Assessment of the willingness to pay and determinants influencing the large consumers' perspectives regarding the supply of premium green electricity in South Africa

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Declaration

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D.M. Möller March 2018

Abstract

Numerous studies have been conducted assessing the determinants influencing consumers' willingness to pay (WTP) for a wide variety of products and services. However, there is no known study to determine the WTP of the large electricity consumers or the determinants influencing the large consumers' perspectives regarding the supply of premium green electricity in South Africa.

South Africa's existing operational electricity-generating plants consist of various generating technologies; yet, coal-fired stations currently represent approximately 90 percent of Eskom's total electricity-generating capacity. Because of climate change, limited natural resources, and the pollution footprint on the environment caused by fossil-fuelled power stations, it is essential for the focus to change towards cleaner electricity-generating technologies.

When considering supply and demand constraints, the current cost for green electricity is higher than the cost for fossil fuels. For this reason, implementing renewable energy as the main source of electricity supply will require that consumers (especially large consumers) be willing to pay a premium for electricity generated from green electricity. Consequently, it is important to understand which aspects influence the WTP of large consumers.

Previous research on residential consumers indicated that WTP is particularly influenced by attitudes towards environmental issues, towards one's power supplier, perceptions of the evaluation of green energy by an individual's social reference groups, and current electricity bill levels versus income. However, previous studies have failed to address the large consumers' WTP a premium for green electricity.

This research explored the different types of green electricity-generating technologies available, as well as the factors relating to green electricity production. An in-depth review was conducted on literature relating to the WTP theory, including consumer surplus and the meaning of value.

In this study, an exploratory model was developed, which indicated the significance of various determinants on the large electricity users' WTP for green electricity. This model was specifically developed to accommodate all the aspects relating to a unique South African electricity environment. The questionnaire used in this study, was rooted in current theoretical perspectives and previously-validated models. The exploratory model was analysed using partial least squares structural equation modelling (PLS-SEM).

The focus of this study was on the top 500 consumers that use approximately 90 percent of the total generated electricity in South Africa. The users were categorised into mining, industry, municipalities, and others. The quantitative data was obtained by using questionnaires completed by senior management of the large electricity consumers.

The outcome of this research indicated which determinants have a significant influence on the large electricity consumers' WTP a premium for green electricity. The exploratory model indicated the most significant influence to be the need to enable the large electricity consumers to contribute, in an easy-to-use system, towards a premium for green electricity. Additionally, this study obtained a first-pass assessment of the large electricity consumers' WTP towards the implementation of green electricity. Electricity suppliers, Eskom, independent power producers and policy-makers can use the outcome to accelerate the implementation of green electricity technologies.

Key words:

willingness to pay

green electricity

large electricity consumers

partial least squares structural equation modelling

renewable energy

Eskom

independent power producers

scenarios

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- My friends, for sharing in my journey; and
- All those who participated in the research study.

When the winds of change blow, some people build walls and others build windmills (Chinese proverb).

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List of abbreviations and acronyms

A-act	attitude towards the behaviour in a given situation
AC	awareness-of-consequences
AICS	Auckland Individualism and Collectivism Scale
ATT	attitude towards green electricity
ATU	attitudes towards usage
AVE	average variance extracted
BIU	behavioural intention to use
CB-SEM	covariance-based structural equation modelling
CI	confidence interval
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
COP-1	First Conferences of the Parties/ Berlin.
COP-21	Conference of the Parties / Paris
COP-3	Third Conferences of the Parties / Kyoto Protocol
CSIR	Council for Scientific and Industrial Research
CSP	concentrated solar power
DESC	Departmental Ethics Screening Committee
DME	Department of Minerals and Energy
DOE	Department of Energy
EBIT	earnings before interest and tax
EC	environmental concern
EPC	electric power company
EPRI	Electric Power Research Institute
ESCOM	The Electricity Supply Commission
ETS	emissions trading systems
EU	European Union
EUETS	European Union Emission Trading Scheme
EVc	exchange value (paid to consumers)
EVh	exchange value (human inputs procured)
EVi	exchange value (original investment)
EVr	exchange value (return to investor)
EVs	exchange values (payment/supplies for separable assets)
FC	facilitating conditions
FFC	Financial and Fiscal Commission
GDP	gross domestic product
GHG	greenhouse gas

GW	gigawatts
GWh	gigawatt-hours
HTF	heat transfer fluid
INDCs	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
IPP	independent power producer
IRP 2010-30	First Integrated Resource Plan by the Department of Energy 2010 for electricity-generating technologies until 2030
IRP 2016-50	Integrated Resource Plan by the Department of Energy 2016 for electricity-generating technologies until 2050
IRP	Integrated Resource Plan
kWh	kilowatt-hours
LC	low-level consumption subsample
Mcs	motivation to comply with social normative beliefs
MFMA	The Municipal Finance Management Act
MW	megawatts
MYPD3	Multi-year Price Determination (process)
NBp	personal normative beliefs
NBs	social normative beliefs (i.e. perceived expectations of others)
NERSA	National Energy Regulator of South Africa
NO and NO_2	nitrogen oxides
OECD	The Organisation for Economic Co-operation and Development
PBC	perceived behavioural control
PEU	perceived ease of use
PLS-SEM	partial least squares-structural equation modelling
PMT	price mark-up tolerance
PU	perceived usefulness
PV	photovoltaic
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme
RSA	Republic of South Africa
SA	South Africa(n)
SADC	Southern African Development Community
SE	self-enhancement
SEA	Sustainable Energy Africa
SN	subjective norm
SO_2 and SO_3	sulphur dioxide and sulphur trioxide
ST	self-transcendence
TWh	terawatt-hours

UNFCCC	United Nations Framework Convention on Climate Change
USA	United States of America
USB	University of Stellenbosch Business School
USEPA	United States Environmental Protection Agency
UVc	use value (perceived use value of product /service. “reservation price”)
UVh	use value (employed labour)
UVs	use values (separable assets from suppliers)
VFP	The Victoria Falls Power Company Limited
VIF	variance inflation factor
VO	value orientation
W0, W1 and W2	represent the empirically determined weights
WTP	willingness to pay
WWF	World Wildlife Fund
ZAR	South African Rand

CHAPTER 1

NATURE AND SCOPE OF THE RESEARCH

1.1 RESEARCH CONTEXT AND INTRODUCTION

Electricity is generated using different sources of energy, including coal, nuclear, solar, wind, biomass, gas and hydro electricity-generating technologies. The worldwide trend is towards an appeal for the use of renewable or 'green' energy (wind, hydro and solar) to preserve natural resources and limit environmental impact (Graßl, Kokott, Kulessa, Luther, Nuscheler, Sauerborn, Schellnhuber, Schubert, & Schulze, 2003:2).

Various factors determine which types and combinations of energy technologies are used to generate electricity. Cost is a significant determinant in deciding which of these technologies should be utilised to generate the required electricity. The electricity supply profile should also match the demand profile of the consumer. Research and literature in this study indicate that in South Africa, more cost is involved in meeting the demand profile of the consumer using renewable energy than of those using non-renewable energy. According to the 2016 Eskom Integrated Report (2016c:8), the electricity consumption of the large consumers, as percentage of total consumption, was as 84.2 percent of the total electricity consumed in South Africa. For these reasons, implementing renewable energy as the main source of electricity supply will require that large consumers be willing to pay a premium for electricity generated from this type of technology. Strategies to implement carbon-reducing premium payments can be implemented through various methods, of which most have had little historic success. Consequently, it is important to understand which aspects influence the willingness to pay (WTP) of large consumers.

1.2 ORIGIN AND DEVELOPMENT OF ELECTRICITY

Electricity is part of the natural environment and can be seen in lightning and some animal species, for example the electric eel and fire-fly. To understand how current electrical systems have been created, it is necessary to look at some of the significant developments of the past.

According to Stewart (2001:50), "Thales of Miletos, the earliest researcher of electricity, made a series of observations on static electricity around 600 BC". This can be seen as the beginning of the scientific understanding of electricity. The word 'electricity' was derived from the Greek word '*electricus*' (meaning 'like amber'), which referred to the attraction that results after small objects have been rubbed (Baigrie, 2006:1). It was only in the 1600s that an English physician, William Gilbert, did an in-depth study of electricity and magnetism using static electricity (Stewart, 2001:50).

During the nineteenth century, progress in the field of electricity was made due to numerous inventions that used and generated electricity. A study by Susskind (1976:1 301) focused on the inventors of the nineteenth century and found that this was a period of rapid progress in electrical science. He referred to inventors like Nikola Tesla, Alexander Graham Bell, Thomas Edison, Ernst Werner von Siemens and Lord Kelvin as the "electricians among them" who turned scientific curiosity into an essential tool for modern life (Susskind, 1976:1 301).

Throughout the nineteenth century there was a consistent increase in the use of electricity, as well as the development of industries which required the provision of electricity. A rise in consumers created the need for interconnected networks between electricity-generating plants and their users. Electricity was transmitted over long distances for the first time in the late nineteenth century when the invention of the transformer made it possible for electricity to be generated at centralised power stations and transmitted across countries with increasing technical and cost efficiency (Patterson, 1999:42). The world today is linked by power lines that connect cities and countries. Most modern-day equipment and machines use electricity to improve comfort and productivity. Electricity is seen as the energy source of the future, which will continue to form part of our daily lives for many years to come.

1.3 WORLDWIDE TREND TOWARDS USING GREEN ENERGY

1.3.1 Reducing environmental impact

One of the main international problems is the burgeoning of the world population and their requirements for food, shelter, and a huge amount of goods and services. Decreasing or stagnant supplies of energy, water, land and minerals juxtapose this situation. Greenhouse and other destructive environmental effects further exacerbate the problem by reducing options for energy provision. Numerous activists and organisations are working on awareness programmes that can alter the public view regarding the use of green energy (Von Wyzsacker, Hargroves, Smith, Desha & Stasinopoulos, 2009:14).

1.3.2 Strategies to reduce carbon emissions

The Kyoto Protocol is an international treaty extension of the 1992 United Nations Framework Convention on Climate Change (UNFCCC), which commits state parties to reducing greenhouse gas (GHG) emissions. The UNFCCC's ultimate aim is to prevent negative human interference with the climate system. The aim of the Kyoto Protocol is to legally bind countries to carbon emission reduction targets so that average global temperature increases and the resulting climate change will be limited. One of the regulatory mechanisms that was developed included carbon emission pricing, which would make it possible to hold those responsible for ecological damage accountable and reduce carbon emissions (Obergassel, Arens, Hermwille, Kreibich, Mersmann, Ott & Wang-Helmreich, 2016:7). There are two main types of carbon pricing, namely emissions trading systems (ETS) and carbon taxes (National Treasury, 2015:3; World Bank, 2016:10).

Emissions trading systems cap the total level of GHG emissions by determining a price per tonne for carbon dioxide that is emitted (permit pricing). Setting a cap ensures that the required emissions reduction will take place. Industries with low emissions can then sell their additional allowances to larger emitters. This means that ETS created supply and demand for GHG emissions allowances. This implies that there is a fluctuation in permit pricing (Euro per tonne of CO_2), as seen in Figure 1.1.

Figure 1.1: Interactive chart for BlueNext European Union Allowances 2008 to 2012

Source: Bloomberg, 2012.

Carbon dioxide tax, or carbon tax as it is more commonly known, is a tax fee for making users of fossil fuels pay for climate damage. Carbon tax directly sets a price on the carbon content of fossil fuels by defining a tax rate on GHG emissions. The fuel used imposes carbon tax for releasing carbon dioxide into the atmosphere, thereby motivating the support for clean energy (Tariq & Ali, 2017:12).

Placing a tax on carbon gives consumers and producers a monetary incentive to reduce their carbon dioxide emissions. Weisbach and Metcalf (2009:501) stated that tax on GHG emissions for the United States (US) considers three major issues: (1) the tax rate; (2) the optimal tax base; and (3) international trade concerns.

The central problems in addressing climate change include uncertainty about its effects and uncertainty about the costs of abatement. Therefore, the most significant challenge is the design of a system for ensuring that the rate changes over time as new information becomes available about the costs and benefits of reducing emissions (Metcalf & Weisbach, 2009:501).

According to Metcalf and Weisbach (2009:501), “We show that a well-designed carbon tax can capture about 80 percent of US emissions by taxing only a few thousand taxpayers, and almost

90 percent with a modest additional cost". Their statement supports the necessity of this study, which focuses on the large electricity consumers' willingness to pay for green electricity.

Deciding on whether to use ETS or carbon tax depends on the national and economic circumstances of each country. The draft explanatory memorandum for the carbon tax bill, published in 2015, was an attempt to utilise carbon price movements to stimulate market innovation for clean technology and encourage the development of low-carbon drivers of economic growth (Koch, Fuss, Grosjean & Edenhofer, 2014:681).

About two-thirds of the submitted Intended Nationally Determined Contributions (INDCs) indicated that they were considering the use of carbon pricing as a cost-effective instrument to reduce GHG emissions. This is a positive progression towards reducing carbon emissions because these INDCs are parties from 101 nations that participated in the 21st Conference of the Parties (COP-21), and account for 58 percent of global emissions (The World Bank, 2016:33).

1.3.3 Carbon pricing strategies

One of the first forms of carbon tax and ETS, which was implemented in an attempt to reduce carbon emissions through the use of trading exchanges, was BlueNext (BNS) – European Union Allowances (EUA), a European environmental trading exchange. As indicated in Figure 1.1 the price of carbon credit declined significantly at the end of 2008 and again during the midyear of 2011. BlueNext subsequently announced that it would close its spot permanently and derivatives trading operations ended on 5 December 2012 (Bloomberg, 2012).

Another trading system, the European Union Emission Trading Scheme (EUETS), is considered to be the front-runner on climate policy in the European Union (EU). From 2008 to 2016 the EUETS experienced a sharp decline in permit prices, which appears to be related to the strained economic climate in Europe since 2008, as seen in Figure 1.2. It can therefore be deduced that the global economic status had a negative influence on WTP, which seems to be related to reductions in carbon pricing (Koch et al., 2014:676). The results of a study by Hu, Crijns-Graus, Lam and Gilbert (2015:162) indicated that the ETS could possibly begin to have a positive impact on carbon emissions from 2025 onwards.

When considering the above, and as illustrated in Figure 1.2, attempts to reduce carbon emissions by implementing carbon pricing have not been as successful as originally envisaged. Continued international pressure through initiatives like the Kyoto Protocol will require that governments and organisations implement strategies in which some percentage of their electricity demand is supplied using environmentally-friendly sources. This will have enormous financial implications according to the International Energy Agency (Simpson, 2012:4), because "over the next 30 years US$30 trillion need to be invested in energy infrastructure globally, and of this $10 trillion must be in low-carbon infrastructure".

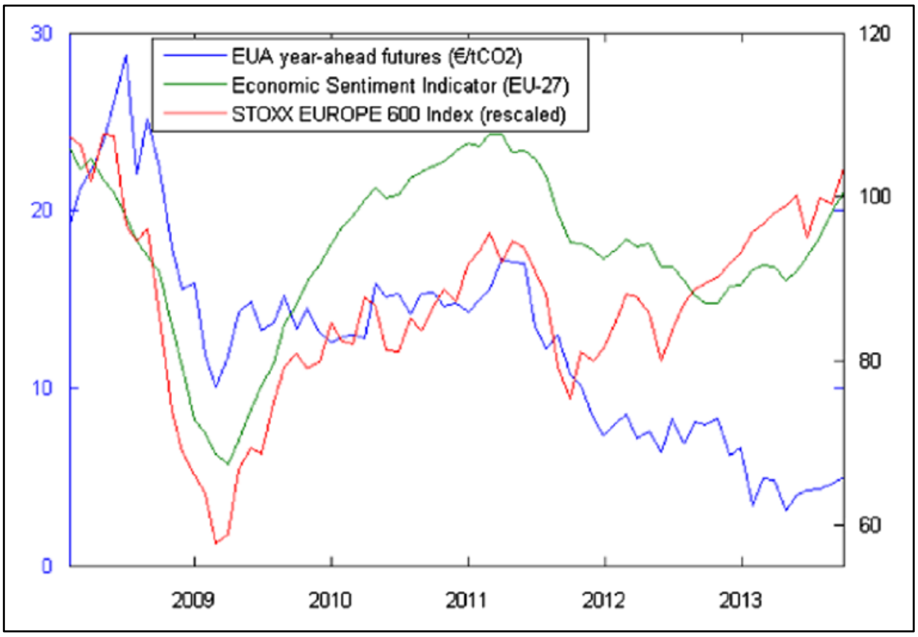


Figure 1.2: Evolution of EUA prices (on the left y-axis) jointly with indicators of economic activity

Source: Koch et al., 2014:679.

The expectation is that this electricity energy supply mix will include more renewable sources in the future to reduce the country's carbon footprint by mainly procuring energy from the South African Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) (Eskom, Report, 2016c:18). To understand the evolution of the South African electricity-generating environment, a brief history is provided in the next section.

1.4 THE DEVELOPMENT OF ELECTRICITY SUPPLY IN SOUTH AFRICA

The Eskom Heritage web page has a detailed history of the electricity industry of South Africa. The summary below provides a brief overview of the development of this industry up until the present day (Eskom Heritage, 2017).

The Encyclopaedia of Southern Africa (Eskom Heritage, 2017) recorded that the first "electric device" in South Africa was used around 1809. In 1860, the early arc light was revealed and the electric telegraph system was introduced which operated between Cape Town and Simon's Town. In 1861, the telegraph system was used as a time signal. In 1881, the local railway station in Cape Town became the first facility to be illuminated by means of electricity. In April 1882, electric arc lamps were used to illuminate Cape Town's Table Bay docks (Figure 1.3). A report on the use of electric lights by the Cape Colonial Parliament in Cape Town in *The Cape Times* of May 1882 reads as follows: "The House of Assembly continues to be lighted by the electric light and the result has so far been highly satisfactory. The light is full, clear, pervasive and steady, and greatly improves the appearance of the chamber".

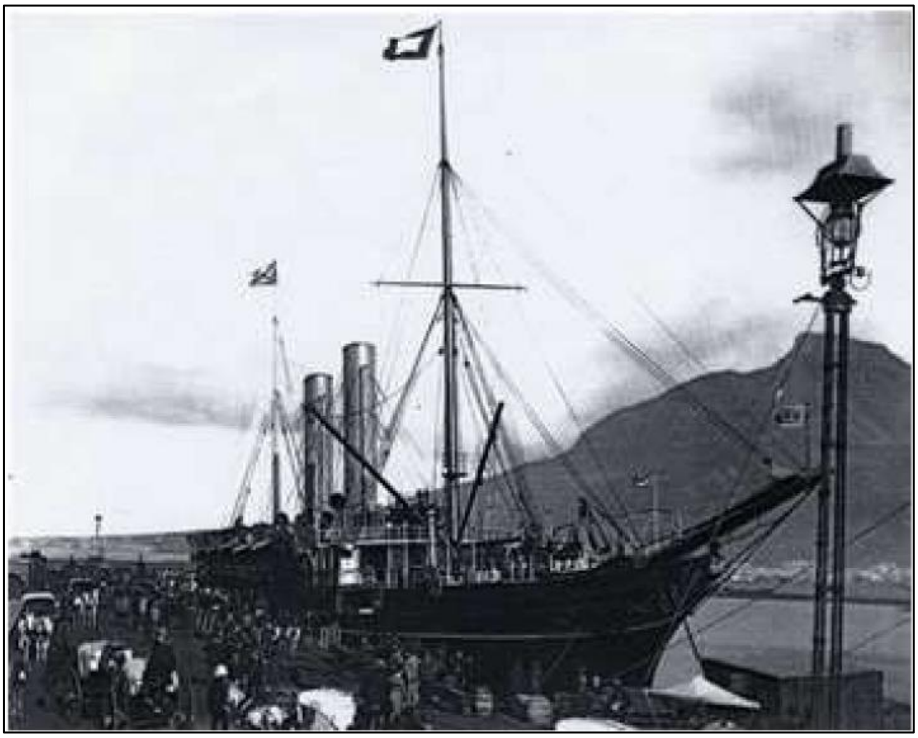


Figure 1.3: Table Bay harbour illuminated from April 1882

Source: Eskom Heritage, 2017.

In 1882, the Diamond City of Kimberley became the first city in Africa to use electric streetlights. The period between 1884 and 1890 saw the evolution of electric motors, lights in mines, private lighting and electric trams. The discovery of gold on the Witwatersrand in 1886 meant that Johannesburg installed its first electric lighting plant in 1889, which was generated by gas engines. An electricity reticulation system followed in 1891. The company Siemens & Halske was granted a concession to supply electricity to Johannesburg in 1889, and began to transmit electricity to the mines of the Witwatersrand in 1894. South Africa's first central power station was established in 1891. Municipal electricity provision was implemented in Rondebosch in 1892, Cape Town city centre in 1895, Durban in 1897, Pietermaritzburg in 1898, East London in 1899, Bloemfontein and Kimberley in 1900, and Port Elizabeth in 1906. Hydro-electric power is reported to have been generated for the first time in 1892.

When mining companies began pumping water from deep level shafts, they realised that the power generated by small lighting plants was inadequate. They therefore joined forces to build larger 'central' power stations to supplement existing supplies of electricity. During 1897, the Simmer and Jack mines were awarded the right to supply electricity to five nearby mines owned by the Consolidated Goldfields Group. A year later in 1898, a subsidiary company, the General Electric Power Company Ltd, was established to deal with this concession. The first steam turbo-generator in South Africa was a 50 kW Parsons, which was installed in 1901 by the Cape Peninsula Lighting Company at the Wynberg Central Station in Cape Town.

The notion of a central electricity undertaking gained the support of, among others, businessmen and engineers. This culminated in the establishment of the Victoria Falls Power Company Limited (VFP) on 17 October 1906 which was registered in Southern Rhodesia (now Zimbabwe). By 1915, four of these thermal power stations, namely Brakpan, Simmerpan, Rosherville and Vereeniging, had a total installed capacity of more than 160 MW collectively. A system control centre was established at Simmerpan, which grew to be the national control centre that currently directs Eskom's entire transmission network.

The VFP also pioneered long-distance transmissions of high-voltage electricity which took the severe climatic conditions of the Witwatersrand into account. The Power Act introduced on 28 May 1910 by the Transvaal Colonial Government, limited the future existence of the VFP. It authorised the operational expansion of the VFP on condition that the company and any other electricity undertaking be expropriated by the State after a period of 35 years. The State viewed the provision of electricity as a public service which should be placed under its authority. *The Government Gazette* of 6 March 1923 announced the establishment of 'The Electricity Supply Commission' (ESCOM), effective from 1 March 1923. This Commission was made responsible for establishing and maintaining regional electricity supply undertakings on a regional basis. The Commission met for the first time on 20 March 1923 in Cape Town and its headquarters opened in Johannesburg on 1 May 1923.

The Eskom Conversion Act was signed into law in 2002. This Act converted Eskom from a public enterprise into a public company with a share capital. The utility's Board of Directors was appointed to preside over the affairs of Eskom Holdings SOC Limited.

The foregoing historical review serves as an important background to illustrate how past developments in the electricity supply industry resulted in the status of electrical generation in the present day.

1.5 ESKOM AS SOUTH AFRICA'S MAIN ENERGY SUPPLIER

Eskom is South Africa's largest electricity producer and generates 90 percent of the electricity used in South Africa. According to the Eskom Integrated Report (2016c:8), the current status of Eskom as an electricity supply company can be summarised as follows: 47 978 group employees, 5 688 640 consumers, net maximum generating capacity of 42 810 MW and 377 287km of power lines.

1.6 SOURCES USED TO GENERATE ELECTRICITY

Technical and financial motives of the past led to the development of current generation technologies like hydro, coal, and nuclear power plants. To understand the terminology used in the electricity-generating industry, it is important to understand the functioning of these different types of generating plants, defined as follows:

1.6.1 Base-load plants

Base-load stations are meant to operate on a constant basis and are only shut down for maintenance. The output of individual units can be adjusted according to demand, but units cannot be shut down or started up rapidly. Eskom's base-load plants are comprised of coal-fired- (including the return-to service coal plants) and nuclear stations.

1.6.2 Peaking plants

Peaking stations operate when demand is high and can be started up rapidly. Eskom's peaking stations use water or diesel to operate.

1.6.3 Self-dispatchable generation

These include plants like wind farms and solar photovoltaic (PV) plants. Wind farms, for example, can only generate electricity when the wind is blowing (Eskom, 2016c:10).

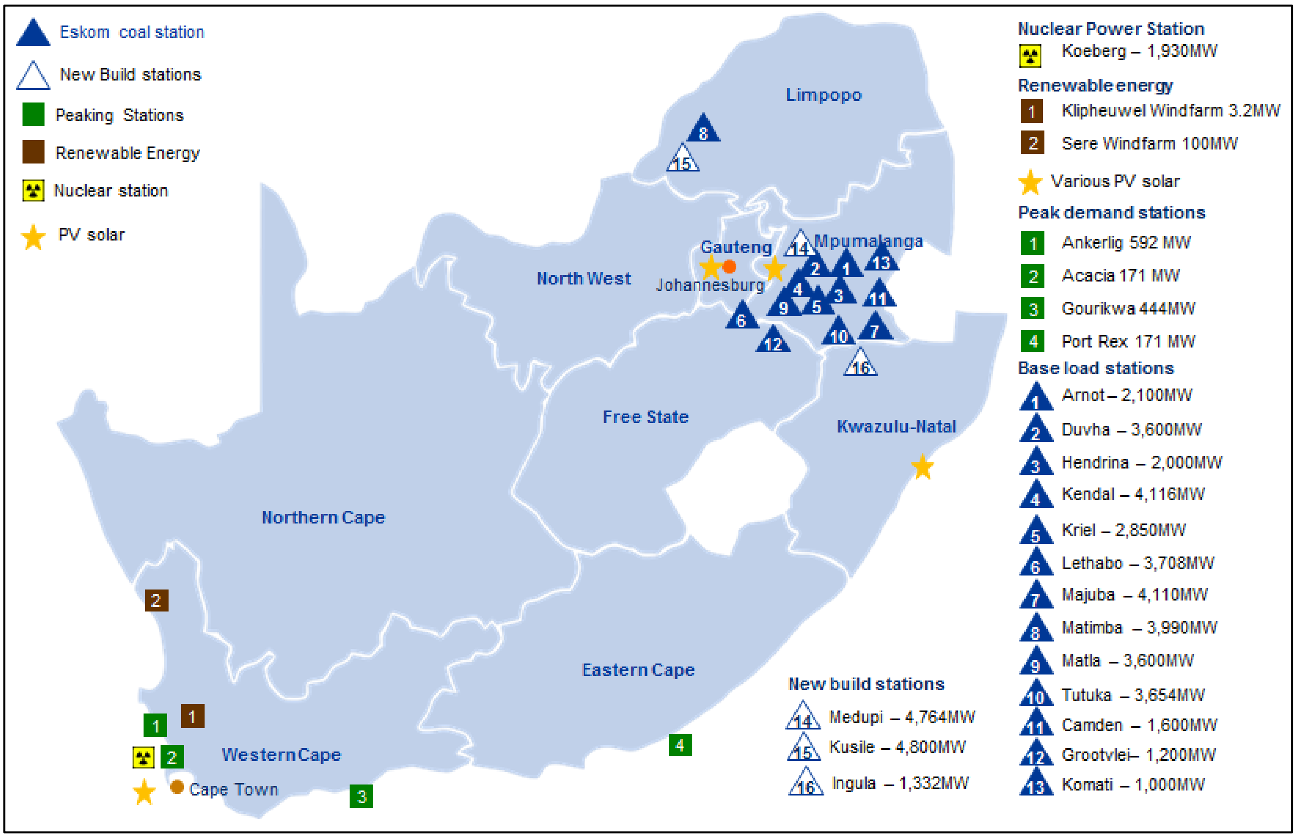


Figure 1.4: Map of Eskom power stations

Source: Eskom, 2017a.

Eskom maintains a substantial network of electricity-generating power plants across the country. The Eskom Integrated Report (2016c:10) stated that the current Eskom electricity-generating capacity consists of "28 power stations, with a total nominal capacity of 42 810 MW, comprising 36 441 MW of coal-fired stations, 1 860 MW of nuclear power, 2 409 MW of gas-fired, 600 MW hydro and 1 400 MW pumped storage stations, as well as the 100 MW Sere Wind Farm". This is also illustrated in Figure 1.4 above.

Coal-fired power stations are the most economical due to the abundant availability of coal in South Africa. For this reason, coal is still used to generate 90.87 percent of the electricity within South Africa. This is also illustrated in Table 1.1, which indicates that coal is still the primary energy source for generating electricity, whilst renewable energy sources only provide a small percentage (Eskom, 2016c:11).

Table 1.1: Electricity generated by Eskom from the primary energy sources

Primary energy source	**GWh**	**%**
Coal-fired stations	199 888	90.87%
Nuclear power	12 237	5.56%
Open-cycle gas turbines	3 936	1.79%
Hydro stations	688	0.31%
Pumped storage stations	2 919	1.33%
Wind	311	0.14%
Total	**219 979**	**100.00%**

Source: Eskom, 2016c:18.

1.7 ELECTRICITY DEMAND IN THE SOUTH AFRICAN CONTEXT

1.7.1 Factors influencing electricity demand

Progressive industrialisation and economic growth resulted in sustained growth in the demand for electricity. There are different factors, which influence the demand for electricity in the various sectors, for example the residential and mining sectors. The residential sector is influenced by factors such as cooking, heating, and lighting. For the mining industry, its electricity consumption is influenced by the production rate. This variance in demand characteristics is due to the nature of the industry and how electricity is consumed.

Between 1930 and 1980, there was sustained growth in industrialisation with a higher demand for electricity in the industrial sector. Between 1930 and and 1950, there were significant changes in the rail, industrial and mining sectors. The municipal sector had significant fluctuations in comparison to the other sectors. This is illustrated in Table 1.2, where the composition of Eskom's total sales during the financial years of 1930, 1950, 1980 and 2016 can be seen.

Table 1.2: Eskom's total sales for the financial years 1930, 1950, 1980 and 2016

<table>
<tr><th></th><th>1930</th><th>1950</th><th>1980</th><th>2016</th></tr>
<tr><td>Total sales:</td><td>889 GWh</td><td>6 910 GWh</td><td>87 539 GWh</td><td>214 487 GWh</td></tr>
<tr><td>Sector</td><td>% of total sales</td><td>% of total sales</td><td>% of total sales</td><td>% of total sales</td></tr>
<tr><td>Municipalities</td><td>78.83% *</td><td>16.05%</td><td>30.80%</td><td>41.8%</td></tr>
<tr><td>Industrial</td><td rowspan="2">6.47%</td><td>14.48%</td><td>33.60%</td><td>23.4%</td></tr>
<tr><td>Mining</td><td>60.24%</td><td>29.50%</td><td>14.3%</td></tr>
<tr><td>International</td><td></td><td></td><td></td><td>6.3%</td></tr>
<tr><td>Residential</td><td>0.11%</td><td>1.65%</td><td>1.00%</td><td>5.6%</td></tr>
<tr><td>Commercial</td><td></td><td></td><td></td><td>4.7%</td></tr>
<tr><td>Agriculture</td><td></td><td></td><td></td><td>2.7%</td></tr>
<tr><td>Rail</td><td>14.59%</td><td>7.58%</td><td>5.10%</td><td>1.2%</td></tr>
</table>

* Bulk supplies to the Victoria Falls and Transvaal Power Company Limited and the Durban Corporation.

Source: Eskom, 1930:7; Eskom, 1950:14; Eskom, 1980:16; Eskom, 2016c:8.

Changes to electricity supply in 2007, 2013, 2015 and 2016 occurred mainly because of influences related to international markets, changes in electricity price, and the local economic environment. The significant increase in the electricity price and over-supply resulted in the reduction of industrial and mining activities. This caused a reduction in these industries' electricity consumption in South Africa. The international economic downturn aggravated the reduction in electricity consumption for the mining and industrial sectors. This is illustrated in Table 1.3 below.

Table 1.3: Electricity percentage usage per sector

Sector	2007	2013	2015	2016	Comments
Mining	18	15	13.8	14.3	
Industrial	46	24	24.7	23.4	
Commercial	10	7	7	7.4	Includes Agriculture from 2013
Municipality	17	42	42.1	41.8	
Residential			5.4	5.6	
Other	9	13	6.9	7.5	Includes Agriculture in 2007 Includes Rail and International sectors

Source: Eskom, 2007; 2013; 2015; 2016a.

Figure 1.5 illustrates the gross domestic product (GDP) growth rate in relation to electricity development. The demand for electricity consistently remained higher than the growth of the national economy from 1950 to 1980. This coincides with the period of industrialisation, which is referred to in Table 1.2.

According to the Eskom Annual Report (1980:11), the increasing demand for electricity was consistently higher than that of the growth in the national economy when comparing information from 1950 to 1980. The international community implemented sanctions against South Africa to expedite the abandonment of *apartheid* during the late 1980s. This resulted in South Africa experiencing a significant decline in GDP during that time. With the establishment of a democratic government in South Africa in 1994, the GDP started recovering from the effects of sanctions and economic growth figures began to increase. Since then, the annual growth figure experienced fluctuations, but during 2009 there was a significant drop as a result of a deceleration in global economic growth. It appears as though events, which affected economic growth, also had an impact on electricity demand. The effect of these events on the GDP growth rate as well as the electricity growth is observed in Figure 1.5. It can therefore be concluded that electricity demand is directly linked to the economic growth of a country.

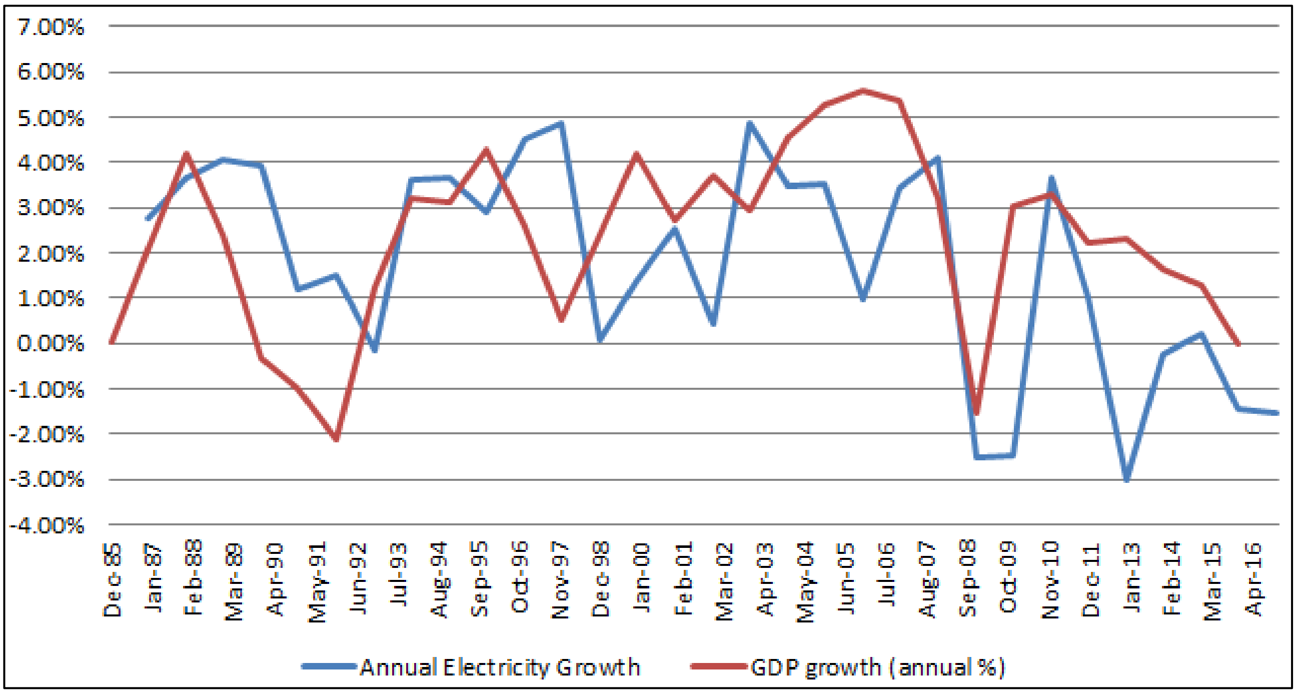


Figure 1.5: South Africa’s electricity sales growth versus economic growth

Source: Statistics South Africa, 2016a; 2016b.

Understanding the connection between economic growth, changes in industry, and the demand for electricity is an important consideration, because electricity-generating technologies need to be able to meet demand requirements.

The current understanding of the South African requirements for the provision of electricity in the future is discussed next.

1.7.2 Future South African electricity demand requirements

Even though the future demand of electricity is dependent mostly on economic growth, other factors, such as demand-side management, also need to be considered. Another factor is the volume of electricity that is exported to neighbouring countries. All of these influences are modelled into various scenario planning options and then presented to indicate scenarios with low electricity growth and high electricity growth. Various studies have attempted to predict the future demand for electricity in South Africa. Alfstad (2005:80) stated that the demand for electricity in the Southern African Development Community (SADC) will most probably double within the next 30 years and illustrated this by using a high-growth scenario and low-growth scenario for electricity sales – as shown in Figure 1.6.

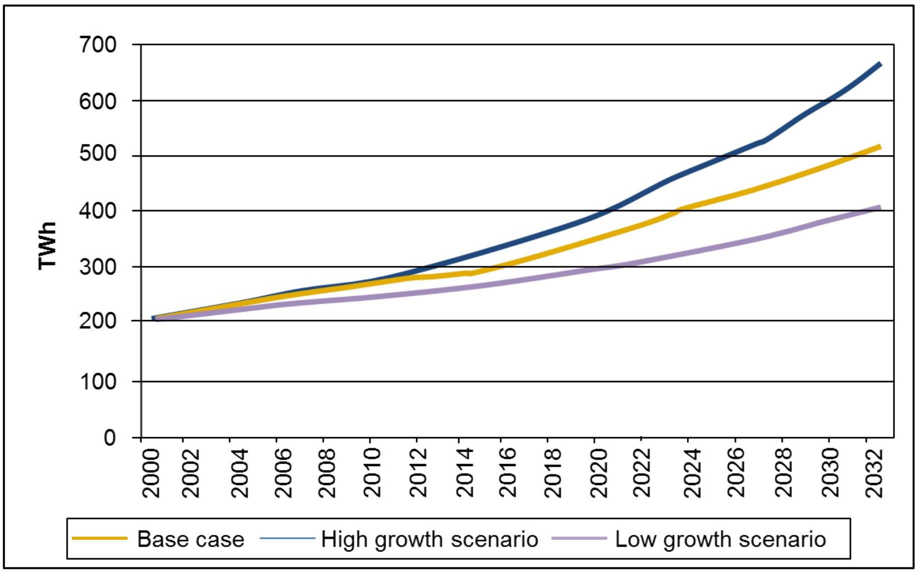


Figure 1.6: Projection of SADC electricity sales for base, high-growth and low-growth scenarios

Source: Alfstad, 2005:80.

In a more recent study by Hedden (2015:6), he created three integrated and cohesive scenarios for South Africa's future energy system, namely:

- The Current Path scenario: This is a continuation of current energy planning and policies.
- The Efficient Grid scenario: This scenario assumes that investments in electricity-generating capacity are accompanied by efforts to ensure the efficiency of the grid's transmission and distribution infrastructure.
- The Smarter Grid scenario: This scenario assumes that investments in generating capacity and the efficiency of the grid are accompanied by integrated energy and grid planning, more flexible generating capacity and advances in operational strategies that enable the integration of decentralised and intermittent electricity, together with policies to unlock small-scale embedded generation (Hedden, 2015:2).

Hedden (2015:6) presented four forecasts for the growth in the electricity usage for South Africa, illustrated in Figure 1.7. These are: (1) the 2010 Integrated Resource Plan (IRP); (2) the 2013 update to the IRP; (3) the International Energy Agency's World Energy Outlook 2014 (New Policies Scenario); and (4) the Mandela Magic Lite Scenario from South African Futures 2035. Actual historical values of electricity demand (net sent-out) from Statistics South Africa are also displayed. This study indicated a profile similar to that of Alfstad (2005:80).

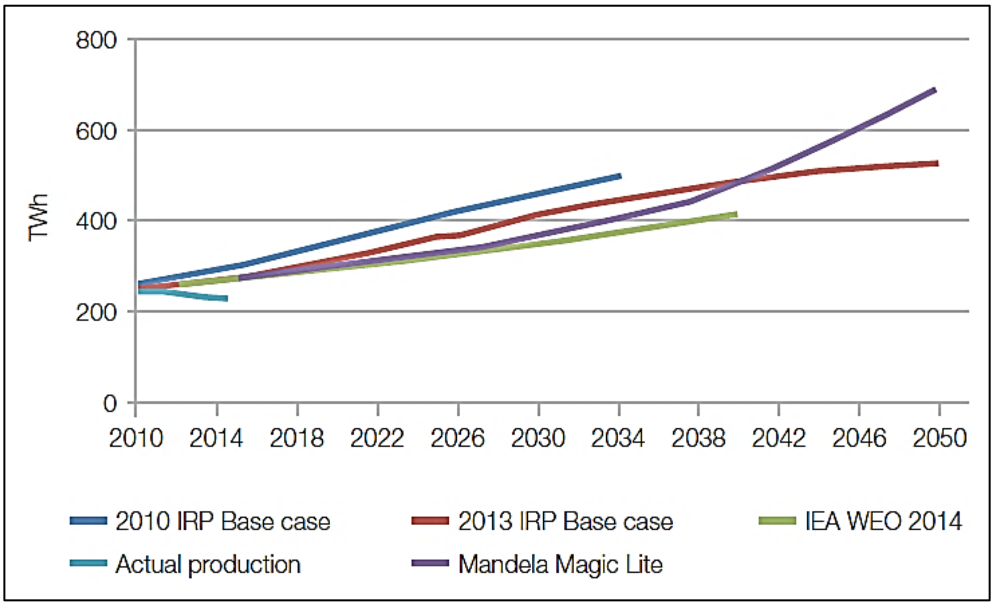


Figure 1.7: South African electricity demand forecast in TWh

Source: Hedden, 2015:6.

The electricity demand forecast which was published in the latest IRP by the Department of Energy (DOE, 2016a) coincides with the trends forecasted by Hedden (2015:6) and Alfstad (2005:80). This DOE forecast predicts that the High annual energy growth rate average will be 2.17 percent and the Low annual energy growth rate average 1.31 percent. The midpoint between the High and Low scenarios in 2050 will be at 450 TWh, as shown in Figure 1.8. This is significant as this study indicates a profile similar to that of Alfstad (2005:80) and Hedden (2015:6).

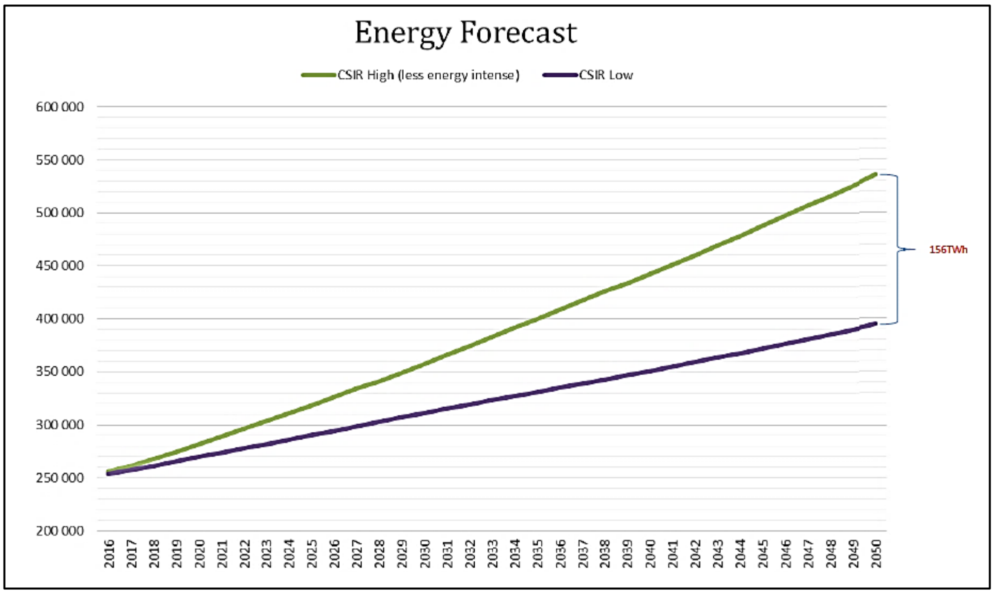


Figure 1.8: IRP 2016-50 electricity demand forecast in TWh

Source: Department of Energy, 2016a:7.

From the forecasted demand requirements, a selection of the current available electricity-generating technologies needs to be made to provide the required electricity. The next section discusses the current difficulties which need to be addressed relating to the South African requirements to provide green electricity in the future.

1.7.3 Challenges for future electricity demand

From 2022, some of the older Eskom-generating power stations will exceed their design life and be decommissioned. New electricity-generating power stations will have to be constructed to replace decommissioned power stations and provide additional electricity requirements. The electricity industry is generally an industry that evolves slowly, and it can take up to ten years to construct a large power station. It is therefore essential to ensure that the correct type of plant is constructed timeously. During the planning phase, electricity requirements, construction time, cost and available technology need to be taken into account.

To ensure a stable and reliable supply of electricity, there also needs to be a reserve margin so that generating plants can be taken off line for maintenance. The current requirement set by the Department of Energy (2010), is 15 percent, and in the past ten years the reserve margin frequently did not meet that requirement. As a result, there were frequent blackouts and load shedding, which had severe implications for the economy. In order to recover, Eskom adopted a maintenance strategy, 80:10:10, which strives for 80 percent plant availability by 2020/21, requiring unplanned losses to be limited to 10 percent on average, while performing an average of 10 percent planned maintenance. Additional capacity coming online through the new-build programme will assist to achieve the required 15 percent reserve margin (Eskom, 2016a:49).

1.7.4 Strategies for future electricity demand

This section takes into consideration the forecasted electricity demand requirements as indicated by Alfstad (2005:80) and Hedden (2015:6). This increasing demand for electricity must be met with reliable and sustainable generating plants. To ensure that the electricity is supplied at the time of demand, the selection of the current available electricity-generating technologies is important.

The expectation is that this electricity energy supply mix will include more renewable sources in the future to reduce the country's carbon footprint by mainly procuring energy from independent power producers (IPPs) (Eskom, Report 2016c:18). Figure 1.9 indicates the projected generating mix in 2030 as well as the total forecasted system capacity. According to Hedden (2015:9), for the policy-adjusted scenario in the 2010 IRP, the total installed capacity will double by 2030 from 44.1 gigawatts (GW) to 89.5 GW. Of this new-build stations, 29 percent will be coal-powered; 17 percent will be nuclear; 16.3 percent will be wind; and 14.9 percent will be solar PV energy, as indicated in Figure 1.9.

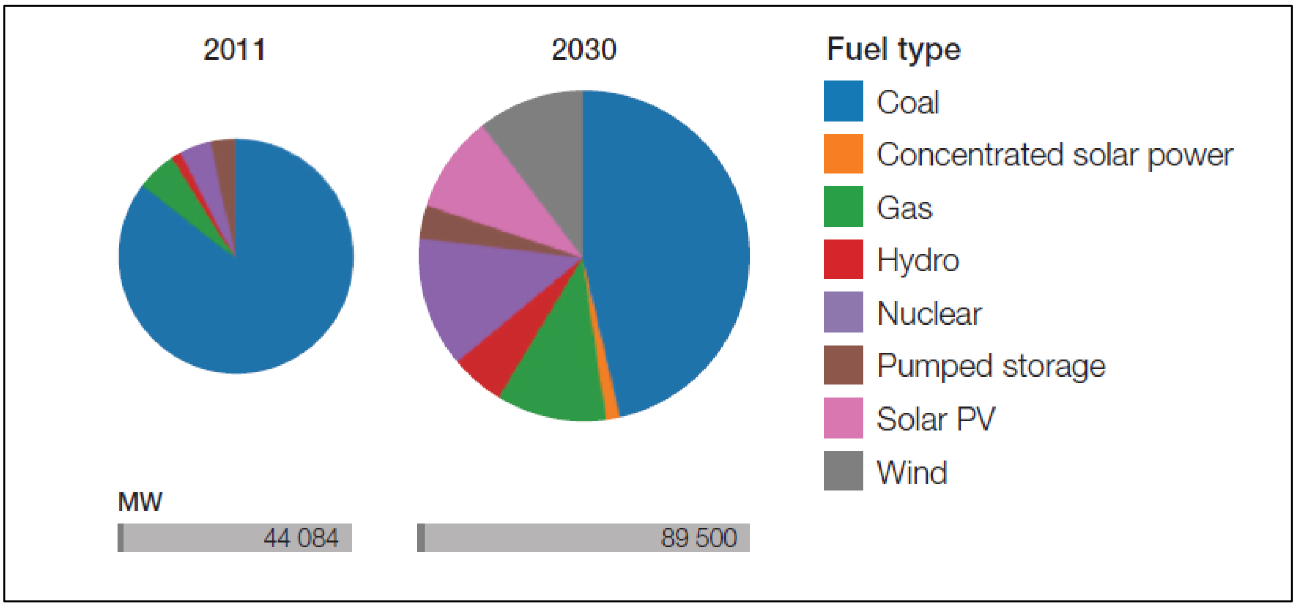


Figure 1.9: Comparison of total generating capacity and supply mix in 2011 vs. 2030

Source: Hedden, 2015:9.

Wind and solar power is added consistently, reaching 8 GW each by 2030. In Figure 1.10 it is indicated that the first new nuclear power station is to come online in 2023 and increases by 1.6 GW in five of the following six years, totalling 9.6 GW by 2030. With the new-build nuclear programming not started yet, this time frame will be extended. In addition, 3.3 GW of hydropower is imported from Mozambique and Zambia and more diesel-, coal- and gas-fired power plants are built.

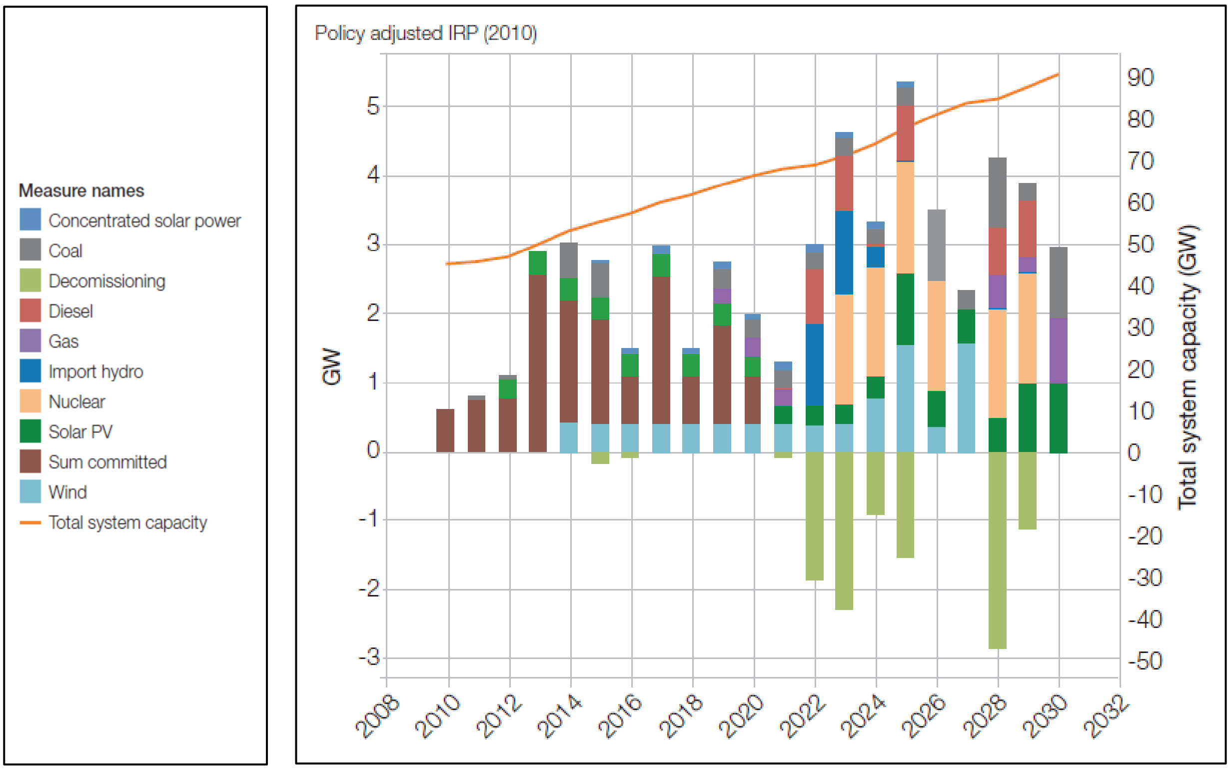


Figure 1.10: South Africa's total system capacity over time and by type

Source: Hedden, 2015:8.

The orange line in Figure 1.10 represents total system capacity over time. As capacity is decommissioned in 2022, new build is required to ensure that the total system capacity continues to rise.

It is clear from this information that the Integrated Resource Plan 2010 (IRP 2010-30), as well as the latest IRP by the Department of Energy (DOE, 2016b), focus towards a much larger component of renewable electricity-generating plants. As this change towards green electricity generation is taking place, a balance between the economic viability and the available electricity-generating capacity will be required. With the current higher cost of green electricity, knowledge of the large electricity consumers' willingness to pay for the implementation of these green-generating technologies is important.

The near-term electricity requirement will largely be met by the construction of Ingula Medupi and Kusile power plants, as well as the IPPs entering the electricity-generating market. Medupi and Kusile are coal-fired stations, which will provide an additional 9 564 MW of power.

1.8 THE NEED FOR RENEWABLE ENERGY SUPPLY

When taking the above into consideration, it becomes clear that coal-fired stations are still the main source of electricity provision in South Africa. Extensive use of coal to generate power, as well as growth in the demand for electricity, has led to significant increases in carbon emissions and a large carbon footprint. Providing cleaner electricity-generating technologies has therefore become very important.

The Integrated Resource Plan 2010 (IRP 2010-30) indicated the shift from 1999 towards a much larger component of renewable electricity-generating plants. This is again indicated with the updated IRP 2016-50 that was issued for comments in November 2016. Van Heerden, Scott and Hibbert (2002:3) stated that Eskom has been involved with the implementation of small-scale renewable technologies for some time. Their department of Research and Development has been testing and evaluating green technologies that can be used to supply electricity to the national power grid in the future.

Eskom’s aim in the future is to include a much larger component of renewable electricity-generating plants in their electricity energy mix (IRP 2010-30; Eskom, 2016c:18). These renewable sources will most likely be procured from IPPs. In 2016, 3 392 MW of power connected to the national Eskom electricity grid was already provided by IPPs. Figure 1.11 indicates the type of plant and the contracted/connected status of each IPP (Eskom, 2016c:53). It is evident that wind and solar are the currently preferred options for generating green electricity with some hydro and landfill-generating plants.

When the demand profiles of consumers and supply profiles of renewable generation plants are compared, it is apparent that they are not compatible, as indicated in Figure 1.12. A backup supply must therefore be provided which can ensure that demand can be met when renewable source options are not generating electricity. Electricity-generating technologies like wind and PV energy therefore have to be combined with gas plants and hydro power stations in order to provide base-load electricity. This is much more expensive than using power stations based on coal. A balance between the economic viability and available electricity-generating capacity will therefore need to be found.

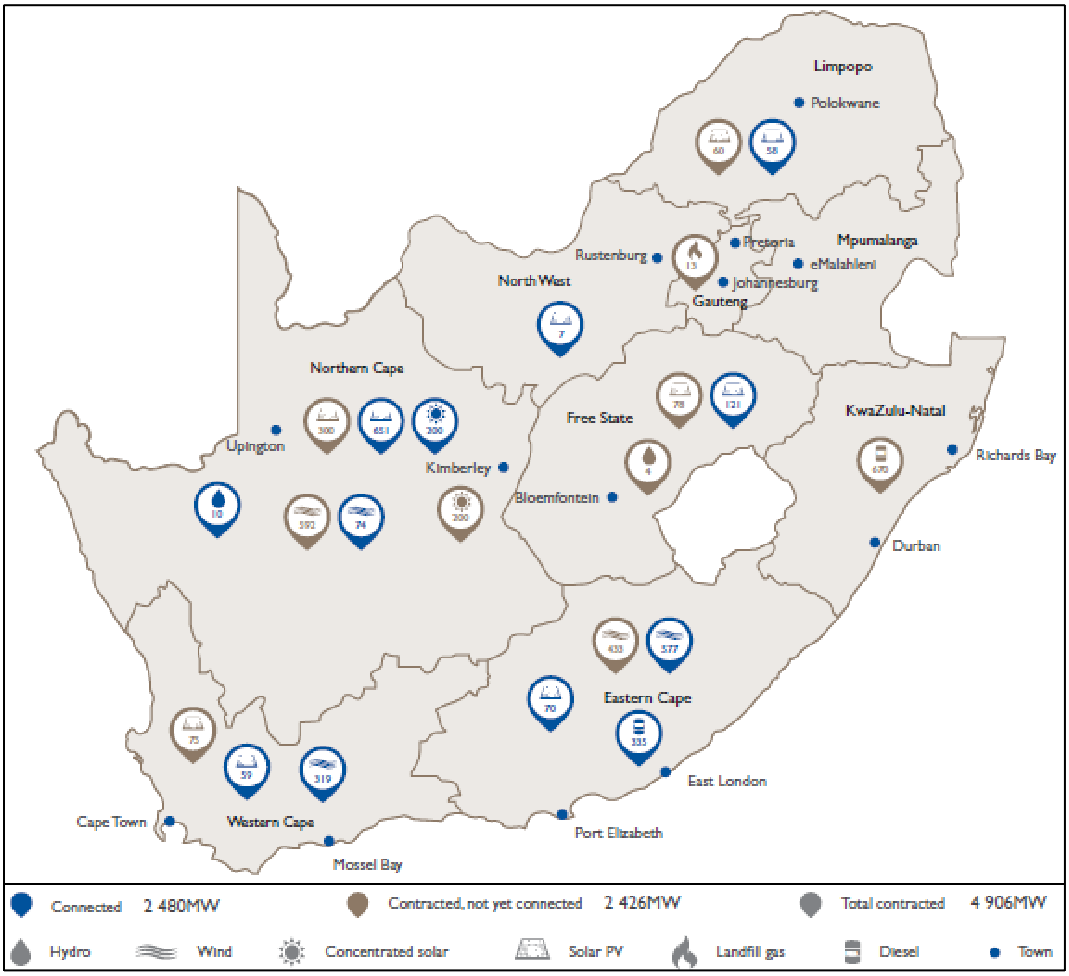


Figure 1.11: Type of plant and the contracted/connected status of each IPP

Source: Eskom, 2016c:53.

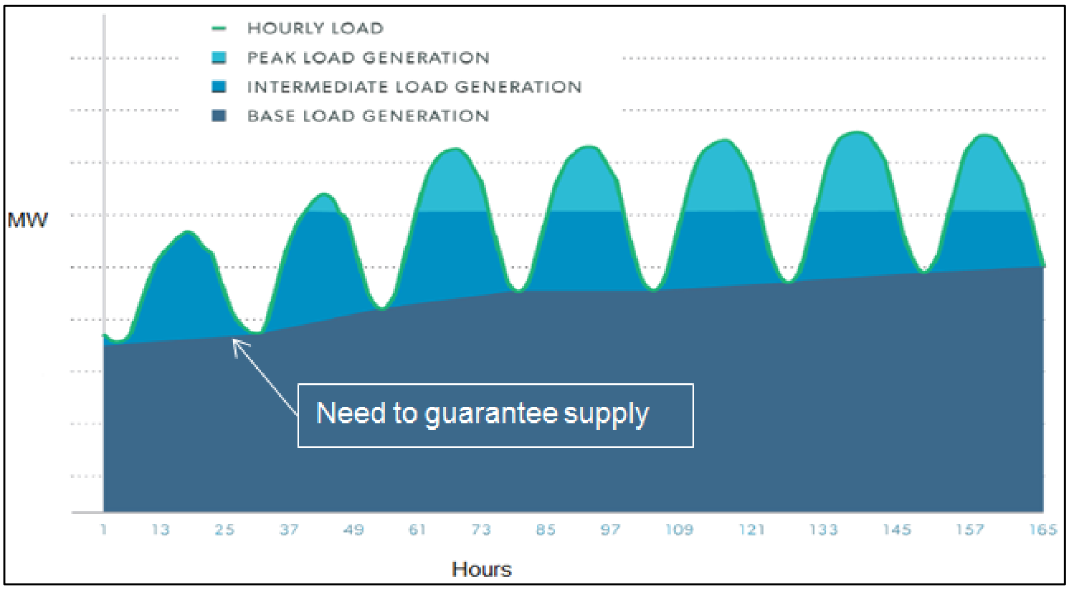


Figure 1.12: Typical weekly electricity load curve, starting on a Saturday

Source: Stacy and Taylor, 2015:8.

1.9 CONTRIBUTION OF LARGE CONSUMERS TOWARDS GREEN ENERGY SUPPLY

According to the Eskom Integrated Report (2016c:8), the electricity consumption of the large sectors, as percentage of total consumption, was as follows: Industry (23.4%), Municipalities (41.8%), Mining (14.3%), and Commerce (4.7%). This means that these sectors together used 84.2 percent of the total electricity consumed in South Africa.

Eskom Customer Services uses an internal procedure in which the top 500 accounts, based on year-to-date sales and revenue at the time of the analysis, are identified as large consumers. The Eskom Multi-Year Price Determination (MYPD3) report (Eskom, 2012b:26) referred to South Africa's 500 largest electricity users as those using more than 25 gigawatt-hours (GWh) a year. These large electricity consumers are found in the municipal, mining, industry, commercial, agriculture, traction/rail, and bulk distribution sectors. An economically viable strategy needs to be implemented involving these large consumers to invest in additional renewable electricity generation sources, and reduce the reliance on coal.

Brent, Hietkam, Wise and O'Kennedy (2009:270) concluded that: "low-carbon products will be preferred, because international buyers will be subjected to substantial carbon taxes". They mentioned an example of aluminium, which is manufactured in Iceland, and may be preferred in European markets. Based on international life cycle analyses, the carbon footprint of the Iceland aluminium ingots is only 33 percent of the South African ingots, because renewable energy resources are used in Iceland.

As yet, carbon tax has not been implemented in South Africa, as stated in the Eskom MYPD3 report (Eskom, 2012b:44). Eskom indicated that they did not include carbon tax in the price structure, as it was still being deliberated at the time of the report and in the Budget speech of 2017 (Fin24, 2017). The report referred to the environmental levy, implemented by National Treasury, of 2c/kWh on electricity generated from non-renewable sources in July 2009. This was escalated to 2.5c/kWh in July 2011 and to 3.5c/kWh in July 2012 (Eskom, 2012b:59).

The National Treasury, however, published the draft explanatory memorandum for the carbon tax bill on 2 November 2015 as a clear indication of its intention with carbon tax. Carbon tax will play a role in achieving the objectives set out in the National Climate Change Response Policy of 2011 and contribute towards meeting South Africa's commitments to reduce GHG emissions (National Treasury, 2015:2). This is a means to comply with the COP-21, Paris Agreement, where pledges were made to cut emissions, which replaced the COP-3 Kyoto Protocol.

From the above it can be reasoned that South African businesses will need to change their preference for high-carbon products if global consumer pressures for low-carbon products are not to become a future business risk. Large consumers will also be required to consider the possibility of carbon tax as part of their business planning. With an increased demand for electricity generated from renewable energy or green power sources and the additional costs involved, it means that investments by large consumers will be essential to providing the required green electricity technologies. As the main consumers of electricity in South Africa, large consumers will have to invest in renewable energy supply to facilitate sustainable economic growth.

1.10 IMPORTANCE OF DETERMINING THE WILLINGNESS TO PAY OF LARGE CONSUMERS

No research has been done regarding large consumers' WTP a premium for electricity generated by renewable sources in South Africa. To understand whether the large consumers will be willing to pay a premium for green electricity, a detailed study is required on the determinants influencing the large consumers' perspectives regarding the supply of premium green electricity in South Africa. The findings of this study will assist in identifying any differences between the residential consumers' WTP and the large consumers' WTP. Electricity demand forecasting and available green technologies also need to be taken into consideration, because they may have an important influence on consumers' willingness to invest in the move towards green electricity resources.

1.11 THE RELEVANCE OF THE STUDY

Due to coal-fired power stations' pollution footprint on the environment, there is a larger focus on providing cleaner electricity-generating technologies. The need for renewable sources of energy will increase as pressure to preserve the environment increases. In addition, current resources, such as coal, which are being used to generate electricity, will be depleted in the future. Understanding the large consumers' WTP is an important aspect to successfully developing and implementing cleaner technologies.

Innovative policies will have to be created to introduce the green-generating plants because at present their efficiency is restricted and the cost involved for using green-generating plants to supply base-load electricity is high. This study will make it possible for policy-makers to gain a better understanding of the determinants that can help facilitate the development of green electricity. Information obtained from this study can assist Eskom and other governmental organisations in reviewing their capacity expansion strategies. The large consumers use more than 84 percent of the electricity generated; therefore, determining current large consumers' sentiments towards paying a premium price for green power can assist policy-makers in finding ways to address long-term sustainable objectives, whilst taking short-term economic key drivers into consideration.

1.12 RESEARCH OBJECTIVE

1.12.1 Overview

The implementation of green energy technologies is important for environmental preservation. This creates international pressures towards implementing green electricity. Unfortunately, the cost of base-load generation using renewable energy is costly when compared to the cost of coal-generating plants in South Africa. However, using technologies with a large carbon footprint could prove costly to businesses in the future due to carbon taxing and reduced product demand with a large carbon footprint. As a result, premium investment in the development of these types of technologies is essential to achieving the implementation of green electricity.

Previous studies on WTP, like those of Oliver, Volschenk and Smit (2010:1) and Van Heerden et al. (2002:1), have focused on residential users' sentiments towards investing in green electricity technologies and small populations in Johannesburg and Cape Town, as well as a limited number of wine farms. Other related research in the electricity industry indicated that WTP is particularly influenced by attitudes towards environmental issues, the evaluation of green energy by an individual's social reference groups, electricity expense level versus income and the user's perception of the power supplier (Oliver, 2009:43; Gerpott & Mahmudova, 2010a:306).

No studies regarding the WTP for green electricity have been done on large consumers in South Africa. Determining the WTP and determinants of WTP of large consumers are essential because electricity consumption is dominated by these top 500 consumers. The consumers who had the highest electricity usage during the financial year of 1 April 2012 to 31 March 2013 were therefore invited to participate in this study.

To understand if the large consumers would be willing to pay a premium for green electricity, a detailed study was required on the determinants influencing the large consumers' perspectives regarding the supply of premium green electricity in South Africa. This study therefore aimed to investigate the determinants influencing the large consumers' WTP a premium for green electricity.

1.12.2 Specific objectives

Because of the pollution footprint that coal-fired power stations create on the environment, more focus is given to green electricity-generating technologies. The need for renewable sources will increase as the pressure to preserve the environment increases and current resources used to generate electricity (such as coal) diminish. Knowing the large consumers' WTP is an important aspect to successfully develop and implement new technologies and policies.

The objective of this study was to develop an exploratory model to determine influences affecting the large electricity consumers' WTP a premium for green electricity. Lowry and Gaskin (2014:132) indicated that, when research is exploratory in nature, it relates to building or testing a new theory. The development of the exploratory model during this study was aimed at the development of a new theoretical model integrating various theoretical and empirical approaches from different disciplines documented in the literature. No previous studies have been conducted on the large electricity consumers' willingness to pay for green electricity and clearly none which have considered the South African electricity environment. Therefore, the research into a new model had to consider aspects of various study fields, including WTP concepts, value theory technology advancement, the perception of the electricity supplier, previous related models used in electricity demand studies, as well as their applicability under local conditions and their relevance in developing and testing the model proposed in this research study.

This study can make a contribution to Eskom and other policy-makers in the implementation of better strategies, which make green electricity more viable in the short term. This can also contribute to protecting the environment and natural resources for future generations.

The specific objectives of this research are to:

(i) Obtain information from studies and various forms of literature detailing the current green electricity environment regarding:

- the nature of the South African electricity industry;
- current available green electricity-generating technologies;
- environmental considerations and trends influencing which types of energy technologies are used; and
- willingness to pay.

(ii) Collect empirical data to:

- develop an exploratory model;
- test the reliability of the developed measurement instrument;
- statistically determine the nature of variables influencing WTP and relationships between these variables;
- obtain a first-pass assessment of the large electricity consumers' WTP a premium for green electricity by exploring the results from the large consumers' responses; and
- provide recommendations for the implementation of renewable electricity investment programmes.

1.13 DISSERTATION OUTLINE

The remainder of this dissertation is organised in the following sequence:

Chapter 2: This chapter discusses the current green electricity technologies. A better understanding is provided of the options for producing green electricity, the environment in which this electricity generation takes place, and the direct influences on these types of technology. Green technologies are at various stages of development from being demonstration plants to viable operational options. This section discusses literature widely used in the field of technological innovation.

Chapter 3: In this chapter, the related literature on WTP is discussed. This part of the literature review focuses on some of the related drivers that are impacting green electricity generation growth. In this chapter, the future requirements and methods of forecasting that are used in the green electricity generation environment are explored. The topics discussed are: environmental considerations, scenario planning, pollution, resource consumption, initiatives to support green electricity and decoupling.

Chapter 4: The factors that motivate people to pay a premium towards preserving the environment are discussed in this chapter. These theories relate to WTP, the free-rider problem, the consumer surplus concept, the theory of 'value', culture and consumer behaviour, and the technology acceptance model. As no previous studies have been done on large electricity consumers, several previous residential studies which tested a country's WTP are reviewed to improve the understanding of WTP in the electricity industry. This chapter ends by combining the literature analysis and information reviewed in this and the previous chapters to offer four propositions.

Chapter 5: The research design and methodology used during this study are explained in this chapter. As an introduction, the purpose and context of this study as well as reasons why green electricity is perceived to be costly are discussed, leading to the development of the WTP theory model. A review of partial least squares structural equation modelling (PLS-SEM) provides an understanding of the method used to evaluate the theoretical proposed model.

Chapter 6: In this chapter, the exploratory model development is discussed. The response demographics and the response rate are discussed first. An initial analysis and the results of the PLS-SEM model followed by the refinement of the model are presented. This chapter illustrates the link between the model's variables and their theoretical domain, including the empirical results relating to the validation of the theoretical base. The refined exploratory research PLS-SEM model is presented, indicating the results.

Chapter 7: This chapter presents and discusses the results relating to the analysis of the exploratory model to test the model's reliability and validity. The reliability of the outer model as well as the structural or inner model is reviewed to determine the degree to which the whole model is consistent with the observed data.

Chapter 8: In this final chapter, the exploratory results are reviewed to test if the initial objectives of the study have been achieved. This chapter discusses the contribution of the study and then concludes with some recommendations for future research.

Appendices: The PLS-SEM model histograms on the large consumers' WTP results are shown with the reliability results dialog of the theoretical model.

CHAPTER 2

DISCUSSION ON CURRENT GREEN ELECTRICITY TECHNOLOGIES

2.1 BACKGROUND

Before WTP for green electricity can be determined, an understanding of factors relating to green electricity production and the different types of technologies available need to be understood.

The GHG emissions of electric power sectors around the world make up about one third of the total emissions worldwide. International organisations and governments therefore place significant emphasis on the environmental impact of electrical power sectors. Renewable energy is an important alternative energy production option which can make a significant difference to reducing GHG emissions in local energy markets (Sheen, Tsai & Wu, 2013:305).

The United States Environmental Protection Agency (USEPA, 2016) defined ‘conventional power’, ‘renewable energy’ and ‘green power’ as follows:

Conventional power includes the combustion of fossil fuels (coal, natural gas, and oil) and the nuclear fission of uranium. Mining, drilling and extraction of fossil fuels have an environmental impact. The combustion of fossil fuels also results in the emission of GHG and air pollution. Although there is no GHG emission during nuclear power generation, there are environmental impacts like mining, extraction and long-term radioactive waste storage.

Renewable energy refers to power that is generated using energy sources that do not diminish and restore themselves over short periods of time. Energy is harnessed from the sun, wind, moving water, organic plant material and waste material (eligible biomass) and the earth's heat (geothermal). Renewable energy technologies can influence the environment even though the impact is small, for example large hydro-electric resources can affect fisheries and the use of land.

Green power is a subset of renewable energy and represents renewable energy sources and technologies that have the least impact on the environment. The United States Environmental Protection Agency (USEPA, 2016) defined ‘green power’ as electricity, which is produced using solar, wind, geothermal, biogas, eligible biomass, and low-impact small hydro-electric sources. Consumers often purchase green power because it has a zero emissions profile and reduces the carbon footprint.

Each green electricity production technology has its own physical attributes and some of these features are perceived as having negative influences on the environment. People may therefore form preferences towards specific green electricity-generating technologies and be resistant towards others. The advantages and disadvantages relating to different types of green electricity-generating technologies therefore deserve consideration.

2.2 GREEN ELECTRICITY-GENERATING TECHNOLOGIES

Various green electricity-generating technologies are currently available. As described by Balachandra, Nathan and Reddy (2010:1 845), these technologies are in various stages of development and are continuously improving. The overall environmental impact associated with electricity generation will be significantly reduced as more green power sources are developed to displace conventional generation. Some of these green electricity technologies used in South Africa are discussed in more detail in the following sections.

2.2.1 Biomass

In this type of technology, materials such as wood, wood waste, straw, manure, sugar cane, and other by-products from a variety of agricultural processes are used. At present, when including the traditional use of biomass energy, it is the largest global contributor to energy. Furthermore, use of biomass energy sources for electricity generation has grown significantly (Ellabban, Abu-Rub & Blaabjerg, 2014:748, Sriram & Shahidehpour, 2005:1).

According to Bauen, Berndes, Junginger, Londo and Vuille (2009:6) as well as Da Silva, De Marchi and Seifert (2016:339), biomass can make a substantial contribution to supplying future sustainable energy demand because it has significant potential to be used increasingly to produce heat, electricity and fuel for transport. Bauen et al. (2009:6) further stated that if the deployment of bioenergy is carefully managed, it could:

- Make a larger contribution towards global primary energy supply;
- Significantly reduce GHG emissions and have other environmental benefits;
- Improve economically-viable energy security because imported fossil fuels will be substituted by domestic biomass;
- Provide opportunities for economic and social development in rural communities; and
- Offer a system for expending waste, reducing waste disposal problems and making better use of resources.

As an energy source, biomass can either be used to produce heat via combustion, or converted into various forms of biofuel. Converting biomass into biofuel can be achieved using thermal, chemical, and biochemical methods. The municipal solid waste system (anaerobic bioreactor), which harvests the gases generated by the decomposing waste and then uses it to generate electricity, is a good example of this kind of technology (USEPA, 2010).

Eberhard, Kolker, and Leighland (2014:14) summarised the tender outcomes of the South African Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) related to biomass and biogas as 12.5 MW each for the first two tender opportunities and 60 MW and 12 MW respectively for the third tender opportunity. From these tenders, one tender was awarded for a 17 MW biomass plant. An additional 25 MW was awarded as part of the fourth tender process.

Cloete (2017) pointed out that Africa's first large-scale waste-to-energy plant in Africa is in Athlone, Cape Town.

2.2.2 Wind generation

Wind energy has been utilised for thousands of years. The oldest applications of wind energy were used for agricultural purposes. Nowadays, its primary purpose is to generate electricity (Jain, 2016:1).

Systematic electricity generation from the wind has been performed for more than 20 years and is one of the more advanced green electricity-generating technologies. Advances in wind energy technology and the absence of carbon emissions have resulted in the increased use of wind power to generate electricity. According to Sheen et al. (2013:305), wind energy is expected to play an important role in the future global energy supply. Wind turbines are small plants that can provide incremental capacity to power systems if they are properly located. These advantages include reduction in the loss of transmission lines, reinforcement of the transmission grid, provision of extra electricity during peak times and increased voltage stability in the system. In comparison to fossil-fuel plants, wind power has low carbon dioxide emissions, which could be beneficial if charges are implemented for carbon emissions in the electricity market (Sheen et al., 2013:305).

The availability of wind energy unfortunately depends heavily on weather conditions (Emeis, 2014:803). In comparison to fossil-fuel plants, wind power has a high capital cost (Sheen et al., 2013:305). According to Mann and Teilmann (2013:1), wind energy also has negative impacts because wind turbines generate noise, can have an impact on human health, alter the atmosphere by changing wind speed, causing turbulent fluxes of heat and reduce necessary emissions of carbon dioxide and other gases. Wind power projects also have a strong influence on aesthetic perception (Warren, Lumsden, O'Dowd & Birnie, 2005:853).

According to the Department of Energy (2015b:5) report, 3 357 MW of wind power had successfully been procured as part of the REIPPPP by June 2015. The South African portfolio of 34 wind IPPs includes some of the largest wind power plants in the world with the average project size being 98.74 MW and a collective annual energy output capacity of 11 796 GWh. The price for wind power plants in the second bid window reduced on average by 20 percent (DOE, 2015b:5, Eberhard & Naude, 2017:28).

2.2.3 Solar generation

The Noble Prize winner in chemistry, Semenov, was the first person to indicate the importance of solar power conversion in the early 1970s. Sunlight is converted into electricity using thermodynamic (thermal), photovoltaic and chemical methods (Parashchuk & Kokorin, 2009:2 543). Ilson, Crystal, Wells and Long (1984b:1 586) described solar energy as power or energy that is obtained from direct conversion using the heating effect or the photo-electric cells of the sun. Many countries feel that rapid development of methods for harnessing the sun's energy should take priority because sunlight can potentially provide a large amount of energy. According to Weinstein, Loomis, Bhatia, Bierman, Wang, and Chen (2015:12 797), the amount of sunlight which reaches earth in an hour exceeds the energy consumed by all of humanity in a year.

Parashchuk and Kokorin (2009:2 543) concluded that the use of photovoltaic cells offers several undeniable advantages including:

- The direct conversion of the energy of light quanta into electricity;
- A diversified elemental base for the development of solar or photovoltaic cells;
- Developed technologies and the possibility of creating modular systems which can provide varied power output; and
- The possibility of using concentrated solar power.

A promising technology for solar energy conversion is solar-thermal conversion which is commonly referred to as concentrated solar power (CSP). The first utility-scale CSP plants were constructed in the 1980s. This technology saw little development in the two decades that followed, but recently significant progress has been made, especially in heat storage technology.

According to Fernández, Ushak, Galleguillos, and Pérez (2014:132), one of the most important lines of research which can improve the viability of CSP plants, involves the design and characterisation of energy storage fluids. Commercial plants that utilise these energy storage fluids can store up to 15 hours of energy. In South Africa, KaXu Solar One is a CSP plant in the Northern Cape which uses molten salts as an energy storage fluid. It has a total capacity of 100 MW plus 2.5 hours of energy storage.

Weinstein et al. (2015:12 797) summarised the process of a conventional CSP system according to the following items:

- Concentration: sunlight reflects from large concentrators and is redirected to a much smaller receiver. A large arrangement of mirrors is used to concentrate solar radiation and its heat is used to generate high temperatures at a receiver.
- Absorption: sunlight on the receiver is converted to heat by an absorber.
- Transfer: heat is carried away from the absorber by heat transfer fluid (HTF).
- Storage: heat can be stored in a thermal energy storage system for later use. Heat storage solutions make it possible for systems to provide steam continuously, even after sunset.
- Generation: the HTF delivers heat to generate high-temperature steam from water. This steam can then power a turbine, which generates electricity.

Tests have been done for some time in various areas and PV and CSP plants have been constructed at selected sites in South Africa. The International Energy Agency (2014:1) estimated that 11 percent of the world’s electricity will be generated using solar technologies by 2050. They further stated that CSP plants will gain popularity because of their built-in storage capabilities which make it possible to supply electricity when needed and when demand peaks after sunset. This is especially valuable for municipal requirements due to peak demand in the early evenings.

In theory, the efficiency of photovoltaic cells is limited to 85 percent due to thermodynamic losses. Current systems may well reach an efficiency range of 45 to 55 percent efficiency (Parashchuk & Kokorin, 2009:2 543).

According to Eberhard and Naude (2017:28), a total of 2 292 MW of solar photovoltaic power had successfully been procured as part of the REIPPPP by the fourth bid process. The solar photovoltaic price in the second bid window was much more competitive, falling on average by 40 percent for solar photovoltaic power plants (DOE, 2015b:3).

2.2.4 Hydro and pumped storage

The machines in pumped storage stations are a reversible pump and turbines. In other words, they function as conventional hydro turbines when generating and can reverse direction to pump the water back again during periods when there is sufficient electricity available. Pumped storage schemes are nett consumers of electricity. The flexibility and speedy reaction of these machines allow them to service the network in many ways, and they operate whenever there is a shortage of electricity. When not generating to meet the morning and evening peaks on the system, they are used to regulate the national system voltage. Eskom, and thus South Africa, has three pumped storage schemes. Two of these schemes, Palmiet and Drakensberg pumped storage systems, operate in conjunction with the Department of Water Affairs and Forestry as part of water transfer schemes.

The advantages of pumped storage stations include that no emissions are produced as water is used as the source of energy and pumped storage schemes allow energy to be stored in the form of the water in their upper and lower dams. The disadvantages of pumped storage stations are that in South Africa, as a dry country, there are limited suitable sites for pumped storage schemes, using a water source, and the construction of dams always has an impact on the environment (Eskom, 2017b).

In a hydro-electric scheme, water is stored in a dam and passed through a turbine before being released back into the river downstream. It is important to note that water is not returned to the dam as in pumped storage schemes. Micro-hydropower is highly site-specific due to the recruitment of a constant supply of water with specific height deference. The advantages of hydro-electric stations include the following (Eskom, 2017):

- Power is continuous and available on demand;
- The process is environmentally friendly;
- Maintenance is limited which means low running costs; and
- The technology is long lasting and robust.

Two small hydro plants totalling 14 MW had successfully been procured as part of the second tender process. Another 5 MW was added during the fourth tender process (DOE, 2015a:29). Eberhard et al. (2014:16) indicated that during the third tender process of the REIPPPP, the maximum size of individual, small hydro plants was increased from 10 MW to 40 MW. Additional to this, Eskom added four units at Ingula, their pumped storage power plant, with a total capacity of 1 332 MW.

2.2.5 Ocean energy

Oceans have the potential to provide a large amount of energy, which can be harvested using several current technologies as well as future ones which are still being developed. At this stage, six characteristic features of the ocean are being used to create energy, namely: (1) ocean wave; (2) tidal range; (3) tidal current; (4) ocean current; (5) ocean thermal energy; and (6) salinity gradient (energy available from the difference in the salt concentration between seawater and river water) (Uihlein & Magagna, 2016:1 071).

Ocean current turbines use sea currents as an energy source. The technology is similar to those used in wind generation, but sea currents rather than wind is the energy source. Ocean currents are generated by the gravitational pull of the sun, moon and planets. Temperature differences and local seabed conditions also affect currents. Most of the conditions relating to South African ocean currents make it impossible to use present ocean turbine technologies. The Agulhas Current in the area of Cape Morgan is the only ocean current which can potentially be used in this type of technology (Meyer, Reinecke, Roberts & Van Niekerk, 2013:54). However, ocean current turbines negatively affect marine ecosystems.

Ocean wave electricity is generated by the movement of waves. According to Joubert (2013:1-8), oscillating water column wave technology:

> *… essentially comprises a collector, which captures and transfers incident waves into air power; and a Power Take-Off system, which converts the pneumatic power to electricity. Inside the collector, wave action causes the air pressure to increase and decrease as the water level rises and falls.*

Joubert (2013:1-8) said an extensive evaluation of the wave conditions off the South African coast was conducted in 1989, which indicated significant potential for generating ocean wave electricity. Parameters which are typically required for output include significant wave height, mean wave period, peak wave period, and mean wave direction.

Delmonte, Barater, Giuliani, Cova and Buticchi (2016:1 701) stated that the world’s first commercial-scale wave energy plant to be connected to an electricity grid was an oscillating water column, the Land Installed Marine Power Energy Transmitter or LIMPET, which was commissioned off the Scottish west coast in November 2001. However, according to Delmonte et al. (2016:1708), further research is required because this technology has not proven to be cost effective.

Katsaprakakis, Christakis, Stefanakis, Spanos and Stefanakis (2013:619) referred to another emerging ocean energy harvesting technology, namely an ocean pump storage system. Here water is pumped through wind or wave energy, to a storage dam at a high altitude. The water is then released back into the ocean, which drives the water turbines. The ocean therefore functions as the bottom reservoir. According to Katsaprakakis et al. (2013:620), there was only one seawater pumped storage system worldwide at the time. It operated in Okinawa, Japan and was used for power peak saving. The Okinawa seawater pumped storage system is an important source of information for investigating the construction and operation of similar stations in the future because it has already been operating for longer than ten years. Difficulties relating to this technology include associated technical concerns, for example, the proximity to the coastline and corrosion. The upper reservoir should also be located in an area with adequate land which is at least 300 m above sea level. There should be a mild slope from the upper reservoir position to the coastline. A ratio of the penstock length over the absolute altitude difference between the penstock's ends (height) must not exceed the value of five. The site should also be accessible by land and sea. There are few sites which meet all these requirements, which means that the extent to which this type of technology can be used is restricted. There may also be external factors which need to be considered, like negative reactions from the local community, influence on tourism, aesthetic concerns and environmental impact (Katsaprakakis et al., 2013:620).

2.2.6 Hybrid plants

Hybrid plants refer to combinations of electricity-generating technologies which are used to improve the efficiency of a principal generation plant. Technologies are selected based on the resources which are available and the electricity demand profile. Wang and Chen (2016:12 261) referred to a number of previous studies where the component sizes and system costs of hybrid power models were adjusted and optimised. Combinations used for the hybrid electricity-generating plants included a hybrid wind/PV/fuel cell generation system, a PV/hydrogen system and a hybrid solar/wind system.

Starke, Cardemil, Escobar, and Colle (2016:89) concluded that using a hybrid plant in which concentrated solar power is combined with PV cells makes it possible to achieve capacity factors above 70 percent and results in lower energy costs. In their study, Starke et al. (2016:96) concluded that a solar hybrid concentrated solar power and PV plant can generate power with a profile close to that of a base-load plant. This reduces the variability of solar power generation and makes it possible to provide electricity to users like mines and factories which have a constant electricity demand. Hybrid technology is therefore better suited to the electricity demand requirements of large consumers. Unfortunately, higher cost is involved, because more than one technology needs to be constructed (Wang & Chen, 2016:12 261).

Hybrid power systems have drawn attention in recent years due to increasing energy demands and decreasing fossil fuel resources; however, the development of hybrid power systems for different load requirements can be very costly and time-consuming. Hybrid power systems can combine various electricity-generating technologies, for instance hybrid wind, PV, CSP, hydro/pumped storage, gas, and fossil fuel. These generation systems are optimised according to the energy sources available (Wang & Chen, 2016:12 261).

2.3 GREEN TECHNOLOGY ADVANCEMENT

2.3.1 Overview

Current research reports on the efficiency of existing environmentally-friendly systems and the development of new green technologies indicate that these technologies are at various stages of development, from being demonstration plants to viable operational options. The possibility that Eskom will have an increasing percentage of its base-load capacity generated by renewable energy in the future is therefore high.

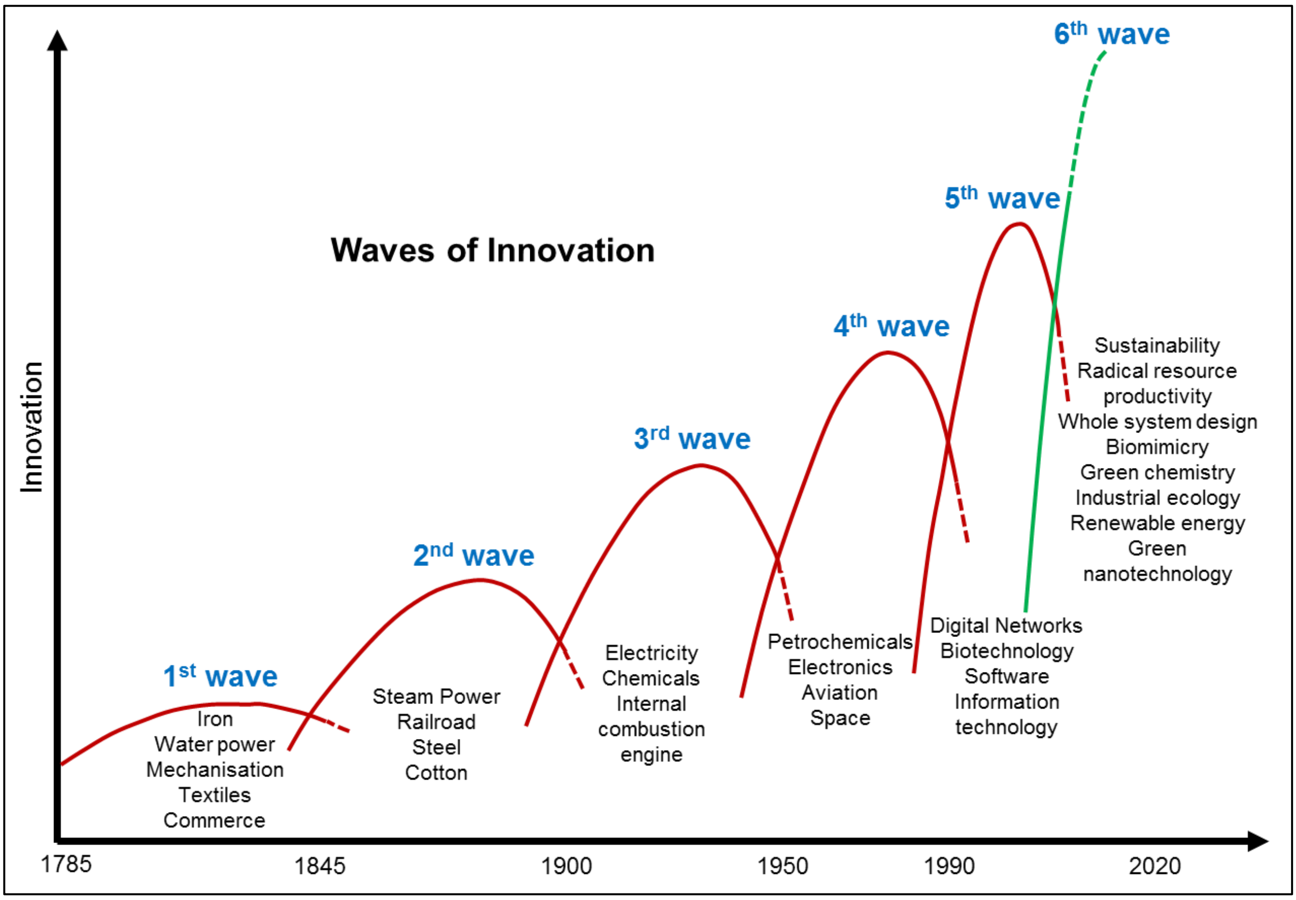


Figure 2.1: Waves of innovation

Source: Von Wyzsacker et al., 2009:13.

Von Wyzsacker et al. (2009:11) indicated that the earliest well-known scholar to describe long-term economic cycles was Kondratiev (1892-1938), whose theories were widely used in the field of technological innovation. The dynamics leading to a Kondratiev wave come from a combination of three major elements, namely: (1) fading enthusiasm about technologies which are older; (2) rising demands for novel goods and services; and (3) the desire for new technologies (Von Wyzsacker et al., 2009:14). For the sixth wave of the Kondratiev cycle to take place, all these elements need to be present. In the field of innovation, all these elements are currently present, which makes it possible to create sustainable and renewable energy (Figure 2.1).

Garcia and Calantone (2001:122) explained that the performance of technology starts slowly due to limited knowledge. Research and repeated attempts result in an increased rate of progress until the technology reaches its limit as an established product. In Figure 2.2, technological advancement phases are illustrated as the rate of adoption that begins slowly, speeds up, and eventually, slows down (Balachandra et al., 2010:1 843).

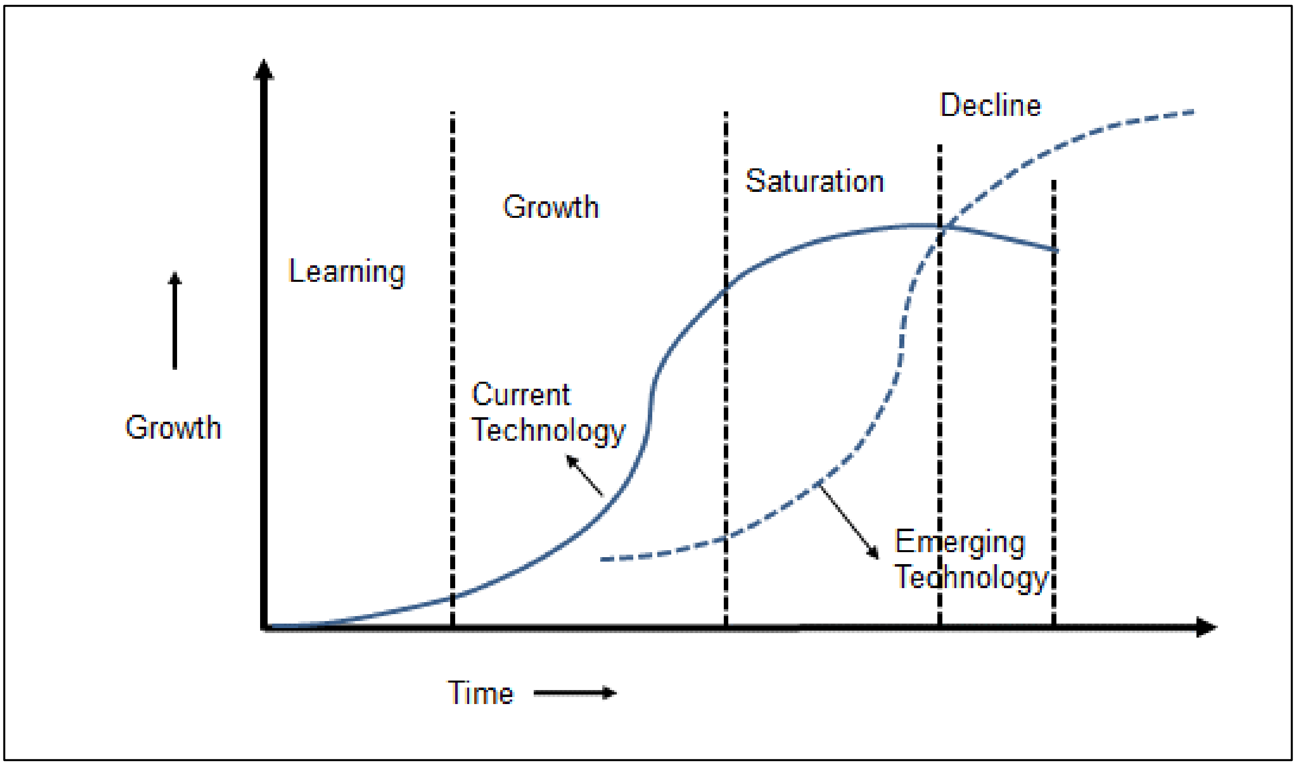


Figure 2.2: S-curve of technology diffusion

Source: Balachandra et al., 2010:1 845.

Green power technology, namely electricity produced from solar, wind, geothermal, biogas, eligible biomass, and low-impact small hydro-electric sources, are in different stages of development. Using the S-curve of technology diffusion from Balachandra et al. (2010:1 845), Table 2.1 on the next page provides an indication of the status of current technologies versus new technologies.

Table 2.1: Stage of development per green technology

Green technology	Stage of development	Technology
Biomass	Early growth	Old technology with new application
Municipal solid waste	Early growth	Old technology with new application
Wind generation	Growth – good progress	Reaching limit
Solar generation – PV	Growth – good progress	Reaching limit
Solar generation – CSP	Early growth	High rate of progress
Ocean current	Learning	Starting – little knowledge
Ocean wave	Learning	Starting – little knowledge
Ocean pump storage	Learning	Starting – little knowledge
Underground coal gasification	Learning	Starting – little knowledge
Hybrid plants	Early growth	Starting – little knowledge

Source: Adapted using the S-curve of Balachandra et al., 2010:1 845; Garcia & Calantone, 2001:122.

Prospective plans for increasing the use of green technologies to generate electricity in South Africa are illustrated in the Integrated Resource Plan by the Department of Energy 2016 for electricity-generating technologies until 2050 (IRP 2016-50). The forecasted technology usage for 2050 is coal (31.6%), nuclear (30.01%), gas (6.96%), PV cells (6.55%) and wind (18.09%) (DOE, 2016a:19).

The main weakness in the current supply of green electricity is that the reliability and availability of energy to provide base-load electricity is not sufficient. This is because electricity supply is reduced when there is no wind or sunshine to generate electricity. An alternative generating supply option is therefore required which can supply the deficit when demand remains the same (Von Wyzsacker et al., 2009:44; Schilling & Esmundo, 2009:6). Coal-fired power stations are still capable of meeting the hourly demand (base-load supply) of electricity at a much cheaper cost than renewable energy technologies. At present, solar plant electricity still costs significantly more than electricity generated by coal. This situation is, however, changing as technology improves and costs of renewable energy will most likely continue to drop in the future, as indicated in Table 2.2, Table 2.3 and Figure 2.3. These tables and figure indicate how prices relating to green electricity technologies have decreased.

Table 2.2: Historical cost of renewables and fossil fuels

Year	Renewables								Fossil fuels			
	Geothermal		Concentrated solar		Photovoltaics		Wind		Coal	Natural gas	Petroleum	Fossil fuel composite
	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower				
1980	13.8	11.3	84.0	69.5	125.0	106.3	51.3	43.0				
1981	13.1	10.6	74.0	57.0	119.0	100.0	47.5	40.0				
1982	12.5	10.0	66.0	46.8	112.5	93.0	43.3	36.3				
1983	11.9	9.4	56.0	38.3	105.0	84.5	38.8	32.5				
1984	11.3	8.8	46.8	27.5	99.0	78.0	36.0	29.0				
1985	10.6	8.1	36.0	24.0	93.0	72.0	31.3	25.3				
1986	10.0	7.5	30.3	21.3	87.5	68.8	28.8	22.5				
1987	9.7	7.2	27.0	19.0	82.0	63.0	25.3	18.8				
1988	9.4	6.9	25.0	17.0	77.0	59.5	22.5	16.8				
1989	8.8	6.3	23.5	16.0	72.0	55.5	20.0	14.8				
1990	8.4	6.3	22.0	15.0	68.8	52.0	17.6	12.5	1.6	2.1	2.6	1.7
1991	8.1	5.9	21.5	14.0	66.0	49.0	15.0	11.3	1.5	1.9	2.1	1.6
1992	7.5	5.6	21.3	14.0	62.5	45.0	13.8	10.0	1.5	1.9	2.0	1.5
1993	6.6	5.3	21.0	13.8	59.0	43.3	12.0	8.8	1.4	2.0	1.9	1.5
1994	6.4	5.1	20.8	13.5	56.3	40.5	11.3	7.6	1.3	1.7	1.8	1.4
1995	6.3	4.9	20.0	13.3	53.0	37.5	9.8	6.9	1.3	1.6	1.8	1.3
1996	6.2	4.8	19.3	13.0	51.0	34.0	8.8	6.3	1.2	1.8	1.9	1.3
1997	5.9	4.4	18.5	12.9	48.0	31.3	8.4	5.9	1.1	1.8	1.7	1.2
1998	5.6	4.0	18.0	12.8	46.0	29.0	7.8	5.3	1.1	1.5	1.4	1.2
1999	5.3	3.8	17.5	12.8	43.8	27.0	7.5	5.0	1.1	1.6	1.5	1.1
2000	5.1	3.8	17.3	12.8	42.5	26.0	7.3	4.9	1.0	2.3	2.2	1.3
2001	5.0	3.7	17.1	12.8	40.5	24.0	6.7	4.7	1.1	2.3	2.0	1.2
2002	4.9	3.6	17.0	12.7	38.0	23.0	6.4	4.6	1.1	1.9	1.8	1.1
2003	4.9	3.4	16.7	12.7	36.0	21.0	6.3	4.5	1.0	2.6	2.2	1.4
2004	4.4	3.2	16.0	12.0	33.0	20.0	6.0	4.4	1.1	2.8	2.2	1.5
2005	4.3	3.1	15.0	11.0	31.0	18.8	5.5	4.3	1.2	3.5	2.9	1.8

* Cost of energy from alternative energy sources, expressed in cents (USD) per kWh

Source: Schilling and Esmundo, 2009:6.

The costs relating to green electricity generation have come down significantly over the last ten years. The International Energy Agency learning curve (Figure 2.3) indicates that innovation, economies of scale and experience have lowered green electricity-generating cost over time.

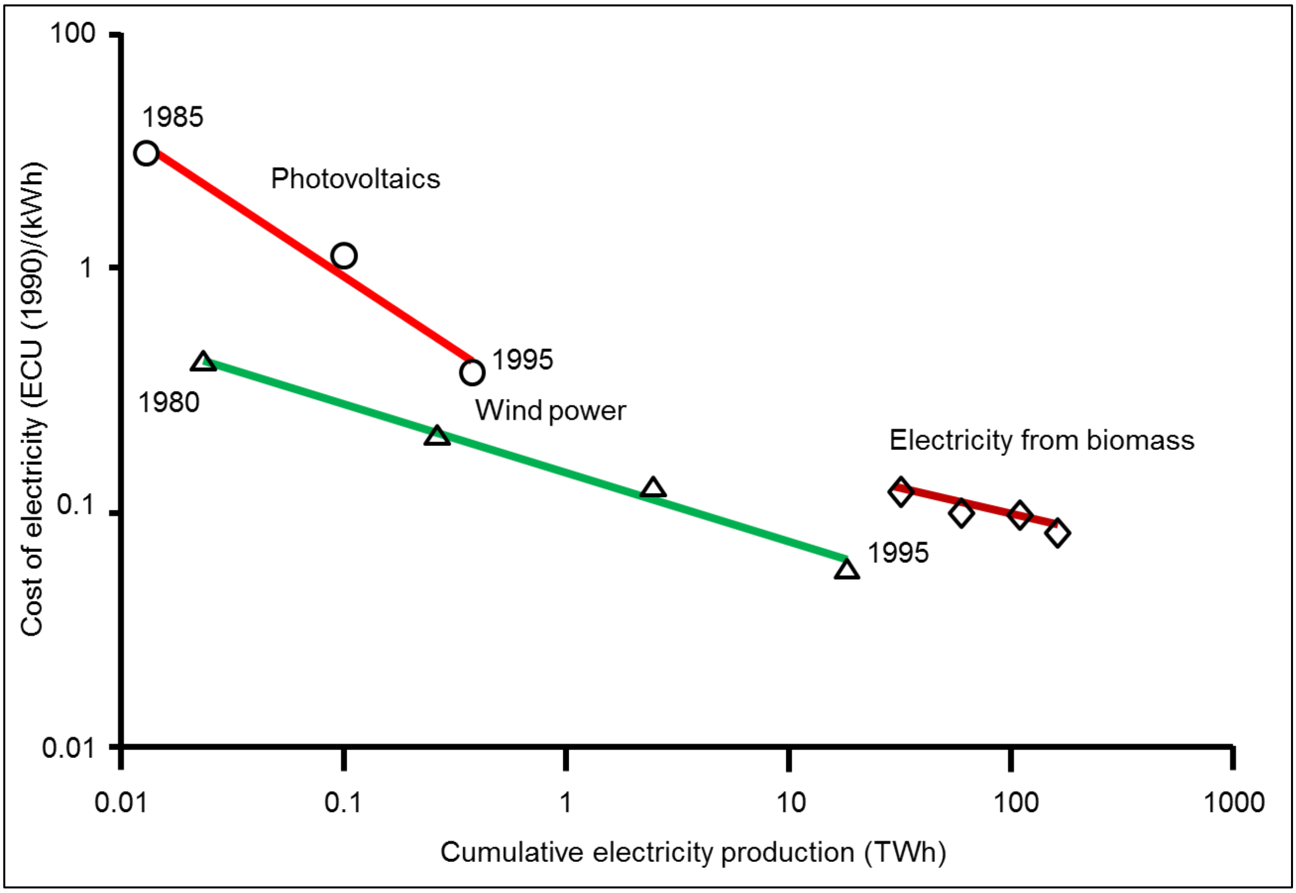


Figure 2.3: International Energy Agency learning curve

Source: Von Wyzsacker et al., 2009:39.

The effect of this learning curve can be seen in the more recent cost per technology indicated in Table 2.3. The cost for coal and nuclear remained relatively constant while the cost for green electricity continues to reduce.

Table 2.3: A summary of costs and technology characteristics

Technology	Range	CAPEX	Fixed OPEX	Variable OPEX	Fuel Costs	Availability *	Turndown limit	Ramp rate (%/ min)*	Maximum life span (years)**
		R/kW	R/kW/a	R/MWh	R/GJ				
PV fixed tilt	Upper	13 115	484	0	0	90%	N/A		25
	Lower	11 210	208	0	0				
CSP – 6h thermal energy storage	Upper	37 610	573	29	0	90%	0	6%	30
	Lower	36 726	573	0	0				
CSP – 9h thermal energy storage	Upper	43 259	573	29	0	90%	0	6%	30
	Lower	42 242	573	0	0				
Wind	Upper	19 463	400	0	0	90%	N/A		20
	Lower	14 502	310	0	0				
Open-cycle gas turbines	Upper	5 738	78	0.2	500	90%	0	22.2%	30
	Lower	5 615	78	0.2	92				
Combined cycle gas turbines	Upper	8 708	163	0.7	92	90%	0	5%	30
	Lower	8 524	163	0.7	70				
Nuclear	Upper	87 754	1 017	29.5	10	90%	0.8	5%	60
	Lower	60 000	532	29.5	6.8				
Coal (Pulverised fuel with flue gas desulfurisation)	Upper	34 938	552	79.8	22-35	80 – 85%	0.4	2%	60
	Lower	34 894	368	51.2	17.5				
Pumped storage	Upper	56 846	333	0	0	90%	0	50%	60
	Lower	23 973	247	0	0				
Imported hydro	Upper	28 341	344	13.9	0	66.7%	0	2%	60
	Lower	12 044	80.2	0	0				
Domestic hydro	Upper	28 341	344	13.9	0	96.6%	0	2%	60
	Lower	12 044	80.2	0	0				

* Availability does not consider the resource variability

Source: Gauché, 2015:39.

By utilising the CAPEX cost, as used by the Department of Energy, the South African technology learning rate between 2015 and 2030 is illustrated in Table 2.4 and Figure 2.4 on the next page. These numbers suggest that technology learning rates initially had stable growth and then stagnated. Further significant changes are unlikely to take place in the long-term future. Through the development of these technologies, paying a premium for green electricity in the future may not be required as green electricity will become a viable and affordable option.

Table 2.4: Technology learning rate 2015 to 2030

Technology	2015 (ZAR/kW) *	2030 (ZAR/kW) *
Photovoltaic cells (fixed tilt)	16 860.6	13 425.03
Photovoltaic cells (tracking)	17 860.6	14 221.27
Wind	19 208.1	17 287.41
Nuclear	55 260.0	53 768.00

* The base date is in 2015 ZAR value for 2015 and 2030.

Source: Department of Energy, 2016a:15.

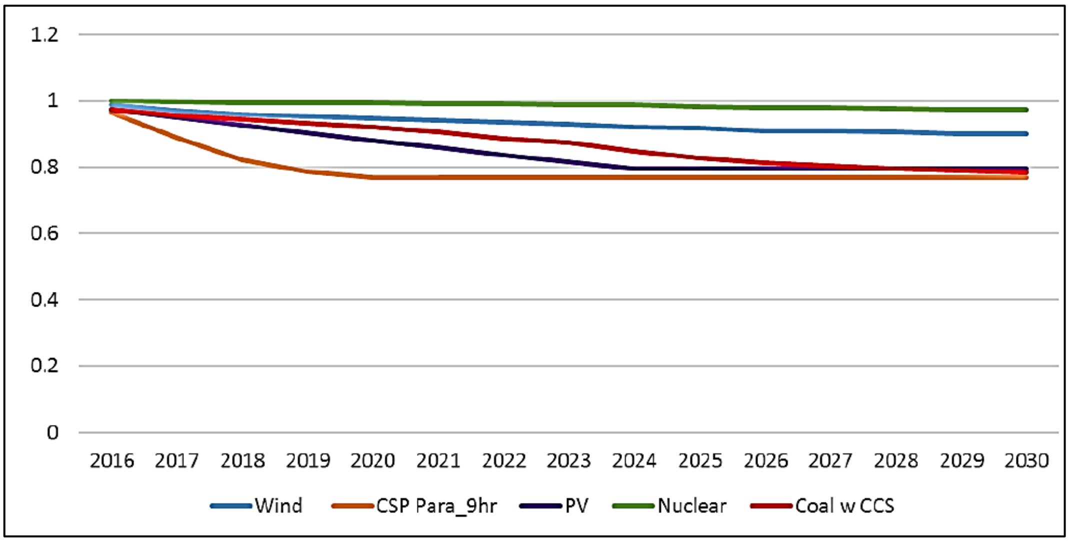


Figure 2.4: Technology learning rate 2015 to 2030

Source: Department of Energy, 2016a:15.

A variety of mathematical models have been proposed to characterise and quantify the dependency of electricity supply technology costs on various drivers of technological change. The most prevalent model form, called a learning curve, is a log-linear equation relating the unit cost of a technology to its cumulative installed capacity or electricity generated. Most reported learning rates for wind systems employ one-factor learning curves for unit capital cost ($/kW) based on cumulative installed capacity. Some of the studies use the term “price” or “investment cost”, rather than capital cost, meaning the amount paid by an owner or operator of the technology, which is the data most commonly available. A smaller number of studies report learning rates for generation cost ($/kWh) as a function of cumulative electricity generated. Most of the learning curve studies reviewed focus on the PV module cost, again using a one-factor model to relate the cost per peak watt of output to cumulative installed capacity (Rubin, Azevedo, Jaramillo & Yeh, 2015:205-206).

Previous studies utilising a two-factor learning model for offshore wind farms, using data from OECD countries from 1994 to 2001, found a learning-by-doing rate of 1%, and a learning-by-researching rate of 4.9% compared to other studies suggesting learning rate of 23% for the erection cost of offshore wind turbines. Two studies of PV systems develop a two-factor learning curve. Here, Miketa and Schrattenholzer (2004) find a learning-by-doing rate of 17% and a learning-by-researching rate of 10%. For all technologies studied, a substantial variability was found in reported learning rates across different studies (Rubin et al., 2015:198-206).

2.3.2 Premium green electricity

Levelised cost of electricity is a means of comparing electricity-generation technologies by considering the cost of the electricity that comes out over its lifetime. Simply put, it is the lifetime sum of all the costs (construction, planning, maintenance, land purchase, waste disposal, pollution charges, and mining) divided by the amount of electricity produced during its lifetime. For example, if R2 000 is spent installing and maintaining solar panels, and they generate 4 000 kilowatt-hours (kWh) over their lifetime (20 years), the levelised cost of electricity is ZAR0,50/kWh.

On 5 August 2016, Eskom Corporate Affairs published the levelised cost per kWh for Medupi and Kusile (including Flue Gas Desulphurisation) coal-fired power stations as ZAR0,71/kWh (after tax) and ZAR0,82/kWh (after tax) respectively (Yelland, 2016).

According to the Government Technical Advisory Centre (2016: 4), the IPP coal price is estimated to be ZAR0,90/kWh using fluidised-bed technology.

As published by the Department of Energy (2015a:15), the price for Bid window 1 in the renewable IPP programme was ZAR1.143/kWh (Base date of April 2011) for onshore wind and ZAR2.758/kWh (base date of April 2011) for solar PV electricity generation plants. The summaries of the various windows are displayed in Table 2.5, Table 2.6 and Table 2.7.

The drop in prices from Bid window 1 (of the REIPPPP) in 2011 and Bid window 4 in 2015 has been quite dramatic. The price for Bid window 4 in the renewable IPP programme was ZAR0.519/kWh (base date of April 2011) for onshore wind and ZAR0.659/kWh (base date of April 2011) for solar PV electricity generation plants as published by Department of Energy (2015:15).

According to the DOE (2015:15), the average cost of energy purchased from all IPPs was ZAR1 570/MWh, while the average cost of renewable IPPs was ZAR2 172/MWh. Although this is cheaper than the cost of generating from open-cycle gas turbines (at about ZAR2 573/MWh), it is still significantly more than the cost of Eskom’s base-load power stations (at about ZAR300/MWh). The request for proposals for bid window 5 was planned for the second quarter in 2016.

Table 2.5: Preferred bidders' salient terms for solar photovoltaic (PV)

	Bid window 4	Bid window 3	Bid window 2	Bid window 1
Price: Fully indexed (Avg. ZAR per MWh) (Base April'11)	ZAR659	ZAR881	ZAR1 645	ZAR2 758
Price: Fully indexed (Avg. ZAR per MWh) (Base April'13)	ZAR740	ZAR990	ZAR1 848	ZAR3 098
Price: Fully indexed (Avg. ZAR per MWh) (Base April'14)	ZAR786	ZAR1 050	ZAR1 961	ZAR3 288
MW allocation	415 MW	435 MW	417 MW	632 MW
Total Project Cost (ZAR millions)	**ZAR8 504**	**ZAR8 145**	**ZAR12 048**	**ZAR23 115**

Source: Department of Energy, 2015a:13.

Table 2.6: Preferred bidders' salient terms for onshore wind

	Bid window 4	Bid window 3	Bid window 2	Bid window 1
Price: Fully indexed (Avg. ZAR per MWh) (Base April'11)	ZAR519	ZAR656	ZAR897	ZAR1 143
Price: Fully indexed (Avg. ZAR per MWh) (Base April'13)	ZAR583	ZAR737	ZAR1 008	ZAR1 284
Price: Fully indexed (Avg. ZAR per MWh) (Base April'14)	ZAR619	ZAR782	ZAR1 069	ZAR1 363
MW allocation	676 MW	787 MW	563 MW	634 MW
Total Project Cost (ZAR millions)	**ZAR13 466**	**ZAR16 969**	**ZAR10 897**	**ZAR13 312**

Source: Department of Energy, 2015a:15.

Table 2.7: Preferred bidders' salient terms for concentrated solar power

	Bid window 3	Bid window 2	Bid window 1
Price: Fully indexed (Avg. **ZAR** per MWh) (Base April'11)	ZAR1 460	ZAR2 512	ZAR2 686
Price: Fully indexed (Avg. **ZAR** per MWh) (Base April'13)	ZAR1 640	ZAR2 822	ZAR3 017
MW allocation	200 MW	50 MW	150 MW
Total Project Cost (ZAR millions)	**ZAR17 949**	**ZAR4 483**	**ZAR11 365**

Source: Department of Energy, 2013:30.

Note that in Table 2.7 there were no CSP awards in Bid window 4. For CSP Bid window 3 cost, the weighted average tariff between base and peak tariff (2.7 times base tariff) was used, as well as assuming a 50 percent annual load factor and full utilisation of the five peak-tariff hours every day.

The current shortfall off these renewable technologies are that the PV and wind capacity factors are 38 percent and 25 percent compared to that of coal being 85 percent. The long-term agreement of the IPPs includes guaranteed take-off conditions to ensure sustainability of their businesses. That load is not linked to the demand requirement and therefore requires a backup generation option, for example a coal-fired or gas-fired power plant. A typical load profile is shown in Figure 1.12 starting on a Saturday. Figure 2.5 indicates the load profiles of 23 solar and wind power plants with a total generation capacity of just over 1 000 MW. These power stations were part of the REIPPPP Bid window 1 and 2.

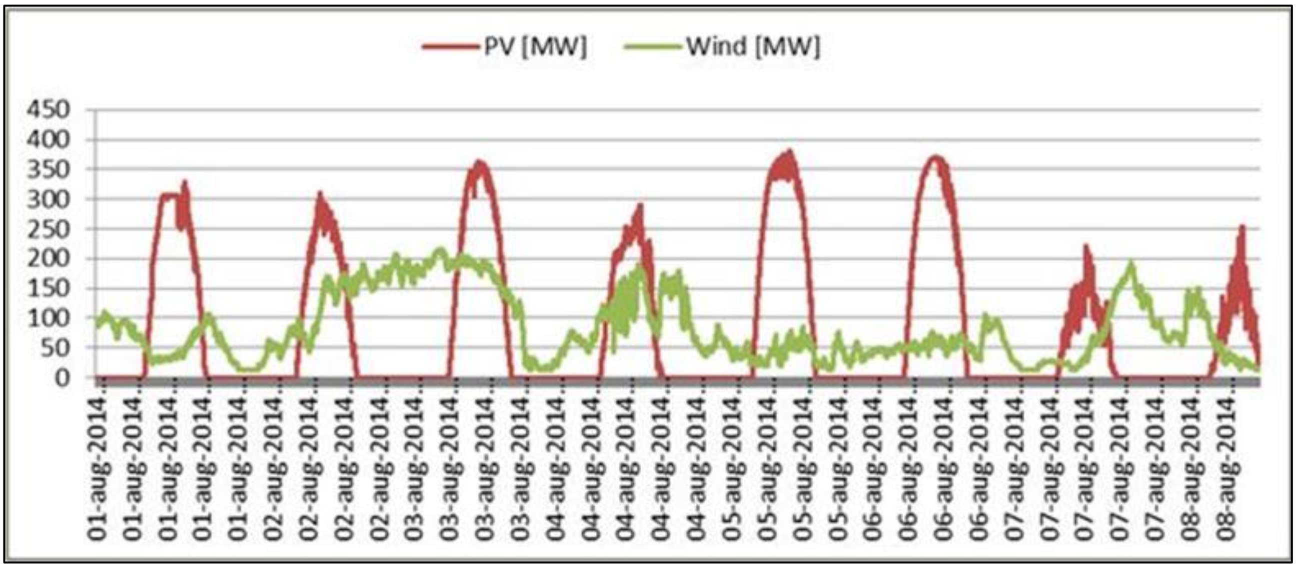


Figure 2.5: Weekly load profile of solar and wind power plants

Source: Eskom, 2014.

When combining the daily demand with the supply of the renewable electricity supply, the best combination is shown in Figure 2.6, with gas and wind combined as base-load resources. This is possible due to the flexibility of the gas electricity-generating plants to increase and decrease supply to make up the shortfall in demand from the wind electricity-generating plants.

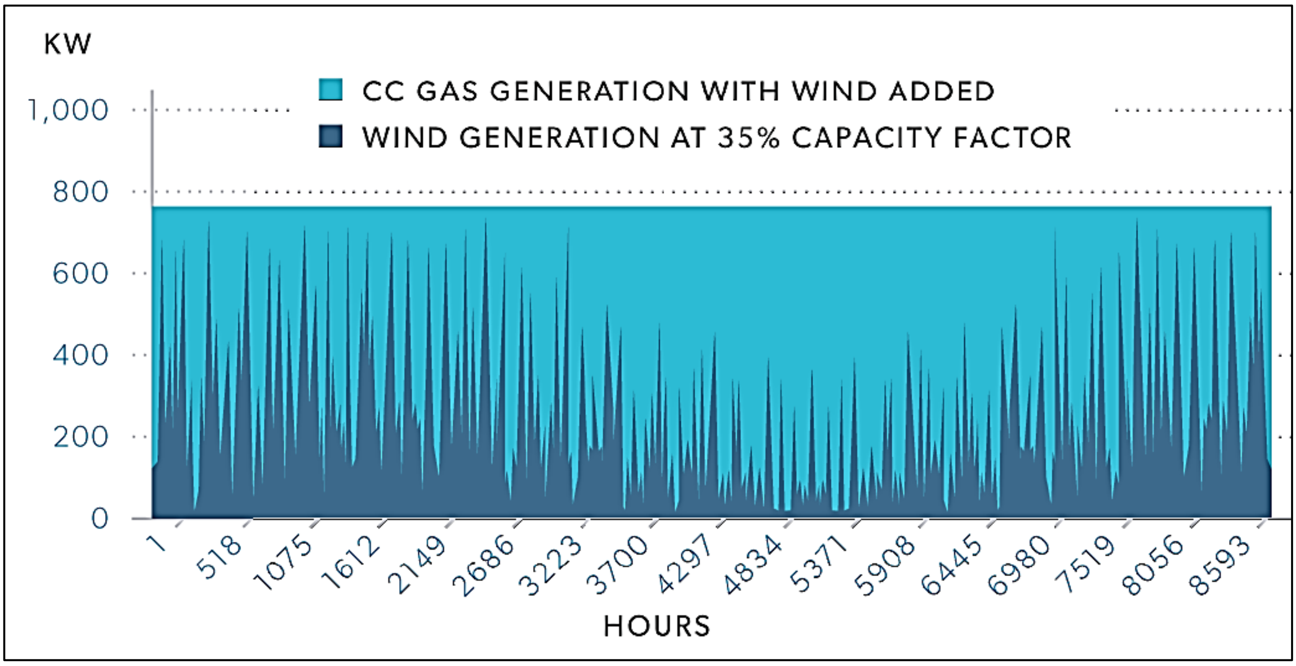


Figure 2.6: Gas and wind as base-load resource

Source: Stacy and Taylor, 2015:32.

It is clear that the load profiles from the demand and renewable generation supply only are not compatible. For this reason, a backup supply must be provided to ensure that the demand can be met when required and when the renewable options are not generating electricity. When combined with the backup option, for example in Figure 2.6, the wind and PV technology selections become very expensive base-load electricity-generation options compared to coal-fired electricity-generating power stations.

2.4 CONCLUSION

This section discussed the options for producing green electricity, the environment in which this electricity generation takes place and direct influences on these types of technology, in order to provide better understanding. The development of these green electricity-generating technologies and related cost reduction were discussed. A premium payment is currently required in order to develop and drive an aggressive uptake of green power. This premium payment will require ‘someone’ to be willing to pay. This payment may be per technology, by an overall system cost increase, or a form of tax incentive. In the next chapter, literature regarding environmental considerations and method of forecasting relevant to WTP is discussed in order to better understand the influences that must be evaluated in the exploratory model.

CHAPTER 3

LITERATURE REVIEW OF RELATED ENVIRONMENTAL AND FORECASTING STUDIES

3.1 INTRODUCTION

Willingness to pay within the electricity generation industry is influenced by many diverse factors. In the literature study during this research, some of these factors were explored so that a more holistic understanding of the related study fields could be obtained. This chapter discusses the literature regarding environmental considerations and method of forecasting relevant to WTP.

A two-fold approach was used in the literature review (1) to gather insight regarding the WTP for green electricity, and (2) to explore previous studies on WTP. The most relevant topics with regard to WTP, based on previous WTP studies in the field of green electricty, are reviewed here, and include:

- Environmental considerations;
- Climate change;
- Growing demand for electricity;
- Resource consumption and decoupling;
- Pollution;
- Sustainability;
- Preservation of nature;
- Initiatives to support green electricity; and
- Scenario planning.

Willingness to pay theories and previous studies are discussed in the following chapter.

3.2 ENVIRONMENTAL CONSIDERATIONS

Environmental considerations are issues that have a very important influence on the use of technology. This section presents some of these environmental considerations that were explored, with specific reference to the key drivers of climate change. Although it was impossible to explore all the facets that relate to the environment, the environmental impacts related to the generation of electricity need to be discussed to provide an understanding of the context of this study and its influence on large consumers' WTP.

3.2.1 Environmental consciousness

In 1988 the Intergovernmental Panel on Climate Change (IPCC) (2007) was convened which released its first assessment report in 1990. The IPCC as well as the second World Climate Conference called for a global treaty on climate change.

Climate change, and particularly the effect of human activities on climate change, also referred to as anthropogenic factors, has been a hotly-debated topic for some time. This topic has been researched and debated on numerous global economic, scientific, and political platforms. Because climate change is a global concern, there needs to be consensus on its scale and a common appreciation for the immensity of the challenge to implement adaptations which can alleviate the problem (Stern, 2006:288). This need for consensus means that Eskom is also obligated to make decisions about energy generation which take climate change into consideration.

The first significant steps towards fighting the effects of climate change were taken when the first World Climate Conference took place in 1979. Countries signed an international treaty called the United Nations Framework Convention on Climate Change (UNFCCC) which highlighted the necessity for reducing greenhouse gases (GHG). The treaty was introduced in 1992 and enforced by 1994, but did not have any regulatory measures at the time.

In 1995 the first Conferences of the Parties (COP-1) took place in Berlin. The third Conferences of the Parties (COP-3) was held in Kyoto in 1997. Here the Kyoto Protocol was agreed upon, which specified binding GHG emission targets for Europe and 37 other countries. After a ratification period, it was enforced from 16 February 2005. In 2014, 195 parties belonged to the Convention and 192 parties ascribed to the Kyoto Protocol (UNFCC, 2014).

In support of the above-mentioned, Eskom's Integrated Report (2012a:52) stated:

> *Eskom actively supported the Department of Energy in finalising the request for proposals and power-purchase agreement for the REIPPPP, formally launched in August 2011. The request for proposals calls for 3 725 MW of renewable energy technologies to be in commercial operation between mid-2014 and the end of 2016. Proposals have been received from 28 preferred bidders so far, with the combined potential to provide 1 416 MW of power. Eskom is working with government to connect successful IPPs to the grid.*

Construction for most of these IPP projects was due to start in the middle of 2012, and some planned to be ready to provide electricity by the end of 2013. The first of these agreements was signed on 5 November 2012.

Bidding, or tendering, on the REIPPPP was done in phases. These phases are called 'bid windows'. By the end of bid window 3.5, the total approved renewable capacity allocated to IPPs was 4 116 MW (DOE, 2015a:2).

Eskom is the largest supplier of electricity in South Africa and the following significantly illustrates Eskom's commitment to implementing renewable energy strategies. Eskom's Integrated Report (2012a:7) stated:

> *Eskom showcased its commitment to reducing its carbon footprint and making its energy mix less dependent on coal at the 17th Conference of the Parties to the United Nations (UN) Convention on Climate Change (COP-17), which took place in Durban in November and December 2011.*

At COP-21 on 12 December 2015, a comprehensive global response to the threat of climate change was achieved when negotiations on the Paris Agreement were concluded. This agreement will replace the Kyoto Protocol. A total of 156 countries, including all of the world's largest emitters except for the Russian Federation, indicated that they intend to sign this agreement. The Paris Agreement has been open for signature in New York since 22 April 2016 and closed on 17 April 2017. When at least 55 country parties to the UNFCCC have ratified, accepted or approved the agreement, it will be enforced (Gilder, Parker & Rumble, 2016).

The fact that South Africa has been party to the Paris Agreement suggests the following:

- South Africa is committed to supporting green electricity;
- IPPs are welcome in the South African electricity market;
- A clear target has been set for 2030 (IRP 2010-30) and beyond (IRP 2016-50); and
- Renewable energy strategies are a significant part of the overall environmental solution.

3.2.2 Climate change

It is important to have an understanding of global challenges, in particular those affecting the energy industry as a whole. South Africa will have to align its capacity expansion efforts with the current global community trends. Climate change and natural resources are important issues influencing energy technology choices. The following areas of climate change which relate to the current trends from an electricity generation perspective are discussed next:

- Growing demand for electricity;
- Resource consumption and decoupling;
- Pollution; and
- Sustainability.

3.2.2.1 Growing demand for electricity

As previously discussed, future electricity demand is expected to grow significantly. In 2030, the predicted electricity demand will be 400TWh (IRP 2016-50; Hedden, 2015:6; Alfstad, 2005:80). Considering the number of power stations built between 1970 and 1990 and their diminishing life span of 50 years, these power stations will probably be decommissioned by 2030 (DOE, 2016a:10). Investment in green electricity-generating technologies is required to ensure that the future electricity supply requirement can be met with a reduced impact on the environment.

For the future planning of the South African electricity landscape, it is important to plan various possible scenarios, while considering a large number of variables. The Minister of Energy is required to issue determinations for new electricity-generating capacity as directed by Section 34 of the Electricity Act. The first IRP to be published was the IRP 2010-30. The Inter-Ministerial Committee on Energy drafted the Integrated Resource Plan 2010-30 by using 17 scenarios to map out the future of the energy landscape in South Africa.

Government attempted to balance the key parameters in the plan, namely: carbon emissions, cost of electricity production, security of electricity supply, creation of sustainable jobs and water usage. However, central to the development of the plan was the conundrum of weighing up the cost of renewable energy production against the objective of limiting carbon emissions (DOE, 2011:8). Finding a balance between these two parameters presented difficulties because there were elements, like the extent of financial incentives necessary to support the transition to a low-carbon economy, which were unknown.

The Department of Energy’s IRP 2010-30 emphasised finding a balance between minimal financial “cost of electricity production” and the low carbon emissions that are being proposed as a country plan. This is important due to increasing international pressure for a reduced carbon footprint. According to the Department of Energy (2016a:3), a credible base case scenario was developed using the IRP 2010-30 by updating the underlying assumptions based on new information. The preferred scenario in the IRP 2010-30 is referred to as the “revised balanced scenario”, balancing cost and carbon emissions. The revised balanced scenario includes the current committed projects under the IRP 2010-30, for example Medupi and Kusile, as well as more renewable energy, beyond the current 10 000 gigawatt-hours by 2013 target. The revised balanced scenario was tested using the following criteria (DOE, 2016a:22):

- Carbon budget as an instrument to reduce GHG emissions;
- Primary fuel price tipping point (coal, gas and nuclear);
- Low demand trajectory;
- Embedded generation (rooftop PV energy);
- Enhanced energy efficiency;
- Low Eskom plant performance;
- Regional options (hydro, gas);
- Indigenous gas;
- Unconstrained renewable energy;
- New technology (storage);
- Electricity network implications; and
- Additional sensitivity.

From the above, it is evident that the various scenarios providing electricity required by the growing demand for electricity must consider the technology used, demand requirements, and renewable options. Environmental consideration is paramount as it relates to a significant number of the criteria used above to determine the future electricity-generating technology mix.

Several scenarios were published as part of the Integrated Resource Plan 2016-50 (DOE, 2016b:12). These scenarios used the base case and adjusted the scenario by constraining the model with items like the carbon limits and transmission power line constraints.

These scenarios can be represented as (DOE, 2016a:29):

(Base Case) + (Carbon Budget) + (Annual Constraints on Renewable Energy) …(3.1)

and

(Base Case) + (Carbon Budget) + (No Annual Constraints on Renewable Energy) ...(3.2)

The criteria used to analyse the various scenarios determine the energy mix. The summaries of the energy mix contribution by technology for South Africa as forecasted by the Integrated Resource Plan 2010-30 and the updated Integrated Resource Plan 2016-50 are indicated in Table 3.1. From this table, it is evident that coal as an energy source will reduce in relation to renewable sources to meet the carbon budget requirements. The nuclear electricity contribution increases significantly in 2050 to ensure that the minimum base-load requirement is met in future.

Table 3.1: Energy mix contribution by technology

Technology	IRP 2010-30	IRP 2016-50 up to 2030	IRP 2016-50 up to 2050
Coal	48.2%	68.98%	31.6%
Nuclear	13.4%	4.11%	30.01%
Renewable energy (wind, solar, solar photovoltaic, landfill, biomass, etc.)	13.8%	Included elsewhere	Included elsewhere
Photovoltaic		4.57%	6.55%
Concentrated solar power	0.7%	1.48%	0%
Peaking open-cycle gas turbine	10.8%	2.9%	6.96%
Closed-cycle gas turbine	2.2%		
Peaking pump storage	3.4%	Included in other	Included in other
Base-load hydro	6.5%		
Wind		9.47%	18.09%
Other	1.0%	8.49%	6.79%

Source: Department of Energy, 2011:9; Department of Energy, 2016a:19.

3.2.2.2 Resource consumption and decoupling

(i) Resource consumption

Fischer-Kowalski, Swilling, Von Weizsåcker, Ren and colleagues (2011:2) reported that “Material resources are natural assets deliberately extracted and modified by human activity for their utility to create economic value. They can be measured both in physical units (such as tonne, joules or area), and in monetary terms, expressing their economic value”. Many natural resources, which are being used to drive economic progress, have an environmental impact since they need to be extracted. Additionally, these natural resources may also become depleted. It is therefore important that sustainable use of natural assets be developed which can facilitate sustainable economic growth.

(ii) Decoupling

Decoupling of natural resources and energy supply will ensure that human welfare is not negatively affected by economic progress. Fischer-Kowalski et al. (2011:ix) reported that the conceptual framework of decoupling and understanding of the instrumentalities for achieving it, are still in an infant stage. They described it as follows: “Decoupling is about shifting from debt-financed consumption (which is unsustainable) as the primary economic driver of our economies, to sustainability-oriented investments in innovation as the primary economic driver of our economies”.

The Organisation for Economic Co-operation and Development (OECD) is a forum of countries providing a platform to compare policy experiences, seeking answers to common problems, identifying good practices and coordinating domestic and international policies of its members. They promote policies that will improve the economic and social well-being of people around the world. The OECD defined decoupling simply as breaking the link between ‘environmental bads’ and ‘economic goods’ (Fischer-Kowalski et al., 2011:4). The OECD appears to have been the first international body to adopt the concept of resource decoupling in 2001.

The Eskom corporate plan for 2016/17-2020/21 (2016b:40) described the decoupling of the gross domestic product (GDP) growth and the percentage sales growth as follows:

> *The National Development Plan (NDP) remains the guiding document for economic growth, but without sustainable and sufficient electricity capacity, further economic growth will be stunted. As the base-load player in the market, Eskom is directly responsible for helping to increase Gross Domestic Product growth. This necessitates increased capacity to support future expected demand and sales.*

The link between the GDP growth and the growth in electricity sales is illustrated in Figure 3.1. The forecasted growth indicates a clear correlation between GDP growth and the growth in electricity sales.

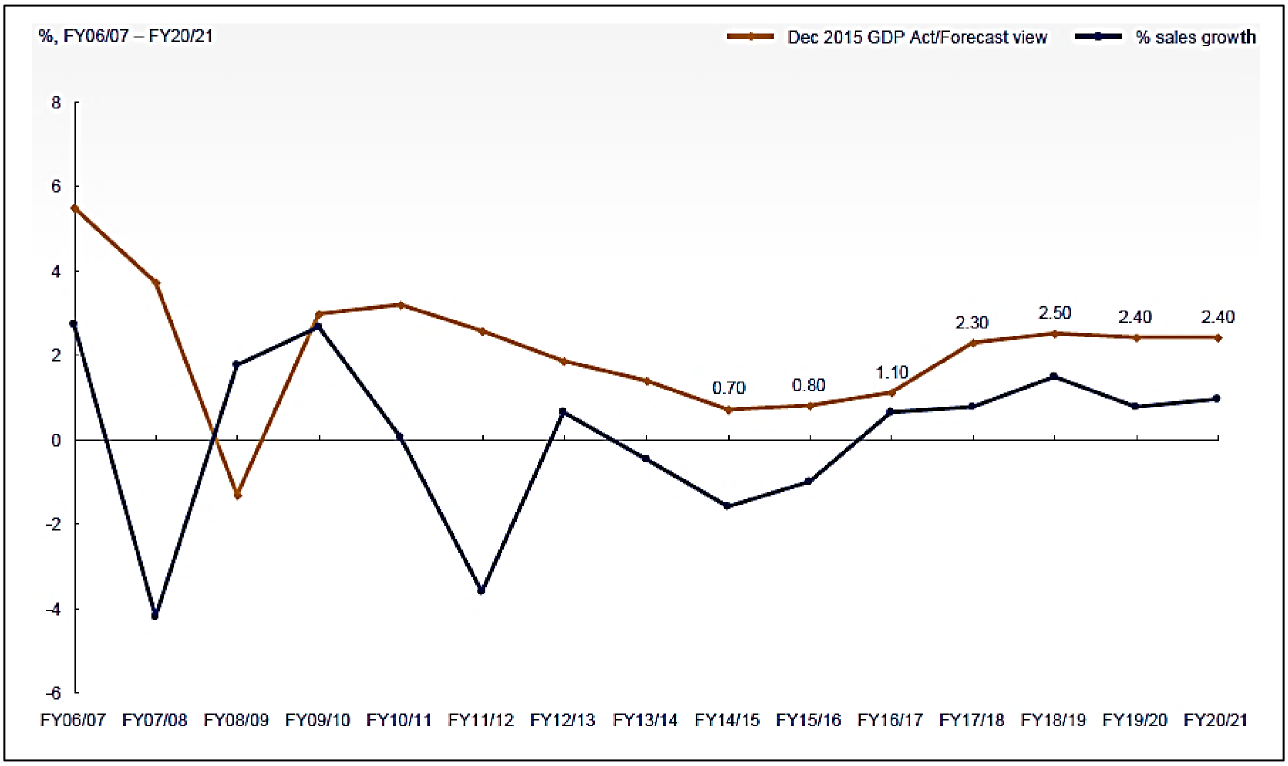


Figure 3.1: Decoupling of GDP and energy demand in South Africa

Source: Eskom, 2016b:40.

The IRP 2010-30 was based on electricity demand growth rates of three percent per annum up until 2030, although this could more realistically only average one percent per annum until 2026. The decoupling of energy demand and GDP growth is both a local and an international trend.

(iii) Relevance of decoupling to WTP

Many of the economies of developing countries, like South Africa, Brazil and India, are built on the extraction and processing of minerals. Their main focus for improvement should be on achieving the flow of energy carriers from renewable sources, as depicted in Figure 3.2.

According to Brent et al. (2009:270), “South Africa’s grand challenge therefore is to decouple its economic growth from carbon emissions in order to remain competitive in a future carbon-constrained global economy”. This is important because markets begin to prioritise environmental concerns and the carbon footprint of an export product will therefore play a significant role in future.

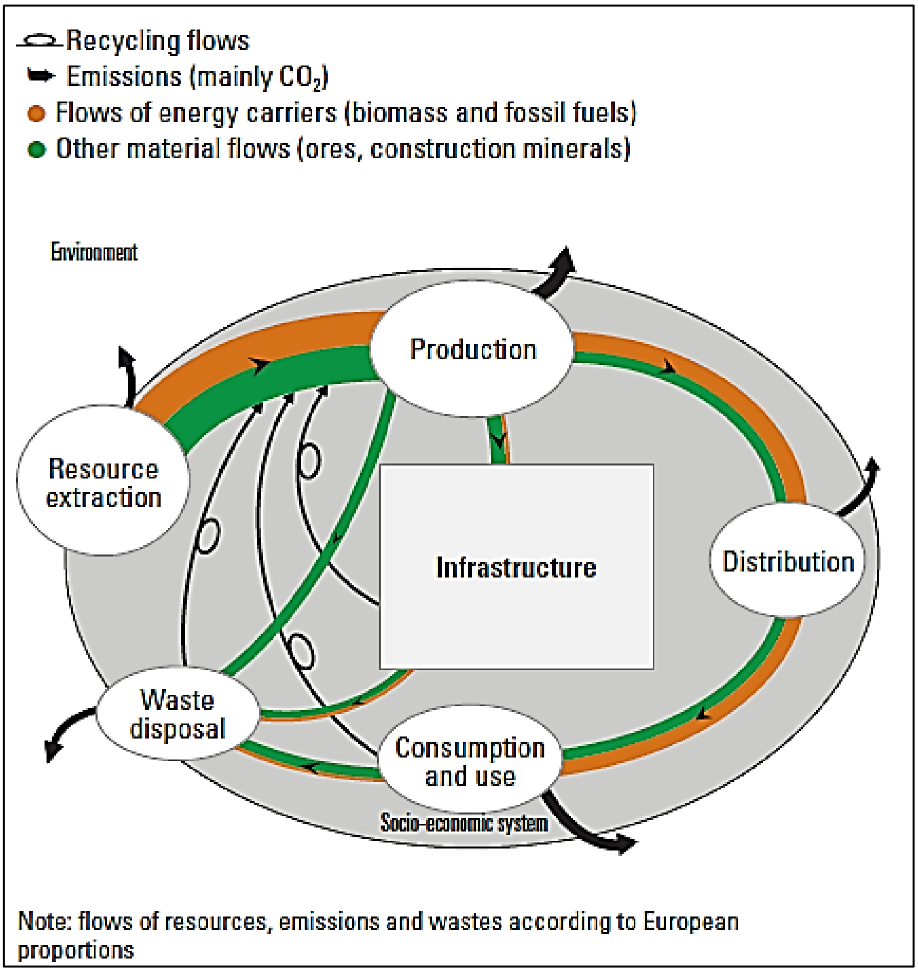


Figure 3.2: The life cycle of resource extraction and use

Source: Fischer-Kowalski et al., 2011:13.

Fischer-Kowalski et al. (2011:12) stated that any part of the cycle in which resources are used can result in an undesirable environmental impact. This is an important consideration when it comes to electricity generation, because conventional as well as green electricity should not have a negative impact on the environment during the phase of extraction, production/manufacture, consumption/use, or post-consumption disposal, as shown in Figure 3.2 (Fischer-Kowalski et al., 2011:7). Implementing decoupling therefore requires that attention be given to how much a resource is used in economic activity as well as the degree to which there is environmental impact during every stage of the cycle, not only at the extraction and production phases.

Over the past century, resource consumption (material and energy flows) has risen exponentially. As illustrated in Figure 3.3, there was a significant increase in the use of ores and industrial minerals, fossil energy carriers and construction minerals between 1900 and the year 2000. This appears to be related to growth in the GDP. Use of fossil fuels increased from five billion tonne to approximately 50 billion tonne during this period. The GDP growth increased at a higher rate than the resource extraction from 1970 onwards. This indicates that a degree of decoupling took place.

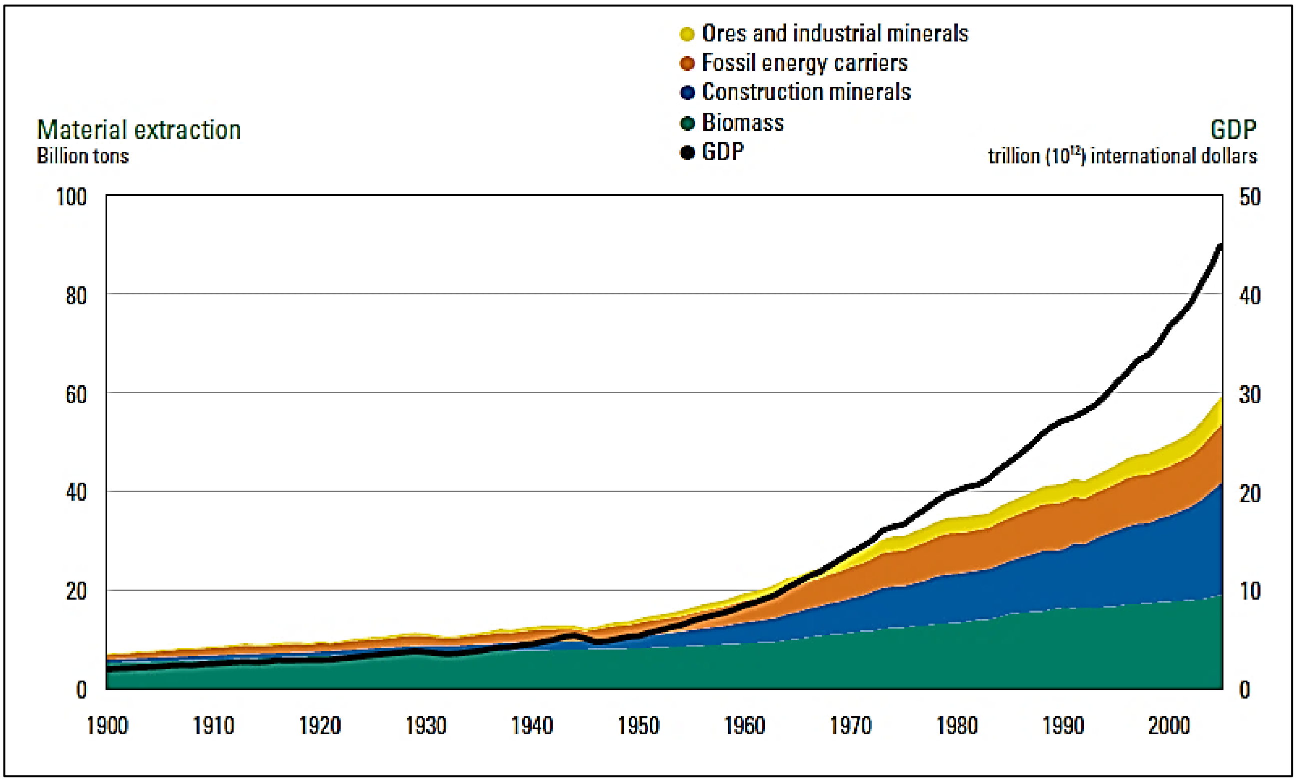


Figure 3.3: Global material extraction in billion tonne, 1900 to 2005

Source: Fischer-Kowalski et al., 2011:7.

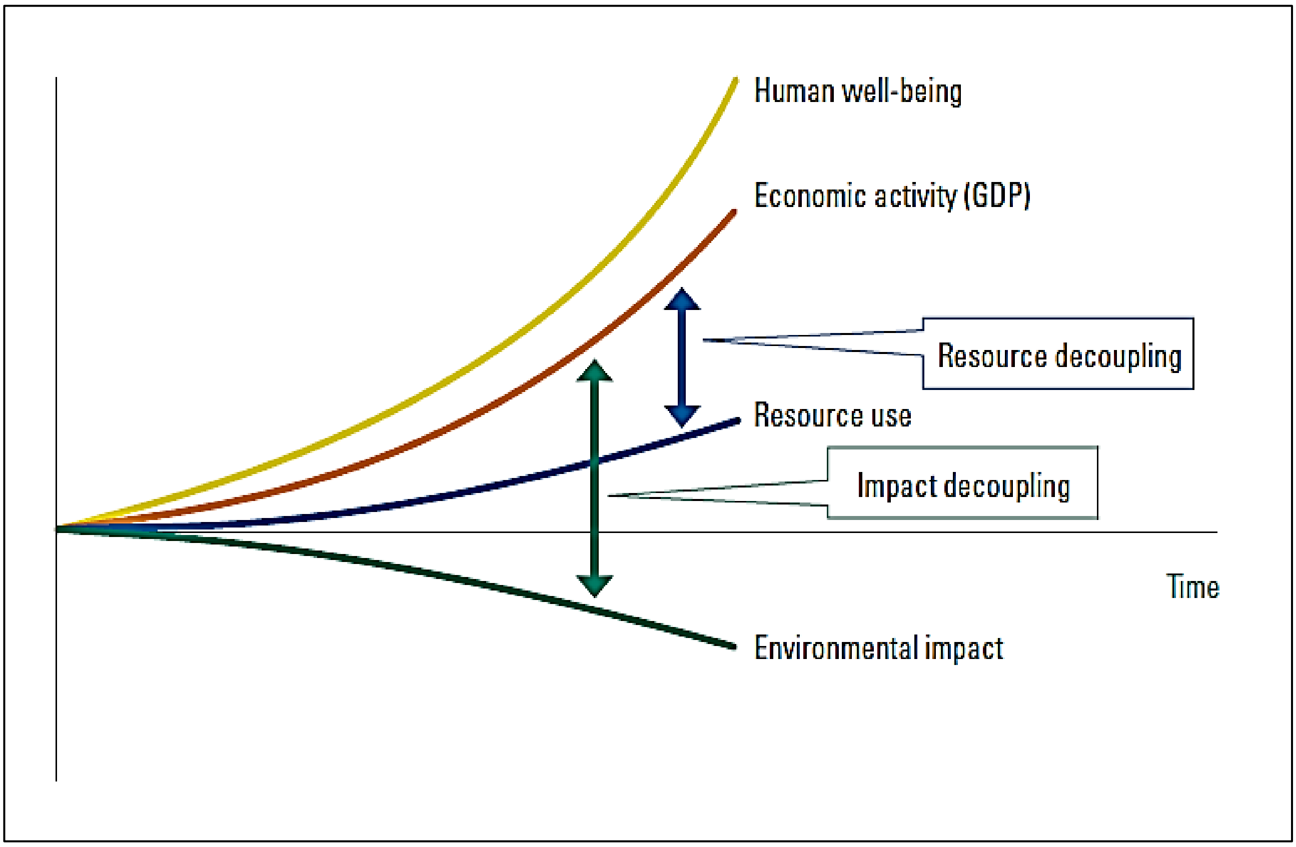


Figure 3.4: Two aspects of decoupling

Source: Fischer-Kowalski et al., 2011:8.

Fischer-Kowalski et al. (2011:8) believed that decoupling means using fewer resources per unit of economic output and reducing the environmental impact of all economic activities in which resources are used. Figure 3.4 illustrates the principal aspects of decoupling as it applies to sustainable development, namely resource decoupling and impact decoupling.

For the electricity generation industry, this implies that the increasing demand for electricity related to economic growth should be sustained using the least possible resources. The increased demand for electricity should also not exacerbate the impact on the environment.

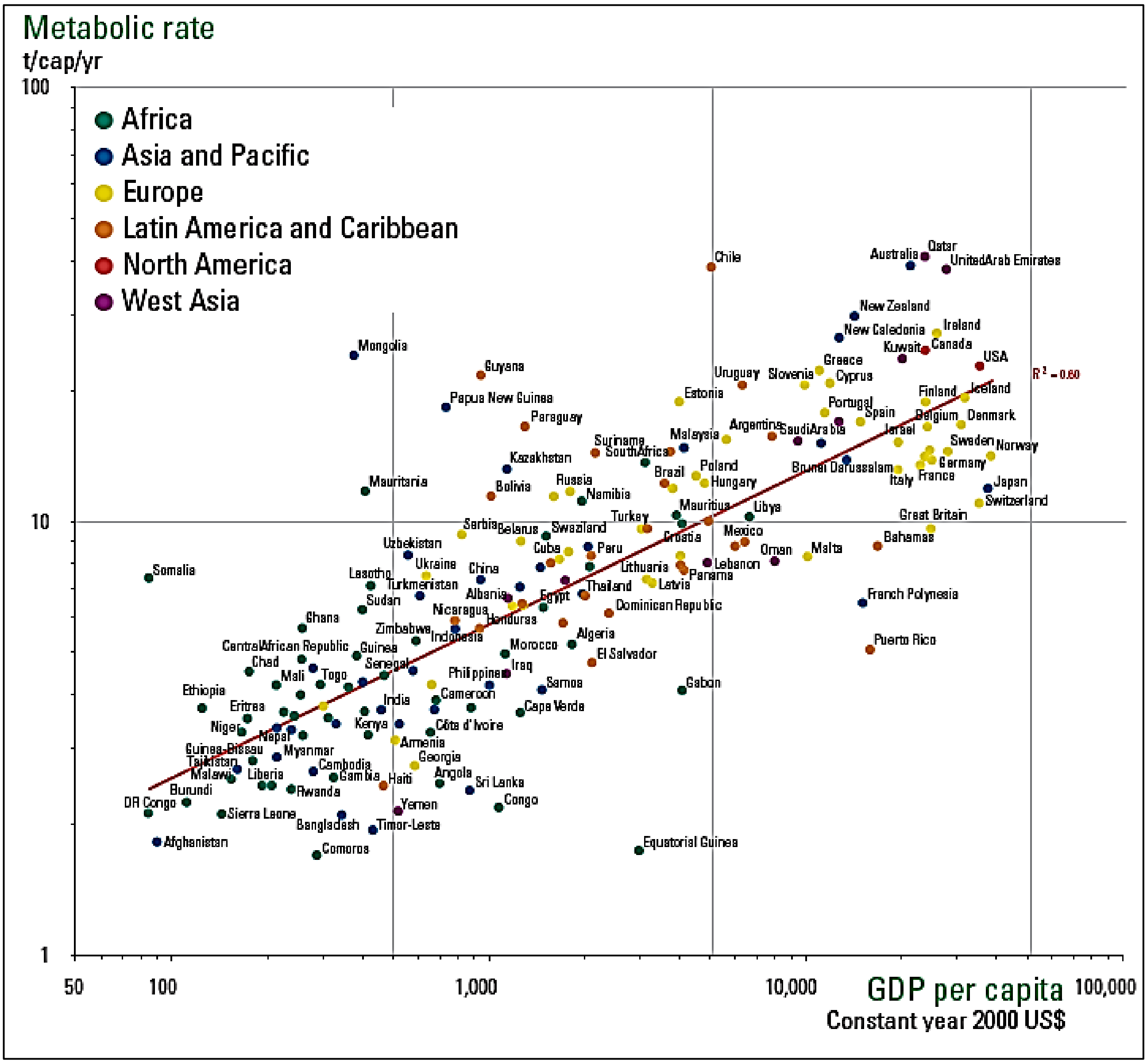


Figure 3.5: The global interrelation between resource use and income (175 countries in 2000)

Source: Fischer-Kowalski et al., 2011:21.

Resource consumption can be consistently linked to the economic prosperity of many countries, as shown in Figure 3.5. In many developing countries, the sale of resources, for example fossil fuels and minerals, constitutes their main economic activity. This is seen in Figure 3.5 where the resource usage is high with a relatively low GDP, measured against a metabolic rate in tonne per capita per year (t/cap/yr). Generating electricity from renewable energy technology sources in the future will ease the impact on the environment.

Decoupling from escalating resource use and environmental impacts requires innovation (Von Wyzsacker et al. 2009:39). They specifically delved into the topic of fuel switching where fuel is changed into renewable energy sources. The development of green electricity technologies is currently not viable for large base-load requirements and even though the cost has been significantly reduced, it still cannot compete with ‘dirty’ electricity-generating technologies (Von Wyzsacker et al., 2009:44).

(iv) How to decouple an economy

Brent et al. (2009:270) mentioned three main approaches, which may be used in the South African context to ensure that decoupling takes place. They are as follows:

(1) To increase the beneficiation of mineral resources in ways that generate domestic economic activity and employment, whilst reducing associated GHG emissions.

Beneficiation of metal ores to metals is energy intensive and will lead to an increase in the carbon footprints of exported products because South Africa’s energy supply is currently mainly driven by coal. For example, the carbon footprint of a ferro-alloy product is five times higher than that of the raw iron material, on a total carbon dioxide (CO_2) export basis. However, the further beneficiation of metals like iron and aluminium to metal products is less energy intensive and will reduce the carbon footprint of South African exports. Therefore, given the energy and carbon intensity of the South African economy, it would seem that government policy should focus on expanding its production and export of metal products, rather than just ores and metals.

(2) To increase the efficiency of energy supply, transmission and utilisation in the South African mining and manufacturing sectors, the South African government approved targets for improved energy efficiency in South Africa.

An example is the implementation of new technologies in the ferrochrome industry, which could reduce the energy intensity of each tonne produced (Brent et al., 2009:270). Government policy should therefore focus on incentivising such technological interventions in the South African metal product value chain.

(3) To diversify South Africa’s energy sources, primarily to increase the contribution of nuclear and solar energy.

The South African white paper on renewable energy set a target that 10 000 GWh of energy should be produced using renewable energy sources (biomass, wind, solar, and small-scale hydro) by 2013. Although this was not achieved, the IRP 2016-50 indicated that there has still been a significant increase in the contribution of nuclear and renewable resources (DOE, 2016b:13). The South African government has also introduced a nuclear policy which was developed by the DOE after a request for information relating to the nuclear industry programme was issued in December 2016. This policy and its strategies are viewed as being key to the government's climate response plans and follows on South Africa's "long-term mitigation scenarios" study. According to Brent et al. (2009:271), the aim is that, by 2025, half of new electricity generated, or 20 000 MW, must be produced using nuclear resources. This time frame has now been extended (IRP 2016-50).

Payments from an energy supplier, if they generate their own electricity and supply the electricity into the national transmission system, are called a feed-in tariff. In 2009 an increase in feed-in tariffs was implemented to encourage diversity of energy supply. Policy interventions were also recommended to further extend diversity. Increases in feed-in tariffs took place from 2008 to fund Eskom's new capacity expansion programme and subsidise the renewable IPP programme.

In light of the above, South Africa can gain additional economic and environmental benefits if future policies, which consider the decoupling process, result in GDP growth, while using fewer resources. Figure 3.6 indicates that South African energy has a higher than average energy intensity and that significant opportunities for improvement exist (Hedden, 2015:5).

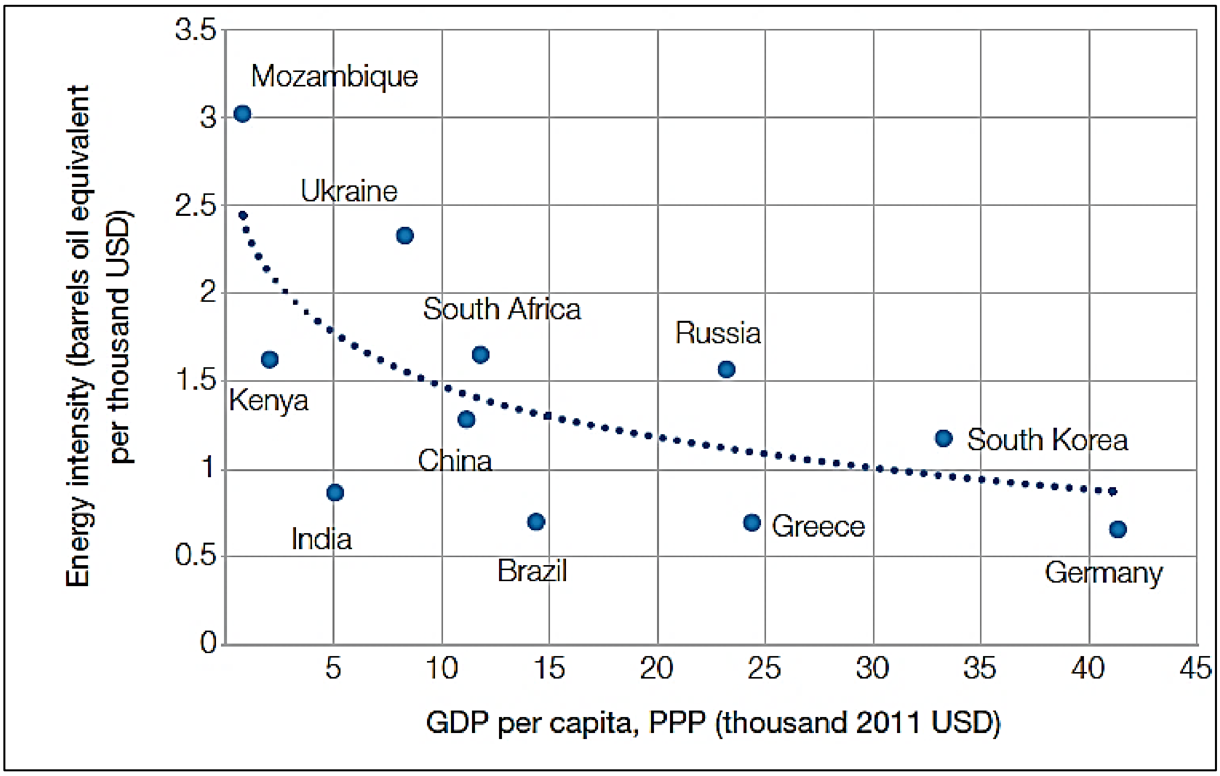


Figure 3.6: Energy intensity of economies (energy consumption divided by GDP vs. GDP per capita at purchasing power parity)

Source: Hedden, 2015:5.

Hedden (2015:5) stated that both the models of Eskom's Systems Operator and the Council for Scientific Research (CSIR) assumed that the energy intensity of the South African economy will decrease over time. The CSIR model forecasts declining energy intensity indices for various mining and manufacturing sectors. The underlying logic behind the models used for the IRP 2010-30 is that South Africa is transitioning away from energy-intensive industries, for example mining and manufacturing, towards less energy-intensive sectors, such as the services sectors (Hedden, 2015:5). This is also illustrated in Table 1.2, which indicates that Eskom's total sales in mining and industry declined between the financial years of 1930 to 2016.

3.2.2.3 Pollution

According to Hubbell (2006:256), 'pollution' can be anything that has a detrimental effect on the environment. Holdgate (1980:17) defined 'pollution' as:

> *The introduction by man into the environment of substances or energy liable to cause hazards to human health, harm to living resources and ecological systems, damage to structures or amenity or interference with legitimate users of the environment.*

The important concepts in this definition are:

- Pollution is caused by certain substances or processes involving generation of energy.
- Pollution has a source or sources, created by man.
- Pollution acts in the environment as a result of pollutant discharges, leading to the exposure of structures or organisms.
- Its significance is determined by the effect on a range of targets, including man and the resources and ecological systems on which he depends.
- Pollution is judged according to impact on environmental components and social values. If substances interfere with the environment or damage structures or amenities they are considered to be pollutants.
- Pollution is judged according to a scale of hazard, damage or interference. Hazardous by-products in the production of substances or energy supply qualify as pollutants.

Different types of pollutants are produced by different types of fuel. Particulate matter, like fly ash and soot, sulphur dioxide (SO_2 and SO_3) and nitrogen oxides (NO and NO_2) are the major pollutants when coal is used to generate electricity (Rao & Rao, 2007:252). Electricity generation in solid fuel-fired power stations is currently the main source of flying particles and GHG emissions (Androutsopoulos & Hatzilyberis, 2001:171). Energy-environmental impacts associated with non-renewable electricity generation have attained critical importance in South Africa. These impacts were quantified to obtain a monetary cost relative to local electricity prices. The primary externality contributors were found to be greenhouse gas (GHG) emissions and public health effects from coal combustion. Aggregated central externality costs were found to range from ZAR0.0586 to 0.3536/kWh, with central externalities estimates at ZAR0.1343/kWh. These central estimates were found to be 68.5 percent of average electricity prices during the year 2008 (Thopil, & Pouris, 2015:501).

Figure 3.7 indicates the increase in GHG emissions from 1970 to 2010. Renewable energy sources do not produce particulates or pollutant gases. The negative environmental influences of the current coal-fired power generation industry have led to an increased focus on green technology.

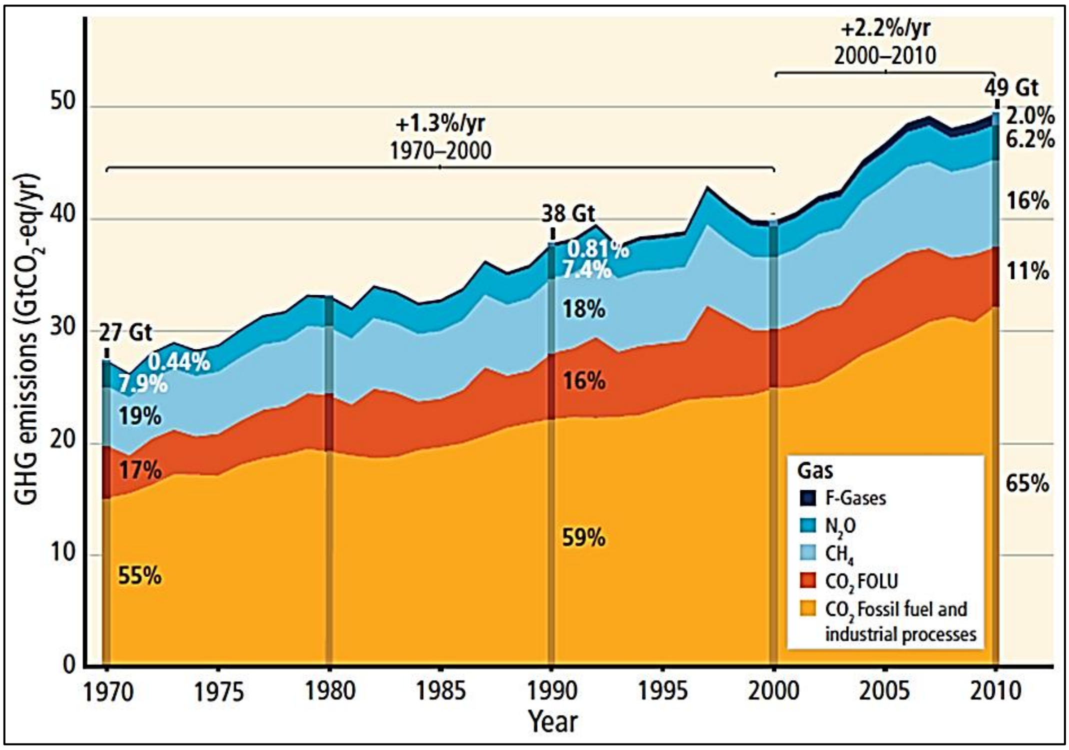


Figure 3.7: The global annual emissions of anthropogenic greenhouse gases from 1970 to 2010

Source: IPCC, 2014:5.

Figure 3.8 indicates the significant impact that fossil fuel electricity generation had on GHG emissions compared to other industries. The fossil fuels used in energy supply are the largest contributors to pollution. The impact on the environment will be significantly reduced if additional new technologies that generate electricity without polluting the environment are introduced.

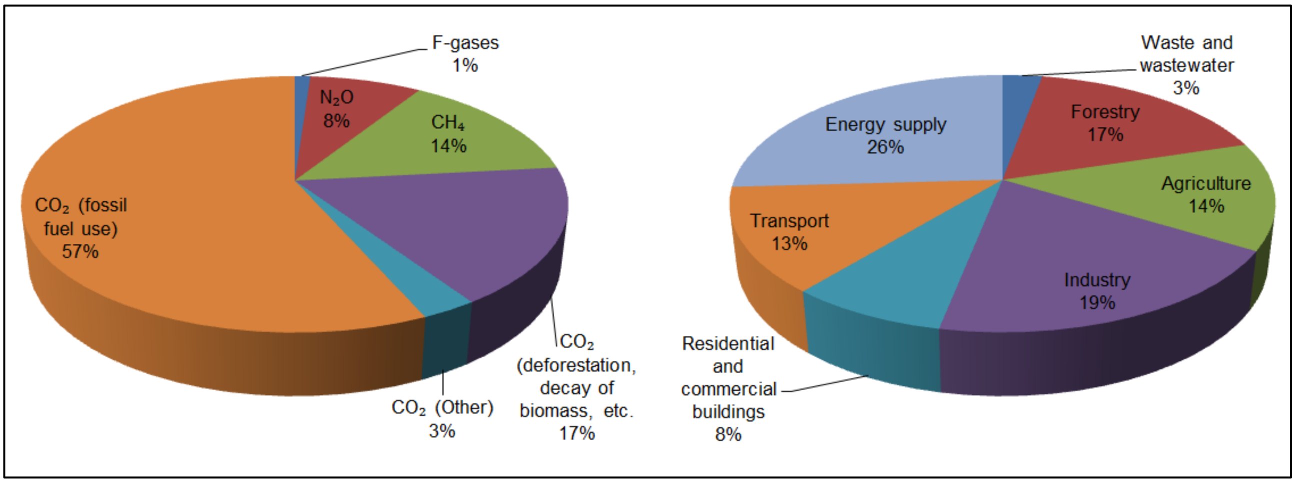


Figure 3.8: The share of different anthropogenic greenhouse gases in total emissions in 2004 in terms of carbon dioxide equivalent (CO_2e) and the sectors

Source: IPCC, 2007:36.

Total emissions continued to increase until 2010 with more significant increases occurring between 2000 and 2015. In Figure 3.9 below, six paths to stabilisation at parts per million carbon dioxide equivalent (550 ppm CO_2e) are illustrated. In the legend, the rate of decline in global emissions which can be achieved in the next three decades is demonstrated.

According to Stern (2006:xii), cuts like these can only be achieved at an additional cost. He estimated the annual cost of stabilisation at 500 to 550 parts per million carbon dioxide equivalent (550 ppm CO_2e) will be approximately one percent of the GDP by 2050. Stern (2006:xii) concluded that this level is significant, but manageable. The Intergovernmental Panel on Climate Change (2014:8) stated that the concentration of carbon dioxide equivalent in 2011 is estimated to be 430 parts per million with an uncertainty range of 340 to 520 parts per million. This is despite a decline in energy-related carbon dioxide emissions between 2006 and 2012 (Energy Information Administration, 2016:MT34).

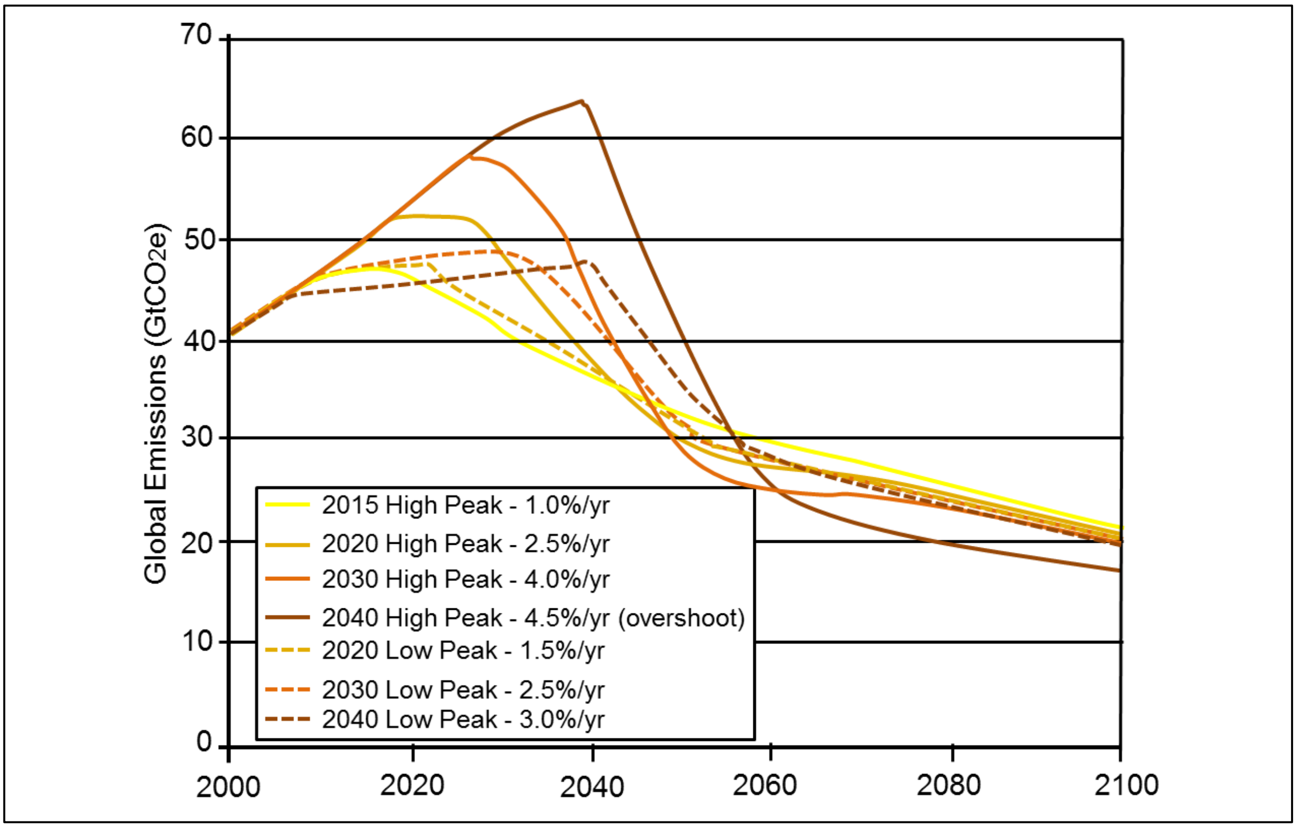


Figure 3.9: Illustrative emission paths to stabilise at 550 ppm carbon dioxide equivalent

Source: Stern, 2006:xii.

For the global emissions to be reduced, a concerted effort needs to be made in all industries, especially the electricity industry, because this industry is responsible for the largest portion of GHG emissions (Figure 3.8).

Green technology has shown significant progress, but is still in the developmental phase, especially green technology related to base-load electricity generation. Implementing strategies to reduce the impact of greenhouse gases will require funding, which is why it is important to understand the WTP of large consumers.

3.2.2.4 Sustainability

Sustainable development is achieved by three interconnected objectives, namely: (1) economic development; (2) social inclusion; and (3) environmental sustainability (Singh, 2016:248). The functioning of sustainable development is illustrated by Oelofse (2002:5) in Figure 3.10 as three spheres of sustainable development, namely: (1) economic; (2) community; and (3) ecological development. The three interconnected objectives mentioned by Singh (2016) and the three spheres as discussed by Oelofse (2002) are conceptually similar. These three spheres are interrelated and positive outcomes can be realised when interaction between these spheres is managed correctly. These spheres must be combined for holistic sustainable development to be accomplished. New green technologies need to be developed for the electricity industry to balance electricity demand with economic, community, and ecological requirements.

Agenda 21 is a commonly-used training manual which provides effective guidelines for achieving this balance. Oelofse (2002:10) referred to it as "a global programme that hopes to change economic, environmental and community development in such a way that development will be far more sustainable".

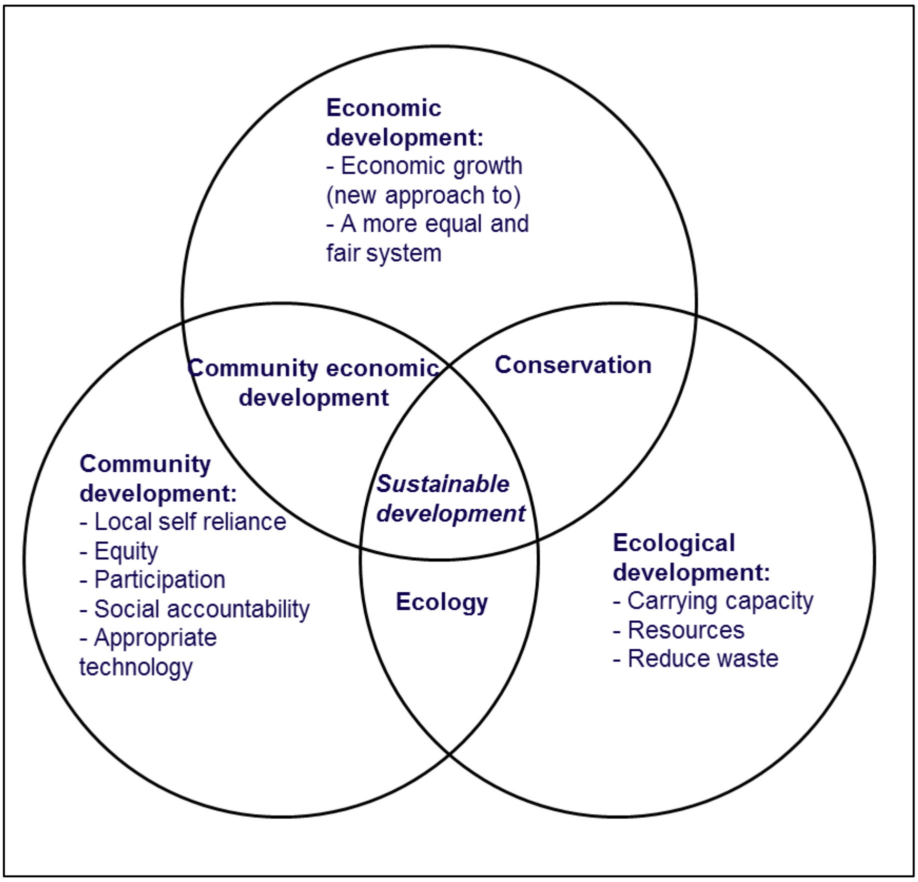


Figure 3.10: The sustainable development challenge

Source: Oelofse, 2002:5.

Oelofse (2002:9) identified the key principles for sustainable development in order to:

- Revive growth, so as to alleviate poverty and thus reduce pressure on the environment;
- Change the definition of growth to include notions of equity and non-materialistic values;
- Meet the basic human needs for food, shelter, water, and energy;
- Stabilise and manage population growth, especially by changing the economic pressures to have children;
- Conserve and enhance the resource base;
- Develop technology which is oriented towards environmental risk management; and
- Integrate economic and environmental factors in decision-making, in other words, put the environmental perspective into economics.

Oelofse, Scott, Oelofse and Houghton (2006: Abstract) concluded that technocentric scientific approaches to environmental management have dominated the energy environment both in South Africa and internationally. These technocentric scientific approaches support key principles for sustainable development relating to the development of technology as identified by Oelofse (2002:9) and supported by Singh (2016:247). For any economy to develop, it is essential to have resources. Africa has an abundance of resources, but some areas do have constraints with regards to water supply. The influence of the following resources on electricity supply is particularly relevant to electricity generation: energy, land, water, ocean and marine resources as well as mineral resources.

Environmental issues, like pollution and global climate changes, have a negative impact on the health of populations. Minimising this impact on human life can be expensive and have a significant effect on electricity supply. These issues support the importance of the electricity industry finding a balance between economic, community and ecological sustainable development.

3.3 PRESERVATION OF NATURE

Understanding the large consumers' values concerning welfare of those in society and the preservation of nature is important for this study. In his analysis of data collected from over 70 countries, Schwartz (2006:1) identified ten distinct motivational values and demonstrated the conflict and congruence which exists between them, as illustrated in Figure 3.11. One of these values is 'universalism', which has appreciation, tolerance and protection of the welfare of people and nature as its main objectives. The value of universalism is derived from the survival needs of individuals and groups. People do not recognise these needs until they become aware of the scarcity of natural resources (Schwartz, 2006:8). They may only realise then that failure to protect the natural environment will lead to the destruction of the resources on which life depends. Universalism is comprised of two subtypes of concern, namely: (1) the welfare of those in society and the world at large; and (2) the preservation of nature (broadminded, social justice, equality, world at peace, world of beauty, unity with nature, wisdom, inner harmony, protecting the environment).

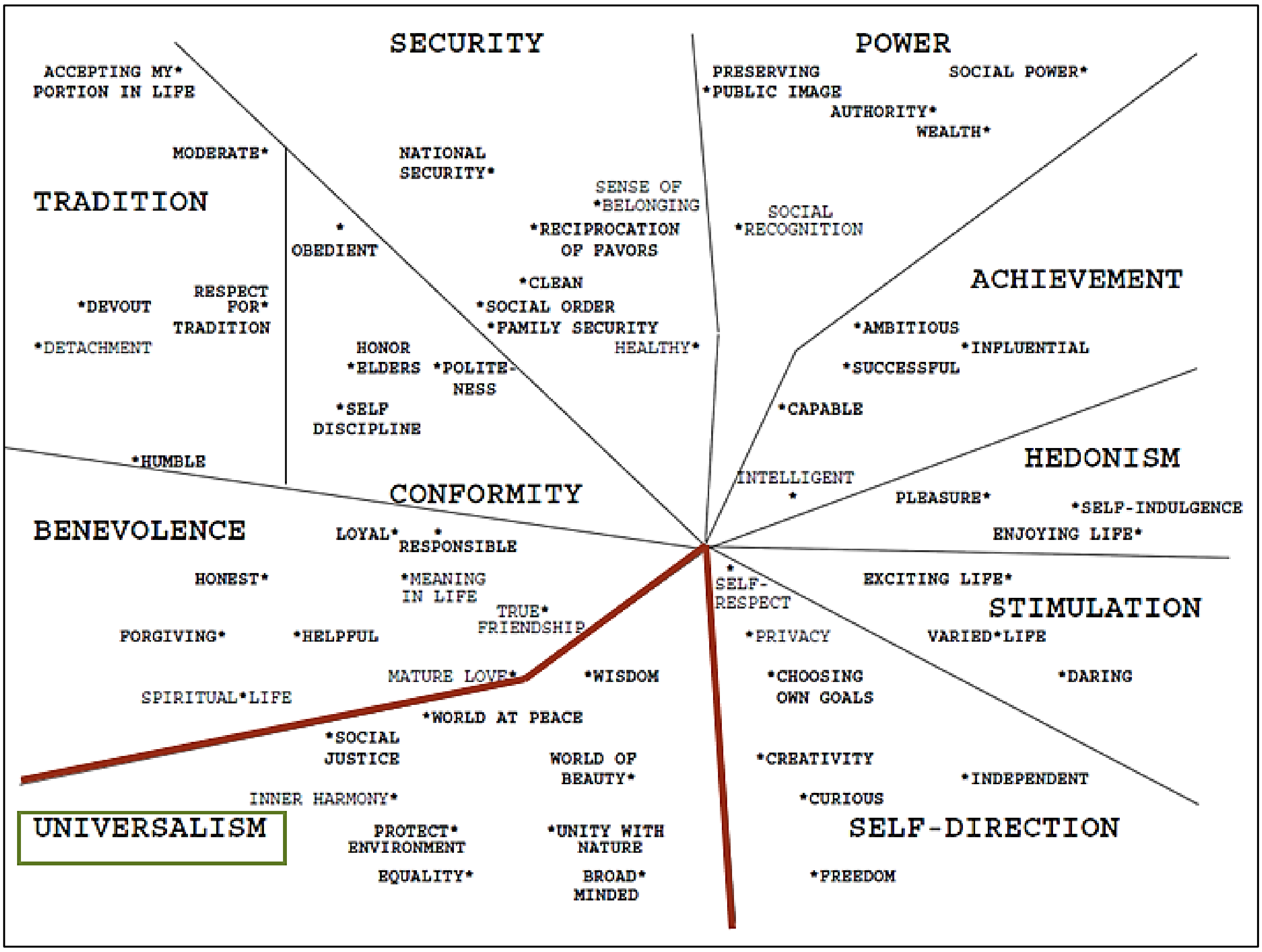


Figure 3.11: Dimensional smallest space analysis: Individual-level value structure averaged across 68 countries

Source: Schwartz, 2006:7.

The principal of universalism in groups are supported by Shulruf, Alesi, Ciochina, Faria, Hattie, Hong, Pepi and Watkins (2011:174) indicating that collectivists are more likely to internalise the group's goals and values.

Power, achievement, hedonism, stimulation and self-direction values primarily regulate how one expresses personal interests and characteristics. Benevolence, universalism, tradition, conformity, security values primarily regulate how one relates socially to others and affects their interests (Schwartz, 2006:14). Typically, people adapt their values to their life circumstances. For example, people with ethnocentric peers find it hard to express universalism values. They upgrade the importance they attribute to values they can readily attain and downgrade the importance of values whose pursuit is blocked. The associations of education with values are largely linear, with the exception of universalism values. Universalism values begin to rise only in the last years of secondary school and are substantially higher among those who attend university. This reflects the broadening of horizons that a university education provides and a tendency for those giving high priority to universalism values to seek higher education (Schwartz, 2006:15).

Schwartz (2006:15) concluded that people prioritising business objectives correlate positively with priority given to power and security values, and negatively with the priority given to universalism values. People prioritising social objectives correlate most positively with the priority given to universalism values.

3.4 CURRENT INITIATIVES TO SUPPORT GREEN ELECTRICITY

The third Eskom MYPD3 report (Eskom, 2012b:25) specified that the five-year revenue that Eskom requested included an average annual electricity price increase of 13 percent to cover Eskom's electricity generation costs, as well as an additional three percent to subsidise the introduction of green electricity from IPPs. This green electricity mainly included the impact of the Department of Energy Peaking Plant which comprises two open-cycle gas turbine plants totalling 1 020 MW. Additionally, it included three rounds of the renewable energy IPP bid programme totalling 3 725 MW supplied by green electricity-generating technologies. The Department of Energy (2016b:35) indicated a continued steady increase in renewable electricity supply technologies in the update of the IRP 2016-50.

3.5 SCENARIO PLANNING

3.5.1 Introduction

Scenario planning is a very useful technique in an environment characterised by uncertainty. Providing scenarios during the implementation of a questionnaire gives the respondents a better idea of the possible options and makes it possible for them to provide informed responses. The main reason for selecting to expand on the theory on scenario planning is the extensive use thereof in the electricity industry and previous WTP studies (Yoo & Kwak, 2009:5 409). In the questionnaire used for this research study, various scenarios were provided to make it possible for respondents to understand the context. Because there is limited knowledge regarding the power sector in most public sectors, this could provide respondents with information on the subject (Yoo & Kwak, 2009:5 409).

Ajzen and Driver (1992:297) indicated that in the absence of relevant knowledge about the subject, the respondents' judgment about WTP rely on intuitive rules of thumb. Raposo and Do Paço (2009:367) stated that people with higher educational levels are expected to display greater concern for the environment. Their argument is that higher-educated people are more likely to have knowledge related to environmental concerns. Willingness to pay seems to be related to being knowledgeable about renewable energy resources. During a price mark-up tolerance (PMT) study, Gerpott and Mahmudova (2010a:310-315) tested the knowledge of residential consumers by asking them to classify eight energy resources as renewable or non-renewable. Their finding was that "customers with a high PMT tend to be characterized by good knowledge about renewable energy sources". Gerpott and Mahmudova (2010a:316) confirmed that residential consumers are commonly uninformed about electricity-related issues and therefore need to be enlightened before being able to respond in research questionnaires relating to the electricity market. As electricity consumption is a significant part of the large electricity consumers' business considerations, they are required to understand the electricity industry, but not necessarily be knowledgeable about renewable energy resources.

Previous research studies have shown that there is a lack of awareness about renewable energy in the public domain. Previous WTP studies have shown that scenario planning is useful for creating context, before respondents complete their questionnaires. For example, the benefit of scenarios was demonstrated by Whitehead and Cherry (2007:251) where a hypothetical market was presented to survey respondents, and by Ladenburg and Dubgaard (2007:4 060) where they determined the WTP for reduced visual disadvantage due to the location of offshore wind farms. Miesing and Van Ness (2007:162) defined scenarios as “carefully crafted views of the future”. Scenario planning is used by most electricity suppliers to estimate long-term demand. Due to the development and construction which take a long time in the electricity-generating environment, a significant amount of future planning is required. Scenario planning is also the main tool which was used to determine future electricity supply capacity for South Africa in the development of the IRP 2016-30 and the IRP 2016-50 (DOE, 2016a:3).

Scenario planning is relevant to this study because it makes long-term planning and the understanding of potential circumstances possible. Scenario planning enables the reader to understand the context of the study before completing the questionnaire. Scenario planning was used in this study to provide large consumers with different options in the questionnaire. The aim was that by presenting scenarios, the questionnaire would be more understandable during a limited period of time. Scenario planning also made it possible to gain a better understanding of the results obtained from the questionnaire. The next sections provide more detailed information on the history, theory, and use of scenario planning in relation to this study.

3.5.2 History of scenario planning

Scenario planning has been established as a successful strategy for long-term planning in which organisations are able to expose and challenge fundamental assumptions about possible future outcomes. The history of scenario planning can be traced back to the Second World War when the US Air Force used it to anticipate what the enemy might do in order to formulate different avoidance strategies. In the 1960s, an ex-member of the US Air Force, Herman Kahn, refined scenario planning so that it could be used as a tool in business forecasting (Mietzner & Reger, 2004:48).

One of the first people to use scenarios in business was Pierre Wack, head of group planning at Shell (Refer Figure 3.12). In response to failures of probability-based forecasting techniques, the Royal Dutch/Shell was able to use scenarios to successfully forecast the oil crisis of 1973 and the oil price collapse of 1981 before these events took place (Cornelius, Van de Putte & Romani, 2005:96; Durbach & Stewart, 2003:261).

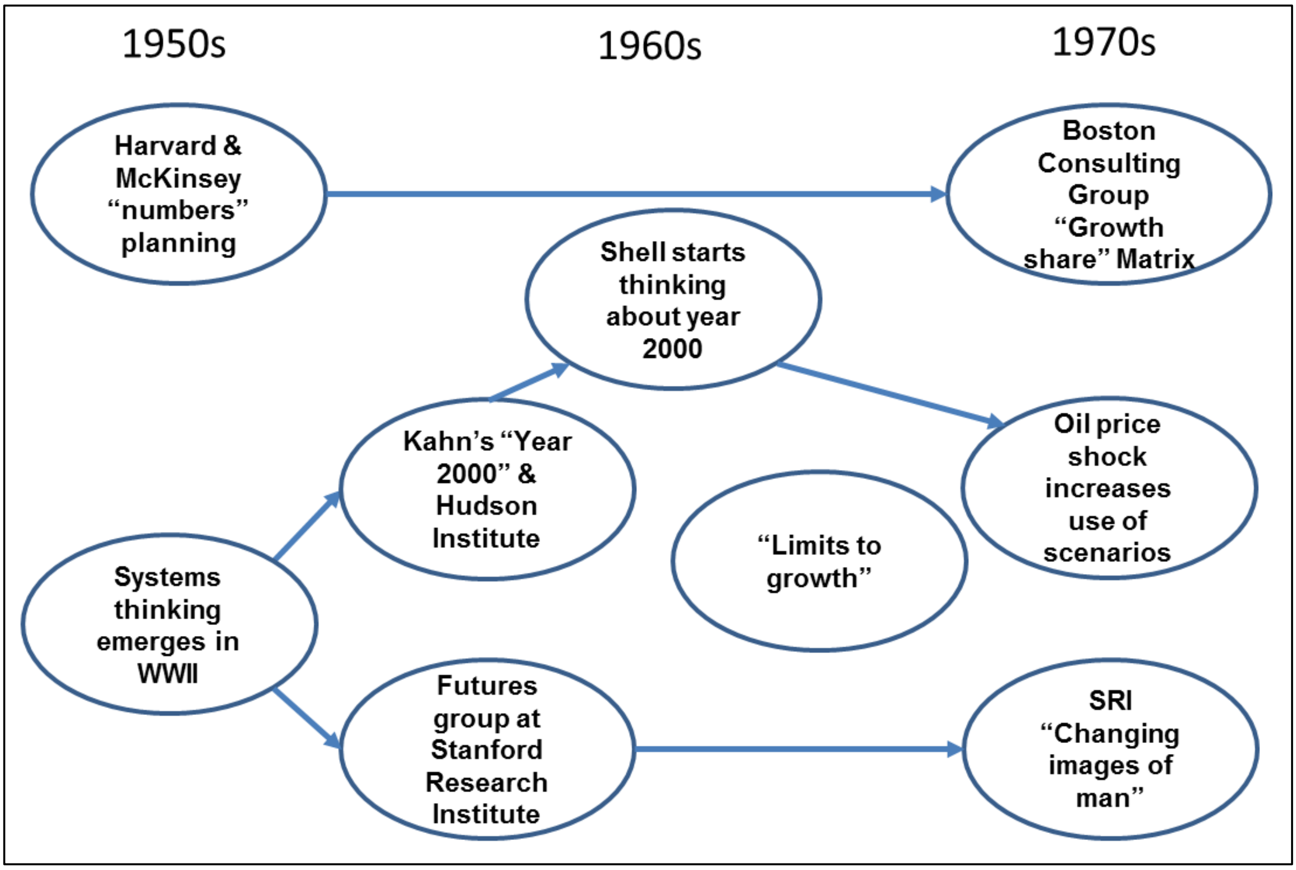


Figure 3.12: Strands in the evolution of scenario planning

Source: Ringland, 2006:15.

According to Miesing and Van Ness (2007:162), the scenario planning process involves the identification of plausible future 'scenes' and the creation of models for learning, anticipating and preparing for the future. This makes it possible to take strategic actions in the present so that the organisation will be shielded from disaster and can strive towards achieving its objectives.

3.5.3 Main principles of scenario planning

Some of the main principles of scenario planning that were studied and applied in 1980 are still valid today. The principles of scenario planning are usually adapted to suit the requirements of the user.

Using scenarios in planning implies that a degree of uncertainty will exist in every possible outcome. In order to address this, a "three-level" estimate is used (Booz Allen & Hamilton, 1980:4). This involves the use of three scenarios in which high (optimistic), medium (most likely), and low (pessimistic) estimates of independent variables are made (in Figure 3.13). This method does not usually include the probability of the occurrence of each forecasted result. The uncertainty involved in forecasting can therefore not be quantified, but may be calculated using the probability tree approach.

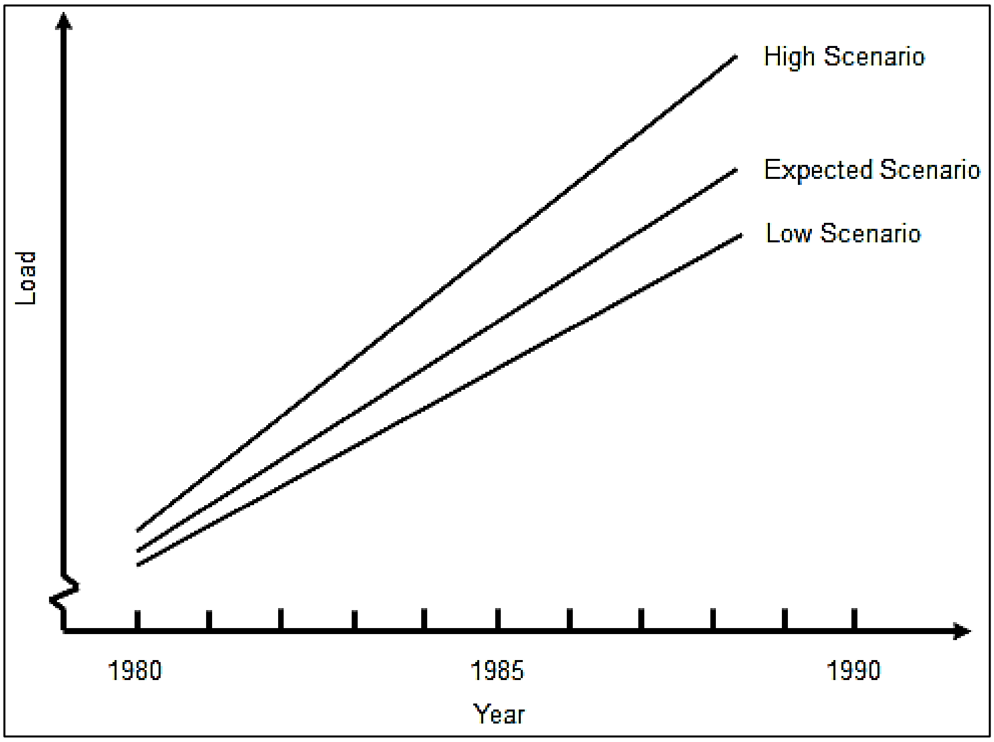


Figure 3.13: Typical presentation of scenario results

Source: Booz Allen and Hamilton, 1980:10.

According to Booz Allen and Hamilton (1980:9), in the probability tree approach, “the probability distribution for each independent variable is discretised into a finite number of points, generally three to five, and these discrete points are utilized to represent the entire distribution”.

It is important that the probability curve be discretised into a sufficiently large number of points to represent the entire curve with reasonable accuracy. At the same time, it is desirable to use the minimum number of points needed to represent the distribution to simplify subsequent analytical work. The probability tree approach is displayed in Figure 3.14.

Ringland (2002:22) suggested that Shell’s scenario model, which uses four scenarios, should be applied because two scenarios lead to the development of two very distinct scenarios, three scenarios create the expectation that one must be the forecast, whilst four scenarios encourage divergent thinking and are useful for stimulating vision.

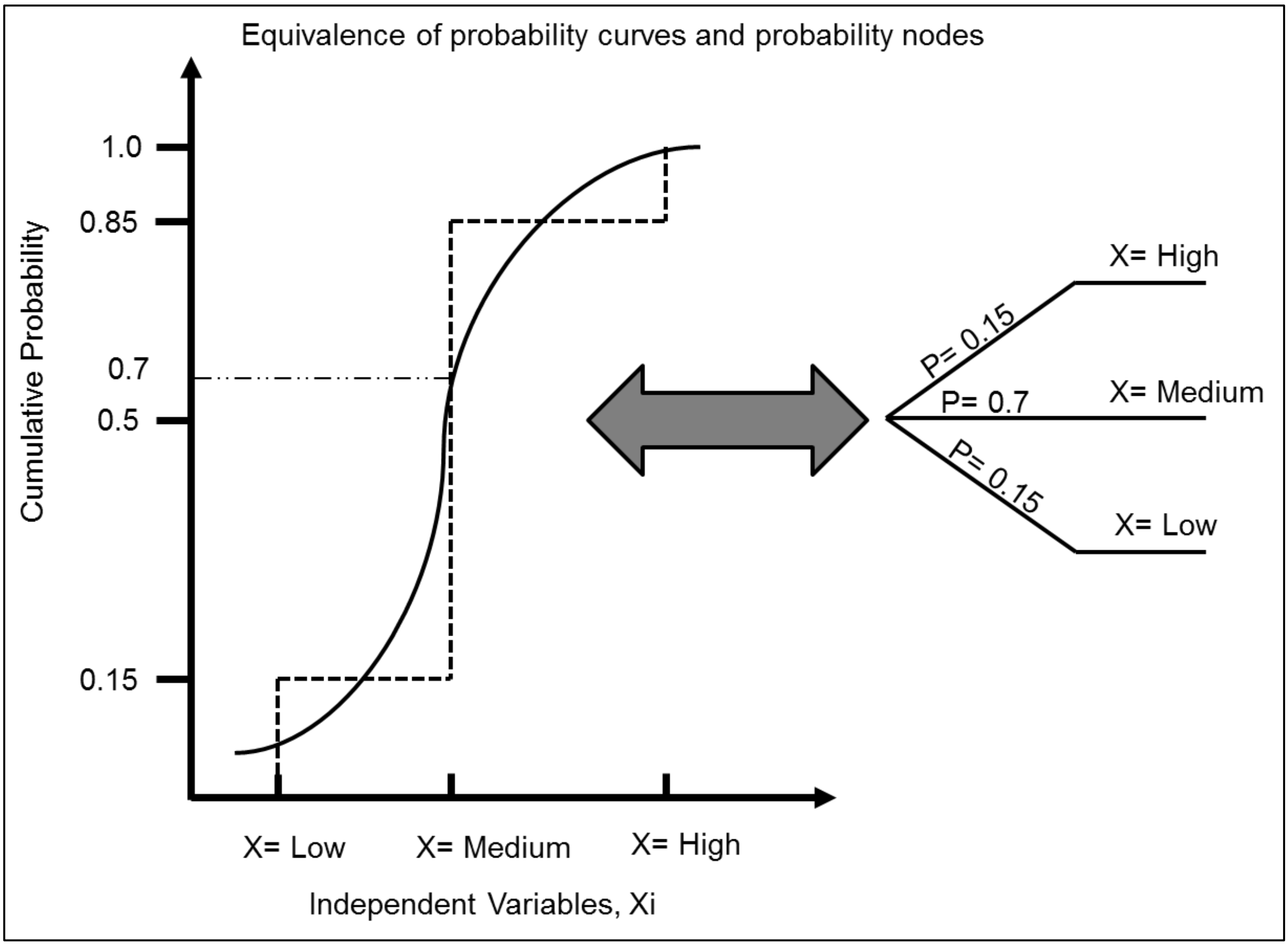


Figure 3.14: Application of the probability tree method for analysing uncertainty

Source: Booz Allen and Hamilton, 1980:9.

3.5.4 Scenario planning as a business tool

Planning is crucial in the current business environment. According to Cronjé, Du Toit, Marais and Motlatla (2004:141), planning is essential because it:

- Provides direction;
- Promotes coordination;
- Compels managers to focus on the future;
- Ensures that businesses keep abreast of technology;
- Ensures cohesion; and
- Promotes stability.

Every sector in business uses planning differently for various, different time frames. Planning within a power utility can be for one hour (short term), or the next 30 years (long term). Scenario planning has been used by the Department of Energy (2016b:12) in their electricity strategic long-term planning process. Ringland (2006:13) described scenario planning as “a set of processes for improving the quality of the educated guesses, and also for deciding what the implications are and when to gamble”.

Scenario planning has been proven to be a tool which organisations can use to reveal and challenge fundamental assumptions about the future. According to Ringland (2002:5), scenario planning was mainly utilised in corporate planning and portfolio management before 1997, but has since increasingly been used to get "the big picture right'. Ringland (2002:3) concluded that: "scenarios help us to understand today better by imagining tomorrow, increasing the breadth of vision and enabling us to spot change earlier".

According to Overmeer (2002:3), scenario planning is a way of "rehearsing the future", an intellectual reconnaissance of what lies ahead. The most prevalent form of scenario planning is one in which multiple plausible future environments are described with a time horizon of five to ten years. Once different scenarios have been created, the most plausible scenarios should be identified so that robust strategies can be formed to support these scenarios.

Bodhanya (2001:9) defined scenarios as being: "a set of reasonably plausible, but structurally different futures, a general direction giving rise to coherent patterns of action". Scenario planning is not just a prediction or optimisation of a known issue. The strength of scenario planning is that it is able to apply both linear and non-linear relationships in their development. If an organisation is to succeed, it needs to anticipate the future and understand the elements that will shape it. There are four main types of scenarios, namely: (1) global scenarios; (2) regional scenarios; (3) national scenarios; and (4) focused scenarios. Focused scenarios focus on a particular decision, issue, market or investment (Bodhanya, 2001:6).

Stakeholders from government, business and civil society agreed at the National Climate Change Conference in October 2005 to embark on this process, seeking to protect the climate, while meeting the development challenges of poverty alleviation and job creation. For these reasons, a Long-Term Mitigation Scenario (LTMS) process was launched in mid-2006 with a focus to reduce emissions of greenhouse gases (Winkler, 2007:1). Various corporate organisations are currently using scenario planning to determine which energy options should be used in the future. Carbon dioxide emissions are an important consideration in much of the scenario work which is being done. This is also an important concern in the scenario planning which is being undertaken by Eskom.

The Energy Modelling Forum Third Working Group (1981:7-11) investigated ten different scenario models which were applied to a set of eight scenarios. They mentioned that the scenarios were designed to examine issues which were expected to be important in future policy or capacity planning decisions. These scenarios indicated that scenario planning has been used to understand the driving force behind the environmental impact of electricity since 1981.

In Korea, a WTP study was conducted in which respondents were supplied with information about the characteristics of renewable energy. Two hypothetical electricity services were provided and respondents had to choose which one they would prefer to buy (Yoo & Kwak, 2009:5 409).

Ringland (2002:129) identified 12 different stages in which scenarios are created:

(i) Identify the focal issue or decision;
(ii) Identify key forces in the local environment;
(iii) Identify driving forces;
(iv) Rank them by importance and uncertainty;
(v) Select scenario logics;
(vi) Flesh out the scenarios;
(vii) Determine the implications of strategy;
(viii) Select leading indicators and signposts;
(ix) Feed the scenarios back to those consulted;
(x) Discuss the strategic options;
(xi) Agree on the implementation plan; and
(xii) Publicise the scenarios.

By making “the physical, economic, political and social determinants of future electricity peaking demand and capacity strategy for Africa” the focal issue, will make it possible to create a scenario using the afore-mentioned 12 steps (Ringland, 2002:129). Making physical, economic, political and social determinants part of the creation of scenarios will make it possible to use scenario planning in the strategic planning process. These stages were used during the development of the IRP 2016-50 to predict growth in electricity usage so that technologies for supplying future demand could be identified. Using Ringland’s structured approach in the scenario planning process adds validity and makes it possible to anticipate credible future developments.

Various scenario processes have been developed. Application can vary considerably depending on the type of industry, which is why the appropriate process needs to be selected for the applicable environment. All of these processes used for scenario planning, however, follow the procedure illustrated in Figure 3.15.

Scenario planning requires the user to go through several iterations of the various scenarios. Each time the outcomes should be reviewed against the alternatives. As new information and insights become available, the scenarios process must be redone. In the electricity industry, there are many influences which constantly change the insights. Advancement in the green electricity-generating technology is one of these influences that necessitate regular reviews of the future electricity requirements.

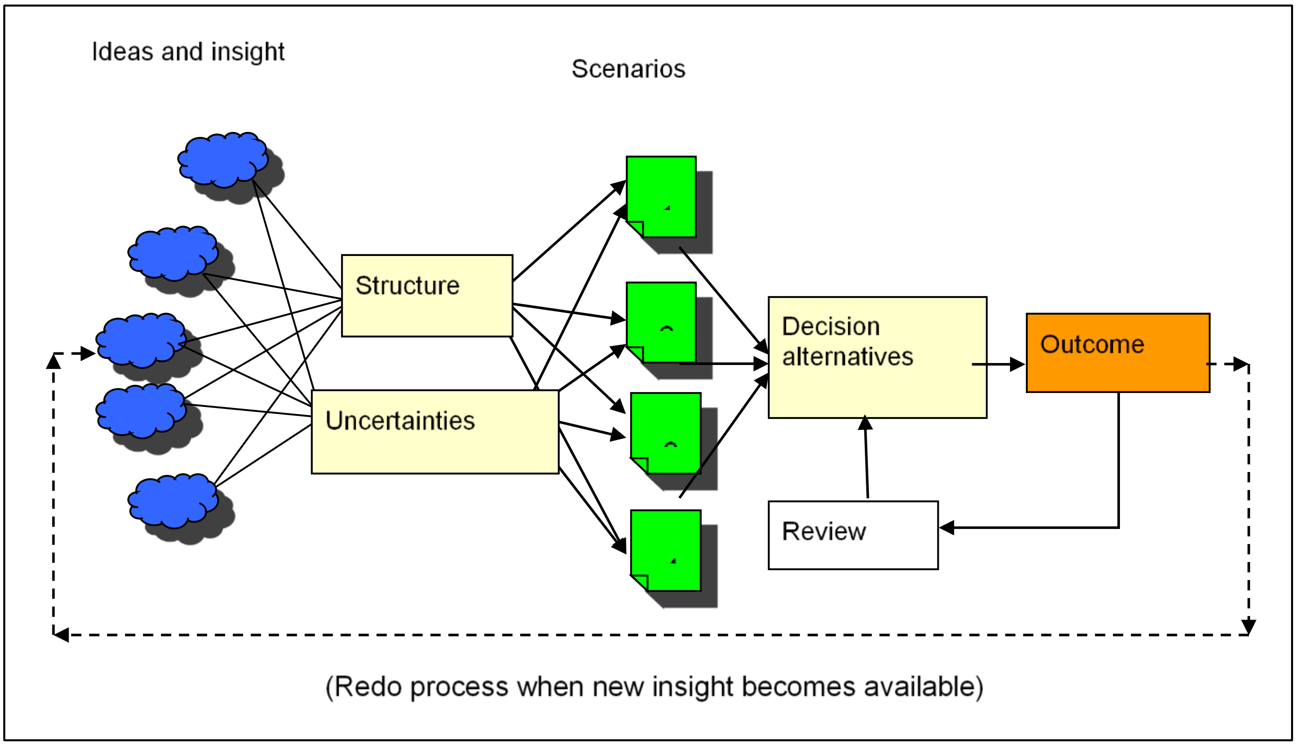


Figure 3.15: Scenario process

Source: Adapted from Malerud, 2006:10.

3.5.5 Conclusion on scenario planning

Providing scenarios makes it easier for respondents to understand the context of the questionnaire. For this study, possible payment methods for green electricity were provided which included the following:

- Eskom will build renewable energy plants and transfer the expenses to consumers.
- Government sponsors the expenses for Eskom to build new energy plants and to recover costs by other means, for example tax.
- Private entities build renewable construction/energy plants and Eskom procures the expenses at a higher cost. Eskom transfers the expenses to all the costumers.
- Consumers pay a voluntary amount to facilitate the building of renewable plants.

3.6 CONCLUSION ON RELATED LITERATURE STUDY

This section of the literature review focused on some of the environmental considerations in providing green electricity. Future requirements for green electricity generation and methods of forecasting green electricity requirements were discussed. Willingness to pay theories and historical studies done on green electricity generation are presented.

CHAPTER 4
WILLINGNESS TO PAY

4.1 INTRODUCTION

This chapter focuses on the literature relating to the study field of WTP. The first sections discuss the theories that motivate and demotivate people to pay a premium. These theories relate to WTP, the free-rider problem, the consumer surplus concept, the theory of 'value', culture and consumer behaviour. The following sections discuss models related to these theories. As no previous studies have been done on large electricity consumers, several previous residential studies which tested a country's WTP are reviewed to improve the understanding of WTP in the electricity industry. This chapter ends by concluding on previous WTP studies, the literature analysis and combining the literature analysis as well as information reviewed in this and the previous chapters to offer four propositions.

4.2 INTRODUCTION TO WILLINGNESS TO PAY (WTP)

Studying the theory on WTP can provide a better understanding of the factors that motivate people to pay a premium for conserving the environment. Green electricity may be considered to be expensive at the moment, but its utilisation is necessary for accelerated development to take place, which will make it the preferred financial and environmental option of the future. Understanding the consumer's WTP necessitates an understanding of consumer economics.

Jules Dupuit (1844) changed thinking on consumer economics in his time with his article on the utility of public works to measure social benefits of public goods, such as canals, bridges, and national highways. In this and following articles, Dupuit debated the question about the nature of utility and value. He formulated the concept of consumer surplus which was derived from the law of diminishing marginal utility and has become essential to the theory of demand and welfare economics (Vatin, Simonin & Marco, 2016:63). Dooley (1983:1 050) stated that: "Despite treating utility as volatile, Dupuit maintains that the concept has a well-defined meaning: utility is whatever people are willing to pay for". The concept of consumer's surplus is an essential concept in the theory of demand and welfare economics, which relates to the WTP for green electricity.

Alfred Marshall (1890) expanded this definition by differentiating between "absolute utility" and "relative utility". Unlike Dupuit, who said that consumer's surplus refers to the maximum acceptable price, Marshall was of the opinion that "consumer's surplus" is the difference between the absolute utility and the price actually paid. According to Marshall, consumer's surplus can therefore be described as:

Consumer's surplus = ∑ Absolute utility – (Price x Number of units of a commodity purchased) …(4.1)

or

Consumer's surplus = What a consumer is willing to pay minus what he actually pays …(4.2)

According to Dooley (1983:26), when Alfred Marshall published his doctrine of Economics in 1890, his principle of consumer's surplus and its underlying theory of consumer demand provoked an intense controversy. Marshall's critics thought his doctrine principles were incorrect in theory and inapplicable in practice; at best, his supporters thought his theory was only approximately true. Some of the input from critics on the consumer's surplus theory relates to the assumption that different units of the goods give a different amount of satisfaction to the consumer (Vatin et al., 2016:147; Dooley, 1983:27). It is assumed that marginal utility of a good diminishes as the consumer has more units of it. Dooley (1983:27) stated that Marshall assumed that the utility function for an individual is independent and additive, so that the utility derived from a cup of tea is independent of the quantities of coffee and sugar acquired. Therefore, a consumer’s surplus is not a definitive, but depends upon the availability of substitutes.

The consumer is in equilibrium when marginal utility from a commodity becomes equal to its given price. This indicates marginal utility or use-value of the commodity for the consumer. (Vatin et al., 2016:56). If the available quantity of a commodity in the market is very large, its marginal valuation or marginal utility will be very small, though its total use-value or total benefit may be very large. If the available quantity of a commodity, such as diamonds and gold, is very small, its marginal valuation or marginal utility may become very high. Therefore, the market price of a commodity is determined not by its total use value, but by its marginal utility, which in turn depends on the actual available quantity.

It is difficult to estimate how much a consumer would be willing to pay for a product, rather than go without it. Therefore, the concept of consumer’s surplus has also been criticised because it is based upon questionable assumptions of measurability of utility and constancy of the marginal utility of money (Dooley, 1983:27).

The essence of the concept of consumer’s surplus is that the consumer gets excess satisfaction from their purchases of the goods (Vatin et al., 2016:54). In other words, the concept of consumer’s surplus is that a consumer derives extra satisfaction from the daily purchases they make over the price they actually pay for them. Vatin et al. (2016:63) concluded that: “Dupuit has inherited from Say and Rossi a subjectivist concept of value; one that takes account of intra-personal as well as inter-personal variation in consumer desires”. If environmental preservation is linked to the concept of consumer’s surplus, the assumption is that people generally get more satisfaction (utility) from the usage of green electricity (consumption of goods) than the price they actually pay for it.

Sugden (2015:1 052) stated that for Dupuit, utility measurement is fundamentally concerned with the amounts of money that people are willing to pay for goods. Law (2007:72) believed that price can be used as a measure of value for most market goods, since a product’s price represents people’s WTP for those goods. Law (2007:72) repeated Kaiser and Roumasset’s opinion, namely, that markets for environmental goods are limited, and where markets do exist, they are imperfect and prices are normally distorted. Law (2007:72) stated: “There are therefore no prices that will reflect a benefit to society for the improvements of environmental resources or social costs of environmental degradation”.

Another word describing value is ‘worth’. Worth can mean the value of something, especially in terms of money or the goodness, usefulness, or importance of something, irrespective of financial value or wealth. This includes the moral or social value. For example, a degree from one university has more worth/value than from another university.

Wiser, Bolinger, Holt and Swezey (2001:46), as well as Oliver et al. (2010:3), concluded that green marketing activities have shown steady growth since their early stages in the United States, Europe and Australia. Unless consumers become concerned about their health or environmental aspects being negatively affected, there will be a slow and restrained growth.

Oliver et al. (2010:3) said that one important group of models comprises the so-called intention models, and stated that consumers’ commitment to a specific behaviour is jointly dependent on their attitudes and subjective norms. According to Ajzen and Fishbein (1980:181):

> *...intentions are assumed to capture the motivational factors that influence a behaviour; they are indications of how hard people are willing to try, of how much of an effort they are willing to exert in order to perform the behaviour.*

Various models have been used in the past to study a large spectrum of WTP milieus. These include WTP for luxury items, medical treatment, travelling and environmental initiatives. The most prevalent is the theory of planned behaviour and theory of reasoned action by Ajzen and Fishbein. Most of the previous studies on WTP for green electricity focused on the individual home owner. This research study focused on the development of an exploratory model to explain the contexts of WTP related to the large electricity consumers.

The following section discusses relevant consumer surplus and WTP concepts, previous related models used in research and their applicability, and the exploratory model of this study.

4.3 STRUCTURAL FACTORS CONSIDERED IN PREVIOUS WTP STUDIES

Salmela and Varho (2006:3 677) wrote that the emphasis has moved from analysing individual factors towards analysing the importance of structural barriers and general constraints, which prevent environmentally-responsible behaviour. This is supported by the studies completed by Do Paço and Raposo (2009:371) as well as Gerpott and Mahmudova (2010b:471), who based their studies on similar structural barriers,

These structural barriers can appear on an individual or group basis and include orientation and economic barriers. Some of these structural barriers, which are prominent in WTP for green electricity studies, are discussed here.

(i) Orientation barriers affecting WTP

- Supply deficits: Shortage of electricity supply changes the behaviour towards additional payment if the basic supply is not met. Therefore load shedding will have an impact on the willingness to pay.
- Social, historical and cultural context: The social effects of *apartheid* and the cultural behaviours of the country's population may have an effect. Large consumers will be more affected by the economy and business environment.
- Source of green electricity: South Africa is mainly focused on solar and wind electricity-generating technologies. In some studies there are communities that do not support wind electricity-generating technologies (Mann & Teilmann, 2013:1).

(ii) Economic environment barriers affecting WTP:

- Mandatory green electricity quota;
- Free-rider problem;
- Cost; and
- Feedback about consumer behaviour.

(iii) Other (barriers) to consider:

- Environmental legislation;
- Current and future power market (suppliers, shortage/oversupply);
- The evaluation of green energy by an individual's social reference groups;
- Current electricity bill level, with a price tolerance (for example, what will the consumer's WTP be if it means a five to ten percent increase in their current electricity bill?).

This study was conducted in the South African context, using data from a questionnaire. The questionnaire was completed during the time of load shedding (isolating consumers during times of shortage of supply of electricity). When considering the barriers, as stated by Salmela and Varho (2006:3677), this should have a negative impact on the electricity consumers' WTP for green electricity. There was a significant increase in the cost of electricity before and during the study as well as very low economic growth. These economic barriers can add an even more significant negative effect on the consumers' WTP. Other structural factors include the history of *apartheid* and all the various social effects that it had on the South African context which shaped the current economic environment and processes. This includes, for example, the Broad-Based Black Economic Empowerment Amendment Act, 2013 (Act No. 46 of 2013) which was promulgated as a result of *apartheid*.

According to Brand (1997), as cited in Salmela and Varho (2006:3 677), the supply deficits (e.g. lack of marketing) are an even greater barrier for environmentally-conscious behaviour than informational shortcomings. The lack of marketing can be understood from the viewpoint of the history of monopolies. Electricity companies may not be entirely used to acting in the liberalised market. This is particularly true in the Eskom context as they have supplied up to 96 percent of the electricity in South Africa. With IPPs entering the market, the future of marketing will need to change, especially for green electricity.

Brand (1997) argued that social, historical and cultural contexts define our actions and environmentally-conscious behaviour in certain situations (Salmela & Varho, 2006:3 676). Monopolies were abolished shortly before the Finland study was conducted and therefore the historical context can partly explain the consumer passivity. The interviewees needed to use their own initiative and take time to seek information, to enable them to compare different products and prices (Salmela & Varho, 2006:3 676). There is still a monopoly (as Eskom supplies most of the electricity) in South Africa and the researcher realised that this could prove to place a limitation on the answers provided by the respondents in this study. Consequently, scenarios were provided to inform them of the various available options in the limited time available to complete the questionnaire. To overcome this barrier once a payment system for green electricity is introduced, significant promotional education may be required to inform consumers.

Another significant barrier to environmentally-responsible behaviour is old behavioural patterns. Studies have suggested that these orientation problems may be even more significant barriers to environmentally-responsible behaviour than knowledge and attitudes (Salmela & Varho, 2006:3 677).

4.4 COST IMPACT FOR THE CONSUMER

Value can mean many things to many people. The first thought that comes to mind usually includes a connection to the cost of an item or service. Furthermore, people's perceptions of value for items and services varies for several personal reasons, as sentiments, aesthetics, age, and scarcity are valued differently by all.

There are many reasons to believe that the human impact on the environment is negative. According to Stern (2006:vi): "The scientific evidence is now overwhelming: climate change is a serious global threat, and it demands an urgent global response". These impacts will influence the natural environment through pollution of water, soil and air. The aesthetic impact and scarcity of natural resources therefore increase the value of these resources, making protection of these resources necessary. Additionally, the negative impact is influencing the surroundings that are seen as having value. It is therefore necessary to better understand how companies value goods and services to measure what they will be willing to pay to preserve natural resources.

When discussing what people will be willing to pay for goods or services, the concept of 'value' becomes relevant. People who need to decide whether they will be willing to pay a premium for green electricity will evaluate their decision based on what the value of green electricity is. Rehman and Dost (2013:100) believed that companies are joining in the green movement due to the value they perceive in saving the planet or to capitalise on the growing consumer demand for greener behaviours.

Salmela and Varho (2006:3 673) argued that a consumer can be mainly concerned with getting the cheapest product, but the same person in the role of a concerned citizen may choose to vote for a party that supports subsidies for renewable energy. This difference in roles is also reflected in the way consumer lobbying groups seem to be more concerned with the costs of electricity than with the environmental quality of the product.

An important barrier was considered during the consumer interviews by Salmela and Varho (2006:3 677), namely the higher cost of green electricity compared to conventional electricity. The premium price for green electricity and the learning curve were discussed in detail in Chapter 2. All the interviewees were of the opinion that higher prices might prevent green electricity purchases. They expected that it would be more expensive than conventional electricity, but they often mentioned that they did not have any knowledge about the price differences.

According to Salmela and Varho (2006:3 679), the results of consumer interviews were rather mixed, and even contradictory. It must be assumed that for certain consumers, much higher prices would form a barrier. However, in Finland it is possible to purchase green electricity for the same or even lower prices from specific companies, than undifferentiated electricity from some other companies. Salmela and Varho (2006:3 680) therefore concluded that the relative importance of costs, as the results of this particular factor, was not clear in this study. The low cost of coal-fired power plants in South Africa will most certainly have a different effect than those in Finland.

Simpson (2012:4) commented on the 'Carbon Disclosure Project', which measures companies in terms of the quality of their disclosure of carbon emissions and their performance in reducing them. He concluded that the top 50 companies, with the best actions on climate change, have outperformed the market and have provided double the financial return of the benchmark returns of the Global 500 companies over the previous six years. He therefore concluded that companies which take the best actions on climate change and sustainability are generally better managed and deliver higher returns.

The Eskom MYPD3 report (2012b:61) stated that electricity costs of IPPs, especially those from renewable energies, are considerably higher than the cost of Eskom-generated electricity, totalling R78 billion (an average of 212c/kWh) for the MYPD3 period (four years).

4.5 FREE-RIDER PROBLEM

According to Oliver et al. (2010:2), as well as Ek (2005:1 680), the environmental benefits associated with renewable energy sources (such as less air pollution) are characterised by non-rivalry and non-excludability. Thus, consumers are often reluctant to contribute to public goods, because the non-excludability characteristics lead to free-rider behaviour (Ek, 2005:1 680). As the purchasing consumers can thus not capture the benefits of the public good solely for themselves, they have strong incentives to become the ‘free recipient’ of the benefits, instead of becoming the ‘sponsor’ of the benefits for others (Ek, 2005:1 681; Wiser, 1998). Oliver et al. (2010:2) concluded that WTP decreases as the perception of free-rider behaviour increases.

Reactions of the interviewees can be explained with the theory of the problem of ‘collective good’, which has been developed to understand the gap between environmentally-conscious attitudes and behaviour. Researchers have pointed out the significance of costs for environmentally-responsible behaviour in situations where individual benefits are in contradiction with social benefits and there is the incentive to ‘free-ride’. Green power provides public benefits, but because the benefits of a public good cannot be captured fully by the purchasing users, they have no incentives to contribute to green power production (Salmela & Varho, 2006:3 678). Arkesteijn and Oerlemans (2005:186) believed that purchasing users can profit from the public good in this manner, while not paying for it. Feedback about the consequences of behaviour is found to be an important factor, which motivates consumers to change their free-riderism into environmentally- and socially-preferable behaviour. However, their material does not provide answers containing feedback regarding green electricity, as the interviewees were not buying green electricity. This situation will probably be similar in South Africa (Salmela & Varho, 2006:3 680).

The energy sector actors and consumers have different points of view when they discuss green electricity and consumer behaviour. The energy sector actors consider the issue on a general and societal level, contrasting green electricity purchases with state policies. The consumers on the other hand, consider the matter at a personal level, where time, money and other resources are significant (Salmela & Varho, 2006:3 680).

Oliver et al. (2010:2) stated, in what can be described as a reversal of the free-rider problem, that what other consumers do, may encourage similar action, even if it is only a perception. They concluded that behaviour, motivated by internal sanctioning, such as guilt or a bad conscience, is often stimulated by the beliefs about others’ behaviour, rather than their actual behaviour. Consumers therefore also need to believe that other consumers are supporting an applicable environmental campaign before they follow in the same direction. Oliver et al. (2010:2) did not test this question, as green electricity was not available in South Africa at the time of their study.

4.6 CONSUMER SURPLUS CONCEPT

According to Bowman and Ambrosini (2010:480), the consumer surplus concept was first formulated by Jules Dupuit in 1844. Their model addresses "value" and the value-creation process from the perspective of a profitable business. Bowman and Ambrosini (2010:480) explained the terms 'use values' (UVs) and 'exchange values' (EVs) as follows:

- Use values: UVs are properties of products and services that provide utility components (such as flour or steel) and human inputs, bought-in materials, and machinery, patents, logos, etc. owned by the firm.
- Exchange values: EVs are the monetary amounts exchanged between the firm and its consumers or suppliers when UVs are traded.

UVs are converted into EVs when they are sold. In most instances firms are established to generate a profit for investors. This means profit is EV retained within the firm. Figure 4.1 illustrates the flows of value as explained by Bowman and Ambrosini (2010:481).

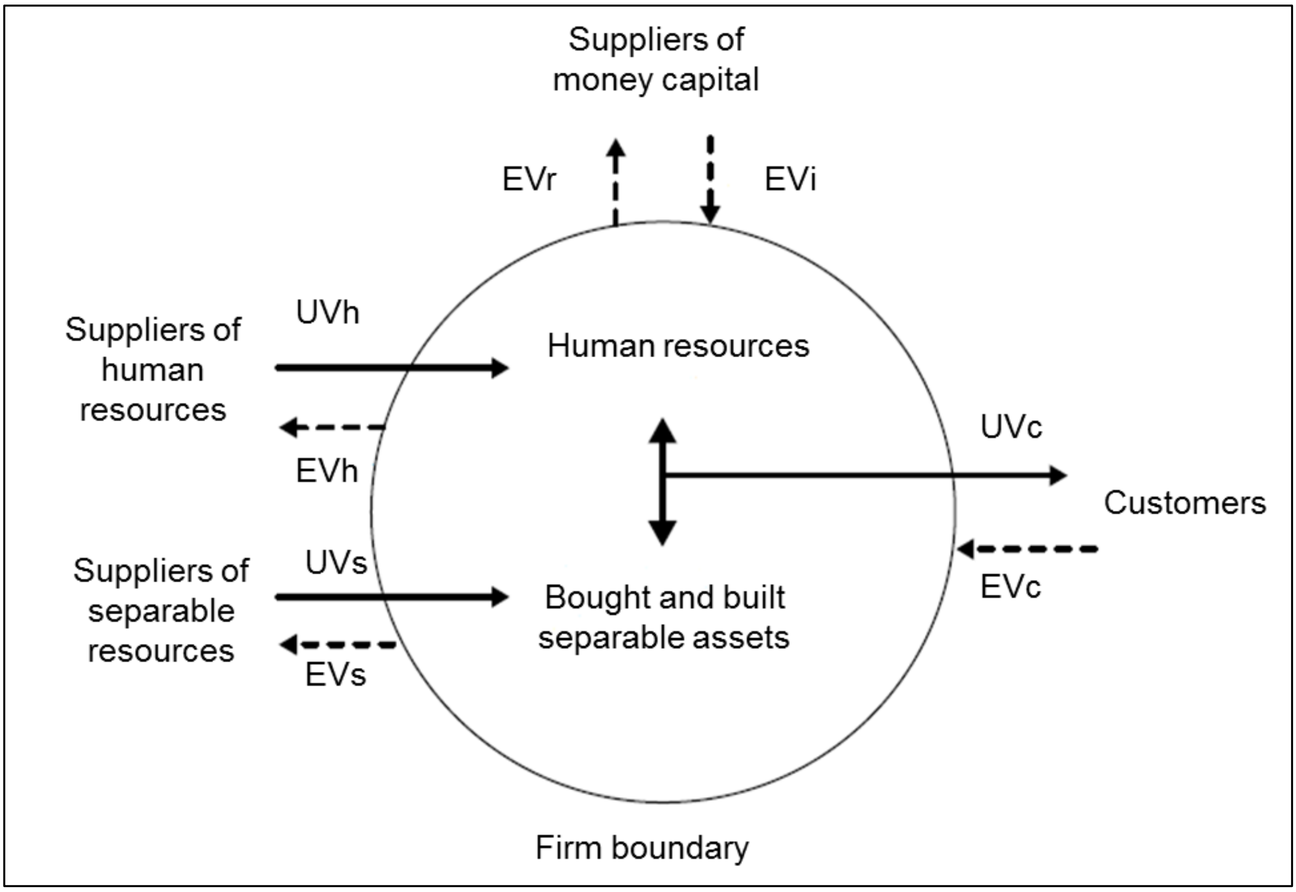


Figure 4.1: Flows of exchange value and flows of use value

Source: Bowman and Ambrosini, 2010:480.

EVr	Exchange value (return to investor)
EVi	Exchange value (original investment)
UVh	Use value (employed labour)
EVh	Exchange value (human inputs procured)
UVs	Use value (separable assets from suppliers)
EVs	Exchange value (payment/supplies for separable assets)
EVc	Exchange value (paid to consumers)
UVc	Use value (perceived use value of product /service. “reservation price”)

The dotted lines in Figure 4.1 indicate flows of exchange value and the solid lines indicate flows of use value. The key stakeholders in the firm are represented in Figure 4.1 as the consumers, the suppliers of separable inputs (components such as flour or steel), the suppliers of human inputs, and the owners of the firm (Bowman & Ambrosini, 2010:483). Value has a different meaning for each of these stakeholder groups. Bowman and Ambrosini (2010:483) stated that the customer value in this model can be argued to mean consumer surplus, or colloquially “value for money”.

Consumer Surplus is a subjective judgement of the UV of the supplied product or service, compared with the price charged for it, i.e. its EV. It can therefore be summarised as:

Consumer Surplus = Rand UVc – Rand Rand EVc …(4.3)

When considering Consumer Surplus in relation to the WTP a premium for green electricity by large consumers, the Consumer Surplus that was explored during this study is displayed in Figure 4.2 below. This figure graphically indicates the Consumer Surplus required by the large consumers to be willing to pay for the supply of electricity using conventional electricity-generating technologies compared to the premium green electricity-generating technologies.

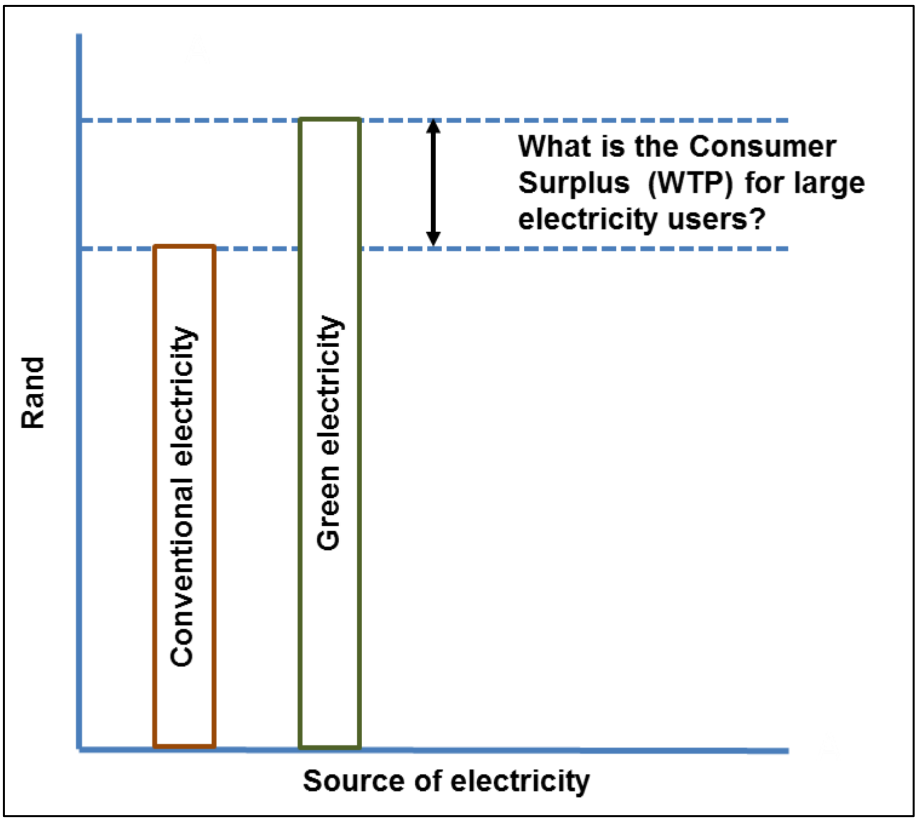


Figure 4.2: Consumer Surplus (WTP) for large electricity users

Woodside, Golfetto and Gibbert (2008:3) described another model of customer value assessment in the business-to-business context, as well as the advances in research in describing and understanding product and/or service value in business markets (Woodside et al., 2008:4). This makes the model relevant when researching the electricity supply value to large companies.

Woodside et al. (2008:4) explained value from the perspective of the consumer as a multi-dimensional concept of total benefits perceived or realised and total cost of using a product of service. They indicated that measuring the total consequences experienced through using the service or product represents a product quality metric.

Woodside et al. (2008:4) listed Formulae 4.4 to 4.7 as examples of value metrics appearing in the business-to-business marketing literature:

$$\text{Value} = \frac{\text{relative sum of weighted benefits perceived}}{\text{relative total costs perceived}} \quad \text{...(4.4)}$$

$$\text{Value} = \text{relative sum of weighted benefits perceived} - \text{relative total costs perceived} \quad \text{...(4.5)}$$

$$\text{Value} = \frac{\text{relative sum of total consequences}}{\text{relative total costs perceived}} \quad \text{...(4.6)}$$

$$\text{Value} = \text{relative sum of total consequences} - \text{relative total costs perceived} \quad \text{...(4.7)}$$

From these equations, Woodside et al. (2008:5) concluded that Formula 4.4 and Formula 4.6 provide ratios indicating the relative value of competing product and/or service designs. Therefore, when testing value for a product or service, the higher the weighted benefits and total consequences, the higher the value. This is similar to what Jules Dupuit concluded in 1844.

In Figure 4.3, Woodside et al. (2008:6) explain the price-benefit performance map. The dashed boundary region in Figure 4.3 illustrates the product-service design values that most consumers are willing to buy. This indicates the WTP boundaries. The three-dimensional box illustration depicts the ideal value location of substantially above-average relative value and substantially below-average relative total costs. The 'fair-value line' represents location points where total relative benefits equal total relative costs.

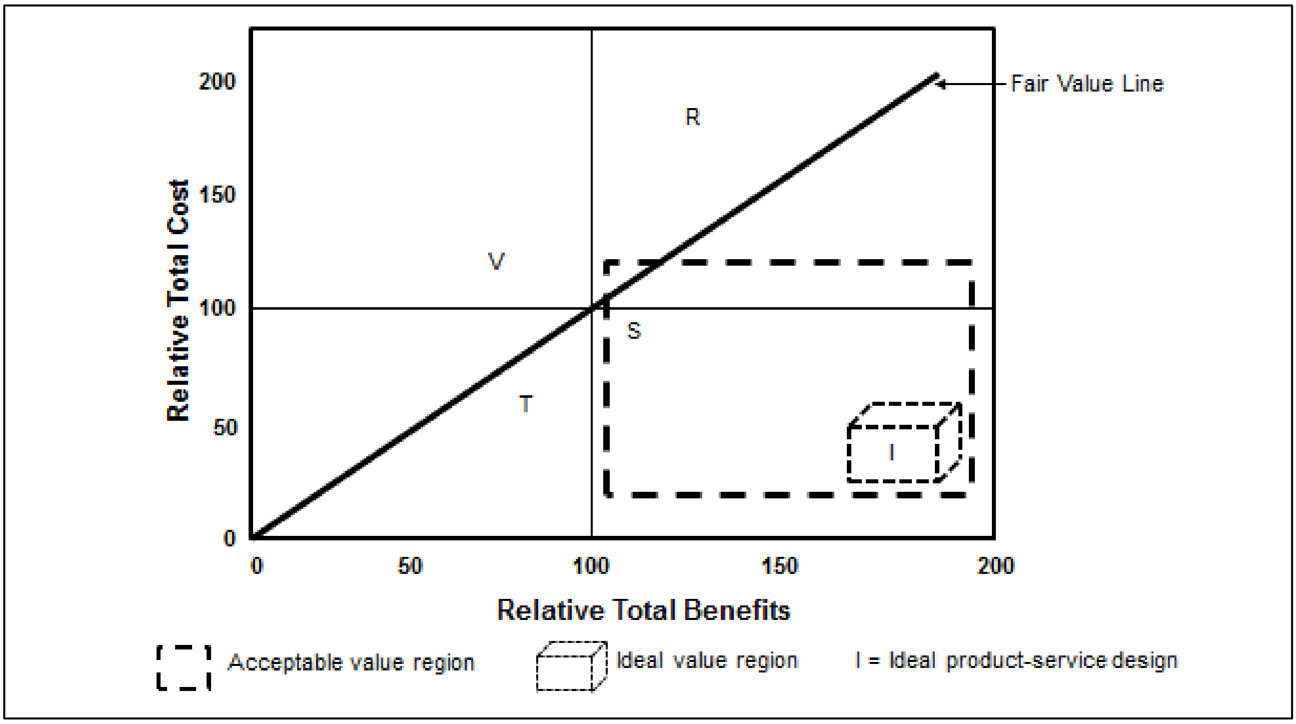


Figure 4.3: Price-benefit value map

Source: Woodside et al., 2008:7.

When determining the fair-value line, it is important to remember that utility as measured by the ‘maximum acceptable price’ is relative not only to the consumer's revenue (the ‘revenue effect’ which Dupuit had observed) but also to the price of other commodities (the ‘substitution effect’) (Vatin et al., 2016:78).

Woodside et al. (2008:12) quoted Louviere and Islam who stated: “We can more accurately determine the benefits that customers value by asking them to make choices among products that have different benefits and different prices”.

Green electricity is currently still a premium product over electricity generated using other products, for example, coal. This is especially so in the South African context. Therefore, green electricity can be considered as a luxury service. In terms of WTP a premium for green electricity, this study explored the large consumers’ willingness to pay on the boundary of the acceptable value region. This may be above the fair-value line for the utility, but may be motivated by the consumer’s environmental considerations.

Defining ‘luxury’ has many forms, depending on how the item is perceived or used. Green electricity as a luxury service is best defined as “non-essential items or services that contribute to luxurious living; an indulgence or convenience beyond the indispensable minimum” (Neufeldt & Sparks 2002). A premium payment is currently required in order to develop the supply of green electricity, therefore making green electricity an “indispensable minimum”.

This section has shown that Consumer Surplus is determined by a subjective judgement of the use value (the consumer value of the supplied product or service), compared with the exchange value (price charged for it). The next section reviews literature on how consumers evaluate the benefits of products or services.

4.7 CONSUMER BENEFIT ANALYSIS

Some consumers are unwilling to consider changing to a product that can provide the same, or sometimes even an improved, benefit at a lower cost. Woodside et al. (2008:6) stated that this status quo bias is because prior purchases from existing suppliers resulted in acceptable outcomes and fear of failure of the new product/service design exists as well as the related additional work in examining, and the search for evidence supporting, the superior value of the discontinuous innovation.

Customer perceived value is commonly defined as the consumer’s overall assessment of the utility of a product, based on perceptions of what is received and what is given. The literature has taken two distinct approaches to conceptualise customer perceived value, either as a uni-dimensional or a multi-dimensional construct. The uni-dimensional approach is based on the price perception between perceived quality and sacrifice. This approach has been criticised for not being able to discern the complex and multi-faceted nature of perceived value.

Multi-dimensional models of customer-perceived value, in order to provide a holistic view of this complex concept, have four distinct value dimensions, namely: (1) performance/quality; (2) price/value for money; (3) emotional value; and (4) social value (Chuah, Marimuthu, & Ramayah, 2014:535). Woodside et al. (2008:9) provided an example of possible benefits that consumers may use to evaluate products or services. In their example, they referred to the perceived benefits and value creation for a new lamppost material standard. This is supported by Petrick (2002:119) who found that the construct of perceived value is one of the most important measures for gaining competitive edge and has been argued to be the most important indicator of repurchase intentions. The large electricity consumers' evaluation of the product/service offerings from green electricity generation is shown in Figure 4.4 when relating the model from Woodside et al. (2008:9) to the green electricity environment.

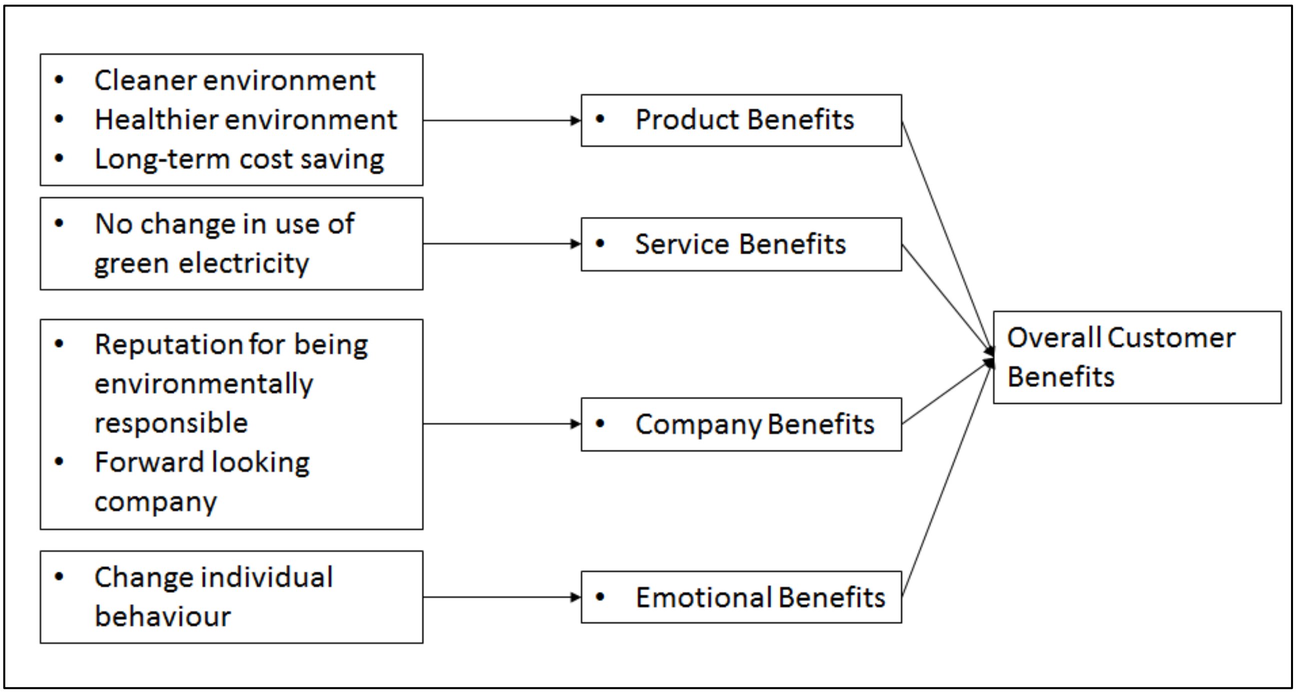


Figure 4.4: Perceived benefits and value creation for green electricity

Source: Adapted from Woodside et al., 2008:9.

Wiedmann, Hennigs and Siebels (2007:1) reviewed the literature regarding the measurement of the perceived luxury value of a service or brand and developed a multi-dimensional conceptualisation, which encompasses financial, functional, individual, and social value components. This model may serve as a basis for further research in identifying and segmenting different types of luxury consumers.

The Wiedmann et al. (2007:5) model of the key dimensions of luxury value perception is shown in Figure 4.9. This is similar to the Woodside et al. (2008:9) model of an example of possible benefits that consumers may use to evaluate product/service offerings. By relating this model to the WTP a premium for green electricity, means that the large consumers, when considering WTP for green electricity, will evaluate the cost relating to the acceptable value region as explained in Figure 4.5. Input cost relates to the actual cost paid for electricity used. Cost offsets are the possible cost benefits that may be realised for using green electricity. The overall cost must be within the acceptable value region for the large electricity consumer to be willing to pay. Considering what Woodside et al. (2008:6) stated about the consumer's status quo bias will depend on the additional benefit to the larger community and not directly to the large electricity consumer.

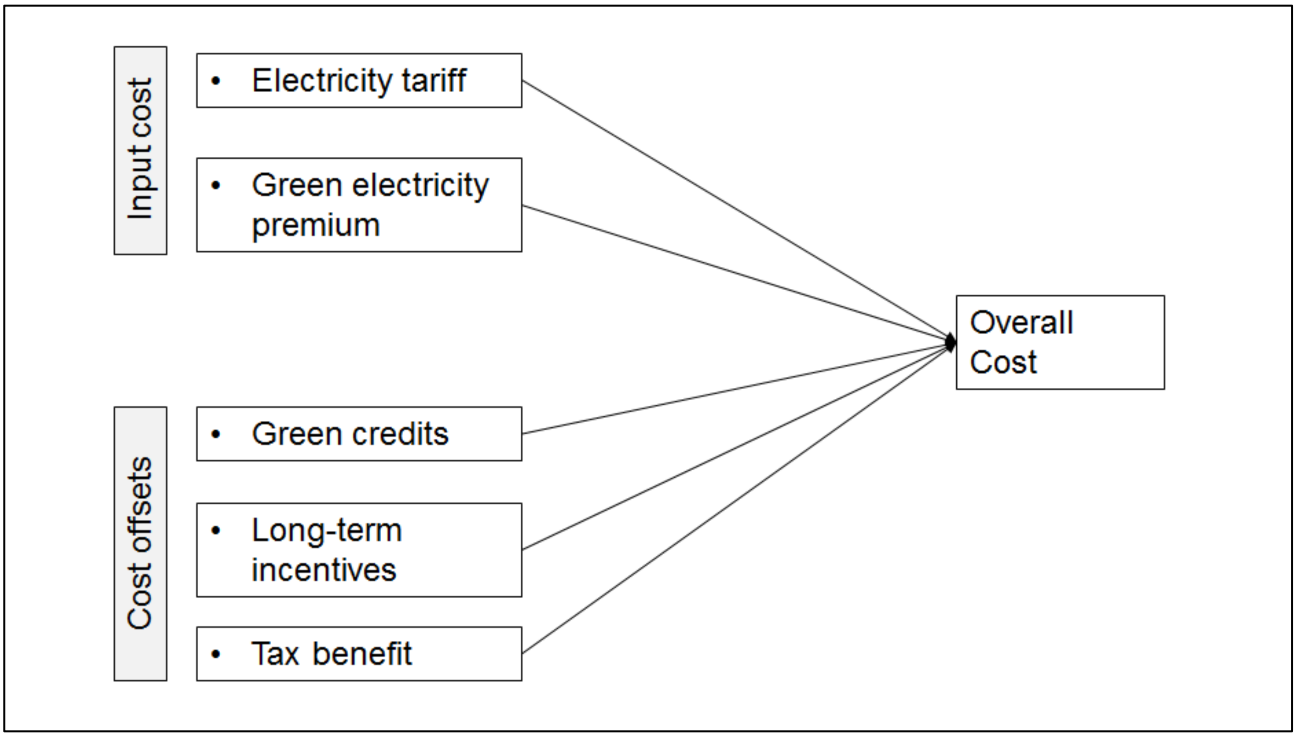


Figure 4.5: Perceived cost benefits for green electricity

Source: Adapted from Woodside et al., 2008:10.

Woodside et al. (2008:12) concluded that "customers do not think and purchase on the bases of 'key drivers' or importance ratings. They think and act on the bases of contingency heuristics" – meaning that customers will use a method of solving a problem for which no formula exists, based on informal methods or experience, and employing a form of trial and error iteration. They gave an example of a contingency decision rule: ''I'm willing to pay a relative price ten percent higher for product-service from vendor X if the total costs are 30 percent lower and the total benefits for vendor X's offering are within 95 percent of vendor Y's product-service design''.

New technology usually has product or service benefits, for example, a new computer will usually have a faster processing speed. To offset the additional cost related to green electricity, the product or service benefits must create sufficient benefits to create consumer surplus (Figure 4.6). In relation to WTP for green electricity, the combination of benefits and costs are limited to a small number of hypothetical scenarios that will provide an indication of what the consumers' preferences may be.

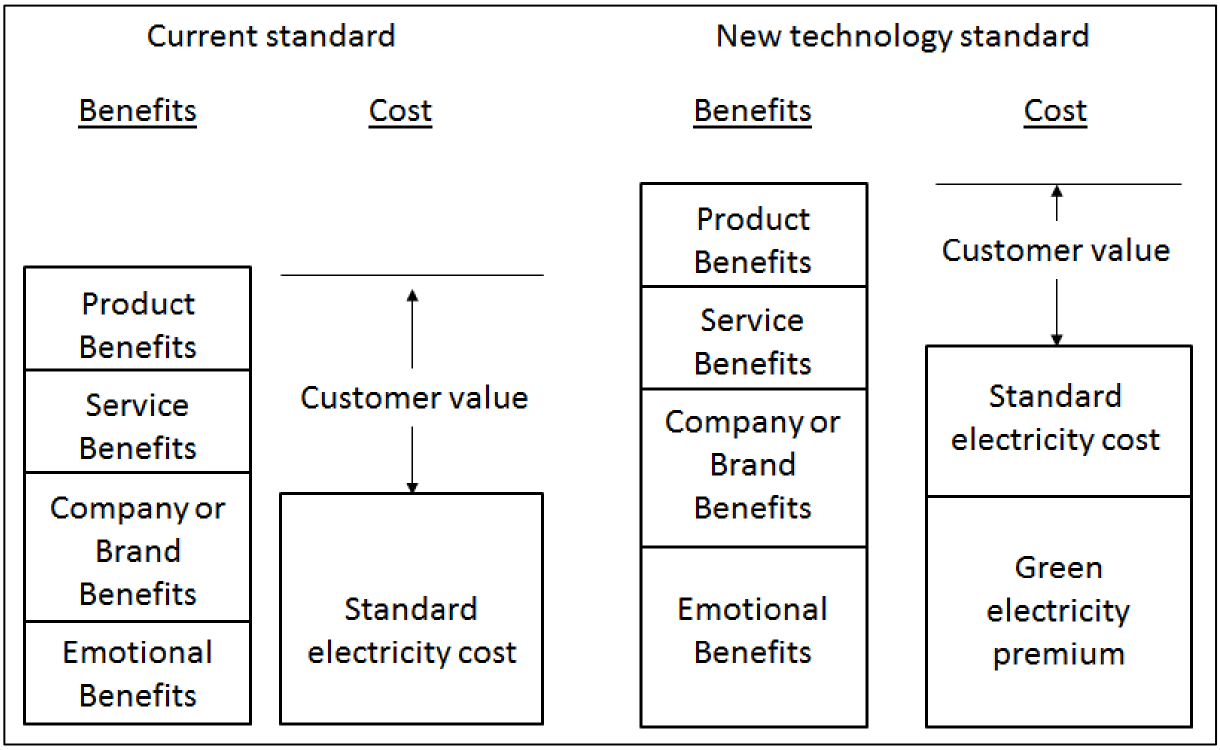


Figure 4.6: Combined view of perceived benefits and cost benefits for green electricity

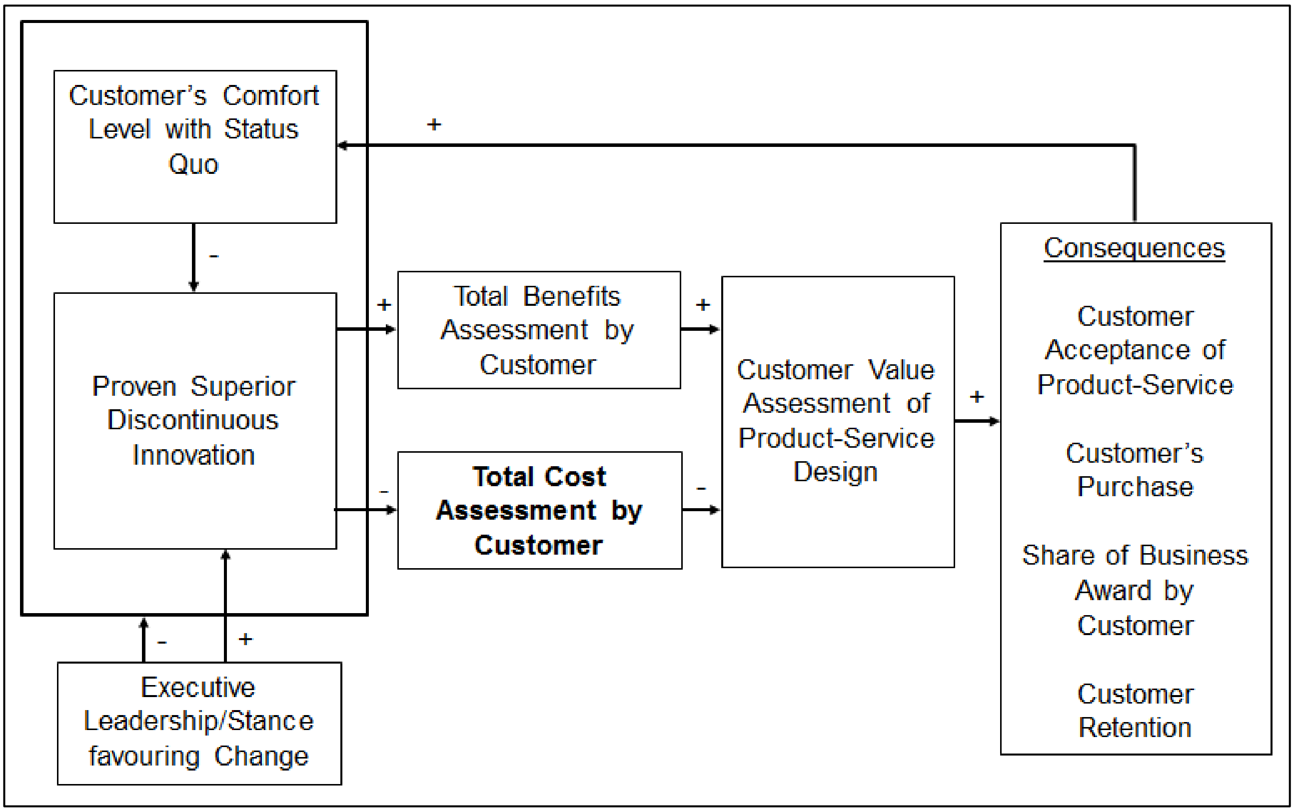
Source: Adapted from Woodside et al., 2008:11.

According to Woodside et al. (2008:12):

> *The think aloud method is one approach for uncovering customer value heuristics. Building forecasting models of customers' choices among various combinations of benefits and costs is another method. Business-to-business studies into customer preferences frequently apply this second method – often referred to as conjoint analysis or trade-off analysis.*

By combining all the above diagrams, Woodside et al. (2008:20) created an influence diagram to determine the consequences of customer value assessment, as shown in Figure 4.7.

When utilising the model of Woodside et al. (2008:20) for the exploratory study on the large consumers' WTP for green electricity, several important aspects were contained in the exploratory model. The customer value assessment relating to the product or service is influenced by the total cost assessment and overall customer benefits. In relation to green electricity, total cost assessment is the input cost of the electricity tariff and a green electricity premium where the total cost offset includes green credits, long-term incentives and tax benefits. The total benefits assessments additionally include product, service, company, and emotional benefits (Woodside et al., 2008:20, Chuah et al., 2014:535). An important aspect to note from the model by Woodside et al. (2008:20) is the influence executive leadership has on the change of product or service. To accommodate the influence of executive leadership in this study, the questionnaire was only sent to senior management and executive leadership of the companies.



*Antecedents – previous circumstances (predecessors). Discontinuous: Intermittent, Broken

Figure 4.7: Antecedents and consequences of customer value assessment of product/service designs

Source: Woodside et al., 2008:20.

This concludes the review of the Woodside et al. model in determining the customer's value assessment of products or services. Sometimes value cannot be physically seen or traded, for example the value associated with a brand. The next section reviews this intangible value.

4.8 INTANGIBLE RELATIONSHIP VALUE

Gerpott and Mahmudova (2010b:464) confirmed their hypotheses that the attitude towards one's current electricity supplier influences the propensity to adopt a green electricity supplier. Baxter and Matear (2003:7) stated that the perception of good governance will have an influence on intangible value. Baxter and Matear (2003:7) tested their hypothesis using their model shown in Figure 4.8, with the set of constructs and the relationships between them. Their model is a representation of the structure of the intangible part of the value of a business-to-business buyer-seller relationship. Baxter and Matear's (2003:15) finding was that business-to-business relationships do have the potential for value and therefore have an influence on value. Their model indicates that structural intangible value is affected by the consumer's attitude. Therefore, the consumer must trust that Eskom will spend the additional income from green electricity correctly.

This relates to the proposition made in Chapter 1, which proposes that what the consumer thinks of Eskom will influence their decision to pay additional for green electricity.

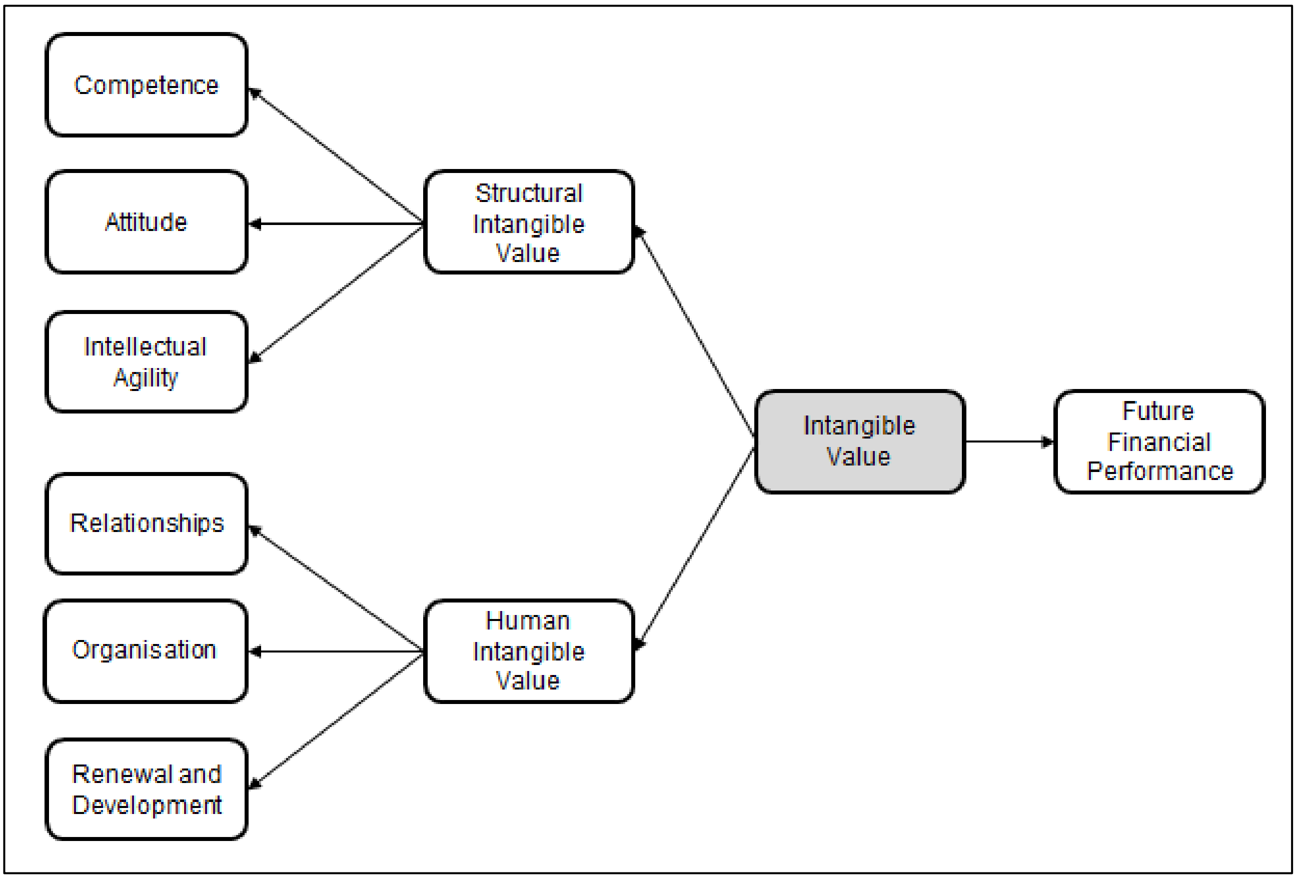


Figure 4.8: Theoretical model of intangible relationship value

Source: Baxter and Matear, 2003:8.

Wiedmann et al. (2007:6) explained 'price value' as referring to luxury goods. Many authors have shown and demonstrated that the price of a product may have a positive role in determining the perception of high quality although consumers can distinguish between the objective price and the actual price of a product. Wiedmann et al. (2007:4) explained the first order latent variables dimensions influencing Luxury Value as Financial Value, Functional Value, Individual Value, and Social Value (Figure 4.9).

Usability is based on both the product's properties and the consumers' needs. Hence, one has to differentiate between an objective and subjective judgment of usability which depends on individual evaluation and the specific purpose of use (Wiedmann et al., 2007:6). Usability Value for green electricity which can currently not sustain the base-load requirement for the large consumers was considered during the value assessment.

In terms of the Self-identity Value, in contrast to the external (social) facet of one’s self, self-identity refers to the internal (private) facet of one’s self. Wiedmann et al. (2007:7) explained this is in terms of the way the individual perceives him or herself. It is widely accepted within the theory of consumer behaviour that the self-image congruity moderates the relationship between one's self-image and one's image of a product or service. This relates to the Hedonic Value which provides the individual with an emotional value and provides intrinsic enjoyment in addition to their functional utility. Hence, hedonism describes the perceived subjective utility and intrinsically attractive properties acquired from personal rewards and fulfilment from the purchase or consumption.

Studies which focused on the influence of reference groups on the consumption of luxury brands revealed that conspicuousness of a product was positively related to its susceptibility to the reference group (Wiedmann et al., 2007:8). Therefore, purchasing green electricity at a premium may be important to individuals and companies in search of social status and representation. Research demonstrated that people tended to conform to the majority opinion of their membership groups when forming attitudes.

According to Wiedmann et al. (2007:4), the consumption of luxury goods appears to have a strong social function. Therefore, the social dimension refers to the perceived utility that individuals acquire by consuming products or services recognised within their own social group(s), such as conspicuousness and prestige value, which may significantly affect the evaluation and the propensity to purchase or consume luxury brands.

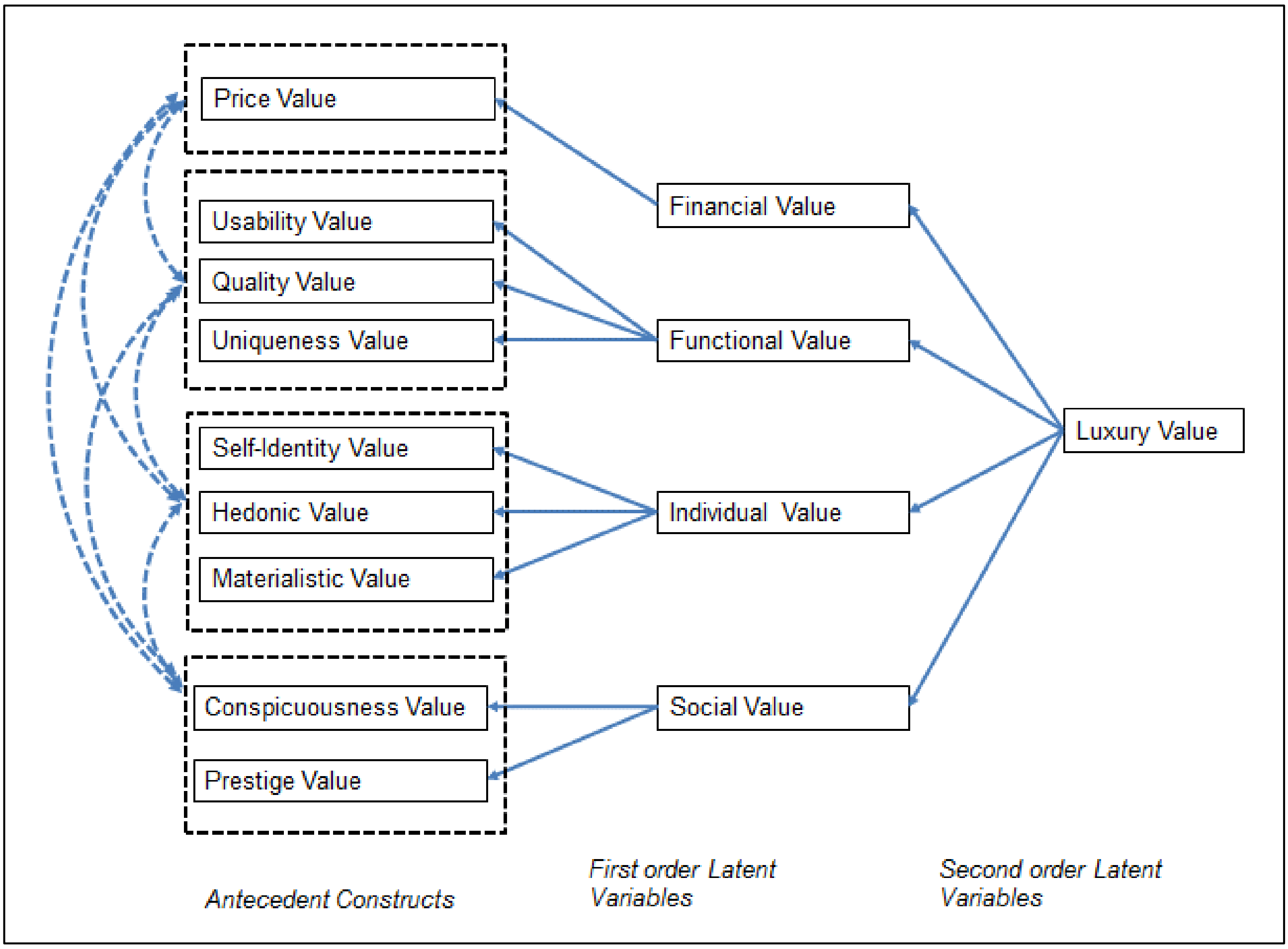


Figure 4.9: The conceptual model of the key dimensions of luxury value perception

Source: Wiedmann et al., 2007:5.

In conclusion, Wiedmann et al. (2007:11) stated that their framework, as seen in Figure 4.9, assumes the existence of a latent luxury value construct which can be applied to premium green electricity.

Another influence to consider is the difference between hypothetical and actual WTP, which necessitates the consideration of attitude-behaviour models. The next section discusses the influence of culture, attitudes and behaviours on the decision-making process of consumers towards a particular utility.

4.9 VALUES

The previous sections reviewed concepts on value and cost related to the WTP concept. This section investigates the theory of 'value' to determine what is meant with the understanding that price can be used as a measure of value.

According to Hansla, Gamble, Juliusson and Gärling (2008:769), values are conceptualised as guiding principles in a person's life for an analysis of the value construct. A cluster of several compatible values is referred to as a value orientation (VO).

Simpson (2012:4) stated that responsible investment starts with ethics or value-based investment, when people choose to invest in line with their beliefs and morality.

Schwartz (2006:2) believed that, when we consider our values, we take account of what is important to us, with reference to life. For each person, a particular value varies in importance. According to Schwartz (2006:2), his value theory adopts a conception of values, which specifies six main features and is implicit in the writings of many theorists. Schwartz (2006:2) also referred to previous studies done by Allport (1961), Feather (1995), Inglehart (1997), Kohn (1969), Kluckhohn (1951), Morris (1956), Schwartz and Bilsky (1987), as well as Rokeach (1973).

The six main features, as described by Schwartz (2006:3), are as follows:

(i) Values are beliefs linked inextricably to affect. When values are activated, they become infused with feeling.

(ii) Values refer to desirable goals that motivate action.

(iii) Values transcend specific actions and situations. Obedience and honesty, for example, are values which may be relevant at work or in school, in sports, business and politics, with family, friends or strangers. This feature distinguishes values from narrower concepts, like norms and attitudes, which usually refer to specific actions, objects or situations.

(iv) Values serve as standards or criteria. Values guide the selection or evaluation of actions, policies, people and events. People decide what is good or bad, justified or illegitimate, worth doing or avoiding, all based on the possible consequences for their cherished values. However, the impact of values in everyday decisions is rarely a conscious matter.

(v) Values are ordered by importance relative to one another. People's values form an ordered system of value priorities, which may beforehand determine an individual's attitude and behaviour. This hierarchical feature also distinguishes values from norms and attitudes.

(vi) The relative importance of multiple values guides action. Any attitude or behaviour typically has implications for more than one value. For example, attending church might express and promote tradition, conformity and security values at the expense of hedonism (delightfulness) and stimulation values. The trade-off among relevant, competing values is the factor which guides attitudes and behaviours. Values contribute to action to the extent that they are relevant in the specific context (hence likely to be activated) and important to the actor.

The following sections comprise a review of the literature on the influences of value and models related to willingness to pay.

4.10 ATTITUDES TOWARDS GREEN ELECTRICITY

Value orientation was described by Hansla et al. (2008:770) as values, which are conceptualised as guiding principles in a person's life. Adler and Gundersen (2008:19) indicated that attitude is influenced by the value construct of a person, as seen in Figure 4.10.

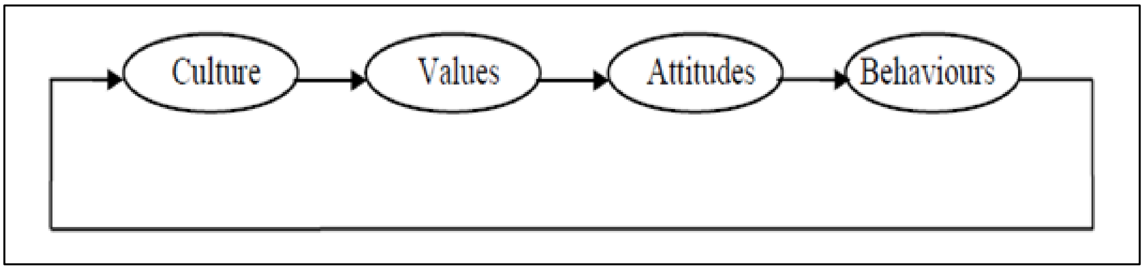


Figure 4.10: Influence of culture on behaviour

Source: Adler & Gundersen, 2008:19.

Warren et al. (2005:853) found that aesthetic perceptions, both positive and negative, are the strongest single influence on individuals' attitudes towards wind power projects. Hansla et al. (2008:769) explained their model of determinants of WTP for green electricity as values that are conceptualised as guiding principles in a person's life. A cluster of several compatible values is referred to as a value orientation (VO). Hansla's general finding is that pro-environmental attitudes and behaviours are positively related to a selfless or self-transcendence (ST) value orientation, while negatively related to an opposite selfish or self-enhancement (SE) value orientation. Awareness-of-consequences (AC) beliefs are related to value orientations (Hansla et al., 2008:769). A rational for this is that the value orientation biases individuals to select congruent information and to disregard or deny value-incongruent information.

Environmental concern (EC) refers to an evaluation of the consequences of environmental problems. A measure of EC was developed by Schultz (2001:330) and collaborators (Schultz, Gouveia, Cameron, Tankha, Schmuck & Franěk, 2005), distinguishing between environmental concerns for oneself, others, and the biosphere, related to different value orientations. In contrast to values and worldviews, for example New Environmental Paradigm, these measures are tuned towards concerns about consequences of environmental problems. Depending on the type of consequences, EC is associated with ST (concern about consequences for humans and the biosphere) or SE (concern about consequences for oneself) value orientations. Since one would not be concerned about consequences one does not believe exist, ECs furthermore presuppose beliefs that the adverse consequences of environmental problems exist. Thus, the relationship between EC and value orientation is expected to be mediated by AC beliefs.

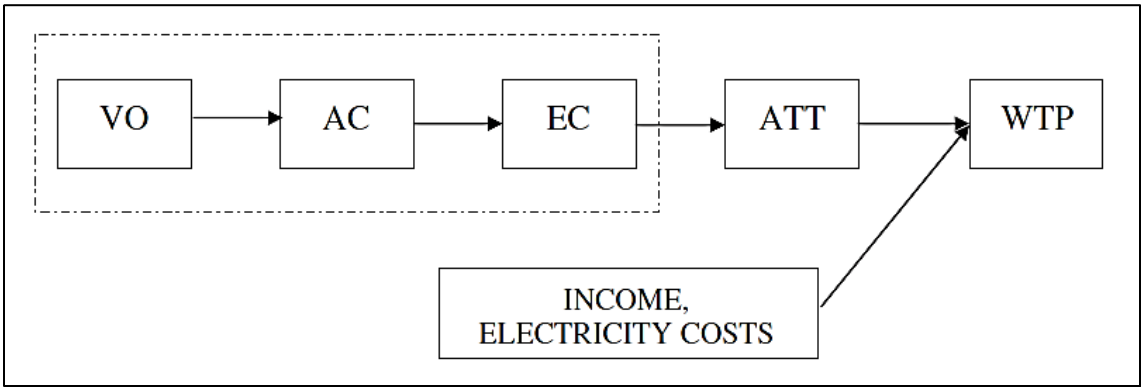


Figure 4.11: Hypothesised model of determinants of WTP for green electricity

Source: Hansla et al., 2008:770.

VO ¼ value orientation
AC ¼ awareness-of-consequences beliefs
EC ¼ environmental concern
ATT ¼ attitude towards green electricity

Hansla et al. (2008:769) gave the following example to clarify their statement: A person with an ST value orientation would pay attention to the adverse consequences of environmental problems for humans and the biosphere. On the other hand, an SE value orientation would make individuals form beliefs about adverse consequences of environmental problems for themselves. However, support for this assumption is not uniform. Hansla et al. (2008:769) stated that individuals prioritising SE values are more concerned about adverse consequences for themselves on environmental protection than the adverse consequences of environmental problems for themselves. Only the former type of AC beliefs will restrain pro-environmental behaviour. Measures taken to protect the environment imply sacrifices of one's own comfort. Examples include reducing car traffic, household energy saving, or paying for green electricity. It is thus hypothesised that individuals prioritising self-enhancement (SE) values would be opposed to such measures and will not be willing to pay a premium for green electricity.

The above description of the model defining the various determinants to the attitudinal factors from Hansla et al. (2008:769) is summarised in Figure 4.11. Although this model is useful to form the basis of an exploratory model, there are influences not considered. Shortcomings with this model when relating it to the WTP a premium for green electricity include the consideration for technology advancement, perception of the electricity supplier, and various others that were incorporated in the exploratory model of this study.

How behaviour influences change has been studied for many years. The next section reviews some of the related literature and models used to study behaviour.

4.11 THEORY OF PLANNED BEHAVIOUR AND REASONED ACTION

Understanding the large electricity consumers' intended behaviour and reasoning leading to their actions are important factors to be considered in the exploratory model. The two main factors that determine specific behaviour intentions are: (1) a personal or attitudinal factor; and (2) a social or normative factor.

A measure of WTP can be hypothesised as the intention to pay a certain amount of money for attaining 'public good' (Figure 4.12). It therefore becomes possible to apply theories of behavioural intentions as a basis for explaining WTP responses, of which the theory of planned behaviour and theory of reasoned action are the most prominent (Ajzen & Fishbein, 1973:42; Ajzen & Driver, 1992:300).

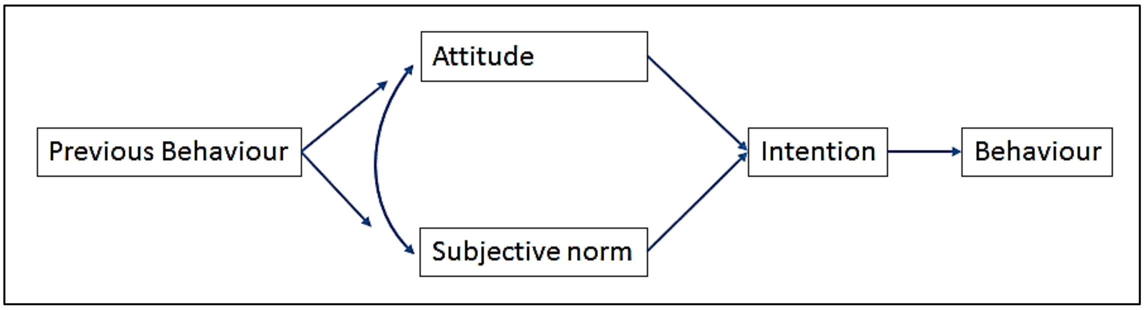


Figure 4.12: Theory of reasoned action

Source: Rossi and Armstrong, 1999:44.

Using the theory of reasoned action, Ajzen (1991:181) stated that the individual's intention to perform a given behaviour is a central factor in the theory of planned behaviour. He explained his theory in the form of a structural diagram (see Figure 4.13) by indicating that it depends, at least to some degree, on such non-motivational factors as availability of requisite opportunities and resources, for example time, money, skills and cooperation of others. Collectively, these factors represent people's actual control over their behaviour.

Ajzen and Fishbein (1969:401) presented a theoretical model for the prediction of behavioural intentions and corresponding behaviours as follows:

$$B \propto BI = [A\text{-}act]W0 + [NBp]W1 + [(NBs)(Mcs]W2 \quad \ldots(4.8)$$

where:

B overt behaviour
BI behavioural intentions
A-act attitude towards the behaviour in a given situation
NBp personal normative beliefs
NBs social normative beliefs, i.e. perceived expectations of others
Mcs motivation to comply with social normative beliefs
W0, W1 and W2 represent the empirically-determined weights

Ajzen and Fishbein (1973:42) stipulated that the main factors that determine specific behaviour intentions are a personal (NBp) and attitudinal factor (A-act) as well as a social (NBs) and normative factor (Mcs). Ajzen and Driver (1992:300) specified that a measure of WTP can be conceptualised as the intention to pay a certain amount of money for attaining benefit for the society. They therefore concluded that it becomes possible to apply theories of behavioural intentions as a basis for explaining WTP responses, of which the theory of planned behaviour and theory of reasoned action are the most prominent.

According to Rossi and Armstrong (1999:44), the underlying assumption of the addition of the final component in Ajzen's theory of planned behaviour, is that a person's perceived control corresponds to actual control and better predicts future behaviour from behavioural intentions than the first two components alone.

Using the theory of reasoned action, Ajzen (1991:181) concluded that the individual's intention to perform a given behaviour is a central factor in the theory of planned behaviour. It depends, at least to some degree, on such non-motivational factors as the availability of requisite opportunities and resources, for example time, money, skills and cooperation of others. Collectively, these factors represent people's actual control over their behaviour. Figure 4.13 depicts Ajzen's (1991:181) theory in the form of a structural diagram.

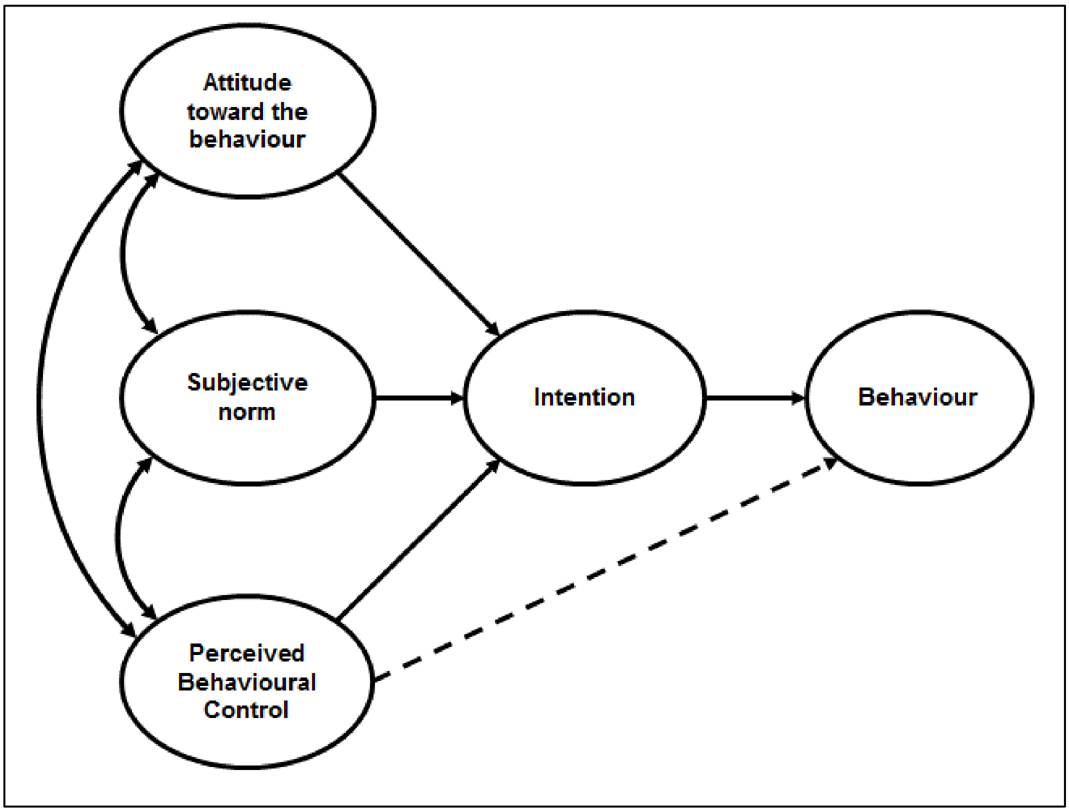


Figure 4.13: Theory of planned behaviour

Source: Ajzen, 1991:182.

When people are asked whether they will support an initiative, which is for the greater good of the masses, their answer will most probably be positive. Hansla et al. (2008:768) quoted Bird, Wüstenhagen and Aabakken (2002), who believed the rate of voluntary purchase of green electricity did not seem to exceed one percent, although a substantially higher number (40% to 90%) expresses a positive attitude towards green electricity. Hansla et al. (2008:769) concluded that a possible explanation of this gap is due to partly different factors determining attitudes towards green electricity (ATT).

Ajzen (1991:189) indicated that salient beliefs are considered to be the prevailing determinants of a person's intentions and actions. He distinguished three kinds of salient beliefs as follows: (1) behavioural beliefs which are assumed to influence attitudes towards the behaviour; (2) normative beliefs which constitute the underlying determinants of subjective norms; and (3) control beliefs which provide the basis for perceptions of behavioural control.

Oliver et al. (2010:2) believed that psychographic characteristics tend to be more reliable than demographic characteristics. Demographic characteristics imply the study of the characteristics of the human population, for example distribution, density, growth and vital statistics (Ilson, Crystal, Wells & Long, 1984a:454). These characteristics are discussed in more detail in the next sections.

Both the Theory of Reasoned Action and the Theory of Planned Behaviour are 'user-friendly' models. Rossi and Armstrong (1999:45) stated that "Ajzen and Fishbein (1980) and Ajzen (1991) state that the models can and should be tailored to sufficiently explain different behaviours, and that the base variables (ATT, SN and PBC1) may be broken down, rearranged, extended, etc. to suit the researcher's needs".

In summary, Ajzen and Fishbein (1969:401) presented a theoretical model for the prediction of behavioural intentions and corresponding behaviours. Hansla et al. (2008:770) defined various determinants to the attitudinal factor. According to Oliver et al. (2010:2), psychographic characteristics tend to be more reliable than demographic characteristics and they listed these aspects as knowledge/awareness, values, attitudes, concern for the environment and perceptions of the effectiveness of particular interventions.

Although the models from Ajzen and Fishbein (1969), Hansla et al. (2008) and Oliver et al. (2010) are valuable to measure influences of attitude and behaviour and form the basis of the exploratory model, the cultural influences on behaviour as well as technology acceptance influences are not considered. These influences on behaviour are discussed in the next section.

4.12 CULTURE AND CONSUMER BEHAVIOUR

In the following sections, the factors influencing behaviours towards WTP and their theoretical underpinnings are reviewed.

Previous research done by Oliver (2009:430) and Gerpott and Mahmudova (2010a:306) on residential electricity consumers indicated that WTP has particularly been influenced by the following:

- Attitudes towards environmental issues;
- Attitudes towards one's power supplier;
- Perceptions of the evaluation of green energy by an individual's social reference groups; and
- Current electricity bill level versus household income.

Paying a premium for electricity to improve the environment is an act that is for the benefit of oneself and others. Knowing that one may be paying while others will not and they still have the benefit, relates to a social responsibility value.

Schwartz (2009:1) stated that values have been a central concept in the social sciences since their inception. He quoted both Durkheim (1893, 1897) and Weber (1905) who argued that values are crucial for explaining social and personal organisation and change. Schwartz (2009:1) concluded that values are used to characterise societies and individuals, to trace change over time, and to explain the motivational bases of attitudes and behaviour. This study therefore focused on how a company's behaviour will be influenced relating to their collectivism and individualism values.

Individualists are more likely to prioritise their own goals over those of the group and are more likely to belong to more 'in-groups' in comparison to collectivists (Shulruf et al., 2011:174). Most of the studies related to collectivism are concerned with a sense of duty to a group, harmony, and working with a group. To a lesser extent, collectivism is related to a sense of belonging to a group, one's contextual self and hierarchical value. Shulruf et al. (2011:174) concluded that collectivists are more likely to internalise the group's goals and values and give higher priority to these. It is therefore important to understand the individual's orientation related to the group or personal greater good.

Adler and Gundersen (2008:19) and Hansla et al. (2008:769) indicated that attitude is influenced by the value construct of a person, as illustrated in Figure 4.10 and Figure 4.11. Schwartz (2006:2; 2009:10) as well as Pinillos and Reyes (2011:25) stated that values are the core element of culture. According to Gouveia, Milfort and Guerra (2014:42), values guide actions, From these studies, it is clear that values significantly influence attitudes and must be incorporated into the model. Values are however very wide statements and need to be defined in more detail to determine which values relate to the WTP of green electricity.

Delobbe, Haccoun, and Vandenberghe (2002:6) stated:

> *Hofstede's (1980) study indicates that cultural values reliably distinguish national subsidiaries of a multi-national corporation. Values belong to people more than to organizations and, to paraphrase Hofstede, Neuijen, Ohayv and Sanders (1990), organizations import values more than they create them. Appraisal of values, therefore, may be of particular significance to the recruitment and selection sub-system within organizations. At the same time values appear less sensitive to differences between firms within the same national culture (Hofstede et al., 1990).*

Grojean, Resick, Dickson and Smith (2004:225) concluded that other factors provide environmental cues regarding ethics, and that it is the organisation's leaders who establish and enact the goals, policies, and practices that provide these environmental cues, and thus play the primary role in the creation of climates related to ethics (Dickson, Smith, Grojean & Ehrhart, 2001).

Melé (2014:465) concluded that several scholars affirm that managers have an influence on developing virtuous or vicious behaviours in their subordinates by their own behaviours and how they communicate values.

Waldman, De Luque, Washburn, House, Adetoun, Barrasa et al. (2006:834) concluded the following:

> *…the current findings suggest that organizational-level variables are likely to account for variance in managerial values pertaining to CSR (corporate social responsibility), beyond individual or societal-level factors. Specifically, CEO leadership in the form of vision and integrity may be a driver of how subordinate managers view the importance of CSR in their decision-making.*

The researcher could not find any arguments against the influence of a leader's values on an organisation. According to Hofstede (1998:479), "Culture is a characteristic of the organization, not of individuals, but it is manifested in and measured from the verbal and/or nonverbal behaviour of individuals".

As indicated in Figure 4.7, the model by Woodside et al. (2008:20) concluded that executive leadership influences the decision to change a product or service. Therefore, to understand the company's behaviour towards WTP for green electricity, first requires an understanding of the senior management and executive leadership's orientation related to their collectivism and individualism values. The exploratory model incorporated questions related to the collectivism and individualism values that influence culture.

Shulruf et al. (2011:176) explained that the final version of the Auckland Individualism and Collectivism Scale (AICS) consisted of 26 items of which 11 relate to collectivism and 15 relate to individualism. Of the 11 collectivism items, seven relate to advice and four to harmony. Of the 15 individualism items, seven relate to competition, four to uniqueness, and four to responsibility.

A six-point scale was used ranging from never or almost never to always. This model is shown in Figure 4.14 below.

Based on the finding by Shulruf et al. (2011:174) that individualists are more likely to prioritise their own goals over those of the group in comparison to collectivists, it can be concluded that the large consumers' WTP for green electricity will be influenced by their leadership, depending on the cultural values.

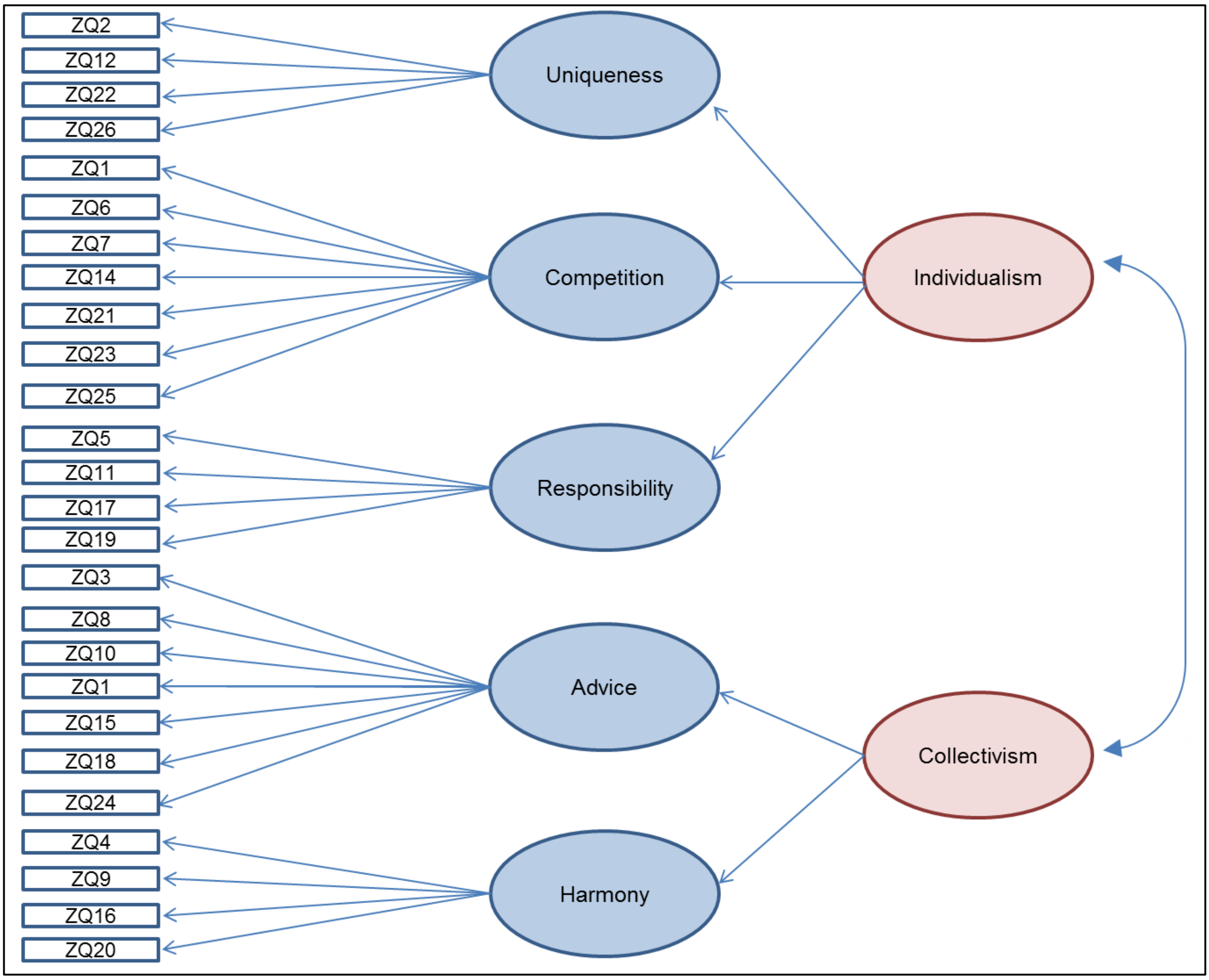


Figure 4.14: Collectivism and individualism model

Shulruf, Hattie and Dixon, 2007:395.

The AICS was developed to address methodological issues that were identified when using previous scales for collectivism and individualism (Shulruf et al., 2011:182). They argued that respondents are asked about the frequency of their behaviour or thoughts concerning a particular issue, rather than the importance of certain individual values and that this makes the AICS superior to other individualism and collectivism measures. In their view, this records the respondent's perception of their own behaviour rather than those behaviours they regard as optimal or desired – therefore providing more accurate information on people's behaviours.

From the above, it can be argued that when you test the organisation's leadership values, it will be a good indicator of the organisational values. The studies of Shulruf, Hattie and Dixon (2007) and Shulruf et al. (2011) used the AICS to determine the differences related to collectivism and individualism values of various nations. Their studies indicated that the AICS is not only valid but highly reliable (α>.70).

The questionnaire used in this study was focused on the leaders of the organisation's cultural values related to collectivism and individualism as this would give an indication of the organisation's values towards social responsibility and protecting the environment. For this study, their model was used to determine the cultural values related to collectivism and individualism of an organisation's leaders. The hypothesis is that collective leaders have a higher value towards social responsibility than individualists. The cultural value model relates to the model developed by Ajzen (1991:182), the theory of planned behaviour, and was one of the inputs to the exploratory model.

4.13 TECHNOLOGY ACCEPTANCE MODEL

According to Davis, Bagozzi and Warshaw (1989:319), better measures for predicting and explaining system use would have great practical value. The study by Davis et al. (1989:319) focused on the perceived usefulness, ease of use and user acceptance of information technology. In the late 1980s, computer technology became a useful business tool, but was not accepted by all businesses. The use of green electricity generation technologies has practical benefits, but is currently not accepted by all users. Davis et al. (1989:985) used the technology acceptance model to provide an explanation of the determinants of computer acceptance. They stated that it is preferable to use a model that is helpful not only to predict actual system use, but also for explaining why a particular system may be unacceptable. With this information, available corrective steps can be taken to encourage system usage.

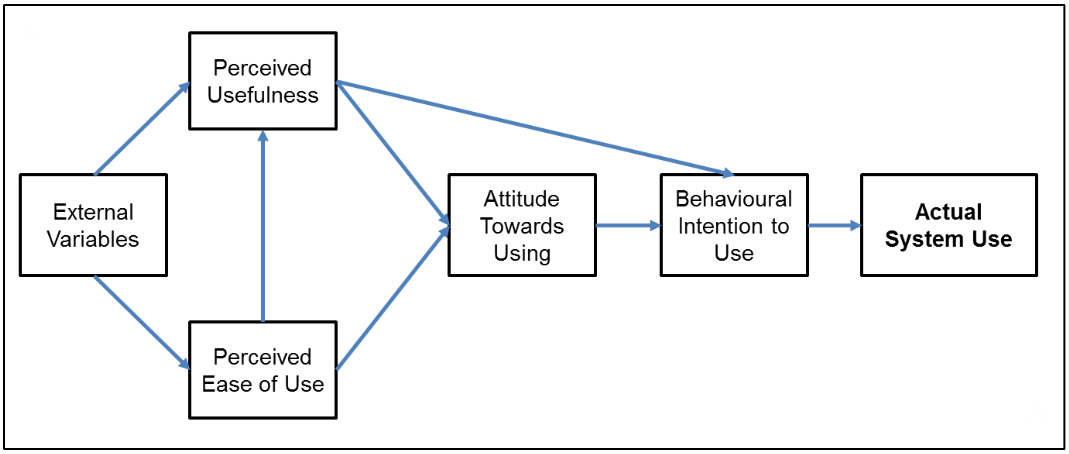


Figure 4.15: Technology acceptance model

Source: Davis, Bagozzi and Warshaw, 1989:985.

The model used in their study is shown in Figure 4.15. Understanding the influences regarding the acceptance of green electricity generation technologies has not been considered in previous WTP studies.

Teo (2010:260) tested teachers' beliefs about usefulness and ease of use of technology. The findings in his study suggest that normative and contextual variables, facilitating conditions (FC) and subjective norms (SN), do influence teachers' beliefs about usefulness and ease of use of technology. These findings support current research, which suggests that a positive feeling towards the use of technology is associated with factors that foster the continued and sustained use of technology (Teo, 2006; and Yildirim, 2000, cited by Teo, 2010).

Teo (2010:260) concluded that the behavioural intention to use technology was indirectly predicted by facilitating conditions and mediated by attitude towards usage. It was concluded that facilitating conditions (FC) alone are not enough to motivate pre-service teachers to use technology. For example, pre-service teachers may not use technology simply because technical support is provided.

Teo (2010:254) used the causal relationships between perceived usefulness, perceived ease of use, attitude towards technology use, and behavioural intention to use technology, based on the technology acceptance model documented by Davis et al. (1989:985) (Figure 4.15) to create his technology acceptance model.

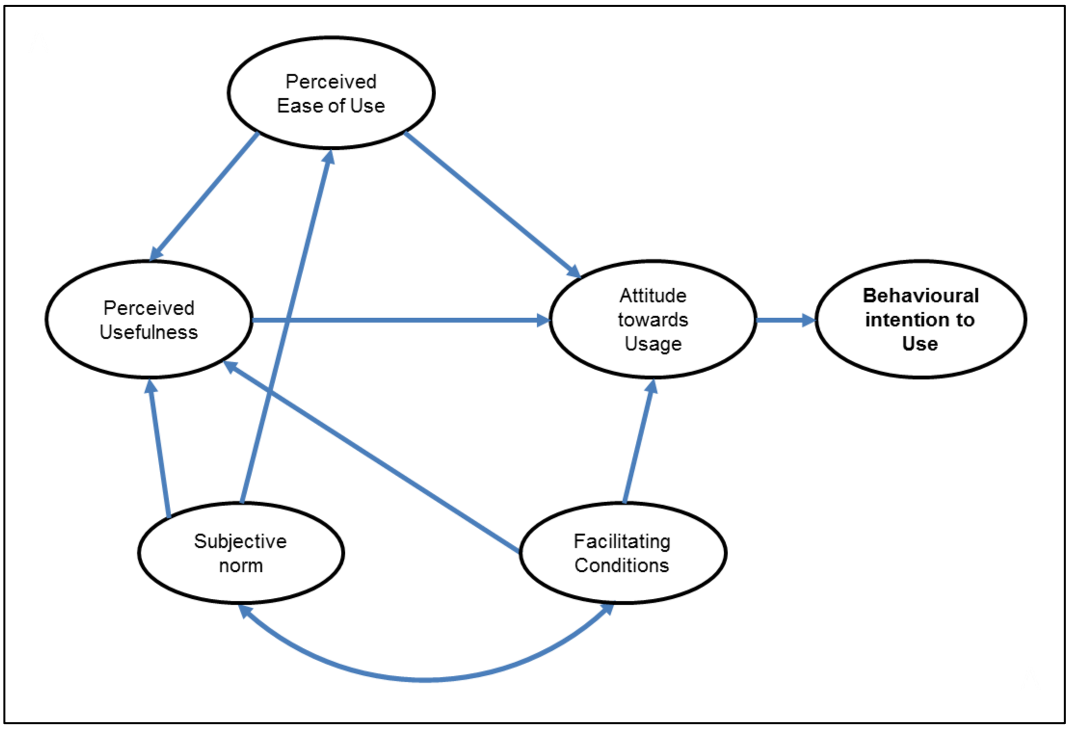


Figure 4.16: Updated technology acceptance model

Source: Teo, 2010:256.

Perceived usefulness (PU), as shown in Figure 4.16, indicates the degree to which a person believes that using a particular technology will enhance their job performance. The perceived ease of use (PEU) is the degree to which a person believes that using a particular technology will be free of effort. In the model, PU and PEU are hypothesised to have a significant influence on attitude towards usage (ATU), which in turn influences the behavioural intention to use (BIU). In addition, PEU has been shown to significantly influence PU on the basis that, when users perceive a technology to be easy to use, they are likely to find it useful as well (Teo, 2010:255).

Rogers (1995:5) defined diffusion as “the process in which an innovation is communicated through certain channels over time among the members of a social system”. The diffusion of innovations is essentially a social process in which subjectively-perceived information about a new idea is communicated in relation to the basis of a scientific assessment. For Rogers, the innovation-decision process involves five steps: (1) knowledge; (2) persuasion; (3) decision; (4) implementation; and (5) confirmation. These stages usually follow each other (Sahin, 2006:15).

The technology acceptance model and innovation diffusion theory are similar in some constructs and complement each another to examine the adoption of new technology. The integration of these two theories delivered good results, providing an even stronger model than either standing alone (Lee, Hsieh & Hsu, 2011:125). Utilising this concept and the literature from previous WTP studies, the theoretical research model was developed. For this study, the large electricity consumers’ perception towards ease of use and usefulness of green electricity was tested as a predictor of behavioural intention to their WTP for green technology.

4.14 CONCLUSION ON WTP CONCEPTS AND MODELS

This concludes the section that has focused on the relevant WTP concepts and models used to explore those concepts that were used in the exploratory model for this study. The next section is a review of studies related to willingness to pay. These studies were conducted on a country level to establish the WTP determinants for the residential consumers. As no previous studies have been conducted on large electricity consumers, the researcher reviewed these studies (1) to better understand how the studies were conducted and (2) to evaluate the conclusions for the development of the exploratory model relating to the large electricity users.

4.15 PREVIOUS STUDIES RELATED TO THE WILLINGNESS TO PAY OF ORGANISATIONS

Numerous WTP studies have been conducted on residential electricity users, focusing on the opinion of individuals. These studies were done in various countries and used varying methodologies. The outcomes, however, were remarkably similar and are discussed in more detail later in this study.

After an extensive search by the University of Stellenbosch Business School (USB) library staff and the researcher, no evidence of a study on the willingness to pay of the large consumers in any country could be found. One of the main issues of installing green energy plants currently, is the cost to supply continuous electricity. This premium for green electricity has been discussed by Zografakis, Sifaki, Pagalou, Nikitaki, Psarakis and Tsagarakis (2010:1 088) as well as Whitehead and Cherry (2007:247). Obtaining the large companies' involvement may assist the payment for new technology development and implementation when 'someone' needs to pay.

The Climate Group conducted a study amongst 137 leading corporations, cities and states from 20 countries (De Villiers, 2010:15). From the selected population in their study, the Climate Group found that companies reduced their carbon emissions by improving energy efficiency, using green electricity and managing waste more optimally.

In their study, they summarised the drivers that encourage businesses to purchase green electricity as follows: Organisational values, civic responsibility, employee morale/employee value proposition, company public image, green marketing, reduced regulatory risk/regulation, lowest cost, forced action, consumer request, media attention, senior executives' 'personal conviction', investment opportunities, competitive pressure, threats to personal assets, responsibility to be community leaders with regards to green energy, and shareholders being concerned about climate change. De Villiers (2010:15) found that civic responsibility is significant in South Africa and in Europe as the company public image is a significant motivator.

Wiser, Fowlie and Holt (2001:1 090) concluded that for companies in the USA, the four greatest motivations to purchase green electricity are: (1) organisational values; (2) civic responsibility; (3) employee morale; and (4) the company's public image.

De Villiers (2010:15) concluded that in Europe (Germany, Great Britain, Finland, Sweden and the Netherlands), the key motive of a business to buy green electricity is the enhancement of corporate image. An important finding was also that there is a strong correlation between the perceived benefits of green electricity and a business's WTP a premium for it. This emphasises the importance of understanding the motivators and drivers for large electricity consumers to pay for green electricity.

4.16 RESIDENTIALLY-FOCUSED STUDIES RELATED TO THE WILLINGNESS TO PAY

4.16.1 Overview

Some of the previous WTP studies conducted on the residential electricity users are discussed in this study for better understanding of the topic. The focus of these studies was mainly on the willingness to pay a premium for green electricity and to test the price tolerance of the users. Oliver et al. (2010:2) listed the different aspects that characterise psychographic factors as follows:

- Lack of knowledge/awareness related to the electricity industry will influence your WTP;
- Values and awareness will influence your attitude towards your WTP;
- Attitude will influence your WTP;
- Concern for the environment will influence your WTP; and
- Perceptions of the effectiveness of particular interventions protecting the environment will influence your WTP.

Figure 4.17 is the model of Oliver et al. (2010:3), as adapted from Salmela and Varho (2006:3 678), relating to the determinants of WTP. This model indicates that price tolerance for green electricity will be influenced by value orientation, awareness-of-consequences beliefs, environmental concern and attitude towards green electricity. This model is a comprehensive model and includes most factors to be considered during a WTP study. Some adjustment, however, is required for the large consumer because this model focused only on the residential consumer (which involved household income) and did not include cultural aspects or the technology acceptance and ease-of-use aspects, which are important in an organisation.

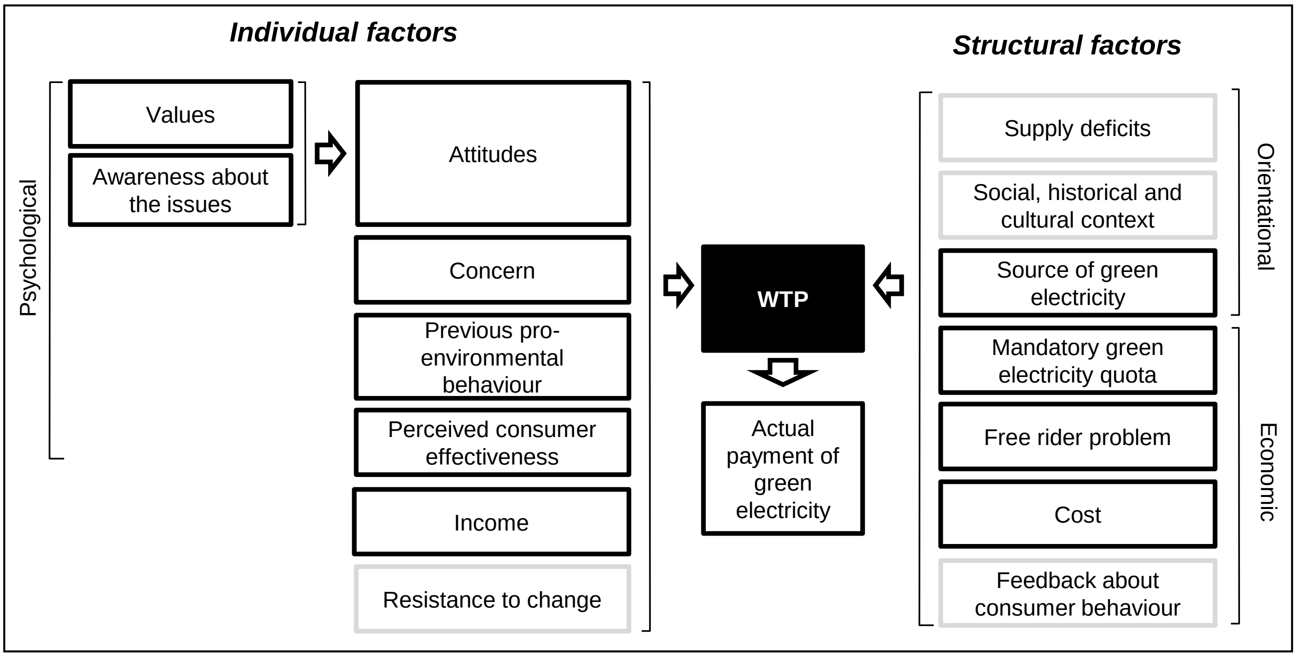


Figure 4.17: Factors impacting WTP

Source: Oliver et al., 2010:3, model adapted from Salmela and Varho, 2006:10.

After an extensive review of the available WTP literature studies, the researcher selected the studies listed in Table 4.1 to be used for this study. This selection was based on WTP studies that had included a significant population within a country and not only selected regions or related to selected sectors of the country. The South African study was included, even though it only related to South Africa's Cape Peninsula, because it is the most in-depth study done in South Africa.

The WTP studies that have been discussed or referred in this document are listed in Table 4.1, for ease of reference. The details of each study follow in the next sections.

Table 4.1: Willingness to pay studies of different countries

Country study	Authors
Portugal	Do Paço & Raposo (2009:364-378)
Crete	Zografakis, Sifaki, Pagalou, Nikitaki, Psarakis & Tsagarakis (2010:1 088-1 095)
Germany	Gerpott & Mahmudova (2010a:304-318; 2010b:464-473)
USA	Roe, Teisl, Levy & Russell (2001:917-925) Whitehead & Cherry (2007:247-261)
Japan	Nomura & Akai (2004:453-463)
UK	Scarpa & Willis (2010:129-136)
Korea	Yoo & Kwak (2009:5 408-5 416)
Italy	Bollino (2009:81-96)
Finland	Salmela & Varho (2006:3 669-3 683)
SA	Oliver, Volschenk & Smit (2010:1-7)

4.16.2 Portuguese WTP study

The focus of the study by Do Paço and Raposo (2009:364) was to identify distinct market segments based on environmental and demographic variables.

The methodology used to collect data was through a survey of Portuguese consumers by using a self-administered questionnaire. The questionnaire was composed of two sections, namely: (1) data about the demographic characteristics of respondents; and (2) the environmental dimension. Do Paço and Raposo (2009:364) included the following aspects as part of the environmental dimension: concern, affect, knowledge, environmentally-friendly behaviours, information search, activism, green products buying behaviour, sensitivity to price, waste separation/recycling, perceived efficiency and scepticism.

Do Paço and Raposo (2009:364) submitted the data obtained to a multi-variate statistical analysis, which included the following sequence of statistical treatments: factor analysis, cluster analysis and discriminant analysis. After this, a characterisation was made of the segments they had established.

The results of this study showed that certain environmental and demographic variables are significant for differentiating between the ‘greener’ segment and the other segments. Do Paço and Raposo (2009:364) concluded that the Portuguese do not translate their concerns for the environment into actions, despite their support for policies designed to improve the environment. The Portuguese respondent’s participation is often based on protecting the environment by saving electricity and water, which shows that these concerns may be more closely related with economic factors than with an environmental consciousness. According to Do Paço and Raposo (2009:364), Portuguese consumers understand the challenges currently relating to environmental preservation, but they are reluctant to act on these concerns.

Table 4.2 offers a summary of Do Paço and Raposo’s (2009:369) literature review, which shows the main criteria and respective segmentation variables that may be used to segment the green consumer market.

Table 4.2: Segmentation studies of the green consumer market

Criteria	Variables	Studies
Demographic	Age, gender, family dimension, religion, subculture, education, job/occupation, income, social class, habitation type	Anderson et al. (1974); Banerjee & McKeage (1994); D’Souza et al. (2007); Jain & Kaur (2006); Laroche et al. (2001); Mainieri & Barnett (1997); Roberts (1996); Samdahl & Robertson (1989); Webster (1975)
Psychographic	Lifestyle, personality, values motivation	Cornwell & Schwepker (1995); McCarty & Shrum (1994); Straughan & Roberts (1999); Vlosky et al. (1999)
Behavioural	Knowledge, attitude, product usage, purchase behaviour, brand loyalty, benefits	Alwitt & Berger (1993); Balderjahn (1988); Cornwell & Schwepker (1995); Kinnear et al. (1974), Rios et al. (2006); Schuhwerk & Lefkokk-Hagius (1995)
Environmental	Concern, knowledge, affect, commitment, ecological consciousness, perceived behavioural control, norms, subjective environmentally-friendly behaviour, activism, green products buying behaviour, information search, willingness to pay, scepticism towards environmental claims, recycling	Antonides & Van Raaij (1998); Chan & Yam (1995); De Pelsmacker et al. (2002); Maloney & Ward (1973); Maloney et al. (1975); Martin & Simintiras (1995); Mostafa (2007); Schlegelmilch & Bohlen (1996)

Source: Do Paço and Raposo, 2009:369.

In order to carry out the factor analysis, Do Paço and Raposo (2009:371) used the principal components method to extract the factors. The variables were grouped into nine factors and all together, accounted for 57.37 percent of the total variance. In order to facilitate the understanding and interpretation of the results, the factors were rotated using the Varimax method. This method is used to simplify the expression of a particular sub-space in terms of just a few major items. The descriptions of the factors are provided in Table 4.3.

Table 4.3: Green segmentation: An application to the Portuguese consumer market

Factors	Description
1. Environmentally-friendly buying behaviour	This reflects a tendency for consumers to be careful when shopping, buying more energy-efficient, less polluting, environmentally-friendly, recycled and biodegradable products, as well as products of which the packaging causes less harm to the environment.
2. Environmental activism	This essentially brings together the variables related to the interest in and search for information, collaboration with environmentalist organisations, and an active participation in protests held in defence of environmental causes.
3. Environmental knowledge	These variables are related to the knowledge of practices that do not harm the environment, knowledge about aspects such as the “greenhouse effect”, “acid rain” or the “hole in the ozone layer”.
4. Environmental concern	These variables are related to the concern about the various aspects of pollution (air pollution, problem of ozone depletion, pollution caused by industries, etc.).
5. Recycling	These variables are related to the separation of packages, the availability/willingness to take them to recycling collection points, and the attempt to encourage others to behave in a similar way.
6. Perceived consumer effectiveness	This presents a mixture of variables which, on the one hand, relate to the concern about environmental problems and the unwillingness to believe that such problems will sort themselves out alone and, on the other hand, the personal stance that is linked to the propensity to believe that individual action can help to solve these problems.
7. Resource saving	This includes variables that may reflect an environmentally-friendly behaviour, since they relate to the saving of energy resources and the attempt to reduce the quantity of rubbish produced.
8. Economic factors	These variables are related to the WTP a higher price for green products and to pay more taxes in order to protect the environment, as well as the greater concern with the environment in detriment to the economy.
9. Scepticism towards environmental claims	The emphasis is on consumer reactions to the promotional messages and claims made by firms at the level of advertising, packaging and labelling.

Source: Do Paço and Raposo, 2009:371.

The main themes from this study are: attitudes towards environmental issues, attitudes towards one’s power supplier, environmental activism, environmental knowledge, and economic factors. These themes correlate with the literature study and strengthen the argument that an exploratory model for large consumers is required, as a minimum, to consider the nine factors as described in Table 4.3 as variables.

4.16.3 Crete WTP study

The aim of the study done by Zografakis et al. (2010:1 088) was to analyse and to evaluate the citizens’ public acceptance and willingness to pay for renewable energy sources in Crete. They conducted a contingent valuation study, utilising a double-bound dichotomous choice format to elicit people’s WTP and factors affecting it. Interviews were held with residents’ households. Their questions were structured in two fields, namely: (1) information and awareness level for renewable energy sources and (2) estimation of WTP for renewable energy sources.

To determine the WTP, Zografakis et al. (2010:1 089) shaped the WTP question under three different initial sums of WTP. The question was:

> *If we suppose that the renewable energy sources projects to be developed in Crete result into the environmental and social benefits already described to you, and an additional cost is required, which would be included in your four-month bill of electricity, would you be willing to pay x€? (where x was 5€ for the first, 10€ for the second and 12€ for the third version of the questionnaire, respectively).*

Those who had answered positively were asked about a higher bid, while those who had answered negatively, were asked a lower bid. This describes what is known as the double-bound dichotomous choice format question and they preferred this to the single dichotomous choice question. Zografakis et al. (2010:1 089) asked a follow-up question to those who had replied 'no' to both WTP questions. If the amount was zero, there was an additional question asked about the reasons behind the response to help locate zero and protest responses. This was done to distinguish between the different underlying motives for a 'no' response.

Zografakis et al. (2010:1 088) concluded that the mean WTP per household was found to be 16.33€ to be paid quarterly as an additional charge on the electricity bill. Larger WTP was reported by those with a high family income and residence size, those having a higher level of energy information and awareness concerning climatic change, those who have invested in some energy-saving measures, and those who suffer from more electricity shortages than others. All of these influences are incorporated into the theoretical model to explore how the large electricity consumers' WTP relates to these influences.

4.16.4 German WTP study

Gerpott and Mahmudova (2010a:304) developed hypotheses on the effects of various attitudinal and perceptual variables, as well as socio-demographic characteristics of residential electricity consumers on an individual's WTP a mark-up for electricity generated from renewable energy sources, compared with the price due for electricity from conventional sources. Their hypotheses were tested with data from a standardised telephone survey of 238 household electricity consumers in Germany. Gerpott and Mahmudova (2010a:306) structured their investigated determinants of WTP for green electricity into psychological constructs and socio-demographic characteristics.

In another study of Gerpott and Mahmudova (2010b:464), they tested their hypotheses on the effects of eight attitudinal and perceptual characteristics of residential electricity consumers on their propensity to adopt a green electricity supplier. The hypotheses were tested empirically with data generated by means of a standardised telephone survey of 267 household electricity consumers of a German regional power supplier.

Gerpott and Mahmudova (2010a:305) stated that the literature refers to this basic intention to accept a certain maximum mark-up for a specific service as WTP (synonyms: price acceptance, reservation price, maximum price). A specific WTP variant, which has a special relevance for pricing green electricity, is called price mark-up tolerance (PMT). According to Gerpott and Mahmudova (2010a:311), the five attitudinal characteristics relating to the WTP, under the psychological construct are the following:

- Attitude towards environmental protection issues;
- Attitude towards one's current electricity supplier;
- Difficulty of switching one's electricity supplier;
- Household ecological conservation behaviour; and
- Valuation of green energy by social reference groups.

Gerpott and Mahmudova (2010a:307) stated that more cognitive and less evaluative psychological determinants of WTP for green electricity include perceptions of:

- Difficulty in switching one's electricity supplier;
- Household ecological conservation behaviours;
- Evaluation of green energy by social reference groups; and
- Knowledge about renewable energy sources.

Gerpott and Mahmudova (2010a:310) listed five socio-demographic characteristics of persons and residential households that were measured by single questions in connection with: (1) household income/financial restrictions; (2) monthly electricity bill; (3) household size; (4) age; and (5) gender.

Gerpott and Mahmudova (2010a:315) found that the monthly electricity bill, age and financial restrictions still have a significant influence on PMT for green electricity. A low level of financial restrictions was associated with the acceptance of mark-ups of five or ten percent. They concluded from their study that household income and gender had no unique effect on the mark-up level.

Gerpott and Mahmudova's (2010b:466) motivation for the project was to gain a better understanding of the reactions of residential energy consumers in Germany to environmentally-friendly investment programmes and offerings of electric power companies. They conducted a telephone survey with a random sample of residential electricity consumers of a German regional electric power company in mid-2008 to gather the data.

The purpose of their latest study was to empirically explore factors influencing the willingness to adopt green electricity tariffs in a sample of residential energy consumers in Germany (Gerpott & Mahmudova, 2010b:465).

The remainder of their paper focused on developing propositions on significant adoption of green electricity determinants. Potential adoption of green electricity determinants may be structured into (1) supply-side factors (e.g. price level, competitive intensity in a region, certification or branding of green power offers) and (2) consumer-side variables. Their latest work focused on consumer-side variables.

A recapitulation of Gerpott and Mahmudova's research (2010b:468) on the adoption of green electricity determinants can be summarised as follows:

- Willingness to adopt green electricity was measured by four reflective indicators derived from researchers like Bansal, Taylor and James (2005), Henseler (2006) and Kim, Shin and Lee (2006).
- Social endorsement of green energy used, was captured by two reflective indicators adopted from Bansal and Taylor (1999).
- Attitudes towards environmental protection issues were gauged reflectively through five indicators, addressing one's valuation of environmental issues and protection activities.
- Perceived difficulty of switching one's electricity supplier was captured formatively by four items, dealing with various monetary and psychological cost incurred by a move to another electric power company (also called electricity power producer). The indicators were derived from measures similar to those developed by Burnham, Frels and Mahajan (2003) and Henseler (2006).
- A person's knowledge ability, concerning electricity power producer switching procedures and consequences, was tapped formatively by factual questions concerning the switching process for residential energy consumers.
- A household's past switching experiences in various contractual goods markets, such as financial services, mobile communications or electricity, were measured formatively by the following items: probing whether respondents had changed their bank or their mobile network operator within the previous 12 months and whether they had ever switched their electricity power producer.
- Price emphasis was captured reflectively by two indicators. They were inspired by researchers like Lichtenstein and colleagues (1990) and (1) refer to the willingness of consumers to search for lower electricity prices in spite of the efforts required to detect such prices; and (2) refer to their intention to switch to another electricity power producer in the case of unfounded price increases of their current electricity power producer.
- The construct differences between electricity power producer offerings were measured by two reflective items. They were adopted from Ping (1993) and Jones, Mothersbaugh and Beatty (2000) and address perceptions concerning the dissimilarity among electricity power producers in terms of their offerings and price levels.

The results of the hypothesis tests by Gerpott and Mahmudova (2010b) are listed in Table 4.4.

Table 4.4: Summary of the hypothesis test results by Gerpott and Mahmudova

Hypothesis	Result
1. Social endorsement	Confirmed
2. Environmental protection attitude	Confirmed
3. Switching difficulty	Most confirmed
4. Knowledge ability	Not confirmed
5. Switching experiences	Partially confirmed (LC subsample only)
6. Price emphasis	Not confirmed
7. Differences between EPC offerings	Not confirmed
8. EPC social responsibility	Partially confirmed (LC subsample only)

EPC Electric power company or Electricity power producer
LC Low level consumption subsample

Source: Gerpott and Mahmudova, 2010b:471.

Gerpott and Mahmudova (2010b:471) concluded that social endorsement, environmental protection attitude, and switching difficulty had significant influences on WTP. Switching experiences and EPC social responsibility only had partial influence, with knowledge ability, price emphases and differences between EPC offerings not indicating a significant influence on WTP. The most unexpected outcome from this study was that the price emphasis hypothesis test result was not confirmed as most literature would suggest.

Gerpott and Mahmudova (2010a:304) concluded that 53.4 percent of the participants were willing to pay a mark-up for green electricity. A price tolerance of 26.1 percent was reported, equal to a five to ten percent increase in their current electricity bill. Binary logistic and ordinal regression analyses indicated that an increased price tolerance for green electricity is particularly influenced by the following:

- Positive attitudes towards environmental issues;
- Positive attitudes towards one's current power supplier;
- Positive perceptions of the evaluation of green energy by an individual's social reference groups;
- Smaller household size; and
- Lower current electricity bill level.

These findings are used to derive suggestions for energy-related informational activities of public institutions, green marketing strategies of energy companies and future consumer research regarding demand for pro-environmental goods.

During the study of Gerpott and Mahmudova (2010b:464), they concluded that, regardless of a person's level of actual power consumption in the recent past, the propensity to adopt green electricity is most strongly influenced by general consumer attitudes towards environmental protection issues and social endorsement of green power used by close social contacts. They also concluded that the identification of factors influencing the adoption of green electricity offers practical implications for marketers of utilities and contributes to the academic knowledge base of a service domain, characterised by increasing societal importance.

4.16.5 United States of America WTP study

Roe, Teisl, Levy and Russell (2001:917) analysed the environmental attributes of the United States residential consumers' willingness to pay for price premiums charged for green electricity. This survey followed the conjoint analysis technique by providing two hypothetical electricity services and having the respondents choose the one they would buy.

They found that many population segments are willing to pay for decreased air emissions, even if there is no alteration in fuel sources. Several groups are willing to pay significantly more when emission reductions stem from increased reliance upon renewable fuels.

Further analysis done by Roe et al. (2001:917) suggested that several product features, not considered in the survey, help explain real price premiums, including fuel mix from newly-created renewable generation capacity, Green-e certification, brand name, and state of offer. They summarised the results by stating that: "consumer-driven purchases can, in part, support the future of renewable generation capacity in the United States, though reliance upon other policy alternatives may be needed if energy prices spike".

Survey methods and analysis used by Roe et al. (2001:917) featured numerous questions about electricity use, awareness and intentions. Their survey used the conjoint analysis methodology which is commonly used as a statistical technique in research to determine how people value different attributes that make up an individual product or service.

Roe et al. (2001:924) concluded that a wide array of population segments is willing to pay small amounts for tangible improvements in air emissions, even if no alteration of power generation sources takes place. They furthermore suggested that, for certain population segments only, larger premiums may be obtained for emission reductions that are accompanied by increased reliance upon renewable fuels. These results suggest that firms may not need to enter the realm of renewable generation sources to garner a price premium, as long as they can communicate their improved emissions record.

According to Roe et al. (2001:925), the US electricity-generating firms have responded with several product offerings, priced to capture the value consumers hold to environmental benefits, created from alterations in electricity generation methods.

In another study done in the USA, Whitehead and Cherry (2007:247) said: "The most persistently troubling empirical result in the contingent valuation method (CVM) literature is hypothetical bias, the tendency for hypothetical willingness to pay to overestimate real willingness to pay".

Both ex-ante and ex-post approaches have been shown to successfully mitigate hypothetical bias. Whitehead and Cherry (2007:247) compared ex-ante and ex-post hypothetical bias approaches. The ex-ante approach to hypothetical bias mitigation has evolved from simple reminders about economic constraints to elaborate lessons on how to avoid overstating one's WTP. Whitehead and Cherry (2007:247) referred to Loomis and his associates (1994) who reminded respondents about substitutes and income constraints and found that these reminders did not affect WTP. In 1996, their respondents were reminded about income constraints and were asked to answer as if they would actually pay. The additional survey information moved hypothetical WTP to real WTP.

Whitehead and Cherry (2007:247) referred to Caplan (2003) who found that a ''short-scripted'' cheap talk design for phone surveys is able to mitigate hypothetical bias for respondents who have strong environmental preferences. In addition to this information, they wrote about Lusk's findings (2003) that the cheap talk script eliminates hypothetical bias for respondents with less knowledge about the goods.

Whitehead and Cherry (2007:247) developed a realistic WTP scenario. They presented a hypothetical market in which survey respondents first described the Green Energy Program which will deliver improved air quality in the western North Carolina mountains. Whitehead and Cherry (2007:247) then described the change in air quality. After the payment mechanism and policy implementation rules had been described, the WTP question was presented. Whitehead and Cherry (2007:250) based their survey design on the prior studies that had examined WTP for green power, for example Champ and Bishop (2001) and Poe et al. (2002).

Whitehead and Cherry (2007:247) found, that by employing both approaches (both ex-ante and ex-post) to mitigate hypothetical bias, the annual benefits of the regional amenities associated with a Green Energy Program in North Carolina are $186 million, thereby supporting their hypotheses that many population segments are willing to pay for decreased air emissions.

4.16.6 Japan WTP study

Nomura and Akai (2004:453) reported the results of a survey on the willingness of Japanese households to pay more for renewable energy, using the contingent valuation method. They defined renewable energy systems as environmentally sound from the viewpoint of carbon-dioxide emissions and resource depletion.

Nomura and Akai (2004:454) gave an example of the cost of photovoltaic systems in the year 2000 and concluded that the higher cost of energy, supplied from renewable energy systems, than that of conventional fossil-fuel systems, hinders the wider spread of renewable energy systems.

For their survey, Nomura and Akai (2004:455) selected potential respondents by utilising telephone directories. They then sent out a mail survey. Their questionnaires consisted of the following three parts:

- In the first part, they asked about the willingness to pay by using a dichotomous choice with a follow-up question.
- In the second part, the respondents were asked about their characteristics, for example annual income and age.
- In the third part, questions were asked about respondents' possession of equipment related to energy use and their thinking about the Kyoto Protocol to the United Nations' Framework Convention on Climate Change.

The respondents were asked about their WTP premiums for renewable energy by applying a dichotomous choice with follow-up questioning. The absolute amount the respondents would be willing to pay was asked directly, because an amount is easier to visualise than a ratio or percentage.

Nomura and Akai (2004:462) found that people would be willing to pay more for renewable energy under the following circumstances: (1) when they can visualise renewable energy technologies being used in future; (2) when renewable energy systems become more familiar; and (3) when the efficiency of renewable energy becomes more widely known.

4.16.7 United Kingdom WTP study

Scarpa and Willis (2010:129) conducted a study to investigate households' WTP for renewable energy technologies in the United Kingdom. They stated that the renewable energy policy is driven by the projected damage costs of continued carbon emissions into the atmosphere, the real rise in carbon-based domestic energy prices over the previous few years, and the perceived need for security of supply.

Scarpa and Willis (2010:130) defined renewable energy (micro-generation technologies) as solar photovoltaic, micro-wind, solar thermal, heat pumps, biomass boilers, and pellet stoves.

Scarpa and Willis (2010:130) used choice experiments, based upon consumer demand theory. This was based on the notion that consumers are not only interested in energy, but also in the modes in which energy is produced. The choice experiments by Scarpa and Willis (2010:130) presented consumers with sets of alternative combinations of attributes of renewable energy technologies, and then asked them to choose their preferred alternative. The choices made by the consumers were modelled as a function of the attributes of that micro-generation, using the random utility theory. Random utility theory is based on the hypothesis that individuals will make choices based on the characteristics of an objective along with some degree of random objective, which helps the analyst reconcile theory with observed choice (Scarpa & Willis, 2010:131).

Scarpa and Willis (2010:132) decided to use the stated preference choice experiment approach, because it might allow for (1) more variation in price; or (2) better control over information provision and choice set consideration.

Two choice experiments were designed by Scarpa and Willis (2010:132). The first-choice experiment investigated respondents' choice in a situation where their existing heating system was no longer functioning and had to be replaced. The second-choice experiment investigated respondents' choice in a discretionary situation, where they had the discretion to supplement their existing heating and electricity supply with a renewable energy (micro-generation) source.

Scarpa and Willis (2010:132) used the following five attributes in their choice experiments:

- The type of technology (solar power, solar water, wind turbine);
- Capital cost of the new system (in British pounds);
- Maintenance cost (in British pounds per year);
- The source of the recommendation (none, friend, plumber, friend & plumber); and
- The energy saved by the technology (in British pounds per year).

The experimental sample was comprised of a random sample of households across England, Wales, and Scotland, utilising a computer-assisted personal interview. The conclusion from Scarpa and Willis (2010:135) was that renewable energy adoption is significantly valued by households. They further concluded that this value is not large enough for the vast majority of households to cover the higher capital costs of renewable energy (micro-generation) technologies.

Scarpa and Willis (2010:135) also concluded:

> *The results of this study suggest that the British government will have to give substantially larger grants than those currently available (in 2009), if it is to induce significantly more households to install micro-generation technologies; or conversely the price of micro-generation technologies will have to fall substantially.*

4.16.8 Korea WTP study

Yoo and Kwak (2009:5 408) argued that "although green energy sources are more environmentally friendly than fossil energy sources, they are costlier, given the prevailing technologies".

Based on this statement, they conducted a study, using the contingent valuation method, to obtain at least a preliminary evaluation of the benefits that result from the introduction of the policy that raises the percentage of green electricity consumption. Their aim was to assist the South Korean government in creating a cost-effective carbon reduction policy.

Yoo and Kwak (2009:5 409) decided to conduct face-to-face interviews with heads of households or housewives. Their reasoning for using face-to-face interviews was "that the data quality was thought to be the highest in terms of completeness and meaningfulness".

A scenario was used in the contingent valuation to provide the respondents with information about the characteristics of renewable energy and thus a better understanding thereof (Yoo & Kwak, 2009:5 409). The survey was then grouped into the following sections:

- Introductory questions such as respondents' perceptions following the provision of general background information on green electricity;
- Questions on the monthly WTP for the proposed policy on the use of green electricity; and
- Household information.

The WTP question by Yoo and Kwak (2009:5 409) was: "Would your household be willing to pay a given, additional amount each month for the next five years in electricity bills for raising the level of consumption of green electricity, provided that the success of this policy is guaranteed?"

Yoo and Kwak (2009:5 413) found that most respondents did not have a WTP at all for a green electricity policy. A small number of respondents (19.5%) had knowledge of renewable energy and only 54 individuals (6.8%) were aware of the current policy of the Korean government. These findings indicate that Korean people do not have sufficient knowledge about renewable energy. Yoo and Kwak (2009:5 415) concluded that: "the results can offer a useful framework for organising information about the consequences of alternative actions for addressing the issue of introducing environmentally-friendly energy sources".

4.16.9 Italy WTP study

The study of Bollino (2009:81) focused on Italian consumers' WTP for the development of renewable energy sources. Bollino (2009:86) used a national survey with web interviews. Each respondent was requested to respond to general questions on renewable energy sources and potential development, knowledge about the Italian energy system, and monetary amount they were willing to pay within a prescribed range. The survey included attitudinal, behavioural and socio-demographic questions. Bollino (2009:82) stated that the higher cost of renewable energy sources prevented the widespread uptake of renewable energy systems and introduced the need of public funding to the benefit of development. When consumers think positively of renewable energy technologies, this attitude will influence their WTP. Furthermore, Bollino (2009:83) stated:

> *The dependence of consumers' WTP on their views on the potential usefulness of alternative energy sources is also analysed. In other words, the aim is to examine to what extent various attitudinal, behavioural, and demographic variables are associated with WTP and also whether these relationships are a function of bids amount.*

He referred to prior studies done in Italy, the United States, the United Kingdom, Australia, Spain and Japan that consistently found consumers to have a modest WTP, if compared with national policy energy goals.

According to Bollino (2009:83), the previous studies are not fully comparable because "they differ in terms of survey periods, countries, institutional context, survey typology, elicitation format, as well as for methodology and econometric technique used, but it can be useful to summarise their empirical results in order to better understand different results". A common feature of all the previous surveys that Bollino (2009:84) reviewed is the results' variability, which can be the consequence of two main factors, namely: (1) relevance of socio-demographic determinants; and (2) uncertainty in respondents' information set.

Bollino (2009:84) stated that: "Different social status, different knowledge and different environmental feelings are the crucial determinants of individual preferences". In addition, Bollino (2009:95) concluded that Italians will pay for renewable energy sources and if they are better informed, they will even pay more.

4.16.10 Finland WTP study

Salmela and Varho (2006:3 669) reviewed the barriers identified by consumers to purchase green electricity and compared these with the interpretation to consumer passivity. They defined green electricity as "electricity that is produced from renewable sources and that has been differentiated from other electricity products and marketed as being environmentally friendlier" (Salmela & Varho, 2006:3 670).

In Finland, consumers are able to choose their electricity supplier and not only the price, but certain other criteria as well. This is currently not available to the South African consumer. Even with the existence of product differentiation in Europe, the number of green electricity household consumers has remained low. This is despite many studies indicating a positive WTP for green electricity (Salmela & Varho, 2006:3 670).

Salmela and Varho (2006:3 670) provided two reasons affecting the Finnish consumers' decision to buy green electricity:

(i) Mainly 'clean' fuels (hydropower and nuclear) are used to generate electricity. There is still little demand for labelled green electricity, except for wind power.

(ii) Residential electricity consumption in Finland is only about 20 percent of total consumption, as shown in Figure 4.19, and the household consumers will only have a limited impact on the overall structure.

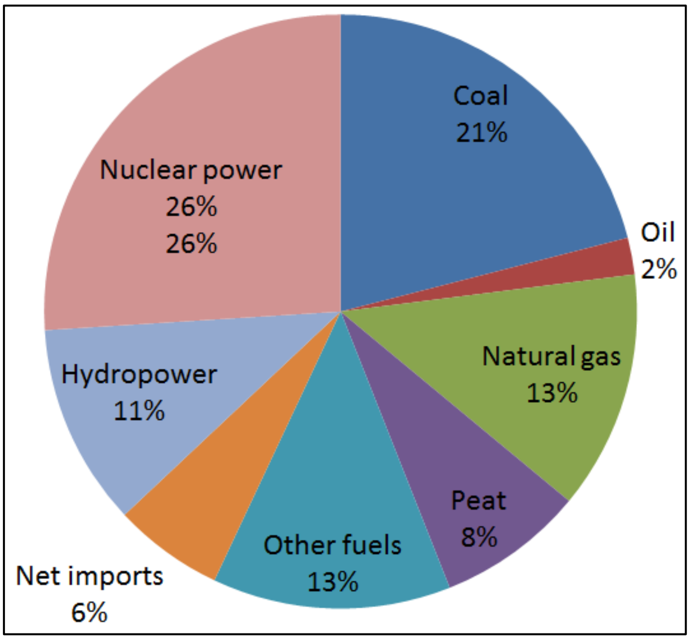


Figure 4.18: Electricity supply in Finland in 2003

Source: Salmela and Varho, 2006:3 670.

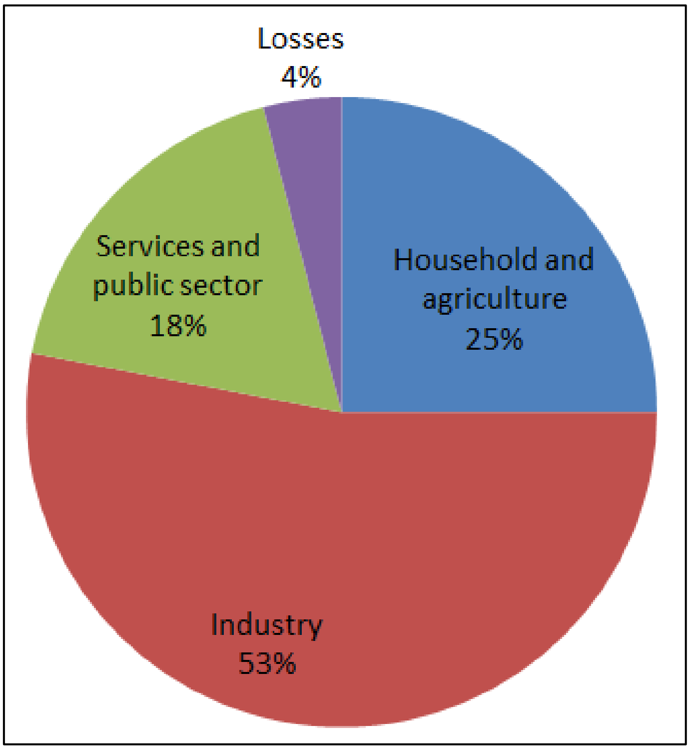


Figure 4.19: Sectors of electricity consumption in Finland in 2003

Source: Salmela and Varho, 2006:3 671.

Significant consumer research regarding green electricity has concentrated on consumers' attitudes towards and WTP for green electricity, as well as the price of green electricity. Salmela and Varho (2006:3 671) focused their study on issues that prevent green electricity purchase and they wanted to be able to answer the following questions:

- How are consumers expected to behave, and how do actors in the energy sector interpret consumer behaviour?
- What barriers do consumers themselves identify in buying green electricity, and what explains the gap between positive attitudes and passive behaviour?

The answers to these questions will result in a model of factors influencing a green electricity purchase.

Previous studies found that environmentally-active consumers are largely in certain professions, such as humanist, social, and healthcare sectors. Salmela and Varho (2006:3 671) found that typical early adopters of green electricity products live in larger cities in Finland. They therefore chose to interview five random male and five female teachers and librarians living in the Helsinki metropolitan area. The teachers ordered teaching material from the World Wildlife Fund (WWF) and the first librarian was from the city library, specialising in environmental issues. The others were chosen through co-nomination, in which the first interviewees suggested further persons to be interviewed.

The second source of material for this study consisted of 25 interviews of energy sector actors (Salmela & Varho, 2006:3 672). The interviewees were chosen to represent all the relevant fields of political and economic decision-makers in the wind power sector. During the interviews, two explanations for consumer passivity emerged:

- Structural barriers, such as the abstract nature of electricity, the obscurity of the electricity market, and ignorance about how to change to green electricity products.
- Finns are not environmentally conscious enough to pay more for their electricity just because it is 'green'.

Salmela and Varho (2006:3 672) demonstrated that in reality, people's preferences are not always consistent or transitive. In addition, preferences and behaviour do not always go hand in hand, because there can be a strong incentive to 'free ride'.

Some interviewees argued that only households can afford to pay extra for their electricity and that business use of green electricity was considered impossible and might be jeopardised because of the competitiveness of companies. Some companies do use renewable electricity and may use this to legitimise their activities, or as a marketing tool (Salmela & Varho 2006:3 674).

Salmela and Varho (2006:3 674) referred to Perrels and De Villiers (2010:17) who believed that business users could become significant buyers of green electricity, as they can reap economic benefits as well as a positive reflection of the company's ethics. Some interviewees wanted the state, municipalities and other public bodies to buy at least some green electricity as an inspiring example and as a way to reach the targets for renewable electricity.

According to Salmela and Varho (2006:3 675), it is important to define the concept of environmentally-responsible behaviour and separate it from the concept of environmental consciousness. Environmental consciousness refers to knowledge about environmental issues and to attitudes towards environmentally-responsible behaviour. Environmentally-responsible behaviour, in turn, includes these cognitive aspects, but also the actual behaviour or action. They deducted from the responses that these issues should be explained to consumers.

The price of electricity seemed to be an important factor to many of the interviewees, but very few acted by requesting the price from suppliers. Consumers stated that they believe they do share the responsibility of promoting renewable electricity, but promoted tools that were all state policy tools, such as subsidies and taxes (Salmela & Varho, 2006:3 677). Salmela and Varho (2006:3 678) presented a model indicating the factors influencing green electricity purchases. This model is split into two groups, namely individual and structural factors, as can be seen in Figure 4.20.

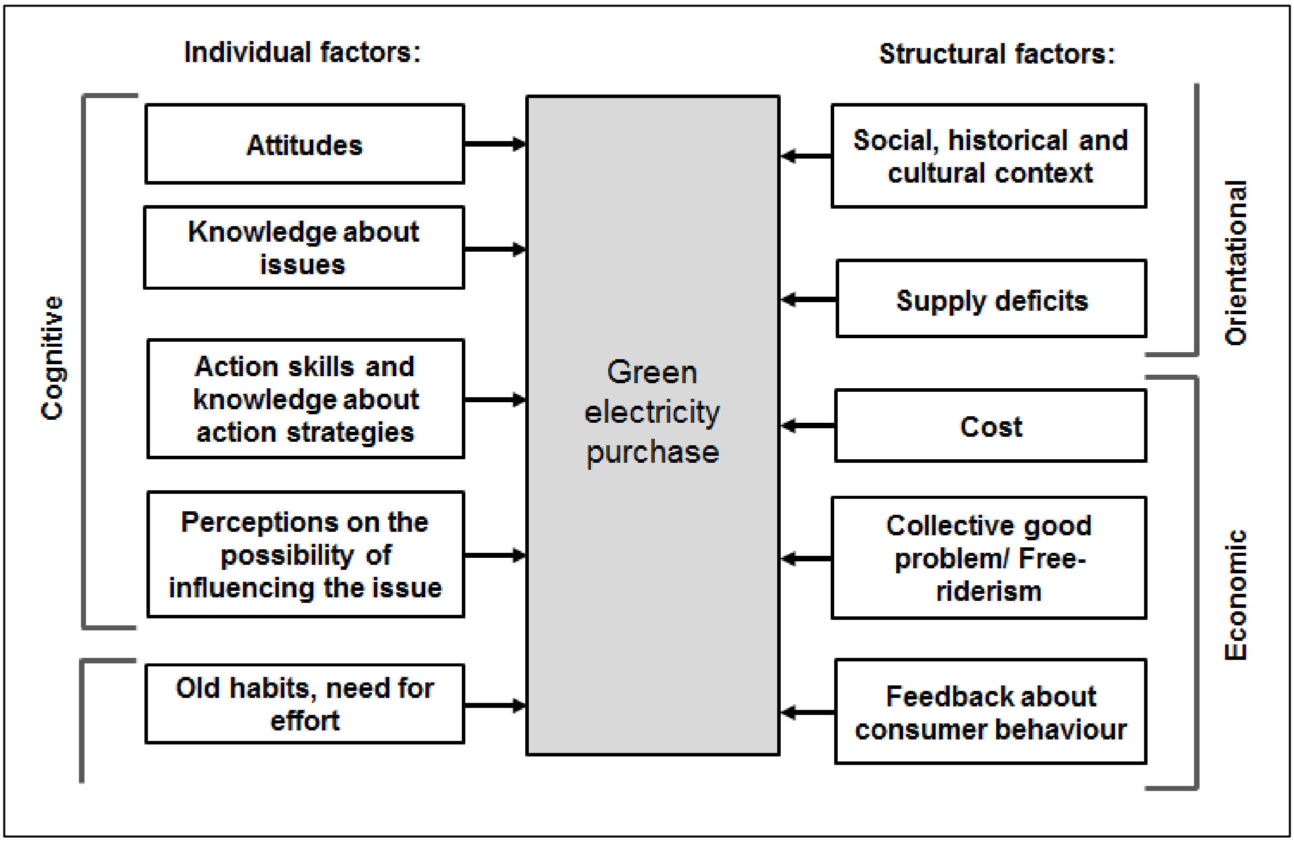


Figure 4.20: Individual and structural factors influencing a green electricity purchase

Source: Salmela & Varho, 2006:3 678.

This model has been constructed in conjunction with the analysis of the research material and previous theories concerning environmentally-responsible behaviour (Salmela & Varho, 2006:3 678). The model does not measure the technology acceptance and ease-of-use aspects relating to WTP for green electricity. By using this model, Salmela and Varho (2006:3 678) found that, even if the consumers are aware of environmental problems and support renewable energy in general, the issue is not of such importance to them that they would actually pay more for green electricity. They also found that the consumers have a lack of understanding about how electricity is produced.

Salmela and Varho (2006:3 678) summarised the main barriers as attitudes, knowledge about issues, and high costs, but mentioned that this situation pointed to many other issues. In addition to cognitive barriers, the consumers identified orientational problems, such as old habits and the need for effort as a deterrent to changing to green electricity.

Salmela and Varho (2006:3 678) said "Because consumers may be unfamiliar with green electricity, they may require a lot of external information and incentive in order to become active. This relates to the factor of supply deficits". They also found that the purchaser of green electricity must believe that other consumers will take similar action. This affects the consumer's perception of the possibility of influencing the issue and reflects the problem of collective goods.

The division between structural and individual factors in the model is rather artificial and in reality, these factors influence each other. The objective of Salmela and Varho's model (2006:3 679) was therefore to identify the main barriers, attitudes, knowledge about issues, and high costs, which can explain consumer passivity in the green electricity market.

4.16.11 South African WTP study

Oliver, Volschenk and Smit (2010:1) investigated the level of WTP a premium for electricity from renewable energy of residential households in South Africa's Cape Peninsula. This study is currently the most in-depth study in its field done in South Africa during the past ten years. Oliver et al. (2010:1) used recent contributions in the literature on norm-motivated behaviour to identify factors that could influence residential consumers' WTP.

Using previous literature, Oliver et al. (2010:3) created a model which they adapted from the model of Salmela and Varho (2006:10). They then based their questionnaire on this revised model shown in Figure 4.17.

Figure 4.17 indicates drivers of WTP that were considered important for this study (shown in black outline), while certain other drivers were excluded for varying reasons (shown in grey). The factors used by Oliver and his partners (2010:2) are summarised below:

Psychological and psychographic indicators of WTP. Psychographic characteristics include aspects such as:

- Knowledge/awareness,
- Values,
- Attitudes,
- Concern for the environment, and
- Perceptions of the effectiveness of particular interventions, namely:
  - consumers' perception of effectiveness,
  - income and price,
  - free-rider behaviour,
  - feedback about consumer behaviour,
  - mandatory quotas and their effect on WTP for additional green electricity, and
  - source of green electricity.

A significant positive link between household income and WTP for green electricity exists, contrary to the findings of some previous studies. Oliver et al. (2010) further found that higher income households are more likely to pay a premium, as well as be willing to pay a bigger premium. They also established that the view of green electricity as reliable, involvement in the recycling of waste, and the belief that everyone should contribute to green electricity generation, drive the consumers' WTP (Oliver et al., 2010:1).

A 2015 study conducted by Chan, Oerlemans, and Volschenk in South Africa, did not aim to determine a representative estimation of the willingness to pay of South African consumers. The main purpose of their study was to test the construct validity of contingent valuation method. Chan et al. (2015) considered two dimensions of construct validity, namely: convergent and theoretical validity. They used the theory of planned behaviour to build two regression models, namely: double-bounded dichotomous choice and open-ended measures. The sample for their study comprised of 890 postgraduate students of two South African universities (Chan et al., 2015:321-327).

The research found that the two elicitation methods yielded significantly different results. Chan et al. (2015:327) concluded that some free-riding behaviour may have occurred as the respondents were aware that green electricity would be provided on a voluntary basis, which may have led to a misstatement of the open-ended WTP value. Differences between the two measures may have occurred due to the higher complexity of the open-ended WTP measure. It is easier for respondents to answer the double-bounded dichotomous choice WTP question because the respondents did not have to state a value estimate, as a specific value was offered. There are more methods to estimate willingness to pay a premium for green electricity and there are reasons to believe that similar issues are at play with other elicitation methods. Based on their findings, they concluded that for various reasons open-ended and dichotomous choice, and several other, elicitation methods tend to overestimate willingness to pay values (Chan et al., 2015:321-327).

De Villiers (2010:5) conducted a survey on businesses in the Western and Northern Cape of South Africa to determine (1) whether businesses would be willing to pay a premium for green electricity; (2) why they would be willing to buy it; (3) which factors influence the purchasing decision; and (4) what barriers exist that will deter a purchase. The results of this study on medium to small businesses located in the area of study are summarised in the Table 4.5. De Villiers (2010:53) summarised the top three results for the following categories: Motivators, Factors, Barriers and Responsibility and finance.

According to De Villiers (2010:17), businesses can enter into long-term contracts and negotiate a good price which can then translate into cost-effective marketing utilities. Most businesses believe the most important reason for buying green electricity would be the enhancement of their corporate image, and coupled with their social responsibility, other advantages are to (De Villiers, 2010:29):

- Emit less pollution;
- Contribute to sustainability of the environment;
- Incur a cost saving eventually; and
- Promote health (through prevention of pollution).

De Villiers (2010:20) referred to the studies done by Nielson (2002) and Nielsen (2004), indicating that the greatest disadvantages for South African businesses were the perceived cost premium and the unreliability of green electricity.

Table 4.5: Summary of the survey results of businesses in the Western Cape and Northern Cape regarding green electricity

	All respondents	Ranking [1=highest]	Ranking [1=highest]	Organisations more likely to purchase green electricity
Motivators	The shareholders of your company are concerned about climate change	1	1	Your company upholds a responsibility to be community leaders with regards to green energy
	Your company feels a strong commitment to public health and the environment	2	2	The shareholders of your company are concerned about climate change
	A 'green' public image is important for your company	3	3	Employees have more pride in a company that is giving back to the environment
Factors	Green products must be officially certified and endorsed by an accredited organisation	1	1	Your money will contribute towards constructing new renewable generation
	Companies would receive a physical certificate	2	2	Companies would receive a physical certificate
	Your money will contribute towards constructing new renewable generation	3	3	Certificates tradable
Barriers	The extra cost of green electricity is the main reason why your company would not purchase green electricity	1	1	The extra cost of green electricity is the main reason why your company would not purchase green electricity
	There is insufficient information about the true environmental benefits of green electricity	2	2	There is insufficient information about the true environmental benefits of green electricity
	The internal resistance by key decision-makers is the main reason why your company would not purchase green electricity	3	3	The internal resistance by key decision-makers is the main reason why your company would not purchase green electricity
Responsibility and finance	Pollution by companies should be taxed or more stringently regulated	1	1	Power utilities should be required to include a minimum percentage of green energy in their energy mix
	Power utilities should be required to include a minimum percentage of green energy in their energy mix	2	2	All large companies should be required to include a minimum percentage of green energy in their electricity mix
	All large companies should be required to include a minimum percentage of green energy in their electricity mix	3	3	The electricity price should be increased to facilitate finance for green energy projects

Source: De Villiers, 2010:53.

Eskom conducted a green power marketing study in 2002. Van Heerden et al. (2002:3) focused on the following objectives:

- Conduct a literature scan of international initiatives.
- Obtain a first-pass assessment of market sentiment towards the concept of green power.
- Suggest a possible green power marketing methodology suitable for South Africa.
- Conduct an EPRI-supported workshop (Electric Power Research Institute) with line group representatives to explore the green power concept within Eskom.
- Make recommendations for the next actions required.

Van Heerden et al. (2002:3) conducted a literature study detailing current green power marketing programmes in Europe and the USA. The successes or failures of these initiatives were documented, as well as trends emanating from analyses of these initiatives. They also conducted a consumer survey in a two-phased approach. Phase 1 comprised focus group discussions with residential consumers and wine farmers, followed by Phase 2 comprised of telephonic and in-depth interviews with industrial consumers.

Van Heerden et al. (2002:3) summarised the international green power initiatives of the USA and the EU based on the following three basic types of programmes that are currently being implemented in the USA:

- Contribution Programme: Consumers contribute to a utility-managed fund for renewable project development, with a minimum contribution level set by the utility.
- Capacity-based Programme: Fixed blocks of capacity generated using renewables are offered to consumers at a premium (ranging from $3 to $6.59/100 W).
- Energy-based Programmes: Consumers have an option of buying a percentage of their electricity supply from renewable sources. Premiums charged vary from 0.4c/kWh to 20.0c/kWh , with a median of 2.5c/kWh .

Green power activities vary considerably across the EU member states (Van Heerden et al., 2002:4). Some of the incentive schemes, found within the various countries, are as follows:

- Investment subsidies: These are divided into subsidies on renewable energy capacity and on renewable energy output. Generally, higher subsidies are given to promote the development of less commercial technologies.
- Feed-in tariffs: These tariffs implicate subsidies on output, in the form of guaranteed prices, in combination with a purchase obligation by the utilities. These schemes have been successful in promoting the deployment of renewable energy sources.
- Bidding systems: This is the provision of limited subsidies on capacity produced, which is awarded to only a limited number of developers. The developers have to compete for the subsidies through a bidding system, facilitating the reduction of the cost of generation.

- Voluntary green pricing: Utility consumers pay a premium on their electricity to develop renewables for personal reasons.
- Fiscal instruments: This is mostly based around the tax systems. The formats range from rebates on general energy taxes, rebates from special emission taxes, and proposals or lower value-added tax rates, to tax exemption for green funds, and favourable depreciation schemes.
- Green certificates: The main objective of the tradable green certificates is to stimulate the penetration of green electricity in the electricity market. Green certificates are mainly applied where conditions are imposed by governments and a demand is created by legislation.

4.17 CONCLUSION ON PREVIOUS WTP STUDIES

The studies discussed in the previous section (Section 4.14) are all focused on the residential consumers' willingness to pay for green electricity in various countries. Although the specific environments differed in each country, the human behaviour remained relatively consistent, as shown in Table 4.6. The researcher therefore decided that the previous studies could be used as a basis for developing a model with the purpose of testing the WTP for green electricity of large consumers in South Africa.

From the previous studies conducted in other countries to determine the WTP, the following can be concluded:

- They were focused on the residential consumers;
- They did not include large consumers;
- Human behaviour remained relatively consistent;
- Awareness and knowledge were topical;
- Scenarios and background setting were frequently used to assist with understanding of questionnaires;
- Psychological attributes were frequently used to test attitude, behaviour and intention; and
- A limit of the cost for green electricity was established (value).

Table 4.6: Summary of previous WTP studies in different countries

Country study	Factors and characteristics considered in the study
Portugal	Demographic, psychographic, behavioural, environmental
Crete	Demographic, information and awareness level, estimation of WTP in €
Germany	Demographic, psychological construct, cognitive
USA	Demographic, electricity use, awareness and intentions, two scenarios/demographic, hypothetical scenario, WTP questions
Japan	Demographic, WTP premium, awareness, knowledge of solar and wind
UK	Demographic, presented sets of alternative micro-generation technology combinations
Korea	Demographic, general background information provided, WTP premium
Italy	Demographic, knowledge, attitudinal, behavioural variables
Finland	Demographic, individual (cognitive) and structural (orientational, economic) factors
SA	Demographic, individual (cognitive, psychological) and structural (orientational, economic) factors

4.18 CONCLUSION OF LITERATURE ANALYSIS AND PROPOSITIONS

From the literature review done relating to the willingness to pay a premium for green electricity, it is clear that this is an extremely large study field influenced by a significant number of aspects.

This study used previously-validated models discussed during the literature review to test the proposition in the following section. Data was gathered by means of a questionnaire and partial least squares structural equation modelling (PLS-SEM) was used to test the theoretical model in order to understand the determinants influencing the large consumers' willingness to pay.

After analysing the literature on WTP studies, many propositions were made and tested, such as the following:

- The more positive the consumers' general attitude is towards environmental protection issues, the higher their WTP a premium for green electricity will be.
- The more positive the attitude among large electricity consumers is towards their electricity supplier, the higher their WTP a premium for green electricity will be.
- If large consumers are already participating in other environmental conservation activities, the higher the likelihood of their WTP a premium for green electricity.
- The more convinced large electricity consumers are that social reference groups (World Bank, shareholders, and others) would support their decision to adopt green electricity, the higher the likelihood of their WTP a premium for green electricity.
- The higher the large electricity consumers' level of knowledge about renewable energy sources is, the higher the likelihood of their WTP a premium for green electricity.
- The South African large consumers will not pay more than five percent as a premium for green electricity.

- The more positive the large electricity consumers' attitude towards Eskom, the higher the likelihood of their willingness to pay a premium for green electricity.

As this study focused on the large electricity consumers' WTP, these propositions were selected and adapted to relate to the questions asked in the beginning of the study. Some of these propositions are similar and therefore the following propositions in Table 4.7 were created for this study.

Table 4.7: Propositions and aim of propositions

	Proposition	**Aim of proposition**
1	The more positive the large consumers' general attitudes towards environmental protection issues, the higher their WTP a premium for green electricity.	This proposition aimed to test if using green electricity is going to make a difference.
2	If large consumers engage in positive behaviours towards conservation, the likelihood that they will be willing to pay a premium for green electricity will be higher.	This proposition aimed to test if companies generate or plan to generate electricity by using green technologies.
3	The higher the large consumers' value perception towards renewable energy sources, the higher the likelihood that they will be willing to pay a premium for green electricity.	This proposition aimed to test whether the financial status of the companies will influence their WTP for green electricity.
4	The more positive the large electricity consumers' attitudes towards the electricity supplier, the higher the likelihood that they will be willing to pay a premium for green electricity.	This proposition aimed to test if the companies will trust Eskom to implement a green energy programme for an additional fee.

By using the information gained from reviewing literature for this study, a theoretical model to assess the large electricity consumers' WTP towards the supply of premium green electricity in South Africa was created. This model was used to test the above-mentioned propositions. The next chapter discusses the research design and methodology employed for this study.

CHAPTER 5
RESEARCH DESIGN AND METHODOLOGY

5.1 INTRODUCTION

Due to coal-fired power stations' pollution footprint on the environment, more attention is being given to cleaner electricity-generating technologies. The need for renewable energy will increase as the pressure to preserve the environment increases. Our current resources, such as coal, used to generate electricity will be depleted in the near future. Knowing the large consumers' WTP a premium for green electricity is an important aspect to successfully develop and implement new policies. This was an exploratory study which aimed to better understand the SA large consumers' WTP for green electricity.

TerreBlanche and Durrheim (1999:33) stated that researchers need a series of decisions, based on the following four dimensions:

(i) Purpose of the research;
(ii) Context in which the research is carried out;
(iii) Research techniques employed to collect and analyse data; and
(iv) Theoretical paradigm informing the research.

The following sections comprise these dimensions and explain the research methodology followed during this study.

5.2 PURPOSE OF THE RESEARCH

Due to the current higher cost of green electricity, 'someone' must pay a premium to establish the green supply market. To investigate the propositions presented in Section 4.17 of Chapter 4, this study made use of previously-validated models; data was gathered by means of a questionnaire; and partial least squares structural equation modelling (PLS-SEM) was utilised to test the theoretical model.

Whitehead and Cherry (2007:247) argued that the most persistently troubling empirical result in the literature is the tendency for hypothetical willingness to pay to overestimate real willingness to pay. This study therefore predominantly focused on the behavioural aspects of WTP.

In order to supply base-load electricity from green electricity-generating plants, innovative policies will have to be created to introduce additional green electricity-generating plants. This study will have the following benefits:

- Assist policy-makers to better understand the determinants to ensure the development of green electricity-generating capacity;
- Assist in establishing the large electricity consumers' WTP a premium for green electricity;

- Establish the consumers' view of the supplier's commitment to green electricity will have been determined and the effect thereof on the large consumers' WTP; and
- Establish the large electricity consumers' preferred method of payment and their plans to generate and/or save electricity.

With the aim to achieve these benefits, the next sections discuss the research design and the methodology followed to achieve the specific objective of collecting empirical data. This data was used to develop an exploratory model and test the reliability of the developed measurement instrument. The exploratory model was used to determine the nature of variables influencing WTP a premium for green electricity and relationships between these variables to obtain a first-pass assessment of the large electricity consumers' WTP a premium for green electricity.

5.3 CONTEXT IN WHICH THE RESEARCH WAS CARRIED OUT

The previous study conducted by Eskom is outdated as it was done in 2002 on small industrial consumers located in the Stellenbosch area. A more recent study was conducted by Oliver et al. (2010:1) investigating the level of WTP a premium for electricity from renewable energy of residential households in South Africa's Cape Peninsula.

This study focused on the large consumer, and as over 90 percent of electricity usage in South Africa is used by Eskom's top 500 key consumers, the sampling frame was selected from the following categories: Municipalities, Mining, Industrial, Commercial, Agriculture, Traction/Rail and Bulk Distributors. The April 2012 to March 2013 data obtained from Eskom indicated that the top 500 large consumers use 91.9 percent of all generated electricity in South Africa. The study was therefore limited to the top 500 consumers as defined by their electricity usage during the 2012 to 2013 financial year. Using the respondents of Eskom's top 500 consumers was deemed to be sufficiently representative of the large consumers' view when using a PLS-SEM model. This is supported by Wong's (2010:21) indication of the number of respondents required for exploratory research using PLS-SEM. Informed consent from the participants was obtained, and the study complied with all ethical requirements.

Previous WTP studies in other countries were researched and documented during this study. However, those studies did not focus on large consumers and are not fully relevant to South Africa due to differences regarding the socio-demographical characteristics, economy, and electricity supply market structure. This study explored the large consumers' willingness to pay a premium for green electricity in order to assist future planning and policy making.

5.4 RESEARCH TECHNIQUE EMPLOYED TO COLLECT AND ANALYSE DATA

5.4.1 Overview

A questionnaire was developed from a theoretical base combining previously-tested models into an exploratory model that could be analysed using PLS-SEM. Approval from the Departmental Ethics Screening Committee of the USB (USB DESC) was obtained on 14 October 2014. The questionnaire was tested on senior management from medium-sized companies which do not consume a sufficient amount of electricity to be included in the top 500, before sending it to the large consumers who comprised the sampling frame of the study. (Refer to Appendix A for the Ethical clearance and Appendix B for the Questionnaire).

5.4.2 Development stages of the measurement instrument

Several of the previous related studies were reviewed and related validated models were combined to form a new comprehensive theoretical exploratory research model focusing on the predicted WTP behaviour of large electricity consumers based in South Africa. The exploratory model was used as the measurement instrument and is discussed in Chapter 6. Wepener (2014:109) referred to Hinkin (1995) who had recommended ‘best practices’ and concluded that all scales should demonstrate content validity, construct validity and internal consistency. Three basic stages were recommended, namely: (1) item generation; (2) scale development; and (3) scale evaluation as indicated in Table 5.1.

Table 5.1: Hinkin’s three-stage approach to scale development

Stages	Description
1. Item generation	1.1 Content validity is an important first step. The construct must adequately capture the specific theory. Latent variable definitions are important. 1.2 Deductive or inductive item generation can be used. Deductive development happens when researchers utilise a previously defined theory. Inductive development happens when respondents provide descriptions about behaviour of organisations. 1.3 A clear link between variables and their theoretical domain is necessary. 1.4 Enough items have to be created to allow for deletion.
2. Scale development	2.1 Design of the developmental study Important considerations are choice of sample, sample size, response rates, the number of items, positively versus negative worded items, variance among respondents and the type of scale. 2.2 Scale construction Important considerations are factor analytical techniques (e.g. exploratory and confirmatory factor analysis) to assess stability of the factor structure, satisfactory item loadings and percentage variance, rationale for the retention and deletion of items, etc. 2.3 Reliability assessment (inner and outer model reliability) Considerations include the consistency of items and internal consistency reliability.

3. Scale evaluation	3.1 Confirmatory factor analysis (CFA) is used frequently in modern scale development. 3.2 A stable factor structure provides evidence of construct validity. 3.3 Discriminant validity is regarded as important. 3.4 The use of an independent sample enhances generalisability.

Source: Wepener, 2014:109.

This study was conducted utilising the principles of the Hinkin's three-stage approach. The next section discusses PLS-SEM and related principles.

5.5 PARTIAL LEAST SQUARES STRUCTURAL EQUATION MODELLING

5.5.1 Introduction

There are several distinct approaches to structural equation modelling including the widely-applied covariance-based structural equation modelling (CB-SEM), partial least squares (PLS) which focuses on the analysis of variance, component-based SEM, generalised structured component analysis and non-linear universal structural relational modelling (Wong, 2013:2). According to Svensson (2015:448), the origins of CB-SEM can be traced back to the 1920s. Afthanorhan (2013:198) summarised the history of PLS-SEM stating that structural equation modelling (SEM) was first applied by Bollen (1989) and Joreskog (1973) in social sciences. PLS-SEM was further developed by a number of people, including Ringle, Wende and Will (2005).

The PLS-SEM is an exploratory technique with the focus on the development of new theory and it does so by explaining the variance in the dependent variables of the model (Svensson, 2015:448). The PLS-SEM technique can assess the measurement model and the structural model at the same time (Ang, Ramayah, & Amin, 2015:193). Hair, Sarstedt, Hopkins, and Kuppelwieser (2014:107) stated that the characteristic which makes PLS-SEM particularly valuable for exploratory research purposes, unlike CB-SEM, is that PLS-SEM operates much like multiple regression analysis.

Although most of the characteristics and advantages of CB-SEM also apply to PLS-SEM, PLS-SEM can provide advantages over the CB-SEM technique for preliminary theory building. CB-SEM has advantages over PLS-SEM in terms of model validation. PLS-SEM incorporates several statistical techniques that are not part of CB-SEM, such as principal components analysis, multiple regression, multi-variate analysis of variance, redundancy analysis, and canonical correlation. This is done without inflating the t-statistic as would happen if each analysis were conducted separately from the others. CB-SEM seeks to model the co-variation of all the indicators to demonstrate that the assumed research model (the null hypothesis) is insignificant. Therefore, all the paths as specified in the model are plausible, given the sample data. The primary objective of PLS-SEM is to demonstrate that the alternative hypothesis is significant, allowing the researcher to reject a null hypothesis by showing significant t-values and a high R^2 (Lowry & Gaskin, 2014:128-130).

PLS-SEM is an exploratory technique used to develop new theory by utilising structural equation models. According to Hair, Ringle and Sarstedt (2012:312) and Hair, Sarstedt, Pieper and Ringle (2012:324), the main reasons for using PLS-SEM are when:

- The goal is predicting key target constructs;
- Formative constructs are included in the structural model;
- The structural model is complex (many constructs and many indicators);
- The sample size is small and/or the data is not-normally distributed;
- The plan is to use latent variable scores in subsequent analyses; and
- The theories are developed and tested.

These attributes of PLS-SEM were ideal for this exploratory research involving a small sample group of large electricity consumers and a complex structural model. The research component of this study employed a PLS-SEM approach to develop a theoretical model that represents the relationships related to the WTP for green electricity and the behavioural influences.

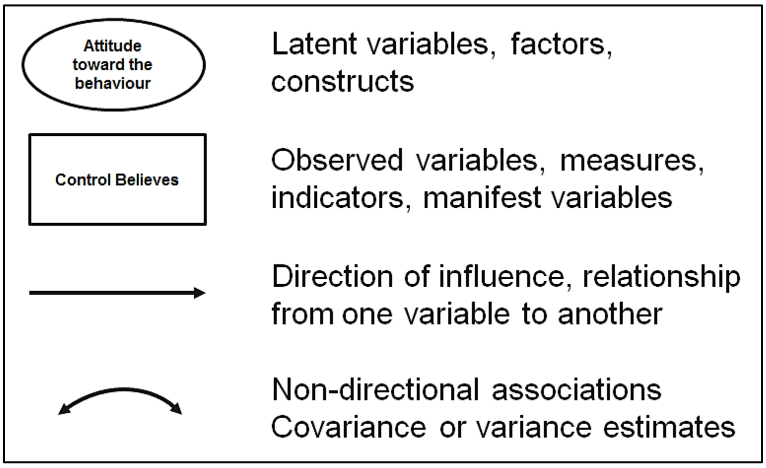


Figure 5.1: Symbols used in PLS-SEM models

Source: Researcher.

Path models are diagrams used to visually display the hypotheses and variable relationships that are examined when SEM is applied. Within the PLS-SEM models the following symbols are utilised (Figure 5.1):

- Constructs are variables that are not directly measured, and are represented in path models as circles or ovals.
- Indicators are also referred to as items or manifest variables, are the directly measured proxy variables that are constructed from the raw data. They are represented in path models as rectangles.

- Paths are relationships between constructs, and between constructs and their assigned indicators, shown as arrows. In PLS-SEM, the arrows are single-headed, thus representing directional relationships. Single-headed arrows are considered a predictive relationship, and with strong theoretical support, can be interpreted as causal relationships.
- Unexplained covariances among variables are indicated by curved arrows.

SEM statistical models represent causal relationships as paths. A path is a hypothesised correlation between variables representing the constructs of a theoretical proposition. For example, in the technology acceptance model of Teo (2010), the theory proposes that the perceived ease of use has a causal relationship with the attitude towards the usage of a system. SEM would then represent that relationship as a path between the variables that measure ease of use and attitude towards usage. Paths are presented as arrows in diagrams of SEM statistical models, with the arrows pointing in the proposed direction of causation.

There are two sub-models in a structural equation model, namely the inner and outer models. The inner model specifies the relationships between the independent and dependent latent variables, whereas the outer model specifies the relationships between the latent variables and their observed indicators as indicated in Figure 5.2.

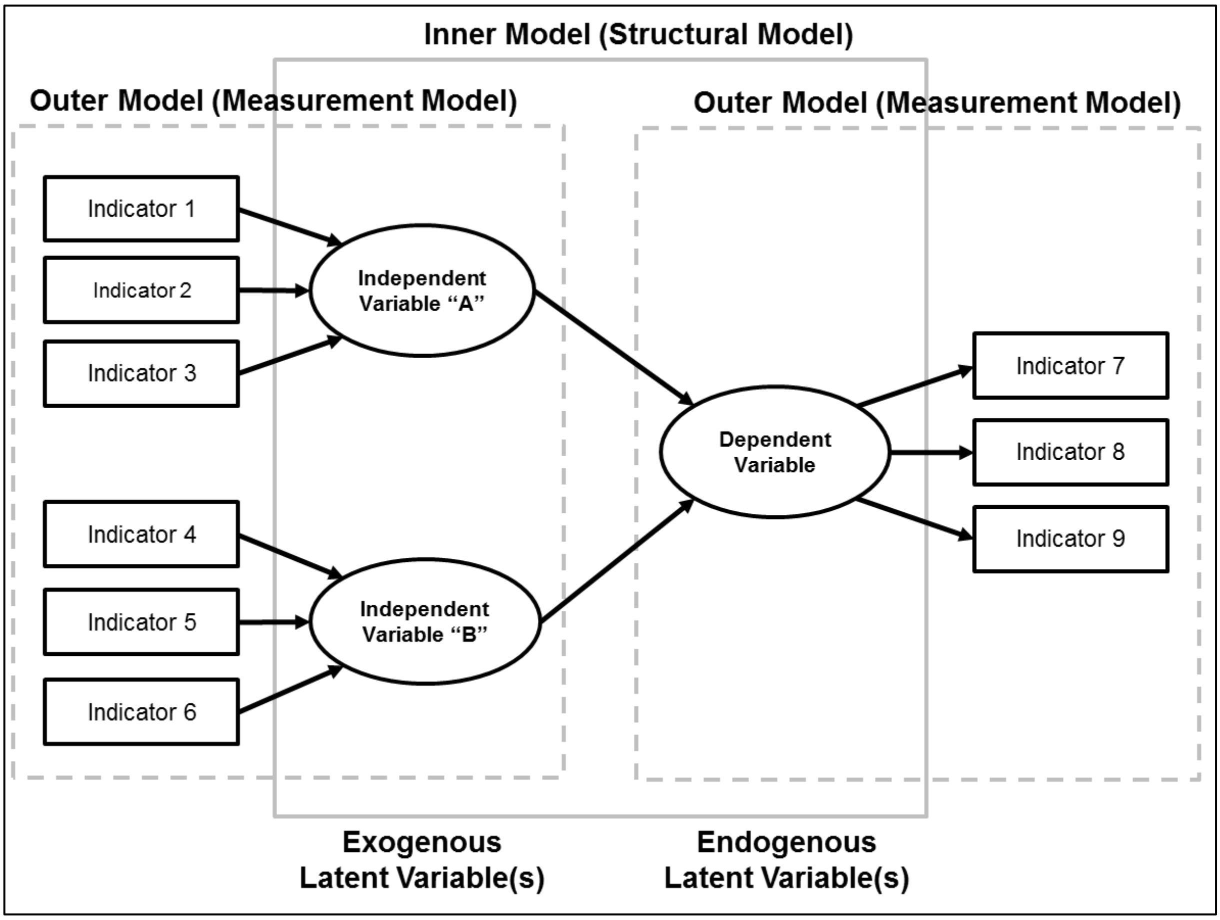


Figure 5.2: Inner vs. outer model in a SEM diagram

Source: Wong, 2013:2.

In SEM, a variable is either exogenous or endogenous. An exogenous variable has path arrows pointing outwards and none leading to it. An endogenous variable has at least one path leading to it and represents the effects of other variable(s) (Wong, 2013:3).

5.5.2 Reflective and formative measurement in SEM

If the indicators cause the latent variable and are not interchangeable among themselves, they are formative. In general, formative indicators can have positive, negative, or even no correlations among each other as indicated in Figure 5.3.

When formative indicators exist in the model, the direction of the arrow has to be reversed, meaning the arrow should be pointing from the rectangle (formative indicators) to the oval (latent variable). This indicates that changes in one or more of the indicators cause changes in the latent variable and changes in the latent variable directly cause changes in the assigned indicators. A good example of formative measurement scale is the measurement of health. If people have a balanced diet, it does not necessarily mean that they exercise regularly. However, to be healthy, people should have a balanced diet and they should exercise regularly. If you send a questionnaire to fitness fanatics, the chance is high that the responses to balanced diet and exercise will be highly correlated, but they remain formative items. Consequently, there is no need to report indicator reliability, internal consistency reliability, and discriminant validity if a formative measurement scale is used. This is due to the outer loadings, composite reliability, and square root of average variance extracted (AVE) being meaningless for a latent variable made up of uncorrelated measures (Wong, 2013:14).

Reflective indicators are related to each other and if the latent variable changes, the indicators are affected meaning that, in reflective measurement each measured variable reflects its latent variable. If the indicators are highly correlated and interchangeable, they are reflective and their reliability and validity should be scrutinised as well as their outer loadings, composite reliability, AVE and its square root should be examined and reported. In a reflective measurement scale, the causality direction is pointing from the circle to the square. When a reflective measurement model is used, the following topics have to be discussed during the model evaluation (Wong, 2013:16):

- Explanation of target endogenous variable variance;
- Inner model path coefficient sizes and significance;
- Outer model loadings and significance;
- Indicator reliability;
- Internal consistency reliability;
- Convergent validity;
- Discriminant validity; and
- Checking structural path significance in bootstrapping.

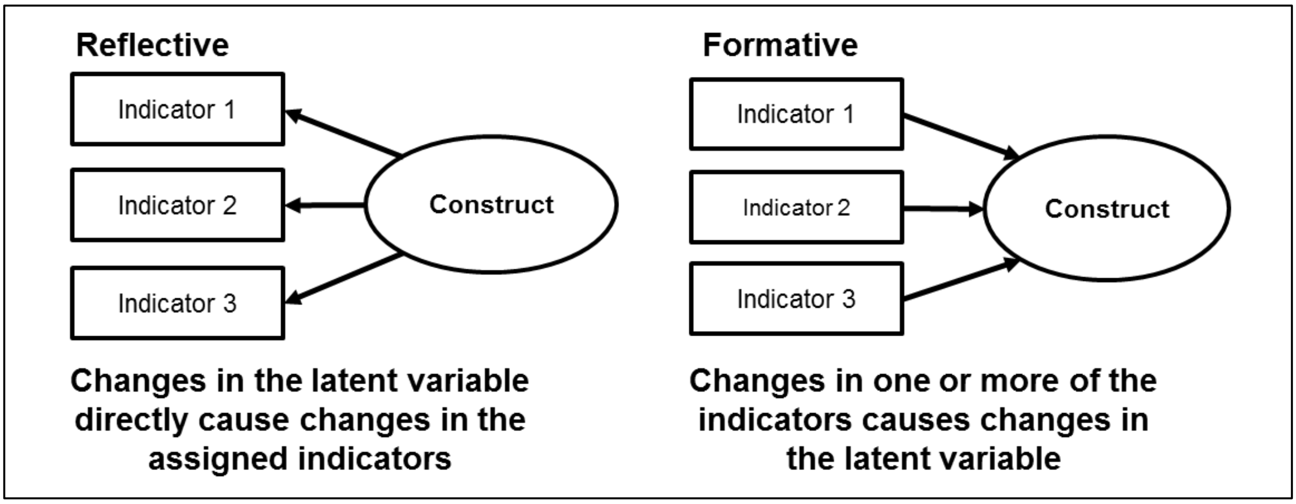


Figure 5.3: Reflective and formative SEM models

Source: Researcher.

5.5.3 Partial least squares structural equation model selection

In developing models to test propositions or hypotheses using PLS-SEM, researchers use theory, judgment, experience and the research objectives to identify and develop propositions about relationships between multiple independent and dependent variables. Hair et al. (2014:107) indicated that the top three reasons given for applying PLS-SEM are: (1) data distribution; (2) sample size; and (3) the use of formative indicators.

Hair et al. (2014:109) concluded that the minimum sample size for a PLS model should be equal to the larger of the following:

- Ten times the largest number of formative indicators used to measure one construct (this study's model has 8 therefore, minimum 80); or
- Ten times the largest number of inner model paths directed at a particular construct in the inner model (this study's model has 5 therefore, minimum 50).

Based on the conclusion of Hair et al. (2014:109), it can be said that the overall complexity of a structural model has little influence on the sample size requirements for PLS-SEM. Afthanorhan (2013:198) stated that sample size should not be used as the main reason for employing PLS-SEM because it does not have adequate statistical power at a small sample size. He recommended PLS as a powerful method when a small sample size is compared to CB-SEM. According to Sarstedt (2008:140) and Wong (2013:3), the PLS-SEM technique is preferred to the traditional structural equation modelling approaches because of the following reasons:

- It is suitable for small sample sizes;
- Normality assumptions do not have to be met;
- It has good predictive accuracy;
- It can accommodate improper and non-convergent results;

- Observations do not have to be independent;
- The PLS-SEM model incorporates formative indicators;
- Applications have little available theory; and
- Correct model specification cannot be ensured.

Wong (2013:3) indicated that it is important to note that PLS-SEM has some weaknesses, including the following:

- High-valued structural path coefficients are needed if the sample size is small;
- Problem of multi-collinearity if not handled well;
- PLS-SEM cannot model undirected correlation as the model must use arrows that are single direction;
- A potential lack of complete consistency in scores on latent variables may result in biased component estimation, loadings and path coefficients; and
- It may create large mean square errors in the estimation of path coefficient loading.

In spite of these limitations, PLS is useful for structural equation modelling in applied research projects, especially when there are limited participants and the data distribution is skewed; for example, when surveying female senior executives or multi-national CEOs (Wong, 2013:3).

According to Hair, Sarstedt, Ringle, and Mena (2012:415), PLS-SEM is an alternative to (covariance-based) CB-SEM that would emphasise prediction, while simultaneously relaxing the demands on data and specification of relationships. Application of CB-SEM typically overlooks a key objective of empirical studies, which is prediction (Hair et al., 2014:116). The solution to this inherent weakness is the use of PLS-SEM, which has the overriding objective of predicting the dependent latent variables. This is especially useful for exploratory research as supported by (Svensson, 2015:448) who said:

> *The primary purpose of CB-SEM is to test theory, while the primary purpose of PLS-SEM is to develop theory (for further meaning of 'theory', see Svensson, 2013). PLS-SEM focuses on explaining the variance in the dependent variables when examining the model (Hair et al., 2014), while CB-SEM is used to confirm or reject existing theory (Babin & Svensson, 2012). CB-SEM could furthermore be viewed as a confirmatory approach, while PLS-SEM could be viewed as an exploratory approach to build theory (Hair et al., 2014).*

Hair, Hult, Ringle, and Sarstedt (2012:416) concluded that, in general, PLS-SEM's weaknesses are CB-SEM's strengths, and vice versa and that neither of the SEM methods is generally superior to the other. Hair et al. (2012:416) further recommended that researchers need to apply the SEM technique that best suits their research objective, data characteristics, and model set-up.

Lowry and Gaskin (2014:132) indicated that, when the researcher must choose between PLS-SEM or CB-SEM, they should initially consider whether the research is exploratory (building or testing a new theory) or confirmatory (testing a well-established theory). "For exploratory work, PLS should be selected. For confirmatory work, either technique may be used" (Lowry & Gaskin, 2014:132).

The PLS-SEM algorithm aims at estimating the values for latent variables by an iterative process. In Step 1, the algorithm constructs each latent variable by the sum of its measured variables. In Step 2, the inner approximation reconstructs each latent variable by means of its neighbouring latent variables. In Step 3, the outer approximation finds the best linear combination to express each latent variable by means of its measured variables. The coefficients are referred to as outer weights. In Step 4, each latent variable is constructed as the weighted sum or linear combination of its measured variables. Figure 5.4 depicts the flowchart of the algorithm. After each step, the latent variables are scaled to have zero mean and unit variance. The algorithm stops if the relative change for all the outer weights is smaller than a predefined tolerance (Monecke & Leisch, 2012:10).

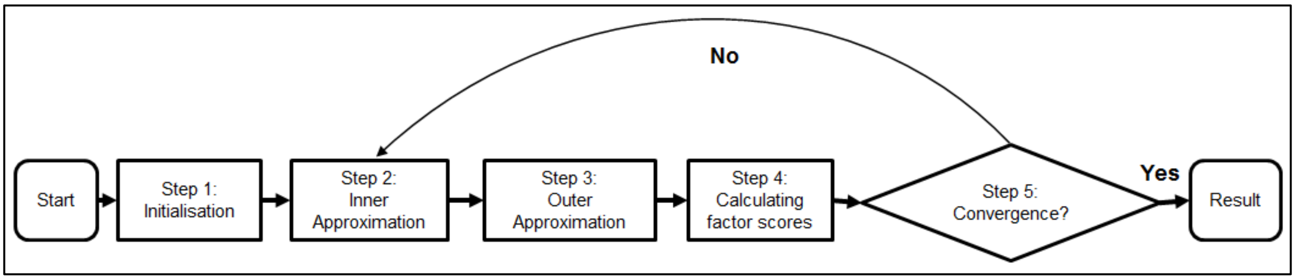


Figure 5.4: The diagram depicts the flowchart for the PLS algorithm

Source: Monecke and Leisch, 2012:9.

5.6 SAMPLE SELECTION

Data was collected through using a survey questionnaire to elicit demographic information from participants as well as responses to multiple items measuring each construct reflected in the theoretical research model, as indicated in Figure 6.2. Informed consent to participate was obtained from the participants and the study complied with all ethical requirements. Top 500 consumers refer to the consumers (per account) that used the most electricity (kWh) during a financial year. The April 2012 to March 2013 data obtained from Eskom indicated that the top 500 large consumers use 91.9 percent of all generated electricity in South Africa. The sampling frame was selected from the following categories: Municipalities, Mining, Industrial, Commercial, Agriculture, Traction/Rail and Bulk Distributors.

The sampling frame was contacted by sending the questionnaire to a senior representative of the large consumers. According to Hewstone, Stroebe and Jonas (2008:34), the major advantage of web-based experiments is the large amount of information that can be obtained in a short period of time. They further stated that the disadvantage of web-based experiments is the loss of control over when and where the questionnaires are completed. Due to the large number of consumers that were requested to complete the questionnaire for this study, and their geographical distance from each other, a web-based questionnaire was used. The researcher planned to send emails to the 500 large electricity consumers (Eskom's key customers) requesting them to participate in this study. A notification of the study and request to complete the questionnaire was sent out by the Eskom key customer department. As most of these large electricity consumers had more than one contact person, a total of 2 346 questionnaires were sent on 20 October 2014 using Checkbox Surveys (as used by the USB Sunsurveys). Subsequently, regular reminders were sent to the non-responsive email addresses. The final responses were received by 27 January 2015. A total of 352 (15.0%) responses were received. An additional five respondents (0.21%) indicated that they did not want to participate in the survey.

Respondents were asked to rate the importance of each value item on a 6-point scale. People view most values as varying from mildly to very important. This scale eliminates the respondent option of selecting an average score. The PLS-SEM model was used to test the significance of the multiple path coefficients and to identify directionality in associations.

5.7 CONCLUSIONS

In Chapter 5 the research methodology followed during this study was described. The approaches to structural equation modelling and specifically PLS-SEM were discussed. Chapter 6 illustrates the link between the model's variables and their theoretical domain including the empirical results relating to the validation of the theoretical base.

CHAPTER 6
EXPLORATORY MODEL DEVELOPMENT

6.1 INTRODUCTION

This chapter focuses on the theoretical model specification, empirical findings of the response demographics, data collection and analysis of the results relating to the theoretical PLS-SEM model. The analysis of the results is presented to illustrate how the theoretical model variables were configured by stating the theoretical model as a path diagram. This was done in relation to their theoretical base, in accordance with the first step to specify the model (Wepener, 2014:109; Lowry & Gaskin, 2014:132).

6.1.1 Main assumptions

Knowledge about the production technologies for green electricity varies from individual to individual. This knowledge barrier may be influenced by this particular lack of knowledge. According to Salmela and Varho (2006:3678), their interviewed consumers knew fairly well which electricity production sources are used when producing green electricity, but their knowledge varied about the environmental impacts of different forms of energy production. Salmela and Varho (2006:3679) concluded that, in order to purchase green electricity, the consumers need to trust the products. There were indications in the interviews that such trust might be lacking because of crucial informational shortcomings, and that some consumers almost anticipated misleading information from the companies.

The main assumptions related to this study include the following:

- The senior leadership targeted for this questionnaire had reasonable knowledge of the electricity supply environment.
- Using Eskom's direct customers as a sampling frame indicated the general views of the large consumers.
- Previous studies in other countries are not fully relevant due to differences in the socio-demographical characteristics, economy, electricity supply market and the residential studies are not relevant to large organisations.

6.1.2 Reverse wording questions

Reverse wording questions change the direction of the scale by asking the question in a positive or negative formulation. In other words, reverse wording is when the question is asked twice in different areas of the survey, using a positive voice and using a negative voice. The argument is that if the respondent's negative response scale is reversed, both scores should be the same. This is done as an additional measure to validate responses (Van Sonderen, Sanderman & Coyne, 2013:5). When respondents' answers on reverse-worded questions are consistently an outlier, they are not reading the questions correctly. Van Sonderen et al. (2013:5) concluded that the reverse-worded items do not prevent response bias. Instead, their data suggested scores were contaminated by the respondents' inattention and confusion. Fewer mistakes were made with items posed in the same direction and they therefore recommend such a format for both epidemiological and clinical studies.

Due to the contradicting opinions in the literature it was decided to use a limited number of three reverse-worded questions in the questionnaire to test the effect thereof. For example, a question from Teo (2010:261), measuring ATU, was adapted for green electricity generation technology as per Table 6.9 and the question was changed to reverse wording as follows:
Q24: Reading about Green electricity is uninteresting.

The related positively-formulated question in the questionnaire was:
Q26: Green electricity is an interesting subject.

6.2 ITEM GENERATION

Hinkin's stage one describes the deductive development when researchers utilise a previously-defined theory. For this study, previously-validated questionnaires from Ajzen (1991), Teo (2010) and Shulruf et al. (2011) were used as a basis.

The theoretical model designed for this study consists of sections to consider the behavioural, technological, cost, implementation method, consumer's perception of Eskom, and cultural influences (Figure 6.1). These sections include: the theory of planned behaviour (Ajzen, 1991), the technology acceptance model (Teo, 2010), cultural model measuring collectivism and individualism (Shulruf et al., 2011) as well as the value and perception of the electricity supplier orientation inputs.

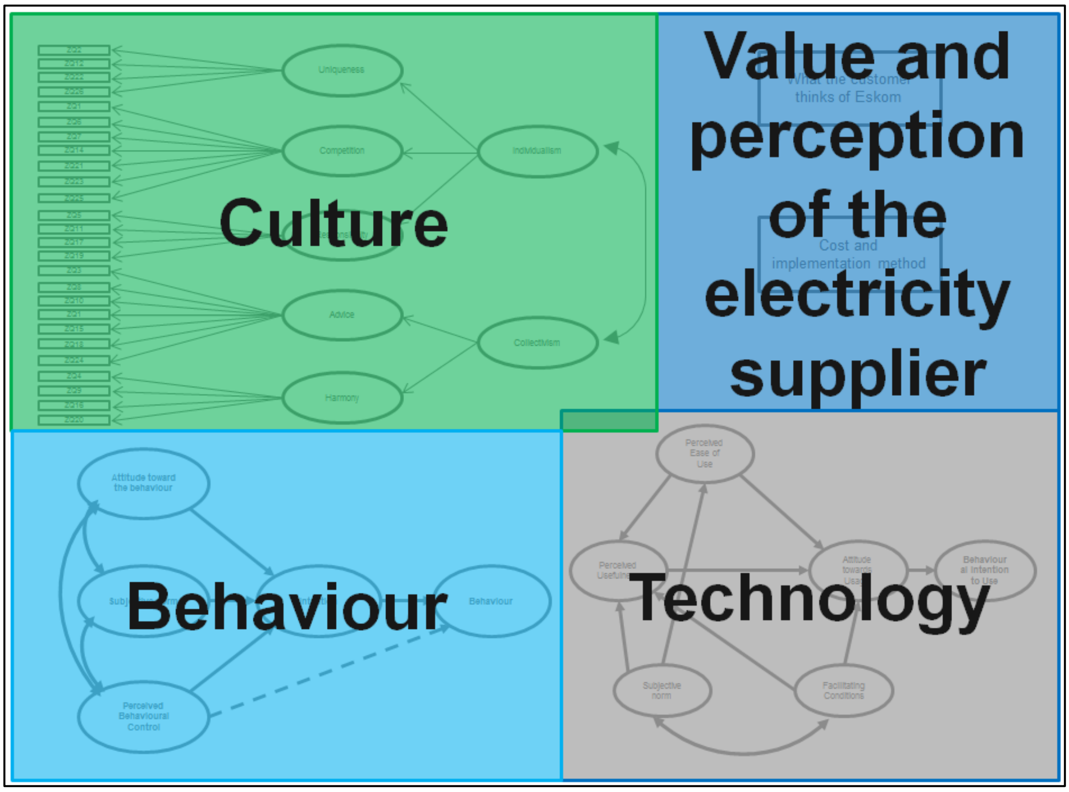


Figure 6.1: Aspects of the theoretical model

Ajzen's (1991:182) theory of planned behaviour forms the foundation of the theoretical model used in this study. According to Rossi and Armstrong (1999:45), as per Figure 4.12, both theory of reasoned action and the theory of planned behaviour are 'user-friendly' models. Ajzen and Fishbein (1980) and Ajzen (1991) stated that: "the models can and should be tailored to sufficiently explain different behaviours, and that the base variables (ATT, SN and PBC1) may be broken down, rearranged, extended, etc. to suit the researcher's needs" These aspects are indicated in black on the theoretical exploratory model in Figure 6.2 on page 140.

The model of Shulruf et al. (2011) on the measurement of collectivism and individualism includes the values-driven motives which are indicated in green on the theoretical exploratory model in Figure 6.2.

Teo's (2010) model includes the intention to use technology motivations in the model as indicated in magenta in the theoretical model Figure 6.2.

An additional influence on the attitude variable is the question relating to what the consumer thinks of Eskom as the main electricity supplier in South Africa as well as the cost and implementation method or payment vehicles (Gerpott, 2010b:466; Whitehead & Cherry, 2007:252; Wiser, 2003:xii; Hansla et al., 2008:770). These aspects are indicated in blue on the theoretical model in Figure 6.2. The theoretical bases and the outcomes of these studies are discussed in the next sections.

6.3 THEORETICAL PARADIGM INFORMING THE RESEARCH

6.3.1 Overview

People's intentions will eventually direct their behaviours – this statement is supported by Ajzen (1991:179), who concluded that intentions to perform behaviours can be predicted from attitudes towards the behaviour, subjective norms, and perceived behavioural control. His theory of planned behaviour model (Figure 4.13) has been used in various studies covering many subject fields. When measuring the WTP a premium for green electricity, it is essential to understand the respondent's intentions towards the action of paying for green electricity. Therefore, the theory of planned behaviour formed the basis of the model used in this study.

Gerpott and Mahmudova (2010a:308) concluded the following:

> *Empirical studies, with a focus on specific or general environmental behaviour, found correlations between environmental knowledge, environmental attitudes and stated environmental behaviour that were statistically significant, but small in terms of absolute size.*

When attempting to measure the large electricity consumers' WTP a premium for green electricity, the model for the 'theory of planned behaviour' requires additional input from other related subjects. As new technology is utilised for the generation for green electricity, the technology acceptance model was also used for this study as it influences the attitude of the consumer. Adler and Gundersen (2008:19) and Hansla et al. (2008:769) indicated that attitude is influenced by the value construct of a person, as illustrated in Figure 4.10 and Figure 4.11. Schwartz (2006:2; 2009:10) and Pinillos and Reyes (2011:25) stated that values are the core element of culture and Gouveia et al. (2014:42) concluded that values guide actions. This study therefore included the company value orientation as this could influence the attitude of the consumer.

The biases of the leaders of the organisation towards their cultural values related to collectivism and individualism provide an indication of the organisation's predisposition towards social responsibility and protection of the environment. The exploratory model therefore incorporated a cultural section which had been developed by Shulruf et al. (2011:178).

Previous WTP studies found that the technology used to generate the green electricity and the knowledge/awareness of the technology had an influence on the WTP. This is supported by Zografakis et al. (2010:1 089), Nomura and Akai (2004:458), Scarpa and Willis (2010:129) as well as Yoo and Kwak (2009:5 409). For this reason, the exploratory model included the technology acceptance model as it may influence the overall attitude towards behaviour.

Earlier research done by Oliver (2009:43), Raposo and Do Paço (2009:368) as well as Gerpott and Mahmudova (2010a:306), indicated that WTP is particularly influenced by attitudes towards environmental issues and towards one's power supplier, by the perceptions of an individual's social reference groups of the evaluation of green energy, and by the current electricity bill level versus household income.

The combined model used in this study, therefore has the following variables as seen in Figure 6.2:

- Attitudes toward the behaviour (technology and behavioural);
- Perceived usefulness (technology);
- Perceived ease of use (technology);
- Subjective norm (technology and behavioural);
- Facilitating conditions (technology and behavioural);
- Intention (technology and behavioural);
- Perceived behavioural control (behavioural);
- Behaviour (technology and behavioural);
- Cultural values (value-driven);
- Individualist (value-driven);
- Collectivist (value-driven);
- Uniqueness (value-driven);
- Competition (value-driven);
- Responsibility (value-driven);
- Advice (value-driven);
- Harmony (value-driven);
- What the consumer thinks of Eskom (Measured variable); and
- Cost and implementation method (Measured variable).

Data was collected by using a web-based survey questionnaire to elicit participants' responses to measure multiple observed variables influencing the constructs reflected in the theoretical model. By combining the models as discussed above, the exploratory model depicted in Figure 6.2 was crested as the theoretical basis for the PLS-SEM model of the WTP of large consumers. Once the theoretical research model had been completed, the data collection and evaluation process started.

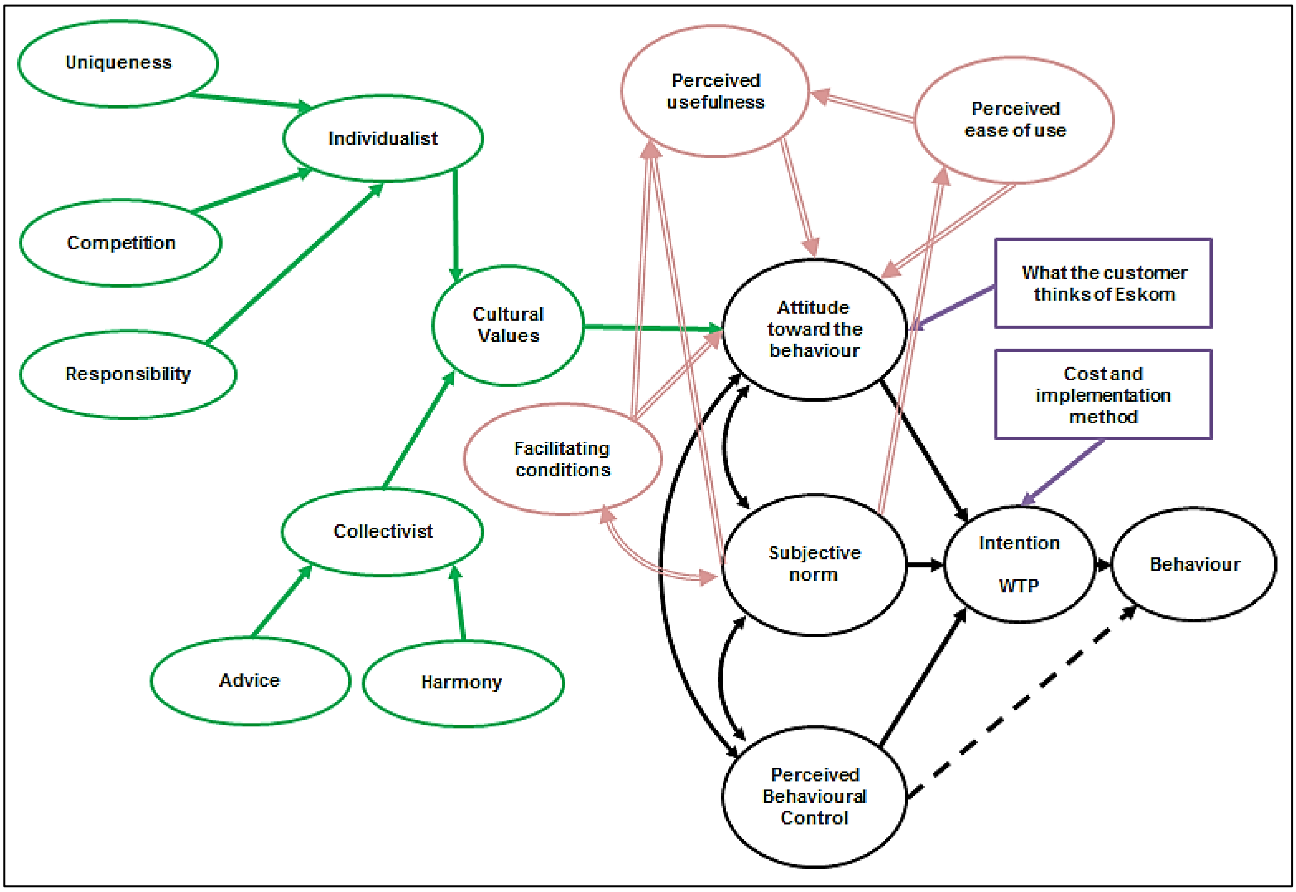


Figure 6.2: Proposed theoretical research model

The next section focuses on the data analysis from the respondents based on the theoretical research model. The data analysis starts with a review of the homogeneity of the various sectors. The results are presented to illustrate the questionnaire compilation and validation based on the theoretical foundations in accordance with the process detailed by Lowry and Gaskin (2014:132).

6.3.2 Response demographics of the industries

The large electricity consumers were the sampling frame (500 of Eskom's key consumers) of this study and the total number of questionnaires sent out to individuals was 2 346. Some of the companies/organisations have more than one facility, for example the mining sector. Therefore, questionnaires were sent to the various mines and head office senior management. For this reason, some of the large consumers received up to ten questionnaires where the individual facility's electricity consumption put them in the top 500 consumers.

The USB ethical committee requested that the respondents not be identifiable. However, from the results there is a limited number (less than 10), of respondents that indicated the same sector as well as the same usage of electricity. The respondents indicated an approximate monthly average usage of electricity and therefore, some of the consumers may have stated a similar usage of electricity. It can therefore be assumed that the respondents were not from the same organisation. After the questionnaires had been sent, the municipal sector (which includes amongst others mostly residential users), mining sector and industrial sector made up the majority (87%) of the responses received, as indicated in Figure 6.3.

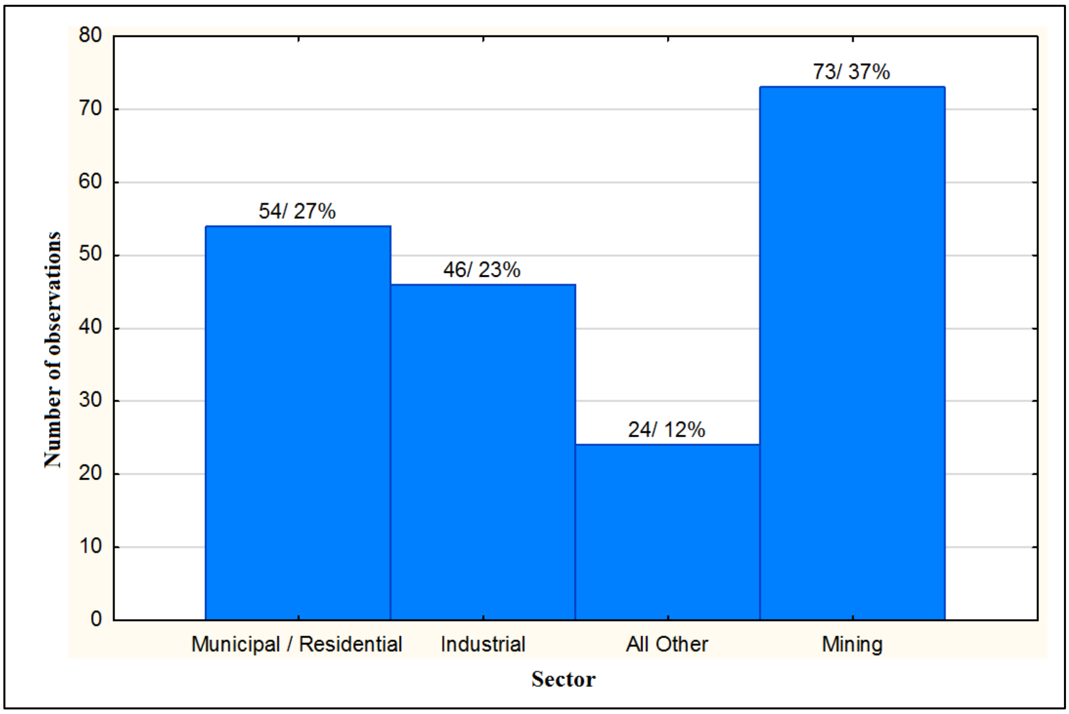


Figure 6.3: Histogram of responses per sector

6.3.3 Sectorial applicability assessment

Due to the differences in the sectorial business environment, it was important during this study to ensure that the sectors indicate homogeneity to be grouped in one category of large electricity consumers. In the following section, the sector comparisons are discussed.

6.3.4 Municipal sector vs. Industrial and Mining sectors

The hypothesis made is that the path coefficients are the same for both sectors. A theoretical discussion on why it is expected to be the same follows.

Sustainable Energy Africa (2015:39) stated that municipalities are demonstrating their strong commitment by installing their own renewable energy generation, such as landfill gas, sewage methane and micro-hydro on water distribution systems. From 2000 to 2003, the first local-level energy data collection and energy strategy was developed in Cape Town. In November 2003, Sustainable Energy Africa, the South African Cities Network and the City of Cape Town hosted the City Energy Strategies Conference. The conference was attended by high-level national and local decision-makers and resulted in the Cities Energy Declaration, which challenged cities to set their course on a more sustainable energy path. Since then, an expansion of local-level data collection and energy strategy development has occurred (Figure 6.4).

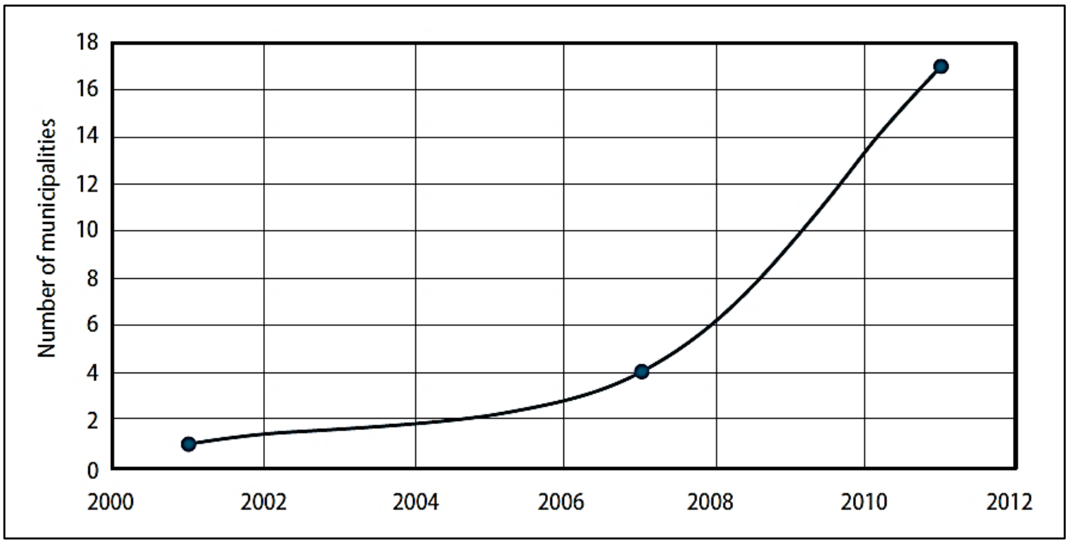


Figure 6.4: Expansion of energy and climate change mitigation strategies among municipalities from 2000 to 2012

Source: Sustainable Energy Africa, 2015:57.

The municipalities are required to follow strict governance processes. The next section summarises the electricity distribution governance as described by the Submission for the 2015/16 Division of Revenue made in terms of Section 214(1) of the Constitution of the Republic of South Africa (1996), Section 9 of the Intergovernmental Fiscal Relations Act (1998), and Section 4(4c) of the Money Bills Amendment Procedure and Related Matters Act (Act 9 of 2009).

The Financial and Fiscal Commission (FFC, 2015) stated that, in South Africa, the supply and distribution of electricity is led by the government. Through its state-owned entity, Eskom, national government is responsible for the bulk (96%) of electricity generation and all transmission (FFC, 2015:117). Schedule 4b of the Constitution assigns responsibility for distributing electricity to municipalities (RSA, 1996). Oversight of the electricity sector lies with The National Energy Regulator (NERSA), which is a regulatory authority, established as a juristic person in terms of Section 3 of the National Energy Regulator Act, 2004 (Act No. 40 of 2004). In terms of the Act, NERSA has a wide range of powers to ensure regulatory compliance, including considering applications for constructing and operating distribution facilities, issuing rules to facilitate implementation of government's electricity sector policy and objectives, regulating prices and tariffs and enforcing compliance (RSA, 2004). NERSA is central in setting the tariffs charged by Eskom to municipalities for generating electricity, and tariffs charged by municipalities to end users. Municipalities wishing to exceed the tariff increases charged to their end users are allowed to apply and motivate to NERSA for an above-guideline increase permission, which is granted in most cases (FFC, 2015:117).

Various factors can restrict the extent of revenue derived from electricity, including non-payment, stemming from consumer inability or unwillingness to pay. Significant tariff increases, coupled with the poor economic environment, present a dilemma for municipalities because the electricity sector is subject to administered prices. This situation is similar to those of other sectors that experience difficulties with non-payment (FFC, 2015:115).

Various sections of legislation regulate the electricity distribution operations of municipalities:

- The free basic electricity policy stipulates the minimum amount of electricity that each municipality must provide free of charge to poor households (Department of Minerals and Energy (DME), 2005).
- The Municipal Systems Act provides guidance to municipalities on the principles that should underpin the levying of fees for basic services. Section 74 outlines the items that revenue derived from electricity distribution should be spent on: capital, operating, maintenance, administration, replacement costs and interest. Essentially revenue earned via tariffs should be reinvested in the sector.
- The Municipal Finance Management Act (MFMA), in Sections 41 and 42, manages the interface between state utilities (in this case, Eskom, a municipality, and National Treasury) and regulatory agencies within a sector (NERSA). In accordance with the MFMA, Eskom must submit plans for any increase in the price of bulk electricity to both the Department of Energy and NERSA. Eskom’s submission must contain the written views of National Treasury, the South African Local Government Association or any municipality, and must explain how these views have been taken into account (RSA, 2003).
- The Municipal Fiscal Powers and Functions Act regulate the imposition of surcharges on electricity tariffs by municipalities (RSA, 2007). Revenue from tariffs and revenue from surcharges are governed by different pieces of legislation and have different purposes. Revenue from tariffs must be reinvested in the sector (as detailed in the Municipal Systems Act) but, as a surcharge is a municipal tax, revenue from surcharges can be used for general expenditure.

The legislation thus envisages robust norms and standards. In practice, it is difficult to determine where the tariff for a service ends and a surcharge begins.

The Financial and Fiscal Commission (FFC, 2015:117) indicated that revenues generated from electricity distribution enable municipalities to reinvest in the sector and to cross-subsidise the delivery of electricity to poor households. Electricity losses and theft further exacerbate losses. Municipalities have historically overpriced electricity and charged high tariffs. The resulting large surpluses (which should be reinvested in the electricity sector) are used to fund the delivery of non-electricity services and other expenditure items such as wages (Bisseker, 2012; Barnard, 2010).

The Financial and Fiscal Commission (FFC, 2015:120) explained that electricity is an important source of revenue for municipalities, but potential developments in the sector threaten to negatively affect municipal revenue derived from electricity – for example, a shift towards using non-grid energy and renewable technologies by businesses and those households that can afford the initial high cost.

The Financial and Fiscal Commission (FFC, 2015:120) mentioned that the current emphasis on environmental sustainability has implications for the price that municipal distributors will pay for the purchase of bulk electricity. Developments such as the pending implementation of a carbon tax, which was not implemented by 2016, the already implemented National Environmental Management Air Quality Act of 2004 and the 2012 National Framework for Air Quality Management (DEA, 2013) all entail compliance costs for Eskom. Ultimately, the associated costs of compliance will be transferred to end users – whether directly from Eskom to end users or via municipal distributors to end users. In the case of municipal distributors, these increased costs are likely to be transferred via higher prices for bulk electricity purchases.

Gawel and Bretschneider (2011) provided a comprehensive summary of the trade-offs that municipal officials face (Figure 6.5). The Financial and Fiscal Commission (FFC, 2015:120) stated that while they refer to the water sector, similar parallels can be drawn for the municipal electricity distribution sector. Striving for financial and ecological sustainability and economic efficiency negatively affects affordability and subsequently the ability of poorer households to access electricity. Gawel and Bretschneider (2011) emphasised the importance of comprehensive data on poverty, and willingness to pay, as a means of setting accurate affordability limits. Adding to the competing policy objectives is the increasing priority being given to environmental sustainability.

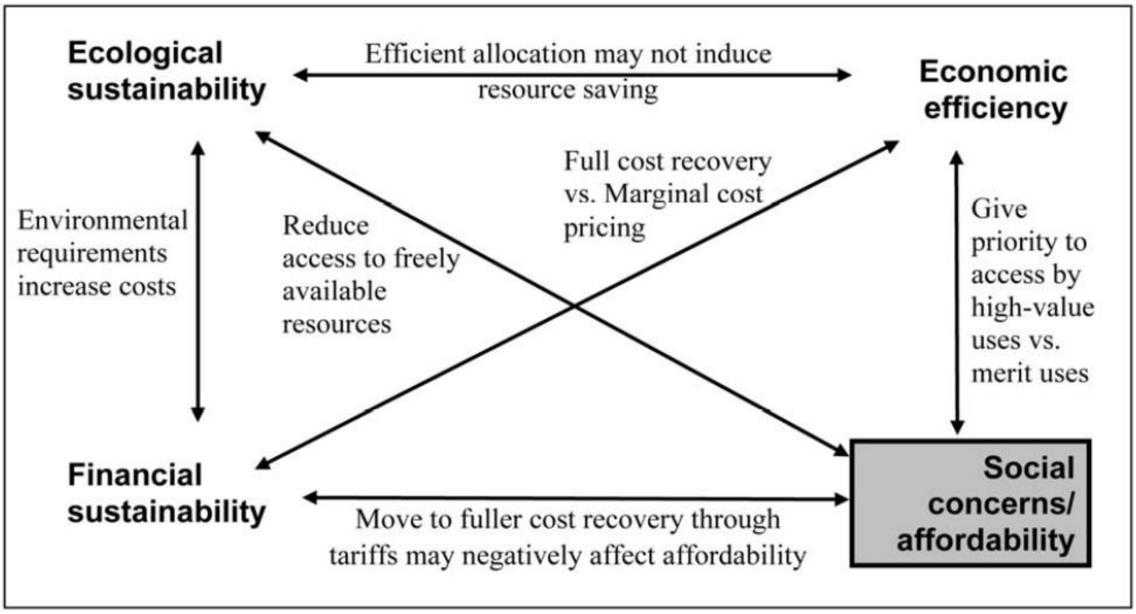


Figure 6.5: Trade-offs affecting municipal tariff levels and structures

Source: Gawel and Bretschneider, 2011:13.

Gawel and Bretschneider's (2011:13) definitions for ecological sustainability, economic efficiency, financial sustainability, and social concerns are as follows:

- Ecological sustainability: As a scarce and vulnerable natural resource, water should be used to protect the basic ecological functions of natural capital and preserved for future generations. Savings are part of this objective, which requires avoiding wasteful uses that put unnecessary pressure on the resource (use efficiency).
- Economic efficiency: As a valuable economic good, resources should be allocated to the uses that maximise overall benefits to society (allocation efficiency). This means that unnecessary investment should be avoided if the value of the services or functions they provide is lower than their cost.
- Financial sustainability: As activities requiring investment in costly infrastructures, service provision should be kept viable over time and should be able to attract capital, skills and technology by adequately compensating them.
- Social concerns: As a public interest good, acceptable levels of services should be accessible and affordable to all, including to lower-income groups.

Steurer, Langer, Konrad and Martinuzzi (2005:272) indicated the dimensions concept of sustainable development for corporations as economic, social, and environmental dimensions. A cultural and societal framework can help to understand the behaviour of financial intermediaries. These dimensions are supported by Dyllick and Hockerts (2002:132). Scholtens (2006:22) designed a framework to assess the interaction amongst finance, the firm and the economy relating to the business environment (Figure 6.6). When considering similarities of the governance processes and the business models as mentioned above, it was reasonable in this study to apply these models to the mining and industrial sectors, as well as to the municipal sector. In addition, the respondents indicated that they are in a position to influence the decision to purchase green electricity within their company/organisation. Therefore, the effect of increasing bulk electricity costs on the expenditure and revenue of municipalities will be similar to the mining and industrial sectors.

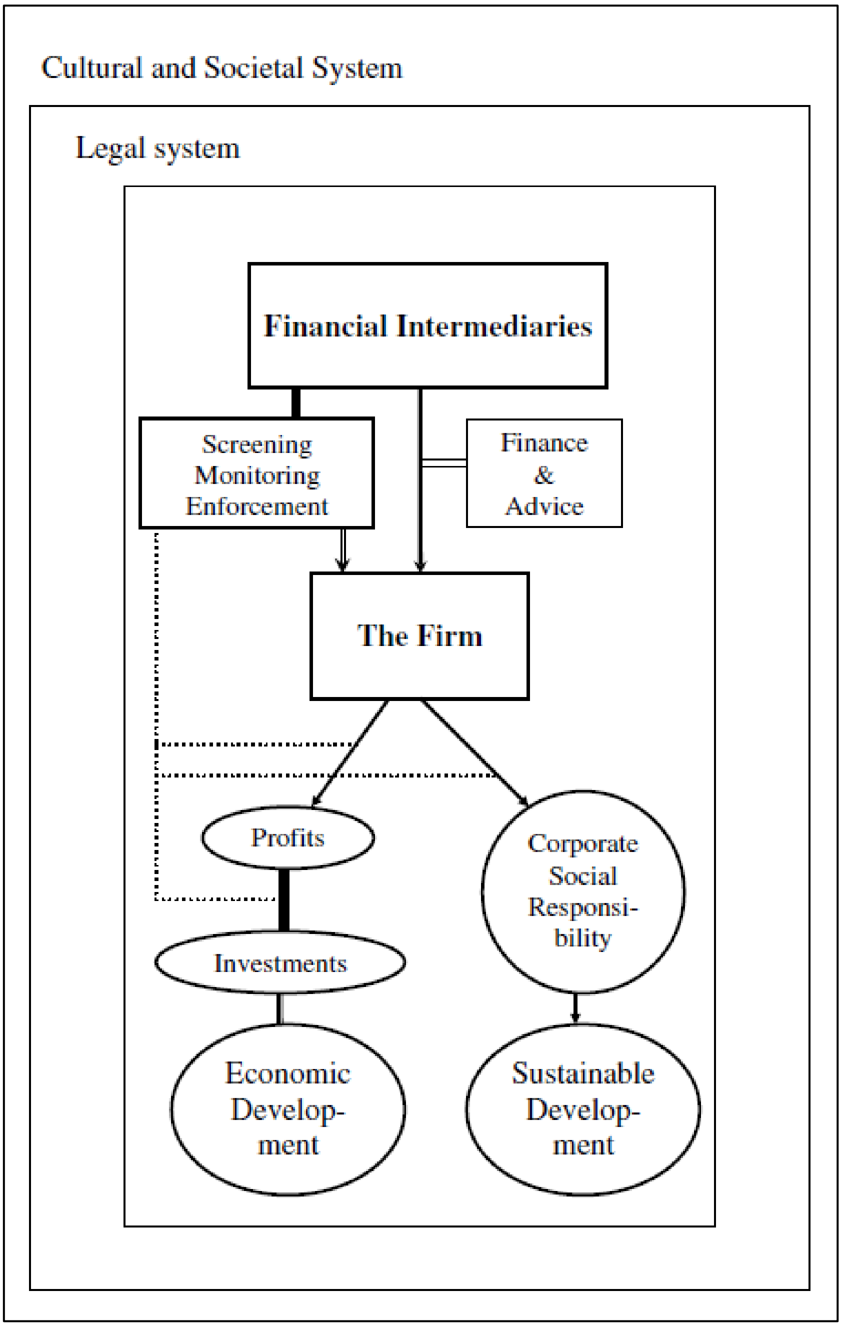


Figure 6.6: The interaction of financial intermediaries, the firm and the economy

Source: Scholtens, 2006:22.

The following section indicates the statistical evaluation to confirm the similarities between municipalities, mining and industrial sectors as discussed in this section.

6.3.5 Industrial sector vs. Mining sector

To ensure that the results can be used in one model, a comparison was done between the industrial and mining sectors. Table 6.1 indicates the reliability test results relating to the path coefficient difference between the industrial sector and mining sector (The hypothesis is that the path coefficients are the same). Therefore, a P-value, above 0.05, indicates a small deviation in the path coefficients. All path coefficients have high p-values, indicating no significant difference between the path coefficients of the industrial and mining sectors. This test confirmed the data’s homogeneity and that the sectors can be used together in this exploratory model.

Table 6.1: Industrial sector vs. Mining sector

	Industrial sector vs. Mining sector		
	Path	**Path coefficients-diff GROUP sector (Industrial) – GROUP sector (Mining)**	**p-Value GROUP sector (Industrial) vs. GROUP sector (Mining)**
1	Attitude towards the electricity supplier -> Behaviour WTP	0.061	0.574
2	Intention to use technology -> Overall attitude towards behaviour	0.079	0.299
3	Overall attitude towards behaviour -> Behaviour WTP	0.22	0.229
4	Support for green electricity -> Overall attitude towards behaviour	0.169	0.239
5	Support for green electricity -> Positive behaviours towards conservation	0.239	0.935
6	Support for green electricity -> Value perception towards renewable	0.123	0.298
7	Positive behaviours towards conservation -> Overall attitude towards behaviour	0.122	0.268
8	Value perception towards renewable -> Behaviour WTP	0.144	0.786

6.3.6 Industrial sector vs. Municipal sector

To ensure that the results can be used in one model, a comparison was done between the industrial and municipal sectors. This is additional to the industrial and mining sectors in the previous section.

Table 6.2: Industrial sector vs. Municipal sector

	Industrial sector vs. Municipal sector		
	Path	**Path Coefficients-diff GROUP sector (Industrial) – GROUP sector (Municipal / Residential)**	**p-Value GROUP sector (Industrial) vs. GROUP sector (Municipal / Residential)**
1	Attitude towards the electricity supplier -> Behaviour WTP	0.132	0.291
2	Intention to use technology -> Overall attitude towards behaviour	0.023	0.507
3	Overall attitude towards behaviour -> Behaviour WTP	0.001	0.389
4	Support for green electricity -> Overall attitude towards behaviour	0.079	0.322
5	Support for green electricity -> Positive behaviours towards conservation	0.129	0.786
6	Support for green electricity -> Value perception towards renewable	0.059	0.593
7	Positive behaviours towards conservation -> Overall attitude towards behaviour	0.251	0.07
8	Value perception towards renewable -> Behaviour WTP	0.183	0.196

Table 6.2 indicates the reliability test results relating to the difference between the industrial sector and municipal sector (The hypothesis is that the path coefficients are the same). Path coefficient 7 (positive behaviours towards conservation > Overall attitude towards behaviour) is 0.07 (7%). This value is just above the acceptable value, which should be above five percent (Kock, 2014:3). Only this specific path is further tested in Table 6.3, as the other path coefficients passed the first test.

Table 6.3: Path coefficients per group (Industrial sector vs. Municipal sector)

	Path coefficients per group				
	Path	**Path Coefficients Original GROUP sector (Industrial)**	**Path Coefficients Original GROUP sector (Municipal / Residential)**	**p-Values GROUP sector (Industrial)**	**p-Values GROUP sector (Municipal / Residential)**
7	Positive behaviours towards conservation > Overall attitude towards behaviour	0.04	-0.211	0.799	0.005

Path coefficient 7 (positive behaviours towards conservation > Overall attitude towards behaviour) tests the hypothesis that the path coefficients are not significant from the null hypothesis (H_0). The result is a marginally low P-value, indicating a slight significant difference between the path coefficients of the industrial and municipal sectors.

Path coefficient 7 was related to question number 9 of the questionnaire: "Does your business generate electricity by using any of the following technologies?" A list of green electricity-generating options was provided to the respondents to choose from. The path coefficient for Industrial was 0.04 and for Municipal -0.211 (Mining was -0.082). The municipal sector indicated some negative correlation, but there is no significant influence for the mining and industrial sectors. This is an indication that the industry sector invested more in renewable electricity-generating technologies than municipalities. The model indicates that this path coefficient did not influence the overall attitude towards behaviour.

6.3.7 Mining sector vs. Municipal sector

To ensure that the results can be used in one model, a comparison was done between the mining and municipal sectors. This is additional to the industrial and mining, as well as industrial and municipal sectors in the previous sections.

Table 6.4: Mining sector vs. Municipal sector

	Mining sector vs. Municipal sector		
	Path	**Path Coefficients-diff GROUP sector (Mining) – GROUP sector (Municipal / Residential)**	**p-Value GROUP sector (Mining) vs. GROUP sector (Municipal / Residential)**
1	Attitude towards the electricity supplier -> Behaviour WTP	0.193	0.171
2	Intention to use technology -> Overall attitude towards behaviour	0.102	0.725
3	Overall attitude towards behaviour -> Behaviour WTP	0.221	0.862
4	Support for green electricity -> Overall attitude towards behaviour	0.09	0.653
5	Support for green electricity -> Positive behaviours towards conservation	0.11	0.246
6	Support for green electricity -> Value perception towards renewable	0.181	0.843
7	Positive behaviours towards conservation -> Overall attitude towards behaviour	0.128	0.181
8	Value perception towards renewable -> Behaviour WTP	0.327	0.036

Table 6.4 tests the path coefficient difference between the mining sector and the municipal sector (The hypothesis is that the path coefficients are the same). Therefore, a high P-value indicates weak evidence against the null hypothesis. Path coefficient 8 (value perception towards renewable -> Behaviour WTP) is 0.036 (3.6%). This value is just below the acceptable values which, should be above five percent (Kock, 2014:3). Only this specific path is further tested in Table 6.5 because the other path coefficients passed the first test.

Table 6.5: Path coefficients per group (Mining vs. Municipal)

	Path coefficients per group				
	Path	**Path Coefficients Original GROUP_sector (Mining)**	**Path Coefficients Original GROUP_sector (Municipal / Residential)**	**p-Values GROUP_sector (Mining)**	**p-Values GROUP_sector (Municipal / Residential)**
8	Value perception towards renewable -> Behaviour WTP	0.203	-0.124	0.038	0.421

In Table 6.5, the "Path coefficients per group" tests the hypothesis that the path coefficients are not significantly different from 0, the null hypothesis (H_0).

The result is a high P-value, indicating no significant difference between the industrial and municipal sectors for this specific path coefficient. Path coefficient 8 was related to question number 6: "How significant will the financial status of your company/organisation influence your willingness to pay a premium for green electricity?" Mining was 0.203 and Municipal -0.124 (Industrial was 0.059). None of these are highly significant positions, but indicate a slightly significant impact in relation to the behaviour of WTP for the mining sector, almost neutral position for the industrial sector and a slightly negative influence for the municipal sector in relation to the behaviour of WTP.

The comparison test results of the path coefficients indicate that the different industrial, mining and municipal sectors can be used in the one PLS-SEM model. These results support the literature, which indicated that similar business models are used by these sectors as discussed in Section 6.3.4.

6.4 RESPONSE EVALUATION

The total number of questionnaires sent out was 2 346, with a response rate of 197 (8.4%) completed responses and 155 (6.6%) incomplete responses. The response rate as well as the non-responses on the questionnaires were comparable with similar studies. The ethical clearance requirements from the USB ethical committee stated that the respondents should not be identifiable. However, some non-respondents indicated their reasons for not completing the questionnaire. These reasons were evaluated and are discussed in the next section.

6.4.1 Non-responses

Feedback from some of the respondents indicated why they did not respond to the questionnaire. The main reason provided was information technology constraints. For example, they had a restriction with the web-based questionnaire due to the limited internet access granted by some companies. This was in addition to the company's web security that prevented delivery of the survey software to the email address as it was seen as spam. This result is supported by Fan and Yan (2010:134).

In this study, unwillingness to share information was another common reason provided for non-response. Some potential respondents regarded the questions as too personal, or felt that their company information is confidential. Nulty (2008:305) mentioned confidentiality concerns as a hindrance in research of this kind, which supports this outcome.

Three respondents felt that they were not capable of answering the questionnaire and provided alternative respondents' email addresses. Another respondent requested to complete the questionnaire in a group (meeting). One respondent was unwilling to share information and stated that the information was too personal. This person added that their company information is confidential and cannot be shared. One elusive response was received, asking the following question: 'Is Eskom aware that the city is currently selling green electricity?' and in this way the person avoided completing the questionnaire. These reasons came from all the sectors and no pattern could be established that could lead to bias in non-response. Various other studies on low response rates are discussed below in detail.

Petrovcic, Petric and Manfreda (2016:323) referred to a few studies on various types of online communities that provided estimates of non-response bias based on comparisons between early and late respondents (e.g., Chou, 2010; Jeppesen & Frederiksen, 2006; De Valck, Langerak, Verhoef, & Verlegh, 2007), or on a distinction between respondents from self-selection and random samples (Walsh, Kiesler, Sproull & Hesse, 1992). This aspect was not evident during this study.

In conclusion, no pattern could be established that could lead to bias in non-response from the grouping of the reasons provided for non-responses. The reasons for non-responses experienced in this study are similar to the reasons that were given in the literature for non-responses relating to web-based questionnaires.

6.4.2 Response rate

This section assesses the response rate to the questionnaire compared to the results of similar previous studies. A study by Fan and Yan (2010:136) expressed various factors affecting respondents' decision of whether they are willing to participate in a survey. They grouped contributing factors influencing participation decisions in web surveys into three categories: (1) society-related factors; (2) respondent-related factors; and (3) design-related factors. Their finding was that the type of population significantly affects the response rate according to several meta-analyses. For example, general populations are found less willing to respond than employee populations, student populations, or army populations. Among the professionals, the top managers were found less likely to respond than the employees and managers (Baruch, 2000). This confirms that for this study, the response rate correlated to the type of population since this study's questionnaire was sent to executives and senior managers as decision-makers who are responsible for managing the company's/organisation's electricity account. Figure 6.7 indicates the distribution of the respondents relating to their company/organisational positions. Strategic decisions are made by the executives and senior managers and their responses would therefore be indicative of their organisation's strategic intent. The group named 'other' mainly comprised the electricity account managers who interface with Eskom directly.

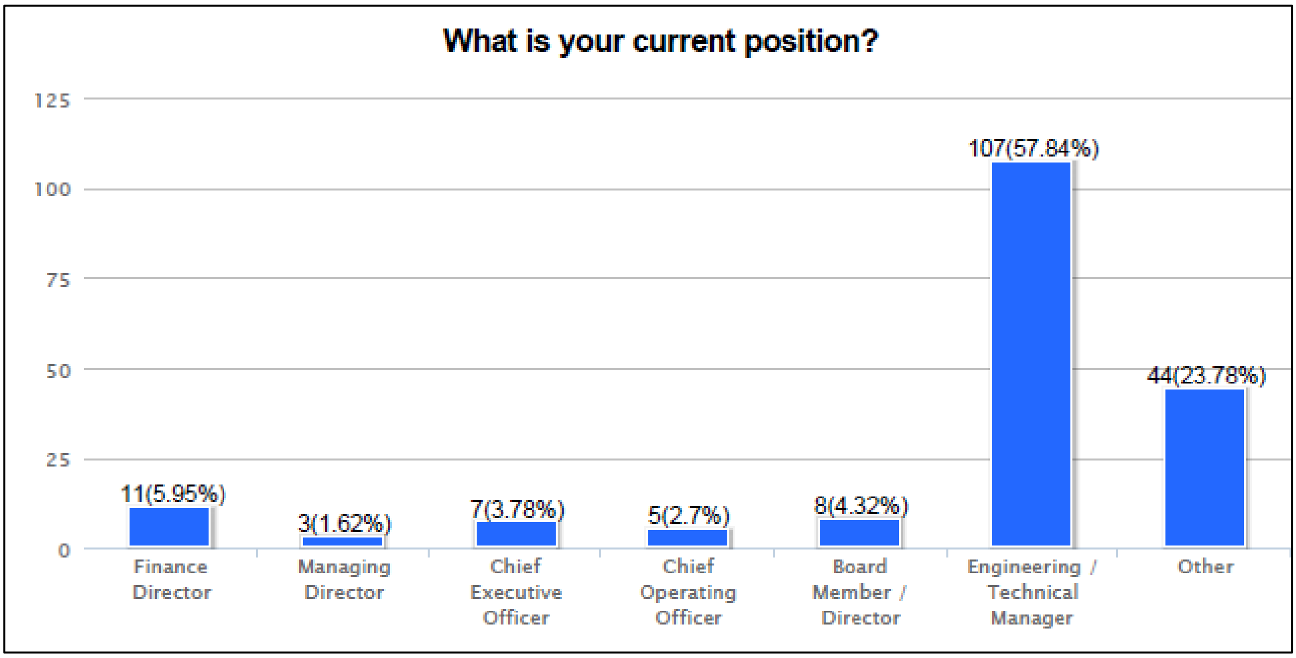


Figure 6.7: Respondent's position in company/organisation

Fryrear (2015) indicated that surveys distributed internally (i.e. to employees) generally have a much higher response rate than those distributed to external audiences (i.e. consumers). He further stated that internal surveys will generally receive a 30 to 40 percent response rate (or more) on average, compared to an average 10 to 15 percent response rate for external surveys. The different motivation levels of these two audiences to a high degree relates to the big variance in response rates. His reasoning for this is that a survey to employees is likely well targeted and they probably have good reasons to complete it. Fryrear (2015) stated that for external surveys, no matter what incentive you choose, it will not appeal to everyone who receives the survey request/questionnaire. Response rates can soar past 85 percent when the respondent population is motivated and the survey is well-executed. Response rates can also fall below two percent when the respondent population is less-targeted, when contact information is unreliable, or where there is less incentive or little motivation to respond.

Petrovcic et al. (2016:325) indicated in a study of online surveys that in total, 211 respondents completed their survey out of 2 500 sample members. The aggregate response rate was therefore 8.4 percent. This study came to several conclusions, including that the authority of the sender does not enhance the response rates of users of online communities. A plea for help in the invitation letter proved to be an important and effective predictor of response rate.

According to Petrovcic et al. (2016:327), making the respondents feel a sense of community in the questionnaire invitation does not improve the response rate. For this study, a letter from Eskom was sent to the potential respondents' companies in an attempt to improve the response rate. Another factor to consider is the administration of the email list of recipients that was used to send the questionnaire. This list is updated periodically and with staff resigning from their companies, internal movements as well as incorrect email addresses on the list can contribute to a lower response rate.

Petrovcic et al. (2016:328) indicated that previous studies on online communities reported comparable response rates, namely: "9% reported by Zillmann et al., 2014; 5% reported by de Valck et al., 2007; and less than 1% reported by Koo & Skinner, 2005". The final conclusion of Petrovcic et al. (2016:328) was that further research is warranted since some other studies on online communities reported higher response rates, namely 19 percent by Sneijers (2008); 35 percent by Matzat (2009); 37 percent by Matzat (2010); 38 percent by Matzat (2013); 63 percent by Jeppesen and Frederiksen (2006); and 76 percent by Walsh et al. (1992). There are probably many other response-inducing elements, including length of the invitation letter and the topic itself, which may have had different effects on different members of the online community.

Nulty (2008: 304), supported by Fan and Yan (2010:137), specified strategies that have been used during studies which have achieved high response rates to online surveys. Some of these include:

- Push the survey. This basically means making it easy for students to access the survey. (University software was easy to use, internet access was an issue for some.)
- Provide frequent reminders. (Send numerous reminders.)
- Persuade respondents that their responses will be used. (A communication was sent from the customer services manager to encourage participation.)
- Provide rewards. (Not allowed within the Eskom ethical policies.)

- Extend the duration of a survey's availability (This was done four times.)
- Assure anonymity of their responses.
- Keep questionnaires brief. (The questionnaire for this study was possibly too long as 10.8 percent of the respondents did not complete the questionnaire.)

During the questionnaire's active period, frequent reminders were sent out, and extending the duration of the survey was granted to allow more respondents to complete the questionnaire. At a state-owned company, employees are not permitted to provide rewards to service providers and customers. All other recommended strategies that have been used during previous studies, and which have achieved high response rates to online surveys, were utilised. In conclusion, for this study, the questionnaires were sent out utilising the university survey software (web based) and the sampling frame was a general population of professionals and top managers, which confirms that the response rate of this study conforms to comparable previous studies.

In the next section, the relationships of each of the latent variables in the model are evaluated and discussed in accordance to Hinkin's (1995) three-stage model and the model improvement process of Lowry and Gaskin (2014), which includes the design of the developmental study, scale construction and reliability assessment.

6.5 PLS-SEM MODEL REFINEMENT

6.5.1 Introduction

The theoretical research model (Figure 6.2) was tested and refined to improve the model fit. By conducting statistical analysis of the data received from the questionnaire, as well as incorporating the theory from literature, the final exploratory research model was proposed. Hinkin's (1995) stage one describes the deductive development when researchers utilise a previously-defined theory to create enough items to allow for deletion. The theoretical proposed research model (Figure 6.2) was refined utilising this principle where the variables are extracted and grouped it into factors. This method is used to simplify the expression of a particular model in terms of just a few major items. The next sections demonstrate the process followed to establish the final proposed exploratory model and demonstrate construct validity. In this refined exploratory model, the main constructs remain as per the theoretical proposed model as indicated in Figure 6.8. The paths in the refined exploratory model are linked to the propositions at the end of Chapter 4 and discussed in detail in Chapter 8.

6.5.2 Improving model fit

It is expected for the fit of a proposed model to be initially poor given the complexity of structural equation modelling. Allowing modification indices to drive the process is risky; however, some modifications can be made locally that can substantially improve results. It is good practice to assess the fit of each construct and its items individually to determine whether there are any items that are particularly weak. Items with a low R^2 (less than 0.20) should be removed from the analysis as this is an indication of high levels of error. Subsequently, each construct should be modelled in conjunction with every other construct in the model to determine whether discriminant validity has been achieved. The value between two constructs is comparable by their covariance. A covariance of 1.0 indicates that the two constructs are measuring the same entity and further inspections of item cross-loadings need to be made. The discriminant validity test determines whether constructs are significantly different (Hooper, Coughlan & Mullen, 2008:56).

6.5.3 The model evaluation and improvement process

This process is summarised in the following steps below (Lowry & Gaskin, 2014:132-140).

(i) Step 1: Model specification

Before conducting a PLS analysis, configure the model in a way that will produce the results required by stating the theoretical model either as a set of structural equations or as a path diagram.

(ii) Step 2: Establish construct validity of reflective constructs

Utilising the observed data, establishing validity and testing the entire path model occurs in one pass. This is done by establishing convergent and discriminant validity for the reflective constructs by (1) examining the t-values of the outer model loadings. These results indicate strong convergent validity if it is greater than 0.05 for the constructs; and (2) determining the discriminant validity of the indicators. To confirm the discriminant validity of the indicators further, calculate the average variance extracted (AVE).

(iii) Step 3: Establish the reliability of the reflective constructs

Reliability refers to the degree to which a scale yields consistent and stable measures over time and applies only to reflective indicators. PLS-SEM computes a composite reliability score as part of its integrated model analysis, similar to Cronbach’s alpha in that they are both measures of internal consistency. Each reflective construct in the model must demonstrate a level of reliability above the recommended threshold of 0.70.

(iv) Step 4: Establish construct validity of formative indicators

The procedures for determining the validity of reflective measures do not apply to formative indicators since formative indicators may move in different directions and can theoretically co-vary with other constructs. Ensure the indicator weights for formative constructs are roughly equal and all have significant t-values. Assess formative validity, which involves testing the multi-collinearity among the indicators. The final reported validity statistics should be those gathered once all changes to the structure of the measurement model are complete.

(v) Step 5: Test for common methods bias

Since the endogenous variables were collected at the same time and using the same instrument as the exogenous variables, this study tested for common methods bias to establish that such bias did not distort the data collected. The full collinearity test is effective for the identification of common method bias by simultaneously assessing both vertical and lateral collinearity. Through this procedure, variance inflation factors (VIFs) are generated for all latent variables in a model. The occurrence of a VIF greater than 3.3 is an indication of pathological collinearity, and also as an indication that a model may be contaminated by common method bias.

(vi) Step 6: Test for moderation effects (if applicable)

Moderating effects are evoked by variables whose variation influences the strength or the direction of a relationship between an exogenous and an endogenous variable. As this is an exploratory research study to determine influences regarding WTP, moderation effects were not used.

(vii) Step 7: Test for mediation (if applicable)

A mediator is a construct in a causal chain between two other constructs. During this study, no mediator was included in the model.

(viii) Step 8: Assess the predictive power of the model

This indicates how well the model explains variance in the dependent variables, as demonstrated by the path coefficients and R^2s in the model. To be 'substantial', standardised paths need to be close to 0.20 or ideally higher than 0.30 to indicate that the model has meaningful predictive power.

(ix) Step 9: Provide and interpret final statistics

As the final step of the analysis of the model, provide the measurement model statistics.

In developing models to test propositions using PLS-SEM, researchers use theory, judgment, experience and research objectives to identify and develop propositions about relationships between multiple independent and dependent variables (Hair et al., 2014:108).

As part of Stage 2 of Hinkin's approach (1995), the development of the questionnaire included the evaluation of the initial variables. Hair et al. (2014:107) quoted Lohmöller and Wold (1980:1):

> *PLS is primarily intended for research contexts that are simultaneously data-rich and theory-skeletal. The model building is then an evolutionary process, a dialog between the investigator and the computer. In the process, the model extracts fresh knowledge from the data, thereby putting flesh on the theoretical bones. At each step PLS retests content with consistency of the unknowns.*

By conducting statistical analysis of the data received from the questionnaire as well as incorporating the theory from literature, the final exploratory research model was proposed. In this refined exploratory model, the main constructs remain as per the theoretical model: culture (in green), technology (in grey), behaviour (in red / brown) and value aspects (in purple) of the exploratory model as indicated in the Figure 6.8. Additionally, theory from literature suggests that the final exploratory model needs to consider the general support for green electricity as well as the relationship between support for green electricity and the perception of the electricity supplier. These components were included in the refined exploratory model.The theoretical exploratory model was uploaded and evaluated by the USB's statistical support using the STATISTICA™ software programme with the assistance of the Stellenbosch University's Centre for Statistical Consultation.

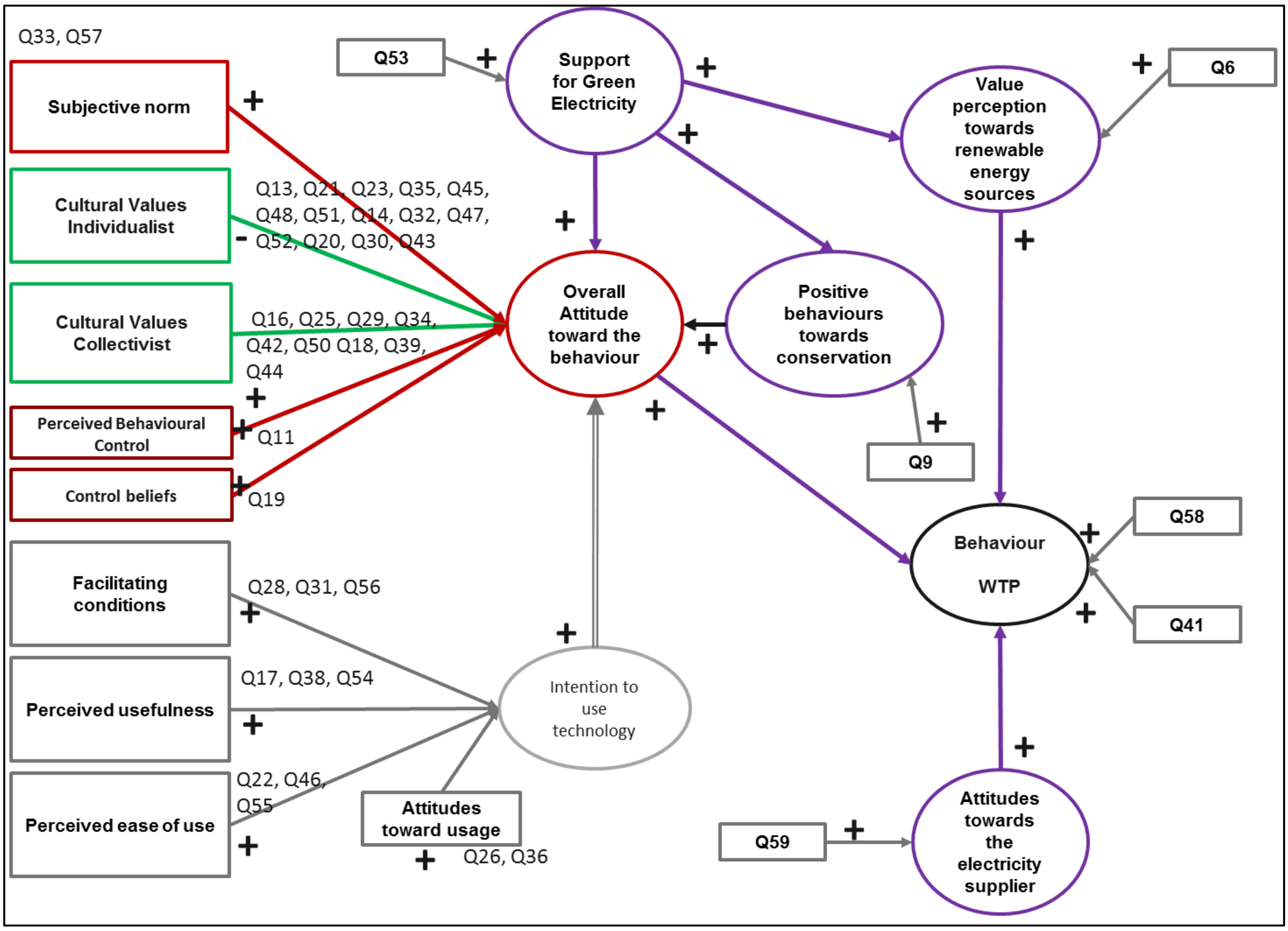


Figure 6.8: Refined explorative model used for evaluation

When using PLS-SEM, the model refinement does not have a defined completion. Therefore, the researcher decides when the model is sufficiently refined (Hair et al., 2014:107). In order to verify the construct validity of items used in the exploratory model, an evaluation process on each construct was completed as described in the next sections.

6.6 EVALUATING RESPONSES RELATED TO THE CULTURE QUESTIONS

The proposition made relating to this aspect of the model is that collective leaders value social responsibility higher than individualists (Shulruf et al. 2011). The leaders of the organisation's bias towards their cultural values related to *collectivism* and *individualism* provides an indication of the organisation's predisposition towards social responsibility and protection of the environment. The cultural section incorporated in the exploratory model was developed by Shulruf et al. (2011:178).

Shulruf et al. (2011) used the Auckland Individualism – Collectivism Scale to determine the differences related to collectivism and individualism values of nations. Their cultural value model relates to the model developed by Ajzen (1991:182), the theory of planned behaviour, specifically the "Attitude towards the behaviour" element (function), which was one of the inputs of the exploratory model for this study.

The questions, as used by Shulruf et al. (2011) and Ajzen (2006), were formulated to be relevant in terms of the large consumer's WTP a premium for green electricity, and are listed in Table 6.6. The scale for the answers was selected to prevent the respondents from using the neutral answer.

Therefore, a scale from 1 to 6 was utilised as shown below:

- Always/Strongly Agree = 6
- Very often/Agree = 5
- Often/Agree Somewhat = 4
- Occasionally/Disagree Somewhat = 3
- Rarely/Disagree = 2
- Never or almost never/Strongly Disagree = 1

Table 6.6: Culture questions

#	Culture questions
13	I define myself as a competitive person
14	I enjoy being unique and different from others
16	Before I make a major decision, I seek advice from people close to me
18	Even when I strongly disagree with my group members, I avoid an argument
20	I consult with superiors/board members on work-related matters
21	I believe that competition is a law of nature
23	I prefer competitive rather than non-competitive recreational activities
25	Before taking a major business trip, I consult with my colleagues
27	I sacrifice my self-interest for the benefit of my group
29	I consider my colleagues' opinions before taking important actions
30	I like to be accurate when I communicate
32	I consider myself to be a unique person who does not follow the crowd
34	It is important to consult colleagues and get their ideas before making a decision
35	I believe it would not be possible to have a good society without competition
37	I ask the advice of friends and colleagues before making career-related decisions
39	I prefer using indirect language rather than upsetting my colleagues by telling them directly what they may not like to hear
40	It is important for me to act as an independent person
42	I discuss job or study-related problems with my parents/partner
43	I take responsibility for my own actions
44	I do not reveal my thoughts when it might initiate a dispute
45	I try to achieve better results than my peers
47	My personal identity independent of others is very important to me
48	I enjoy working in situations involving competition with others
50	I consult my colleagues before making an important decision
51	Winning is very important to me
52	I see myself as 'my own person'

Source: Adapted from Shulruf et al., 2011; Ajzen, 2006.

The questionnaire data was analysed to determine the senior management and executive leadership orientation related to their collectivism and individualism values. The cultural model gave input to the theory of planned behaviour section of the model and specifically the "Attitude towards the behaviour" latent variable, of the exploratory model. The cultural aspect of the exploratory model is indicated in Figure 6.9.

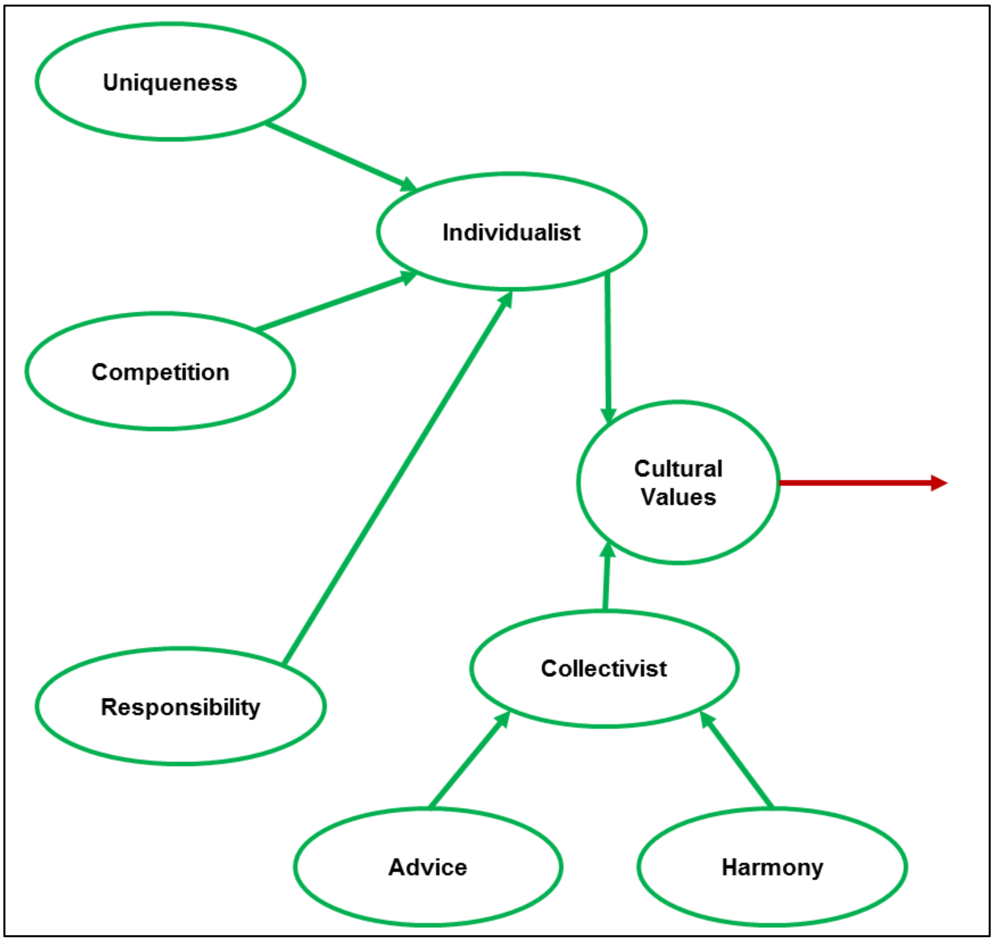


Figure 6.9: Cultural values aspect of the exploratory model

Collectivism is measured in the exploratory model by Advice and Harmony in accordance to the cultural measurement model developed by Shulruf et al. (2011:178). Advice was measured by questions 16, 25, 29, 34, 37, 42 and 50. Harmony was measured by questions 18, 27, 39, 44.

Individualism was measured in the exploratory model by Uniqueness, Competition and Responsibility in accordance to the cultural measurement model developed by Shulruf et al. (2011:178). Uniqueness was measured by questions 14, 32, 47 and 52. Competition was measured by questions 13, 21, 23, 35, 45, 48 and 51. Responsibility was measured by questions 20, 30, 40 and 43. The number of respondents who indicated a predisposition towards individualism or collectivism are indicated in Table 6.7.

Table 6.7: Culture outcome indicating predisposition

Culture outcome indicating predisposition per level of electricity consumption				Culture outcome indicating predisposition per sector			
Usage	Number	Collectivism	Individualism	Sector	Number	Collectivism	Individualism
Up to 100k	17	1	16	Mining	74	2	72
>100k-300k	31	2	29	Industrial	46	2	44
>300k to 600k	25	1	24	Municipal	53	4	49
>600k to 1000k	20	0	20	Commercial	2	0	2
>1m to 4m	46	1	45	Agriculture	2	0	2
>4m to 200m	39	3	36	Traction / Rail	2	0	2
>200m to 500m	11	0	11	Bulk Distributors	7	0	7
>500m to 6000m	8	0	8	Other	11	0	11
Total	197			Total	197		
All users		8	189	All sectors		8	189

The results indicate a significant predisposition towards individualism with 189 of the respondents' results being higher for their individualist score than their collectivist score. Only eight of the respondents' collectivist score was higher than their individualist score.

Table 6.8 indicates the average scores of the respondents per sector for individualism and collectivism, as well as the overall average score considering all respondents. Some of the sectors' respondents are limited between two and eleven respondents and a combined average of the smaller sectors is displayed for comparison as 'All other'.

The *Individualism* average scores per sector was 4.792 and the *Collectivism* average score was 3.794. The *Individualism* average score per level of electricity consumption was 4.792 and the *Collectivism* average score was 3.779. The overall average score was 3.794.

The *Individualism* average score for all respondents was 3.794 and the *Collectivism* average score for all respondents was 4.792. The results from the 19 electricity consumers using the most electricity and the 24 respondents from sectors not included in the three large sectors were similar to the overall average scores.

The results from this analysis confirm that a significant predisposition towards individualism exists except for the Agriculture sector where the *Individualism* score is an outlier at 2.776. As there were only two respondents for this sector, this score can be ignored.

Table 6.8: Cultural values analyses

Cultural values analyses per level of electricity consumption				Cultural values analyses per sector			
Usage	**Number**	**Collectivism**	**Individualism**	**Sector**	**Number**	**Collectivism**	**Individualism**
Up to 100k	17	3.954	4.954	Mining	74	3.616	4.728
>100k-300k	31	3.824	4.712	Industrial	46	3.784	4.807
>300k to 600k	25	3.479	4.629	Municipal	53	4.069	4.928
>600k to 1000k	20	3.740	4.827	Commercial	2	4.321	5.190
>1m to 4m	46	3.902	4.912	Agriculture	2	3.482	2.776
>4m to 200m	39	3.817	4.723	Traction / Rail	2	3.464	4.500
>200m to 500m	11	3.794	4.886	Bulk Distributors	7	3.990	4.835
>500m to 6000m	8	3.723	4.696	Other	11	3.604	4.497
Average of consumption		**3.779**	**4.792**	**Average of sectors**		**3.791**	**4.533**
Total	197				197		
All users		**3.794**	**4.792**	**All sectors**		**3.794**	**4.792**
Mega users	19	3.764	4.806	Mining	24	3.754	4.659

When considering the results above, they indicate that the respondents have a predisposition towards individualism. From the findings in his study, Shulruf et al. (2011:185) concluded that by determining how many respondents in a group relate to collectivism or individualism, one may determine the group’s behaviour. As individualists are more reluctant to contribute to social responsibility, they may be therefore less willing to pay for green electricity.

6.7 EVALUATING RESPONSES RELATED TO THE TECHNOLOGY MODEL

When attempting to measure the WTP a premium for green electricity, the model for the ‘theory of planned behaviour’ requires additional input from other related subjects. Previous WTP studies found that the technology used to generate green electricity and the knowledge/awareness of the technology have an influence on the WTP. This is supported by Zografakis et al. (2010:1 089), Nomura and Akai (2004:458), Scarpa and Willis (2010:129) as well as Yoo and Kwak (2009:5 409). For this reason, the exploratory model includes the technology acceptance model as it influences the overall attitude towards behaviour latent variable.

Teo (2010:260) concluded from the results of his study that behavioural intention to use technology was indirectly predicted by facilitating conditions and mediated by attitude towards usage, as described in Figure 4.16. Teo (2010) used the causal relationships between perceived usefulness, perceived ease of use, attitude towards technology use and behavioural intention to use technology based on the technology acceptance model documented by Davis (1989:322) to create his model. This theoretical framework was incorporated into the exploratory model as indicated in Figure 6.10.

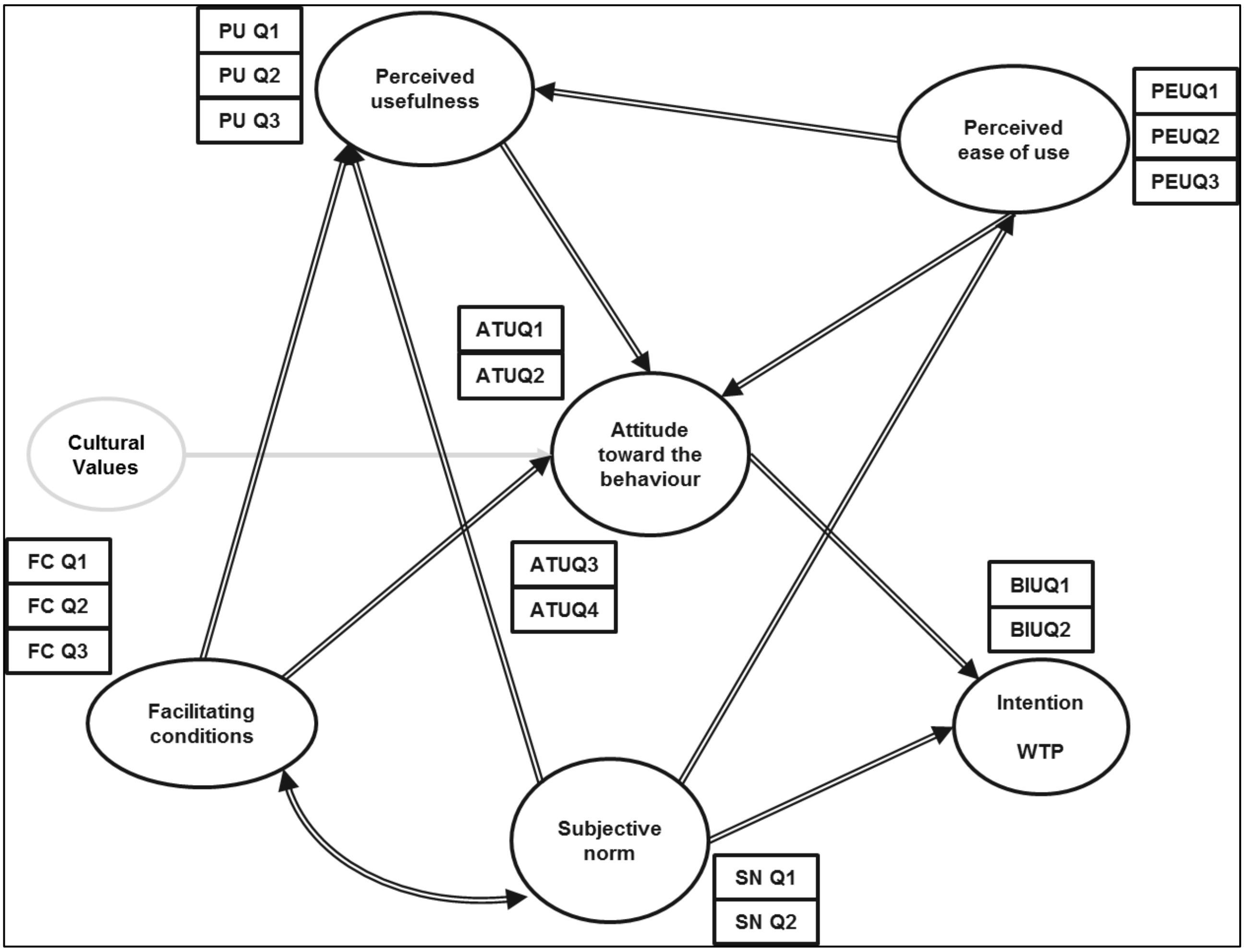


Figure 6.10: Intention to use technology structure in the exploratory model

The technology acceptance model is among the few models to include psychological factors that affect technology acceptance. Perceived behavioural control refers to the extent to which people perceive the performance of a specified behaviour to be easy or difficult. This behaviour is associated with the beliefs about the presence of control factors that may facilitate or hinder the performance of the behaviour (Ajzen, 2002:668). From the literature, various studies have applied the technology acceptance model to study issues involving pre-service teachers as used by Teo (2010:261). The questions used by Teo (2010:261) were adapted from various sources as indicated in Table 6.9. The questions for this study were formed by utilising the principles of Ajzen (2002) and the questionnaire used by Teo (2010).

Table 6.9: Technology acceptance model questions

Construct	Item	Questions
Attitudes towards usage (adapted from Compeau and Higgins, 1995)	ATU1 ATU2 ATU3 ATU4	Computers make work more interesting Working with computers is fun I like using the computer I look forward to those aspects of my job that require me to use computers
Perceived usefulness (adapted from Davis, 1989)	PU1 PU2 PU3	Using computers will improve my work Using computers will enhance my effectiveness Using computers will increase my productivity
Perceived ease of use (adapted from Davis, 1989)	PEU1 PEU2 PEU3	My interaction with computers is clear and understandable I find it easy to get computers to do what I want it to do I find computers easy to use
Facilitating conditions (Thompson et al., 1991)	FC1 FC2 FC3	When I need help to use the computer, guidance is available to me When I need help to use the computer, specialised instruction is available to help me When I need help to use the computer, a specific person is available to provide assistance
Subjective norm (adapted from Ajzen, 1991; Davis et al., 1989)	SN1 SN2	People whose opinions I value will encourage me to use computers People who are important to me will support me to use computers
Behavioral intention to use (Davis et al. 1989)	BIU1 BIU2	I will use computers in future I plan to use the computer often

Source: Teo, 2010:261.

To relate the questions of this research to the technology model, these questions were adapted by ensuring the questions measure the extent to which the respondents perceive their ability to understand and procure green electricity to be easy or difficult. This behaviour was associated with the respondents' belief that they had control over facilitating or hindering their ability to procure green electricity. This is consistent with the theory of Ajzen (2002) and Teo (2010) and is displayed in Table 6.10. Reverse-worded questions were incorporated to test for consistency.

Table 6.10: Technology acceptance model questions adopted for green electricity

Questions from Teo (2010: 261)	Item	Questions adopted for WTP	#
Computers make work more interesting	ATU1	Green electricity is an interesting subject	26
Working with computers is fun	ATU2	Reading about green electricity is uninteresting	24
I like using the computer	ATU3	I support the use of green electricity	36
I look forward to those aspects of my job that require me to use computers	ATU4	Using green electricity is not going to make a difference	53
Using computers will improve my work	PU1	Using green electricity will improve my life	54
Using computers will enhance my effectiveness	PU2	Using green electricity will enhance my environment	17
Using computers will increase my productivity	PU3	Using green electricity will increase my quality of life	38
My interaction with computers is clear and understandable	PEU1	My knowledge and understanding of green electricity is good	55
I find it easy to get computers to do what I want it to do	PEU2	I believe it is easy to convert to green electricity	22
I find computers easy to use	PEU3	I find green electricity difficult to procure	46
When I need help to use the computer, guidance is available to me	FC1	When I need help to learn more about green electricity, guidance is available to me	56
When I need help to use the computer, specialised instruction is available to help me	FC2	Specialised support is available to advise me when I need help choosing between green electricity-generating technologies	28
When I need help to use the computer, a specific person is available to provide assistance	FC3	Specialised support is available to help me when I need help implementing a green electricity procurement strategy	31
People whose opinions I value will encourage me to use computers	SN1	People whose opinions I value will encourage me to purchase green electricity	57
People who are important to me will support me to use computers	SN2	It is expected of me to support the purchase of green electricity	33
	SN3	I feel under social pressure to purchase green electricity	49
I will use computers in future	BIU1	I am willing to pay a premium for green electricity in future	58
I plan to use the computer often	BIU2	I expect to pay a premium for green electricity	41

Question SN3 was added to the initial theoretical exploratory model relating to SN. This question was added because of Ajzen's (1991:181) statement that human behaviour is guided by beliefs about the normative expectations of others, resulting in perceived social pressure or subjective norm considerations about the normative expectations of others. This question was removed during the refinement process to update the theoretical model to the exploratory model in order to remain with the original two questions used in the questionnaire from Teo (2010:261).

It is essential to establish the reliability and validity of the questions. The content validity of the questions was insured by confirming the questions were compiled based on comprehensive theory.

The questions were further verified by statistically analysing the reliability and validity of the results as part of the model refinement utilising Cronbach alpha as indicated in Appendix D as well as the evaluation below. Further analysis was completed on the data from the questionnaires in order to verify that the results are reflective of the related literature.

Teo (2010:258) concluded that behavioural intention to use (BIU) was predicted by attitude towards usage (ATU), perceived usefulness (PU), perceived ease of use (PEU), subjective norm (SN), and facilitating conditions (FC).

The results from this study indicate a lower BIU than ATU and PU (See Table 6.11 and Table 6.12). This reflects the theory that the electricity consumers support the idea of green electricity, but are reluctant to pay a premium for green electricity. The average score for PEU is low, therefore indicating that most consumers believe it is difficult to purchase green electricity. This proposes that an opportunity exists to increase the behavioural intention to use green electricity in future if it can be made easier to procure green electricity.

The three large sectors, Mining, Industrial and Municipal, have similar average scores for all constructs (BIU, ATU, PU, PEU, SN and FC). Some outliers exist where there were a small number of respondents in a sector, for example, Commercial, Agriculture and Traction/Rail, when compared to the three large sectors. When combining all the small sectors (24 respondents), their average score correlates with the large sectors' average scores as well as the average score from all the respondents (All sectors).

The same outcome was evident from the results when evaluating the results in relation to the level of electricity consumption. There is a close correlation between the largest 19 (Mega) electricity users and the smallest 17 electricity users.

Q24 and Q53 made use of reverse wording and had slightly lower scores than the average of the other questions measuring ATU. This outcome supports the conclusion by Van Sonderen et al. (2013:5) that the reverse-worded items may contaminate the respondent answers through inattention and confusion. The average scores for the questions related to ATU were Q24 (4.53), Q26 (4.95), Q36 (4.95) and Q53 (4.75). Because the average of question 24 was lower than the other questions, it was removed from the refined exploratory model.

Table 6.11: Intention to use technology analyses per sector

Intention to use technology							
	Number	**ATU**	**PU**	**PEU**	**FC**	**SN**	**BIU**
Mining	74	4.750	4.545	3.466	4.374	3.428	3.338
Industrial	46	4.804	4.507	3.420	4.130	3.377	3.522
Municipal	53	4.887	4.547	3.472	3.906	3.704	3.604
Commercial	2	5.125	5.167	3.667	3.333	4.000	4.000
Agriculture	2	4.125	4.667	3.667	3.833	3.833	3.250
Traction / Rail	2	3.750	3.333	3.667	3.000	2.667	3.000
Bulk Distributors	7	5.214	4.619	3.762	3.048	3.524	3.357
Other	11	4.614	4.576	3.515	4.242	3.515	3.682
Average		**4.659**	**4.495**	**3.579**	**3.733**	**3.506**	**3.469**
Total	197						
All sectors		**4.796**	**4.536**	**3.476**	**4.107**	**3.501**	**3.475**
All Other	24	4.719	4.542	3.625	3.681	3.514	3.521

Table 6.12: Intention to use technology analyses per level of electricity consumption

Intention to use technology							
	Number	**ATU**	**PU**	**PEU**	**FC**	**SN**	**BIU**
Up to 100k	17	4.882	4.804	3.745	3.882	3.765	3.912
>100k-300k	31	4.702	4.602	3.538	3.989	3.333	3.452
>300k to 600k	25	4.670	4.293	3.253	3.813	2.987	3.420
>600k to 1000k	20	4.667	4.667	3.433	4.450	3.383	3.175
>1m to 4m	46	4.853	4.674	3.493	4.348	3.688	3.685
>4m to 200m	39	4.833	4.393	3.359	4.077	3.624	3.128
>200m to 500m	11	4.750	4.061	3.515	4.485	3.545	3.818
>500m to 6000m	8	5.188	4.708	3.750	3.333	3.750	3.563
Average		**4.818**	**4.525**	**3.511**	**4.047**	**3.509**	**3.519**
Total	197						
All users		**4.794**	**4.536**	**3.470**	**4.107**	**3.501**	**3.475**
Mega users	19	4.934	4.333	3.614	4.000	3.632	3.711

From the results above, it can be concluded that the results are similar when the respondents are measured according to the various sectors as well as for level of electricity consumption. The above evaluation confirms the construct and statistical validity of the questionnaire used to measure the technology model within the exploratory model.

6.8 EVALUATING RESPONSES RELATED TO THE THEORY OF PLANNED BEHAVIOUR

The theory of planned behaviour concluded that human behaviour is guided by three kinds of considerations Ajzen (1991:181):

- Beliefs about the likely consequences of the behaviour (behavioural beliefs), that produce a favourable or unfavourable attitude towards the behaviour;
- Beliefs about the normative expectations of others (normative beliefs), resulting in perceived social pressure or subjective norm; and
- Beliefs about the presence of factors that may facilitate or impede performance of the behaviour (control beliefs), giving rise to perceived behavioural control.

Ajzen's (1991:182) theory of planned behaviour model as described in Figure 4.13 has been used in various studies covering many subject fields.

Examples of these studies are:

- *Pollution Reduction Preferences of US Environmental Managers: Applying Ajzen's Theory of Planned Behavior* by Cordano and Frieze in 2000.
- Application of the Theory of Planned Behavior to Leisure Choice by Ajzen and Driver in 1992.
- Choice of Travel Mode in the Theory of Planned Behavior: The Roles of Past Behavior, Habit, and Reasoned Action by Bamberg, Ajzen and Schmidt in 2010.
- Understanding and Predicting Electronic Commerce Adoption: An Extension of the Theory of Planned Behavior by Pavlou and Fygenson in 2006.
- *Application of the Theory of Planned Behavior to green hotel choice: Testing the effect of environmental friendly activities* by Hana, Hsub and Sheu in 2010.

It is thus clear that Ajzen's (1991:182) theory of planned behaviour model has been used in various fields of study with significant success.

A combination of attitude towards the behaviour, subjective norm, and perception of behavioural control lead to the formation of a behavioural intention. Intention is assumed to be the immediate predecessor of behaviour. Many behaviours pose difficulties of execution that may limit unforced control and it is therefore useful to consider perceived behavioural control in addition to intention. Given a sufficient degree of actual control over the behaviour, people are expected to carry out their intentions when the opportunity arises (Ajzen, 1991:188). From Ajzen's (1991) model, the latent variable measuring perceived behavioural control, indicated on the final explorative model in

Figure 6.11, was incorporated into the theoretical model. This section of the theoretical model is linked to the technology model and the remaining variables of Ajzen's model are incorporated into the exploratory model through the technology model. The related questions are indicated in the red rectangles next to the latent variable in Figure 6.11.

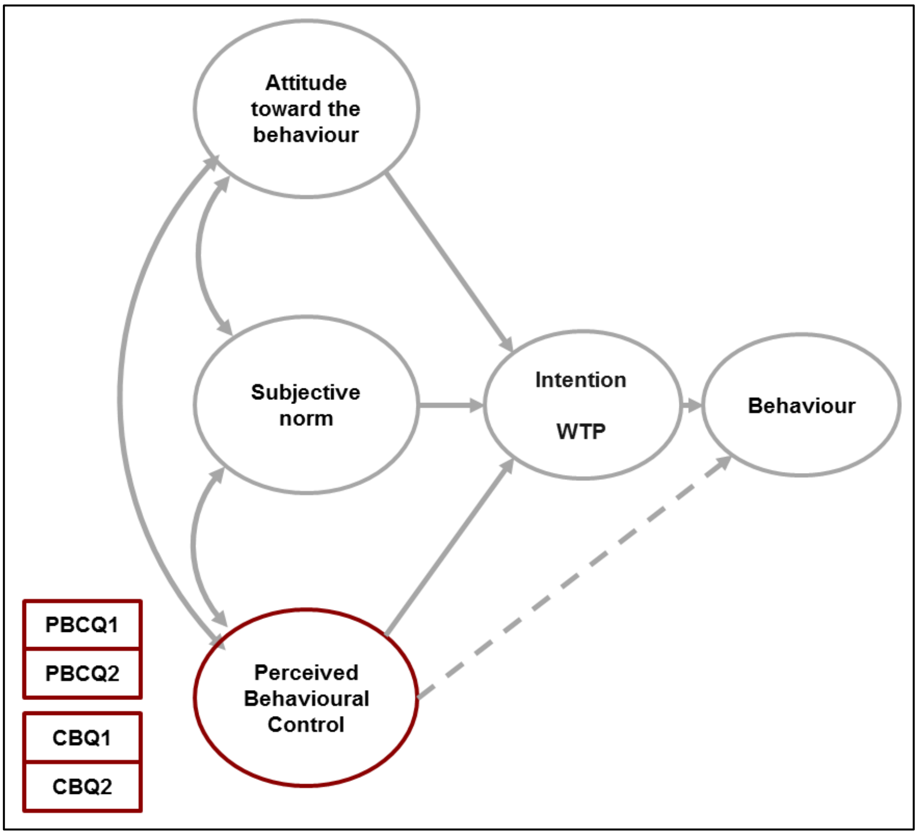


Figure 6.11: Measuring perceived behavioural control in the exploratory model

Behavioural beliefs produce a favourable or unfavourable attitude towards the behaviour; normative beliefs result in perceived social pressure or subjective norm; and control beliefs give rise to perceived behavioural control. This study utilised the manual of constructing a questionnaire based on the theory of planned behaviour by Francis, Eccles, Johnston, Walker, Grimshaw, Foy, Kaner, Smith and Bonetti (2004:9).

> *Perceived behavioural control is the extent to which a person feels able to enact the behaviour. It has two aspects: how much a person has control over the behaviour (e.g., low control over measuring blood pressure (BP) if the BP machine often malfunctions); and how confident a person feels about being able to perform or not perform the behaviour (e.g., not sufficiently skilled in measuring blood pressure).*

When using the manual from Francis et al. (2004), the perceived behavioural control questions relating to the WTP for green electricity and the extent to which a person feels able to enact the behaviour were created. The questions used in the questionnaire included the two aspects of how much a person has control over the behaviour and how confident a person feels about being able to perform or not perform the behaviour.

Perceived behavioural control is determined by control beliefs about the power of both situational and internal factors to inhibit or facilitate the performing of the behaviour. (Francis et al., 2004:9). By selecting the beliefs most often documented and converting these into a set of statements, these statements reflect the beliefs which make it difficult to perform (or not perform) the target behaviour (Francis et al., 2004:22).

Francis et al. (2004:23) used the measuring of blood pressure as an example to creating perceived behavioural control questions. His example said to imagine that the elicitation study has identified a control factor to do with patients being inappropriately dressed for BP measurement; another to do with feeling rushed when measuring BP in the consultation; another about uncomfortable cuffs on BP machines. When relating the control beliefs questions to the WTP a premium for green electricity, the questions used in the questionnaire included the two aspects of situational and internal factors which may inhibit or facilitate the performing of the behaviour as detailed in Table 6.13.

Table 6.13: Questions on perceived behavioural control

Aspects of perceived behavioural control	Item and question number	Question in questionnaire
Perceived behavioural control	PBC1 Q15	For me to purchase green electricity is easy
	PBC2 Q11	I can influence the decision to purchase green electricity within the company/organisation
Control beliefs	CB1 Q19	A high price of green electricity would make my purchasing decision harder
	CB2 Q12	To what extent will your decision to use premium green electricity be influenced by changes in the level of your company's usage of electricity?

Source: Adapted from Fishbein and Ajzen, 2010:458, utilising Francis et al., 2004.

The average score for question 19 is significantly higher than the other averages. This question related to the price of green electricity and how it will influence the respondents' willingness to procure premium green electricity. This supports previous studies which indicated that the price of electricity has a significant influence on the respondents' WTP. The amount of green electricity usage had a minor impact on the purchasing decision, especially for the agricultural sector and the top 19 users. It is not possible to make any conclusion from the agricultural sector score as there were only two respondents. For the top 19 users, this outcome may indicate that their electricity consumption is so substantial that the respondents believe a change in the consumption will not make a difference to their purchasing decision.

For question 11 the respondents were requested to indicate whether they can influence the decision to purchase green electricity within the company/organisation. The average score for this question was high, indicating that they have an influence on the decision to purchase green electricity or not. Only 11 of the respondents indicated that they believe to have a low influence on the decision. The agricultural sector respondents (two) had a low score and the top 19 consumers' score was marginally lower. This is an indication that some of the very large electricity consumers limit the individual decisions relating to the purchasing of electricity. This may be due to the significant value of over R500 million per month spent on electricity.

The respondents' average score for question 15 was low. This question tested the respondents' behaviour control relating to the purchasing of green electricity. This indicated that the respondents find it difficult or outside their control to purchase green electricity. The commercial sector responses were an outlier responding with higher than the average. Due to this sector having only two respondents, this abnormality will not influence the average and cannot be analysed. The top 19 electricity users have a lower than average score indicating that the larger consumers find it more difficult to purchase green electricity. The results from these questions are indicated in Table 6.14 and Table 6.15.

Table 6.14: Perceived behavioural control analyses per sector

			PBC			CB	
	Number	**Avg. PBC**	**Q11**	**Q15**	**Avg. CB**	**Q12**	**Q19**
Mining	74	3.595	3.932	3.257	4.446	3.608	5.284
Industrial	46	3.533	4.043	3.022	4.598	3.783	5.413
Municipal	53	3.519	3.906	3.132	4.585	3.868	5.302
Commercial	2	4.250	4.500	4.000	4.750	4.500	5.000
Agriculture	2	3.000	3.000	3.000	3.500	2.500	4.500
Traction / Rail	2	3.500	4.500	2.500	4.500	3.500	5.500
Bulk Distributors	7	3.786	4.000	3.571	4.000	3.429	4.571
Other	11	3.273	3.636	2.909	4.409	4.091	4.727
Average		**3.557**	**3.940**	**3.174**	**4.348**	**3.660**	**5.037**
Total	197						
All sectors		**3.548**	**3.939**	**3.157**	**4.495**	**3.736**	**5.254**
All Other	24	3.500	3.833	3.167	4.250	3.750	4.750

Table 6.15: Perceived behavioural control analyses per level of consumption

			PBC			CB	
	Number	**Avg. PBC**	**Q11**	**Q15**	**Avg. CB**	**Q12**	**Q19**
Up to 100k	17	3.824	4.353	3.294	4.559	4.059	5.059
>100k-300k	31	3.677	3.903	3.452	4.306	3.581	5.032
>300k to 600k	25	3.380	3.720	3.040	4.400	3.640	5.160
>600k to 1000k	20	3.575	3.700	3.450	4.550	3.550	5.550
>1m to 4m	46	3.728	4.152	3.304	4.674	4.000	5.348
>4m to 200m	39	3.462	4.000	2.923	4.654	3.872	5.436
>200m to 500m	11	3.045	3.636	2.455	4.136	3.000	5.273
>500m to 6000m	8	3.000	3.375	2.625	4.188	3.250	5.125
Average		**3.461**	**3.855**	**3.068**	**4.433**	**3.619**	**5.248**
Total	197						
All users		**3.548**	**3.939**	**3.157**	**4.505**	**3.736**	**5.274**
Mega users	19	3.026	3.526	2.526	4.158	3.105	5.211

The respondents' perceived behavioural control relating to the purchase of green electricity is low supporting the outcome of the technology model. The price of green electricity in question 19 indicates significance influence with high average scores. It is essential to establish the reliability and validity of these questions. The content validity of the questions was insured by confirming the questions were compiled based on comprehensive theory. The outcomes on the results are consistent with literature explored during this study. The reverse-worded questions as indicated for CB in Appendix D were corrected during the refinement process as they were not reverse-worded. The outcome from the data analyses supports the literature confirming the exploratory model's content validity.

6.9 EVALUATING RESPONSES RELATED TO THE SUPPORT FOR GREEN ELECTRICITY

This analysis reviews the questions in the exploratory model that are related to the general support for green electricity. The related questions are indicated in Figure 6.12 with a red circle around the questions.

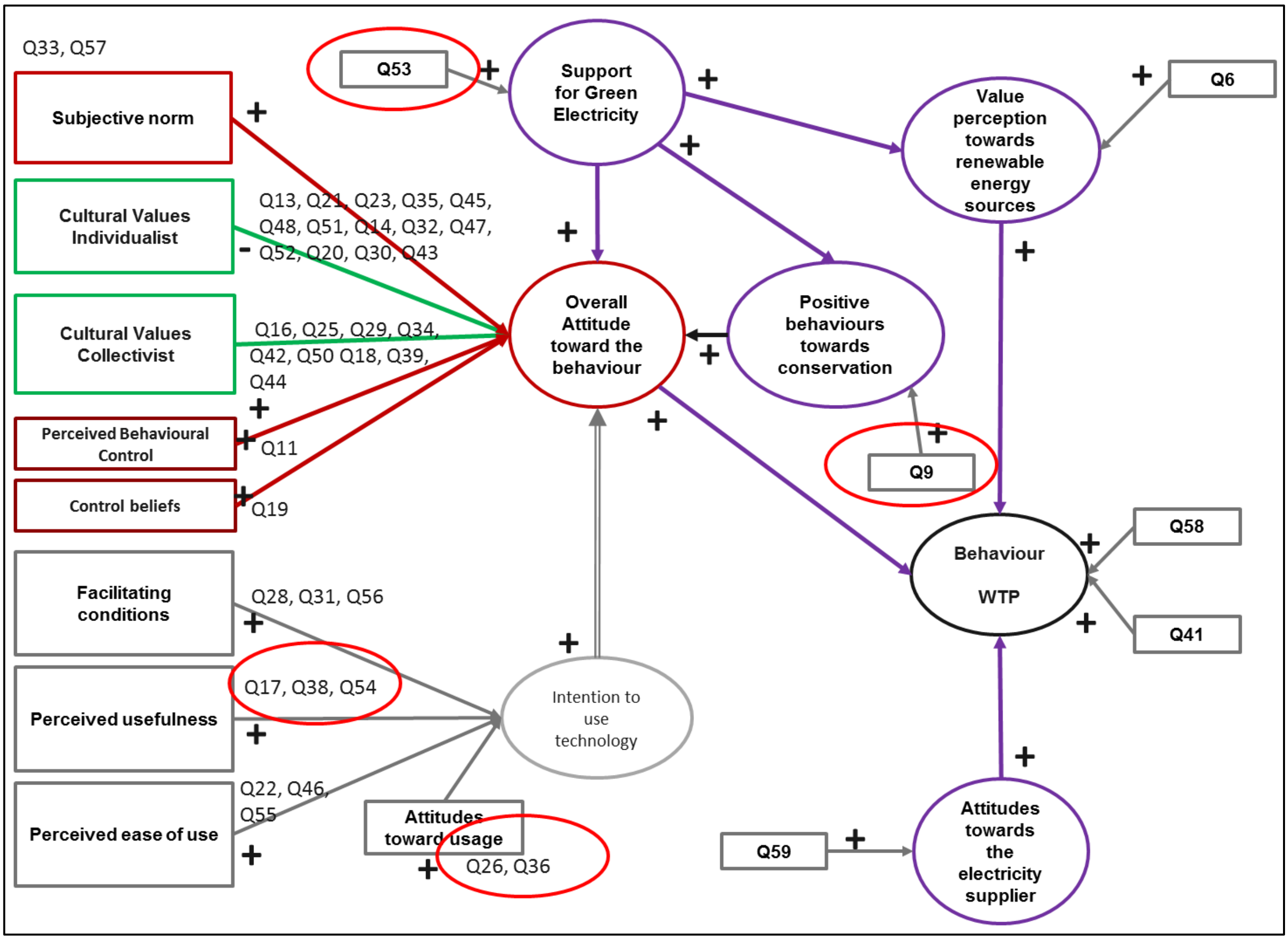


Figure 6.12: Questions on support for green electricity

To assess the respondents' support for green electricity, the model used by Hansla et al. (2008:769) (Figure 4.11) was incorporated into the final exploratory model. They concluded that individuals prioritising self-enhancement (SE) values are more concerned about adverse consequences for themselves when protecting the environment, than the adverse consequences of environmental problems for themselves. Only the former type of awareness-of-consequences (AC) beliefs will restrain pro-environmental behaviour. Measures taken to protect the environment imply sacrifices of one's own comfort. Examples include reducing car traffic, household energy saving, or paying for green electricity. It is thus proposed that individuals prioritising self-enhancement (SE) values would be opposed to such measures and will not be willing to pay a premium for green electricity.

Hansla et al. (2008:768) established the rate of voluntary purchase of green electricity did not exceed one percent, although a substantially higher number of respondents in their study (40% to 90%) expressed a positive attitude towards green electricity. Hansla et al. (2008:769) concluded that a possible explanation of this gap is due to partly different factors determining attitudes towards green electricity (ATT).

The studies of Lee (2011:190), Davis et al. (1989:319), and Teo (2010:254) indicated that the support for green electricity influences the observed variable, *Perceived usefulness,* which is an input to the latent variable, *Intention to use technology,* which influences the latent variable, *Overall attitude towards behaviour*. Adler and Gundersen (2008:19) indicated that attitude is influenced by the value construct of a person; this is supported by Hansla et al. (2008:769). A cluster of several compatible values is referred to as a value orientation (VO). The general finding by Hansla et al. was that pro-environmental attitudes and behaviours are positively related to a selfless or self-transcendence (ST) value orientation, while negatively related to an opposite selfish or self-enhancement (SE) value orientation. It is thus hypothesised that individuals prioritising self-enhancement (SE) values would be opposed to such measures and will not be willing to pay a premium for green electricity.

In Table 6.16 the questions related to the support for green electricity are indicated with their related average scores. These average scores are very high indicating a significant positive inclination in relation to the support for green electricity by the respondents.

Table 6.16: Summary of questions relating to support for green electricity

Perceived usefulness	
Q17	Using green electricity will enhance my environment (Average score: **4.772**)
Q38	Using green electricity will increase the quality of life (Average score: **4.658**)
Q54	Using green electricity will improve my life (Average score: **4.178**)
Support for green electricity	
Q53	Using green electricity is not going to make a difference (Average score: **4.746**)
Q9 and Q10	Significant indicated increase in usage of future green electricity-generating technologies (See Table 6.19)
Attitudes towards usage	
Q26	Green electricity is an interesting subject (Average score per sector: **4.743**, overall average score: **4.954**)
Q36	I support the use of green electricity (Average score per sector: **4.883**, overall average score: **4.944**)

The three large sectors, Mining, Industrial and Municipal, have similar average scores for questions 17, 36, 38, 53 and 54. Outliers exist where a small number of respondents in a sector responded compared to the three large sectors. When combining all the small sectors, their average score correlates with the large sectors' average scores as well as the average score from all the respondents (All sectors).

The same outcome was evident from the results when evaluating the results in relation to the level of electricity consumption. There is an outlier evident for question 17 on the electricity users larger than R200 m to R500 m per month. It is not known why this specific population is lower. Due to the respondents in this category being a small number (11 respondents), it had an insignificant impact on the overall average score. There is a close correlation between the top 19 electricity users and the smallest 17 electricity users. Question 53 used reverse wording and scored very similar to the average scores of the other questions measuring the respondents' support for green electricity and therefore remained part of the questions used in the exploratory model. The detail scores are shown in Table 6.17 and Table 6.18.

Table 6.17: Support for green electricity analyses per sector

Support for green electricity							
	Number	**Q17**	**Q26**	**Q36**	**Q38**	**Q53**	**Q54**
Mining	74	4.811	4.959	4.836	4.676	4.699	4.149
Industrial	46	4.630	4.913	4.978	4.652	4.804	4.239
Municipal	53	4.755	5.057	5.057	4.654	4.623	4.226
Commercial	2	6.000	6.000	5.500	5.000	6.000	4.500
Agriculture	2	5.000	4.000	5.500	5.000	4.000	4.000
Traction / Rail	2	3.500	3.000	3.000	3.500	6.000	3.000
Bulk Distributors	7	4.714	5.286	5.286	4.571	5.143	4.571
Other	11	5.182	4.727	4.909	4.727	4.818	3.818
Average		**4.824**	**4.743**	**4.883**	**4.598**	**5.011**	**4.063**
Total	197						
All sectors		**4.772**	**4.954**	**4.944**	**4.658**	**4.746**	**4.178**
All other	24	4.958	4.958	4.958	4.625	5.042	4.042

Table 6.18: Support for green electricity analyses per level of consumption

Support for green electricity							
	Number	**Q17**	**Q26**	**Q36**	**Q38**	**Q53**	**Q54**
Up to 100k	17	5.235	4.941	5.059	4.824	4.941	4.353
>100k-300k	31	4.839	4.806	4.968	4.806	4.581	4.161
>300k to 600k	25	4.360	4.640	4.560	4.520	4.880	4.000
>600k to 1000k	20	5.000	4.900	5.105	4.750	4.850	4.250
>1m to 4m	46	5.065	5.022	4.978	4.689	4.674	4.261
>4m to 200m	39	4.718	5.051	5.026	4.487	4.744	3.974
>200m to 500m	11	3.727	5.182	4.909	4.455	4.182	4.000
>500m to 6000m	8	4.250	5.500	4.875	4.875	5.500	5.000
Average		**4.649**	**5.005**	**4.935**	**4.676**	**4.931**	**4.250**
Total	197						
All sectors		**4.772**	**4.954**	**4.944**	**4.658**	**4.746**	**4.178**
Mega users	19	3.947	4.895	4.895	4.632	4.737	4.421

Previous studies, such as Do Paço and Raposo (2009) as well as Zografakis et al. (2010), discussed in Chapter 4, supported the hypothesis that current and future implementation of green initiatives are positive indicators of the intention to use green electricity. To assess positive behaviours towards green electricity, the respondents were asked to indicate what green electricity-generating technologies they are currently using and what green electricity-generating technologies they are planning to implement in the future.

The question started with: “Do you generate any electricity?” Out of the 197 respondents, 49 indicated that they generate electricity internally by one of the following means: biomass, solid waste, wind generation, solar generation, ocean current, ocean wave, ocean pump storage, underground coal gasification, hybrid plants or other technologies. The follow up questions were:
Q9: Does your business generate electricity by using any of the following technologies? (Indicating current internal-generated renewable electricity technologies being used)

Q10: Does your company plan to implement any of these (green) electricity-generating technologies over the next 5 years? (Intention for future internal-generated renewable electricity)

Table 6.19: Behaviour analyses towards conservation

Positive behaviour towards conservation					
Per sector	**Current**	**Planned**	**Per level of electricity consumption**	**Current**	**Planned**
	Q9	**Q10**	**ZAR**	**Q9**	**Q10**
Mining	21	69	Up to 100k	4	19
Industrial	12	43	>100k-300k	0	23
Municipal	9	79	>300k to 600k	9	21
Commercial	0	2	>600k to 1000k	4	17
Agriculture	2	1	>1m to 4m	9	55
Traction / Rail	2	3	>4m to 200m	13	52
Bulk Distributors	1	7	>200m to 500m	5	10
Other	2	7	>500m to 6000m	5	14
Total number	**49**	**211**	**Total number**	**49**	**211**

The results in Table 6.19 conclude that a substantial increase was displayed by the respondents for the future use of internal electricity generation from green electricity-generating technologies. This is another indication of a general trend supporting green electricity. Table 6.19 also shows that 32 of the 49 large consumers, consuming above a million ZAR of electricity per month, have internal green electricity-generating technologies and planned future green electricity-generating technologies. This is substantially more than the 17 large consumers, consuming less than a million ZAR of electricity per month.

The results from the questionnaire indicate the preferred technologies in use at the time of the study, as well as the planned future technology are solar, biomass and wind technologies. The data analysis above supports the literature indicating that respondents in general would support the implementation of green electricity. The next section reviews the respondents' actual willingness to pay.

6.10 EVALUATING RESPONSES RELATED TO STATED WILLINGNESS TO PAY

This section analyses the outcome from the data relating to the actual willingness to pay as indicated on the final explorative model in Figure 6.13. The related questions are indicated with a red circle around the questions.

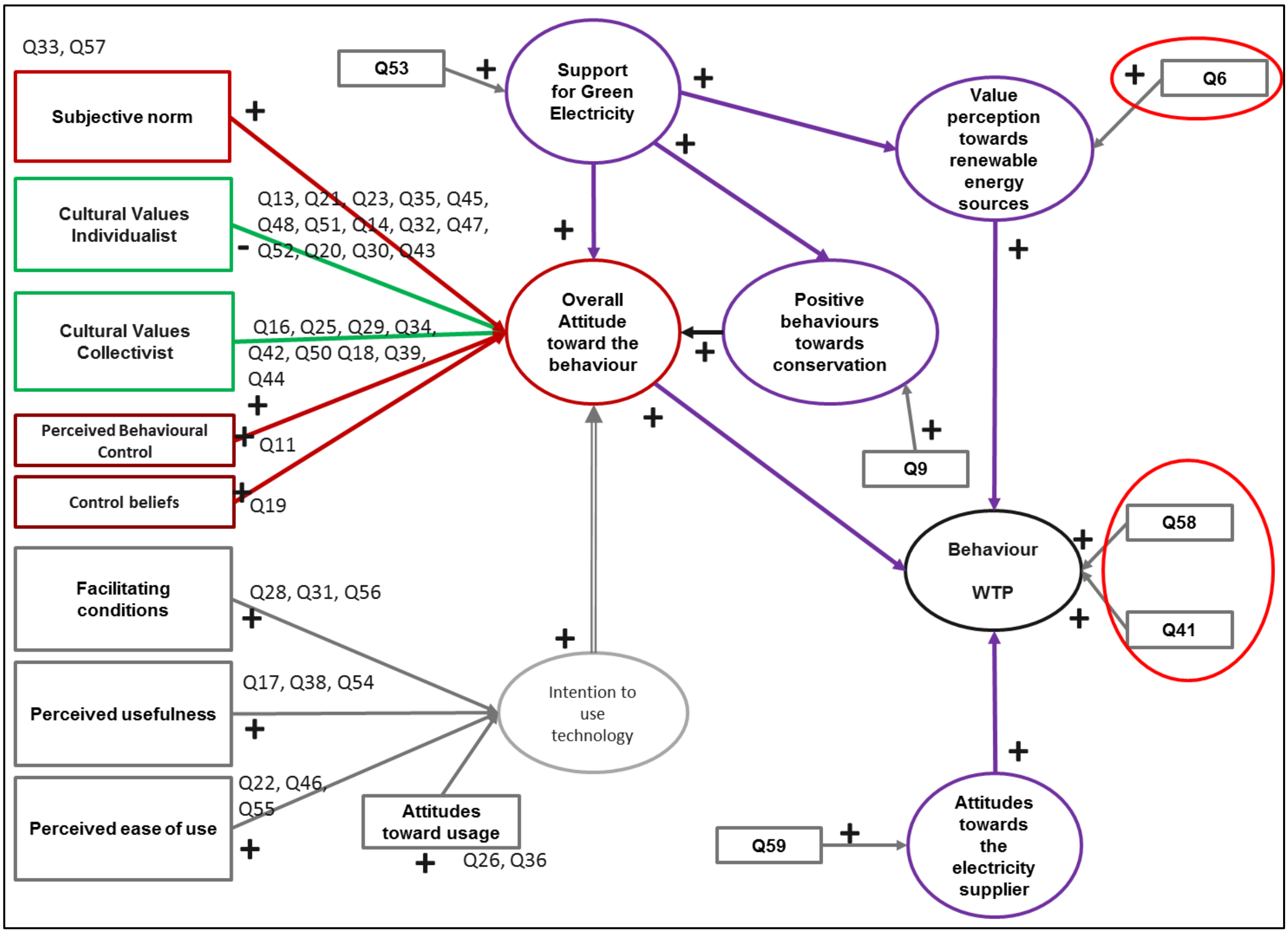


Figure 6.13: Questions on stated willingness to pay

Previous studies relating to the willingness to pay for green electricity indicated a general trend of higher stated willingness to pay than actual willingness to pay. In the study of Hansla et al. (2008:768), the rate of voluntary purchase of green electricity did not exceed one percent, although a substantially higher number of respondents expressed a positive attitude towards green electricity. Consumer interviews by Salmela and Varho (2006:3 677) indicated that the higher cost of green electricity compared to conventional electricity might prevent green electricity purchases. This is supported by most WTP studies; for example, Van Heerden et al. (2002:3), Oliver et al. (2010:3), Whitehead and Cherry (2007:247), among many others.

The questions used in the exploratory model to test the stated WTP were:
Q41: I expect to pay a premium for green electricity.

Q58: I am willing to pay a premium for green electricity in future.

Q6: How significant will the financial status of your company/organisation influence your willingness to pay a premium for green electricity?

The industrial sector average score for question 41 was higher than those of the mining and municipal sectors, indicating that the industrial sector expects to pay more for green electricity. The average score for question 58 was consistently low indicating a general reluctance to pay for green electricity. This was even more pronounced for the industrial sector.

The results when evaluating the level of electricity consumption showed several user categories that indicated a high score on question 41 and all categories indicated a general expectancy to pay more for green electricity. There is an outlier evident for the electricity users between R4 m and R200 m per month which is slightly lower than the midpoint of 3.5. It is not known why this specific population was lower, but they indicated a borderline expectancy not to pay a premium for green electricity. The top 19 electricity users have the highest expectancy to pay a premium for green electricity, but a low willingness to pay a premium for the green electricity. The results from these questions are indicated in Table 6.20.

Table 6.20: Analyses of the questions on stated willingness to pay

Analyses per sector				Analyses per level of consumption			
	Number	**Q41**	**Q58**	**ZAR**	**Number**	**Q41**	**Q58**
Mining	74	3.649	3.027	Up to 100k	17	4.059	3.765
Industrial	46	4.130	2.913	>100k-300k	31	3.645	3.258
Municipal	53	3.755	3.453	>300k to 600k	25	3.640	3.200
Commercial	2	4.500	3.500	>600k to 1000k	20	3.550	2.800
Agriculture	2	3.000	3.500	>1m to 4m	46	4.109	3.261
Traction / Rail	2	3.000	3.000	>4m to 200m	39	3.385	2.872
Bulk Distributors	7	3.143	3.571	>200m to 500m	11	4.182	3.455
Other	11	3.818	3.545	>500m to 6000m	8	4.125	3.000
Average		**3.624**	**3.314**	**Average**		**3.837**	**3.201**
Total	197			Total	197		
All sectors		**3.777**	**3.173**	**All users**		**3.777**	**3.173**
All other	24	3.542	3.500	Mega users	19	4.158	3.263

Question 6 was asked to determine how significant the financial status of the company/organisation will influence their WTP a premium for green electricity. The introduction statement asked the respondents to consider the financial status in terms of debt ratio, earnings before interest and tax (EBIT) and net cash flow. The average score indicates a significant relationship between the company/organisation financial status and their willingness to pay. A total of 148 respondents indicated that there is a significant impact and 49 indicated that the impact is not significant. From the 49 respondents, 32 indicated some significance with scoring this question a four. The agriculture and traction/rail sectors are outliers, but this did not make any difference to the overall score as there were only four respondents in these sectors. The results from question 6 are indicated in Table 6.21 and Table 6.22.

The results discussed above support the previous studies, which were completed mainly on residential electricity consumers, that the electricity consumers' WTP is influenced by their financial status. The analyses from this section concluded that the general trend is that the respondents expect to pay a premium for green electricity, but that their actual willingness to pay is low and is significantly influenced by their financial status.

Table 6.21: Financial status impact analyses per sector

			Not significant			Significant		
	Number	**Q6**	**1**	**2**	**3**	**4**	**5**	**6**
Mining	74	2.419	2	1	14	10	29	18
Industrial	46	2.370	3	2	5	5	15	16
Municipal	53	2.491	3	2	10	4	18	16
Commercial	2	2.000	0	0	0	1	0	1
Agriculture	2	4.000	1	0	0	0	1	0
Traction / Rail	2	4.000	1	0	0	0	1	0
Bulk Distributors	7	2.714	0	1	2	1	0	3
Other	11	2.455	1	0	1	2	4	3
Average		**2.806**	1.375	0.75	4	2.875	8.5	7.125
Total	**197**		**11**	**6**	**32**	**23**	**68**	**57**
All sectors		2.467						
All other	24	2.750						

Table 6.22: Financial status impact analyses per level of consumption

			Not significant			Significant		
ZAR	**Number**	**Q6**	**1**	**2**	**3**	**4**	**5**	**6**
Up to 100k	17	2.647	1	1	2	2	9	2
>100k-300k	31	3.129	4	1	7	8	5	6
>300k to 600k	25	2.760	3	0	4	5	7	6
>600k to 1000k	20	1.900	0	0	2	1	10	7
>1m to 4m	46	2.348	2	0	10	2	18	14
>4m to 200m	39	2.179	0	3	4	4	14	14
>200m to 500m	11	2.455	0	1	2	1	4	3
>500m to 6000m	8	2.125	1	0	1	0	1	5
Average		**2.443**	1.38	0.75	4	2.88	8.5	7.13
Total	**197**		**11**	**6**	**32**	**23**	**68**	**57**
All users		2.467						
Mega users	19	2.316						

In addition to the questions relating to the various models used in the previous studies on behaviour, a question specific to the WTP a premium for green electricity included the perception of the electricity supplier. The next section reviews the results relating to the perception of the electricity supplier.

6.11 EVALUATING RESPONSES RELATED TO THE PERCEPTION OF THE ELECTRICITY SUPPLIER

6.11.1 Overview

The outcome from this analysis reviews the relationship between support for green electricity and the perception of the electricity supplier. From 2008, Eskom had difficulty to provide sufficient electricity in South Africa. One of the options selected to ensure that the entire electricity network does not shut down was to implement load shedding. This method would disconnect selected areas of the national grid to reduce the demand for electricity over peak demand periods. Load shedding created a very negative perspective on Eskom and may influence the action to pay a premium for green electricity.

Whitehead and Cherry (2007) provided a scenario background to the respondents and then asked them the question: “Suppose you were given the opportunity to participate in the Green Energy program for an extra fee of ‘A’ dollars each month. Would you sign up for the Green Energy program?” Several follow-up questions were asked to determine the reasons for supporting or not supporting a green electricity programme. Whitehead and Cherry (2007:252) concluded from their study that the answer of ''I don't trust the power companies'' was one of the most popular reasons provided for not being willing to pay an additional monthly fee for green electricity.

Gerpott and Mahmudova (2010b:470) found that in Germany customers' perceived difference between the offerings of various electric power companies was not a significant positive determinant in the adoption of green electricity. As a result of their findings, the question for this study focused on the trust relating to the power company. For South Africa, there are currently one main generator and supplier for electricity. Question 59 was formulated as indicated in Table 6.24 to assess the large consumers' perception of Eskom.

Table 6.23: Customers' perception of Eskom

Construct	Item	Questions
Gerpott & Mahmudova (2010b:466) Whitehead & Cherry (2007:252)	EskQ1	Suppose Eskom gives the opportunity to participate in a green energy programme for an additional fee, would you trust Eskom to manage the process effectively?

This question was used in the exploratory model as input to the latent variable *attitude towards the electricity supplier* as seen in Figure 6.14 with a red circle around the question.

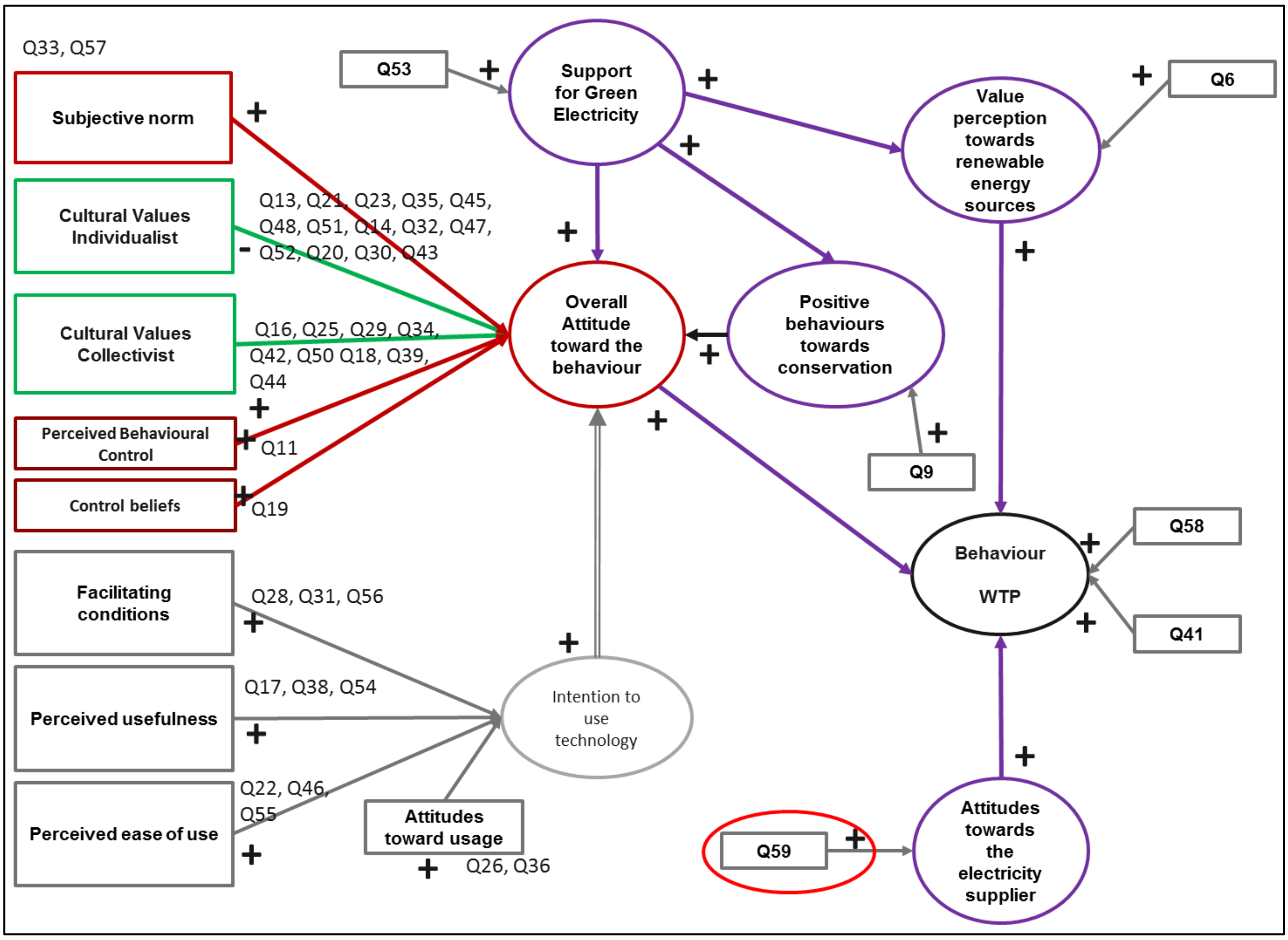


Figure 6.14: Perception of the electricity supplier within the exploratory model

The overall average scores on question 59 are low. Bulk distributers, municipal and agriculture sectors indicated that they trust Eskom by having higher average scores, whereas the mining and industrial sectors indicated a trend of not trusting Eskom and had lower scores. The sectors scoring higher may be due to the electricity distribution industry's similarities to Eskom. The other possibility is that these industries are government organisations and therefore there may be a higher trust relationship.

The results when evaluating the level of electricity consumption indicate a general lack of trust. There are two outliers evident for the electricity users (R300k to R600k and R600k to R1 000k per month), which are slightly lower than the other average scores. The top 19 electricity users and the small sectors (24 off) have both slightly higher average scores than the overall average scores but still indicate a general trend of not trusting Eskom. The results from these questions are indicated in Table 6.24.

Table 6.24: Analyses of the perceptions regarding the electricity supplier

Electricity supplier perception analyses per sector			**Electricity supplier perception analyses per level of consumption**		
	Number	**Q59**	**ZAR**	**Number**	**Q59**
Mining	74	2.635	Up to 100k	17	3.647
Industrial	46	2.783	>100k-300k	31	3.000
Municipal	53	4.000	>300k to 600k	25	2.560
Commercial	2	3.000	>600k to 1000k	20	2.400
Agriculture	2	4.000	>1m to 4m	46	3.435
Traction / Rail	2	2.000	>4m to 200m	39	3.256
Bulk Distributors	7	4.286	>200m to 500m	11	3.273
Other	11	2.909	>500m to 6000m	8	3.375
Average		3.202	Average		3.118
Total	**197**		**Total**	**197**	
All sectors		3.122	All users		3.122
All other	24	3.333	Mega users	19	3.316

These results indicate an overall negative perception of Eskom. According to Whitehead and Cherry (2007) as well as Gerpott and Mahmudova (2010) this negative perception will reduce the respondents' WTP for green electricity.

Governments have applied various measures to accelerate the implementation of green electricity initiatives. A popular view on the pricing for green electricity is to add a percentage value to the electricity account of all the users. In South Africa, an electricity levy was introduced in July 2009 at a rate of 2 cents/kWh for electricity generated from non-renewable sources. On 1 April 2011, the levy was increased to 2.5 cents/kWh. This levy included funding of road maintenance to roads damaged because of coal haulage supporting electricity generation. The electricity levy was again increased to 3.5 cents/kWh during 2012 to support the funding of energy-efficiency initiatives, such as the solar-water heater programme. During the 2015 Budget Speech, the Minister of Finance announced a proposed increase to 5.5 cents/kWh and advised that this latest increase was a temporary measure meant to be withdrawn when the carbon tax is introduced (Steenkamp, 2015). In the 2017 Budget speech, it was stated that the proposed carbon tax and its date of implementation will be considered by Parliament during 2017. However, the carbon tax on electricity in the form of an environmental levy remained at 3.5 cents/kWh (Fin24, 2017).

Oliver et al. (2010:3) concluded that over the last decade, many developed countries have implemented policies that require electricity suppliers to obtain some portion of the generation in their resource portfolio from renewables. This can potentially be passed on to consumers as a mandatory quota (often very small), or by the payment of taxes by the consumers. But if everyone already pays for green electricity, it is unclear how it would impact on the willingness of consumers to pay for additional green electricity. It is hypothesised that this relationship may be negative.

An introduction to this section of the questionnaire was provided to clarify the process to the respondents for better understanding due to the influence that knowledge and awareness have on WTP studies (Oliver et al., 2010:2; Do Paço & Raposo, 2009:364). This was set out as follows in the questionnaire:

> *Electricity levy was introduced in July 2009 at a rate of 2 cents per kWh. It is applied to electricity generated from non-renewable sources. The levy was increased to 2.5 cents per kWh from 1 April 2011 and some of the revenue was set aside to fund the rehabilitation of damage to roads as a result of the haulage of coal for electricity generation. In 2012, the levy was increased to 3.5 cents per kWh and additional revenue is now used to fund energy efficiency initiatives such as the solar water heater programme.*

Another measure to accelerate the implementation of green electricity initiatives was introduced during the MYPD3 process (Eskom, 2012b). This stated that three percent of the allocated price increase was provided to support the renewable energy IPPs programme. NERSA (2013:44) stated that several policy issues requiring consideration had been raised during the third MYPD3 and other views were considered during the implementation of the price determination process, for instance, “the environmental levy should be used to fund IPPs development instead of imposing an additional three percent on the electricity price increase”.

Participants were asked to please mark the cell with an X, that corresponds with the maximum percentage (%) they would be willing to pay for each alternative scenario. Alternatively, they were asked to provide their own scenario and motivate their view in the space provided. By taking the above into consideration, the researcher created the following five scenarios listed in Table 6.23 as alternative implementation options that can be used to accelerate implementation of green electricity initiatives.

Table 6.25: Scenarios for the questionnaire

Scenarios:	**What is the maximum additional amount you will be willing to pay in percentage (%) if…?**					
	0.50%	**1%**	**2%**	**3%**	**4%**	**>5%**
Scenario 1: Eskom builds a renewable energy-generating plant and transfers costs to all consumers						
Scenario 2: Government sponsors Eskom to build a renewable energy-generating plant and recovers the cost by other means (e.g. tax)						
Scenario 3: Private entities build a renewable plant and Eskom procures the generated electricity at a higher cost. Eskom then transfers the additional cost to all customers						
Scenario 4: Customers pay a voluntary amount to facilitate the building of a renewable plant (Separate fund)						
Scenario 5: Customers do not pay any additional amount for renewable energy but rather spend it on energy reduction technologies						
Scenario 6: **Specify any additional scenario you may prefer and indicate** the maximum additional amount you will be willing to pay in percentage (0.50%, 1%, 2%, 3%, 4% >5%) for your scenario. Not compulsory to complete						

Source: Researcher.

This questionnaire was sent out during a time when load shedding occurred in South Africa. Load shedding creates a negative perspective of Eskom and may have had an influence on the willingness to participate in the survey, as well as the outcome of the results discussed in this section. The results from this study indicated a general trend of higher stated willingness to pay than actual willingness to pay, supporting previous literature.

As part of the scenario questions a scenario was provided to the respondents and then the following question was asked to the respondents:
What is the maximum additional amount you will be willing to pay in percentage (%) if…?

The respondents selected for each scenario the percentage they would be willing to pay for green electricity. Some scenarios proposed an option for Eskom to be involved and other scenarios excluded Eskom. The respondents had to select options between 0.5 percent and more than five percent, where 0.5 percent equalled a score of 1 and five percent equalled a score of 6. The analyses of the scenario questions relating to the perception of the supplier are indicated in Table 6.26 and Table 6.27.

Table 6.26: Analyses of the scenario questions regarding the perceptions of the electricity supplier per sector

Scenario questions						
		Eskom	Not Eskom	Voluntary	Energy saving	Other options
	Number	Q60- Q61	Q62- Q63	Q63	Q64	Q66
Mining	74	**1.870**	**2.058**	2.087	2.696	2.444
Industrial	46	**1.688**	**1.725**	1.600	2.696	2.444
Municipal	53	**2.235**	**2.167**	2.250	2.604	2.045
Commercial	2	**1.000**	**1.000**	1.000	1.000	1.000
Agriculture	2	**1.500**	**1.500**	1.500	1.500	1.500
Traction / Rail	2	**2.000**	**2.500**	2.000	2.000	
Bulk Distributors	7	**1.417**	**2.000**	2.000	1.833	1.500
Other	11	**1.909**	**1.818**	1.727	2.273	2.000
Average		**1.702**	**1.846**	1.771	2.075	1.848
Total	197					
All sectors		**1.908**	**1.989**	**1.983**	**2.592**	**2.054**

Table 6.27: Analyses of the scenario questions regarding the perceptions of the electricity supplier per level of consumption

Scenario questions						
		Eskom	Not Eskom	Voluntary	Energy saving	Other options
ZAR	Number	Q60- Q61	Q62- Q63	Q63	Q64	Q66
Up to 100k	17	**1.967**	**1.933**	2.067	2.000	2.125
>100k-300k	31	**2.278**	**2.185**	2.111	2.741	2.071
>300k to 600k	25	**1.917**	**1.813**	1.833	2.250	1.750
>600k to 1000k	20	**1.611**	**1.750**	1.833	2.667	2.000
>1m to 4m	46	**2.012**	**2.179**	2.238	2.929	2.278
>4m to 200m	39	**1.649**	**1.917**	1.889	2.139	2.000
>200m to 500m	11	**1.864**	**2.000**	1.636	4.182	1.833
>500m to 6000m	8	**1.917**	**1.750**	1.667	2.000	3.000
Average		**1.902**	**1.941**	1.909	2.613	2.132
Total	197					
All users		**1.908**	**1.989**	**1.983**	**2.592**	**2.054**

The scenarios where Eskom is in control of the implementation, questions 60 and 61, have the lowest average score of 1.908. The municipal sector indicated a slightly higher average score for the scenarios where Eskom is in control of the process to manage the sale of green electricity. The scenario results support question 59, indicating an overall negative perception of Eskom existed during the time of the questionnaire, which will reduce the WTP for green electricity.

Scenario 6 in the questionnaire required the respondents to optionally add any additional scenario they might prefer and to indicate the maximum additional amount they would be willing to pay in percentage. These responses varied from short comments to suggestions, as summarised below. These response outcomes support the propositions and literature discussed in this study. The responses were grouped into six themes indicating the respondents' views on WTP for green electricity relating to the respondent's own scenario.

6.11.2 Themes from the specified scenarios

(i) Technology-constraining usage of green electricity

- The company is energy intensive and cannot be operated from renewables. The company can only utilise renewables to substitute supply to buildings.
- Green energy can only supplement a base-load derived from coal-fired or nuclear-powered power stations.
- The cost of electricity in our industry is about 29 percent of total cost. Any additional cost will affect our business negatively and on top of that, we are dependent on the market price of gold.
- Energy reduction technologies are ongoing and will continue to be supported as everyone is assisting with shortfall supply versus demand. The bottom line is that green electricity will be expensive, due to the economy of scale between fossil-based fuel and green electricity power generation infrastructure; one exists in form and the other is in its infancy.

(ii) Responses relating to economic conditions

- The low price on export coal currently discourages any possible investment into green energy [respondent's opinion]. Most of the mines are currently running marginally or at a loss. Investment into green energy will increase if the market improves. [Company name removed for confidentiality] as a global player is very interested and involved in green energy.
- In our smelting industry, it will be very difficult to justify any additional costs with regards to energy, as the high electricity costs are already putting a massive strain on our industry.
- Electricity cost is 25 percent of our company's total overheads. We cannot afford to pay any extra for green electricity as electricity is already increasing at a much higher rate than inflation, although the sales price of our product increases at less than inflation.

- In a competitive market, the question should not be if we are willing to pay more than the current rates; it should be competitive and compete at the current rates. If it can't, the market will not support it and it will fail.
- Since electricity is one of the top five input costs for any manufacturing company, the cost to take on green electricity will have to be transferred to the product being manufactured, and hence at the end of the day, the customer will bear the brunt of the increased cost for the product.

(iii) Privatising the electricity market

- Encourage private enterprise as competition to Eskom.
- Renewable electricity entity separate from Eskom.
- International companies which have a proven track record for building and maintaining green energy plants.
- Government needs to outsource the renewable energy and give the outside companies a chance to bid for this job.
- 'Green' technology is still expensive. However, we need to get a mix of generation. Eskom should NOT have the ability to 'play the game, referee the game and make all the rules'. They have no competition, so they can do what they like. South Africa should have many IPPs.
- I favour open competition and hope that 'green' electricity will not come at an additional price, but rather cheaper than current supply. Opening the market and adding competition will lead to excellence in service and technology and force Eskom to become more competitive.
- There is currently no benchmarking for Eskom; therefore, they manipulate.
- Eskom should be privatised and not be used by the government to build anything. Eskom should be privatising new generating power plants since Eskom clearly is not capable of the construction on Medupi and Kusile on time and within budget.
- Place a cap on the renewable IPP programme equal to the cost of alternative new technology options. This will be higher than grid parity (which is the blended average cost of the current generation fleet) and judging from the third bid window prices, it will still allow for significant investment in renewable energy.
- The split between electricity generation and the energy regulatory role should be prioritised with all generation to be privatised to provide for a fair and cost-competitive market.

(iv) Alternative scenarios suggested by a respondent

- A scenario that might not be mentioned is: What if the government subsidised private entities to generate green electricity? The environmental levy or electricity levy revenue can be made available to any entity that can produce and supply green electricity. If Eskom is interested in green energy, then they would compete with any company.

- Pay once-off to build a green energy plant and then not pay for the usage. Eskom should maintain it from a government subsidy.

(v) Other general outcomes from the scenarios that respondents proposed

- All scenarios are covered.
- Maximise current energy efficiency.
- Stop supplying other countries with electricity, while SA is having load shedding, taking business away from South Africa.

(vi) Summary of the stated willingness to pay (Specified Scenario)

- We are willing to pay three percent, provided the funds are made available to enable the municipality to pay its own feed-in tariffs to IPPs in order to support renewable energy.
- We are willing to pay four percent if there are government incentives in place for those who generate energy in specific regions without the requirement of major infrastructure expenses and no interruptions on private households or businesses.
- We are willing to pay zero percent. The present increase in cost of electricity is killing our business. Green energy needs to be cost effective to lower our cost of production to have any significant attraction.
- We are willing to pay zero percent. Before speaking about additional cost and green electricity, Eskom must stop doing load shedding and improve its quality.
- We are willing to pay four percent. Allow IPPs a free-market system to generate power. Also, hand over the national grid to NERSA and make Eskom only a state-owned power producer.
- Do not want to pay extra for electricity; therefore, zero percent.
- Not more than ZAR100 000 per month. Currently we need to see how it will be implemented and at what cost.
- We are willing to pay a maximum of 0.5 percent. This is based on current volatile economic conditions which have resulted in a cost reduction focus across the company.
- We are willing to pay zero percent. Industry and private sectors are presently paying for inefficiencies of Eskom and should not be asked to fund this any further. Use the present 3.5c/kWh environmental levy to fund the replacement of lesser energy-efficient installations and enforce through trade and installations legislation the introduction of high-efficient solutions.
- I will be willing to pay over five percent if a competent bidder has been appointed to do this. Eskom has shown over the years that they cannot be trusted with securing the country's future in terms of energy.

The outcome from the scenario analysis supports the relationship between the electricity user's support for green electricity and their perception of the electricity supplier.

6.12 CONCLUSION

The key findings related to the data collected by the questionnaire were presented in this chapter. These included the findings related to the main constructs of the exploratory model: culture, technology, behaviour and value aspects.

The cultural tendency found in this study is towards individualism, indicating a general reluctance towards paying for items related to social responsibility, including protecting the environment. Many surveys have documented the preference among customers for renewable energy over other energy sources.

The technology model results indicated that electricity consumers support the idea of green electricity, but are reluctant to the actual payment for green electricity, and have a general perception that the purchasing options are difficult to use. A negative perception of the electricity supplier (Eskom) will reduce the WTP for green electricity. The results of this study indicate very high support for green electricity, but very low actual WTP, supporting the literature review of this study.

Figure 6.15 presents the refined exploratory research PLS-SEM model indicating all the significant and non-significant paths with their respective path coefficients on the lines, as well as the R^2 in the circles, that represent the respective latent variables. The numbers in the circle indicate how much the variance of the latent variable is being explained by the other latent variables. The numbers on the arrows are called the path coefficients. They explain how strong the effect of one variable is on another variable. The weight of different path coefficients enables us to rank their relative statistical importance.

As indicated in Figure 6.15, the coefficient of determination in, R^2, is 0.266 for the *Behaviour WTP* latent variable. This means that the three latent variables (*Overall attitude towards behaviour, Attitude towards the electricity supplier*, and *Value perception towards renewable*) moderately explain 26.6 percent of the variance in *Behaviour WTP*. The variables *Support for green electricity*, *Positive behaviours towards conservation* and *Intention to use technology* together explain 50.0 percent of the variance of *Overall attitude towards behaviour*. The inner model suggests that *Intention to use technology* has the strongest effect on *Overall attitude towards behaviour* (0.701), followed by *Overall attitude towards behaviour* (0.339) and *Attitude towards the electricity supplier* (0.269) effects on *Behaviour WTP*. However, the proposed path relationships between the other paths are not statistically significant because the standardised path coefficients are lower than 0.05. The analysis of the inner model shows that *Overall attitude towards behaviour* (33.9%) and *Attitude towards the electricity supplier* (26.9%) together can explain some of the *Behaviour WTP*.

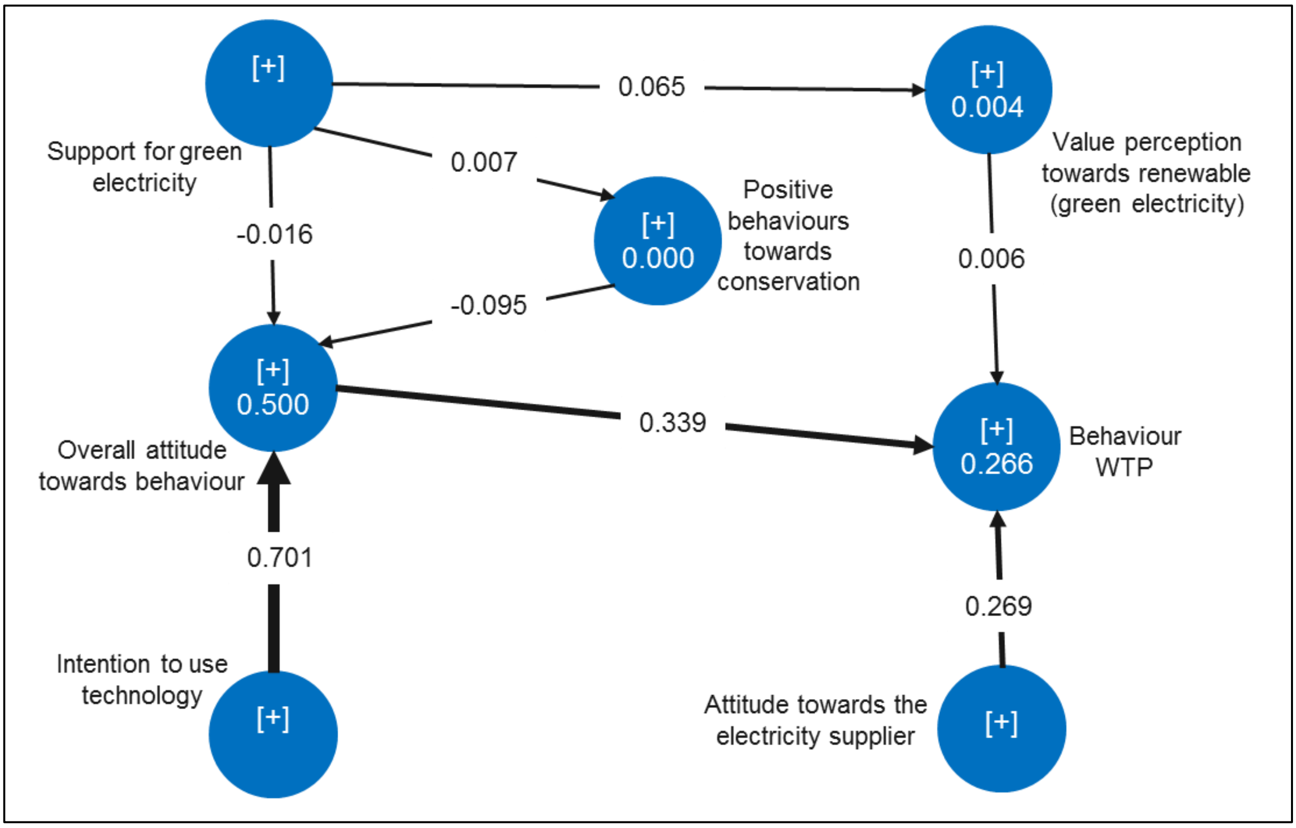


Figure 6.15: PLS final explorative model with results

Optimising and testing the model was done to confirm construct validity once the data had been received. This completed the first two stages of Hinkin's (1995) three-stage approach, namely: (1) item generation; (2) scale development; and (3) scale evaluation as indicated in Table 5.1. The exploratory model as indicated in Figure 6.15 is examined for validity and reliability in the next chapter.

CHAPTER 7

RELIABILITY AND VALIDITY EVALUATION OF THE EXPLORATORY MODEL

7.1 INTRODUCTION

The purpose of evaluating a model's overall fit is to determine the degree to which the model as a whole is consistent with the observed data. These include the culture, technology, behaviour and value aspects of the exploratory model, as indicated in Figure 6.1. During stage two of Hinkin's (1995) approach, a significant emphasis was placed on construct validity. This chapter presents the results relating to the analysis of the exploratory model to test the model's reliability and validity.

When a reflective measurement model is used, as was done in this study, Wong (2013:16) recommended the following topics to be discussed during the model evaluation:

- Explanation of target endogenous variable variance;
- Inner model path coefficient sizes and significance;
- Outer model loadings and significance;
- Indicator reliability;
- Internal consistency reliability (composite reliability);
- Convergent validity (average variance extracted);
- Discriminant validity (square root of AVE); and
- Checking structural path significance.

Wong (2013:21) indicated that there are two sub-models in a structural equation model: (1) the inner model specifies the relationships between the independent and dependent latent variables; whereas (2) the outer model specifies the relationships between the latent variables and their observed indicators.

Hooper et al. (2008:53) mentioned that, ever since structural equation modelling was first developed, statisticians have sought and developed new and improved indices that reflect some facet of model fit previously not accounted for. Wong (2013:21) summarised the relevant PLS-SEM reliability and validity checks, as listed in Table 7.1. Each fit measure and results are discussed in the following sections. Hypothesis (proposition) testing produces a decision about any observed difference, whether it is either that the difference is 'statistically significant', or that it is 'statistically not significant'.

Table 7.1: Recommendations for model fit evaluation

Fit measure	What to look for in PLS-SEM	Reasonable (acceptable) fit
Reliability		
Indicator reliability	"Outer loadings" numbers	Square each of the outer loadings to find the indicator reliability value. **0.70 or higher** is preferred. If it is an **exploratory research, 0.4** or higher is acceptable (Hulland, 1999).
Internal consistency reliability	"Reliability" numbers	Composite reliability should be **0.7 or higher**. If it is an **exploratory research, 0.6** or higher is acceptable. (Bagozzi & Yi, 1988).
Validity		
Convergent validity	"AVE" numbers	It should be **0.5 or higher** (Bagozzi & Yi, 1988).
Discriminant validity	"AVE" numbers and latent variable correlations	Fornell and Larcker (1981) suggested that the "**square root**" of AVE of each latent variable should be greater than the correlations among the latent variables.

Source: Wong, 2013:21.

Combining these topics with the nine-step model evaluation and improvement process from Lowry and Gaskin (2014:132-140), the following sections discuss the exploratory model's reliability and validity.

7.2 RELIABILITY TEST FOR THE OUTER MODEL

In the measurement of the outer model, the discriminant validity, average variance extracted (AVE), outer loadings (CI), indicator reliability, and the composite reliability, were calculated to determine the convergent validity of the model (Ang et al., 2015:194). Each of these measures is discussed below.

7.2.1 Discriminant validity

Convergent and discriminant validity are both considered subsections of construct validity. Discriminant validity measures constructs that theoretically should not be related to each other. Discriminant validity is demonstrated by the square root of the average variance extracted (AVE) being greater than any of the inter-construct correlations. A result greater than 0.85, however, means that the two constructs overlap greatly and they are likely measuring the same component. Therefore, it is not possible to claim discriminant validity between them. The two scales measure theoretically different constructs (Henseler, Ringle & Sarstedt, 2014:121). Wong (2013:21) stated that the square root of AVE in each latent variable can be used to establish discriminant validity, if this value is larger than other correlation values among the latent variables.

According to Henseler et al. (2014:121), there is no standard value for discriminant validity. They indicated a result less than 0.85 which indicates that discriminant validity likely exists between the two scales. A result greater than 0.85, however, shows that the two constructs overlap greatly and they are likely measuring the same component. They stated that some authors suggest a threshold of 0.85, whereas others propose a value of 0.90. Therefore, it is not possible to claim discriminant validity between them. In SmartPLS, using Heterotrait-Monotrait ratio (HTMT), if a value is below 0.90, discriminant validity has been established between two reflective constructs.

Table 7.2: Discriminant validity

Latent variables	Sample	Discriminate when p value is >0.85
Behaviour WTP -> Attitude towards the electricity supplier	0.498	Yes
Intention to use technology -> Attitude towards the electricity supplier	0.375	Yes
Intention to use technology -> Behaviour WTP	0.639	Yes
Overall attitude towards behaviour -> Attitude towards the electricity supplier	0.525	Yes
Overall attitude towards behaviour -> Behaviour WTP	0.664	Yes
Overall attitude towards behaviour -> Intention to use technology	0.886	No
Support for green electricity -> Attitude towards the electricity supplier	0.068	Yes
Support for green electricity -> Behaviour WTP	0.217	Yes
Support for green electricity -> Intention to use technology	0.481	Yes
Support for green electricity -> Overall attitude towards behaviour	0.347	Yes
Positive behaviours towards conservation -> Attitude towards the electricity supplier	0.034	Yes
Positive behaviours towards conservation -> Behaviour WTP	0.068	Yes
Positive behaviours towards conservation -> Intention to use technology	0.102	Yes
Positive behaviours towards conservation -> Overall attitude towards behaviour	0.064	Yes
Positive behaviours towards conservation -> Support for green electricity	0.007	Yes
Value perception towards renewable -> Behaviour WTP	0.047	Yes
Value perception towards renewable -> Attitude towards the electricity supplier	0.046	Yes
Value perception towards renewable -> Intention to use technology	0.116	Yes
Value perception towards renewable -> Overall attitude towards behaviour	0.134	Yes
Value perception towards renewable -> Support for green electricity	0.065	Yes
Value perception towards renewable -> Positive behaviours towards conservation	0.015	Yes

Due to the result of 0.886 which is above 0.85, measuring *Overall attitude towards behaviour* and the *Intention to use technology*, it can be concluded that only one discriminant validity marginally does not exist. *Attitude towards behaviour* and *Intention to use* do have conceptually some relation therefore supporting the outcome of the exploratory model results.

For all the other latent variables, it can be assumed that the two scales measure theoretically different constructs. If SmartPLS is used as guidance, it is still acceptable as the value is below 0.90.

7.2.2 Average variance extracted

Convergent validity measures constructs that theoretically should be related to each other. To confirm the discriminant validity of the indicators further, the average variance extracted (AVE) is calculated (Lowry & Gaskin, 2014:136). The convergent validity assessment has the goal to ensure that a reflective construct has the strongest relationships with its own indicators (e.g. in comparison with any other constructs) in the PLS path model (Hair et al., 2014:112). Conceptually, the AVE test is equivalent by testing that the correlation of the construct, with its measurement items, is larger than its correlation with the other constructs. Wong (2013:23) indicated that each latent variable's AVE should be evaluated and acceptable AVE values are greater than a threshold of 0.5 for discriminant validity to be confirmed. The AVE results are indicated in Table 7.3.

Table 7.3: Average variance extracted

Latent variables	Sample
Attitude towards the electricity supplier	1
Behaviour WTP	0.692
Intention to use technology	0.513
Overall attitude towards behaviour	0.367
Support for green electricity	1
Positive behaviours towards conservation	1
Value perception towards renewable	1

At 0.365 the 'overall attitude towards behaviour' is below 0.5, indicating that convergent validity is not confirmed. The latent variable *Overall attitude towards behaviour* has the following observed variables: subjective norm, cultural values (individualist), cultural values (collectivist), perceived behavioural control, and control beliefs. During the simplification of the model, these items were grouped together because they were linked to the attitude of the respondents.

7.2.3 Outer loadings

Outer loadings indicate the correlations between the latent variable and the indicators in its outer model. Kock (2014:3) indicated that each path coefficient will refer to a hypothesis/proposition, with each hypothesis being tested through the calculation of a p-value, associated with the path coefficient. In the frequentist approach of statistical significance testing used in PLS-SEM, which draws conclusions from sample data by emphasising the frequency of the data, if a p-value is below a certain threshold (in exploratory research, 0.4 or higher is acceptable), the corresponding hypothesis is assumed to be supported. Bootstrapping can be used to test the significance of indicators' outer weight. After running the procedure, it is useful to check the t-statistics value. If a particular indicator's outer weight is shown as not significant, one should check the significance of its outer loading (Wong, 2013:28). The p-value refers to the probability of observing the sample statistic or an extreme value of the sample statistic if the null hypothesis is true (Wegner, 2007:266). A very small p-value, which approaches zero, provides strong evidence to reject the null hypothesis in favour of the alternative hypothesis. A large p-value would provide strong evidence to accept the null hypothesis. This study applied the rationale to reject the null hypothesis in favour of the alternative hypothesis if the p-value is smaller than 0.05 (therefore less than 5%), according to Hooper et al. (2008:55) and supported by Kock (2014:3). These results are indicated in Table 7.4.

Table 7.4: Outer loadings results

Latent variables	**Sample**	**Significant from CI (confidence interval)**
Facilitating conditions <- Intention to use technology	0.546	Yes
Perceived behavioural control <- Overall attitude towards behaviour	0.602	Yes
Q41 <- Behaviour WTP	0.729	Yes
Q53 <- Support for green electricity	1	Yes
Q58 <- Behaviour WTP	0.923	Yes
Q59 -> Attitude towards the electricity supplier	1	Yes
Q6 <- Value perception towards renewable	1	Yes
Q9 <- Positive behaviours towards conservation	1	Yes
Attitude towards usage <- Intention to use technology	0.811	Yes
Control beliefs <- Overall attitude towards behaviour	-0.126	No
Cultural values Collectivist <- Overall attitude towards behaviour	0.567	Yes
Cultural values Individualist <- Overall attitude towards behaviour	0.636	Yes
Perceived ease of use <- Intention to use technology	0.704	Yes
Perceived usefulness <- Intention to use technology	0.775	Yes
Subjective norm <- Overall attitude towards behaviour	0.855	Yes

The outer loading indicating the correlations between the latent variable *Overall attitude towards the behaviour* and the indicator *Control beliefs* in its outer model was low and negative. This shows that this indicator does not correlate and is slightly contrary to the other indicators of the same latent variable.

7.2.4 Indicator reliability

By squaring each of the outer loadings, the indicator reliability value can be determined. An indicator reliability value of 0.70 or higher is preferred. If it is an exploratory research study, 0.4 or higher is acceptable (Wong, 2013:21).

Table 7.5: Indicator reliability results

Latent variables	Sample	Significant
Facilitating conditions <- Intention to use technology	0.298116	No
Perceived behavioural control <- Overall attitude towards behaviour	0.362404	No
Q41 <- Behaviour WTP	0.531441	Yes
Q53 <- Support for green electricity	1	Yes
Q58 <- Behaviour WTP	0.851929	Yes
Q59 -> Attitude towards the electricity supplier	1	Yes
Q6 <- Value perception towards renewable	1	Yes
Q9 <- Positive behaviours towards conservation	1	Yes
Attitude towards usage <- Intention to use technology	0.657721	Yes
Control beliefs <- Overall attitude towards behaviour	0.015876	No
Cultural values Collectivist <- Overall attitude towards behaviour	0.321489	No
Cultural values Individualist <- Overall attitude towards behaviour	0.404496	Yes
Perceived ease of use <- Intention to use technology	0.495616	Yes
Perceived usefulness <- Intention to use technology	0.600625	Yes
Subjective norm <- Overall attitude towards behaviour	0.731025	Yes

The indicators that have an individual indicator reliability value smaller than the minimum of 0.4 can remain if the indicator's outer loading is greater than 0.40, the AVE is <0.50 or the composite reliability is <0.70 (Hair et al., 2014:111). Considering these criteria, the outer loading indicating the correlations between the latent variable *Overall attitude towards the behaviour* and the indicator *Control beliefs* in the outer model can possibly be further enhanced.

7.2.5 Composite reliability

Composite reliability is used to evaluate the construct measures' internal consistency reliability. Traditionally, Cronbach's alpha has been used to measure internal consistency reliability in social science research, but it tends to provide a conservative measurement in PLS-SEM. Prior literature has suggested the use of composite reliability as a replacement (Wong, 2013:21, Bagozzi & Yi, 1988; Hair et al., 2012).

Reliability refers to the degree to which a scale yields consistent and stable measures over time and applies only to reflective indicators. The University of Stellenbosch Business School statistical support used the STATISTICA™ software program to compute a composite reliability score as part of its integrated model analysis similar to Cronbach's alpha in that they are both measures of internal consistency. Each reflective construct in the model must demonstrate a level of reliability above the recommended threshold of 0.7 or higher. For an exploratory research study, 0.6 or higher is acceptable (Wong, 2013:21).

The composite reliability results for this study's model can be seen in Table 7.6. The sample values are shown to be larger than 0.6; therefore, high levels of internal consistency reliability have been demonstrated among the reflective latent variables.

Table 7.6: Composite reliability results

Latent variables	Sample
Attitude towards the electricity supplier	1
Behaviour WTP	0.816
Intention to use technology	0.805
Overall attitude towards behaviour	0.67
Support for green electricity	1
Positive behaviours towards conservation	1
Value perception towards renewable (energy)	1

All the composite reliability values from the exploratory model are larger than 0.6, indicating high levels of internal consistency reliability among the latent variables.

7.3 RELIABILITY TEST FOR THE STRUCTURAL/INNER MODEL

In the measurement of the inner model the R-Squared (R^2), multi-collinearity and the path coefficients were calculated to determine the validity of the model. Each of these measures is discussed below.

7.3.1 R-Squared (R^2)

The coefficient of determination is an important tool in determining the degree of linear-correlation of variables ('goodness of fit') in regression analysis. R^2 value assesses the magnitude or strength of relationship between the latent variables. R-squared is the percentage of the response variable variation that is explained by a linear model.

$$\text{R} - \text{squared} = \frac{\text{Explained variation}}{\text{Total variation}} \qquad \ldots(7.1)$$

R-squared is always between 0 and 100 percent where the higher the R-squared, the better the model fits the data.

It is generally accepted that a R^2 of 0.75 is substantial, 0.50 is moderate, and below 0.25 is weak. From this definition, it can be determined that *Behaviour WTP* and *Overall attitude towards* *behaviour* have moderate to weak R^2 values. However, *Positive behaviours towards conservation* and *Value perception towards renewable*, do not indicate any significance, as seen in Table 7.7.

Table 7.7: R-Squared (R^2)

Latent variables	R-Squared
Behaviour WTP	0.266
Overall attitude towards behaviour	0.5
Positive behaviours towards conservation	0
Value perception towards renewable	0.004

The coefficient of determination, R^2, is 0.266 for the *Behaviour WTP* latent variable. This means that the three latent variables (*Overall attitude towards behaviour, Attitude towards the electricity supplier*, and *Value perception towards renewable*) moderately explain 26.6 percent of the variance in *Behaviour WTP*.

Support for green electricity, *Positive behaviours towards conservation* and *Intention to use technology* together explain 50.0 percent of the variance of *Overall attitude towards behaviour*.

7.3.2 Multi-collinearity

The depth of the PLS-SEM analyses depends on the scope of the research project, the complexity of the model, and common presentation in prior literature. A detailed PLS-SEM analysis would often include a multi-collinearity assessment. Each set of latent variables in the inner model is checked for potential collinearity problems to see if any variables should be eliminated, merged into one, or simply have a higher-order latent variable developed.

In statistics, multi-collinearity is an occurrence in which two or more exploratory variables in a multiple regression model are highly correlated. This indication means that one variable can predict another variable with a significant degree of accuracy. Multi-collinearity can be assessed by examining the variance inflation factor and is calculated by $(1/(1 - R^2))$ (Brooks, 2008:12).

Perfect multi-collinearity occurs when the correlation between two independent variables is equal to one (1) or minus one (-1). A variance inflation factor of less than ten rules out multi-collinearity (Kumar & Banerjee, 2012:907).

Table 7.8: Multi-collinearity results

Latent variables	**Attitude towards the electricity supplier**	**Behaviour WTP**	**Intention to use technology**	**Overall attitude towards behaviour**	**Support for green electricity**	**Positive behaviours towards conservation**	**Value perception towards renewable**
Attitude towards the electricity supplier		1.237					
Intention to use technology				1.236			
Overall attitude towards behaviour		1.239					
Support for green electricity				1.228		1	1
Positive behaviours towards conservation				1.008			
Value perception towards renewable		1.01					

From the data in Table 7.8, the results indicate that one latent variable cannot predict another latent variable with a significant degree of accuracy. Therefore, it is not required for variables to be eliminated or to be merged into one.

7.3.3 Path coefficients

Path coefficients represent the hypothesised or proposed relationships linking the constructs. The estimation of path coefficients is an important element of empirical investigations employing PLS-SEM, since it provides the basis for hypothesis (proposition) testing. Each proposition is tested through the calculation of a p-value associated with the path coefficient (Kock, 2014:10). In the frequentist approach of statistical significance testing used in PLS-SEM, if a p-value is below a certain threshold, the corresponding proposition is assumed to be supported. The p-value of each t-value needs to be significant at 0.05 (needing a t-value of about 1.96 or greater) or the specific item demonstrates a lack of validity on that factor. This study used the STATISTICA™ software program to generate t-statistics for significance testing of the inner model utilising a procedure called bootstrapping. In this procedure, many subsamples (for this study it was 1 000) are taken from the original sample with replacement to give bootstrap standard errors, which in turn give approximate t-values for significance testing of the structural path.

Path coefficient values are standardised on a range from minus one (-1) to plus one (+1), with coefficients closer to plus one (+1) representing strong positive relationships and coefficients closer to minus one (-1) indicating strong negative relationships. (Hair et al., 2014:114). The threshold is usually 0.05, used in conjunction with a one-tailed linear test of a directional hypothesis (Kock, 2014).

Table 7.9: Path coefficients results

Path coefficients	Sample	Significant from CI
Attitude towards the electricity supplier -> Behaviour WTP	0.269	Yes
Intention to use technology -> Overall attitude towards behaviour	0.701	Yes
Overall attitude towards behaviour -> Behaviour WTP	0.339	Yes
Support for green electricity -> Overall attitude towards behaviour	-0.016	No
Support for green electricity -> Positive behaviours towards conservation	0.007	No
Support for green electricity -> Value perception towards renewable	0.065	No
Positive behaviours towards conservation -> Overall attitude towards behaviour	-0.095	No
Value perception towards renewable -> Behaviour WTP	0.006	No

The outcome of the path coefficients indicated some to be statistically significant (at $p<0.01$). There are three path coefficients indicating statistical significance, as shown in Table 7.9, and four indicating no statistical significance. The significant path coefficients are discussed below.

Relating to the path coefficient, *Attitude towards the electricity supplier -> Behaviour WTP*, the findings of the study indicated that attitude towards the electricity supplier has been a direct determinant of *Behaviour WTP*. This concurs with the theoretical results of the study by Gerpott and Mahmudova (2010a:311) on the electricity consumers in Germany.

For the hypothesised path relationship: *Intention to use technology -> Overall attitude towards behaviour,* the results revealed that *Intention to use technology* is a statistically significant predictor of *Overall attitude towards behaviour*. *Overall attitude towards behaviour* is a predictor for the consumers' behaviour towards WTP. These path coefficients are the statistically most significant in the model demonstrating that these predictors had the most significant influence relating to the large consumers' behaviour towards their willingness to pay a premium for green electricity.

In summary, the inner model suggests that *Intention to use technology* has the strongest effect on *Overall attitude towards behaviour* (0.701), followed by *Overall attitude towards behaviour* (0.339) and *Attitude towards the electricity supplier* (0.269) effects on *Behaviour WTP*.

However, the hypothesised path relationship between the other paths are not statistically significant because the standardised path coefficients were lower than 0.05.

This finding is supported by Lee (2011:190), quoted as follows:

> *Both Heijden and Verhagen (2004) and Liu et al. (2003) found the significant direct effect of perceived ease of use on perceived usefulness, and indirect effects of perceived ease of use on attitudes towards technology usage and purchase intentions through perceived usefulness.*

Lee (2011:190) indicated that other studies found insignificant relationships related to technology ease of use:

> *Although empirical research has found significant direct effects of perceived ease of use on attitudes towards technology usage (Chen & Tan 2004; Chen et al., 2002; Moon & Kim, 2001; O'Cass & Fenech, 2003; Vijayasarathy, 2004), other research has found insignificant effects of perceived ease of use on consumer responses to technology usage (Heijden & Verhagen, 2004; Liu et al., 2003).*

However, there was an insignificant direct effect of the following paths, namely:

- Support for green electricity on Overall attitude towards behaviour;
- Support for green electricity on Positive behaviours towards conservation;
- Support for green electricity on Value perception towards renewable; and
- Value perception towards renewable on Behaviour WTP.

Positive behaviours towards conservation on *Overall attitude towards behaviour* indicated a very small significance, but still too insignificant to consider.

7.4 CONCLUSION

The analysis of the inner model shows that *Overall attitude towards behaviour* (33.9%) and *Attitude towards the electricity supplier* (26.9%) together can explain some of the *Behaviour WTP*. The results of this study indicate that there are different outcomes compared to the results of previous WTP studies conducted in other countries on the residential electricity consumers, especially relating to the influence of *Support for green electricity* as well as *Positive behaviours towards conservation*. It is an important finding, because it suggests that there are other factors that could be considered when exploring large electricity consumers' WTP.

The discussion from this chapter assessed the proposed model's reliability and validity to assess the willingness to pay influencing the large consumers' perspectives regarding the supply of premium green electricity in South Africa. Reliability tests for the outer model were conducted on the final explorative model, namely: Discriminant validity, Average variance extracted, Outer loadings, Indicator reliability and Composite reliability. These tests indicated that the final explorative model successfully passed the convergent validity assessment of the model.

The following section focused on the reliability tests relating to the structural/inner model. The validity of the model was confirmed by the R Square (R^2), Multi-collinearity and Path coefficients tests. The coefficient of determination, R^2, is 0.266 for the *Behaviour WTP* latent variable. This means that the three latent variables (*Overall attitude towards behaviour, Attitude towards the electricity supplier*, and *Value perception towards renewable*) moderately explain 26.6 percent of the variance in *Behaviour WTP*.

Support for green electricity, *Positive behaviours towards conservation* and *Intention to use technology* together explain 50.0 percent of the variance of *Overall attitude towards behaviour*.

The inner model suggests that *Intention to use technology* has the strongest effect on *Overall attitude towards behaviour* (0.701), followed by *Overall attitude towards behaviour* on *Behaviour WTP* (0.339) and *Attitude towards the electricity supplier* (0.269) effects on *Behaviour WTP*. However, the hypothesised path relationship between the other paths are not statistically significant because the standardised path coefficients were lower than 0.05.

The next chapter discusses the overall conclusions and contribution of this research study.

CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

8.1 INTRODUCTION

The previous chapter presented the analyses, results, and interpretations from the exploratory model used to obtain a first-pass assessment of the large electricity consumers' willingness to pay a premium for green electricity. The analysis of the exploratory model was done through a data analysis method called structural equation modelling (SEM) for consumer research, with a focus on partial least squares (PLS), which is a path modelling approach successfully used in exploratory research.

This chapter presents the results, which were integrated with the objectives and the quantitative findings of this study to ascertain if these objectives had been achieved. The chapter finally concludes with some recommendations for future research.

8.2 REVIEW OF THE OBJECTIVES OF THE STUDY

Due to coal-fired power stations' pollution footprint on the environment, more focus is being given to green electricity-generating technologies. The objective of this study was to obtain an exploratory model to establish the large electricity consumers' WTP a premium for green electricity.

During this study, the following steps were followed to achieve the objective:

- An exploratory model was developed as a measurement instrument in order to assess large electricity consumers' WTP a premium for green electricity;
- The reliability of the developed measurement instrument was tested;
- The results from the large consumers' responses were explored;
- The nature and the extent of the inter-relationships between the variables influencing WTP were statistically determined.

8.3 RESULTS ON THE PROPOSITIONS

The propositions were rooted in previous research, which indicated that WTP for green electricity is particularly influenced by individual attitudes towards environmental issues, and their view of the power supplier; perceptions of green energy; social reference groups; as well as current electricity bill levels versus income (Oliver, 2009:43; Gerpott & Mahmudova, 2010a:306). A summary of each proposition is provided in the next sections.

8.3.1 Proposition 1

The more positive the large consumers' general attitudes towards environmental protection issues, the higher their WTP a premium for green electricity.

The path coefficients relating to the support for green electricity are indicated below:

Support for green electricity -> Overall attitude towards behaviour (-0.016)

Support for green electricity -> Positive behaviours towards conservation (0.007)

Support for green electricity -> Value perception towards renewable (0.065)

This proposition was tested in the model by asking respondents to rate question 53: "Using green electricity is not going to make a difference".

The outcome indicated that this variable path coefficient has no significant influence in the model and will therefore be insignificant in measuring the behaviour towards the WTP of the large electricity consumers. This finding contradicts the previous WTP studies on residential electricity consumers, as discussed in Chapter 4, which indicated that a positive general attitude towards environmental protection issues is an indicator of the consumer's WTP. This outcome may be related to the large consumers' priority concerning the business requirements, rather than the individual's personal preferences.

8.3.2 Proposition 2

If large consumers engage in positive behaviours towards conservation, the likelihood that they will be willing to pay a premium for green electricity will be higher.

The path coefficient which relates to the behaviours towards conservation is indicated below:

Positive behaviours towards conservation -> Overall attitude towards behaviour (-0.095).

This proposition was tested in the model by asking respondents to rate questions 9 and 10: "Does your business generate electricity by using any of the following green technologies?" and "Does your company plan to implement any of these green electricity-generating technologies over the next five years?"

The outcome of the test on this variable influence indicated that this variable path coefficient has no significant influence in the model, as found in the previous studies on residential electricity consumers, which indicated that positive behaviours towards conservation is an indicator of WTP. This outcome may be related to the large consumers' priority concerning the business requirements, rather than the individual's personal preferences.

8.3.3 Proposition 3

The higher the large consumers' value perception towards renewable energy sources, the higher the likelihood that they will be willing to pay a premium for green electricity.

The path coefficient relating to the value perception towards renewable energy is indicated below:

Value perception towards renewable -> Behaviour WTP (0.006)

This proposition was tested in the model by asking respondents to rate question 6: "How significant will the financial status of your company/organisation influence your willingness to pay a premium for green electricity?"

The outcome of the test on this variable influence indicated that this variable path coefficient in the model has no significant influence, as found in the previous WTP studies on residential electricity consumers, as discussed in Chapter 4. There were some studies that had similar outcomes indicating that the consumer surplus concept had no significant influence. The reason for this can be several factors, including the actual vs. hypothetical test in this and previous studies. Another reason can be the South African electricity supply environment with load shedding and significant price increases at the time of this research. Consumers' general willingness to purchase premium green electricity was not significant, but they indicated a willingness to invest in electricity savings initiatives. This can possibly be attributed to the difficult economic conditions at the time of the survey, as well as the trust in the electricity supplier, as discussed in the outcome of Proposition 4.

8.3.4 Proposition 4

The more positive the large electricity consumers' attitudes towards the electricity supplier, the higher the likelihood that they will be willing to pay a premium for green electricity.

The path coefficient relating to the attitude towards the electricity supplier is indicated below:

Attitude towards the electricity supplier -> Behaviour WTP (0.269)

This proposition was tested in the model by asking respondents to rate question 59: "Suppose Eskom gives the opportunity to participate in a green energy programme for an additional fee, would you trust Eskom to manage the process effectively?"

The findings of the study show that attitude towards the electricity supplier is a direct determinant of the consumer's behaviour towards WTP. This confirms the theoretical results found in the previous WTP studies on residential electricity consumers, for example Gerpott and Mahmudova (2010a:311) who had similar findings in their study on the residential electricity consumers in Germany.

The outcome of this proposition was therefore found to be significant in the behaviour towards WTP of the large electricity consumers. In the current South African context, this is an important factor for Eskom and the IPPs entering the market to consider. With significant price increases and load shedding, the attitude towards Eskom in particular was not positive at the time when the questionnaire was completed. The more recent negative publicity in 2017 regarding Eskom's coal contracts, corruption allegations of senior management as well as the turnover of the CEO and chairman positions reinforce the need to consider this influence. This study appears to have indicated the consumer perception as a significant indicator before it was considered by the main stakeholders. The consumers' attitude towards their electricity supplier is an important influence, which electricity providers can improve in order to increase the consumers' WTP for green electricity.

8.3.5 Significant outcome: Intention to use technology

The path coefficient, which relates to the intention to use new technology, is indicated below:

Intention to use technology -> Overall attitude towards behaviour (0.701).

The results revealed that *Intention to use technology* is a strong indicator of *Overall attitude towards behaviour*. Overall attitude towards behaviour is a predictor for the consumers' behaviour towards WTP. Even though literature indicated that the intention to use technology will have an influence on the consumers' WTP, it was not expected to be the most significant influence. This path coefficient is the strongest in the model demonstrating that the technology acceptance predictors had the most significant influence relating to the large consumers' behaviour towards their WTP a premium for green electricity.

This finding is supported by Lee (2011:190):

> *Both Heijden and Verhagen (2004) and Liu et al. (2003) found the significant direct effect of perceived ease of use on perceived usefulness, and indirect effects of perceived ease of use on attitudes towards technology usage and purchase intentions through perceived usefulness.*

Lee (2011:190) indicated that other studies found insignificant relationships related to technology ease of use:

> *Although empirical research has found significant direct effects of perceived ease of use on attitudes towards technology usage (Chen & Tan 2004; Chen et al., 2002; Moon & Kim, 2001; O'Cass & Fenech, 2003; Vijayasarathy, 2004), other research has found insignificant effects of perceived ease of use on consumer responses to technology usage (Heijden & Verhagen, 2004; Liu et al., 2003).*

This outcome suggests that implementing systems making it easy to pay an additional premium for green electricity, will increase the consumers' WTP for green electricity. This is an important finding for electricity providers and governments to consider in future policies and procedures.

8.3.6 Insignificant path coefficients

In the exploratory model, there was an insignificant direct effect of the following paths:

- Support for green electricity on Overall attitude towards behaviour;
- Support for green electricity on Positive behaviours towards conservation; and
- Support for green electricity on Value perception towards renewable.

The following paths indicated a very small significance but not important enough to consider:

- Value perception towards renewable on Behaviour WTP; and
- Positive behaviours towards conservation on Overall attitude towards behaviour.

The analysis of the inner model shows that *Overall attitude towards behaviour* (33.9%) and *Attitude towards the electricity supplier* (26.9%) together can explain some of the behaviour towards the large consumers' WTP for green electricity. The results of this study do not support some of the results of previous WTP studies conducted in other countries on the residential electricity consumers. These significant and insignificant paths are important findings because they clarify the main areas of influence and suggest that there are other factors, such as ease of use, that could be considered in future research, when exploring large electricity consumers' WTP.

8.4 SCENARIO PLANNING CONCLUSIONS

8.4.1 Overview

Scenario planning is a highly-useful technique in an environment of uncertainties. By displaying scenarios during the implementation of the questionnaire, the respondents can form a better idea of the relevant options and can therefore provide better-informed responses. Due to possible limited knowledge relating to the power sector, scenario planning can assist the researcher in the comprehension of information on the subject, when compiling the questionnaire.

Additionally, the scenario planning process can be used to clarify options where it might be difficult for the respondent to think of examples during a questionnaire. Scenarios related to this study were provided for possible implementation methods for green electricity. These scenarios are listed in Table 6.25.

8.4.2 Results of the scenario questions

The results of the scenarios are graphically presented below:

with 1 = 0.5%, 2 = 1%, 3 = 2%, 4 = 3%, 5 = 4% and 6 = >5% as per the questionnaire outcome.

The graph in Figure 8.1 indicates a similar result for Scenarios 1 to 4 and the specified scenario. Most respondents selected the lowest percentage option and only fifteen respondents indicated their WTP five percent or above.

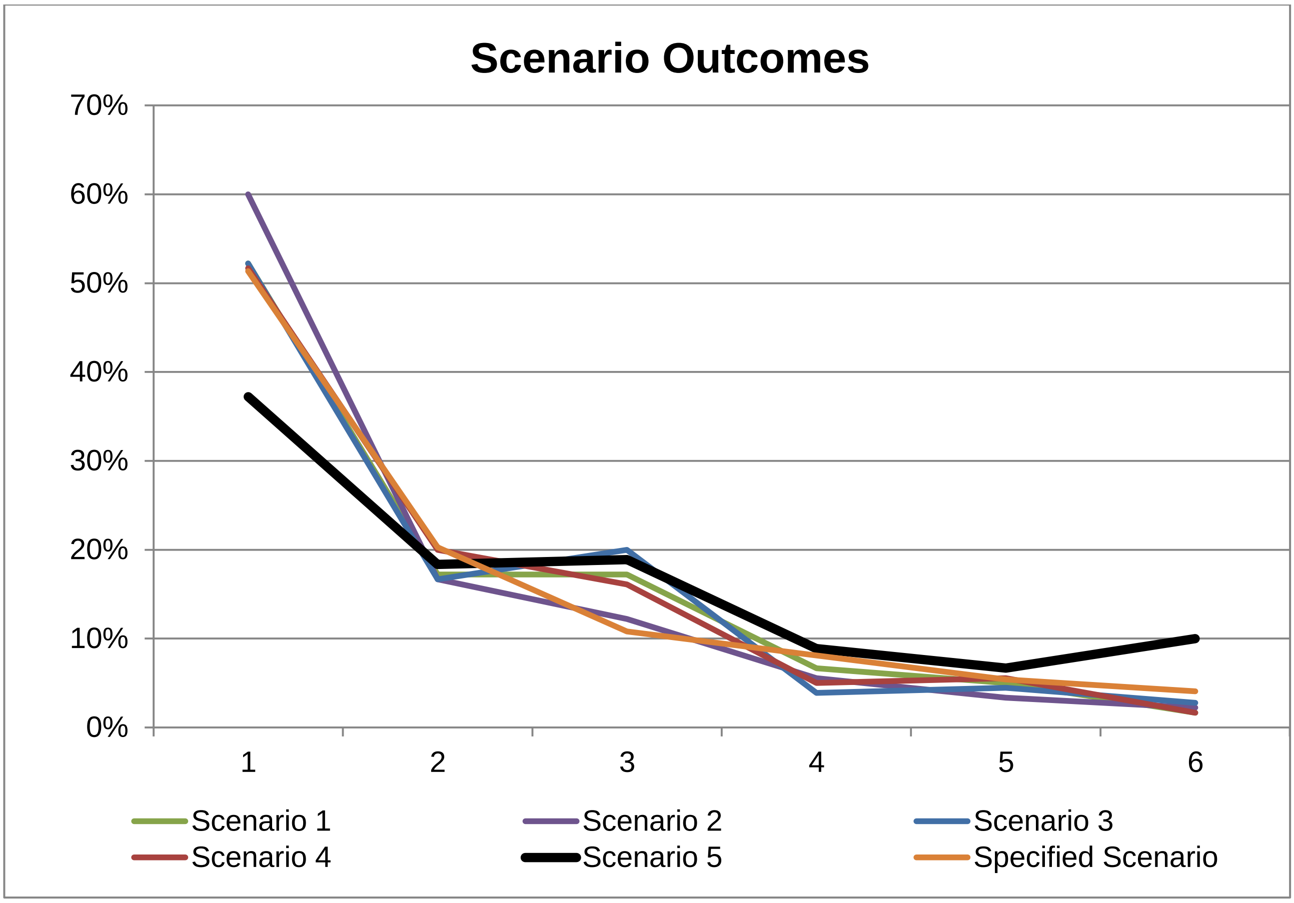


Figure 8.1: Scenario outcomes

Scenario 5 required the responders to indicate the maximum additional amount they would be willing to pay in percentage (%) if it is not for renewable energy, but rather related to energy reduction technologies.

The graph for Scenario 5 (in light blue) is different from Scenarios 1 to 4. This scenario still indicates that most respondents selected the lowest percentage option, but at a lower level. The middle range of two percent is significantly higher than Scenarios 1 to 4 and 18 respondents indicated their WTP five percent or above for this option. This is a strong indication that the respondents are significantly more willing to pay for energy reduction technologies than procuring green-generating electricity.

Scenario 6 in the questionnaire required the respondents to specify a scenario they might prefer. Various statements and comments were made as part of the question. The respondents were requested to optionally add any additional scenario they might prefer and to indicate the maximum additional amount they would be willing to pay in percentage. These responses varied from short comments to suggestions, as summarised in Chapter 6. These response outcomes support the propositions and literature discussed in this study. From these responses, it is clear that respondents indicated a WTP an additional amount of up to five percent. This is significantly higher than the other scenarios as seen in Figure 8.1. The outcome from the self-defined scenarios

(Scenario 5) supports the model outcome that *Attitudes towards the electricity supplier* has a significant impact on the large consumers' WTP.

8.4.3 Conclusion on scenarios

The scenario that indicates a different response is Scenario 5 which does not relate to willingness to pay for green premium electricity. The specified scenario had a slightly more positive profile towards willingness to pay. The next sections summarise the contributions of this study and provide recommendations based on those findings.

8.5 CONTRIBUTIONS OF THE STUDY

The outcome of this research indicated which determinants have a significant influence on the large electricity consumers' WTP a premium for green electricity. Additionally, this study obtained a first-pass assessment of the large electricity consumers' WTP towards the implementation of green electricity. The study indicated that electricity providers and governments should implement systems making it easy to pay an additional premium for green electricity to increase the consumers' WTP for green electricity.

The outcome of the scenarios provided during this study indicated that large electricity consumers will rather pay for demand-side management interventions to reduce their electricity usage than pay a premium for green electricity. Several of the large electricity users indicated that they currently generate green electricity, or plan to generate green electricity, to reduce their dependence on the main suppliers (Eskom and IPPs). These outcomes and their theoretical contributions are discussed in more detail in the following sections.

8.5.1 Conclusion related to the culture questions

The questionnaire data was analysed to determine the orientation of the senior management and executive leadership related to their collectivism and individualism values. The proposition is that collective leaders value social responsibility higher than individualists and will therefore be more willing to pay a premium for green electricity (Shulruf et al. 2011). From the results obtained during this study, it was determined that the respondents had a significant predisposition towards individualism. This outcome was supported by the results from the scenario questions where the respondents indicated their lack of WTP a premium for green electricity. Having this insight on the respondents' orientation related to their collectivism and individualism values can assist in updating the implementation strategies for green electricity.

8.5.2 Conclusion related to the technology model

Previous WTP studies found that the technology used to generate the green electricity and the knowledge/awareness of the technology has an influence on the electricity user's WTP. The causal relationships between perceived usefulness, perceived ease of use, attitude towards technology use and behavioural intention to use technology based on the technology acceptance model were used to create the technology acceptance model. Teo (2010:260) concluded from the results of his study that behavioural intention to use technology was indirectly predicted by facilitating conditions and mediated by attitude towards usage.

The results from this study indicated a lower behavioural intention to use than attitude towards usage and perceived usefulness. This outcome confirms the idea that the electricity consumers support the idea of green electricity, but are reluctant to pay a premium for green electricity. The average score for perceived ease of use is low, therefore indicating that most consumers believe it is difficult to purchase green electricity. This outcome provides a possible reason for the low indicated WTP by the respondents and provides the policy-makers with an option to increase the electricity users' WTP for green electricity. An opportunity therefore exists to increase the actual use of green electricity in future if it can be made easier to procure green electricity.

8.5.3 Conclusion related to the theory of planned behaviour

The theory of planned behaviour determined that human behaviour is guided by beliefs about the likely consequences of the behaviour, beliefs about the expectations of others and beliefs about the presence of factors that may facilitate or impede performance of the behaviour (Ajzen, 1991:181). These beliefs produce a favourable or unfavourable attitude towards behaviour. Given a sufficient degree of actual control over the behaviour, people are expected to carry out their intentions when the opportunity arises. Perceived behavioural control is measured by the extent to which a person feels able to enact the behaviour. It has two aspects: (1) how much a person has control over the behaviour; and (2) how confident a person feels about being able to perform or not perform the behaviour.

The questions tested the influence the price and amount of electricity consumed will have on the respondents' behaviour to procure premium green electricity. The results indicated that the price of electricity has a significant influence on the respondents' WTP and the amount of green electricity usage had a minor impact on the purchasing decision. Considering that the price for electricity is determined outside the control of the electricity users and the electricity usage is within their control, this outcome supports the literature. This knowledge can assist high-level energy supply and demand strategies. For example, policy-makers should consider that the large electricity consumers are more willing to pay for demand-side management initiatives than for the implementation of green electricity initiatives.

8.5.4 Conclusion related to the support for green electricity

Measures taken to protect the environment imply sacrifices of one's own comfort. Individuals prioritising self-enhancement values are more concerned about adverse consequences for themselves on environmental protection, than the adverse consequences of environmental problems for themselves. It is thus hypothesised that individuals prioritising self-enhancement values would be opposed to such measures and will not be willing to pay a premium for green electricity (Hansla et al., 2008:769). Therefore, the outcome of previous studies established that the rate of voluntary purchase of green electricity was very low, although a substantially higher number of the respondents expressed a positive attitude towards green electricity.

The results relating to the support for green electricity from the exploratory model indicated a significant positive inclination in relation to the support for green electricity by the respondents, especially for solar, biomass and wind technologies. The results from this study support the literature as they indicated that respondents in general would support green electricity implementation, but indicated a low actual willingness to pay. Therefore, the respondents' actual willingness to pay must be considered.

8.5.5 Conclusion related to stated willingness to pay

Previous studies relating to the willingness to pay for green electricity indicated a general trend of higher stated willingness to pay than actual willingness to pay. In the study of Hansla et al. (2008:768), the rate of voluntary purchase of green electricity did not exceed one percent, although a substantially higher number of responses expressed a positive attitude towards green electricity. During this study, the respondents indicated how significant the financial status of the company/organisation will influence their willingness to pay a premium for green electricity. The average scores are low, indicating a general reluctance to pay for green electricity. The results relating to the scenarios that required additional payments for green electricity showed a low support with a slightly higher support for the self-defined scenario.

The analyses from this study concluded that the general trend is that the respondents expect to pay a premium for green electricity, but that their actual willingness to pay is low and is significantly influenced by their financial status. The results from this study support the literature indicating that respondents in general would support green electricity implementation, but the respondents have a low actual willingness to pay. For policy-makers, it is important to understand this outcome when planning to implement strategies for accelerated green electricity technologies, otherwise those strategies will not succeed. These interventions may be unsuccessful due to the positive intentions and support for green electricity without the actual intention to pay for these interventions.

8.5.6 Conclusion related to the perception of the electricity supplier

From 2008, Eskom had difficulty to provide sufficient electricity in South Africa. One of the options selected to ensure that the entire electricity network does not shut down was to implement load shedding. The outcome from this analysis reviewed the relationship between support for green electricity and the perception of the electricity supplier, as Whitehead and Cherry (2007:252) concluded from their study that the answer of ''I don't trust the power companies'' was one of the most popular reasons provided for not being willing to pay an additional monthly fee for green electricity.

The overall average scores on this question were low indicating that most of the respondents do not trust Eskom which will reduce the respondents' WTP for green electricity. From the results of the scenarios, questions where Eskom is directly involved had a weaker trend than the scenarios without Eskom, confirming an overall negative perception of Eskom existed during the time of the questionnaire which would reduce the WTP for green electricity. This outcome supports the literature that attitude towards the electricity supplier has a significant impact on the large consumers' WTP. Policy-makers should consider this outcome as it will influence the success of their implementation plans. Interventions to accelerate the implementation of green electricity technologies may be less successful due to the negative perceptions towards the electricity supplier.

8.5.7 Media debate relating to this study

Numerous debates are taking place in the media relating to the premium cost of green electricity. The REIPPPP programme started in 2011 with electricity take-off contracts signed by Eskom. Recently these contracts were not signed by Eskom and the main reason provided were the high cost of the renewable IPP price and the oversupply of electricity existing from the end of 2016. The following media examples indicate the current fierce green electricity debates relating to important discussions on green electricity implementation and the related cost options.

In a recent interview with *TimesLive*, Public Enterprises Minister, Lynne Brown, said (Capazorio, 2017):

> *Policy decisions such as the independent power producers programme – in which Eskom is obliged to buy power from small producers at a much higher cost than coal generation–had the ability to 'crash the Eskom balance sheet' within the next 20 years… In addition to costing more, IPP agreements would also contribute to excess capacity.*

In an article by *Fin24*, a researcher and PhD candidate suggested that renewable energy falls short of being a base-load power source in South Africa. They disputed the claims by the Council of Scientific and Industrial Research (CSIR) that renewables have the capacity for a 70 percent share of South Africa's energy sector which showed that renewables would be the least cost option for South Africa (Omarjee, 2017).

An article in the *Engineering News* featured the debate on the viability of green electricity technologies as well as the recovery options (Creamer, 2017). The Eskom interim CEO, Matshela Koko, was quoted saying that Eskom would sign the outstanding power purchase agreements (PPAs) with renewable-energy IPPs. He furthermore stated that the signing of the PPAs are subject to Eskom receiving clarity on the cost-recovery mechanism in light of Eskom's current under-recovery of IPP costs through the tariff, as well as the prevailing legal uncertainty surrounding recouping those expenses through the Regulatory Clearing Account (RCA) (Creamer, 2017). Koko said: “Since 2014, Eskom has recorded an under-recovery relating to IPP purchases of R6.4-billion and that the under-recovery for 2017/18 is forecast at R3.7-billion.”

This article stated that Public Enterprises Minister, Lynne Brown, had issued a similar warning to the Parliamentary Portfolio Committee on Public Enterprises that IPPs were conceived when growth had been forecast at above five percent and electricity growth was expected to be higher than two percent per year. Instead, demand has fallen and Eskom currently had a surplus supply of electricity of 4 000 MW (Creamer, 2017).

According to Follett (2017), a green energy CEO had stated that companies selling the idea that everything in modern civilization can rely solely on solar and wind power, are selling a ‘hoax’. He further stated that energising all of society with green energy is unfeasible, as the power grid cannot handle so much unpredictable and highly-intermittent wind and solar power as the power grids require demand for electricity to exactly match supply.

From these recent media examples, it is clear that this study is exploring a field that is current and relevant. Therefore, this research provides a significant contribution to critical current difficulties being experienced.

8.5.8 Limitations of the study

The research was conducted on the large electricity consumers in South Africa to determine whether the large consumers would be willing to pay a premium for green electricity. No previous research was done on the large electricity consumers’ WTP. This study would not attempt to generalise its findings on all electricity consumers since it focused only on large electricity consumers in South Africa. Therefore, the proposed exploratory model was developed for a specific sample frame and may require changes if it is to be applied for similar studies in other countries. Aspects to consider are the dynamics of the market at the time the study took place, especially when the questionnaire was sent out. For example, this study was conducted while load sheading took place and specific local and world market influences were present at the time of the study. South Africa had significant annual increases in electricity prices in the time leading to this study. Additionally, the green electricity-generating technology is constantly improving and technology advancement must be considered. The South African conditions are unique in relation to the green electricity-generating technology options, for example, hydro, wind and solar. This country has limited options for hydro-electricity generation due to the relative low rainfall.

8.5.9 Conclusion

As a holistic measurement instrument, the exploratory model considers the various dimensions that large electricity consumers consider when they evaluate their WTP a premium for green electricity within the company or organisation. It is essential to establish the reliability and validity of the exploratory model. The outcomes on the results are consistent with literature explored during this study. The model was further verified by statistically analysing the reliability and validity of the model which confirmed the exploratory model's compliance to the recommended standards. It can therefore be concluded that the exploratory model can be accepted as a reliable tool to measure the large electricity consumers' WTP a premium for green electricity.

The results indicated that the exploratory model considers the various dimensions that large electricity consumers consider when they evaluate their WTP a premium for green electricity within the company or organisation. The results confirmed that the dimensions which organisations in the municipal sector consider when they evaluate their WTP, are similar to the dimensions organisations in the mining and commercial sectors take into account when they evaluate their WTP for green electricity.

Considering the current debate relating to the cost and implementation options for green electricity, this study contributes to a better understanding of the subject field, the willingness to pay and determinants influencing the large consumers' perspectives regarding the supply of premium green electricity in South Africa.

The results of this study indicate that there are different outcomes compared to the results of previous WTP studies conducted in other countries on the residential electricity consumers, especially relating to the influence of *Positive behaviours towards conservation*. According to Gerpott and Mahmudova (2010a:311), one of the five attitudinal characteristics relating to the WTP, under the psychological construct is the household ecological conservation behaviour. This study's outcome suggests that previous support for conservation activities is not a reliable indicator for the large electricity consumers' WTP for green electricity. It is an important finding, because it suggests that South African large electricity consumers' consider different factors when they consider investing in green electricity technologies.

8.6 IMPLICATIONS FOR ESKOM AND POLICY-MAKERS

The outcome of this study can contribute and assist Eskom and policy-makers in implementing better strategies, policies and procedures for making green electricity more viable in the short term and to sustain it for the long term. The results of this study provide insightful outcomes in comparison to previous WTP studies conducted in other countries on the residential electricity consumers.

The outcomes indicate that there is immense scope for greater and more in-depth scrutiny of the factors that either facilitate or inhibit technology acceptance among the stakeholders, including administrators, policy-makers and the power producers. This study can assist in establishing a Green Power Marketing methodology suitable for South Africa's large electricity users. This is particularly true in a changing supply market, where historically Eskom had supplied up to 96 percent of the electricity in South Africa. With IPPs entering the market, the future of marketing, especially for green electricity implementation policies, will need to change. To overcome this barrier, significant promotional education may be required once a payment system for green electricity is introduced.

During the updates of the IRP for South Africa, these outcomes could assist in refining the various scenarios. Conclusions from this study can be used as a basis for sustainable energy planning and policies to enhance the implementation of renewable electricity-generating technologies. Additionally, this study can assist with the implementation for renewable electricity investment programmes and projects relating to energy-saving initiatives for large consumers. To achieve these programmes, governments should invest in preparing implementation conditions and enhance public acceptance of renewable energy investments and programmes.

8.7 RECOMMENDATIONS

If the large electricity consumers can be placed in a position where they can contribute, in a very simplistic and effective way, this study has indicated that they will be willing to pay a premium for green electricity. Future studies could conduct research on the implementation vehicle for the large electricity consumers to contribute to green electricity generation and possible marketing benefits for those electricity consumers. For example, there can be a ‘tick box’ placed on the large electricity consumers’ invoice for them to indicate, as a month-to-month option, if they are willing to pay a percentage towards the implementation of green electricity-generating technologies. The large consumers must be able to monitor the money allocated towards green electricity-generating technologies and utilise those contributions for positive marketing and possible tax benefits. With the technology advancement curves indicating a consistent shorter technology development period as seen in Figure 2.1, the future policies will have to be able to respond to a faster-changing market. Additionally, significant promotional education may be required once a payment system for green electricity is introduced.

Some natural gas options are available for the Southern African region that are being investigated and implemented. If these options can be economically expedited, they would provide a hybrid option to make renewable electricity a viable option for larger electricity consumers.

A possible method of further exploring the large consumers’ WTP could be to request the consumers to explain their view on the positive and negative effects relating to various proposed scenarios. The outcome may then provide policy-makers with a better understanding of the reasons for the large consumers’ positions on the variables in the exploratory model. To increase the response rate for future studies, the email list for the respondents should be improved to ensure that it is up to date with the movements of the staff working for the large consumers. In future large consumer WTP studies it will be advisable to use a shorter questionnaire. This could increase the response rate as the sample frame is mainly senior management and they do not have the time to complete long questionnaires. However, it is important to ensure that the reliability of the shorter questionnaire is not compromised. There was a limited use of reverse-worded questions in the questionnaire. During this study, the reverse-worded questions provided the same results as similar non-reverse-worded questions and can be removed to improve the flow of the questionnaire and avoid confusion. The high individualistic outcome in the culture variable could be further investigated to determine whether it is a South African or large company leader trend and how that information could be utilised to improve WTP for green electricity.

This study has created a baseline of the determinants influencing the large electricity consumers' WTP for green electricity in terms of the electricity industry's environment at the beginning of 2015. It will be useful to repeat this study, or a similar study, to evaluate how the changes in the electricity environment influence the large electricity consumers' WTP. For future studies, the sample size could be increased or an interview-based information gathering process may be followed to further improve the exploratory model. Further development of the exploratory model is suggested to improve the model for future studies on large electricity consumers' WTP. For example: The latent variable *Overall attitude towards behaviour* has the following observed variables: subjective norm, cultural values (individualist), cultural values (collectivist), perceived behavioural control, and control beliefs. During the simplification of the model, these items were grouped together because they were linked to the attitude of the respondents. To possibly improve the latent variable, the positive and negative influences can be separated. Additionally, the outer loading indicating the correlations between the latent variable *Overall attitude towards the behaviour* and the indicator *Control beliefs* in its outer model was low and negative. After receiving this result, it is recommended to review this indicator further in future studies.

8.8 CONCLUDING REMARKS

This study developed the exploratory model to test the large electricity consumers' WTP for green electricity. The outcomes of the significant and insignificant paths are important findings because they suggest that South African large electricity consumers consider different factors to the previous studies, mainly on residential consumers, when they consider investing in green electricity technologies. Therefore, there are additional factors that could be considered when further exploring large electricity consumers' WTP.

All the objectives of this study were successfully achieved. Additional insights on the WTP behaviour of large electricity consumers were obtained. These objectives were to obtain information from studies and various forms of literature detailing the current green electricity environment and collect empirical data to:

- Develop an exploratory model;
- Test the reliability and validity of the developed measurement instrument;
- Statistically determine the nature of variables influencing WTP and relationships between these variables;
- Obtain a first-pass assessment of the large electricity consumers' willingness to pay a premium for green electricity by exploring the results from the large consumers' responses; and
- Provide recommendations for the implementation of renewable electricity investment programmes.

The measurement instrument was developed and satisfied the minimum reliability and validity requirements. The outcome of this study adds new insights to the green electricity industry.

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APPENDIX A:

ETHICAL CLEARANCE

USB University of Stellenbosch Business School

14 October 2014

Dear Danie

Re: Ethical screening application: PhD Business Management & Administration study: Danie Mollier
(BD187/Approved)

Research : The assessment of the willingness-to-pay determinants influencing the large consumers' perspective regarding the supply of of premium green electricity in South Africa

Supervisor : Prof Eon Smit

The Departmental Ethics Screening Committee of the University of Stellenbosch Business School (USB DESC) reviewed your application for the above-mentioned research. The research as set out in the application has been approved.

We would like to point out that you, as researcher, are obliged to maintain the ethical integrity of your research, adhere to the ethical guidelines of Stellenbosch University, and remain within the scope of your research proposal and supporting evidence as submitted to the USB DESC. Should any aspect of your research change from the information as presented to the USB DESC, which could have an effect on the possibility of harm to any research subject, you are under the obligation to report it immediately to your supervisor. Should there be any uncertainty in this regard, you have to consult with the USB DESC.

We wish you success with your research, and trust that it will make a positive contribution to the quest for knowledge at the USB and Stellenbosch University.

Sincerely

Prof Basil C. Leonard
Chair: USB Departmental Ethics Screening Committee
021 918 4250

2/...

University of Stellenbosch Business School
Address: [illegible]
Tel: [illegible] Fax: [illegible]
Email: [illegible] Website: www.usb.ac.za

UNIVERSITEIT·STELLENBOSCH·UNIVERSITY

Please note: Should any research subject, participating organisation, or person affected by this research have any query about the research, they should feel free to contact any of the following:

Researcher : MollerDM@eskom.co.za; 082 350 5291
Supervisor : Eon.Smit@usb.ac.za
USB DESC Chair : Basil.Leonard@usb.ac.za

APPENDIX B:
QUESTIONNAIRE

Reminder to complete the Eskom study on Key Customers' willingness to pay premium for green electricity

Title: Eskom study on Key Customers' willingness to pay premium for green electricity

Dear Key Customer

This is a request to participate in an academic survey for the University of Stellenbosch Business School (sponsored by Eskom). The results of the study are critical to an understanding of Eskom Key Customers' willingness to pay for a premium for green electricity.

You are therefore cordially requested to participate in the study by completing an online web-questionnaire. The questionnaire can be accessed by clicking on the following link: **Link**.

Alternatively, you can also copy and paste the link in your web browser which will open the questionnaire. The questionnaire will be active until the 15th of November 2014. (Final date was 24 January 2015).

Your participation is completely voluntary and anonymous. We expect that the questionnaire will take you less than 20 minutes to complete. Any questions about the study can be directed to Danie Möller at mollerdm@eskom.co.za.

Please note that the study has been approved by the Research Ethics Committee at Stellenbosch University and has the full support of this University and Eskom.

Thank you for participating in this survey. Your contribution is invaluable.

Kind regards,

Mr Danie Möller

INTRODUCTION FROM RESEARCHER

Dear Respondent

My name is Danie Möller and I am conducting an academic survey for the University of Stellenbosch Business School (sponsored by Eskom).

You have been identified as one of the top 500 consumers of electricity in South Africa during 2012 and 2013.

I appreciate your willingness to participate in research regarding the behavioural aspects of large consumers' willingness to pay a premium for green electricity.

INSTRUCTIONS

It will be appreciated if you can answer all the questions in the questionnaire. Please mark the boxes that correspond to your intended answer with an X. There are a few instances where you will be given room to write answers as required. The survey should take between 15 to 25 minutes of your valued time to complete. It will be of great assistance if you can answer all the questions as objectively as possible.

CONSENT INFORMATION

This questionnaire is intended solely for academic purposes and will be kept strictly confidential. Your identity will be protected due to the fact that the questionnaire will be completed anonymously (your name or your company's name need not be provided). Your participation in this study is voluntary. No information linking or identifying you personally shall be disclosed. Completion of the questionnaire implies that the respondent consents to the aforementioned conditions.

QUESTIONNAIRE

1. Do you agree to participate in this study?

Yes	
No	

A. COMPANY PROFILE QUESTIONS

2. Which sector best applies to your company/organisation?

Mining	
Industrial	
Municipal / Residential	
Commercial	
Agriculture	
Traction / Rail	
Bulk Distributors	

3. What is your current position?

Finance Director	
Managing Director	
Chief Executive Officer	
Chief Operating Officer	
Board Member / Director	
Engineering / Technical Manager	
Electricity accounts Manager	
Other	

If other, then specify

4. Who manages the electricity account of your company/organisation?

Finance Director	
Managing Director	
Accounts Manager	
Accounts Payable	
Electricity Accounts Manager	
Other	

If other, then specify

5. In Rand value, what was the company/organisation average monthly expense on electricity for the past year? (Type the numerical value only. Not a R or Rand and no spaces, commas or points)

R

6. With reference to the following items:

How significant will the financial status of your company/organisation, as measured by for example Debt ratio, Earnings before interest and tax (EBIT) and Net cash flow be in influencing your willingness to pay for green electricity

Debt ratio, Earnings before interest and tax (EBIT) and Net cash flow;

How significant will the financial status of your company/organisation influence your Willingness to Pay a premium for green electricity?

Very Significant = 6 Significant = 5 Somewhat = 4 Will be considered = 3 Slight significance = 2 No significance = 1	**1**	**2**	**3**	**4**	**5**	**6**

7. Do you generate any electricity?

Yes	
No	

If the answer is no, go to section B (Willingness to pay)

8. If the answer is yes, what was this electricity mainly used for?

In-house use	
Sale to Eskom	

Q9	**Does your business generate electricity by using any of the following technologies?**		**Q10**	**Does your company plan to implement any of these electricity-generating technologies over the next 5 years?**	
Green technology	**No**	**Yes**	**No**	**Yes**	**Maybe**
Biomass					
Solid Waste					
Wind generation					
Solar generation					
Ocean current					
Ocean wave					
Ocean Pump Storage					
Underground Coal Gasification					
Hybrid Plants					
Other technologies					

If other, then specify

B. WILLINGNESS TO PAY

Always / Strongly Agree = 6

Very often / Agree = 5

Often / Agree Somewhat = 4

Occasionally / Disagree somewhat = 3

Rarely / Disagree = 2

Never or almost never / Strongly Disagree = 1

#	Questions	1	2	3	4	5	6
11	I can influence the decision to purchase green electricity within the company/organisation						
12	To what extent will your decision to use premium green electricity be influenced by changes in the level of your company's usage of electricity?						
13	I define myself as a competitive person						
14	I enjoy being unique and different from others						
15	For me to purchase green electricity is easy						
16	Before I make a major decision I seek advice from people close to me						
17	Using green electricity will enhance my environment						
18	Even when I strongly disagree with my group members, I avoid an argument						
19	A high price of green electricity would make my purchasing decision harder						
20	I consult with superiors/board members on work-related matters						
21	I believe that competition is a law of nature						
22	I believe it is easy to convert to green electricity						
23	I prefer competitive rather than non-competitive recreational activities						
24	Reading about green electricity is uninteresting						
25	Before taking a major business trip I consult with my colleagues						
26	Green electricity is an interesting subject						
27	I sacrifice my self-interest for the benefit of my group						
28	Specialised support is available to advise me when I need help choosing between green electricity-generating technologies						
29	I consider my colleagues' opinions before taking important actions						
30	I like to be accurate when I communicate						
31	Specialised support is available to help me when I need help implementing a green electricity procurement strategy						
32	I consider myself to be a unique person who does not follow the crowd						
33	It is expected of me to support the purchase of green electricity						
34	It is important to consult colleagues and get their ideas before making a decision						

#	Questions	1	2	3	4	5	6
35	I believe it would not be possible to have a good society without competition						
36	I support the use of green electricity						
37	I ask the advice of friends and colleagues before making career related decisions						
38	Using green electricity will increase the quality of life						
39	I prefer using indirect language rather than upsetting my colleagues by telling them directly what they may not like to hear						
40	It is important for me to act as an independent person						
41	I expect to pay a premium for green electricity						
42	I discuss job or study-related problems with my parents/partner						
43	I take responsibility for my own actions						
44	I do not reveal my thoughts when it might initiate a dispute						
45	I try to achieve better results than my peers						
46	I find green electricity difficult to procure						
47	My personal identity independent of others is very important to me						
48	I enjoy working in situations involving competition with others						
49	I feel under social pressure to purchase green electricity						
50	I consult my colleagues before making an important decision						
51	Winning is very important to me						
52	I see myself as 'my own person'						
53	Using green electricity is not going to make a difference						
54	Using green electricity will improve my life						
55	My knowledge and understanding of green electricity is good						
56	When I need help to learn more about green electricity, guidance is available to me						
57	People whose opinions I value will encourage me to purchase green electricity						
58	I am willing to pay a premium for green electricity in future						
59	Suppose Eskom gives the opportunity to participate in a green energy programme for an additional fee, would you trust Eskom to manage the process effectively?						

C. INTRODUCTION TO SCENARIO QUESTION

Government has applied measures to accelerate the implementation of green electricity initiatives. One of these measures is a levy on electricity generated from non-renewable sources.

National Treasury and the South African Revenue Service (2013:13) stated that “Electricity levy was introduced in July 2009 at a rate of 2 cents per kWh. It is applied to electricity generated from non-renewable sources. The levy was increased to 2.5 cents per kWh from 1 April 2011 and some of the revenue was set aside to fund the rehabilitation of damage to roads as a result of the haulage of coal for electricity generation. In 2012, the levy was increased to 3.5 cents per kWh and additional revenue is now used to fund energy efficiency initiatives such as the solar water heater programme”.

Another measure to accelerate the implementation of green electricity initiatives was introduced during the MYPD3. This stated that 3% of the allocated price increase was provided to support the renewable energy IPPs programme. NERSA (2013:44) stated that a number of policy issues requiring consideration have been raised during the third MYPD3 and other views were considered during the implementation of the price determination process for instance, “the environmental levy should be used to fund IPPs development instead of imposing an additional 3% on the electricity price increase”.

Taking the above into consideration the following five (5) scenarios were created as alternative implementation options that can be used to accelerate implementation of green electricity initiatives. Please mark the cell that corresponds with the maximum percentage (%) you will be willing to pay for each alternative scenario with an X. Alternatively provide your own scenario and motivate your view in the space provided.

D. COST AND IMPLEMENTATION METHOD (PAYMENT VEHICLES)

Scenarios:	**What is the maximum additional amount you will be willing to pay in percentage (%) if…?**					
	0.50%	**1%**	**2%**	**3%**	**4%**	**>5%**
Q60. Scenario 1: Eskom builds renewable energy-generating plant and transfer cost to all consumers						
Q61. Scenario 2: Government sponsors Eskom to build renewable energy-generating plant and recover the cost by other means (e.g. tax)						
Q62. Scenario 3: Private entities build renewable plant and Eskom procures the generated electricity at a higher cost. Eskom then transfers the additional cost to all costumers						
Q63. Scenario 4: Customers pay a voluntary amount to facilitate the build of renewable plant (Separate fund)						
Q64. Scenario 5: Do not pay any additional amount for renewable energy but rather spend it on energy reduction technologies						
Q65. Scenario 6: **Specify any additional scenario you may prefer and (Q66) indicate** the maximum additional amount you will be willing to pay in percentage (0.50%, 1%, 2%, 3%, 4% >5%) for your scenarioNot compulsory to complete						

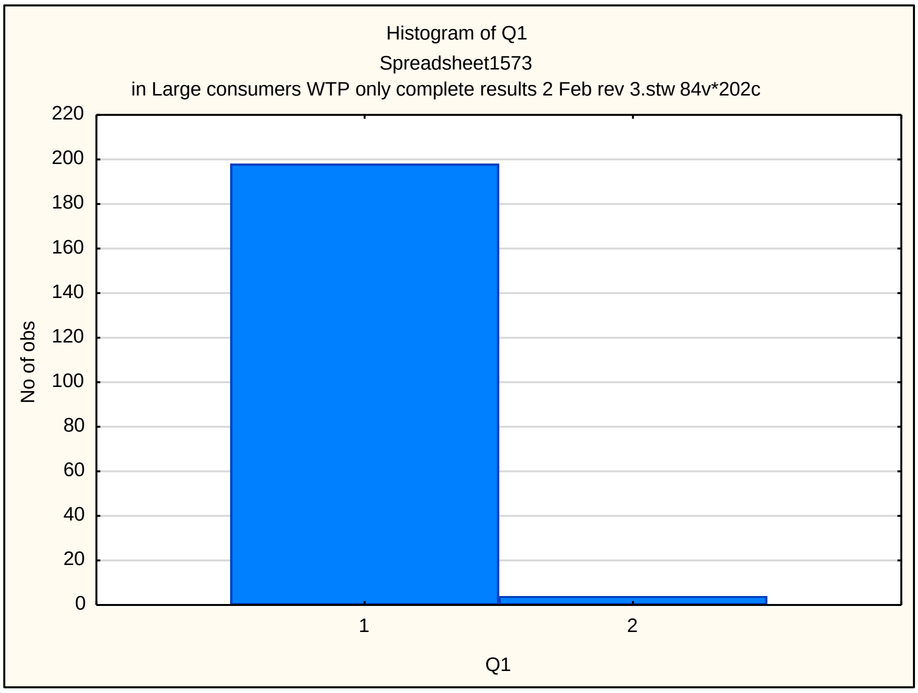
Thank you for your time and participation in this research survey.

APPENDIX C:

2D HISTOGRAMS

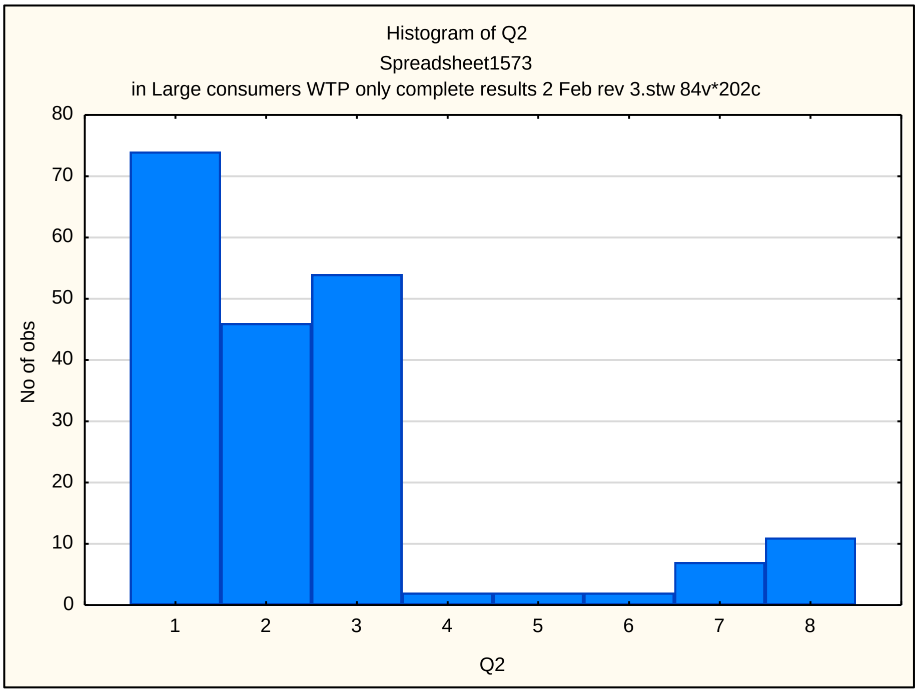
(LARGE CONSUMERS' WTP – ONLY COMPLETE RESULTS 2 FEB 2015)

Q1. Do you agree to participate in this study?

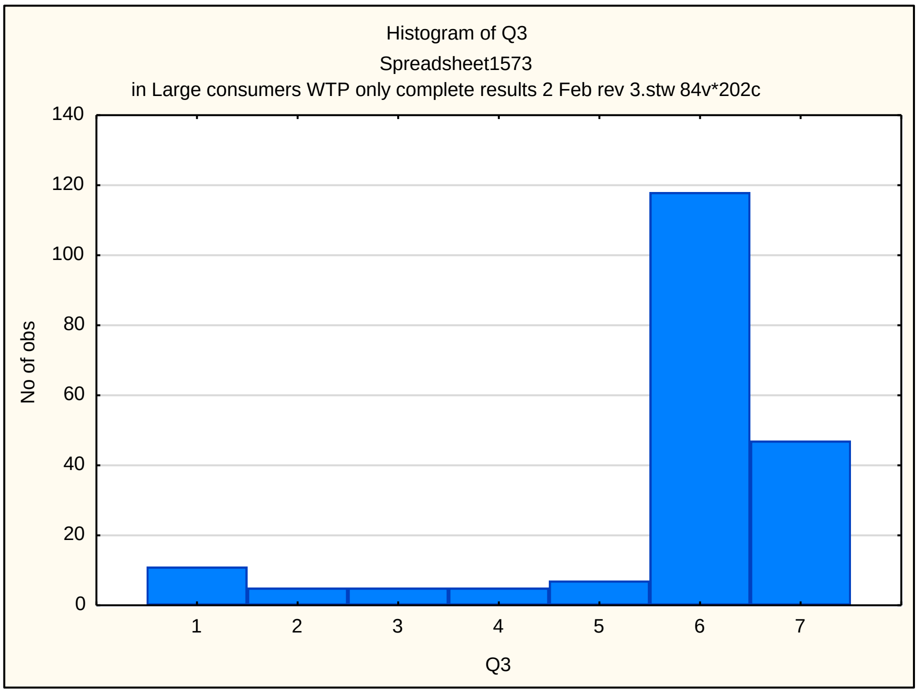


A. COMPANY PROFILE QUESTIONS

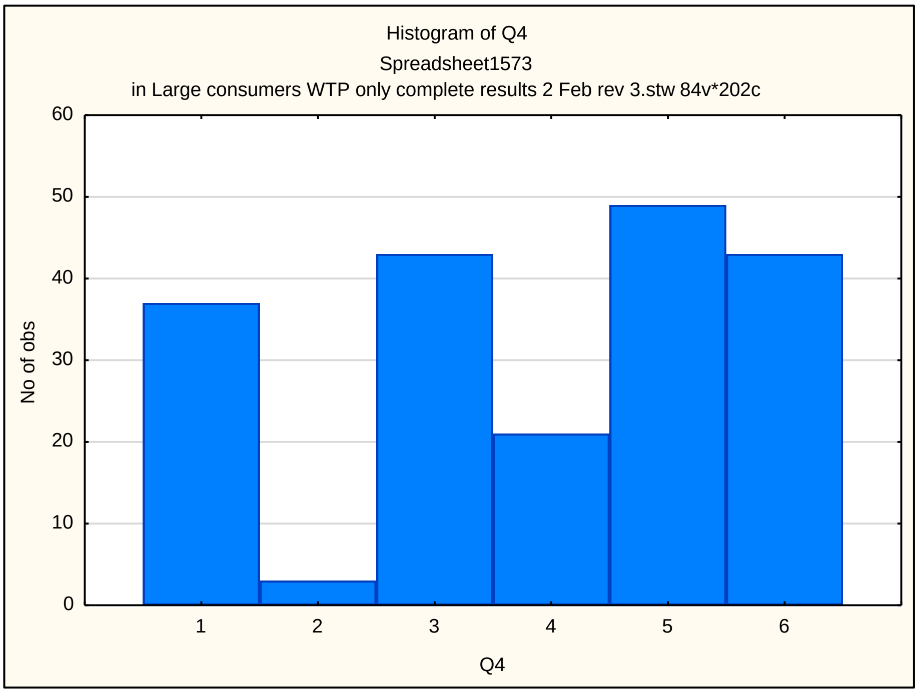
Q2. Which sector best applies to your company/organisation?



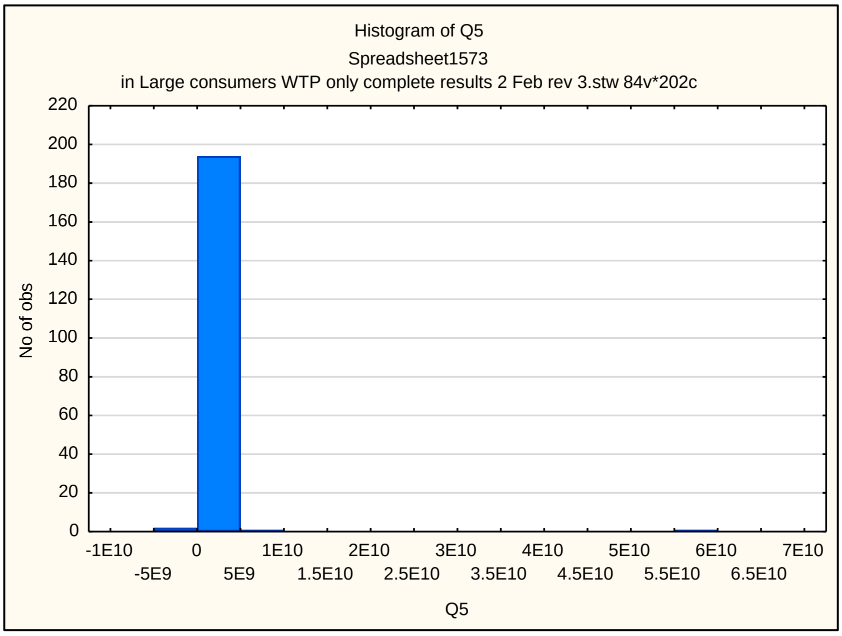
Q3. What is your current position?



Q4. Who manages the electricity account of your company/organisation?



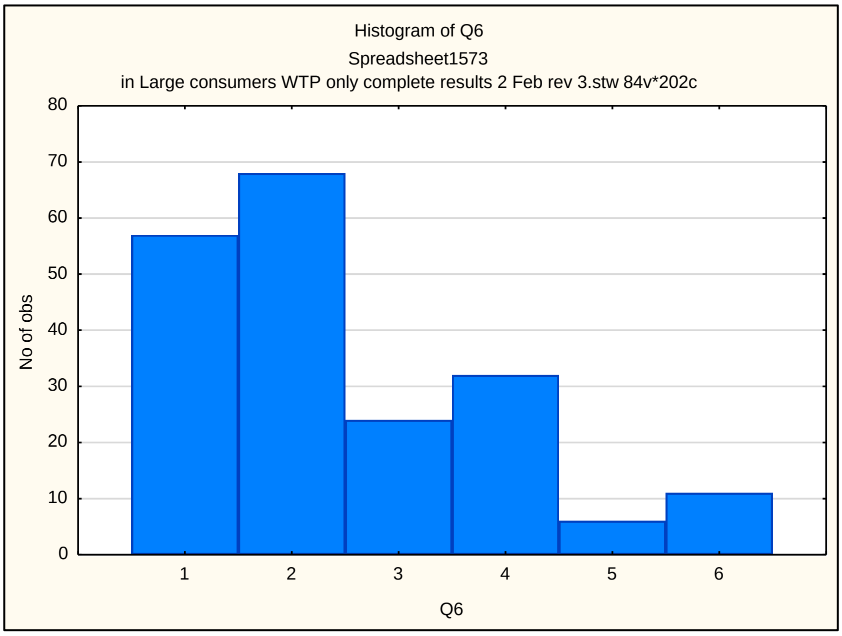
Q5. In Rand value, what was the company/organisation average monthly expense on electricity for the past year? (Type the numerical value only. Not a R or Rand and no spaces, commas or points)



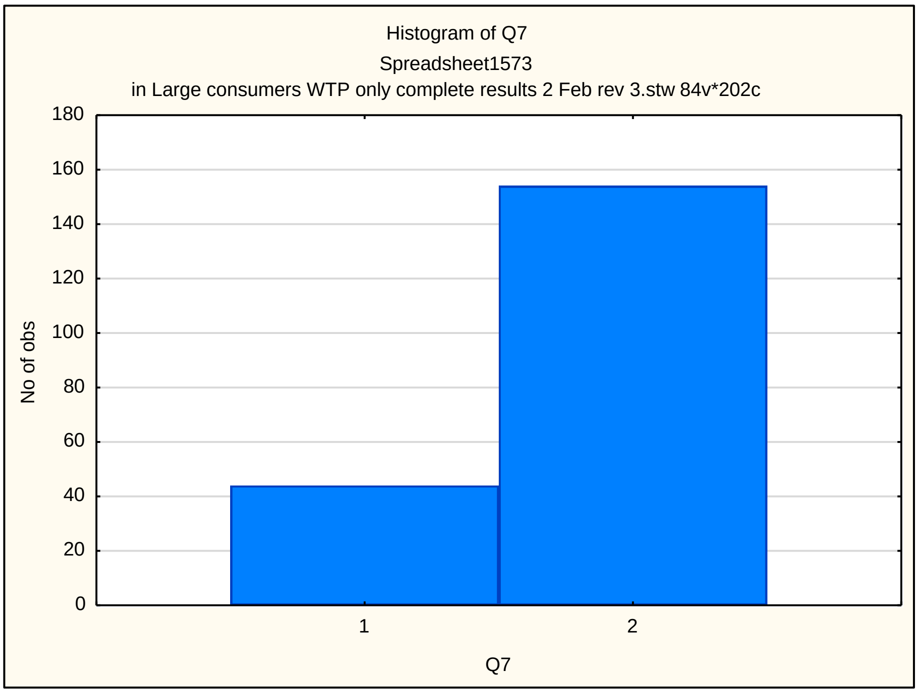
Q6. With reference to the following items:

How significant will the financial status of your company/organisation, as measured by for example Debt ratio, Earnings before interest and tax (EBIT) and Net cash flow be in influencing your willingness to pay for green electricity. (Debt ratio, Earnings before interest and tax (EBIT) and Net cash flow);

How significant will the financial status of your company/organisation influence your Willingness To Pay a premium for green electricity?

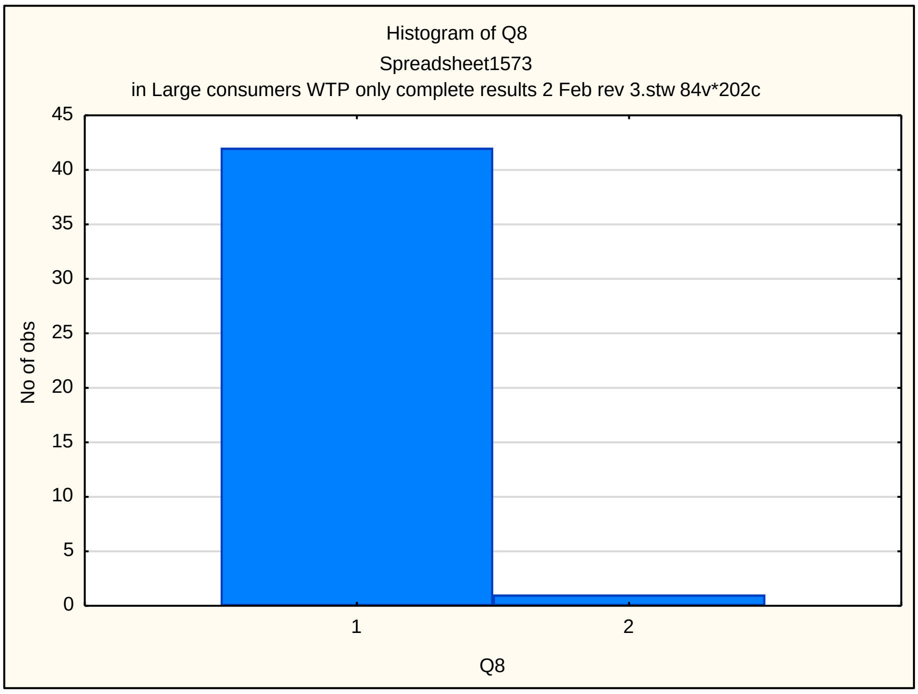


Q7. Do you generate any electricity?



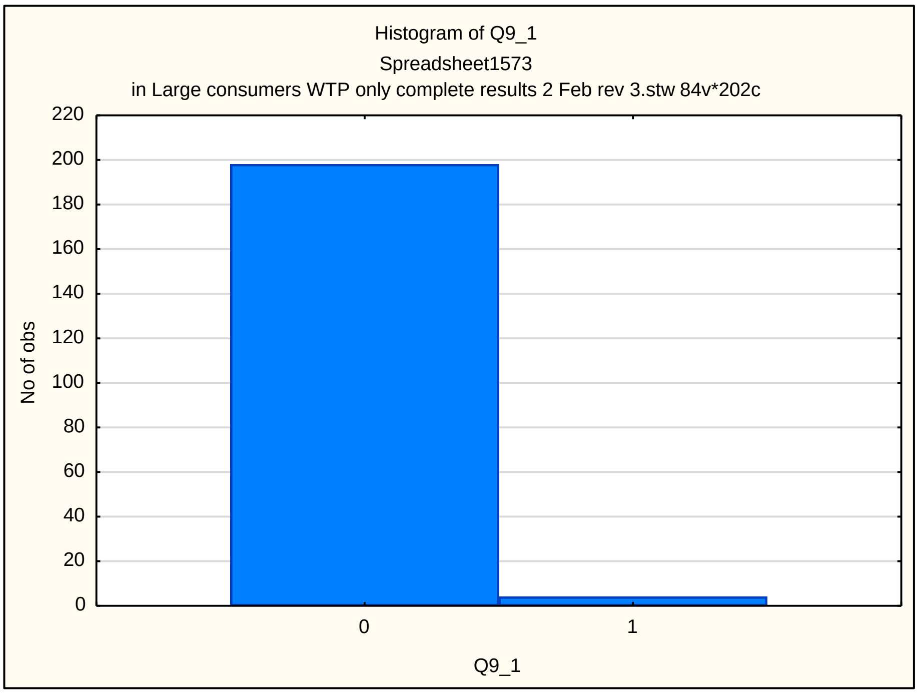
Q8. If the answer is yes, what was this electricity mainly used for?

In-house use or Sale to Eskom

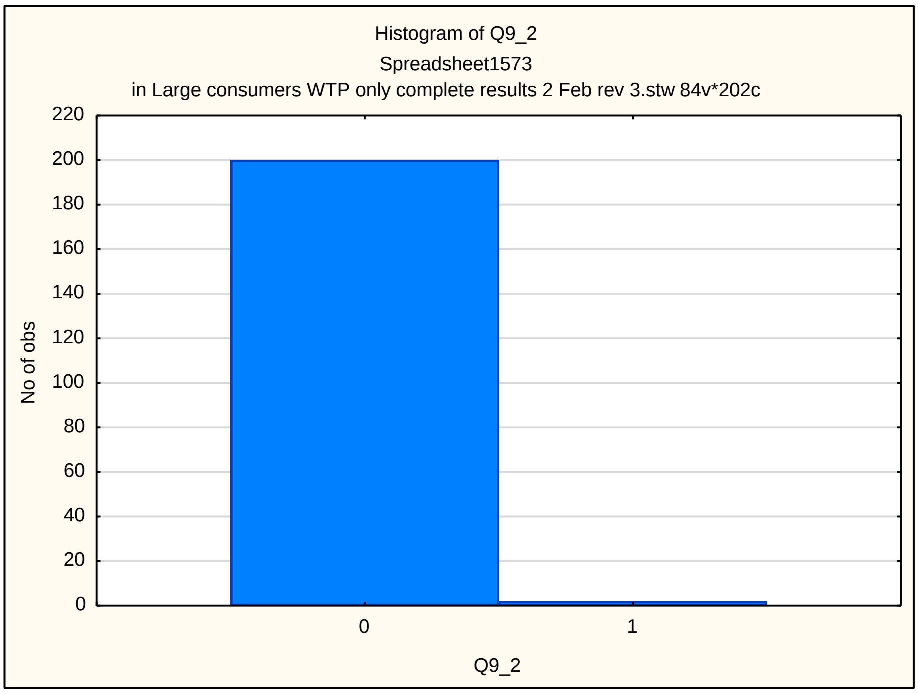


Q9. Does your business generate electricity by using any of the following technologies?

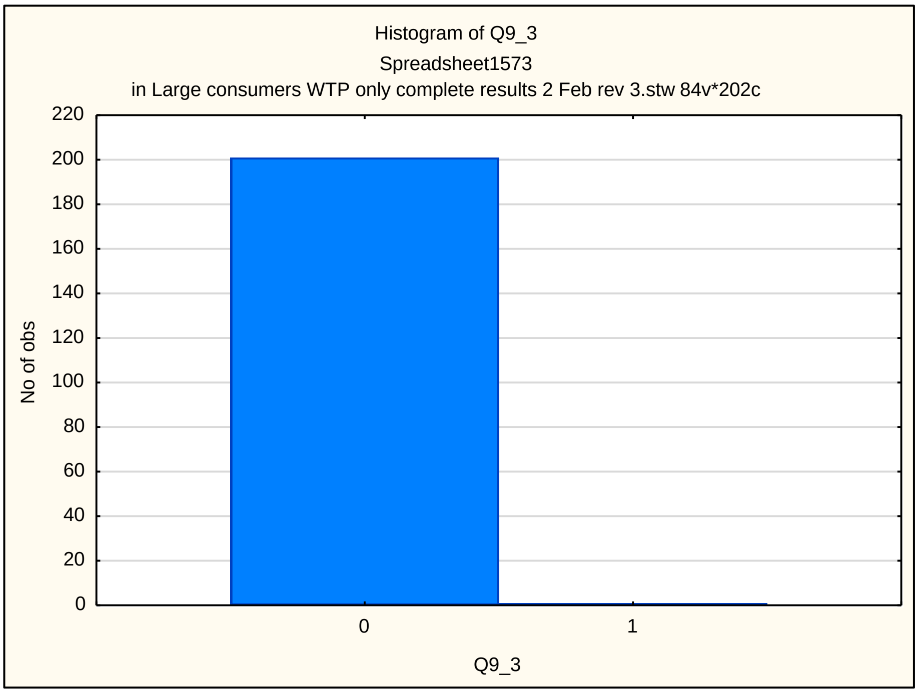
Q9.1. Biomass



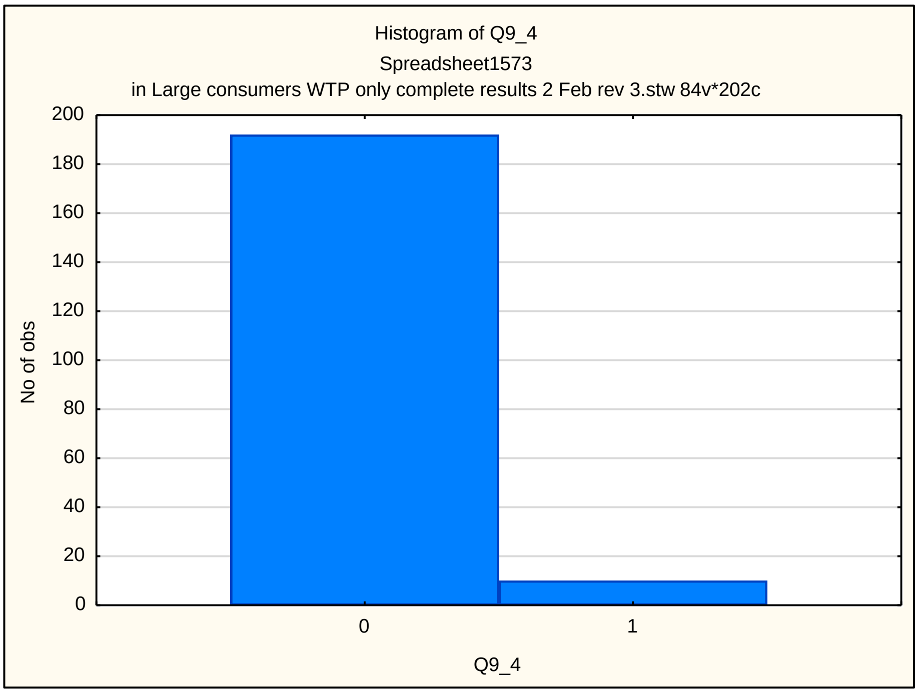
Q9.2. Solid waste



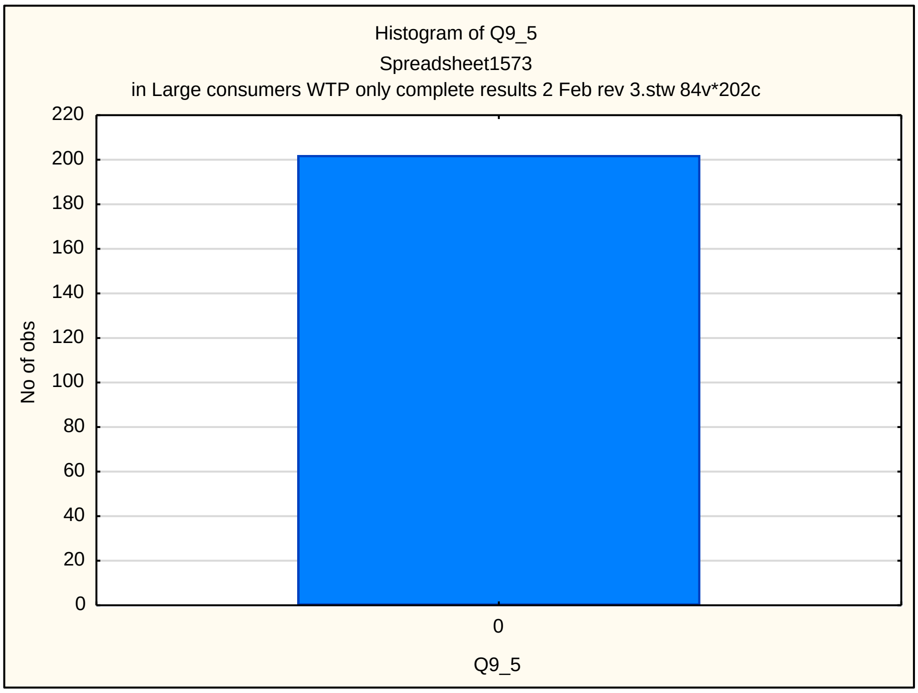
Q9.3. Wind generation



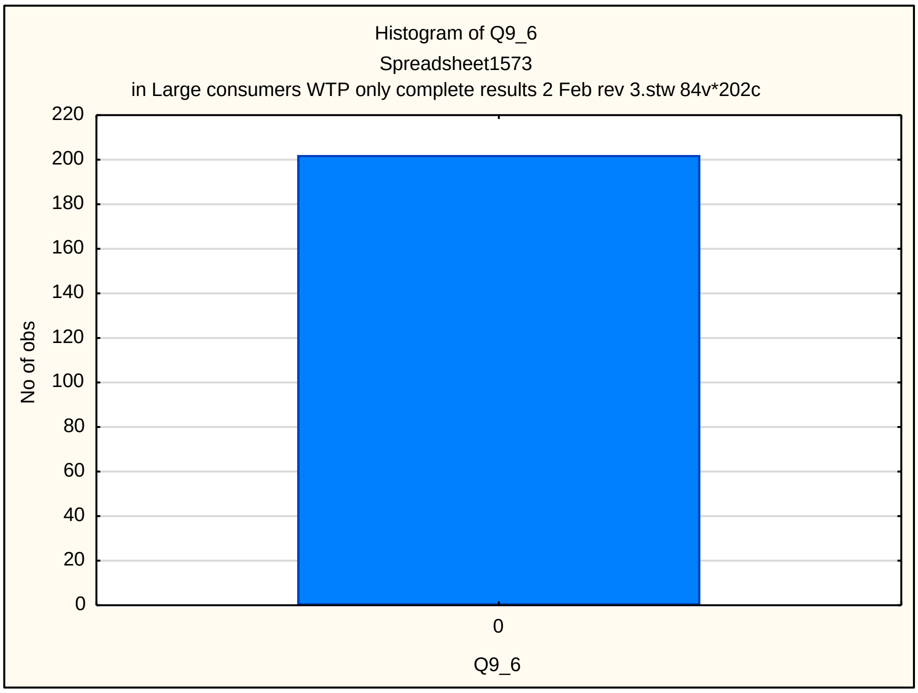
Q9.4. Solar generation



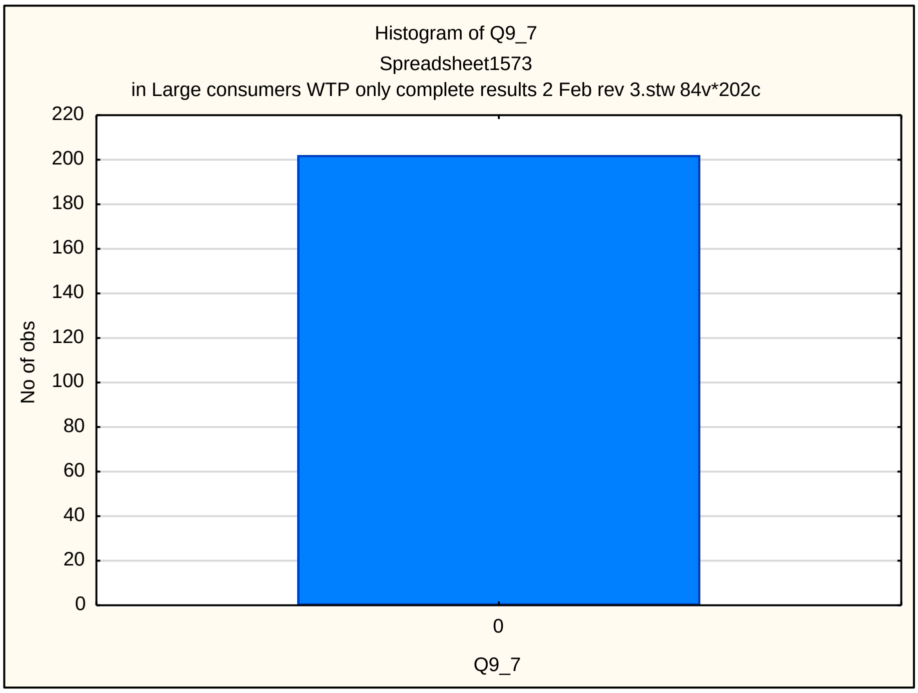
Q9.5. Ocean current



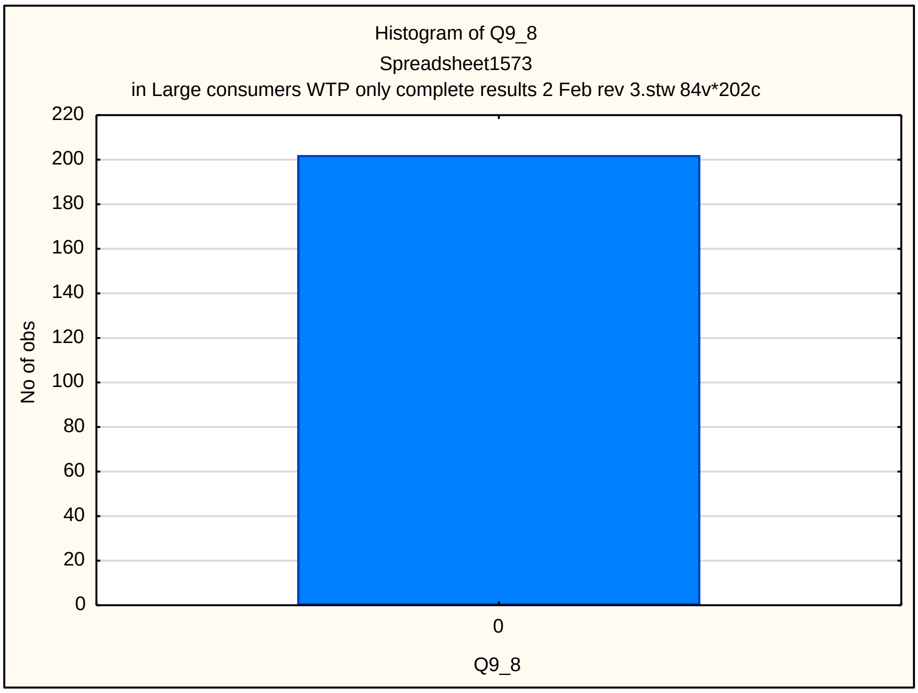
Q9.6. Ocean wave



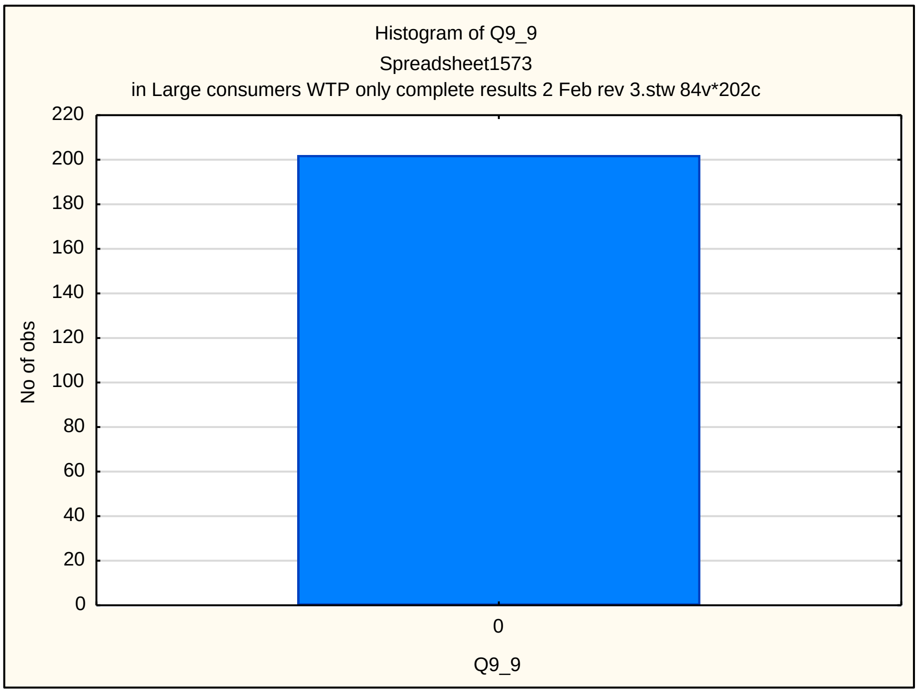
Q9.7. Ocean Pump Storage



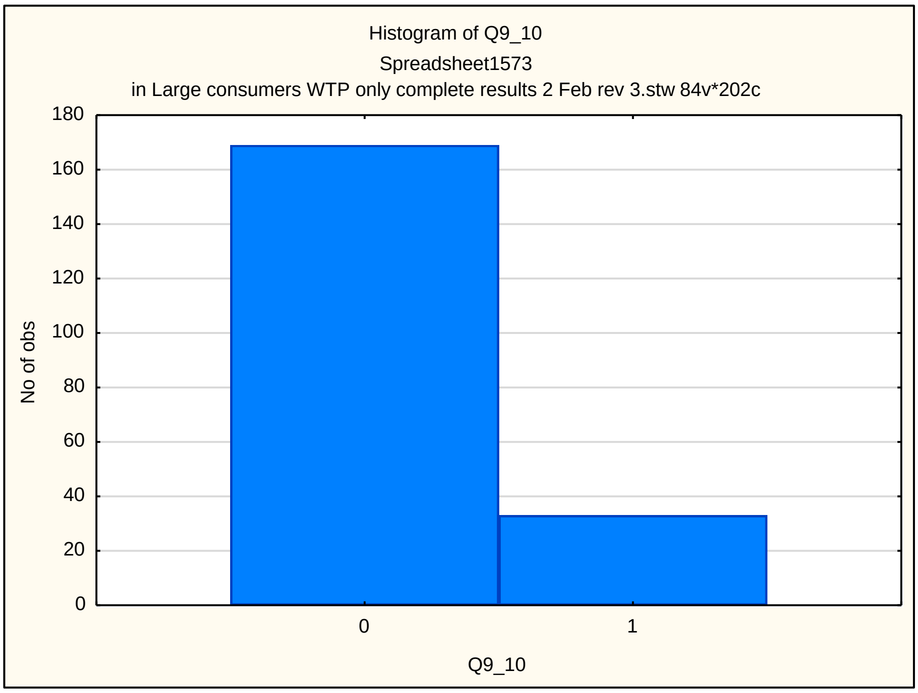
Q9.8. Underground Coal Gasification



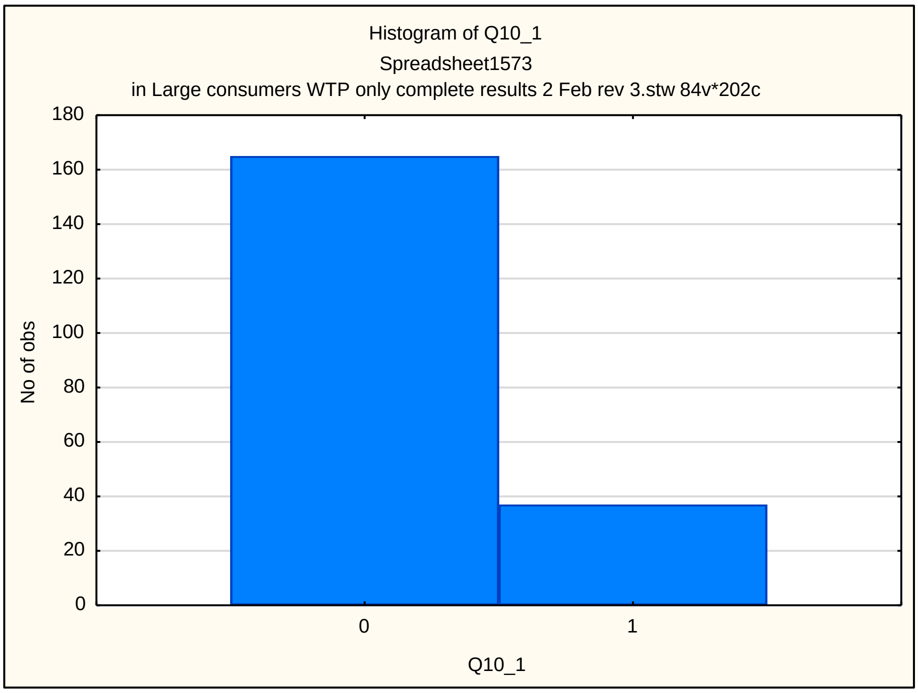
Q9.9. Hybrid plants



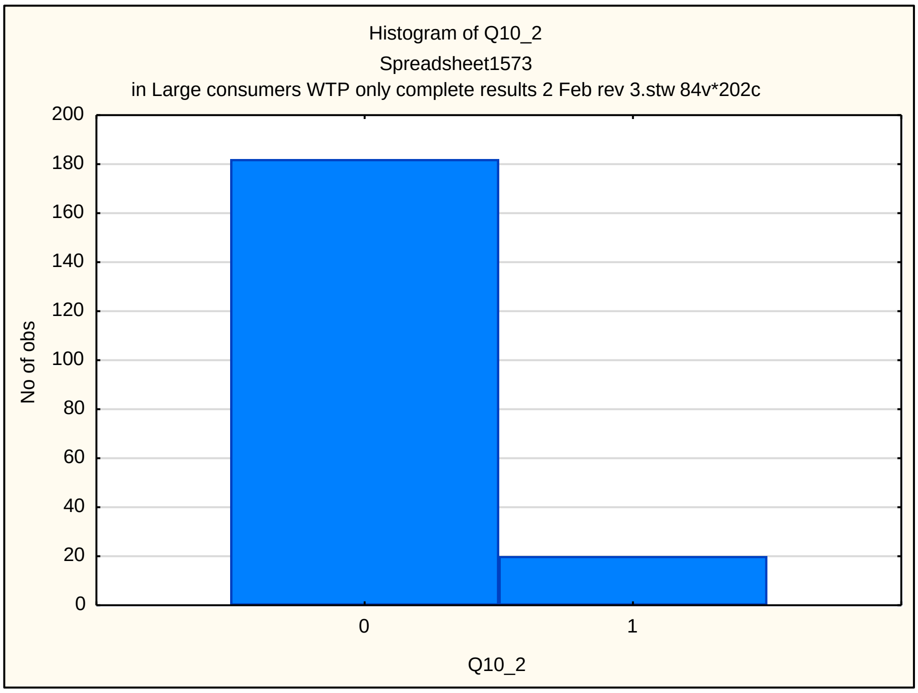
Q9.10. Other technologies



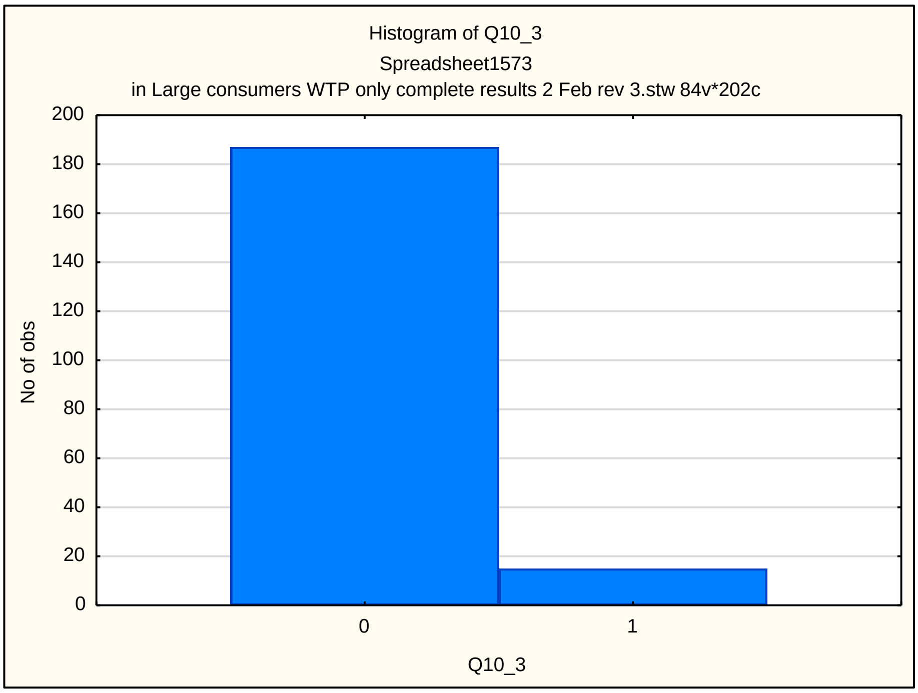
Q10.1. Biomass



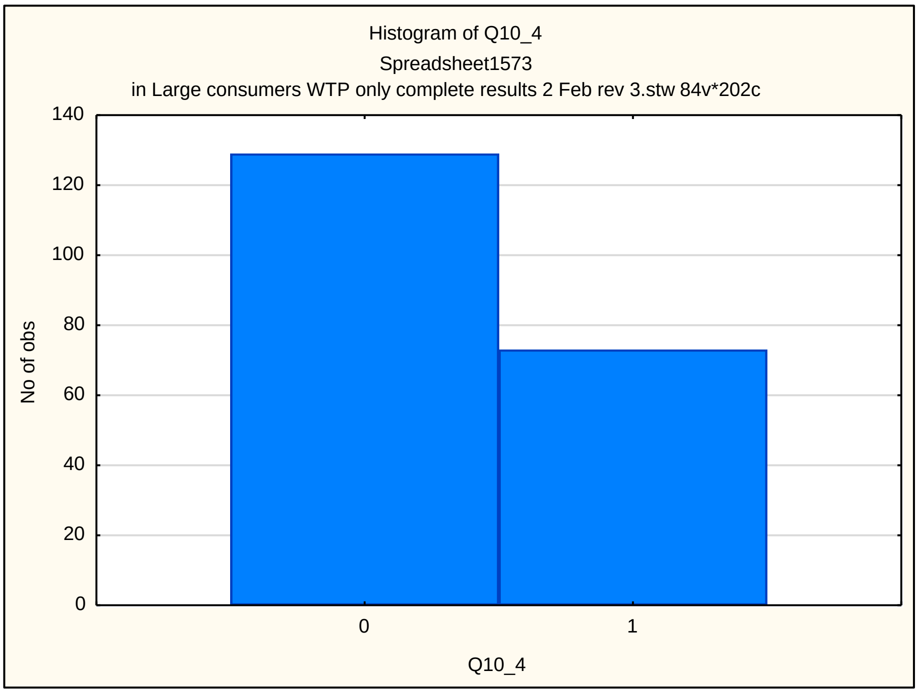
Q10.2. Solid waste



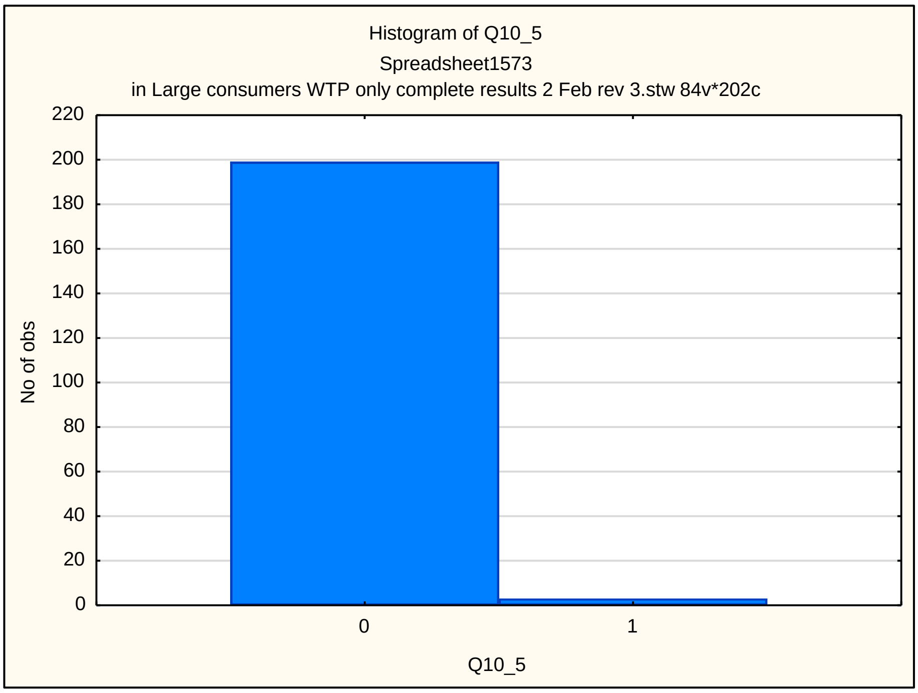
Q10.3. Wind generation



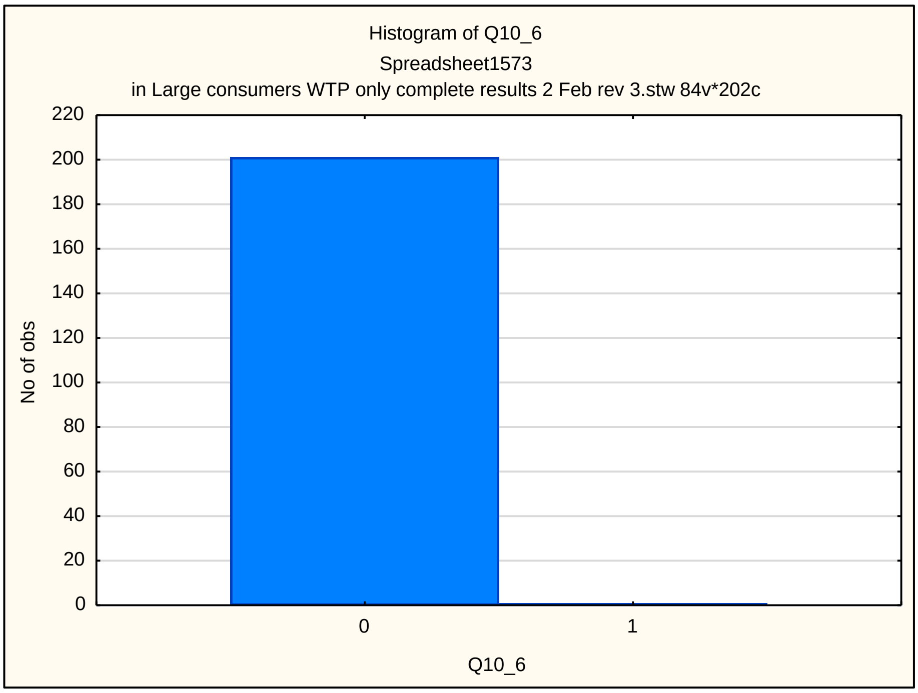
Q10.4. Solar generation



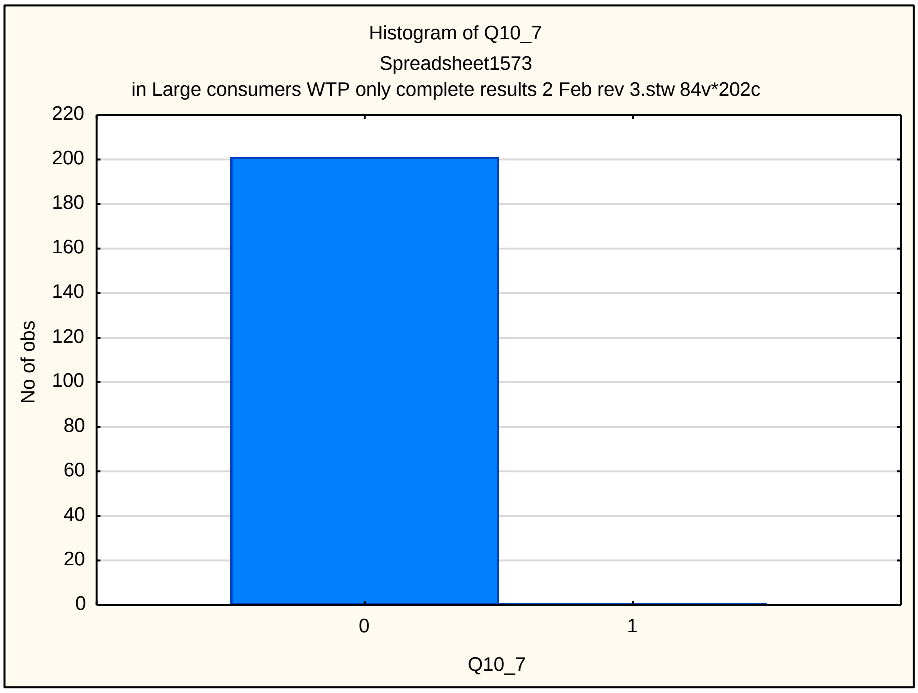
Q10.5. Ocean current



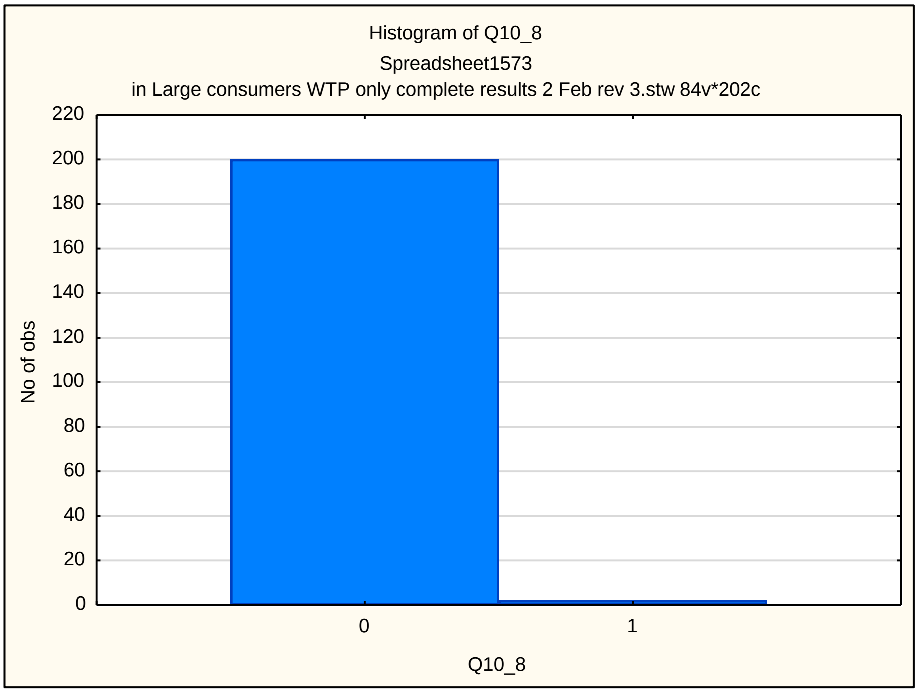
Q10.6. Ocean wave



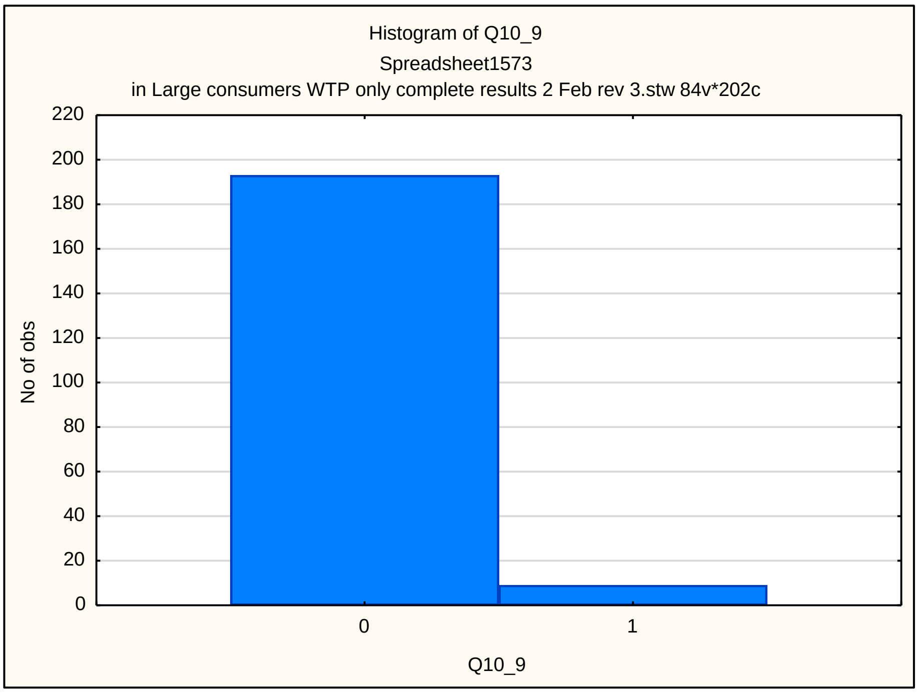
Q10.7. Ocean Pump Storage



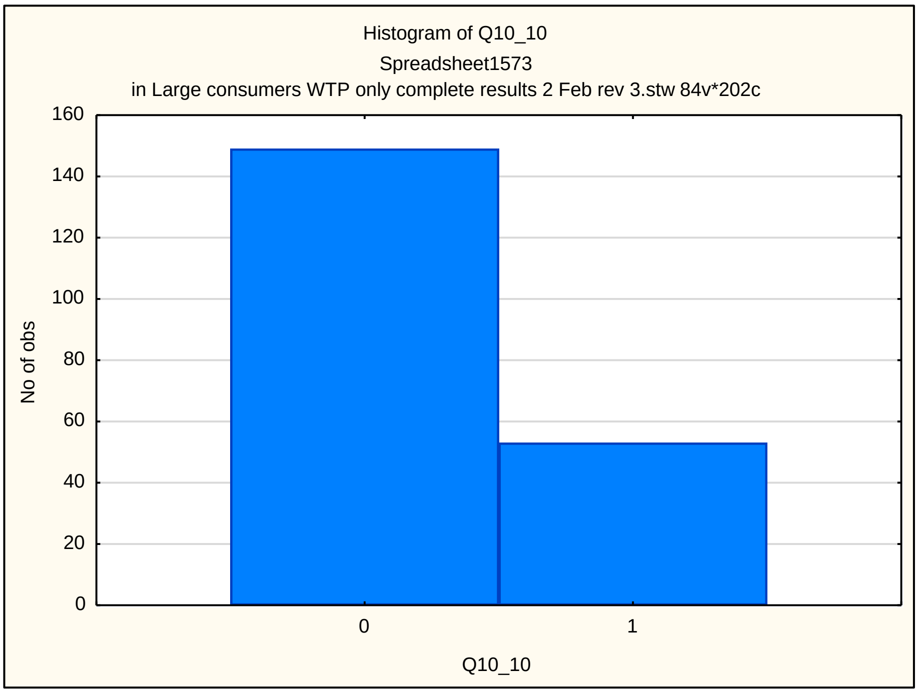
Q10.8. Underground Coal Gasification



Q10.9. Hybrid Plants

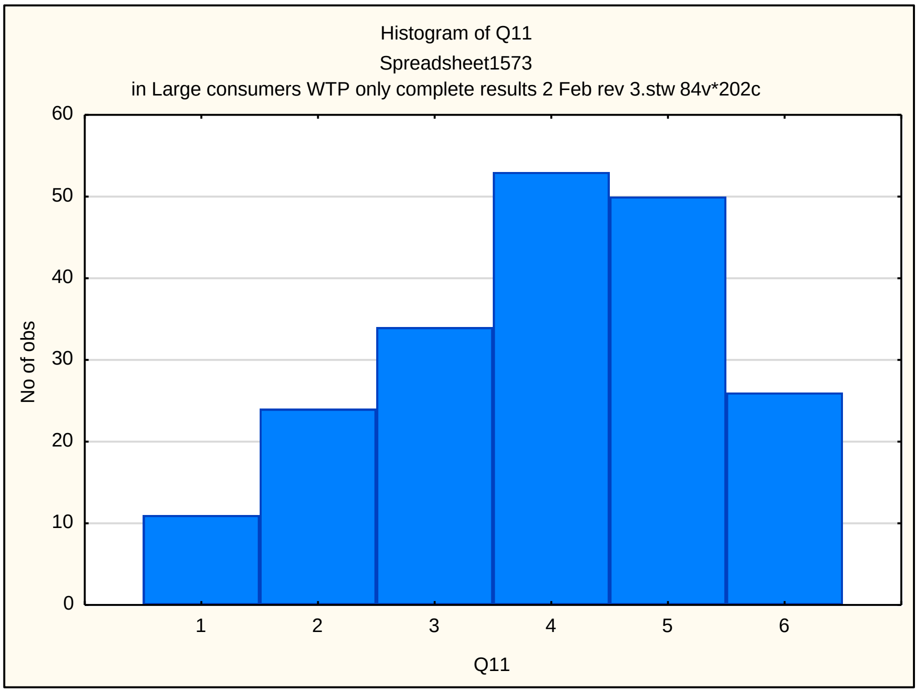


Q10.10. Other technologies

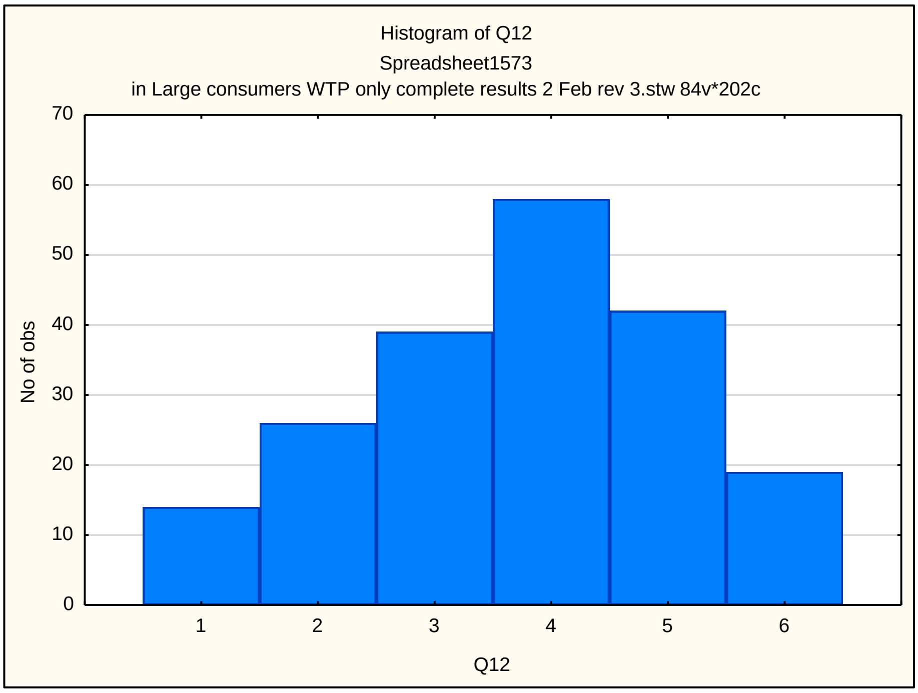


B. WILLINGNESS TO PAY

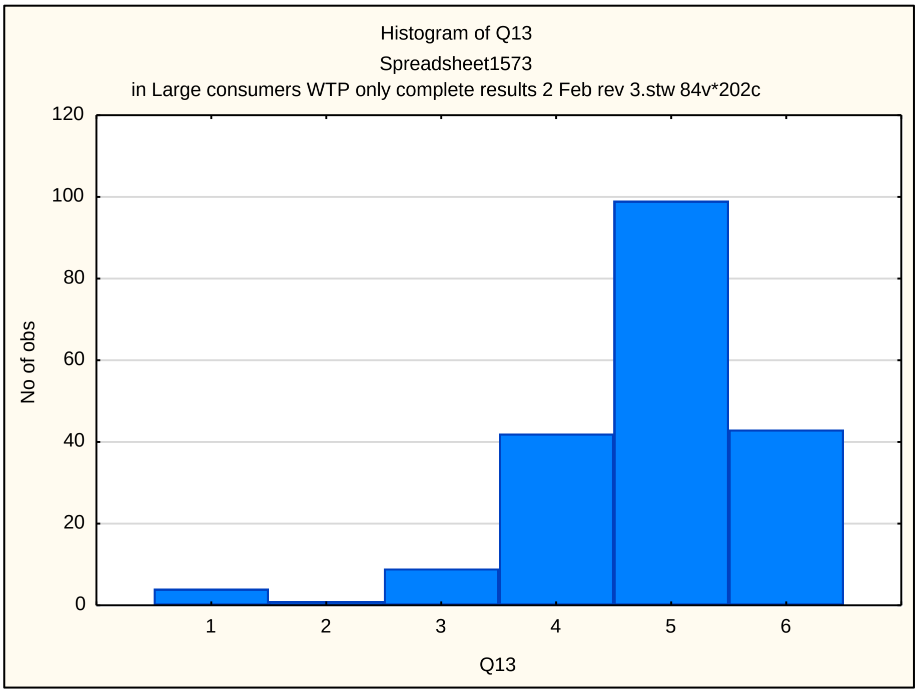
Q11. I can influence the decision to purchase green electricity within the company/organisation



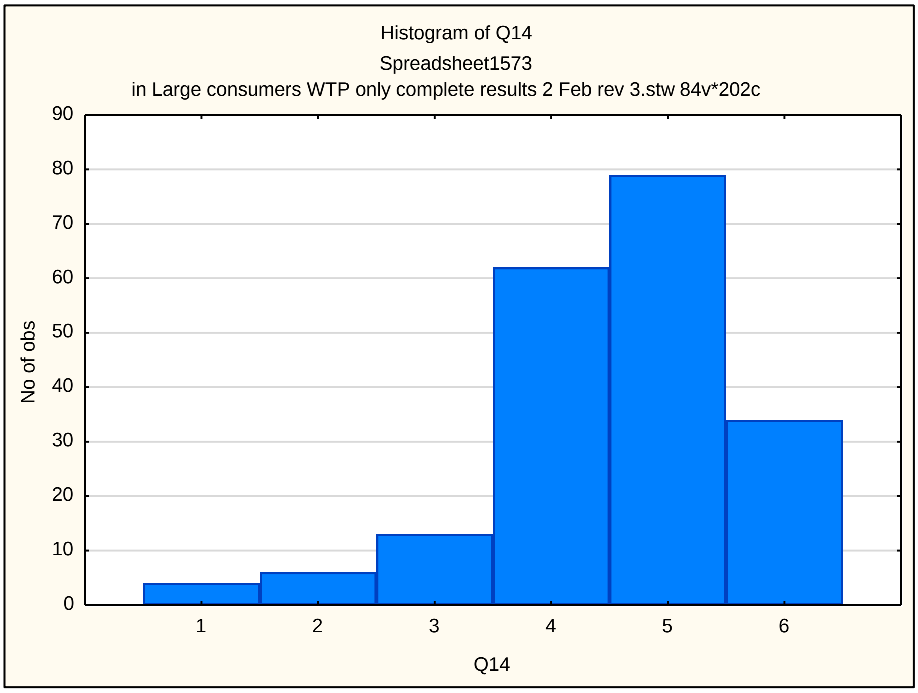
Q12. To what extent will your decision to use premium green electricity be influenced by changes in the level of your company's usage of electricity?



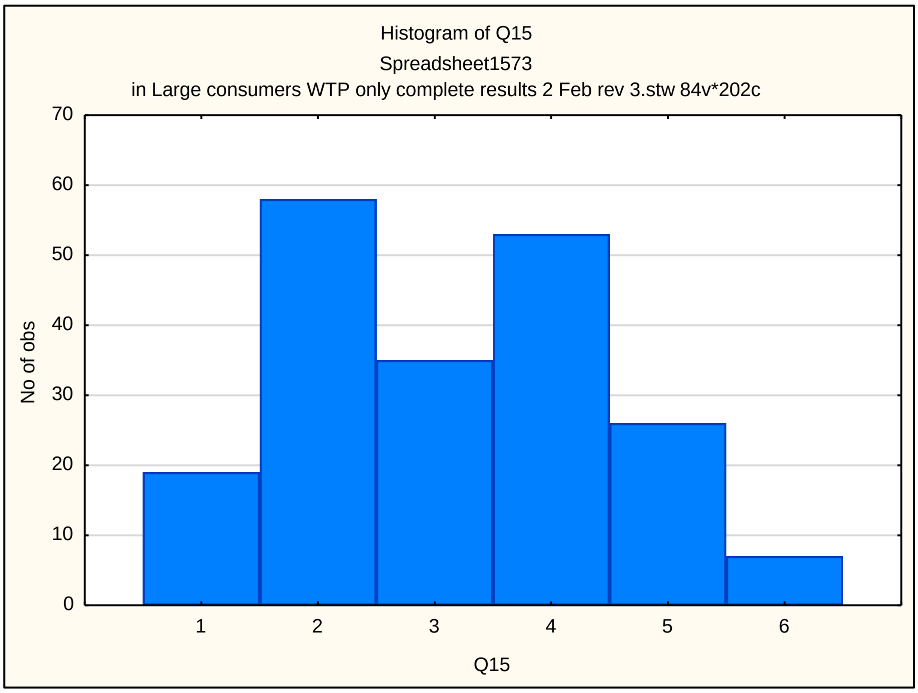
Q13. I define myself as a competitive person



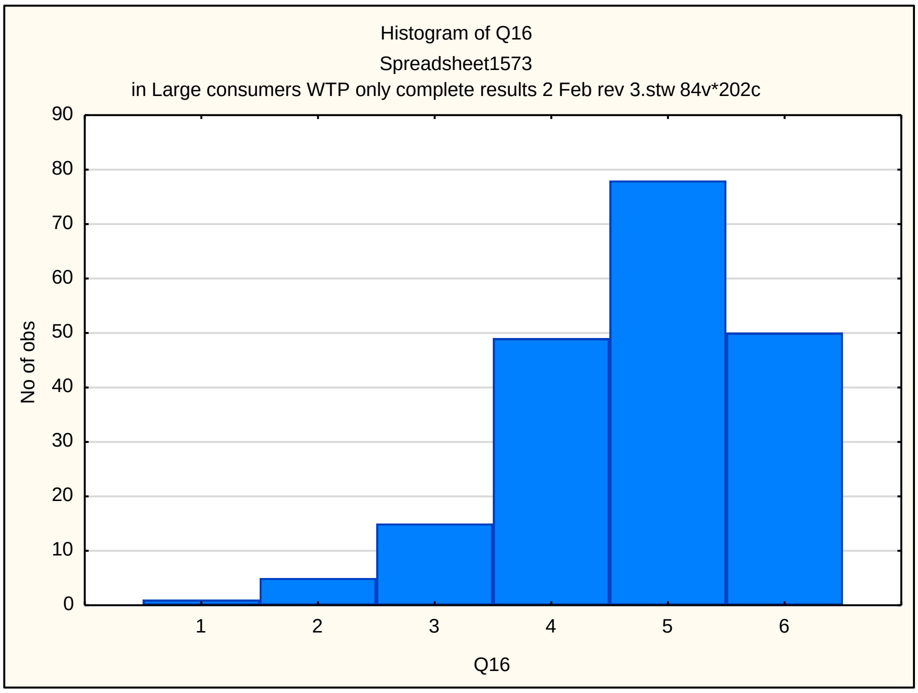
Q14. I enjoy being unique and different from others



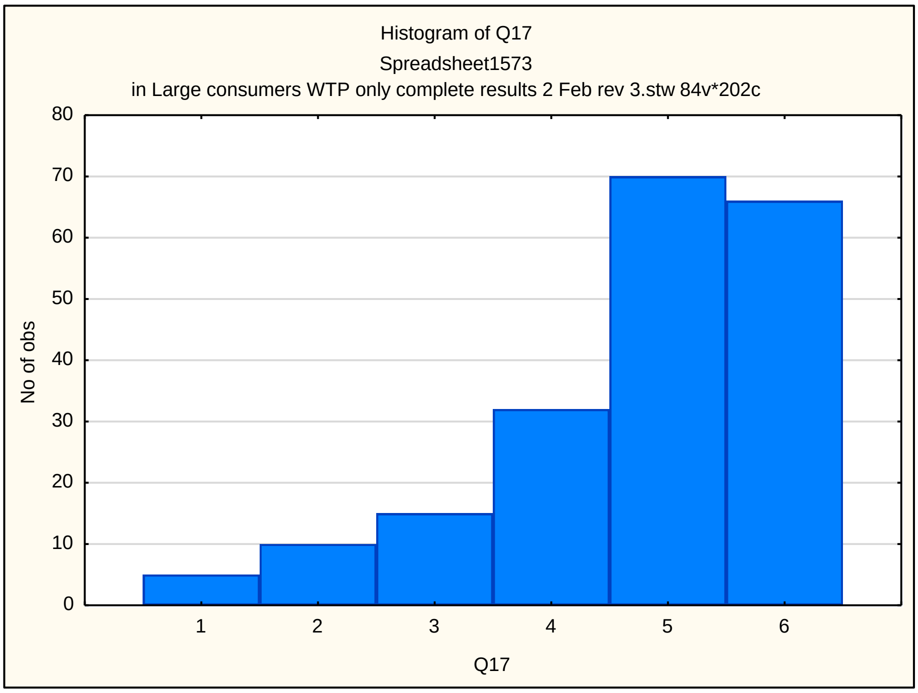
Q15. For me to purchase green electricity is easy



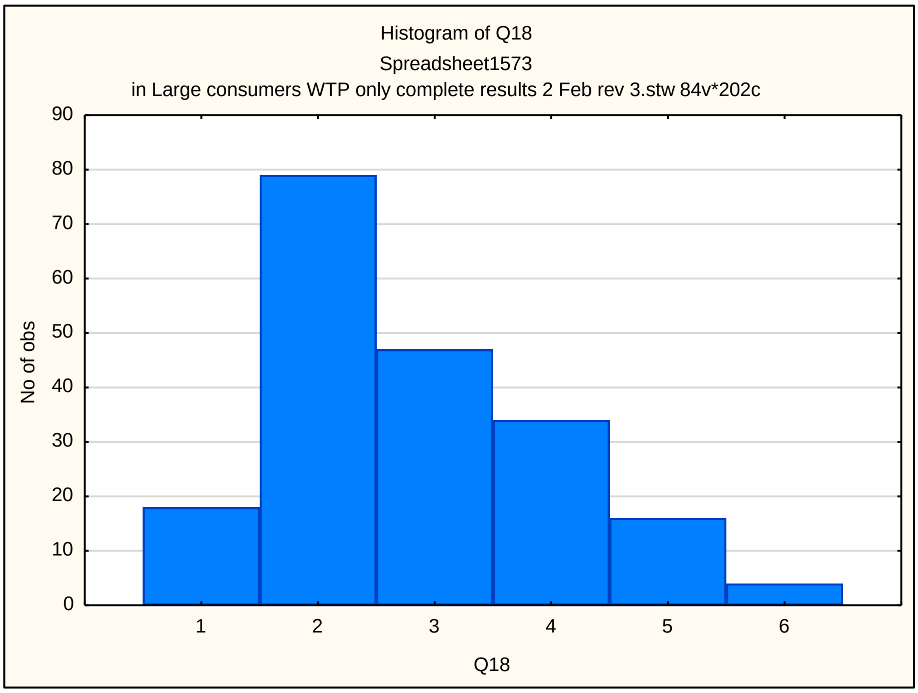
Q16. Before I make a major decision, I seek advice from people close to me



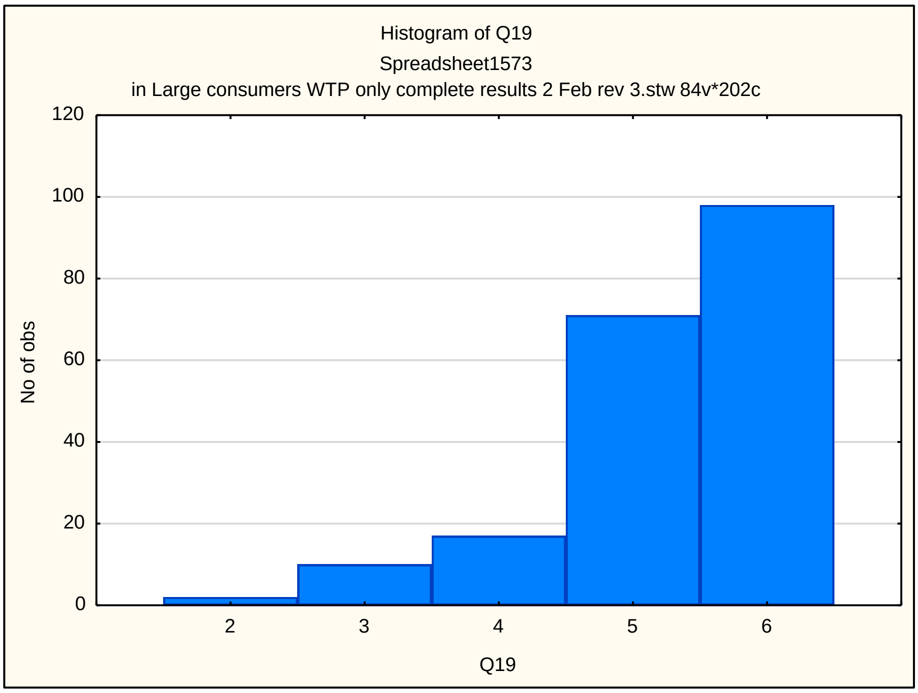
Q17. Using green electricity will enhance my environment



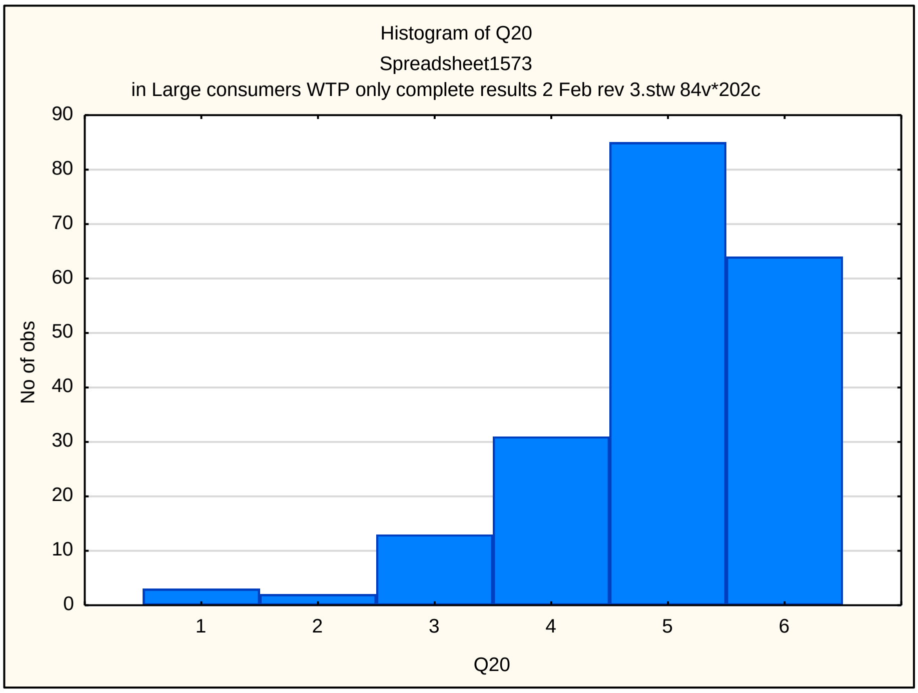
Q18. Even when I strongly disagree with my group members, I avoid an argument



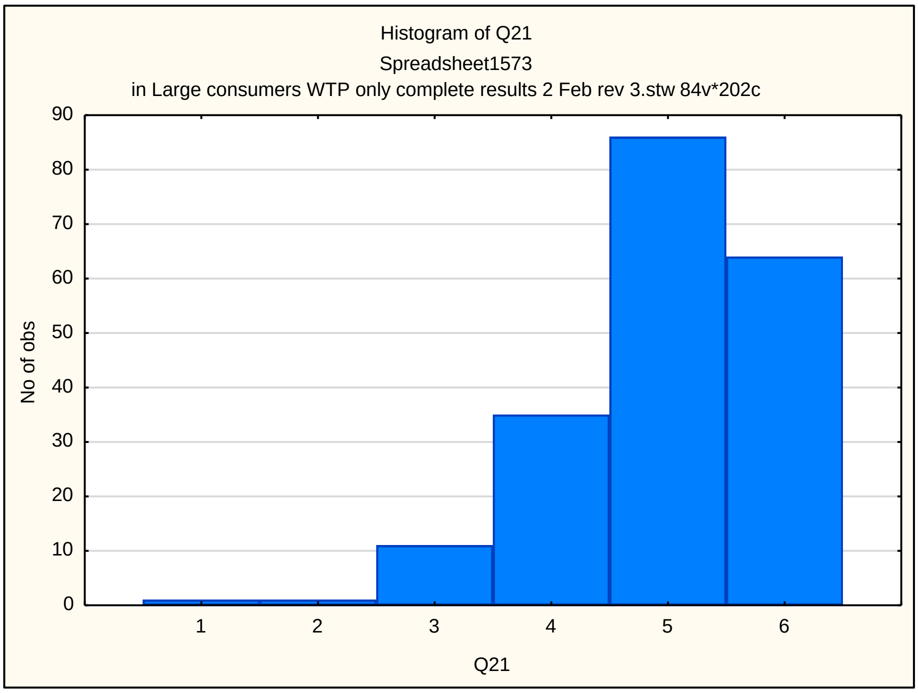
Q19. A high price of green electricity would make my purchasing decision harder



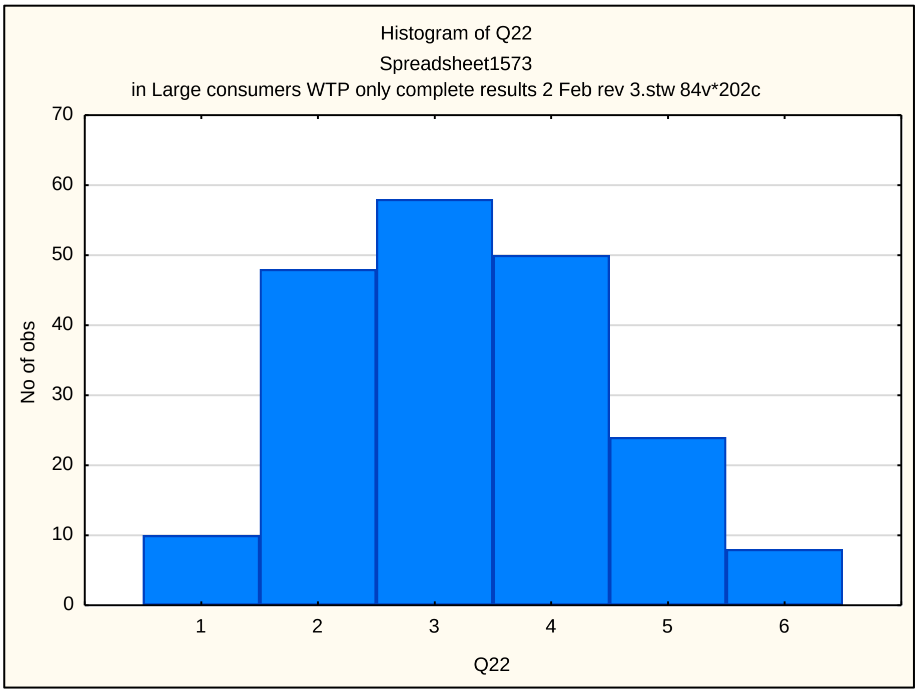
Q20. I consult with superiors/board members on work-related matters



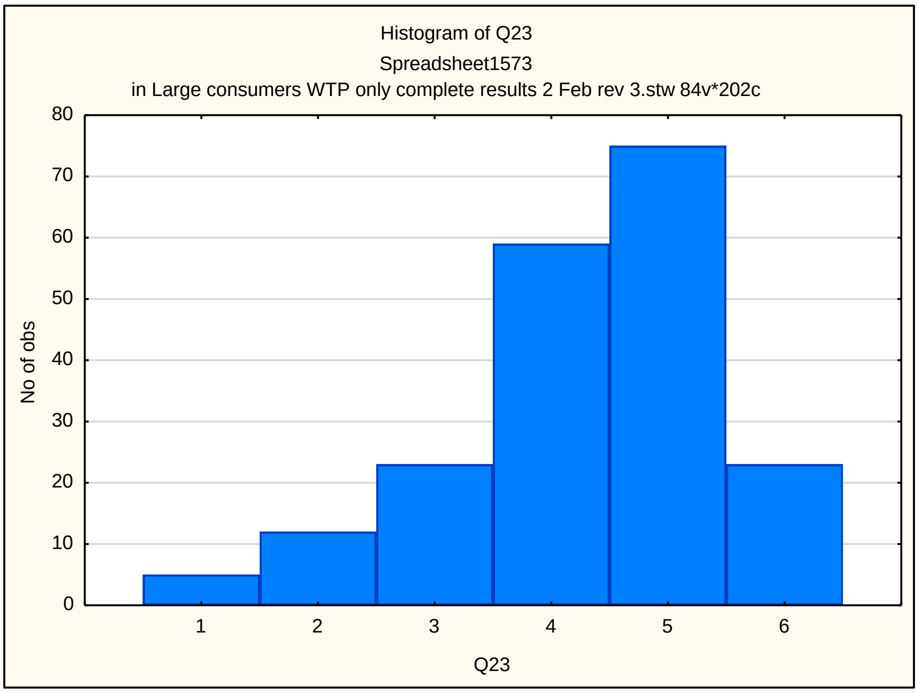
Q21. I believe that competition is a law of nature



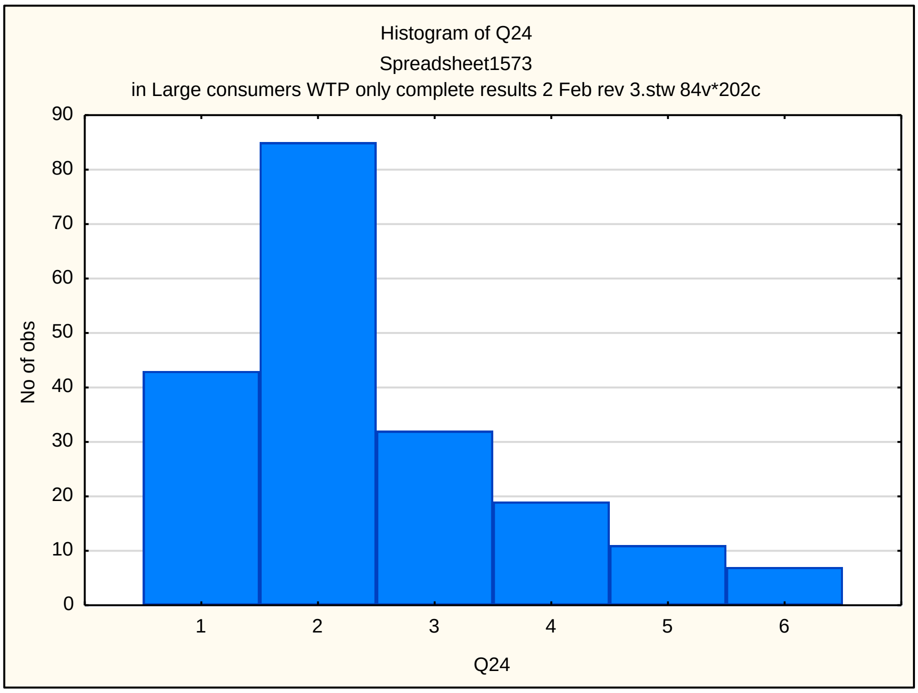
Q22. I believe it is easy to convert to green electricity



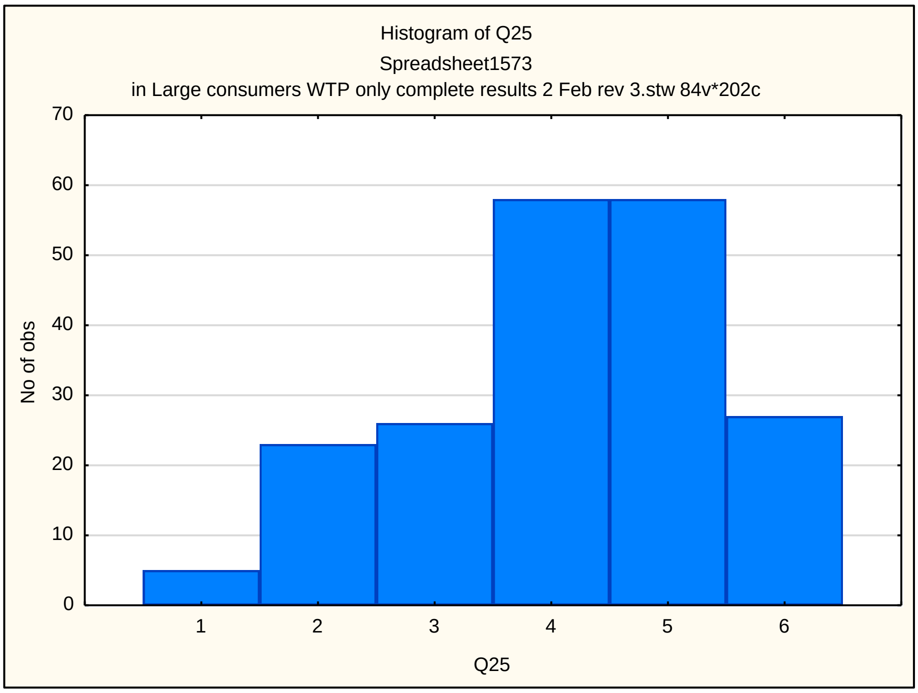
Q23. I prefer competitive rather than non-competitive recreational activities



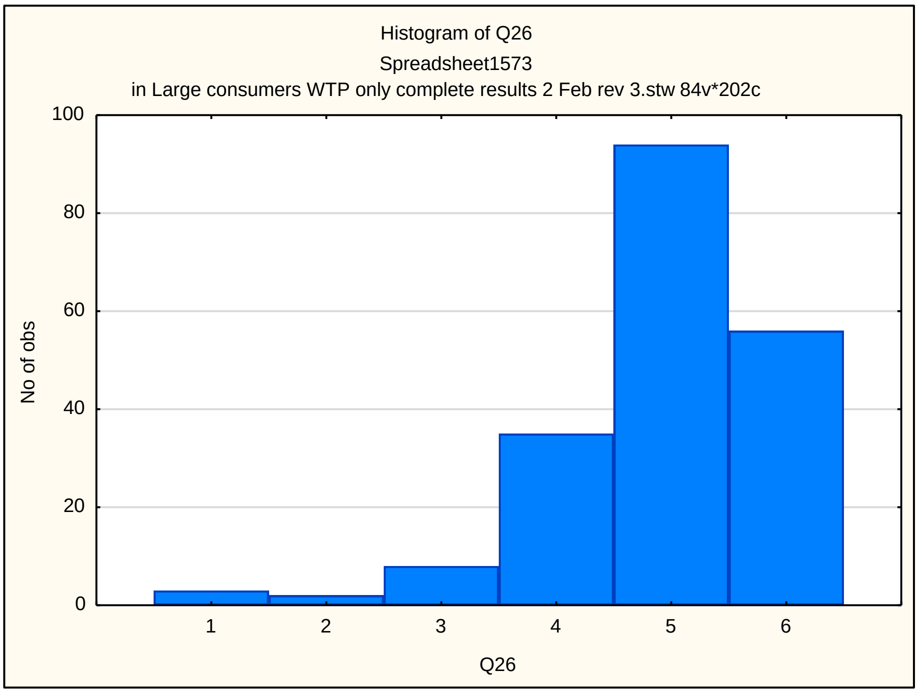
Q24. Reading about green electricity is uninteresting



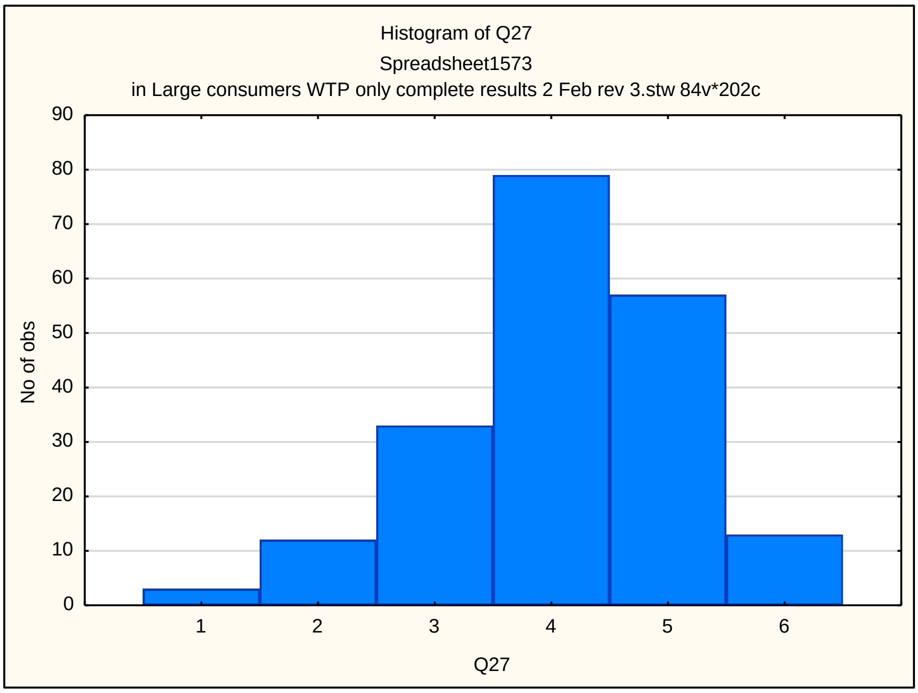
Q25. Before taking a major business trip I consult with my colleagues



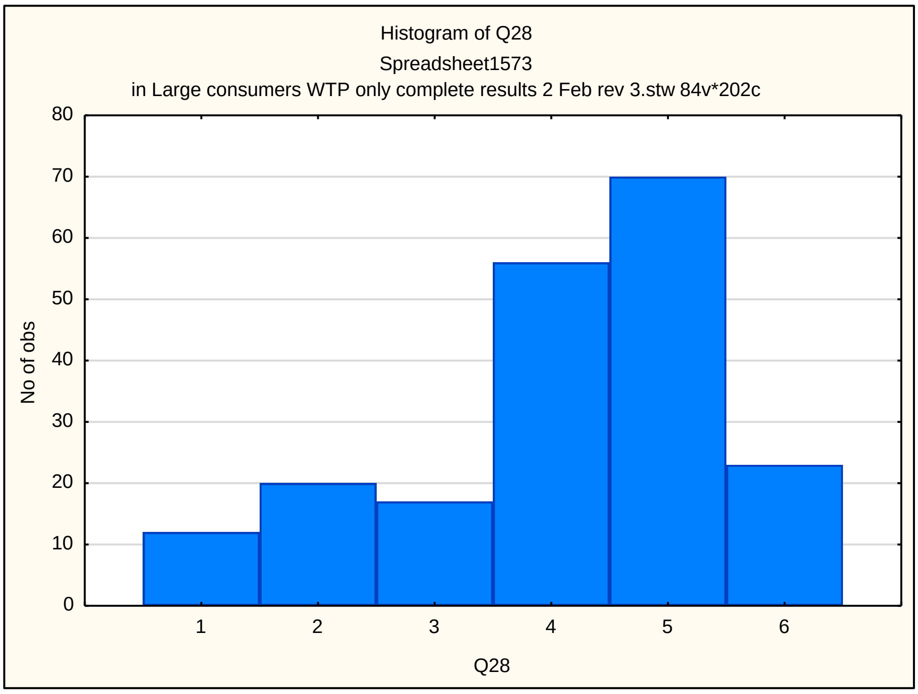
Q26. Green electricity is an interesting subject



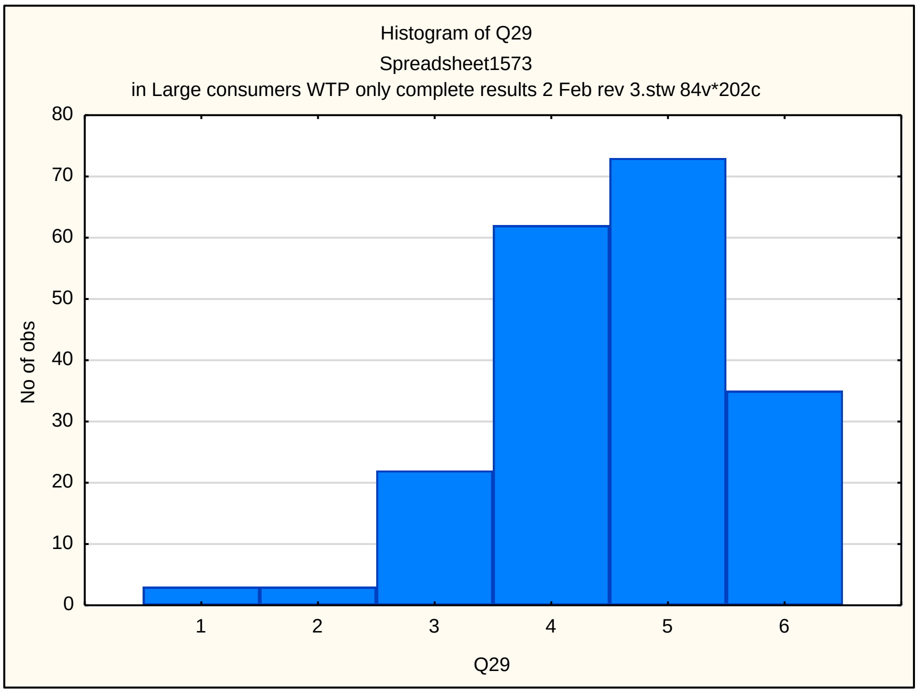
Q27. I sacrifice my self-interest for the benefit of my group



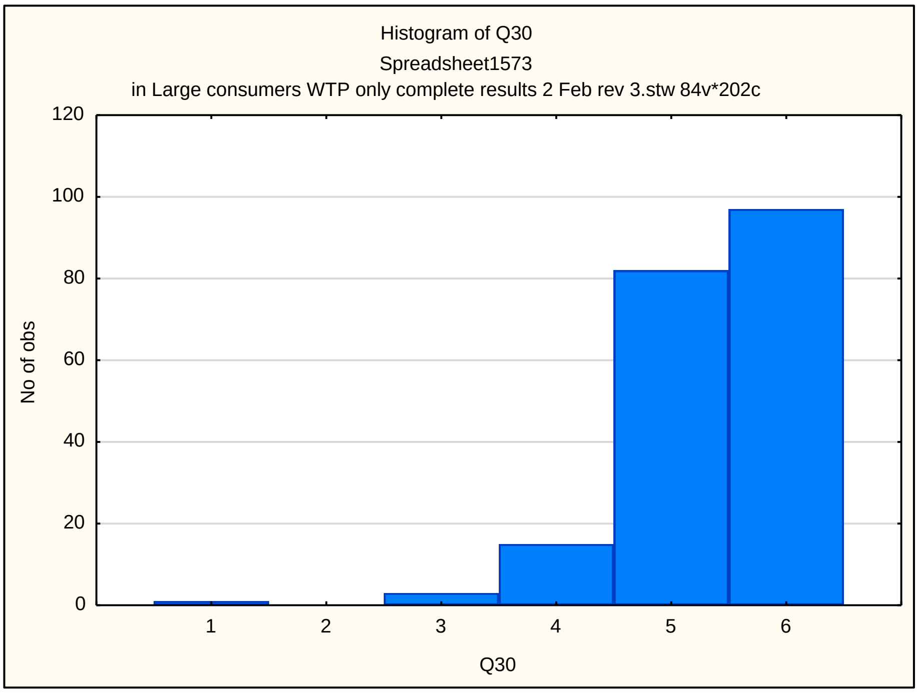
Q28. Specialised support is available to advise me when I need help choosing between green electricity-generating technologies



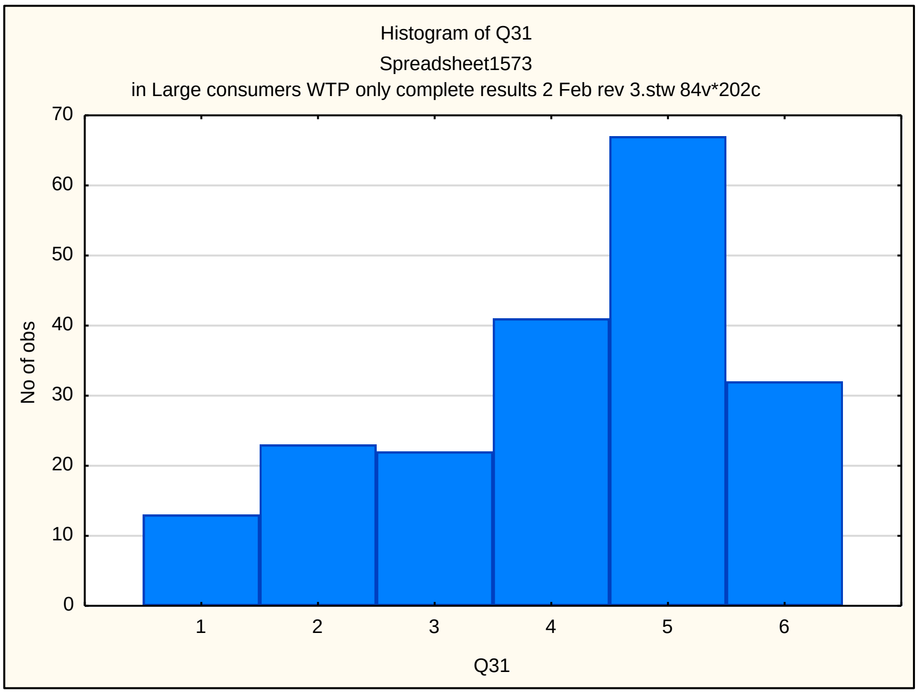
Q29. I consider my colleagues' opinions before taking important actions



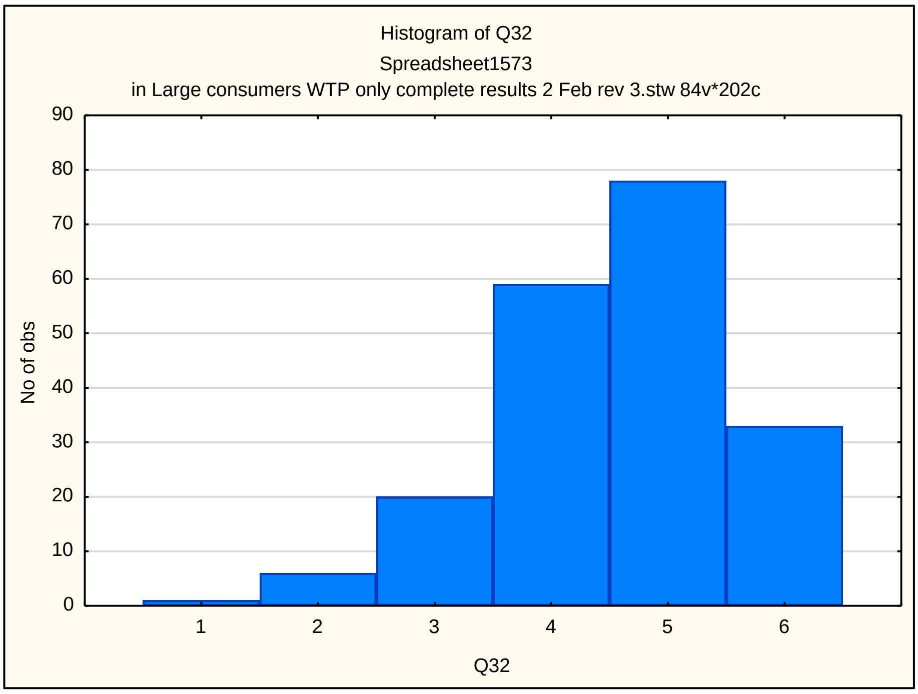
Q30. I like to be accurate when I communicate



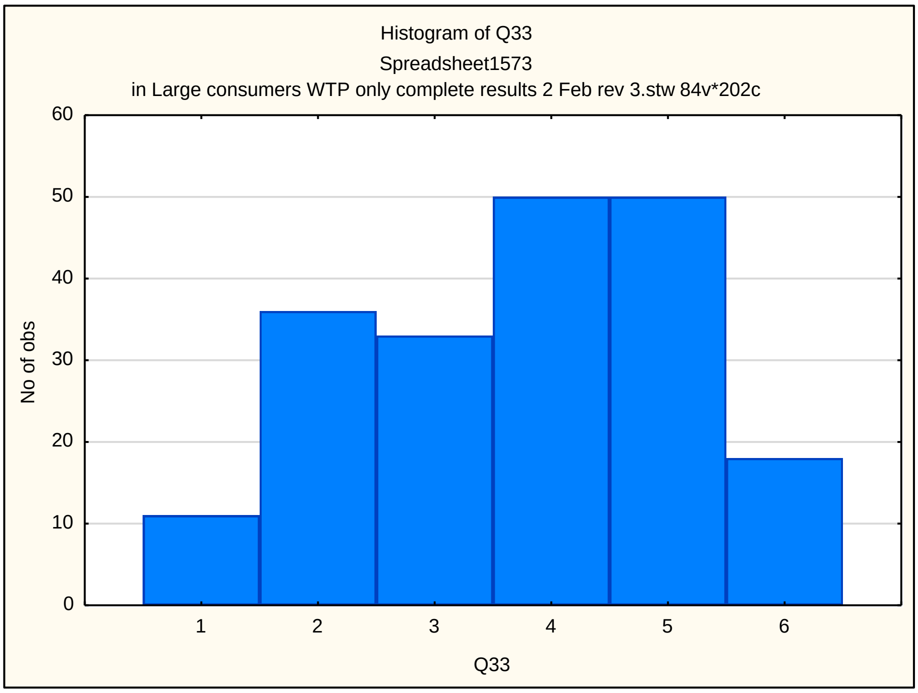
Q31. Specialised support is available to help me when I need help implementing a green electricity procurement strategy



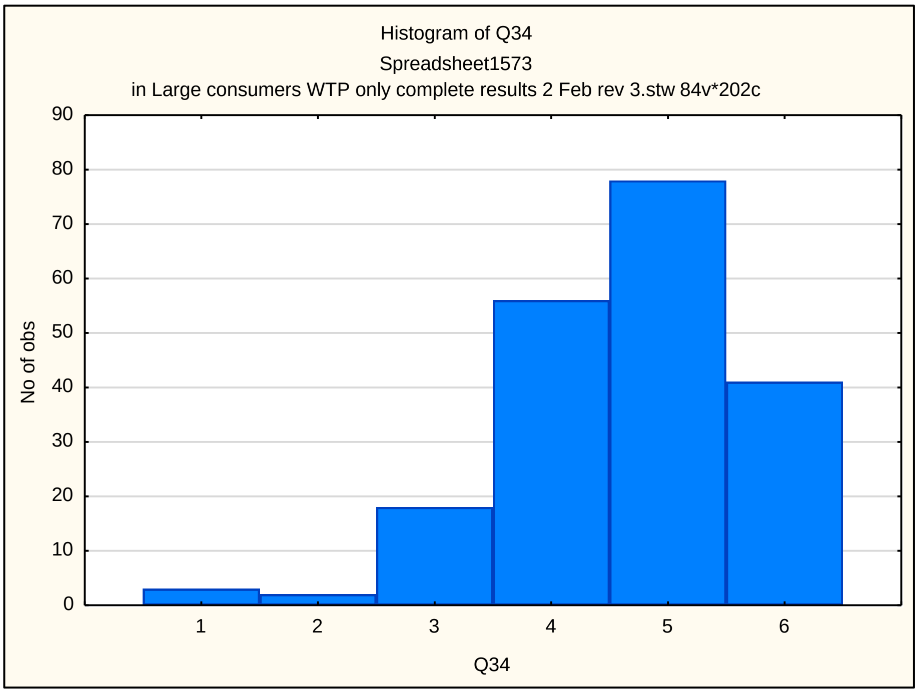
Q32. I consider myself to be a unique person who does not follow the crowd



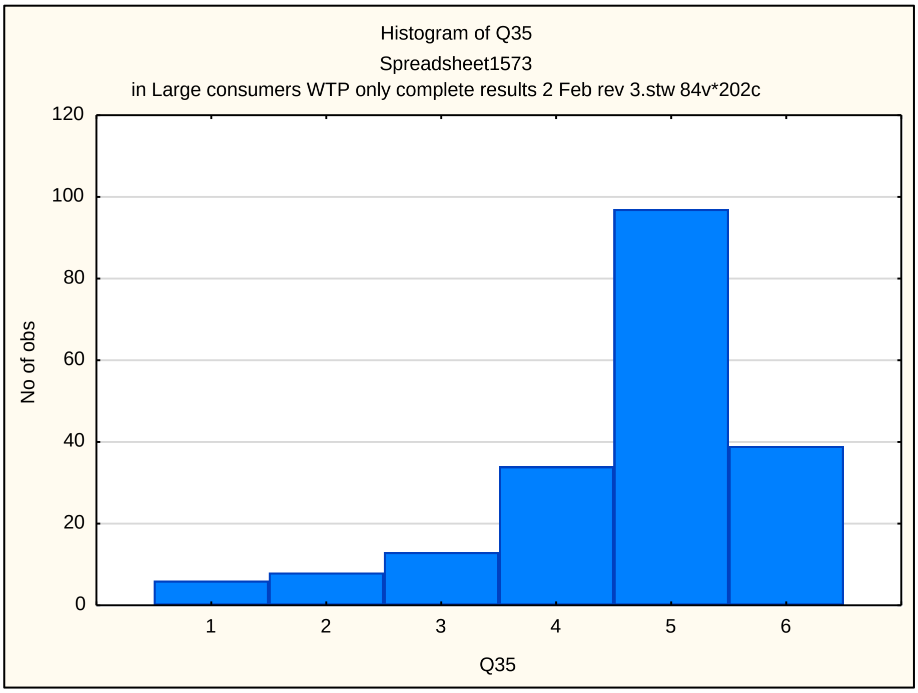
Q33. It is expected of me to support the purchase of green electricity



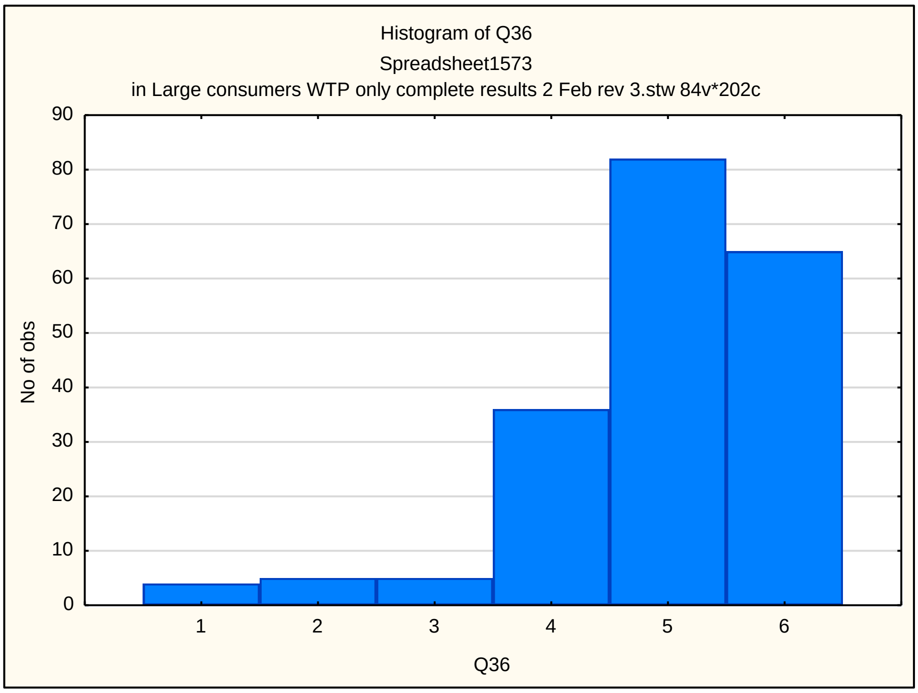
Q34. It is important to consult colleagues and get their ideas before making a decision



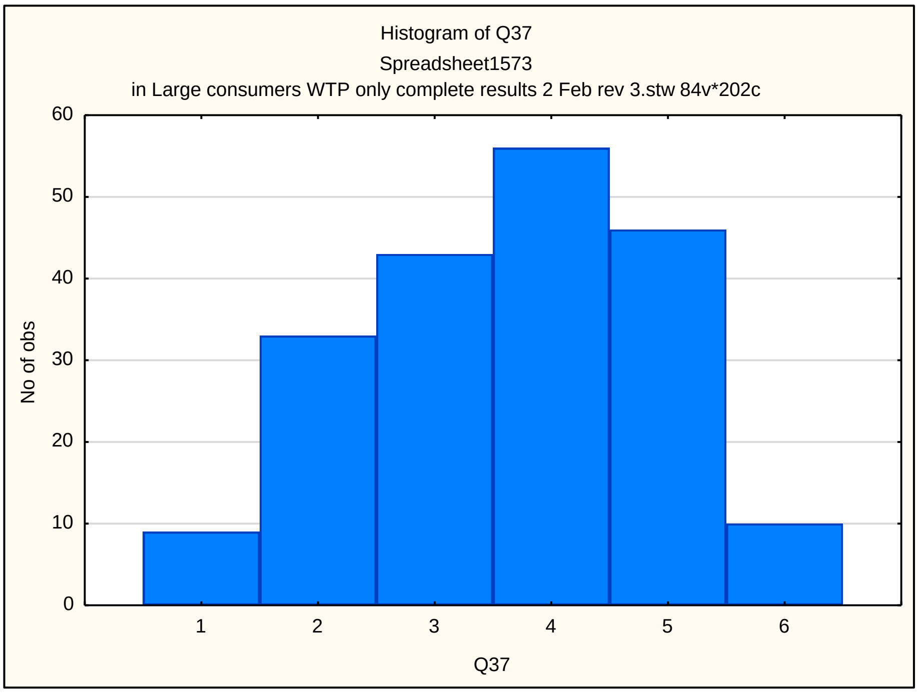
Q35. I believe it would not be possible to have a good society without competition



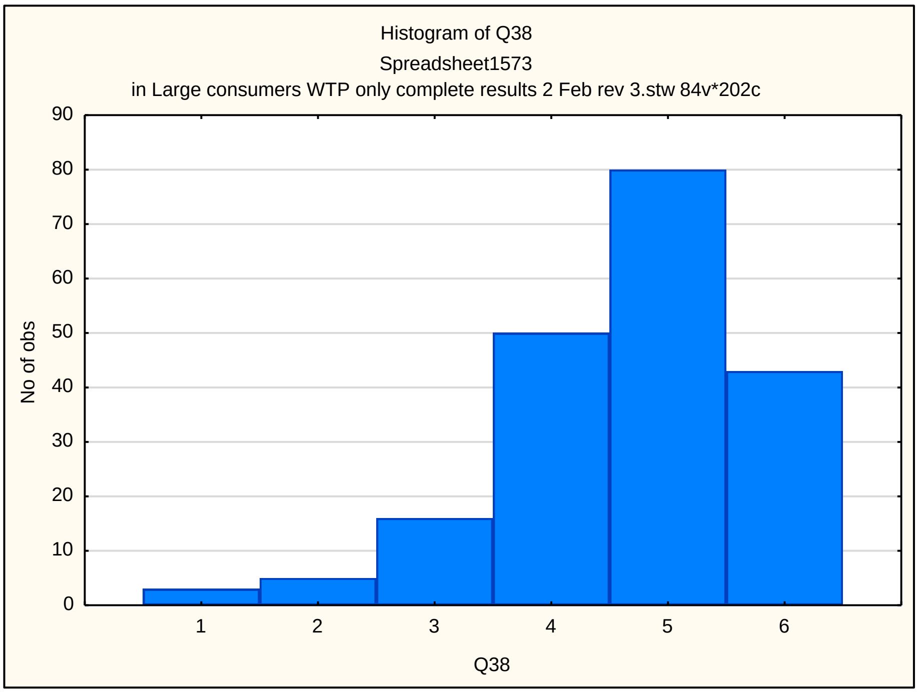
Q36. I support the use of green electricity



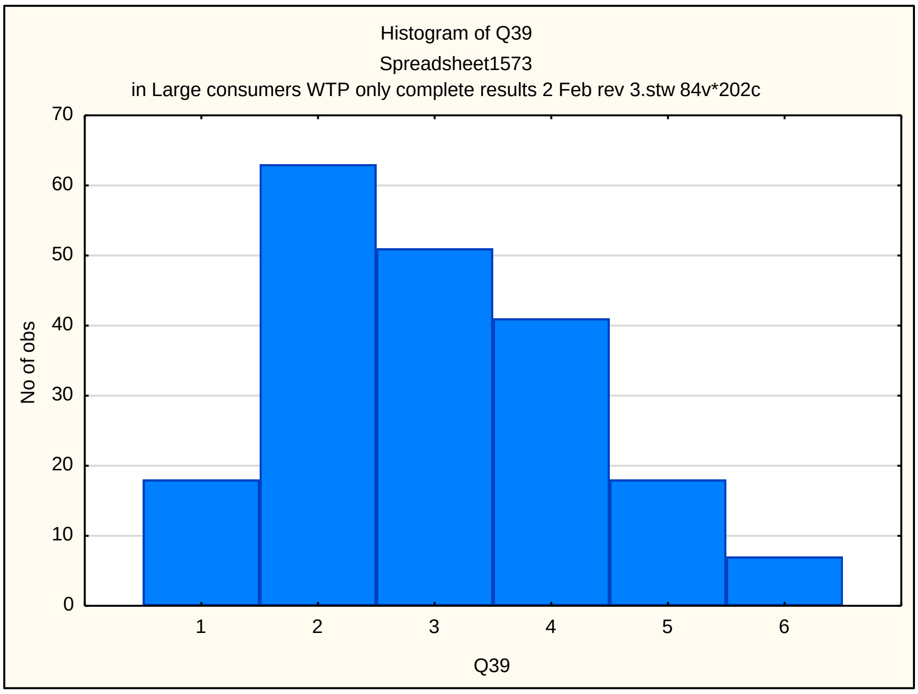
Q37. I ask the advice of friends and colleagues before making career related decisions



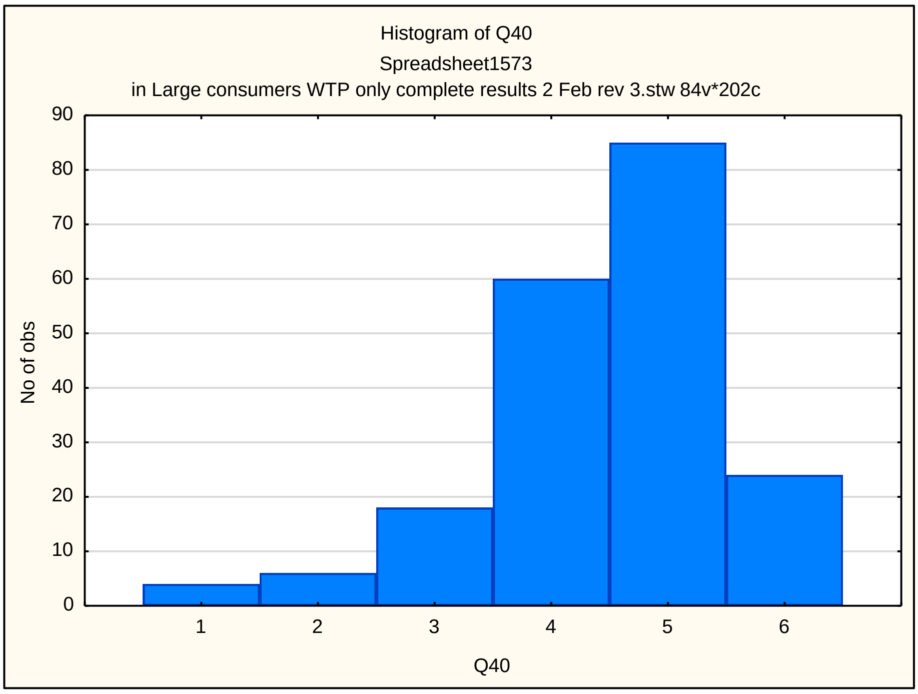
Q38. Using green electricity will increase the quality of life



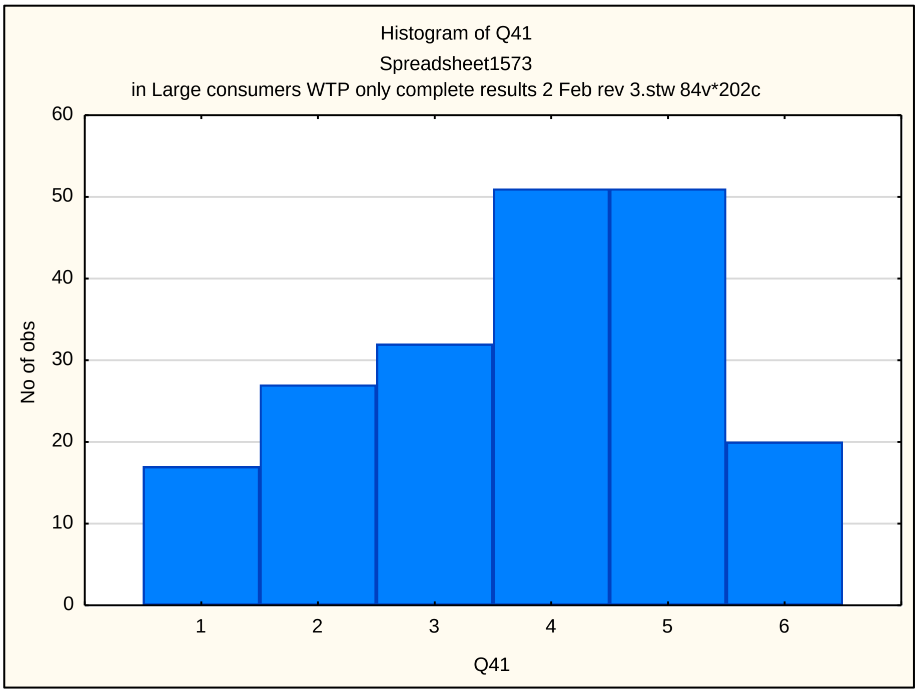
Q39. I prefer using indirect language rather than upsetting my colleagues by telling them directly what they may not like to hear



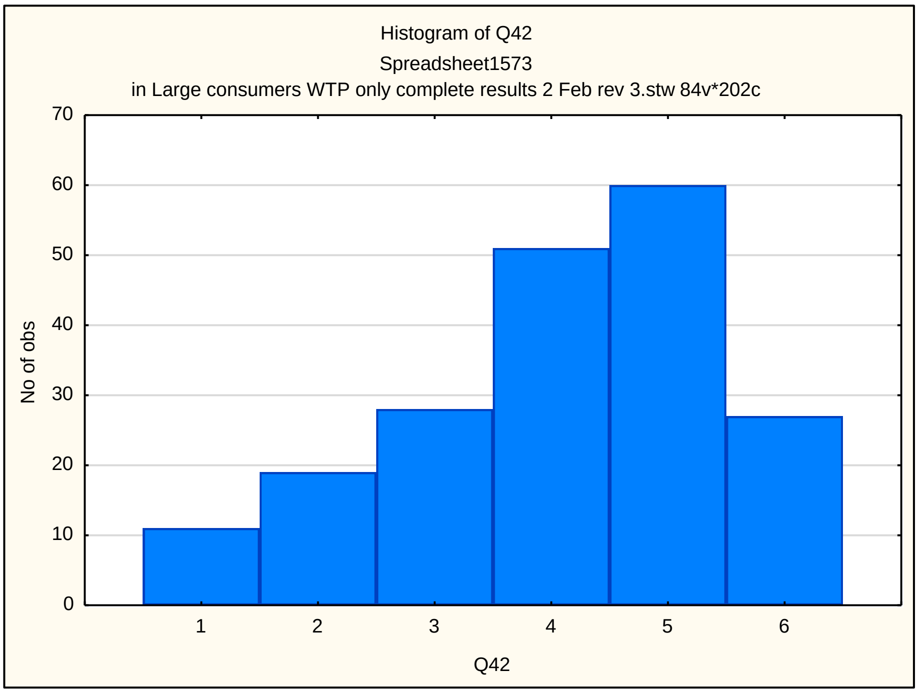
Q40. It is important for me to act as an independent person



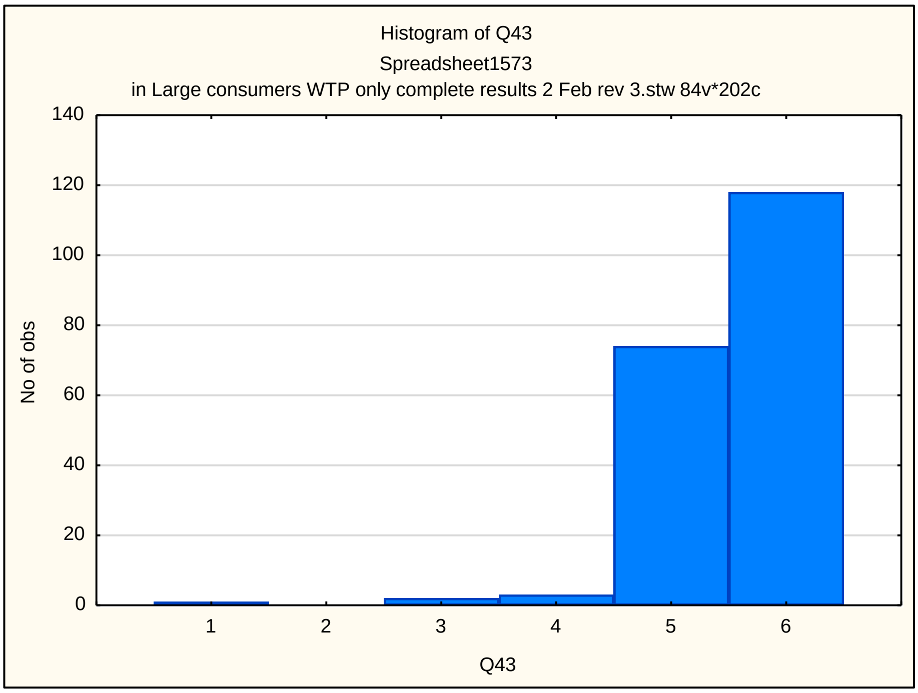
Q41. I expect to pay a premium for green electricity



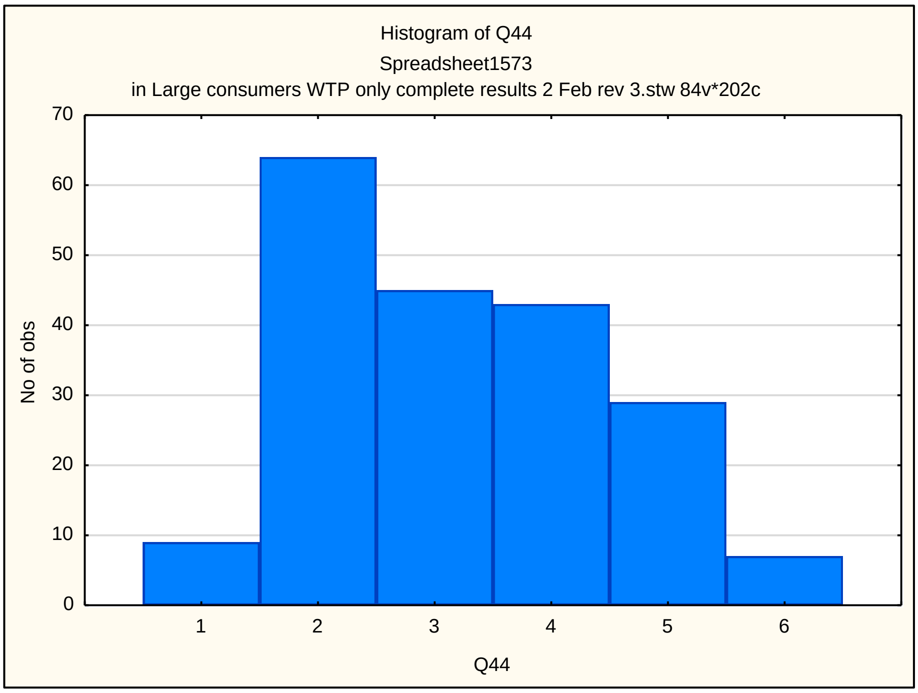
Q42. I discuss job or study-related problems with my parents/partner



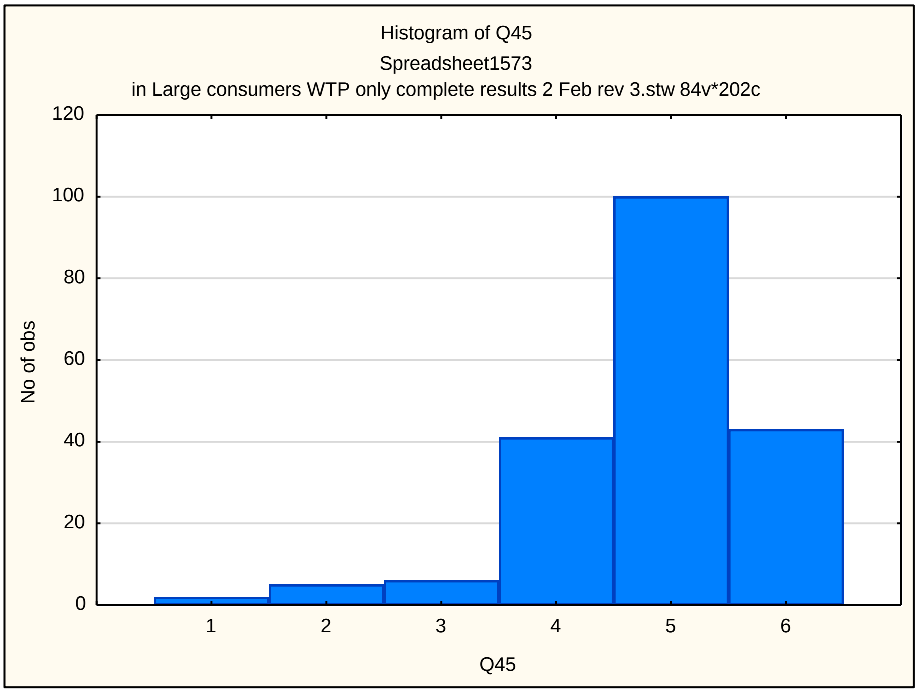
Q43. I take responsibility for my own actions



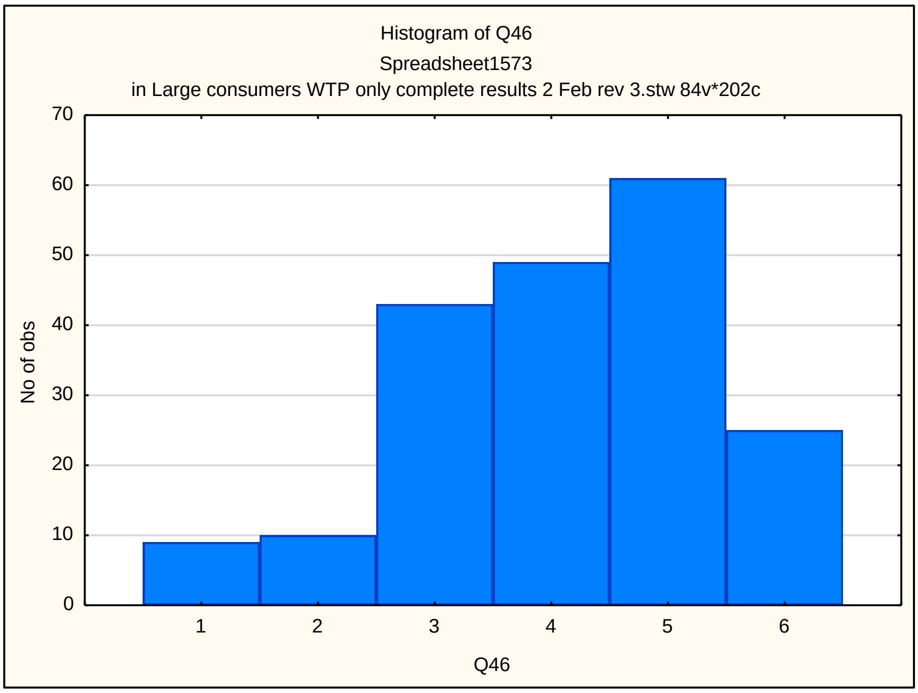
Q44. I do not reveal my thoughts when it might initiate a dispute



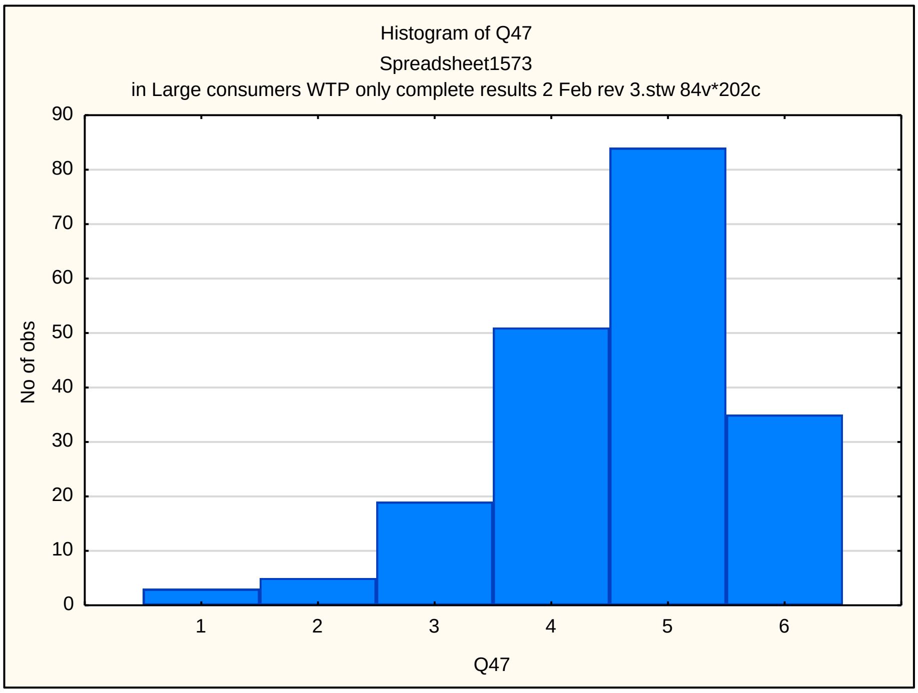
Q45. I try to achieve better results than my peers



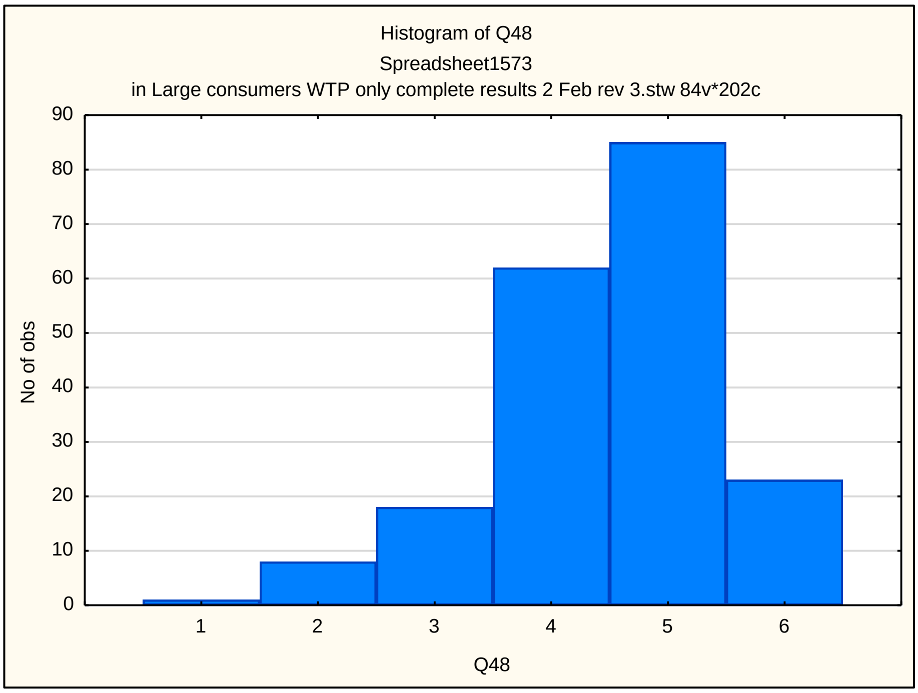
Q46. I find green electricity difficult to procure



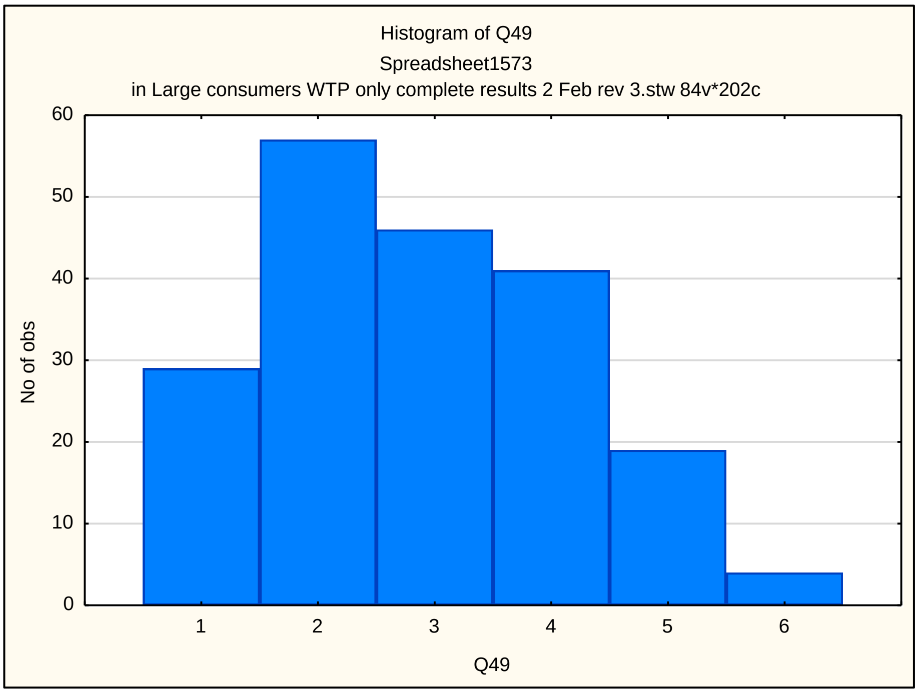
Q47. My personal identity independent of others is very important to me



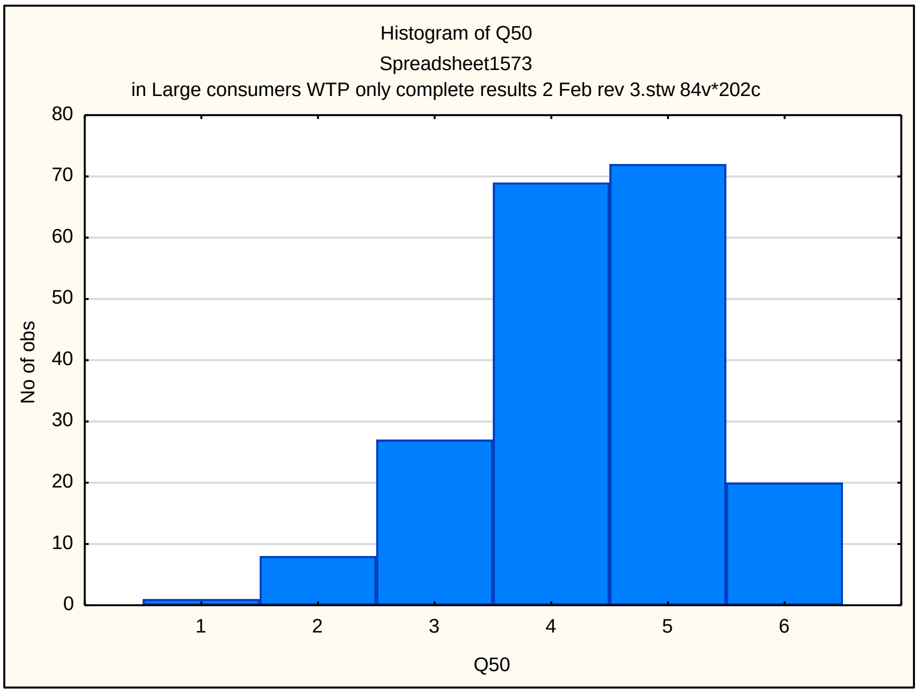
Q48. I enjoy working in situations involving competition with others



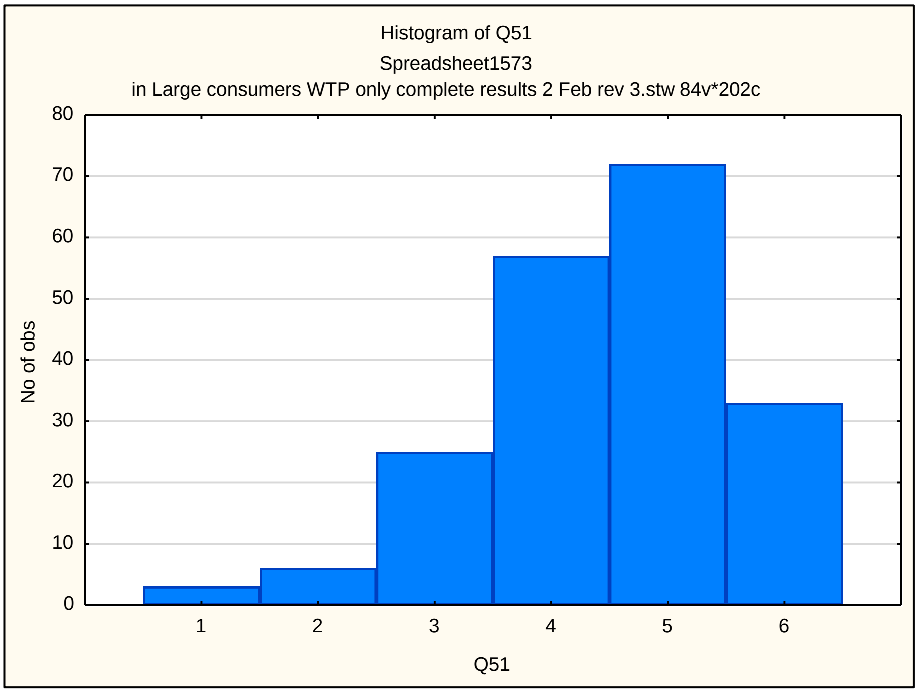
Q49. I feel under social pressure to purchase green electricity



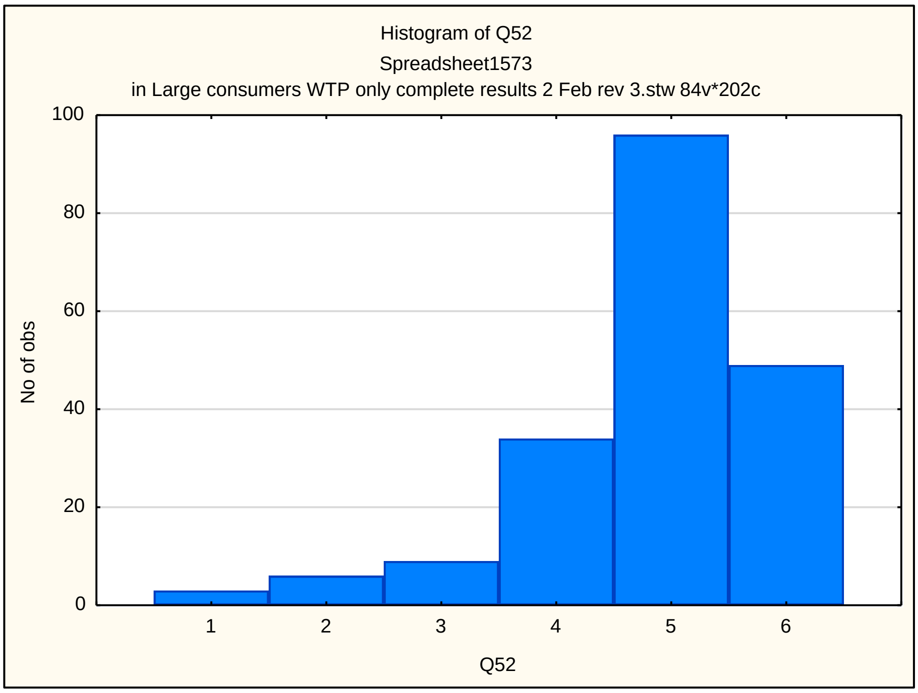
Q50. I consult my colleagues before making an important decision



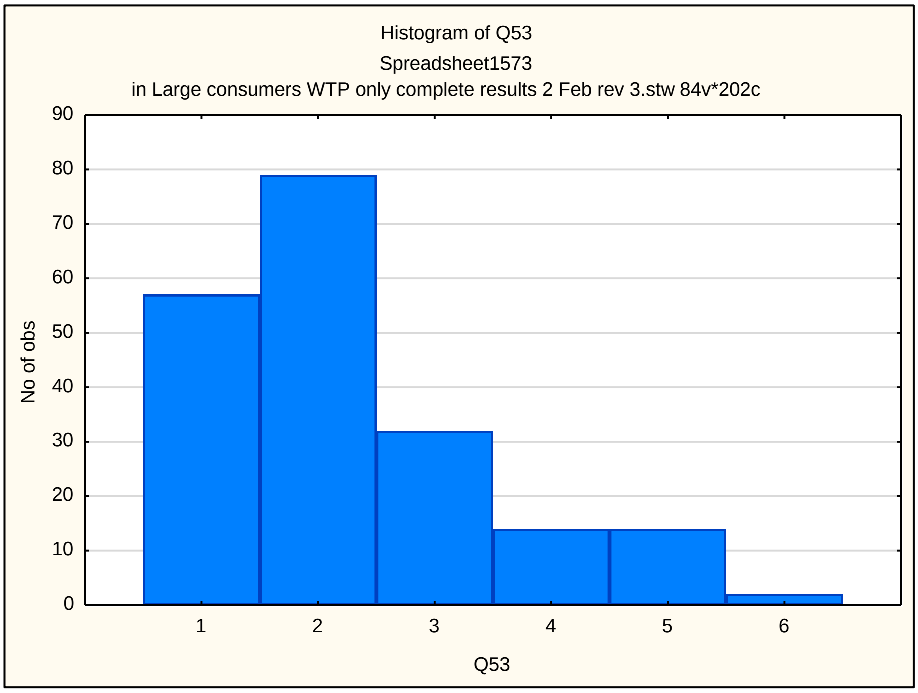
Q51. Winning is very important to me



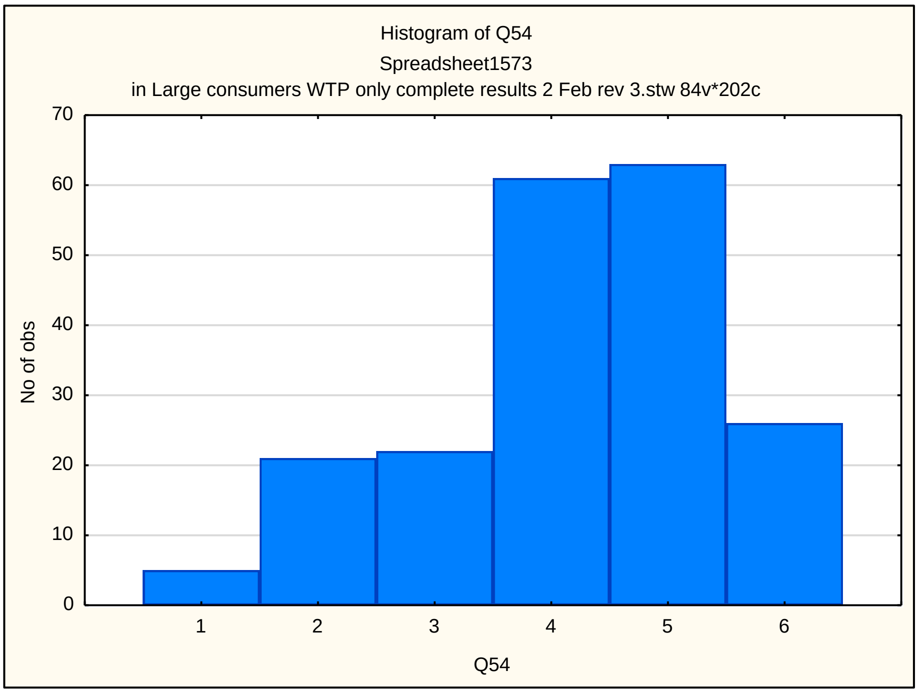
Q52. I see myself as 'my own person'



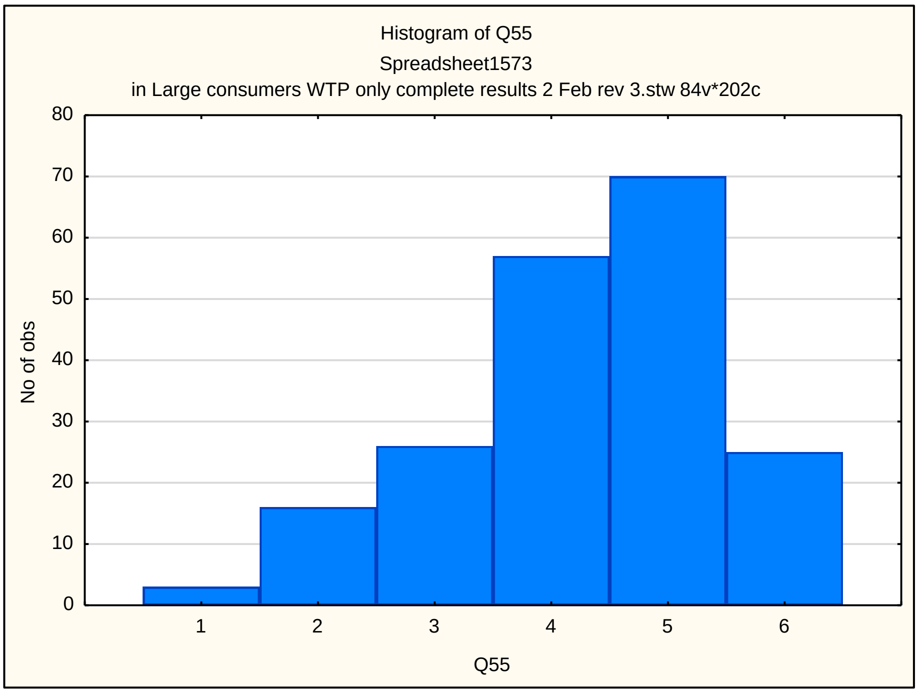
Q53. Using green electricity is not going to make a difference



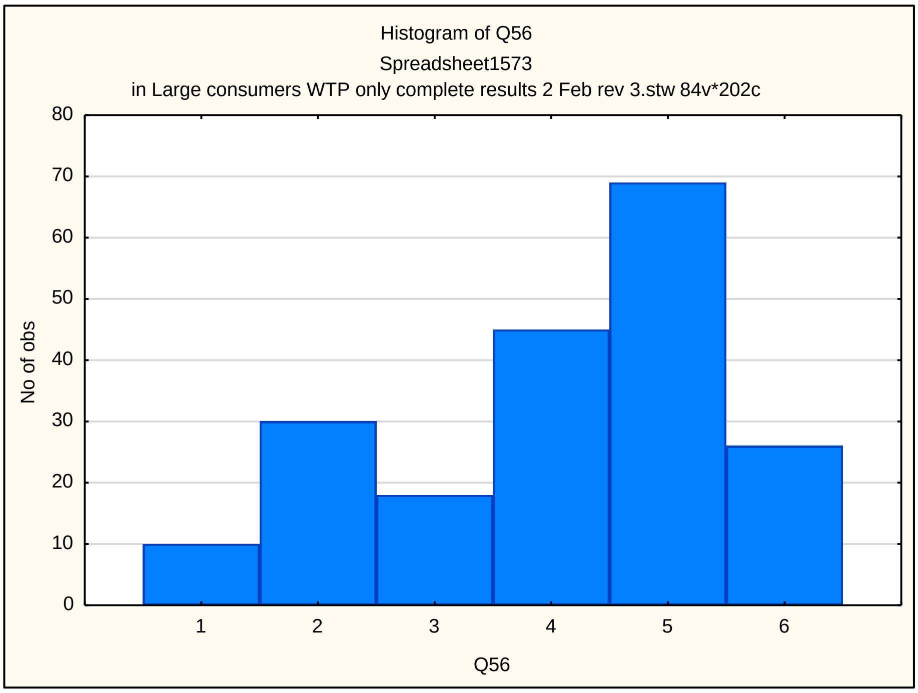
Q54. Using green electricity will improve my life



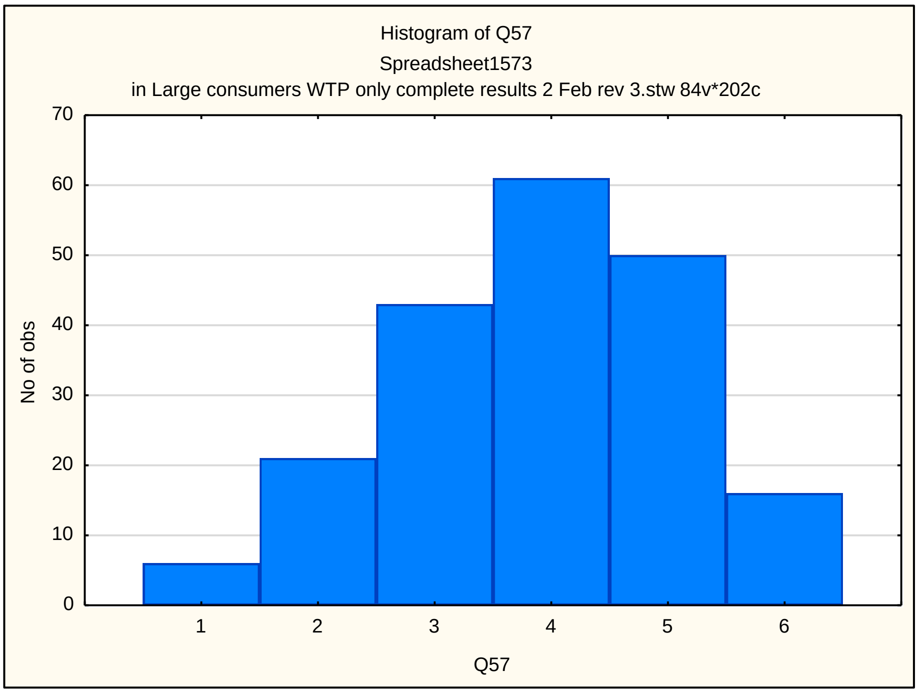
Q55. My knowledge and understanding of green electricity is good



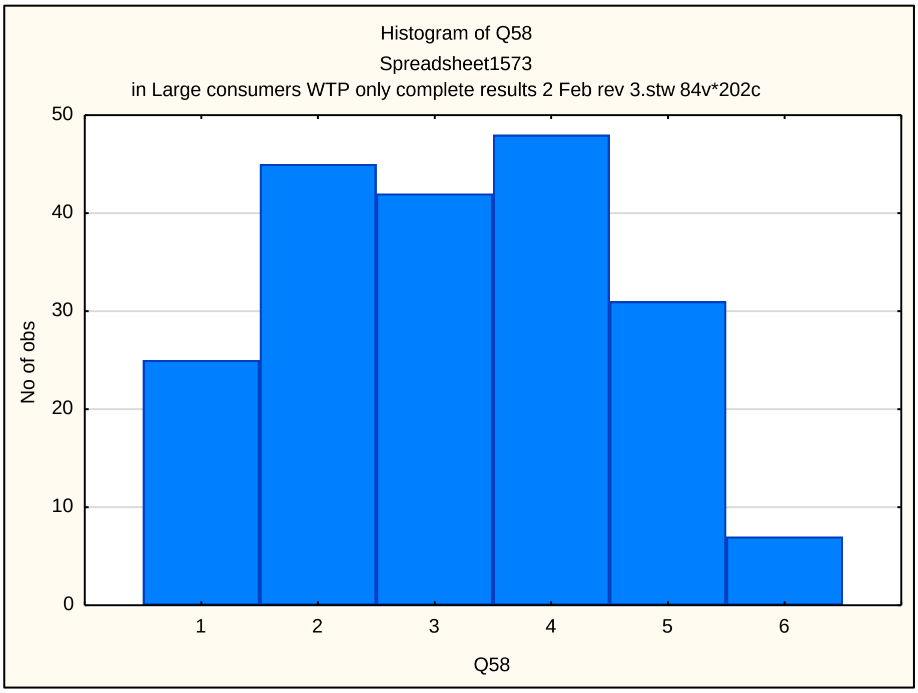
Q56. When I need help to learn more about green electricity, guidance is available to me



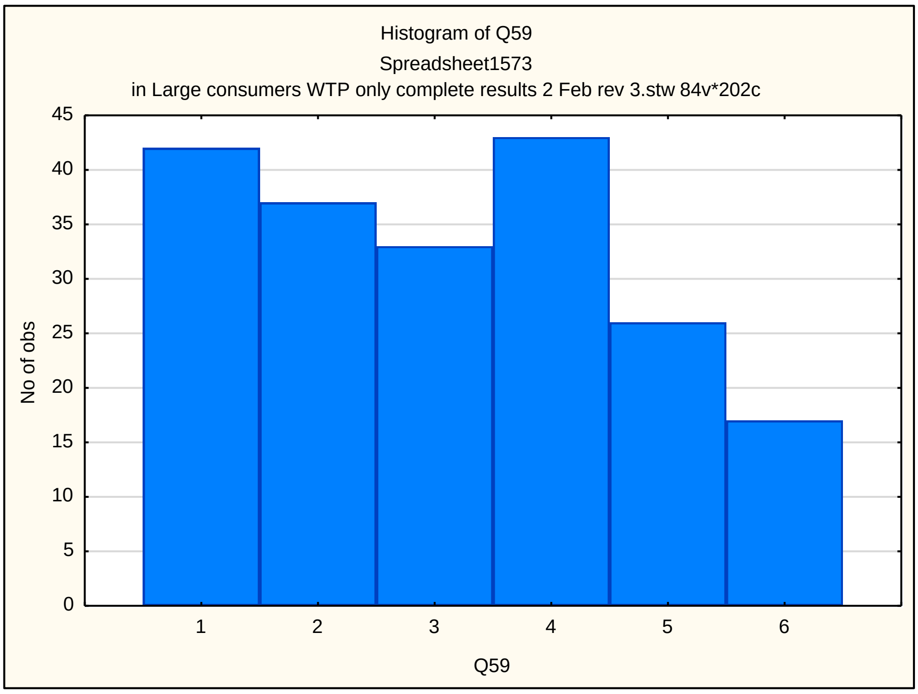
Q57. People whose opinions I value will encourage me to purchase green electricity



Q58. I am willing to pay a premium for green electricity in future



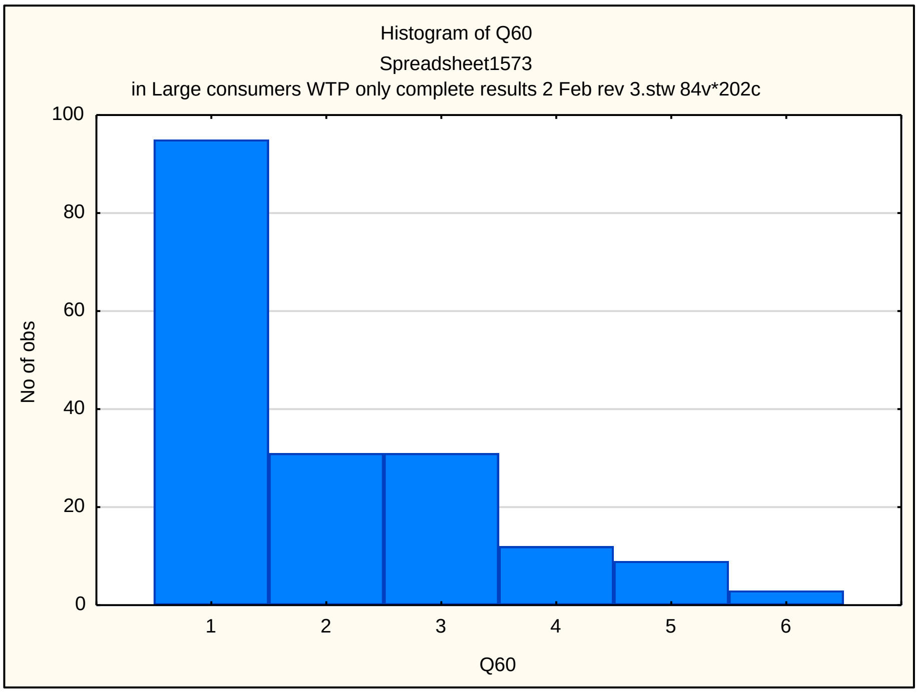
Q59. Suppose Eskom gives the opportunity to participate in a green energy programme for an additional fee, would you trust Eskom to manage the process effectively?



C. SCENARIO QUESTIONS

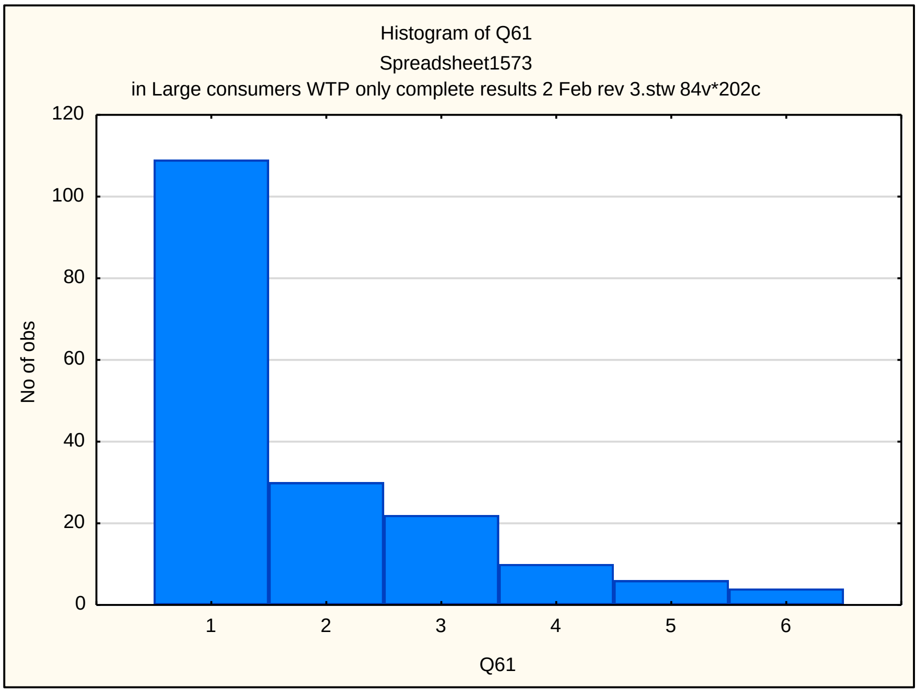
Q60. Scenario 1:

Eskom builds renewable energy generating plant and transfer cost to all consumers



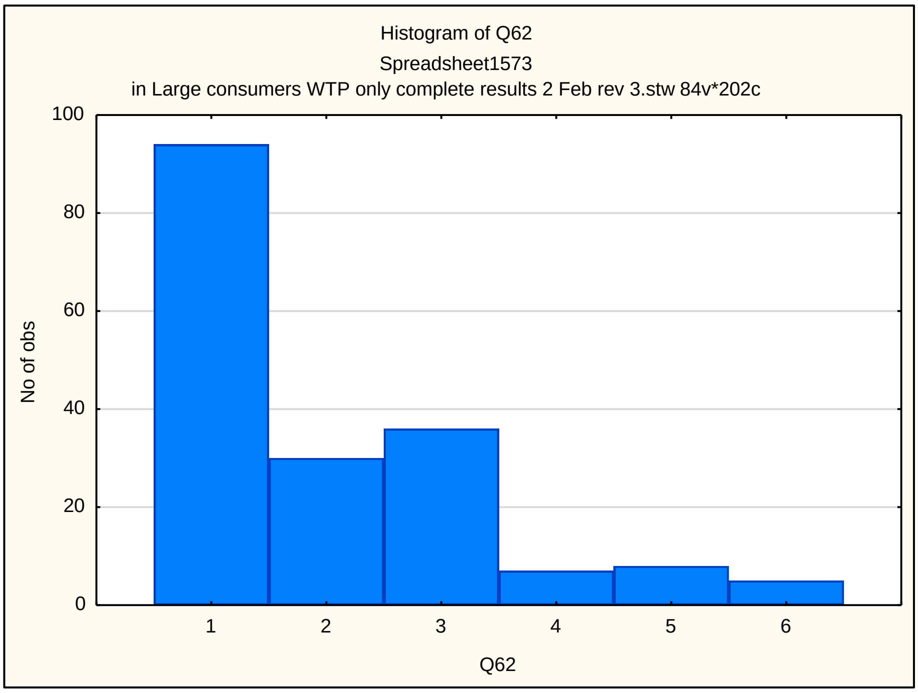
Q61. Scenario 2:

Government sponsors Eskom to build renewable energy generating plant and recover the cost by other means (e.g. tax)



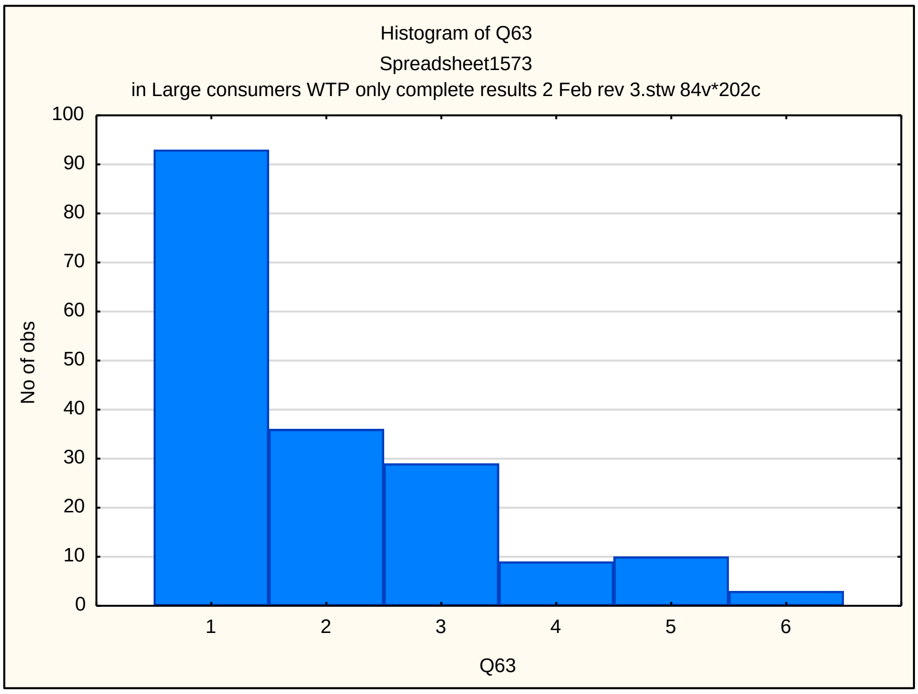
Q62. Scenario 3:

Private entities build renewable plant and Eskom procures the generated electricity at a higher cost. Eskom then transfers the additional cost to all costumers



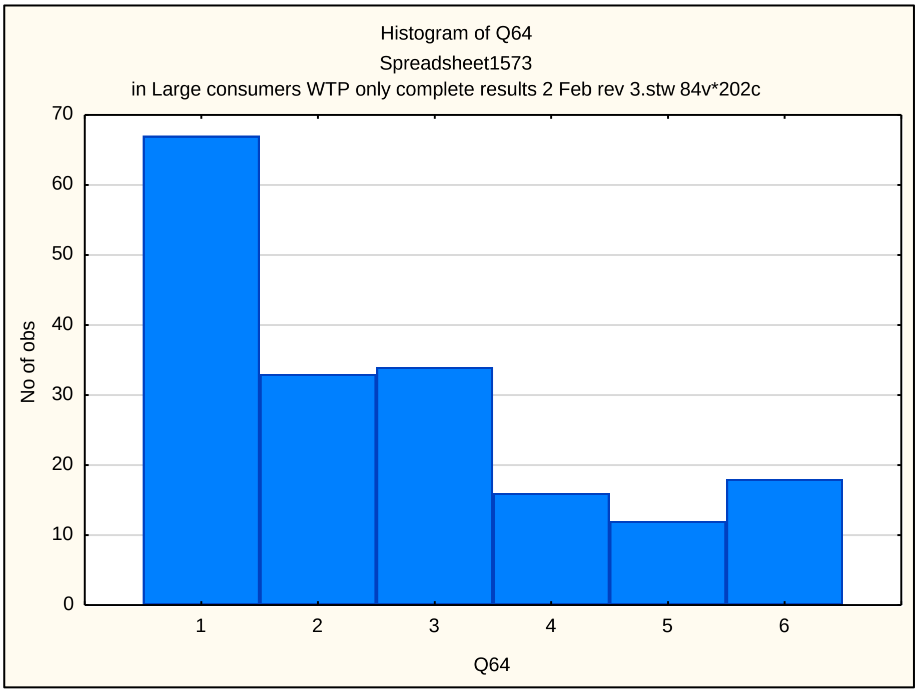
Q63. Scenario 4:

Customers pay a voluntary amount to facilitate the build of renewable plant (Separate fund)



Q64. Scenario 5:

Do not pay any additional amount for renewable energy but rather spend it on energy reduction technologies



Q65. Scenario 6: Specify any additional scenario you may prefer (Not compulsory to complete)

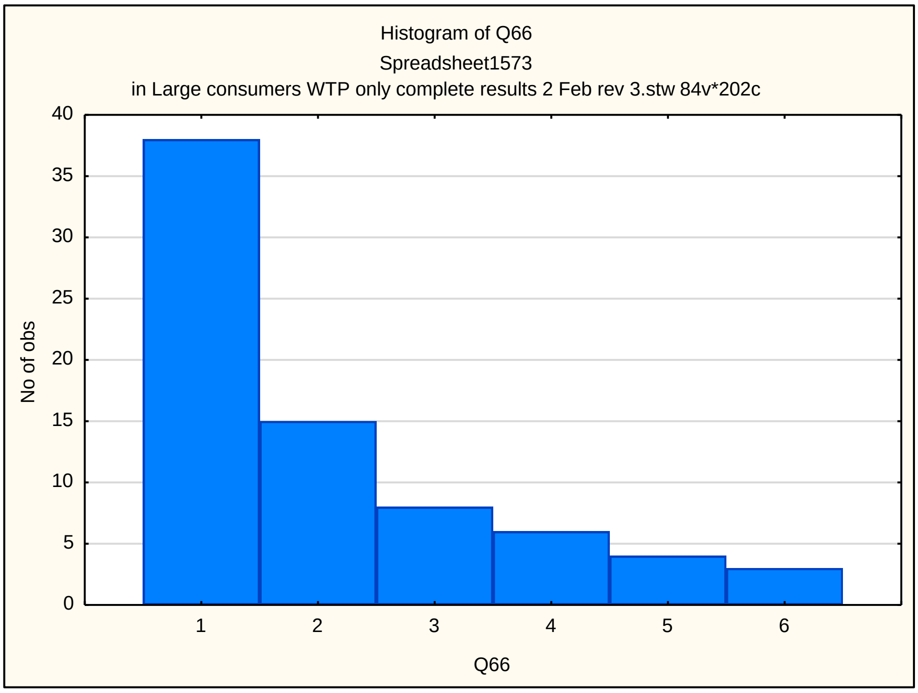
The respondents were given the option to add any additional scenario they might prefer. The following scenarios (opinions) are direct quotes of the respondents:

- [Company name removed for confidentiality] is energy intensive and cannot be operated from renewables. [Company name removed for confidentiality] can only utilize renewables to substitute supply to buildings etc. Eskom should be privatised and not utilize by the government to build anything.
- Green energy can only supplement a base-load derived from coal-fired or nuclear-powered power stations. In my mind, Eskom should get an affordable base-load improvement in place by privatising new generating power plants since Eskom clearly is not capable to do the construction on Medupi and Kusile on time and within budget.
- All scenarios are covered.
- Place a cap on the REIPPP equal to the cost of alternative new technology options. This will be higher than grid parity (which is the blended average cost of the current generation fleet) and judging from the 3rd bid window prices, it will still allow for significant investment in RE.
- 3%, provided the funds are made available to enable the municipality to pay its own feed-in tariffs to IPPs in order to support renewable energy. Many of the %portion questions above are different for a reseller of electricity, as opposed to being the end user and may be difficult for you to reconcile. I have tried to answer these questions.
- Maximise current energy efficiency.
- 4% if there are government incentives in place for those who generate energy in specific regions without the requirement of major infrastructure expenses like km of cable etc. and no interruptions on private households or business.
- None. The present increase in cost of electricity is killing our business. Green energy needs to be cost effective to lower our cost of production to have any significant attraction.
- First, before speaking about additional cost and green electricity, Eskom must stop to do load shedding and improve its quality. Are nuclear plants part of green electricity???
- Allow Independent Power Producers a free-market system to generate power. Also, hand over the National Grid to NERSA and make Eskom only a state-owned power producer (playing in the free-market generation system). Let prices be determined by the consumer, with NERSA only recovering costs and some additional funds to fund electricity reduction projects. 4%
- Do not want to pay extra for electricity = 0%.
- The cost of electricity in our industry is about 29% of total cost. Any additional cost will affect our business negatively and on top of that, we are dependent on the market price of gold.

- When green energy production plants are well planned, energy prices can be procured at levels lower than Eskom.
- In a competitive market the question should not be if we are willing to pay more than the current rates. It should be competitive and compete at the current rates. If it can't, the market will not support it and it will fail. Energy reduction technologies are ongoing and will continue to be supported as everyone is assisting with shortfall supply vs. demand.
- Stop supplying other countries' electricity while SA is having load shedding taking business away from South Africa.
- The bottom line is that green electricity will be expensive, due to the economy of scales between fossil-based fuel and green electricity power-generation infrastructure. One exists in form and the other is in its infancy. Since electricity is the top 5 VP cost for any manufacturing company, the cost to take on green electricity will have to be transferred to the product being manufactured, hence at the end of the day, the customer will bear the brunt of increase cost for the product.
- Currently need to see how it will be and at what cost. But not more than R100 000 per month.
- Maximum of 0.5% is based on current volatile economic conditions which have resulted in a cost reduction focus across the company. A scenario that might not be mentioned is: what if the Government subsidized private entities to generate green electricity; the environmental levy or electricity levy revenue can be made available to any entity that can produce and supply green electricity. If Eskom is interested in green energy, then they would compete with any company.
- The low API price on export coal currently discourages any possible investment into green energy (My opinion). Most of the mines are currently running marginally or at a loss. Investment into green energy will increase if the market improves. (Company name removed for confidentiality) as a global player is very interested and involved in green energy.
- International companies which have a proven track record for building and maintaining green energy plants.
- Encourage private enterprise as competition to Eskom.
- Renewable electricity entity separate from Eskom.
- In our smelting industry, it will be very difficult to justify any additional costs with regards to energy, as the high electricity costs are already putting a massive strain on our industry.
- I am not the responsible person to make these decisions for a contribution towards green electricity. This must be discussed with the Finance Director of (Name removed for confidentiality) Municipality.

- Scenario 1 to 5 is misleading since it does not allow for 0% option. Industry and private sector is presently paying for inefficiencies of Eskom and should not be asked to fund this any further. Use the present 3.5c/kWh environmental levy to fund the replacement of lessor energy-efficient installations and enforce through trade and installations legislation the introduction of high efficient solutions. The split between electricity generation and energy regulatory role to be prioritised with all generation to be privatised to provide for fair and cost-competitive market.
- Government needs to outsource the renewable energy and give the outside companies to bid for this job. Eskom has shown over the years that they cannot be trusted with securing the country's future in terms of energy. If the competent bidder has been appointed to do this, I will be willing to pay over 5% to this course.
- Electricity cost is 25% of our company's total overheads. We cannot afford to pay any extra for green electricity as electricity is already increasing at a much higher rate than inflation although the sales price of our product increases at less than inflation.
- Solar for water pumps and 5% could be spent.
- "GREEN" TECHNOLOGY IS STILL EXPENSIVE. However, we need to get a mix of generation. Eskom should NOT have the ability to "play the game, Ref the game and make all the rules!!" They have no competition, so can do what they like! Totally unhealthy! South Africa would have MANY IPP's if Eskom and the DOE weren't so incompetent, and we wouldn't have the energy crisis we are sitting in now!!!
- I favour open competition and hope that "green" electricity will not come at an additional price, but rather cheaper than current supply. Opening the market and adding competition will lead to excellence in service and technology and force Eskom to become more competitive.
- Pay once off to build a green energy plant and then not pay for the usage; Eskom to maintain from government subsidy.
- There is currently no benchmarking for Eskom, therefor they manipulate [the price].

Q66. Specify any additional scenario you may prefer and indicate the maximum additional amount you will be willing to pay in percentage (0.50%, 1%, 2%, 3%, 4% >5%) for your scenario. Not compulsory to complete



APPENDIX D:

THEORETICAL MODEL RELIABILITY RESULTS

(i) PBC

Summary for scale: Mean=7.08586 Std.Dv.=2.29272 Valid N:198 (Spre
Cronbach alpha: .587016 Standardized alpha: .587431
Average inter-item corr.: .415860

variable	Mean if deleted	Var. if deleted	StDv. if deleted	Itm-Totl Correl.	Alpha if deleted
Q11	3.151515	1.764922	1.328504	0.415860	
Q15	3.934343	1.930033	1.389256	0.415860	

(ii) Control beliefs

Summary for scale: Mean=4.98990 Std.Dv.=1.65560 Valid N:198 (Sp
Cronbach alpha: .034981 Standardized alpha: .038204
Average inter-item corr.: .019474

variable	Mean if deleted	Var. if deleted	StDv. if deleted	Itm-Totl Correl.	Alpha if deleted
Q12(reversed)	1.722222	0.796577	0.892512	0.019474	
Q19(reversed)	3.267677	1.882895	1.372186	0.019474	

These questions were not revers worded questions as indicated and was corrected in the final assessment. Question 12 average score was lower than question 19 but remained higher than the mean indicating a similar trend for questions 12 and 19.

(iii) Compete

Summary for scale: Mean=32.5459 Std.Dv.=4.63686 Valid N:196 (Spreadshe
Cronbach alpha: .751477 Standardized alpha: .756391
Average inter-item corr.: .309018

variable	Mean if deleted	Var. if deleted	StDv. if deleted	Itm-Totl Correl.	Alpha if deleted
Q13	27.72959	16.62586	4.077482	0.477669	0.719562
Q21	27.53572	16.94260	4.116139	0.479626	0.720085
Q23	28.25000	15.52424	3.940081	0.492937	0.716013
Q35	27.89796	16.77530	4.095767	0.338273	0.753521
Q45	27.71428	17.03061	4.126816	0.436172	0.728124
Q48	28.07143	15.99490	3.999362	0.560216	0.701943
Q51	28.07653	15.67272	3.958878	0.518175	0.709652

(iv) Unique

Summary for scale: Mean=18.5431 Std.Dv.=3.07133 Valid N:197 (Spreads
Cronbach alpha: .713007 Standardized alpha: .714411
Average inter-item corr.: .389295

variable	Mean if deleted	Var. if deleted	StDv. if deleted	Itm-Totl Correl.	Alpha if deleted
Q14	13.97462	6.024736	2.454534	0.431866	0.691332
Q32	13.98985	5.461826	2.337055	0.610504	0.583404
Q47	13.95432	5.921771	2.433469	0.452851	0.679033
Q52	13.71066	5.728465	2.393421	0.511954	0.643058

(v) Advice

variable	Summary for scale: Mean=30.0918 Std.Dv.=5.23222 Valid N:196 (Spreac Cronbach alpha: .764551 Standardized alpha: .782237 Average inter-item corr.: .347935				
	Mean if deleted	Var. if deleted	StDv. if deleted	Itm-Totl Correl.	Alpha if deleted
Q16	25.34184	21.17397	4.601518	0.529796	0.727755
Q25	25.96939	20.36641	4.512916	0.448361	0.744596
Q29	25.56633	21.05173	4.588216	0.529602	0.727375
Q34	25.44388	20.52236	4.530161	0.600273	0.713942
Q37	26.45408	19.95197	4.466763	0.500948	0.732135
Q42	26.01531	22.16813	4.708305	0.245940	0.793980
Q50	25.76020	20.33535	4.509474	0.651091	0.705478

(vi) PU

variable	Summary for scale: Mean=13.6091 Std.Dv.=3.01772 Valid N:197 (Spre Cronbach alpha: .780693 Standardized alpha: .788398 Average inter-item corr.: .560377				
	Mean if deleted	Var. if deleted	StDv. if deleted	Itm-Totl Correl.	Alpha if deleted
Q17	8.842640	4.487928	2.118473	0.550890	0.781457
Q38	8.944162	4.560334	2.135494	0.727811	0.601847
Q54	9.431472	4.356979	2.087338	0.596148	0.729742

(vii) Harmony

variable	Summary for scale: Mean=13.1066 Std.Dv.=3.10920 Valid N:197 (Spre Cronbach alpha: .547424 Standardized alpha: .534755 Average inter-item corr.: .228650				
	Mean if deleted	Var. if deleted	StDv. if deleted	Itm-Totl Correl.	Alpha if deleted
Q18	10.28934	5.626943	2.372118	0.458781	0.364134
Q27	9.02031	7.857456	2.803115	0.113667	0.626602
Q39	10.10660	6.217063	2.493404	0.292123	0.511849
Q44	9.90355	5.203896	2.281205	0.489829	0.325137

(viii) Responsibility

variable	Summary for scale: Mean=20.2995 Std.Dv.=2.42577 Valid N:197 (Spre Cronbach alpha: .606615 Standardized alpha: .644070 Average inter-item corr.: .317700				
	Mean if deleted	Var. if deleted	StDv. if deleted	Itm-Totl Correl.	Alpha if deleted
Q20	15.36041	3.469092	1.862550	0.340348	0.583992
Q30	14.93909	3.813549	1.952831	0.494442	0.471345
Q40	15.83756	3.486305	1.867165	0.323252	0.600953
Q43	14.76142	4.130898	2.032461	0.474723	0.501622

(ix) PEU

variable	Summary for scale: Mean=10.4388 Std.Dv.=2.32739 Valid N:196 (Sprea Cronbach alpha: .245648 Standardized alpha: .244891 Average inter-item corr.: .098194				
	Mean if deleted	Var. if deleted	StDv. if deleted	Itm-Totl Correl.	Alpha if deleted
Q22	7.163265	2.983549	1.727295	0.221759	0.000000
Q46(reversed)	7.540816	3.207517	1.790954	0.117397	0.214251
Q55	6.173470	3.704602	1.924734	0.065185	0.316816

Question 55 average score was consistently higher than questions 22 and 46.

(x) ATU

variable	Summary for scale: Mean=19.1574 Std.Dv.=3.03056 Valid N:197 (Sprea Cronbach alpha: .571279 Standardized alpha: .588397 Average inter-item corr.: .267157				
	Mean if deleted	Var. if deleted	StDv. if deleted	Itm-Totl Correl.	Alpha if deleted
Q24(reversed)	14.60406	5.792470	2.406755	0.277114	0.571762
Q26	14.22335	5.858744	2.420484	0.491218	0.407399
Q36	14.21827	5.987890	2.447016	0.376157	0.483261
Q53(reversed)	14.42640	5.858796	2.420495	0.309377	0.538149

(xi) FC

variable	Summary for scale: Mean=12.3030 Std.Dv.=3.83665 Valid N:198 (Spre Cronbach alpha: .885703 Standardized alpha: .886388 Average inter-item corr.: .731333				
	Mean if deleted	Var. if deleted	StDv. if deleted	Itm-Totl Correl.	Alpha if deleted
Q28	8.186869	6.949929	2.636272	0.818720	0.803509
Q31	8.181818	6.451791	2.540038	0.815640	0.803128
Q56	8.237373	7.241633	2.691028	0.703553	0.901666

(xii) SN

variable	Summary for scale: Mean=10.5153 Std.Dv.=2.99483 Valid N:196 (Spre Cronbach alpha: .644869 Standardized alpha: .646941 Average inter-item corr.: .384496				
	Mean if deleted	Var. if deleted	StDv. if deleted	Itm-Totl Correl.	Alpha if deleted
Q33	6.770408	4.187084	2.046237	0.488994	0.499245
Q49	7.637755	5.220819	2.284911	0.350120	0.682678
Q57	6.622449	4.602354	2.145310	0.539169	0.438452

(xiii) BIU

variable	Summary for scale: Mean=6.94949 Std.Dv.=2.37531 Valid N:198 (Spr Cronbach alpha: .584307 Standardized alpha: .584839 Average inter-item corr.: .413267				
	Mean if deleted	Var. if deleted	StDv. if deleted	Itm-Totl Correl.	Alpha if deleted
Q41	3.181818	1.886134	1.373366	0.413267	
Q58	3.767677	2.087440	1.444798	0.413267	