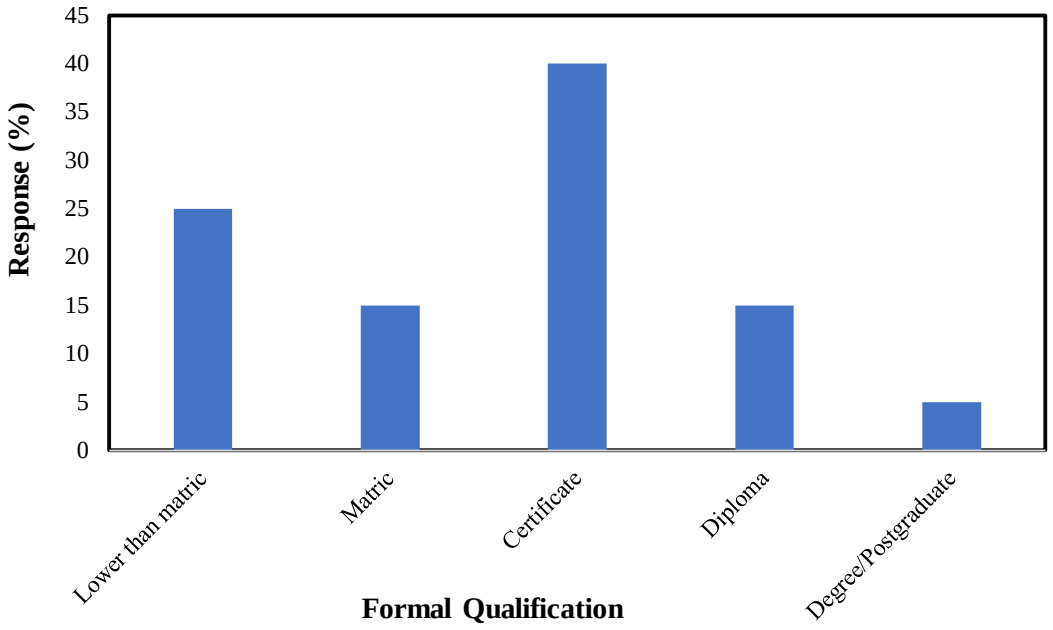

Figure 8.13; Respondents on formal qualification

The results shown in Figure 8.14 represent the work experience of employees working in the plants visited at the time of visit. The results reveal that a great number of employees interviewed had gained sufficient work experience. Some had acquired experience on this field through on-job training. However, it must be remembered that results in Figure 8.2 shows that this is not the most preferred training option. Such practical knowledge is very useful and can be merged with proper green skills to fully equip the employees for the emerging green occupations.

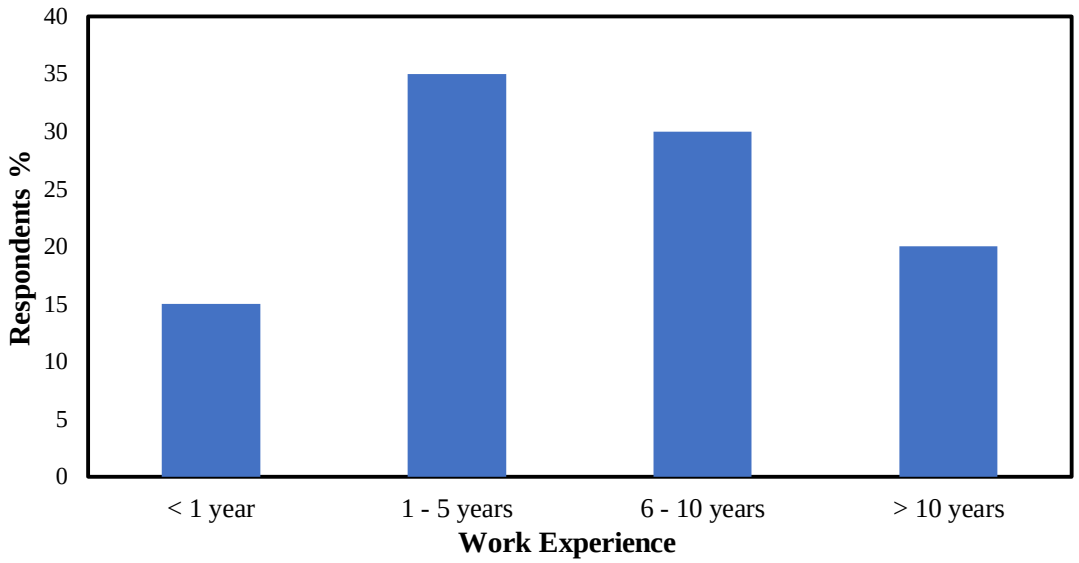

Figure 8.14; Work experience distribution of respondents

8.4. Conclusion

The Western Cape (WC) Province is faced by issues such as poverty and gang violence caused by the high unemployment rate in this region. However, provincial plans, strategies and goals put in place by the WC government to grow and improve the living environment of the local economies are aimed at addressing some of these challenges. It was highlighted from literature that creating job opportunities forms part of the important priorities in developing the green economy in the WC. Creating green occupations and enhancing green occupations from existing conventional jobs in the Western Cape (WC) local governments is very much possible. It was evident from the findings that new green jobs opportunities can improve the growth of employment in the water and wastewater sector. Most plants were being upgraded to modern technologies, with possible green techniques, whilst only few using outdated technologies. In overall, the wastewater treatment plants in this province produced good quality effluent and dried sludge. In such cases, there is a huge potential to create green occupations. However, the results reveal that currently only 37% of the jobs were directly related to green occupations. This also shows that green economy and green occupation is slowly gaining momentum in some parts of the WC province.

Compare to WWT plants in other provinces, the WC plants had the highest number of employees. This enhances the capacity of the municipalities to engage in different treatment activities. Further, it was reported that, unlike other provinces, formal tertiary training was the most preferred career development path, as opposed to on-job training. It was reported that WC has a training centre for renewable energy. This promotes GE in the region. The intensive upgrade of infrastructure, and the high number of highly skilled staff has enabled the WC province to keep most plants in very good condition. It is important to take note; the use of techniques such as UV and membrane is very rare in many provinces of SA.

CHAPTER 9

9. Gauteng Province

9.1. Company Information

The Gauteng Province (GP) is the largest industrial hub in South Africa with three large metropolitan municipalities. The survey in this province was conducted on two metropolitan municipalities and one district municipality. In most cases, each metropolitan municipality had more than 10 wastewater treatment facilities. A total of 8 wastewater treatment works (WWTWs) were visited in the selected municipalities. Table 9.1 summarises the information of plants visited including the type of technologies used.

Table 9.1; Summary of Gauteng Province (GP) visits

DM Visited	No. of LMs visited	Number of WWTWs visited	Technologies used for treatment
GP-MM 1	1	4	Biofilters, Activated sludge, BNR system, Trickling filters, Oxidation ponds and Anaerobic digesters.
GP-MM 2	1	2	BNR system, Anaerobic digesters, Activated sludge, and Oxidation ponds.
GP-DM 1	2	2	Biological filters, BNR system, Activated sludge, and Anaerobic digesters.

Key; DM - District Municipality, LMs - Local Municipalities, MM - Metropolitan Municipality, and BNR - Biological nutrient removal, WWTWs – Wastewater Treatment Works.

Johannesburg Water (JW) is one of the largest waste and sanitation utilities and offers its services to one of the metropolitan municipality (GP-MM2) in Gauteng. All the plants visited in this province employed biological nutrient removal and activated sludge systems. All the eight wastewater treatment works visited in this province had anaerobic digesters. However, of the 8 visited plants, it was found that half of the visited plants were not producing biogas. Of the four WWTWs that produced biogas, only two plants (GP-MM2-Plant1 and GP-MM2-Plant2), were using the biogas produced to supplement some of the energy requirements in the plants. The biogas produced from the other two plants (GP-MM1-Plant3 and GP-MM1-Plant2) was either burnt using incinerators or just discharged into the atmosphere.

It was also found that at least 35% of the plants visited were conducting manure classifications, and the dried sludge was used as fertiliser for agricultural purposes on site, supplied to farmers,

and public sport recreation facilities. One plant (GP-MM1-Plant4) was outsourcing services from a private company to process fertiliser from the produced sludge.

Table 9.2 shows the cumulative demographic profile of all the field visits in the Gauteng Province. The 71% of the plants visited were small size structured WWTWs with less than 50 employees; even so, most of these plants treat large volumes of waste inflows per day. This is due to the rapid increase in population. From the literature, it was reported that the major challenges that this province is currently facing is the increasing illegal settlement which has increased the demands for services including sanitation. In addition, over 70% of the wastewater treatments plants have been operational for more than two and a half decades, thus many of these plants have structural defects.

Table 9.2; Demographic profile of plants visited in Gauteng Province

		Percent (%)
Size of plant	Small (less than 50 employees)	71
	Medium (50–100 employees)	29
	Large (more than 100 employees)	0
Age of plant (years)	Less than 10	0
	10 – 25	25
	More than 25	75
Plant employees qualification	Lower than matric	54
	Matric	30
	Certificate	9
	Diploma	5
	Degree/Postgraduate	2
Employees' occupation type	Direct green occupation	4
	Indirect green occupation	34
	Occupation unrelated to green jobs	62

Just like in the other provinces, it was found that a lack of formal qualification was a major problem in this region. The majority (54%) of the employees did not even have matriculation certificates. In fact, the results reveal that most employees had no formal qualification and only 30% of respondents hold grade 12 qualifications. The minority of the total employees were qualified to perform the duties in the plant that require intensive problem-solving skills. In comparison with other provinces, a similar trend was observed in the KZN province.

Only 4% of direct green related occupations have been reported in the plants visited in Gauteng. This percentage includes employees working on the two mentioned plants that produce bioenergy to supplement other processes in the plant. The rest of the employees were either performing duties indirectly related to green jobs or the normal conventional duties of the plant.

This reflects the slow rate at which the province is greening its existing occupations in the waste and wastewater sector.

9.1.1. Barriers to uptake of green occupations

Jobs creation in the green economy initiative is progressively gaining more attention in some sectors than others. It is expected that most potential green jobs will be created in water and energy sectors. However, there are still some challenges faced. Most green technologies require significant incentives and capital to install; yet the government's position to fund these kinds of initiatives is uncertain. Barriers to green occupations in wastewater treatments in Gauteng Province, presented in Figure 9.1 indicate that 36% of the mentioned challenges arise from the shortage of training on green skills. As might be expected, the 4% of employees whose types of occupation are directly green jobs, were not equipped with the necessary green knowledge or skills. Similar results were observed in the visited plants in other provinces, particularly WC province. In addition to this specific problem of green skills shortage, many plants in this province had poor structures and only a few were being upgraded. The focus should be directed in raising funds to improve the structure of the plants and install green technologies, at the same time, promoting green skills and trainings through workshops and programmes.

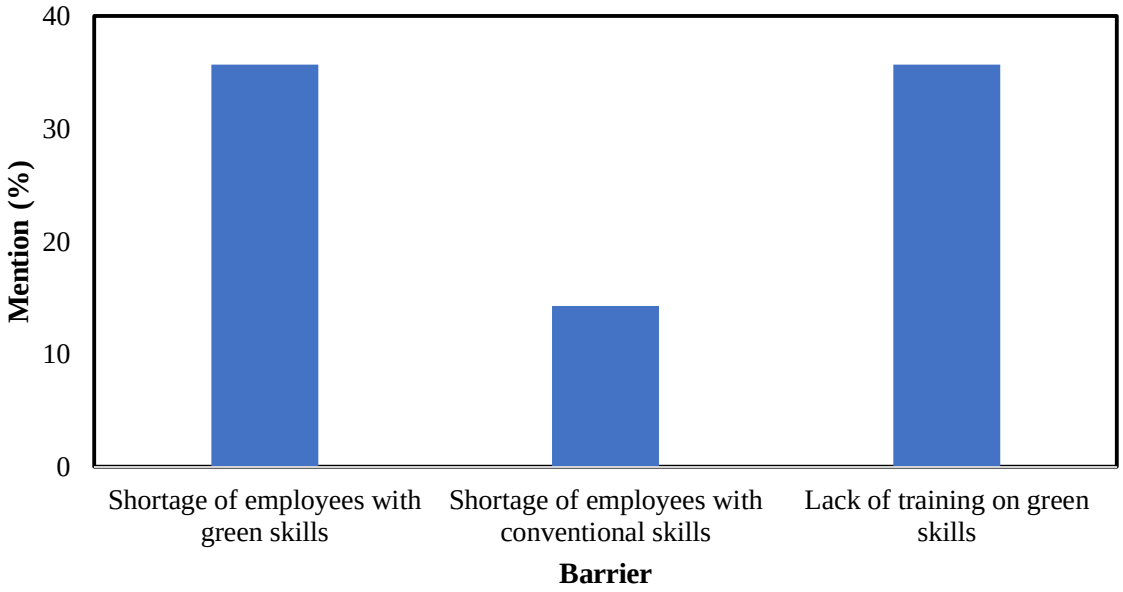

Figure 9.1; Barriers to green occupations in wastewater treatments in Gauteng Province

9.1.2. Training required to meet the skills shortage

The practices and technologies associated with green economy result in changes on the current occupations requirements; this includes skills, knowledge, duties and the types of trainings needed. The most preferred trainings required to enhance green skills in most of the WWTWs in GP were identified as in-house and on-the-job training with 23% mentions (Figure 9.2). Many companies choose to conduct training for employees as they work on site. Only 15% of the companies required apprenticeship, technical and university training. This is in contrast to what was required for WC. The shortage of green skills in wastewater treatment sector can be improved through commitment from private and public division, especially from government organisations such as Skills Education Training Authorities (SETAs) and government parastatals including East Rand Care Association (ERWAT) and Rand Water in this province. This can be achieved through green training programmes both practical and theoretical at the work place, short-courses in traditional colleges and universities, and long distance learning through the University of South Africa (UNISA). This will most benefit workers who are full-time employees.

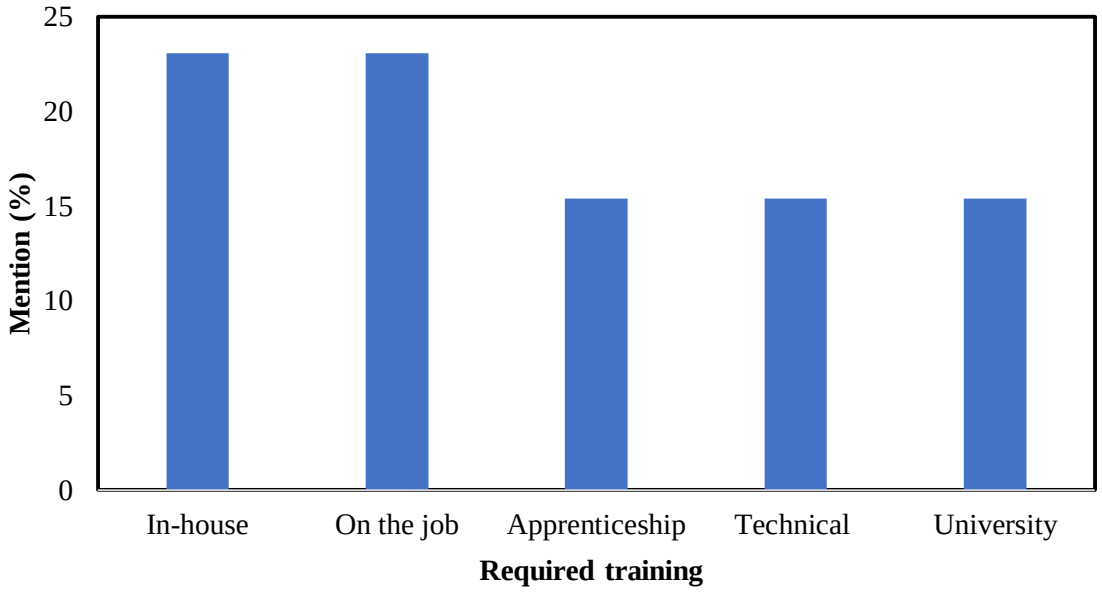

Figure 9.2; Preferred training by WWTWs in Gauteng Province

9.2. Potential for green jobs creation in Gauteng Province

Gauteng has several green projects currently running, some of which are short-term projects. Previously mentioned government parastatals such as Rand Water and ERWAT are some of the largest water companies that are currently providing services for most of the Gauteng water

and wastewater works. Not only do these companies provide services through treating water and wastewater, they also offer programs that promote skills development, promoting water awareness through workshops for the workers as well as the society. The Gauteng Province has the advantage to work even more closely with these companies to develop a foundation in creating green occupations in some of the WWTWs that are not managed by the mentioned companies.

Since GP has the largest population in South Africa (SA), most the WWTWs in this region are receiving high levels of inflow from all the operations including from industries, manufacturing companies and informal settlements. As shown in Figure 9.3, domestic headstreams contributed the highest (44%) amounts of wastewater resources. In this aspect, the potential to create more green jobs in the water and wastewater sector includes the generation of sludge to produce bioenergy and the use of the dried sludge to produce green compost for recreation centres and farms.

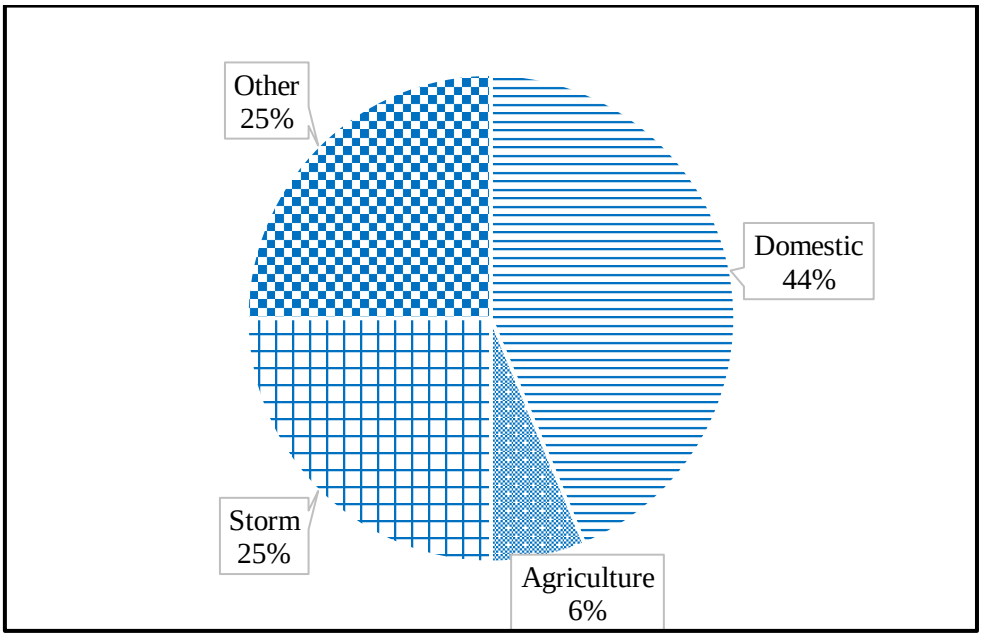

Figure 9.3; Sources of wastewater in Gauteng Province

9.3. Employee information

9.3.1. Employees' awareness of green occupations

The sectors identified to have potential to create green occupations include renewable energy, waste management, building, tourism, water treatment, agriculture, and transport. Many

employees reported that the sectors have green jobs or can create green employment. More than 76% of respondents were aware of which sectors can be associated with greening the existing occupations. Only about 25% of the interviewed employees identified that green jobs cannot be found or created in the mentioned sectors shown in Figure 9.4. This was an indication that not all the employees had knowledge about green jobs.

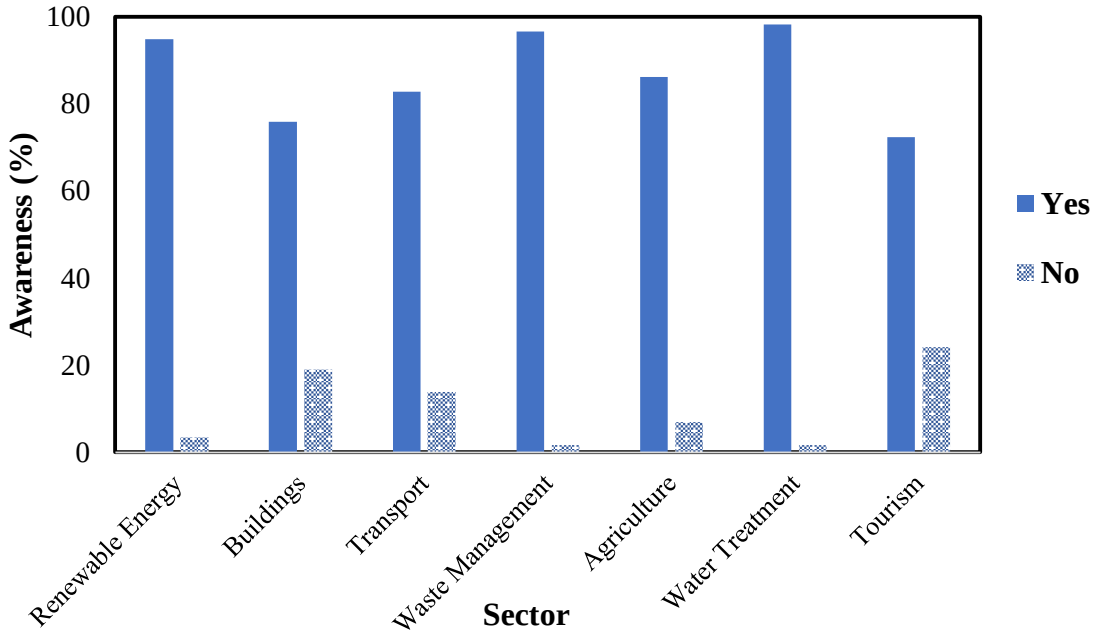

Figure 9.4; Sectors associated with green jobs as per water and wastewater treatment employees in Gauteng Province.

With the view of assisting the employees through this section of the question, the researcher had to elaborate and give examples on each specific sector and a general overview of what green and decent jobs are. As shown in Figure 9.5, as the likelihood of employees awareness to link the green jobs and their general knowledge on green occupations increased, most employees could positively respond to the statements on green jobs. Only a small percentage of respondents, approximately 12%, could not grasp the whole concept and is revealed by the results in Figure 9.5. This could be because green economy is still unknown to some of the workers, and in this case the minority of them still need green job awareness workshops or training. During the field interview, it was suggested by one of the workers that a workshop or presentation on green occupations, would have been necessary to fully prepare the employees before conducting the survey.

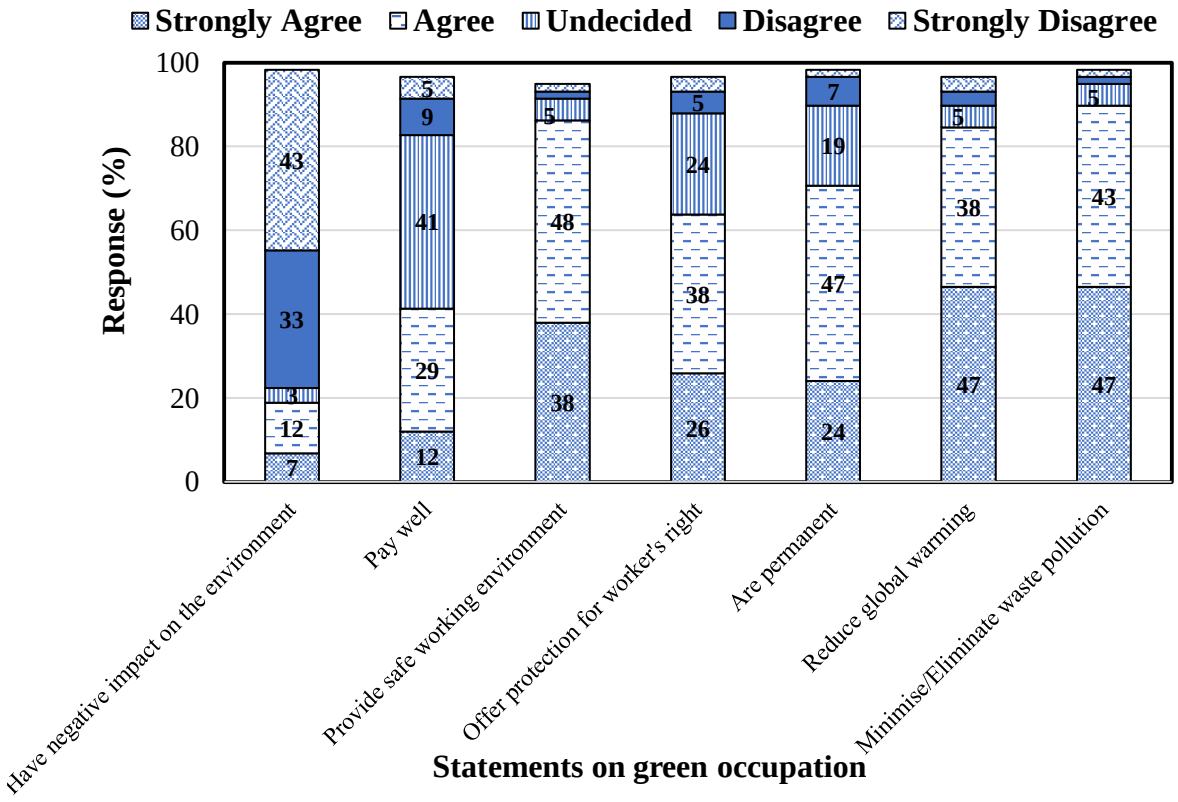

Figure 9.5; Green occupations awareness level

9.3.2. Employees awareness of company's green occupations plans and practices

One of the key important principles in any organisation, company or sector, is to invest on human capital that would pay off in terms of productivity. Hence, there should be a level of communication between the plant management and the field workers. The assessment of the level of employees awareness about their practices and green jobs plans at their plants is shown in Figure 9.6. Most of the employees are very much aware of the company's green plans, strategies and practices. In terms of policies and regulations, a high percentage of respondents were unaware while others assumed that such policies already existed. The idea is to transition to a green economy and GP having powerful strategies and policies in place to achieve its goals for green growth in all its governmental levels, all employees including those working at the operational level should be exposed to such information. This will also assist in overcoming limitation of knowledge on green skills. In this context, sharing of information between the senior personnel and process controllers is important for the overall efficient operation of the plant.

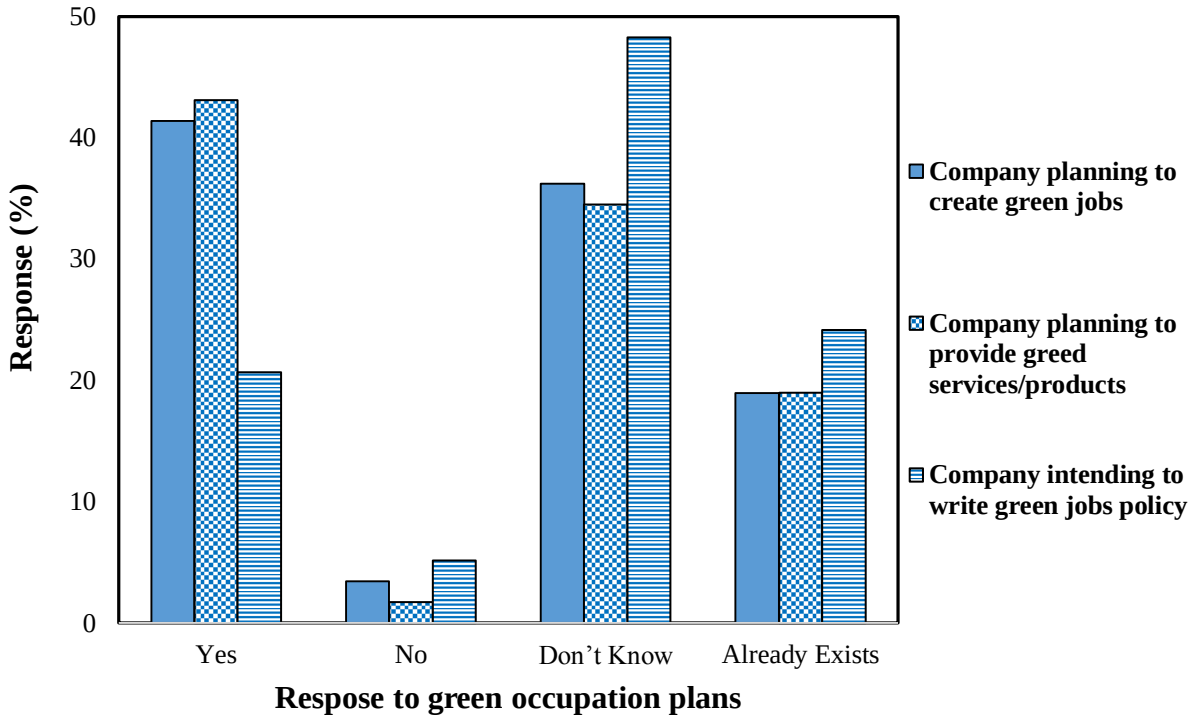

Figure 9.6; Employees' awareness of company's green occupations plans

In Figure 9.7, the focus was to survey the overall respondents' knowledge on green processes and technologies present in their companies. Most of the employees identified water use (90%) and energy efficiency (71%), value addition (66%), waste utilisation (81%), and biogas production (59%) as green processes and technologies presently existing in their plants. Many of the employees could not identify renewable energy as a green energy practise. This was a clear indication that most respondents related renewable energy to practises such as the use of solar lights and solar geysers, of which most of the plants did not have. In only few plants did respondents identify renewable energy as the biogas produced.

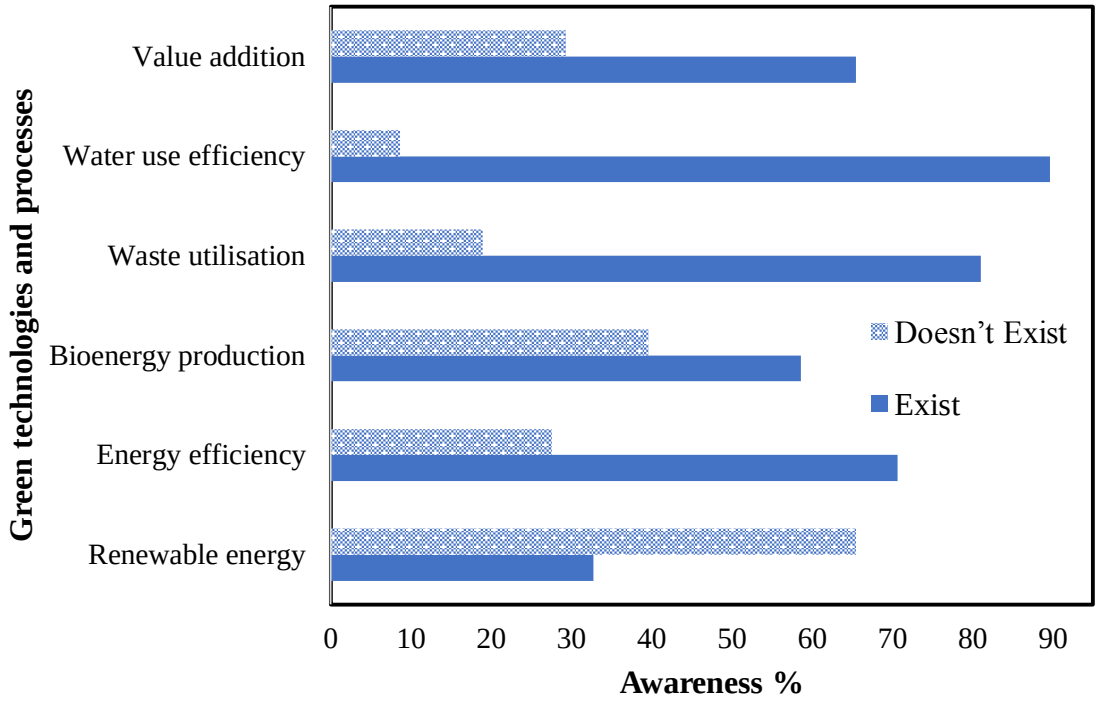

Figure 9.7; Employees' awareness of existing green technologies and processes

9.3.3. Demographic information of the interviewed employees

Figure 9.8, show gender distribution among the interviewed employees in GP. Government must ensure that creation of green occupations is accessible to all; both females and males should be provided an equal chance. Many respondents (67%) were male with the remaining 33% being female. Out of the minority female respondents, only a few were permanently

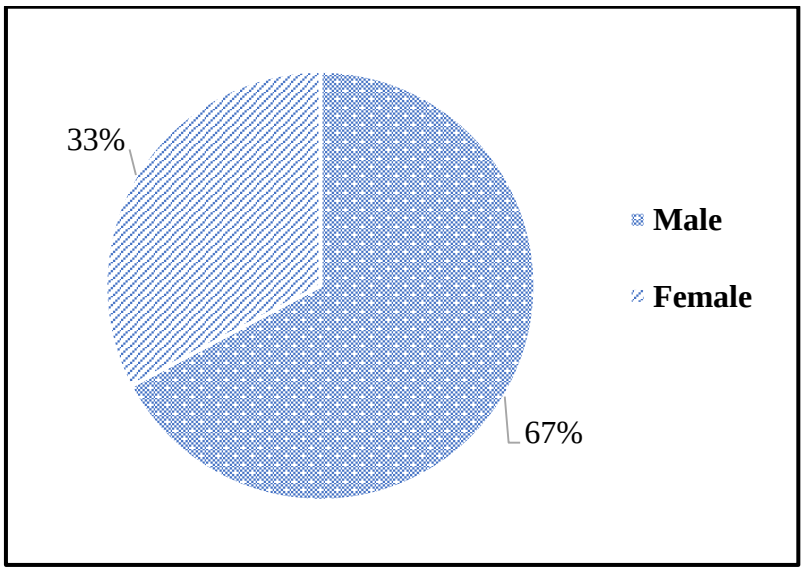

Figure 9.8; Gender distribution of respondents

employed as process controllers and plant managers. All the necessary measures should be taken so that gender inequalities currently existing, is not carried down in the greening of economies. Opportunities for women must be identified and introduced in the water sector as well, to empower women and promote gender equality.

From Figure 9.9, it was unexpected that older employees between 50 to 59 years of age would account for 40% of the total respondents. Less than 10% of respondents were aged 29 years and below, similar results were observed in MP and other provinces.

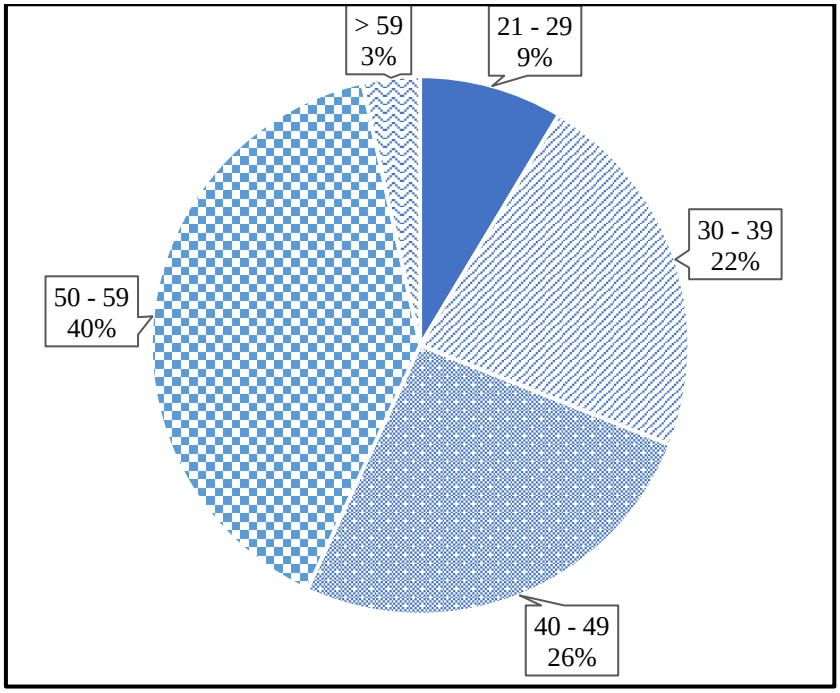

Figure 9.9; Age distribution of respondents

Figure 9.10 reveals that most workers interviewed in the visited plants were working at operational level; this occupation position includes process controllers and general workers. It was also found that 28% of the respondents were in managerial positions as plant and lab managers. This is a very high proportion compared to other provinces such as NW (8%), NC (5%), KZN (14%), MP (14%) and FS (6%). A few of the respondents hold professional, technical and administrative positions. This is because most of the plants visited did not have proper job descriptions and employees who are mostly at managerial positions as plant managers also performed administrative tasks. Also, most plants did not have maintenance or technical teams on site; in most cases, they outsourced these services to private companies.

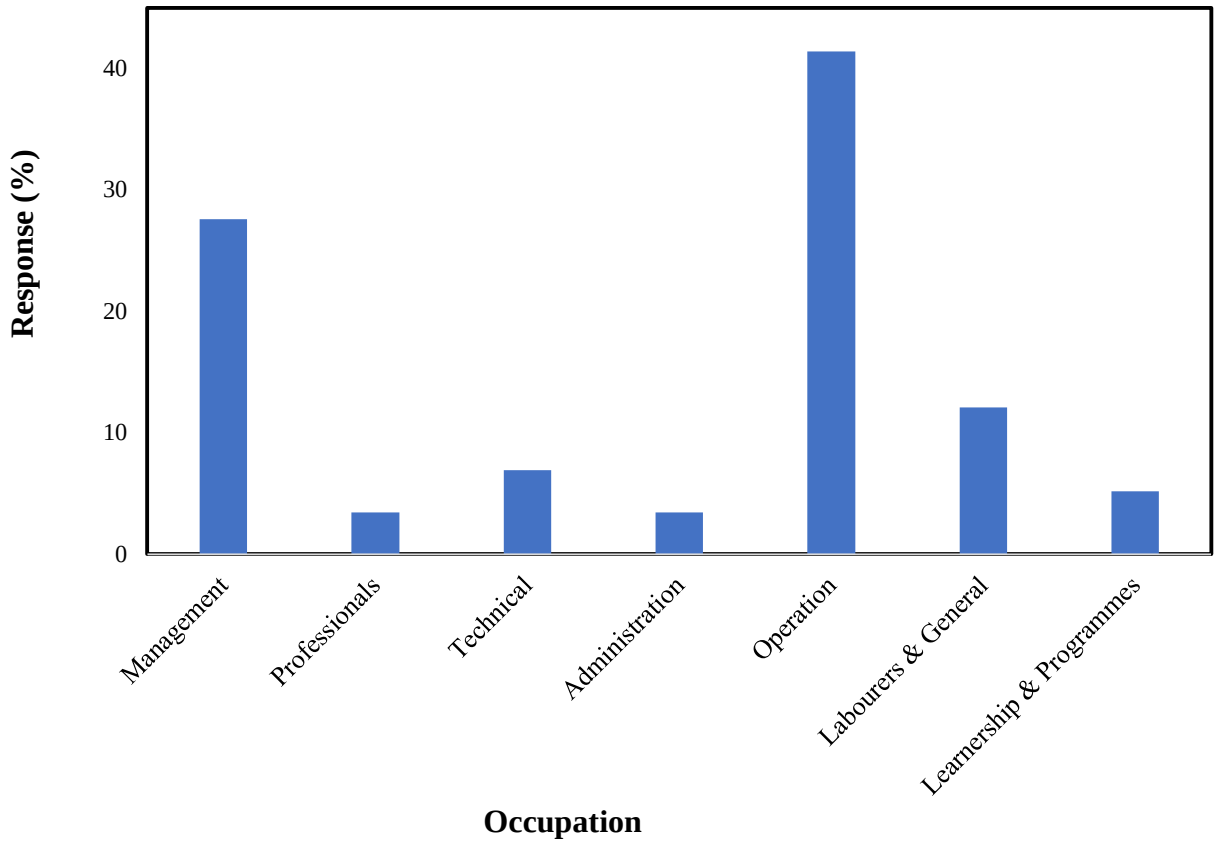

Figure 9.10; Respondents' occupations distribution

The employees educational background is shown in Figure 9.11. About 24% of the employees in the visited plants had no formal qualification (lower than matriculation). The proportion of employees holding matriculation and diploma qualifications is relatively high in this province, at 19% and 24%, respectively. These results highlight the education opportunities currently available for employees in this province, Gauteng has the largest tertiary and manufacturing institutions, despite the high unemployment rate which is a national crisis. In addition, local municipalities in this region can easily work with training institutions and universities to strengthen the focus on green skills developments and upgrade the non-green knowledge and skills.

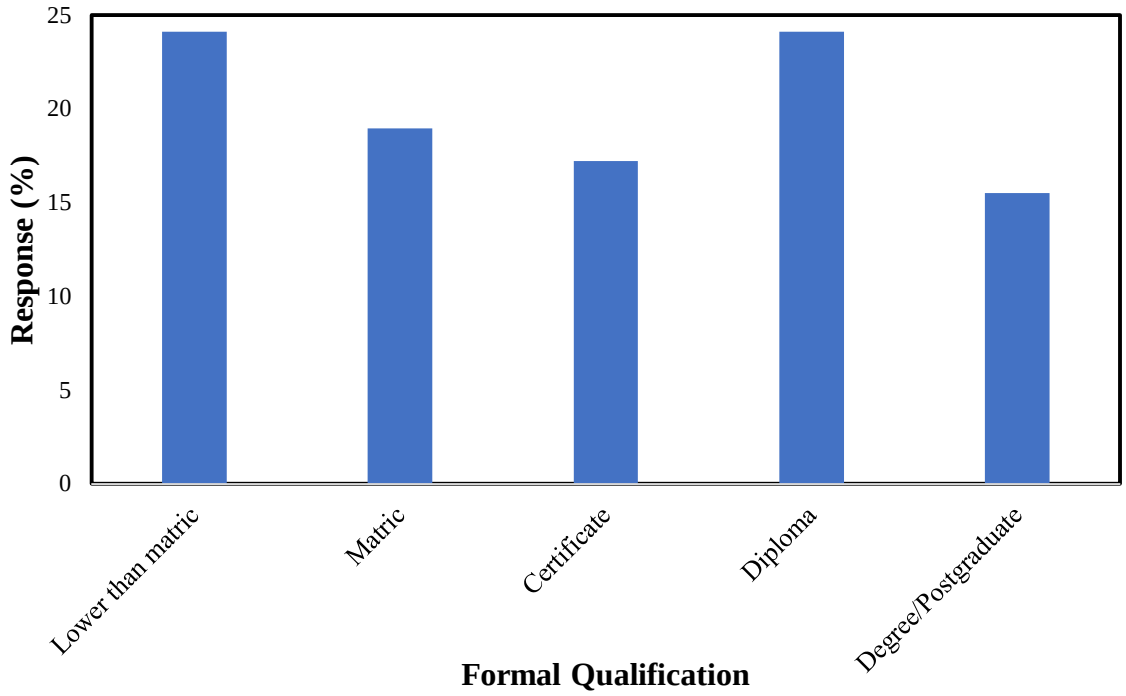

Figure 9.11; Respondents on formal qualification

The wastewater workforce in this province was assessed in terms of employees work experience and it was found that majority of the workers (nearly 35%) had more than 10 years of work experience. Even though majority of these employees lack formal qualification, these workers are very much equipped with practical experience. The experienced acquired by majority of these workers will greatly assist during the implementation and innovation of new green technologies.

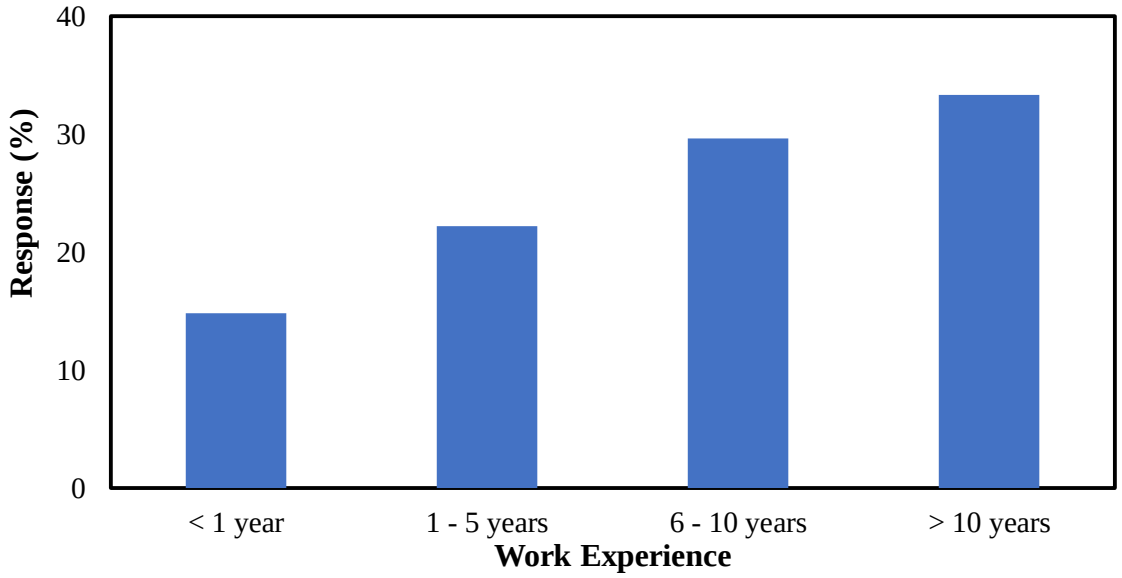

Figure 9.12; Work experience distribution of respondents

9.4. Conclusion

The role of local governments towards a low-carbon economy and green occupations creation is majorly recognised in metropolitan municipalities. Gauteng province (GP) being the largest economic contributor in the country, having three major metropolitans, has a great potential for creating green occupation. Currently, several projects have been implemented to improve and transform systems to adopt green renewable energy in this region. The treatment methods employed in the plants were the normal BNR and activated sludge systems. Biogas production practises were very common in most of the plants, but only two plants (GP-MM2-Plant1 and GP-MM2-Plant2) utilised the biogas produced. Such activity has been identified as a low-carbon practise. Only 4% of the existing jobs are direct green occupations and few employees were performing jobs related to green economy.

From the data collected, majority of the plants had serious challenges including unsuitable work space conditions, inadequate staffing and structural defects. These are some of the barriers experienced by most plants in implementing and achieving green economy goals for green job creation. Of great concern is the aging work force; 40% being in the 50 to 59 years range. This calls for a well-structured succession plan. This is important for the retention of institutional memory that drives continuity. In many ways, GP has taken initiatives along the road to GE. Some of the initiatives include solar energy and biofuel. It is in GP where the highest number of respondents linked energy efficiency to GE.

CHAPTER 10

10. Eastern Cape province

10.1. Wastewater Treatment Works Information

Eastern Cape (EC) is a province located between KwaZulu-Natal and Western Cape provinces of South Africa. EC consist of six district municipalities that are subdivided into thirty-one local municipalities and two metropolitan municipalities (Buffalo City Metropolitan Municipality and Nelson Mandela Bay Metropolitan Municipality). According to the Green Drop Report 2013, the province had 124 wastewater collectors and treatment systems performed by sixteen Water Services Authorities. Furthermore, the province showed a significant green drop improvement from 66.7% in 2013 to 72.9% in 2014 based on cumulative risk ratio. Two district municipalities and one metropolitan municipality were visited to conduct a research on green occupation in water and wastewater treatment plants but mainly focusing on the WWT plants. Twelve wastewater treatment works were visited. There are several wastewater treatment methods used in EC WWT plants that include biological nutrient removal, oxidation ponds/maturation ponds, biofilters and dissolved air flotation as shown in Table 10.1.

More than 60% of the employees in EC water treatment sector have matric certificates, and more than 30% had a formal training such as certificates, diplomas, and degrees (Table 10.2). Nevertheless, most of the certificates were obtained through Department of Water Affairs. Most of the certificates are in water and wastewater treatment (NQF certificates) provided by skills facilitator such as Mahube Training and Development. Less than 16% of the employees have diplomas and degrees and in general scarcity of skills in most of the treatment plants is very high due to lack of formal training. Currently at EC-DM2-LM1-Plant3 the influent from local communities is very low and potable water treatment plants had been stopped due to shortage of water from the rivers. This is all happening because of the current draught that the province is experiencing. Potable water is being supplied to the communities through water tankers and the municipality has liaised with other neighbouring municipalities to get the water. EC-DM1-LM1-Plant1 has a laboratory whereby the effluent quality was measured. At EC-DM1-LM2-Plant1, effluent is currently used by a farmer. The farmer is currently producing vegetables which he sells to the nearby communities using the effluent from this plant. EC-DM2-LM1 has three ponds systems and the plant operators are only responsible to ensure that the plant screens are clean. These plants do not have any working flow meters and there is no

chlorination in two of the mention ponds systems. Both EC-DM2-LM2-Plant1 and EC-DM2-LM2-Plant2 have onsite laboratories whereby some of the wastewater quality indicators such as ammonia, nitrates, phosphates, free chlorine, and chemical oxygen demand are analysed. Effluent from EC-MM1-MM1-Plant1 was discharged directly into Indian Ocean, while effluent from EC-MM1-MM1-Plant3 was used for irrigation in a nearby golf course and a school.

Table 10.1: Summary of Eastern Cape visits

District Municipality	Number of LMs/MMs visited	Number of WWT plants visited	Technology
MM		3	Biofilter, Fine Bubble Aeration and BNR
DM 2	2	4	Oxidation ponds, Activated sludge and BNR
DM 3	2	5	Activated sludge, Oxidation ponds and BNR

Table 10.2: Demographic profile of plants visited in EC province

		Percent
Size of plant	Less than 50 employees	100
Plants employees qualification	Lower than matric	29
	Matric	36
	Certificate	18
	Diploma	9
	Degree/Postgraduate	7

10.2. Potential for green jobs in Eastern Cape

Based on the current visited treatment works in the province the following strategies can be of importance in addressing green occupation:

- Classification and transformation of sludge into compost
- Utilization of final effluent as irrigation water for agriculture and recreational facilities such as golf courses
- Implementation of green policies in the municipalities

About 39% of treated wastewater in WWT plants is domestic water followed by 30% and 22% of storm water and abattoirs influent, respectively, as shown in Figure 10.1.

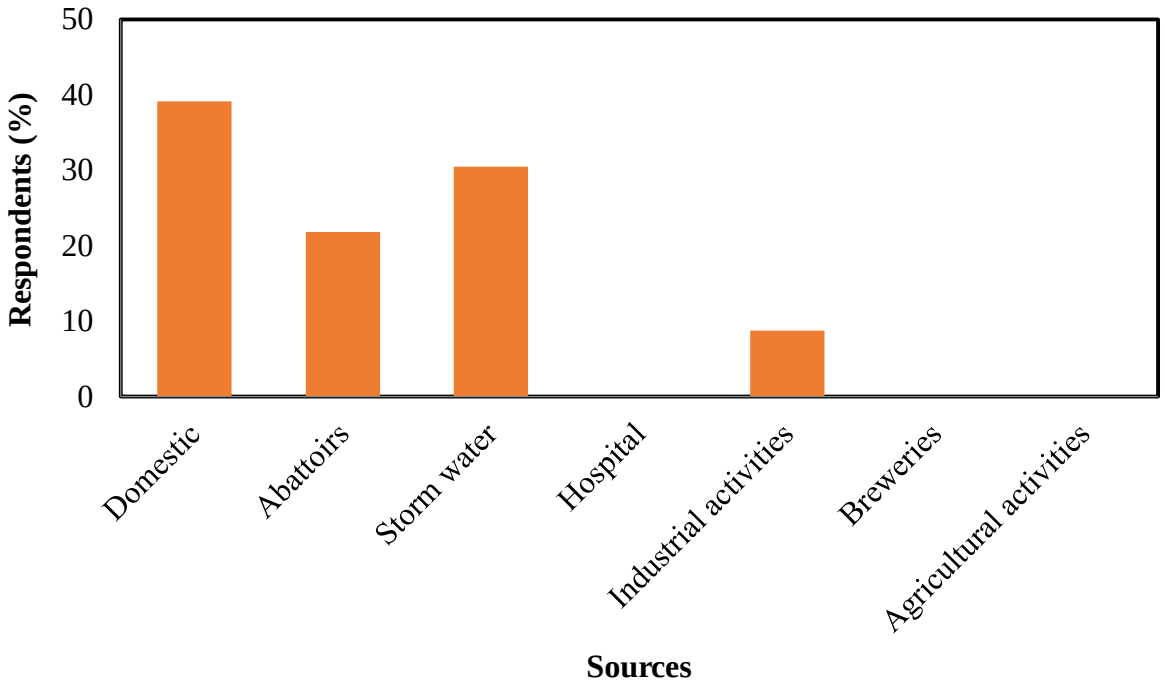

Figure 10.1: Sources of Wastewater in EC province

Only 25% of the visited WWT works utilize anaerobic digesters that are only used for sludge treatment (smell/odour removal) and not for bioenergy recovery, while 75% of the treatment works did not have anaerobic digesters but use biological nutrient removal systems (Figure 10.2). Methane gas produced from the digesters was released to the atmosphere and was not used as a renewable energy, therefore such systems do not address the effect and impact of methane gas on environmental pollution. The ratio of gas volume per cost could have hampered the justification of recovering methane gas produced from anaerobic digesters in these plants. EC-MM1-MM1-Plant3 is one of the few plants that is using fine-bubble aeration instead of conventional surface aerators. Furthermore, the plant is using supervisory control and data acquisition system which measures the real-time data from the plant equipment. Aeration is the most energy-intensive operation in wastewater treatment, amounting to 45–75% of plant energy costs (Rosso et al., 2008). Bubble aeration involves pumping air down a series of pipes to the bottom of the reactor tank so that bubbles rise through the effluent. This method has a high aeration efficiency and is more energy efficient as compared to conventional aeration (Rosso et al., 200).

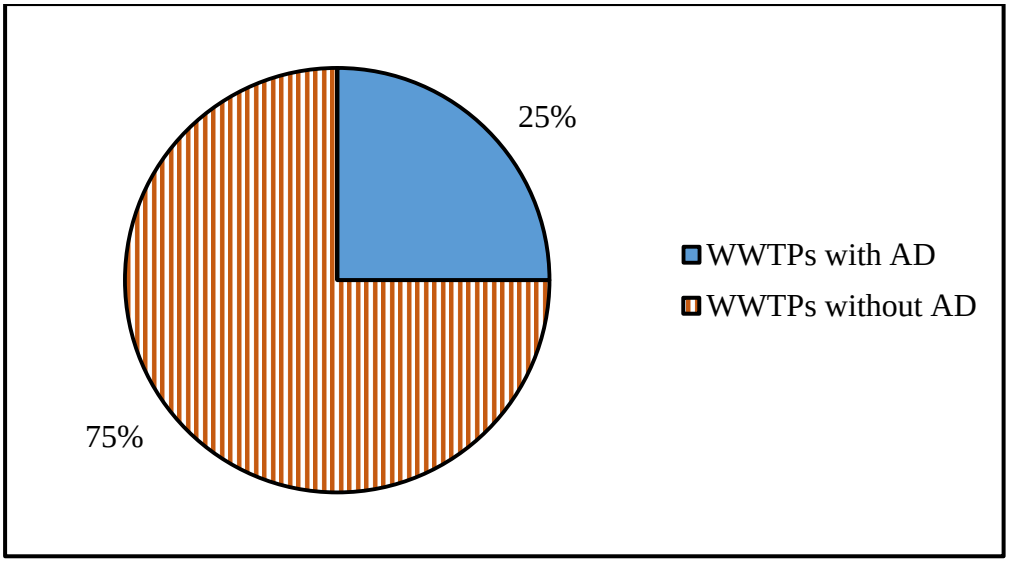

Figure 10.2: Anaerobic digester

10.3. Employees information

Based on the questionnaire developed it was easy to understand how well the employees were aware of the green economy strategies in their respective line of duties. However, some of the employees did not complete some of the questionnaires simply because of their lack of knowledge in green economy as it is a new concept in wastewater treatment plants.

10.3.1. Employees awareness of green occupations

It is often easy to identify green jobs in any sector especially if an employee is working in a green sector; however, based on the interview, only 16% of the employees were certain that green jobs could be found in the water treatment sector and 18% believed that green jobs could be found in the waste management sector (Figure 10.3). About 16% of the employees believed that green jobs could be found in the renewable energy sector, while 16% disagree. Green buildings are not that popular in communities; nevertheless only 17% of the employees believe that green jobs can be found in building sectors. Even though the majority of employees had matric certificates as a minimum qualification (Figure 10.7), they could not identify green economy sectors. It became obvious that if the employees cannot identify such sectors, it would therefore, be difficult for most of them to have a thorough knowledge about green practices and green strategies being implemented by their respective employers or plants.

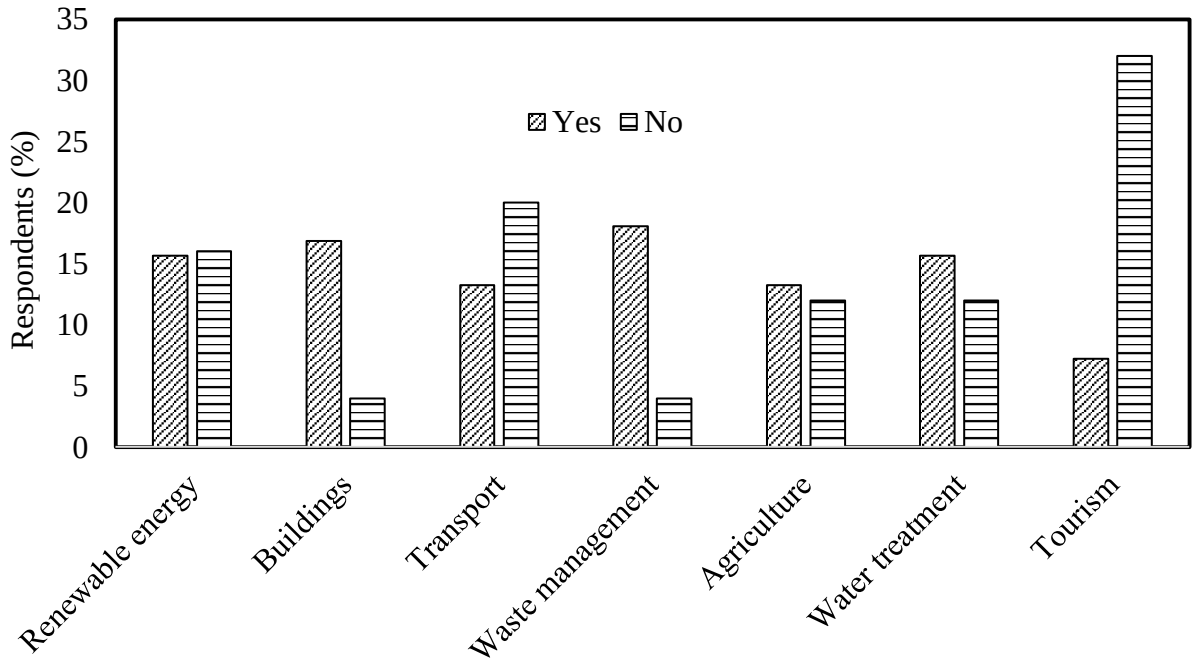

Figure 10.3: Sectors associated with green jobs in EC province

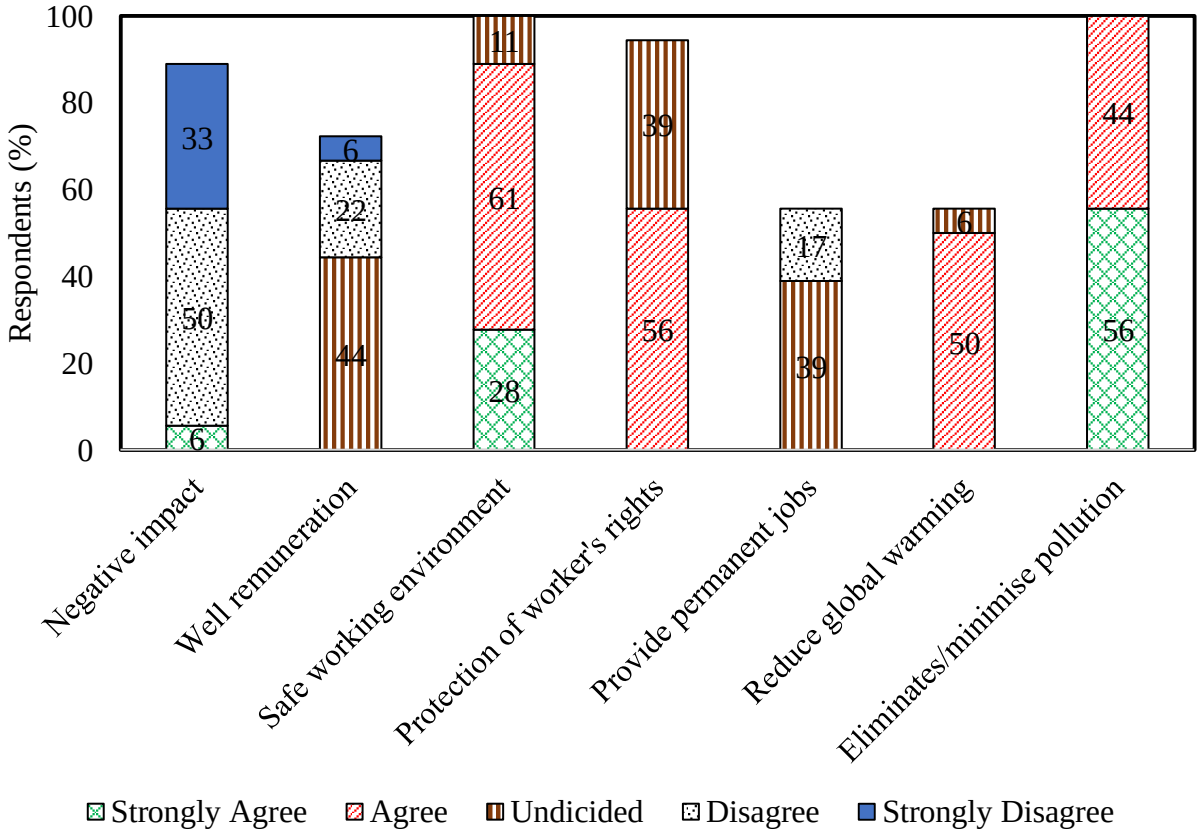

Figure 10.4: Green occupations level awareness

About 50% of the WWT works employees indicated that green jobs do not have a negative impact on the environment. About 61% of the employees do not believe that green jobs can provide a safe working environment, while 44% of the employees were undecided on whether green jobs can provide a good remuneration. About 56% of the employees believed that green jobs do not protect workers' rights, while 39% of the employees were undecided on whether green jobs can be permanent. About 50% of the employees believed that green jobs that do not reduce global warming, while 56% of the employees strongly believed that green jobs do eliminate or minimise environmental pollution as shown in Figure 10.4. It was, however, observed that most of the senior personnel, such as process technicians and plant managers, were aware of the green drop policies and strategies that can be used in their respective plants; however, implementation is still a challenge. Unfortunately, the majority of the process controllers and process operators were not aware of the green drop strategies in their working environment and some of the employees acquired the knowledge of green drop awareness through informal training based on individual interest. It is, however, acknowledged that one of the visited WWT plant (EC-MM1-MM1-Plant1), has consistently received a green drop certificate from Department of Water Affairs (DWA).

One of the visited plants (EC-MM1-MM1-Plant2) in the province has consistently received green drop certificates (Awards) from DWA. DWA green drop award recognise those WWT plants that comply with wastewater legislative requirements and implementation of the best practices in the plants.

10.3.2. Employees' awareness of company's green occupations plans and practices

It was observed that although the some of the WWT plants were trying to implement and practice some of the green drop strategies recommended by DWA, such as waste utilization, use of solar lights, use of alternative technology for effluent management, etc., 54% of the surveyed employees did not understand or did not know if such strategies are addressing green economy. About 15% of the interviewed employees were aware of the renewable energy practices (e.g., use of solar lights) in their respective plants and they had a clear knowledge that such practices can address green drop (Figure 10.5). About 7% of the employees were aware of the energy efficiency strategies in their respective plants, such as the use of air bubble flotation system, use of fluorescent lights, and insulation of the equipment. About 11% of the employees were aware of waste utilization, especially the use of dried sludge as manure in their plants and they understood very well that such strategies are aligned to green drop. About 15%

of the employees were aware of water usage efficiency strategies in their respective plants such as the use of final effluent to irrigate their landscape and the use of final effluent by nearby farmers. Furthermore, only 7% of the employees are aware that classification of dried sludge in their respective plants does address green drop.

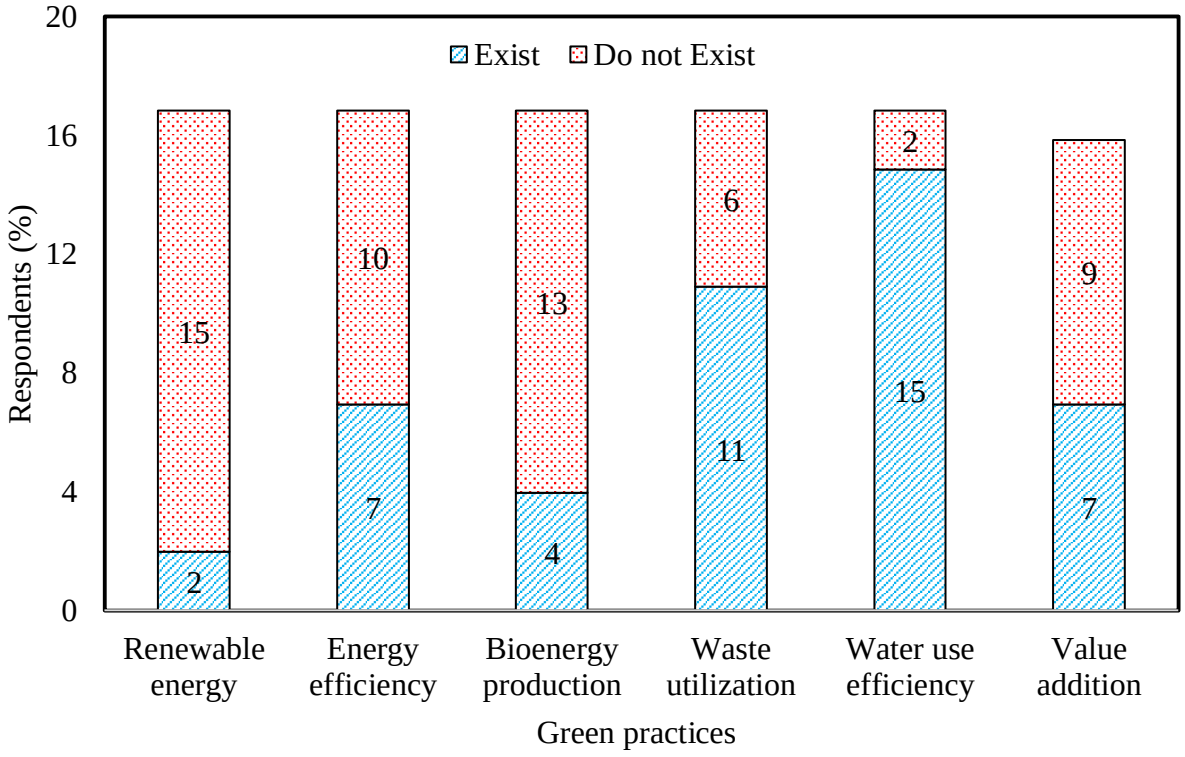

Figure 10.5: Employees' awareness of existing green technologies and processes

It should, however, be noted that these results were based on the knowledge of the employees and not necessarily the plant practices. Therefore, based on the plant visits and physical observation of the plants' practices, the majority of the plants used final effluent to irrigate their respective landscapes while the nearby farmers, schools, and golf courses use the effluent for irrigation. Furthermore, dried sludge is often collected by the nearby farmers, schools and golf courses and is used as manure. Therefore, although there are green economy practices in several WWT plants, the knowledge and understanding of why such practices exist and how such practices relate to green economy or green drop, is still very low.

10.3.3. Demographic information of the interviewed employees

Based on the interviewed WWT plants employees, 62% of the employees are between the age of 30-39 years old with 31% being males and 31% being females (Figure 10.6). Only 6% of the employees were more than 40 years of age and most of them are males. 13% of the

employees are males between the ages of 21-29 years as compared to 19% females of the same age. In general, the province has taken a firm stand to address gender equality in water treatment sector.

More than 50% of the WWT workers have a matric certificate as a minimum qualification, while only ± 5% do not have a matric certificate (Figure 10.7). Unfortunately, less than 19% of the employees had water and wastewater certificates recognised by South African Qualification Authority (SAQA), while 29% of the employees had diplomas, degrees, or postgraduate qualifications.

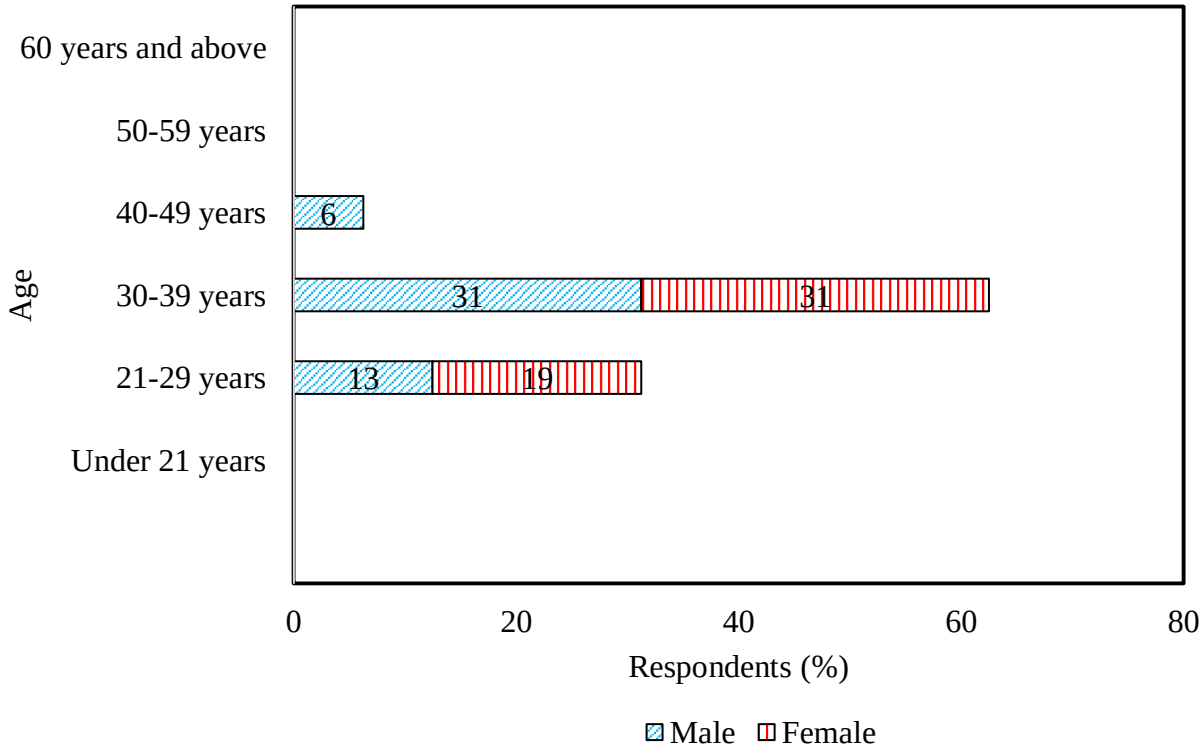

Figure 10.6: Gender and age distribution of employees

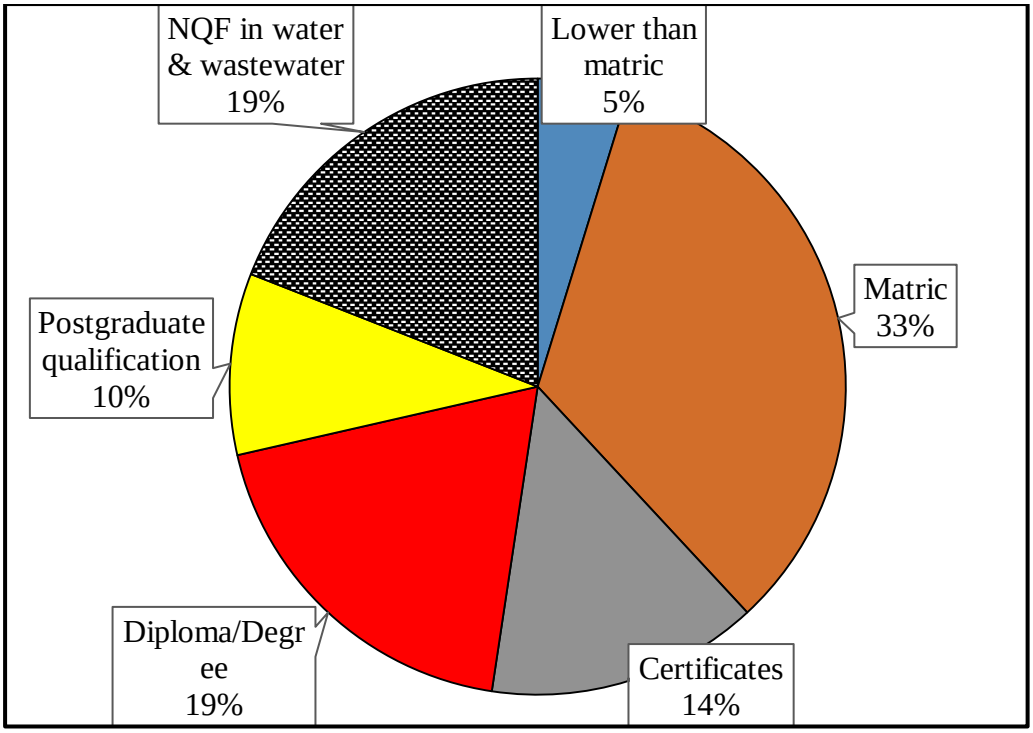

Figure 10.7: Employees' qualifications

Figure 10.8 indicates the number of years the employees have worked in the water sector. More than 63% of the employees had less than 5 years' working experience in the water sector with 44% having between 1-5 years and 19% having less than 1 year working experience in water treatment works. About 50% of the employees are working as operators, 33% are in technical positions and 17% on managerial levels (Figure 10.9). Engineers and professionals are required in treatment plants, the organisational organogram indicates clearly which engineers and professionals are required based on the size of the plant and policies. It was indicated that some of the engineering positions available in some of the WWT plants were not filled as per the organograms.

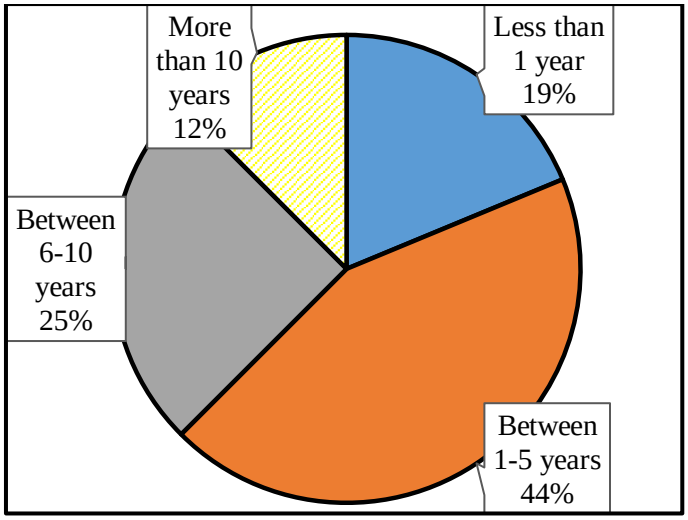

Figure 10.8: Years of experience in wastewater and water sector

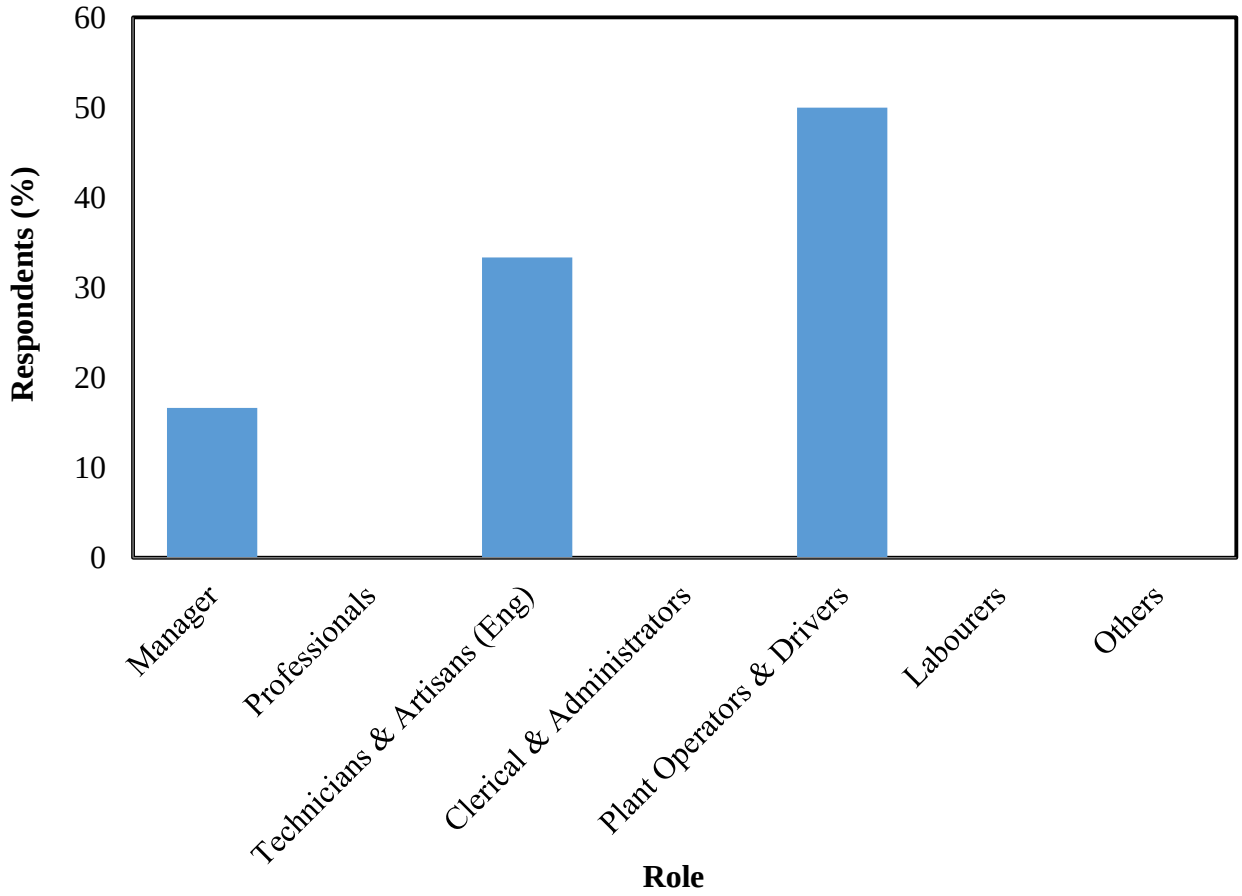

Figure 10.9: Role of the employees in the organisation

10.3.4. Barriers to uptake of green occupation

As already mentioned previously that almost 63% of the WWT plants have less than 5 years' experience, 76% of the employees believed that there were several challenges impeding green jobs creation in their respective plants, while only 24% of the employees believe there are no challenges. About 17% of the employees believe that lack of funding is one of the main attributors of failure by their respective plants or municipalities to create green jobs (Figure 10.10). Though there are green policies available in some of the treatment works, only a few employees were aware of such policies or they do not understand the significance of such policies in their working environment. It is well known that South Africa has a dire shortage of engineering and technical skills required in water treatment sectors and this can be deduced from the survey showing that 32% of the green job creation challenges in EC water sector can be attributed to a lack of skills and lack of staff training in green economy.

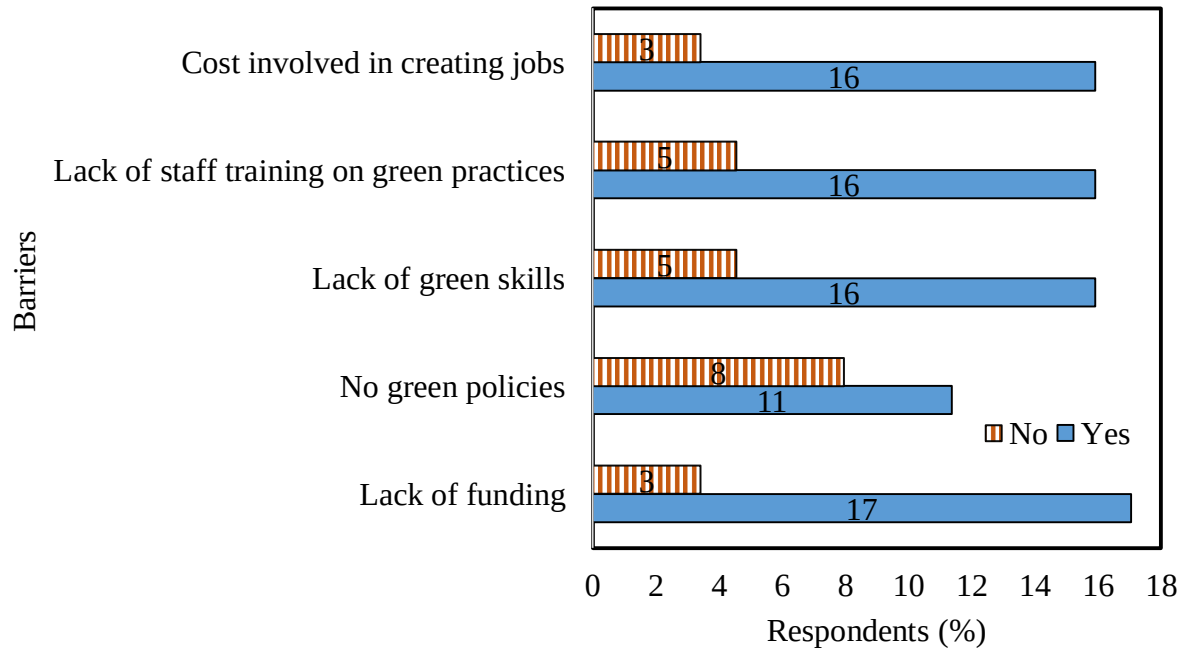

Figure 10.10: Barriers to green occupations in wastewater treatment in EC province

10.4. Current measures in place to promote green jobs and green economy awareness

There are several measures that municipalities and WWT plants can implement in ensuring that all employees are aware of the green economy concept in general and can be able to easily identify either green drop strategies or green jobs. However, based on the survey 63% of the respondents emphasised that their respective municipalities and treatment works were not

doing well to promote the idea of green jobs, including green economy awareness (Figure 10.11). One of the biggest challenges the municipalities are encountering is to clearly stipulate what are the available green job positions in water treatment works. About 31% of the employees were concerned about the lack of appropriate the municipalities or plants to specifically provide training and promote awareness focusing on the green economy. Furthermore, due to lack a of training and knowledge (awareness) of green economy, 17% of the employees felt that there are not enough incentives given to municipalities or treatment works for any initiatives practiced to promote green economy or green jobs. Therefore the government has to relook at how it can recognise such efforts through incentive based criteria.

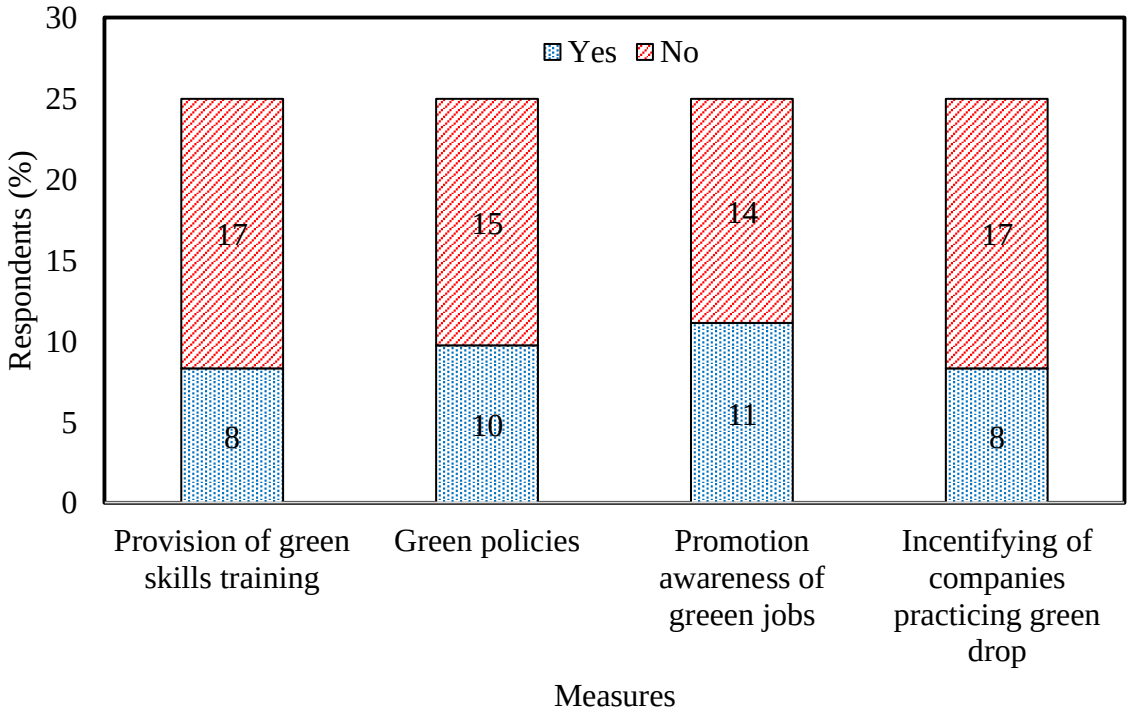

Figure 10.11: Measures to promote green jobs and green economy awareness

10.5. Conclusions and recommendations

According to the survey, it was discovered that green economy is still a foreign concept in some of the WWT plants workers. Majority of the employees working in EC water treatment sectors had matric certificates as an entry level to most of the available operating positions. However, lack of formal training in green occupation is very low. Gender equality especially promotion of woman in water sector where males were dominant before is well addressed. However, the lack of experience and the high shortage of green skills in most of the employees pose a huge challenge in addressing the importance of green occupation. Several municipalities

and Department of Water Affairs are trying to prioritize training and development of their employees in the province. However, more should be done in addressing green skills such as engineering, technicians and artisans. In general, some of the specific skills associated with green economy are not entirely new skills. Skills such as electrical, plumbing, technical, and engineering are not new skills but are either an add-on or an amalgamation of existing skills. Municipalities should invest more in order to harness such skills which are green occupation related.

Green jobs are not easily identifiable in water sector even though they are available. Municipalities and WWT plants managers should ensure that employees understand which positions or jobs are relevant to green occupation. Collaboration between DWA, universities and colleges can assist in developing green economy training programs and courses that are SAQA recognized. There are several training facilitators in water and wastewater service sector. However, it is possible that some of the programs offered by such facilitators or service providers do not highlight the importance of green occupations in water sector. Therefore, qualification such as Wastewater Process Operations accredited by SAQA should include modules on green economy.

Several senior personnel had knowledge about green economy and green occupation because they had attended short courses on green economy such as "Green Jobs for Sustainable Development: Concepts and Practices". Therefore, in the meantime it is very important that senior personnel should take responsibility of sharing with and cascading such knowledge to plant supervisors and plant operators. In order to develop good training programs on green economy, information about what green jobs are in water sector should be available. Therefore, DWA should clearly identify green jobs in water sector so that when it comes to advertising such jobs, one would be able to know and understand that the job is a "green job". Some of the employees felt that green jobs do not provide better wages or market salaries on green jobs is not easily available. Therefore, data on the market salaries of the green jobs should be available to the public.

CHAPTER 11

11. Free State

11.1. Wastewater Treatment Works Information

Several water services authorities are responsible for the wastewater service delivery in the province from almost 95 wastewater collectors and treatment systems. About 10 plants were visited in various district municipalities to conduct research based on several questionnaires and interviews. The questionnaires and interviews were mostly directed to WWTWs employees. Free State WWTWs use various wastewater treatment methods as shown in Table 11.1. There are several treatment works that are currently being upgraded to use biological nutrient removal as the main treatment method. One of the treatment works is currently being upgraded with the "Fine Bubble Aeration" *wastewater* treatment method. Plant FS-DM1-LM2-Plant1 has its own fully commissioned laboratory to analyse effluent. This plant does not rely on external service providers to conduct effluent analysis. FS-DM2-LM2-Plant1 is using maturation ponds as the main wastewater treatment method. However, the plant is currently being upgraded to a BNR system. FS-DM1-LM2-Plant2 is being upgraded to fine bubble aeration system. FS-DM2-LM1-Plant1 has anaerobic digesters which produce biogas. However, currently the gas is released into the atmosphere.

Table 11.1: Summary of Free State visits

District Municipality	Local Municipality	Treatment Works visited	Treatment Methods
DM 1	1	1	Biological Nutrient Removal, Oxidation Ponds
DM 2	2	3	Biological Nutrient Removal, Oxidation Ponds, Trickling Filter, Fine Bubble Aeration
DM 3	2	6	Biological Nutrient Removal, Oxidation Ponds, trickling filter

11.2. Potential for green jobs in Free State province

There are several strategies that FS can use to fully support the green economy policy initiative by the government. However, some of the strategies might require detailed feasibility studies and a large amount of resources. Based on the current visited treatment works in the province the following strategies can be of importance in addressing green economy:

- Classification and utilization of sludge into potential plant fertilizers
- Full utilization of final effluent as irrigation water
- Green buildings in municipalities
- Feasibility of using anaerobic digesters to produce biogas and subsequent use of biogas for heating or electricity production
- Use of fine bubble aeration to save electricity on aerators

The main source of wastewater being fed into the treatment works is domestic wastewater that is 46% of the total influent as seen in Figure 11.1. However, abattoirs and hospital influent contributes 31% of the total inflow. About 3% of the WWT plants are affected by storm water. However, FS is not a very dry province, therefore some of the respondents might have had little knowledge about storm water coming into their respective plants. It was observed that it is sometimes challenging for other treatment works to completely remove colour of the blood from abattoirs or hospitals in their final effluent. The biggest challenge with anaerobic digesters could be how much of the biogas will be produced especially because most of the visited treatment works were of medium sizes (2-10 mega litres per day).

About 23% of the treatment works have anaerobic digesters and 54% of the treatment works are currently being upgraded without anaerobic digesters (Figure 11.2). The majority of these WWTPs are upgraded with biological nutrient removal (BNR) systems. Only 23% of the FS WWTPs have anaerobic digesters that produce methane gas, however, in these WWTPs methane gas is not stored but vented into the atmosphere because the digesters are not working or the digesters. Furthermore, it was discovered that although several WWTPs are being upgraded, none of these WWTPs will use anaerobic digesters to capture methane gas but the plants will only use BNR systems that focus more on nutrient removal.

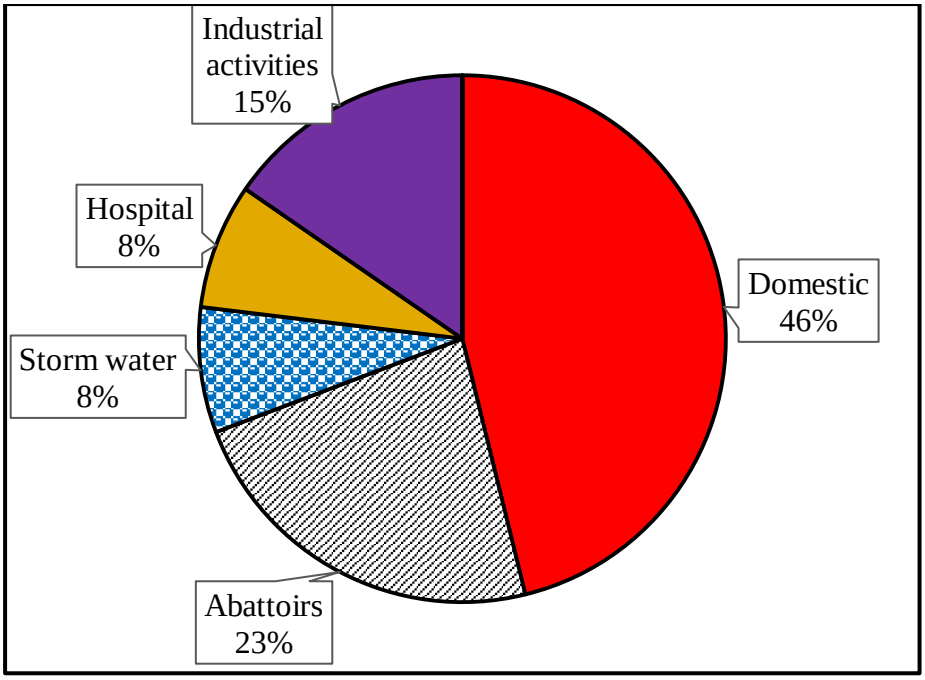

Figure 11.1: Sources of Wastewater in FS province

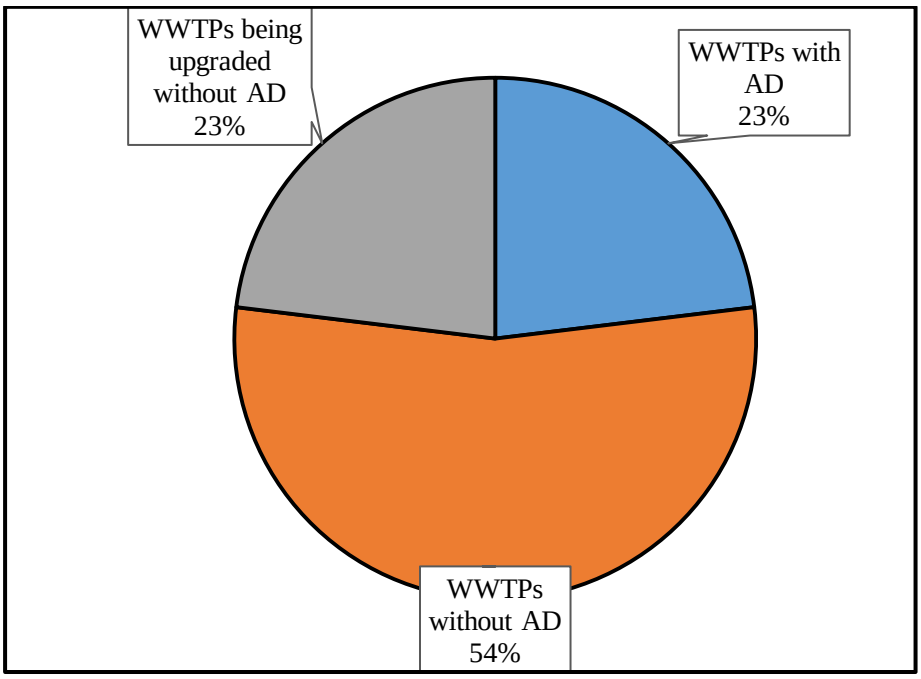

Figure 11.2: Anaerobic digester

11.3. Employees information

The questionnaire was developed in order to assess the WWT plant employees knowledge on green economy. In general, most of the questions were answered by the employees who were

present at various WWT plants during the visits. However, some of the employees did not complete some of the questionnaires simply because of their lack of green economy knowledge as it is a new concept to them.

11.3.1. Employees' awareness of green occupations

The awareness of "where can green jobs" be found in various sectors was assessed. However, the majority of employees, especially the operators, do not understand the concept of green jobs or green economy. About 38% of the treatment works employees showed that they are aware of green jobs in water treatment sector after explaining the concept of green economy as shown in Figure 11.3. About 31% of the employees were aware of green jobs in renewable energy and waste management sectors. Some of the operators have Class 3 & Class 4 water and wastewater control qualifications. However, it is apparent that during the training, the concept of green economy was not taught. Furthermore, some of the employees did not show any interest or even wanted to answer the green economy questionnaire. The concept of green economy is still new in water sectors and there has never been any formal training or awareness of green jobs in water sectors and this had an impact on how the operators answered the questions. Lack of formal training and skills also contributes negatively towards green jobs awareness.

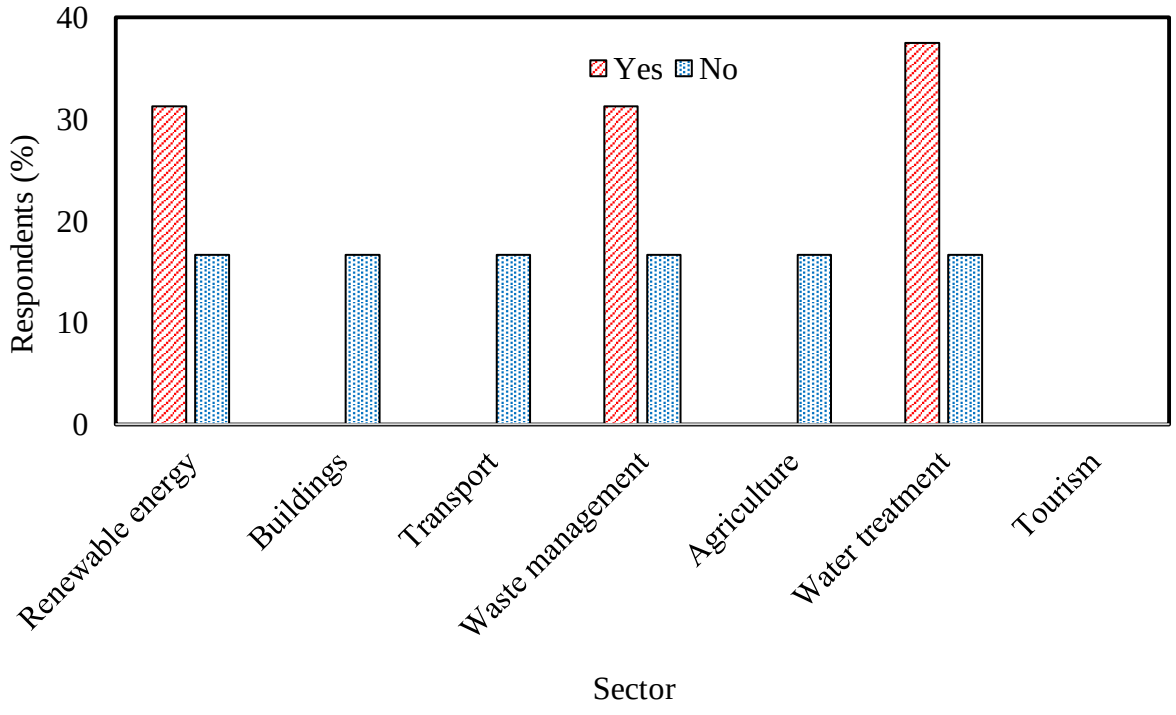

Figure 11.3: Sectors associated with green jobs in FS province

About 57% of the employees indicated that green jobs do not have a negative impact on the environment, while 71% of the employees are not sure if green jobs can provide a stable and good remuneration (Figure 11.4). About 33% of employees were not sure if green jobs could really provide a safe working environment; one employee gave an example about the explosion of nuclear plants. About 50% of the employees disagreed that green jobs can provide protection to workers' rights, while 71% were not sure if green economy could provide good permanent jobs. Results show that 43% of the employees were not sure if green jobs can prevent global warming, while 29% strongly agreed that green jobs can prevent global warming.

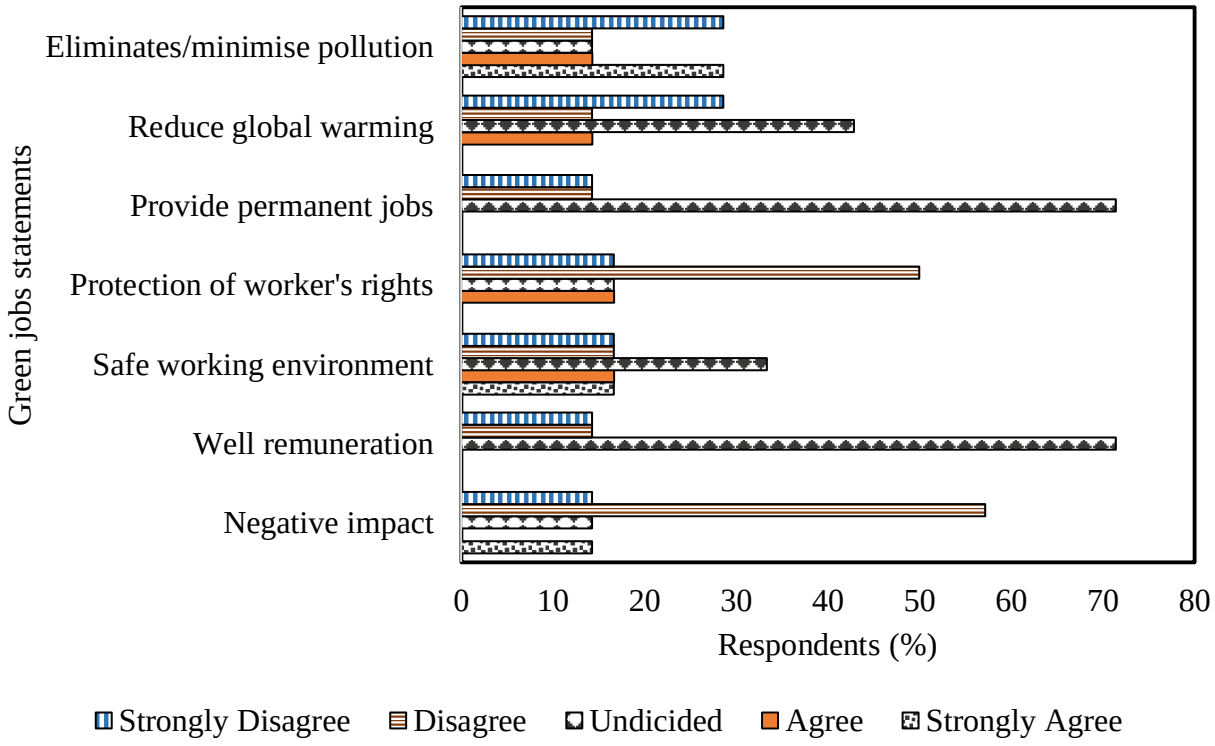

Figure 11.4: Green occupations level awareness

11.3.2. Employees awareness of company's green occupations plans and practices

From Figure 11.5, it can be seen that about 33% of the WWT plants are practicing green economy by using water efficiently. The effluent is used in some of the nearby school gardens, farms and golf courses, while 27% of the waste dried sludge is used by farmers and communities as manure. However, it should be noted that the sludge is not classified and certified by the Department of Water and Sanitation, therefore, whoever is using the sludge as manure or fertilizer is doing so at their own risk. No revenue is generated by the municipalities

from such dried sludge. About 7% of the treatment works are energy efficient because one plant uses the fine bubble flotation system that required the minimum amount of air from compressors and does not use aerators. Unfortunately, the frequency of the use of dried sludge or final effluent by farmers, community members or schools, is not known or even recorded.

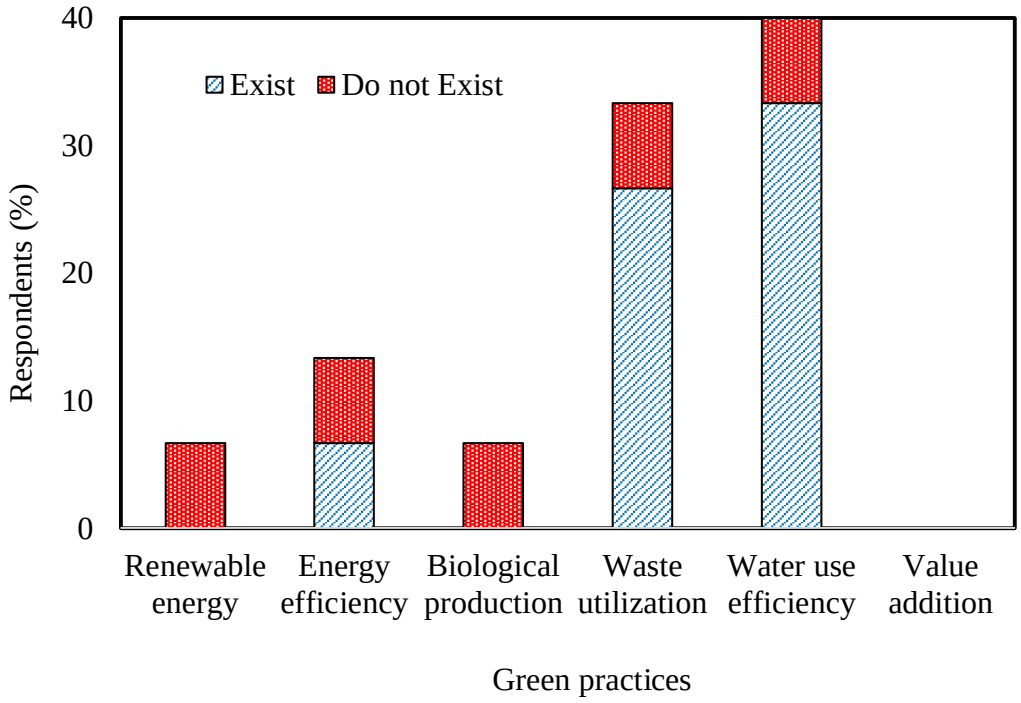

Figure 11.5: Employees awareness of existing green technologies and processes

11.3.3. Demographic information of the interviewed employees

Figure 11.6 shows demographic distributions (age and gender) of employees in wastewater treatment works and this is based on the employees who were present at their respective plants during the survey. About 75 % of the workers are males while 25% are females. Around 50% of the males are between the ages of 40-59 years of age. Furthermore, the data showed that around 32% of the employees had no matric certificate while 25% had a matric certificate (Figure 11.7). About 25% of the employees have water and wastewater related NQF qualifications offered by accredited training organizations such as Mahube Training and Development. DWA is providing resources to bridge the skill gap in water sectors. However more resources are still required in order to support employees who are willing to complete NQF qualification in water and wastewater programs. Learnership and internships are currently

used to provide and bridge the gap between those employees with NQF qualifications. More resources should be available for such development programs.

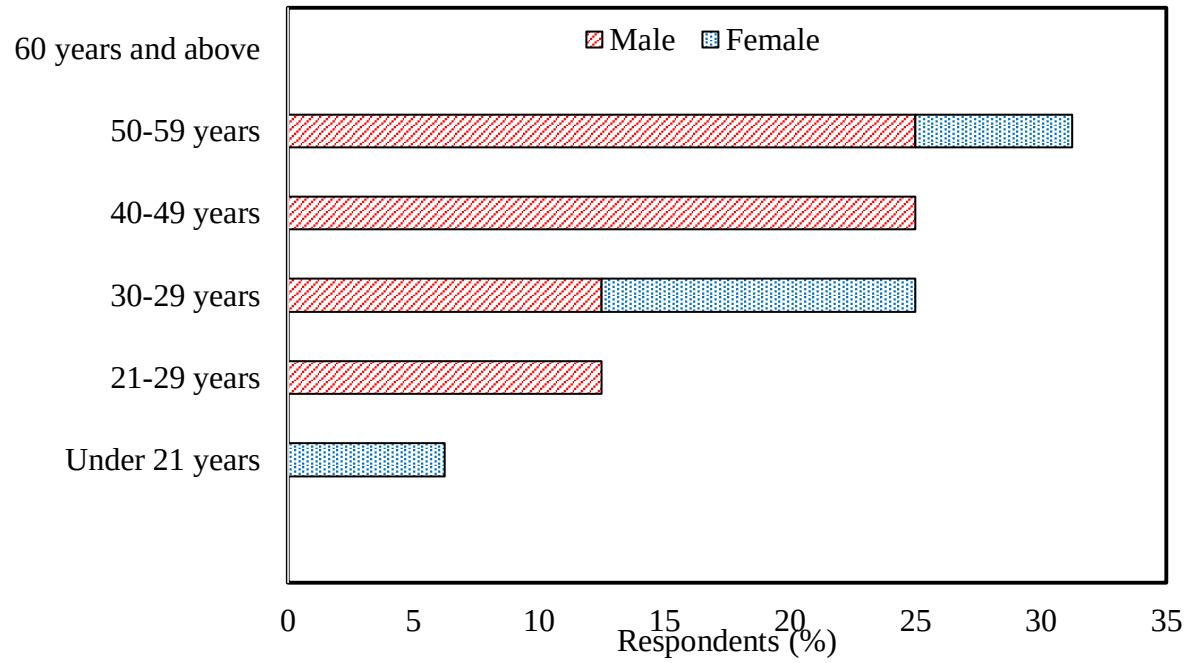

Figure 11.6: Gender and Age distribution of employees

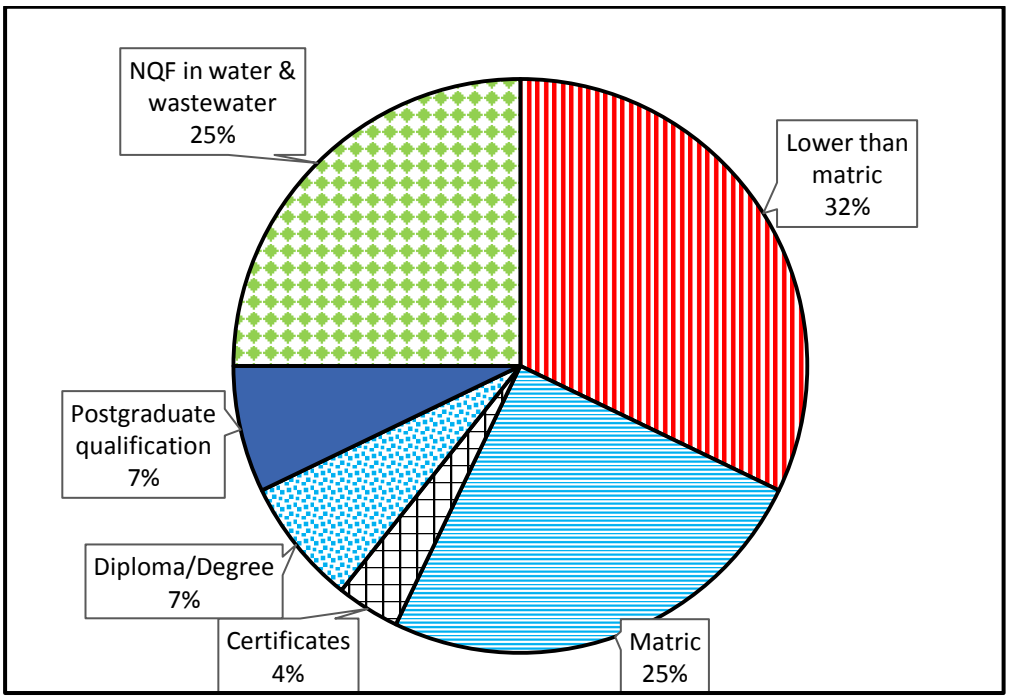

Figure 11.7: Employees qualifications

As shown in Figure 11.8, 53% of the employees had more than 10 years experience in the water sector, while 40% of the employees had between 1-10 years of experience. Although more than 50% of the employees are having more than 10 years of experience in the water sector, it is evident that the majority of such employees are on operational levels (Figure 11.9). The experience however could not significantly indicate the level knowledge of green occupation in WWT plants. Unfortunately, there is still a high shortage of engineers, technicians and artisans in most of the wastewater treatment plants. It was discovered that some of the positions such as engineers, were often determined by the size of the plant (plant capacity) and classification of such plants according to Department of Water Affairs. This implies that not every treatment plant will have an engineer or a technician who is always on site. Nevertheless, it is apparent that some of the available positions were not filled due to various reasons known by the municipalities. WWTPs employees would prefer on site/indoor training to address green skills in their sectors. However, lack of funding was given as a main challenge.

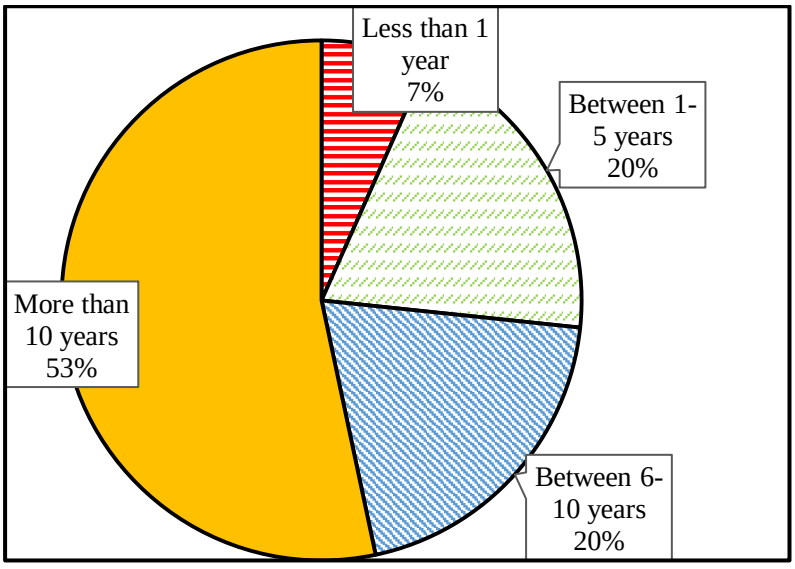

Figure 11.8: Years of experience in wastewater and water sector

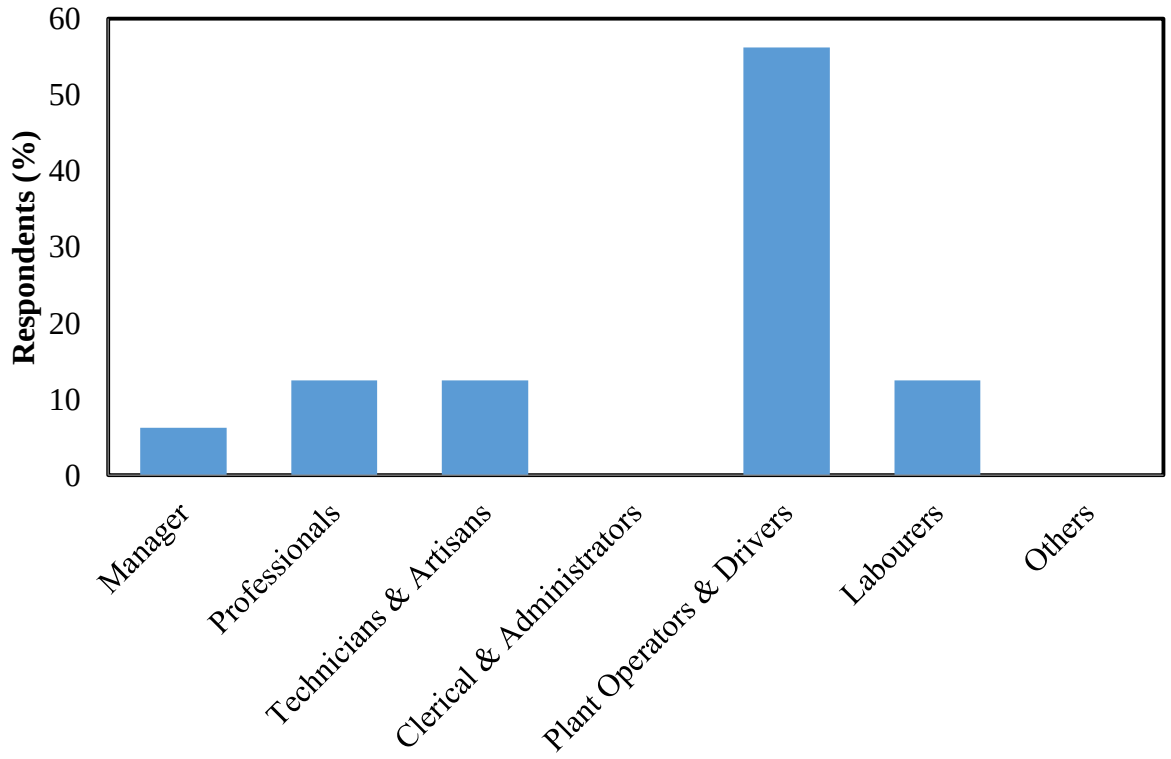

Figure 11.9: Role of the employees in the organization

11.4. Barriers to uptake of green occupation

There are several barriers that can hamper creation of green jobs, green jobs awareness and green economy implementation strategies and policies. More than 75% of the employees believed that there were several challenges impeding green jobs creation in their respective plants, while only 25% of the employees believed there were no challenges (Figure 11.10). The main barrier that employees felt is impeding green jobs creation, is the lack of funds and currently most of the municipalities are owing millions of Rands to companies such as Eskom; therefore, the priority is to repay the debt and priorities on drinking water. Shortage of funds has led to lack of staff training in green skills and green practices. Even though 53% of the employees have more than 10 years of experience in water sector, most of the employees felt that green economy policies and awareness were not cascaded down to the level of the operators. Some of the employees felt that green policies should be well explained to them.

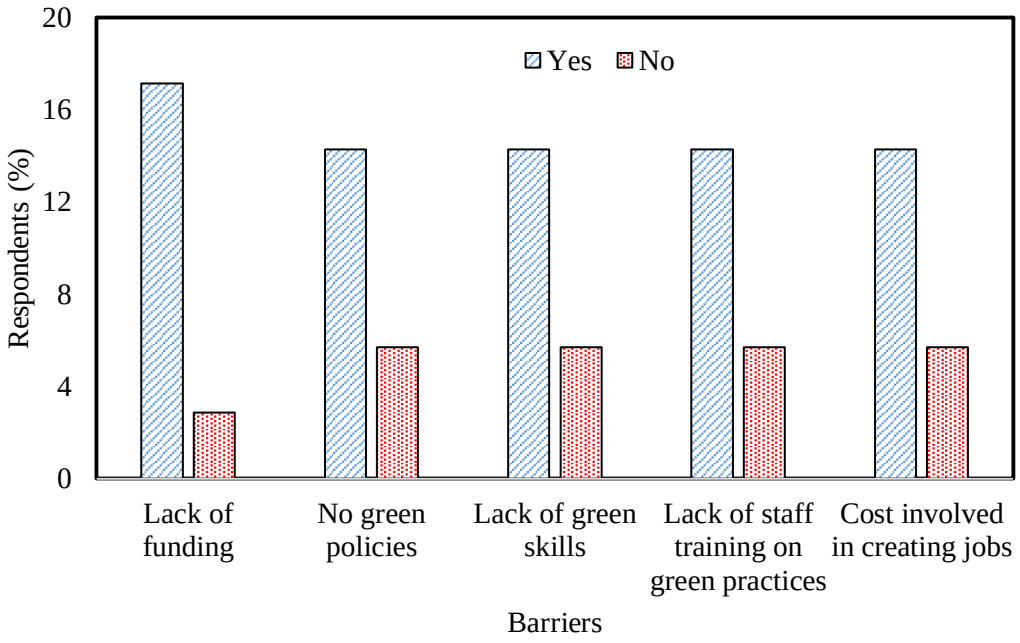

Figure 11.10: Barriers to green occupations in wastewater treatment in FS province

11.5. Current measures in place to promote green jobs and green economy awareness

There are several measures the municipalities can take to promote green jobs. However more than 75% of the FS water sector employees (mostly process controllers and process operators) are not satisfied with the progress the municipalities are making in promoting green jobs (Figure 11.11). Only a few employees had respondent to the questions on the measures their respective municipalities and treatment works are taking in order to promote green jobs. The overall finding is that very little commitment is made by the respective municipalities to create green jobs. Some of the green initiatives are addressed by the water and wastewater NQF qualification obtained by operators and controllers during the training. However, the employees were not aware that some of the things covered during the courses are actually related to green economy. Modules which are related to green economy should be well identifiable when employees are attending trainings offered by Mahube and others. Respective municipalities should ensure that green economy initiatives are well communicated with their respective treatment works employees.

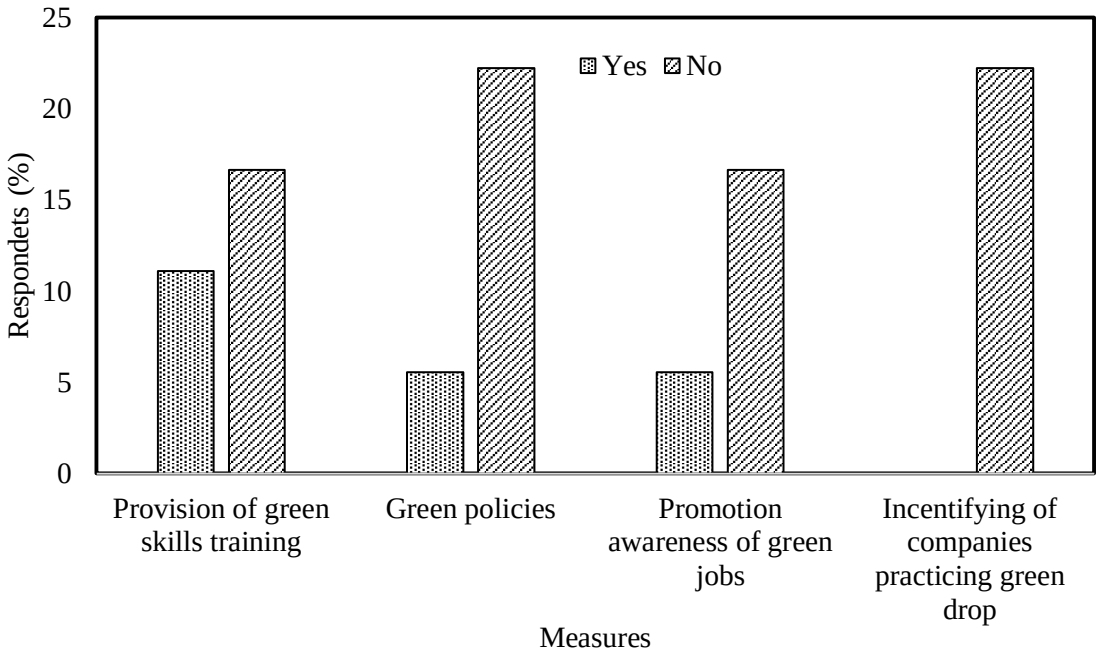

Figure 11.11: Measures to promote green jobs and green economy awareness

11.6. Conclusions and recommendations

It was observed that although the government has several green economy policies, unfortunately such policies are not easily available to most of the WWT plants employees specifically process operators and process controllers. In some instances, whereby such policies exist, the lack of green occupation knowledge by process operators and process controllers hampers the purpose of such policies. Green economy concept is not understood very well by majority of the WWT plants employees. Lack of awareness on green occupation is one of the biggest challenge that municipalities and WWT plants are phased with. There is a need to have awareness on green occupation in all municipalities and WWT plants.

Some of the employees felt that there are no enough incentives for any companies that are practicing green drop. Therefore, the government should be identifying ways of providing incentives to such companies that are practicing green economy and this should include all the employees. Lack of funding, skills, and training are the main challenges impeding the implementation of green practice policies in municipalities and WWT plants.

Allocation of resources is always a challenge in most of the wastewater treatment sector which had impact on the maintenance and efficiency of the plants. Some of the municipalities are prioritizing their resources towards maintenance of portable water treatment plants, and the

repayment of debts owed to Eskom electricity supplier. This, sometimes lead to poor maintenance of WWT plants and shortage of development training programs for workers. Therefore, it is still important to prioritize resource in all of the sectors. It is recommended that during the training of the operators/supervisors by training agencies such as Mahube, green economy policies in water sector should be incorporated during the training.

Feasibility of utilizing anaerobic digesters to produce energy from sludge should be conducted in detail. Several farmers and communities utilize sludge freely from the WWT plants. The challenge is that the sludge is not classified as per DWA requirement. It is recommended that analysis of the sludge from various WWT plants should be conducted. Such analysis will indicate sludge elemental, organic, nutritional, and inorganic compositions and a thorough conclusion to use such sludge for agricultural purposes depends on the sludge compositions as recommended by DWA. WWT plants can generate income by converting and selling sludge as manure/fertilizer to the communities and farmers.

CHAPTER 12

12. Limpopo Province

12.1. Company information

Limpopo province (LP) is divided into five district municipalities and only three were selected to carry out this research. Primary data were collected using direct observation and semi-structured questionnaires (company information) comprised of structured and open-ended questions (Appendix 1). The total number of WWT plants visited and an overview of the wastewater treatment technologies used in LP are shown in Table 12.1. Most municipalities in the province apply activated sludge treatment method, which is an advancement from ponds system. It was discovered that all the plants visited carry out their effluent analysis through external service providers.

It was observed that the oxidation ponds technology is normally applied by small size plants, 1-2 Ml/day in the province. Whereas the medium and large size plants use the combination of activated sludge, biological filters and pond system. Among the wastewater treatment plants visited, LP-DM1-LM1-Plant1 is a macro size plant (32 Ml/day) AND was found to use the combination of different treatment methods. the methane produced at this plant through the anaerobic technology is used as an energy source for further processes including heating in the plant. Thus, LP-DM1-LM1-Plant1 was the only one plant found to run the green project in LP. It was found that LP-DM3-Plant1 also use anaerobic technology, however, the methane gas produced from the anaerobic is vented into the atmosphere.

The major challenge found in LP-DM3-LM1-Plant1 was malfunctioning of anaerobic digester due to mechanical failure. One of the main challenges faced by the plants visited is production of additional sludge. It was also revealed that LP-DM1-LM1-Plant1 is about to commission a belt filter press technology. This technology will efficiently and reliably dewater sludge from wastewater.

Table 12.1: Summary of LP visits

District Municipality	Number of LMs visited	Number of WWT plants visited	Treatment Methods
LP-DM1	2	3	Biological filtration, activated sludge aeration, anaerobic digester Oxidation Ponds
LP-DM2	2	3	Biological filtration, Oxidation Pond system,
LP-DM3	1	2	Biological filtration, Oxidation Ponds, activated sludge

Key: DM- District Municipality, LMs – Local Municipalities, WWT – Wastewater treatment

Table 12.2 present the demographic profile of the employees in the selected municipalities surveyed in LP. The data collected for the demographic profile was based on the whole municipality. Most of the plants were commissioned for more than 10 years. The infrastructural, electrical and mechanical maintenance of the large plants commissioned for more than 10 years are the most challenging. In all the plants visited in LP, sectional shutdown is done once per year for maintenance purposes. To ensure that all WWTPs conform to the process requirements, the safety and maintenance is one of the aspect that must be observed.

The audit was done based on the individual qualifications. It is significant to note that all the plants visited consisted of less than 20 employees operating the plants. Among these, approximately 19% of the staff employed as process controllers hold matriculation as their highest qualification whereas 7% had minimum formal qualification below grade 12. About 24% of the employees had certificates from Technical Colleges. Most of the employees had National Diploma (35%) as the highest qualification. These include the technicians and managers supporting and supervising operations at the WWT plants.

Among the eight WWT plants visited in the province, 16% of the staff are engaged in duties that are directly related to green occupations. This comprises operation of anaerobic digesters for production of methane which is used as an energy source (LP-DM1-LC1-Plant1), and the processing of dried sludge which is used as manure by local farmers. Most of the employees (49%) are involved in duties that are unrelated to green jobs. This is attributed to the limited green treatment methods in the WWT plants visited. Approximately, 35% of employees had indirect green jobs. This involved the daily operational of the plant and drawing of water for irrigation by farmers downstream of the WWT plants visited.

Table 12.2: Demographic profile of plants visited in LP province

		Percent (%)
Size of plant	Small (<50 employees)	29
	Medium (50–100 employees)	43
	Large (more than 100 employees)	29
Age of plant (years)	Less than 10	25
	10 – 25	25
	More than 25	50
Plants' employees' qualification	Lower than matric	7
	Matric	19
	Certificate	24
	Diploma	35
	Degree/Postgraduate	2
	Other (Additional training)	15
Employees' occupation type	Direct green occupation	16
	Indirect green occupation	35
	Occupation unrelated to green jobs	49

12.1.1. Barriers to uptake of green occupations

To illustrate the important role of green occupations development, major challenges were identified concerning skills in the green economy transition. It was revealed that the main central challenges faced by most municipalities within the Limpopo province to develop green jobs, is lack of funding (94%) which in turn affect the cost of green technologies (88%). It is important to note that to create new occupations through new green technologies, higher-level qualifications might be required. In addition, lack of green skills, skills and policies to merge and appropriate training were major challenges faced by the municipalities in LP (Figure 12.1). About 31% of employers identified shortage of green skills as a constrain to the greening of economies in LP. The shortage of green skills can arise where new skills are needed to meet the requirements of changing and newly emerging jobs, and equally where demand is growing for skills in existing occupations. It was also discovered that a lack of training on green skills (56%) necessary to meet the requirements of changing and emerging occupations is already hampering the uptake of green occupations. While it is important to draw up environmental

policies, it was discovered that very few of municipalities in LP have put in place the policies devoted to green job skills development strategies needed to implement them. A lack of green skills dimension in policy development is mainly attributable to inadequate resources and institutional capacity to implement strategies.

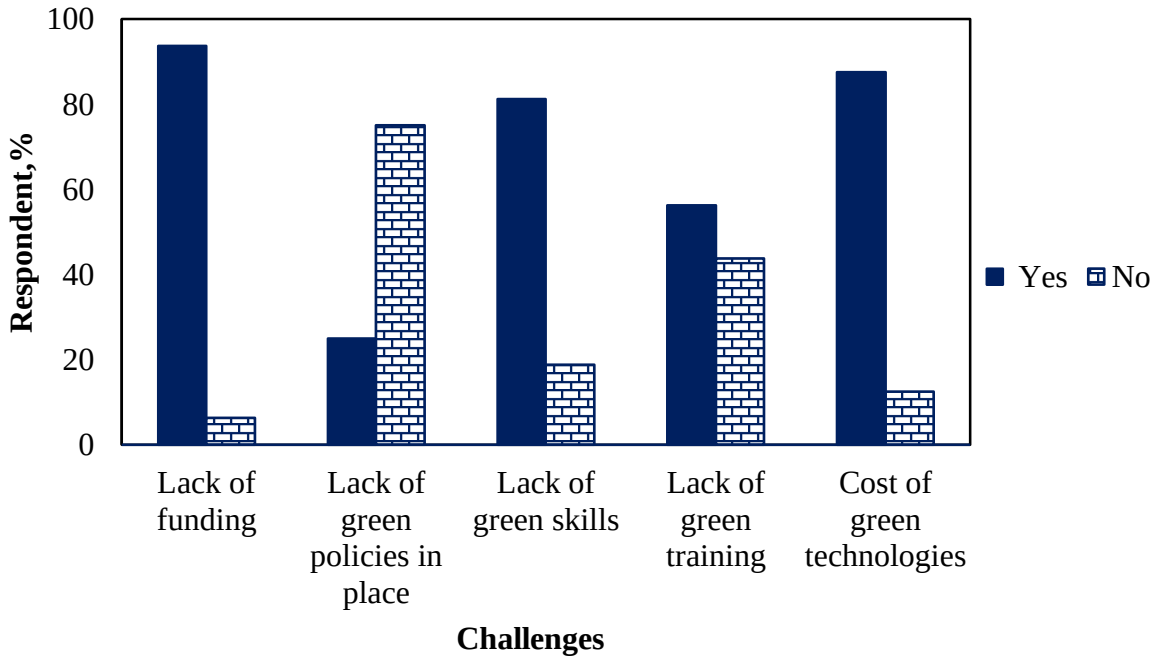

Figure 12.1: Challenges to green occupations in LP wastewater treatment Plants

12.1.2. Training required to meet the skills shortage

Working together is important for greening of the economy. Through intensive social conversation with employees and managers in LP municipalities, many of the challenges relating to the greening of the economy and creation of green occupation can be solved. Surved respondents provided information on different training methods required to overcome the challenges of shortage of green skills (Figure 12.2). About 31% of the survey respondents preferred in-housing training method in meeting skills needs for green jobs. The in-housing training method would also be available to, and affordable for, disadvantaged youth, people with disabilities and rural communities. On the other hand, 25% of the survey respondents desired that a trainer facilitate the training at the plants. Approximately, 19% and 13 % of the workers preferred to develop green skills through apprenticeship and technical programs, respectively. These two training centers play a crucial role in providing entry level skills for green jobs (e.g. plumbers, electrical installers, recyclers, etc.). Although universities play a vital role in the creation of green skills which tend to adapt relatively quickly to new demands,

it was discovered that the university program is the least (6%) ideal training method for most workers. This is confirmed by the low percentage of survey respondents holding degree as their highest qualifications.

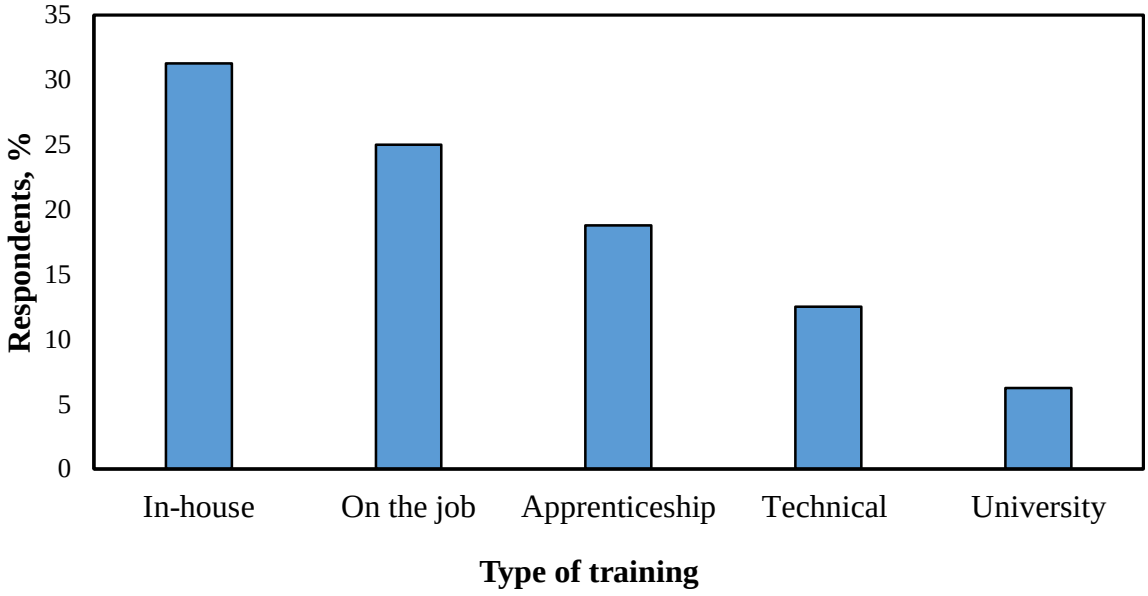

Figure 12.2: Preferred training by WWT plants in LP Province

12.2. Potential for green jobs creation in LP Province

The LP has comparative benefits including high solar intensity, which can be used in solar energy generation; and a viable agricultural sector, capable of producing crops for use as biofuel. As a result, this will contribute to green job creation and poverty eradication. The following approaches can be considered in creating and sustaining green occupations in LP;

- Final disposal methods employed by the wastewater treatment plants surveyed in LP are still dominated by on-site disposal methods. This includes direct land application and stockpiling of the sludge on site. The beneficial use of the produced sludge is still limited. Therefore, sludge produced should be classified according to different criteria to assess the use options. For example, a class "A1a" sludge would be the best quality sludge which could be utilized in agricultural practices.
- Application of anaerobic digester whereby biogas is produced from waste and this can be re-used for process heating in plants.

- Since the province has high solar intensity, solar energy can be considered and this will supplement the amount of energy that is required for the daily plant operation.

It was noticed that domestic wastewater is the primary source of influent (47%) to WWT plants in the province (Figure 12.3). Furthermore, it was discovered that there are commercial consumers that discharge wastewater that contain oil, as a result the wastewater end up in municipal WWT plant. LP-DM-LM-Plant 1 treat both the industrial waste such as brewery effluent and domestic wastewater. Biofiltration method is used to treat domestic effluent, while up flow anaerobic sludge blanket (UASB) is used for brewery effluent at LP-DM-LM-Plant 1. It was further found that the effluent at LP-DM2-LM1-Plant1 sometimes consist of trace amounts of heavy metals associated with surface runoff. The treated effluent is in most cases discharged straight into receiving water streams such as rivers. In some instances, (LP-MM3-Plant1 and LP-MM4-Plant1), the effluent is sent to private companies such as PPL Mine and Exarro for re-use.

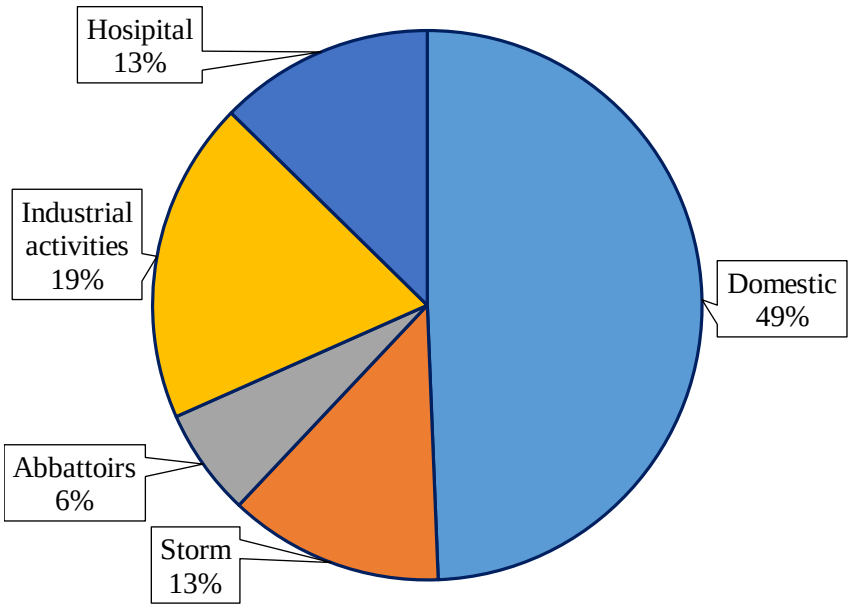

Figure 12.3: Sources of wastewater in LP province

12.3. Employee information

In order to collect the data on employee information, two methods were used. Personal interview as a major technique for collecting factual information as well as opinions and questionnaires as a series of written or verbal questions for which the respondent provided answers.

12.3.1. Employees awareness of green occupations

Among, the objectives of the study, was to evaluate the employees ability to identity green jobs in key economic sectors such as renewable energy, buildings, transportation and agriculture. According to the results presented in **Error! Reference source not found.**, most survey espondents understood the concept of green technology/occupations in waste and water management, 44% and 75% respectively. It was discovered that respondents were not aware and had no idea at all towards the green technology in other remaining sectors such as tourism and transport.

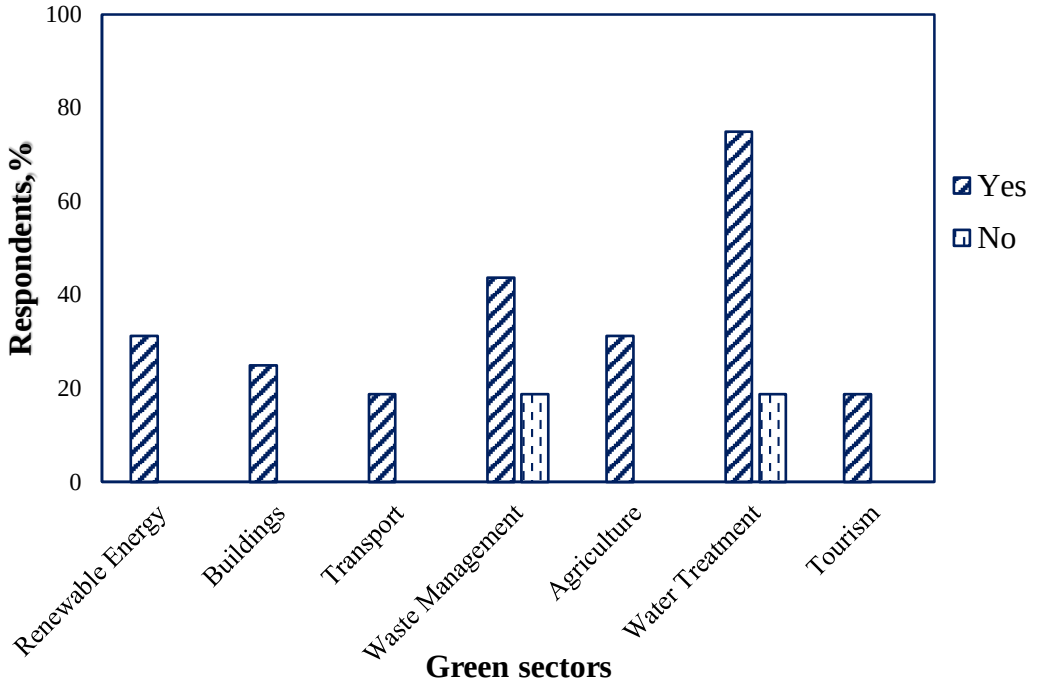

Figure 12.4: Sectors associated with green jobs as per water and wastewater treatment employees in LP province.

Green jobs should offer adequate wages, safe working conditions, job security and career growth, minimize waste pollution and protect workers' rights (UNEP, 2003). A questionnaire based on these factors was given to employees to see if they understood the impact of green occupations to the environment and on their wellbeing and results are shown in Figure 12.5. About 25% of respondents strongly agree that green occupation will have a negative impact on the environment while 31% agree, 19 % undecided, 6% disagreed and 13% strongly disagreed. In addition, it is also show that most of the employees agreed that green jobs will reduce global warming and provide a safe working environment. Approximately 31% of the employees agree that green jobs can provide career growth paths in future. However, about 25% were undecided

whether green jobs could pay well. This result implies that they do not perceive any difference in the net present value of switching to a green sector job as opposed to one that is not green. Furthermore, probable reason may be due to inadequate/absence of training on green occupations and partial understanding of the concept of green occupation which is associated with the low level of formal qualification. Other than that, about 44% of total respondents understood that green jobs have the potential to minimize waste pollution.

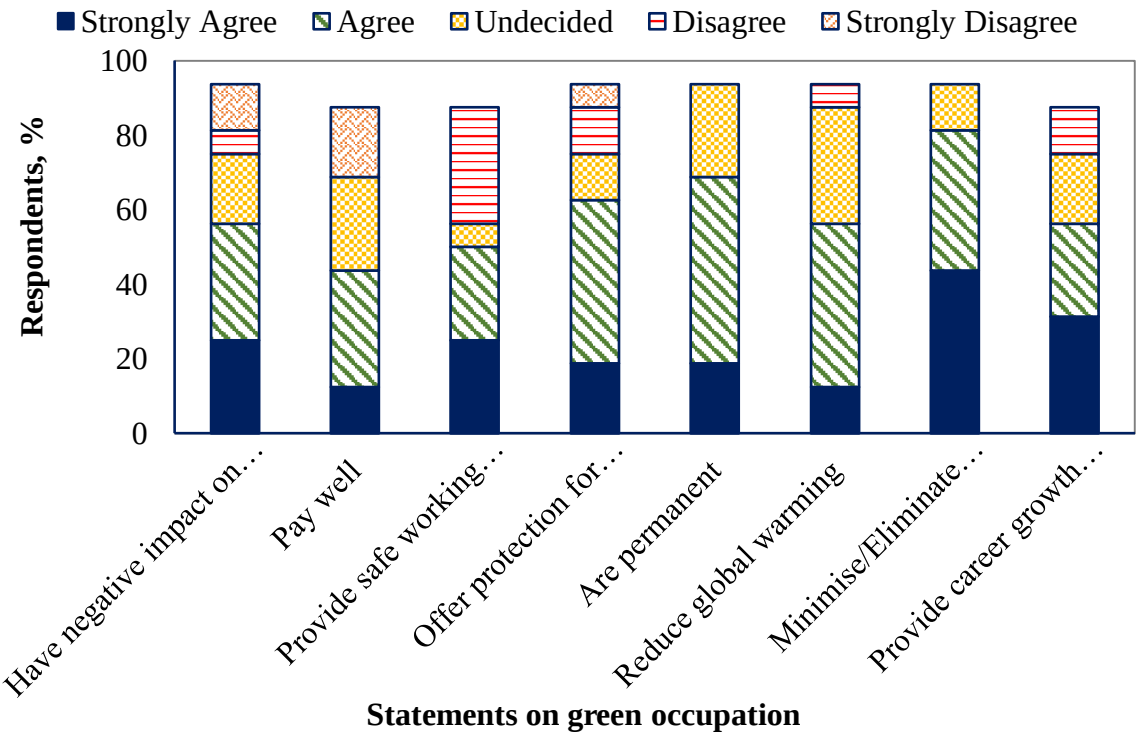

Figure 12.5: Understanding green occupations' impact in LP.

12.3.2. Employees awareness of company's green occupations plans and practices

The survey respondents were asked to identify green activities that are already existing within their work environment (Figure 12.6). Few of the survey respondents were aware of some of the existing green activities taking place. This include the dried sludge supplied to farmers to be used as manure (LP-DM1-LM1-Plant1) although in other municipalities the sludge is dumped (LP-DM1-LM2-Plant1). About 50% of WWT plants visited in Limpopo are practicing green economy by using water resourcefully. It was also discovered that the effluent treated at LP-DM2-LM1-Plant1 is sold to the mines, however, the cost was not revealed. Although LP has the advantage of high solar intensity, the main technologies with high potential for green occupations such as bioenergy production and renewable energy currently do not exist in most of the WWT plants visited and were the least identified by respondents. As a result, solar panels

to produce electricity should be considered in the future and this will mainly contribute to the reduction of operating cost. Furthermore, such methods of generating electricity are friendly to the environment.

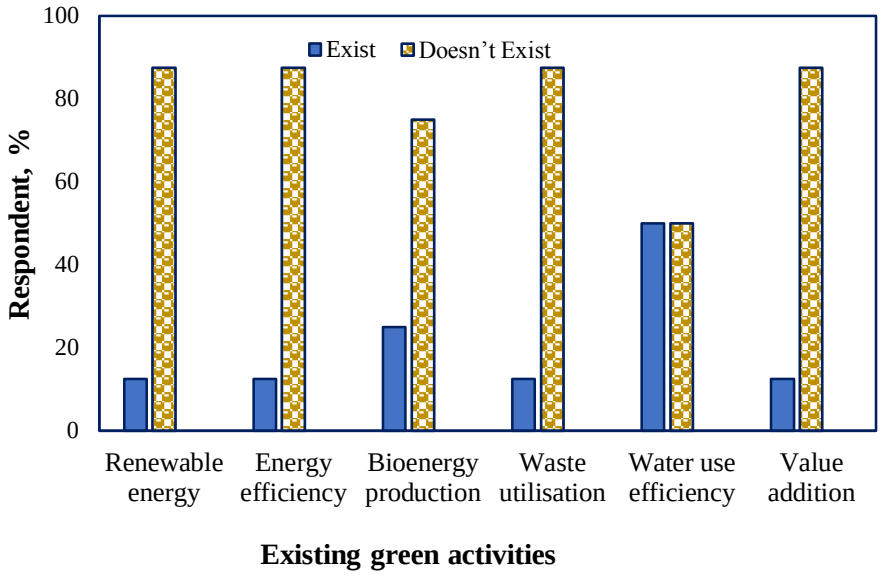

Figure 12.6: Employees awareness of existing green technologies and processes.

12.3.3. Demographic information of the interviewed employees

The questionnaire on the demographic information of the survey respondents such as gender, age group, role in the organization and the number of years in their current position was assessed as well. It was noticed that most municipalities comprised mostly men (78%) who worked as process operators, while the remaining 22% (females) are mainly employed as general workers (Figure 12.7). This implies that there is a huge gap between the number of men and women in wastewater treatment. Women are thought to be at a disadvantage, both in economic and social terms, when compared to their male counterparts. This contribute to the persistent problem of poverty face by the LP (De Swardt 2003). Thirty-eight percent of the employees were aged between 50 to 59 years, while 25% were aged in the range of 30-39 years (Figure 12.8.8). About 6% of respondents were more than 60 years old, and fewer than 19% of respondents were under 30 years of age. The respondents aged less than 30 years are currently working on learnership program. About 38% of the employees have been working as process operators for more than 10 years.

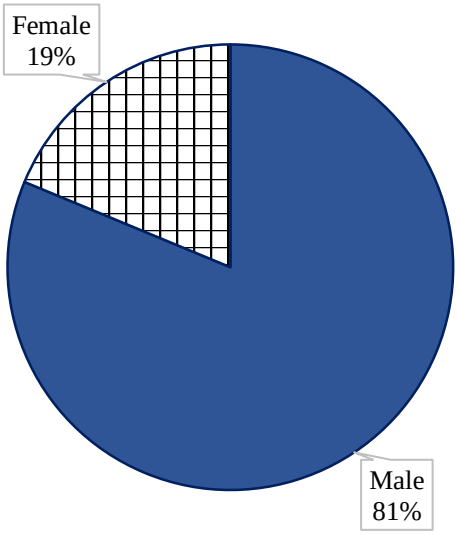

Figure 12.7: Gender distribution of respondents in LP.

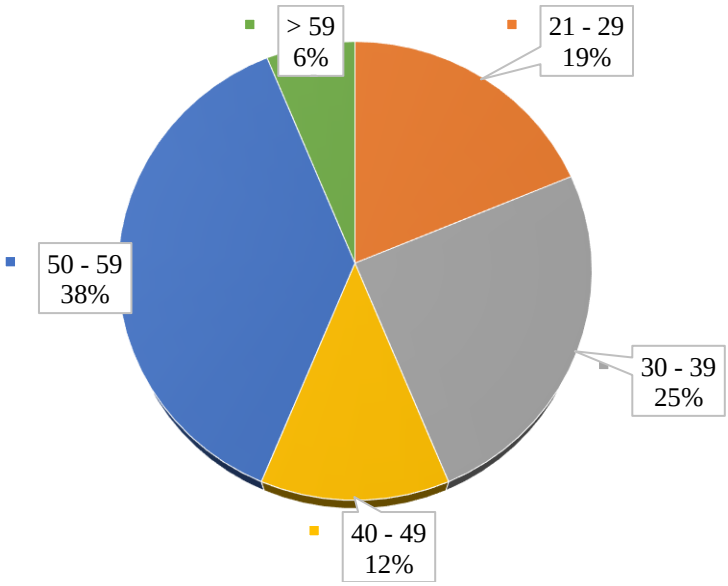

Figure 12.8: Employee's age group in LP.

Figure 12.9 indicate the role of the employees in the water sector. In the survey, managers were defined as workers who provide leadership and accountability and played a role in the hierarchy of the organization, in addition to possessing baseline technical expertise. Among the occupational areas, employees in the water and wastewater treatment work place were largely (50%) employed as process operators. It was observed (Figure 12.10) that the highest percentage of workers have more than 10 years of experience. Although, the municipalities

are offering learnership program, it was found that these employees are not exposed to green related technologies.

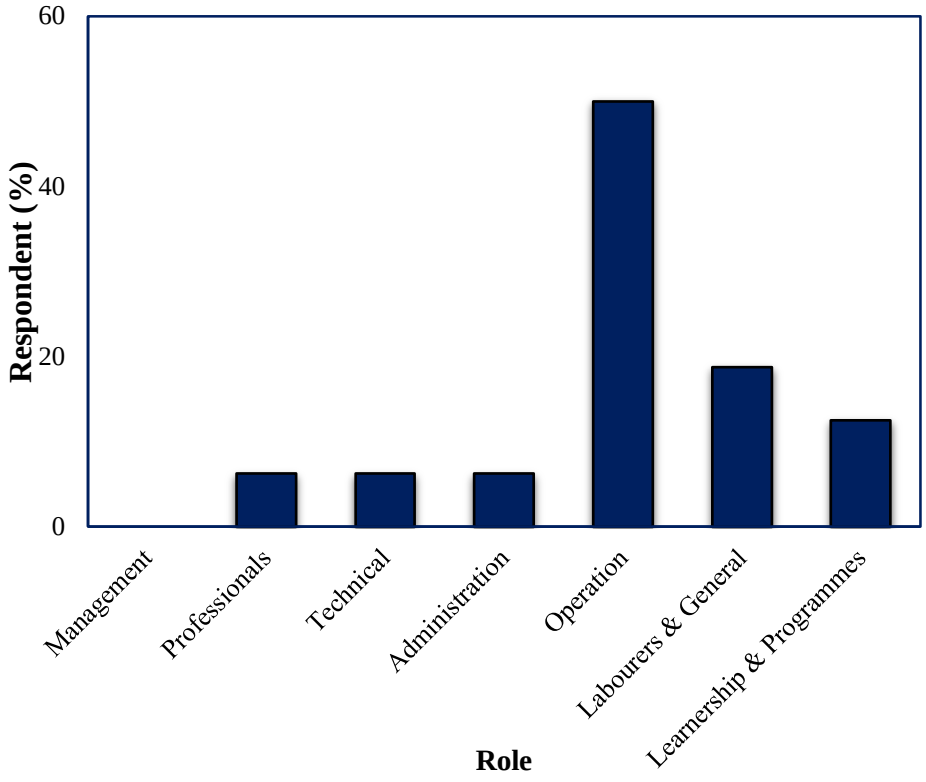

Figure 12.9: Roles in the LP municipalities

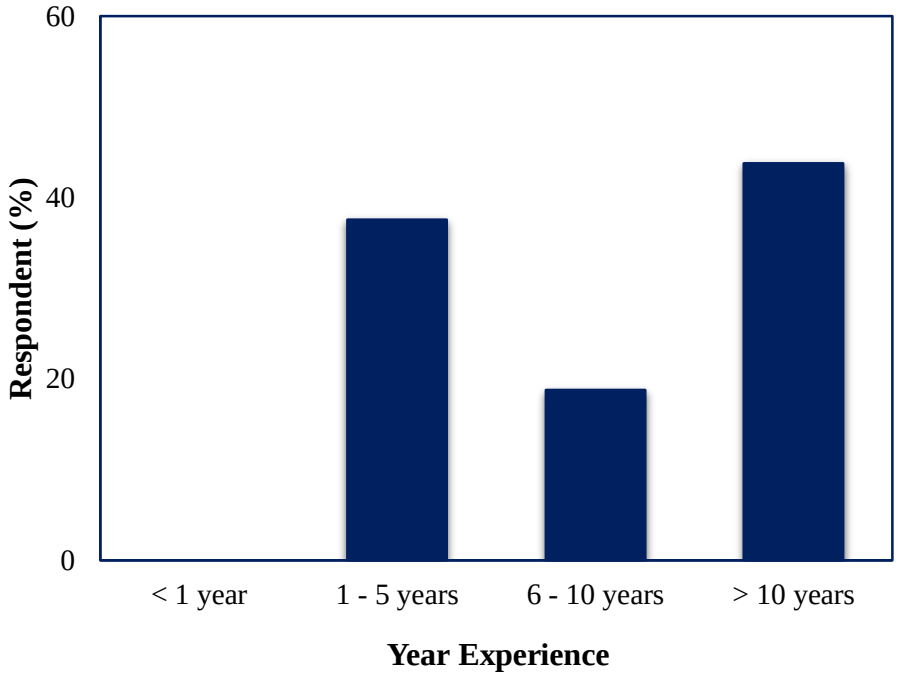

Figure 12.10: Number of years of employees experience in LP municipalities

12.4. Conclusion and recommendation

According to the data obtained from the survey, the adoption of the green technology in the selected municipalities is still comparatively low. Some of the employees working in LP water treatment sectors had matric level as their highest level of qualification and were found to perform general work such as cleaning. This contributed to lack of green skills by most of the employees in the province. As a result, this might have a negative impact when it comes to addressing the significance of greening the economy. Furthermore, gender inequality is also a major challenge in water and wastewater treatment sector of this province. Therefore, women should be empowered through green occupations creation to eradicate the challenge of gender inequality. To sustain related career fields, which span over a wide array of skills, educational backgrounds and occupational profile should play a vital role. To achieve successful transition to greener work, the government, trade unions and employers should collaborate with educational institutions and come together in constructive social dialogue. It is important for the government to enact a public policy which will integrate the information and knowledge of green technology in the academic education especially for primary and secondary schools.

It was further found that only one of the plants visited has currently adopted the green technology. One other plant using anaerobic digester faced a challenge of lack of digester operation as per the civil and structural designs. Like other provinces studied in this research, poor design, insufficient or no maintenance, mechanical breakdowns and lack of operational skills are the main challenges faced by LP as well. In most of the plants visited, sludge lagoons were found filled and not well maintained. Therefore, investing in skills and practices that apply to green technologies in LP remain a serious challenge. To ensure that all WWTPs conform to the process requirements, the safety and maintenance is one of the aspect that should be observed. Due to its geographic location, the province has favourable solar radiation and land to build solar plants. Therefore, production of electricity through concentrated solar plants can be considered in the future.

CHAPTER 13

13. Conclusion and recommendations

Metropolitan municipalities and large local municipalities in WC and GP provinces were leading in the uptake of green technologies and practices leading to the creation of green jobs. In WC, a joint initiative between the local government and other institutions such as University of Cape Town, has led to the development of effective treatment systems such as the modified UCT-BNR treatment system. Use of advanced treatment technologies such as UV disinfection of final effluent before discharge was mostly found in the large treatment plants in WC and GP. Also, the cooperation between WWT plants and industries, such as supply of treated effluent to industry for reuse or to farmers for irrigation, was mostly found to exist in the large municipalities and metropolitans. This trend can be attributed to the financial capability of such municipalities and the ability to foster partnership with other institutions. Moreover, such municipalities being more intensely populated and having several industries within their jurisdiction, receive large amounts of wastewater (domestic and industrial), making the implementation of green processes such as bioenergy production viable. The uptake of renewable energy production using solar is however negligible across all the municipalities visited, despite the high potential that exists.

In EC, NC, NW and LP provinces, the uptake of green technologies was very low. Moreover, municipalities in these provinces were the hardest hit by weather conditions such as drought. Most municipalities in these provinces are small sized with sparse population especially in NC. The WWT plants visited in EC, NW, NC and LP were mostly small sized treating less than 5 ML/day. Due to the drought experienced at the time of the visit, some plants had suspended their operations as no wastewater was being received. Given the size of most of the plants visited (small to medium), installation of green technologies such as bioenergy production was not viable. However, technologies such as effluent reuse for irrigation and utilisation of dried sludge as compost manure can be undertaken.

Conventional water and wastewater treatment, and green skills was found wanting across all the provinces. The larger municipalities and metros had the highest qualified employees as compared to smaller municipalities in NC, EC, LP and NW. Access to training institutions and partners was high in GP, WC, KZN, and lowest in NC, NW and LP. This explains the sharp differences in the level of qualifications across the provinces. Moreover, small municipalities mainly found in sparsely populate provinces such as NC struggle to retain qualified staff as

they offer poor remuneration as compared to the other bigger municipalities and metros. This therefore leads to a high percentage of unqualified personnel being employed as observed in the small municipalities.

Green economy is still a foreign concept, even though there are green strategies and plans in place for all the provinces. The foreignness of green economy and jobs has been brought to light by the low level of awareness by the employees in various water and wastewater treatment plants surveyed. Some of the employees mistook the green occupation concept to mean the "Green drop" or "Blue drop" initiatives. The majority of employees in all the provinces could not easily identify green jobs and technologies without prior elaboration from surveyors. This could be attributed to the low formal qualifications of most employees interviewed. Green skills development is very important for transitioning to greener technologies and jobs. The lack of both conventional and green skills for water and wastewater management should be addressed by local governments. As jobs change from the conventional practices to green occupations, the level of skills will also be affected. The new emerging green jobs require a high level of qualifications and a new training system that is relevant to the emerging trends. The level of green jobs can be improved through several channels including:

- Green awareness workshops offered on site
- Short-term green occupational courses in traditional universities and practical projects on site
- Training-on-the-job programs on green skills, which should include educational training on green technologies and processes, installed at the plants

In addition, environmental studies are key in understanding the green economy concept, in transforming from high-carbon intensive techniques used in these plants to creating low-carbon emission practices. Courses about environmental studies should be incorporated during education and training programs for water care. The department of higher education should offer short-term courses specifically for water and wastewater green treatment to accommodate the employees who cannot be admitted to universities and colleges, to enhance and empower their green skills and knowledge. Self-learning methodologies that employ the use of smartphones and tablets with proximity sensors and interactive applications that guide/teach the process controller should be developed. The applications should be designed to prompt process controllers carry out predetermined activities at various unit processes within the treatment plant. The novel training system could be customised for each treatment plant.

Green skills development is very important and is one of the key factors for green jobs creation. Most municipalities still experience a challenge in providing proper required green skills to workers. The new emerging green jobs requires certain specific level of skills and trainings. New training systems should be implemented and introduced to the employees working in water and wastewater treatment sector.

Considering that lack of funding is a major challenge in the wastewater treatment sector especially for the smaller municipalities, partnership with other institutions including private entities will be important in abating this challenge. Municipalities can collaborate with industries in implementing green projects that will be beneficial to both entities. Partnership with training institutions is also important for developing relevant courses consistent with emerging green technologies and practises. The green projects that can be collaborated on include manufacturing of fertilizer and bioenergy production. Industries can invest in these practices and in turn have their wastes treated by the municipalities at reduced or no costs.

The following are recommended channels which includes;

- Green awareness workshops should be offered onsite, to accommodate employees who do not have formal qualification.
- Short-term green occupational courses in traditional universities and practical projects onsite should be given to workers.
- Training-on the job programmes on green jobs should include educational training on green technologies and processes installed on the plants.
- The development of interactive smartphone based applications that provide a personalised and customised training system.

In addition, environmental studies are key in understanding the green economy concept, this also features in transforming from high-carbon intensive techniques used in these plants to creating low-carbon emission practises, and courses about environmental studies should be incorporated during education and training programmes.

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Appendix

Appendix 1: Company audit tool

Green occupations audit questionnaire
(Employee/Operators Information)

The Local Government Sector Education and Training Authority (**LGSETA**) in partnership with Vaal University of Technology **(VUT)** is interested in identifying the **green occupations** currently available in the Local Government sector. The purpose of this survey is to determine **green occupations** in the local government sector and to **identify the necessary training and qualifications** thereof.

You are kindly invited to participate in this survey by completing this questionnaire as **honestly** and **comprehensively** as possible. The information you give in response to this survey, which will be treated with strictest **CONFIDENCE** and **ANONYMITY**, will provide the LGSETA with valuable insight required to effectively plan for green occupations development.

****Mark with a ✓or give values where appropriate*.

1. AWARENESS OF GREEN OCCUPATIONS

1.1 Can green jobs be found in the following sectors? Yes or NO;

Sector	Yes	No
Renewable energy		
Buildings		
Transport		
Waste management		
Agriculture		
Water treatment		
Tourism		
Others		

1.2 To what extent do you agree with the following statements on green jobs:

Statement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Green jobs have negative impact on the environment					
Green jobs pay well					
Green jobs provide a safe working environment					
Green jobs offer protection of workers' rights					
Green jobs are permanent					
Green jobs reduce global warming					
Green jobs minimise/eliminate waste pollution					

2. GREEN JOBS

2.1 Are green jobs present in your wastewater treatment plant?

Yes	
No	

2.2 Please respond to the following statements with regards to your treatment plant

Statement	Yes	No	Don't know	Already Exists
Company planning to create green jobs				
Company planning to provide green services/products				
Company intending to write an environmental policy				

2.3 Which of the following green practices currently exist in your company?

Green practices	Exist	Doesn't Exist
Use of renewable energy such as solar energy		
Energy efficiency		
Bioenergy production		
Waste utilisation e.g. use of dried sludge as manure		
Water use efficiency		
Value addition e.g. manure classification		
Others		

2.4 Challenges to green jobs creation in your plant:

Challenge	Yes	No
Lack of funding		
No green policies in place		
Lack of green skills		
Lack of staff training on green practices		
Cost involved in creating green jobs e.g. installation of green technologies		
Others		

2.5 Current measures in place to promote green jobs' creation and integration in your company

Measure	Yes	No
Provision of green skills training		
Green policies development		
Promotion awareness of green jobs		
Provision of incentives to companies that employ green practices		
Others		

3. DEMOGRAPHIC PROFILE

3.1 Your age group:

Under 21 years	
21 – 29 years	
30 – 39 years	
40 – 49 years	
50 – 59 years	
60 years and older	

3.2 Your gender:

Male	
Female	

3.3 Your highest formal qualification:

Lower than Matric	
Matric / Grade 12	
Certificate (i.e. awarded at a University, Technikon, Technical College)	
Diploma/Degree (i.e. an undergraduate degree awarded at a Higher Education institution)	
Postgraduate diploma/degree (i.e. an Honours, BTech, Masters or Doctoral degree awarded at a higher education institution)	
Other (please specify)	

3.4 Your role in the organisation:

Manager	
Professionals *(i.e. Chemist, Engineer)*	
Technicians and Trades Workers *(i.e. Plumber, Engineer)*	
Clerical and Administrative Workers *(i.e. Personal Assistants; General Clerical Workers; Receptionist)*	
Plant Operators and Drivers	
Labourers *(i.e. Cleaners)*	
Others (*e.g. Learnership*)	

3.5 The number of years in your current position:

Less than one year	
Between 1- 5 years	
Between 6-10 years	
More than 10 years	

THANK YOU FOR YOUR PARTICIPATION!!!

Initials……Signature……...Date……..……

Appendix 2: Plant audit tool

Green occupations audit questionnaire
(Plant Information)

The Local Government Sector Education and Training Authority (**LGSETA**) in partnership with the Vaal University of Technology **(VUT)** is interested in identifying the **green occupations** currently available in the Local Government sector. The purpose of this survey is to determine **green occupations** in the local government sector and to **identify the necessary training and qualifications** thereof.

You are kindly invited to participate in this survey by completing this questionnaire as **honestly** and **comprehensively** as possible. The information you give in response to this survey, which will be treated with the strictest **CONFIDENCE** and **ANONYMITY**, will provide the LGSETA with valuable insight required to effectively plan for green occupations development.

****Mark with a ✓ or give values where appropriate*.

SECTION 1: COMPANY INFORMATION

1.0 Size of your company (wastewater treatment plant):

Small (0 – 49 employees)	
Medium (50 – 149 employees)	
Large (150 and more employees)	

1.2 Province where your plant is located.

Gauteng	
Mpumalanga	
North West	
Free State	
Limpopo	
Northern cape	
Western Cape	
Kwa-Zulu Natal	
Eastern Cape	

1.3Which of the following defines your plant's role in the Green Industry? (Select all that apply):

Renewable Energy and Alternative Fuels- Using energy sources such as solar, bioenergy	
Energy Efficiency- Energy saving procedures	
Manufacturing Green Products – Use of wastes as raw materials, e.g. use of solid waste as manure and waste water for irrigation.	
Advanced Energy - Replacement or modification of equipment for improved treatment efficiency	
Any other green initiative in your company (Kindly mention)	

1.4 Number of employees in wastewater treatment

Full-time	
Part-time	

1.5 Number of employees with a disability

1.6 Breakdown of employees' highest qualification (please insert figures):

Lower that Matric	
Matric/Grade 12	
Certificate	
Diploma	
Postgraduate diploma/BSc. /BTech/Masters/Doctoral	
Others (please specify)	

1.7 Employees breakdown in green occupations

How many employees have a primary function in producing green related products and/or providing green-elated services?	
How many employees hold support jobs for your green related business activities? (They directly support those holding primary functions and they support green related tasks.)	
How many employees engage in functions unrelated to your green activities?	

1.8 Barriers to green related activities (Select all that apply):

Shortage of workers currently having green knowledge or skills	
Shortage of workers with other non-green related knowledge or skills	
Shortage of programs to train workers in green production, processes or business	
Government policies	
Other (Kindly specify)	

1.9What training providers or sources does your company use to prepare green workers ? (Select all that apply.):

In-house training	
On-the-job training	
Apprenticeship training	
Community/technical college	
University	
We hire only workers who are already trained	

1.10What types of training would you consider to meet your green workforce needs that are not currently being met? (Select all that apply.):

In-house training	
On-the-job training	
Apprenticeship training	

Community/technical college	
University	
Hiring workers who are already trained	

1.11 Kindly complete the table below for occupations critical to green practices' pursuit in your company's technical department.

Job Title	***Total Green Employment***	***Vacancies***	***Education Level Required*** (E.g. None, Matric, Certificate, Diploma, Degree, Honours, Masters, PhD***)***
IT Specialists			
Electricians			
Plumbers			
Artisans			
Chemists			
Chemical Engineers			
Laboratory Technicians			
Biologists			
Mechanical Engineers			
Others (Please specify)			

SECTION 2: PLANT INFORMATION

2.1. Age of plant (when was plant commissioned)

2.2. Maintenance (please indicate frequency e.g. monthly, annually)

Complete shut down	
Sectional	
Units	
Other (please specify)	

2.3. Plant capacity (please insert figures)

Designed/commissioned capacity	
Operating capacity	
Average influent flow rate	

2.4. General condition of plant (please select either Yes or No)

	Yes	***No***
Structurally sound, protected from corrosion		
Pipes/valves/disconnects in good working condition		
Fenced		

Grounds well maintained in safe sanitary condition		
Control panel enclosures in good condition		
Monitoring data collected as required		
Sludge holding tanks in good condition		
Screening bars and secondary filters in good condition		
Aeration system operating properly		
Clarifiers in good condition		
Flow monitoring devices and chlorinator in good condition		

2.5 Average treatment operation parameters (please insert figures)

Influent (mg/L)		Effluent (mg/L)	
BOD		BOD	
COD		COD	
SS		SS	
TOC		TOC	
pH		pH	
Ammonia (NH_4)		DO	
Conductivity (S/m)		Ammonia (NH_4)	
TP		Conductivity (S/m)	
TN		Total coliforms/E. coli per 100 ml	

***COD- Chemical Oxygen Demand, BOD- Biochemical Oxygen Demand, SS- Suspended Solids, TOC- Total Organic Carbon, TN- Total Nitrogen, TP- Total Phosphorus, DO- Dissolved Oxygen

2.6 Source(s) of wastewater:

Domestic		Breweries	
Abattoirs		Storm water	
Petroleum industries		Others (please specify)	
Agricultural activities			

2.7 Where is the treated effluent discharged into?

River	
Pond	
Used for Irrigation	
Lake/sea	
Recycled	
Other (please specify)	

2.8 Treatment operations carried out

Screening	
Aeration	
Clarification	
Desludging	

Tertiary filtration	
Chlorination	
Anaerobic digestion	
Other (Specify)	

THANK YOU FOR YOUR PARTICIPATION

Initials……Signature……Date…….