UNIVERSIDAD PONTIFICIA COMILLAS

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA (ICAI)

OFFICIAL MASTER'S DEGREE IN THE ELECTRIC POWER INDUSTRY

Master's Thesis

The Influence of Carbon Tax Implementation on Green Growth in South Africa

Author: **Tanja Krneta**

Supervisor: **Serge Pajak**

Co-supervisor: **Fukuya Iino**

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Official Master's Degree in the Electric Power Industry (MEPI)
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Summary

The idea of sustainable, greener growth has resonated in South Africa like in the rest of the world. Their national goals, such as reducing very high unemployment, mitigating air pollution, in particular CO2 emissions and addressing the problem of water scarcity are perfect fit with the Green Growth concept. Each country needs to start the change from the policy level downwards. In order to reflect the real environmental and social costs in its economy, South Africa has already made some progress in its policy reform. In 2010, the Government started developing a carbon tax in order to address GHG emission problem and influence the transition towards energy efficiency and renewable energy sources. The goal was correcting present prices of goods and services that produce excessive emissions, so that social cost is included. Carbon Tax Bill was released in November 2015. The drafted Bill states 1 January 2017 as a starting date of implementation.

The biggest concern of the South African Government is redistribution of revenues gained from the carbon tax. This paper analyzes 17 carbon tax designs around the world and combines their experience with economic and environmental profile of South Africa. The main objective is to answer the following question: Will Implementation of a carbon tax positively contribute to the Green Growth in South Africa? In order to answer this question, I have focused on 2 other questions, i.e. sub-objectives: will a carbon tax reduce carbon emissions in South Africa and what is the ideal carbon tax revenue recycling method for South Africa in order for a carbon tax to be cost-effective?

The paper concludes that CO_2 emissions are expected to decrease due to comprehensive effect of a carbon tax and renewable energy program in the country. Moreover, if revenue recycling is designed in such way to compensate firstly poorest tax payers, then finance green energy projects and helps trade exposed industry, a carbon tax will be cost-effective. This means that both, the “Green” and the “Growth” will be achieved and that a carbon tax has a positive influence on Green Growth in South Africa.

Abbreviations

AfDB – African Development Bank
CCPI – Climate Change Performance Index
CO_2 – Carbon Dioxide
tCO_2 – Ton of Carbon Dioxide
tCO_2e – Ton of Carbon Dioxide Equivalent
EPI – Environmental Performance Index
ESM – Environmentally Sound Management
EST – Environmentally Sound Technologies
ESC – Electricity Supply Commission
ETS – Emission Trading System
FiT – Feed in Tariff
GDP – Gross Domestic Product
GHG – Greenhouse Gases
IPPs – Independent Power Producers
IRP – Integrated Resource Plan
NDP – National Development Plan
NERSA – National Energy Regulator of South Africa
PPA – Power Purchase Agreement
REFIT – Renewable Energy Feed in Tariff
REIPPPP – Renewable Energy Independent Power Producer Procurement Programme
RES – Renewable Energy Sources
SDG's – Sustainable Development Goals
SO – System Operator
WWF – World Wild Fund

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1. Introduction

1.1. Motivation & Objectives

This Master Thesis derives from my two-year experience at Erasmus Mundus Economics and Management in Network Industries (EMIN) Master Programme at the Universidad Pontificia Comillas in Madrid and University Pars Sud in Paris, as well as my three-months internship at the Stockholm Convention Division, Department of Environment, United Nations Industrial Development Organization (UNIDO) in Vienna, Austria. Combining gained knowledge from both Universities, in particular from "Environmental and Renewable Energy Policies" classes held by Dr. Pedro Linares at Escuela Técnica Superior de Ingeniería (ICAI), Universidad Pontificia Comillas, with my personal interests for environment-related topics, I have decided to focus my future work on Climate Change mitigation.

This has brought me to the Environment Department of UNIDO, to which I contributed with my knowledge of electric power industry. This United Nations agency's scope of work is covering Sustainable Development Goal 9 – Industry, innovation and infrastructure. UNIDO's objective is to promote industrial development for poverty reduction, inclusive globalization and environmental sustainability Fortunately for me, my scope of work went across Energy and Climate Change Department as well, as both departments are cooperating together in order to create comprehensive, successful projects.

Together with my internship supervisor Fukuya Iino, who was a real professional and personal mentor to me during the internship, I have gradually come up with a relevant topic for my Master Thesis. Relevant to me, to UNIDO and the South African Government. Namely, while working on Stockholm Convention project in South Africa, I conducted a thorough research of South Africa's electricity sector and related policies. Specificity of this system and urgent need for change has attracted my attention. This is country on the development crossroads and its next step could be crucial. South Africa has set Green Growth and Green Economy as National Development Goals of the country in next 15 years in order to achieve sustainable economic growth, reduce unemployment and fight climate change.

The initial step towards greener economy was adoption of Carbon Tax Bill last year, after 4 years of unsuccessful initiatives. The idea behind the tax is reduction of the GHG emission, as South Africa is one of the world's top 15 polluters. The interesting fact for me was that South Africa is the first country on African continent to implement such policy tool. This certainly deserves attention, as mostly developed, European countries have implemented this mechanism. It could be said that besides being pioneer on the continent, South Africa is also one of the pioneering developing countries which adopted a carbon tax. Now the question is will a carbon tax contribute to the Green Growth of South Africa. There are still many opponents in the country concerned about effects of this tax on their businesses, jobs and electricity prices. As tax is entering into force only next year,

from January 2017, the South African Government is still holding regular meetings with the key stakeholders in order to improve tax design. This is where my Thesis comes in.

The main objective of my Master Thesis is to answer the following question:

Will Implementation of a Carbon Tax positively contribute to the Green Growth in South Africa?

In order to answer this question, I have focused on 2 other questions, i.e. sub-objectives:

- **Will a Carbon Tax reduce GHG emissions in South Africa? (Green)**
- **What is the ideal Carbon Tax Revenue Recycling method for South Africa in order for Carbon Tax to be cost-effective? (Growth)**

These questions will be assessed by analyzing experiences of other countries. Answering these two questions will finally give the answer to the main question of this Thesis.

1.2. Methodology & Sources

The methodology used in this Thesis consists of:

- Examining economic and environmental profile of South Africa
- Examining South Africa's electricity sector
- Explaining the Green Growth concept and examining its applications in South Africa
- Examining and explaining a carbon tax as policy tool for mitigation of GHG emissions
- Analyzing current Carbon Tax Bill in South Africa
- Analyzing carbon tax design in other 17 countries/jurisdictions where an explicit carbon tax is implemented

Upon this, the main Thesis questions will be answered in the following way:

1. **Will a Carbon Tax reduce GHG emissions in South Africa?**

Combining the information about CO_2 emissions decrease or increase after the implementation of a carbon tax in 17 analyzed countries/provinces with the emissions facts in South Africa as well as situation in South African electricity sector, the biggest emitter of CO_2 emissions in the country.

2. **What is the ideal Carbon Tax Revenue Recycling method for South Africa in order for a Carbon Tax to be cost-effective?**

Combining the information on reasons for imposing a carbon tax (economic or/and environmental) in analyzed countries/provinces and the revenue recycling methods these countries chose with the economic and environmental situation in South Africa.

3. **Will Implementation of a Carbon Tax positively contribute to the Green Growth in South Africa?**

Finally, when first two questions are answered, the main thesis' question can be answered. Only if both, "Green" and "Growth" are achieved, carbon tax will have positive influence on Green Growth. This means if a carbon tax is cost-effective and emissions are being reduced, overall carbon tax influence on Green Growth in South Africa will be positive. In any other case, the influence will be negative. Even though there is an ideal revenue recycling method that is cost-effective, but emissions are not expected to decline, the influence of a carbon tax on Green Growth is negative. If emissions are expected to decline, but there is no ideal revenue recycling method that could be cost-effective, a carbon tax will again have negative influence on Green Growth. Finally, if there is no ideal, cost-effective revenue recycling method and emissions are expected to increase, this will also have a negative influence on South Africa's Green Growth.

Assumptions:

There is one main assumption in this Thesis and it is related to the 2nd thesis' question. This assumption is the following:

- The ideal revenue recycling method is the only factor defining cost-effectiveness of a carbon tax

This assumption is based on broad literature review, as majority of authors claim that the use of tax revenues is one of the key elements of a carbon tax design, determining tax successfulness the most. This is claimed in (Devarajan, Go, Robinson , & Thierfelder, 2009), (Alton, et al., 2013) and (Van Heerden, et al., 2006).

The sources used for this research are:

- Reports published by UNIDO, UNEP, UNDP, UNFCCC, OECD, IEA, World Bank
- Reports published by the Government of Republic of South Africa: Department of Environmental Affairs, Department of Energy and National Treasury
- Publications by African Development Bank, Africa Institute and Overseas Development Institute
- Previous research papers on this topic such as (Alton, et al., 2013) (Devarajan, Go, Robinson , & Thierfelder, 2009) (Van Heerden, et al., 2006), (Bamidele Fakoya, 2013), (Nakhooda, 2014) and (Morden & Janoska, 2014),

1.3. Structure of the Thesis

Firstly, I will introduce economic and environmental profile of South Africa, as both have strong influence on countries emissions and design of the carbon tax. Secondly, I will focus on detail analysis of South Africa's electric power sector, which is biggest emitter in the country as well as biggest opponent of carbon tax. I will put special focus on Eskom, monopolistic company that

dominates the sector, Integrated Resource Plan (or Integrated Resource Electricity Plan) of the country, being the most important document where future of the sector is estimated and introduction of Independent Power Producers (IPPs) and renewable energy sources. Thirdly, I will introduce the Green Growth concept, explain its purpose on African continent and examine the implementation of the concept in South Africa. In forth step I will explain the basics of the carbon tax, its relation to other similar instruments, specifically Emissions Trading System (ETS). I will explain initial steps towards Carbon Tax Bill and design of the tax in South Africa. In the fifth step I will be analyzing other carbon tax designs upon in advance set assessment framework and finally make a conclusion answering posted questions, objectives of this paper. Thesis is concluded with remarks for future work.

2. State of the Art

In order to approach writing of my Master Thesis, my first step was the investigation of previous work on this topic. Namely, the potential benefits of a carbon tax, and environmental taxes in general have been broadly discussed for almost four decades now. Only in late 2000s the potential implementation of a carbon tax in South Africa, together with potential gains and losses it brings, started getting the popularity it deserves. Four different papers on this topic influenced my work the most. The interesting fact is that upon final adoption of the tax and publishing the Carbon Tax Bill in November 2015, no papers have been published on this topic.

In my opinion, the most important work in this domain has been done by Shantayanan Devarajan, Chief Economist of the World Bank's Middle East and North Africa Region. Since joining the World Bank in 1991, Devarajan has contributed to African Region with many conducted research projects and publications. He was one of the first people to explore the carbon tax initiative in South Africa. In his collaborative work (Devarajan, Go, Robinson , & Thierfelder, 2009)**,** the impact of a carbon tax on economic welfare in South Africa was explored. Methodology in the paper was based on disaggregate general equilibrium model of country's economy. Model covered energy sector, as biggest emitter in the country. Their results at the time showed that potential implementation of the tax is preferred to other environmental taxes. Moreover, the tax could be cost effective only if revenues gained from the tax are used to cut distortionary labor taxes. The big limitation to this work is the fact there is no distinction between different technologies in electricity sector, as well as the fact that Integrated Resource Plan was still not published, thus long term electricity sector plan is not included in the model. This means that results are not relevant as much today due to the fact that one of the most important effects of a carbon tax, the one on electricity prices, is underestimated.

On the other hand, another paper examining the implementation of a carbon tax in South Africa was (Alton, et al., 2013)**,** published only after the first official carbon tax proposal by the Government. Using the same model as (Devarajan, Go, Robinson , & Thierfelder, 2009), but more dynamic, authors explored the potential influence on economic welfare. Results showed that tax would reduce economic welfare and increase unemployment for less than 1%. Moreover, if main trading partners of South Africa introduce a carbon price on their imports, then effect on national welfare and unemployment would be worsened. Once again the use of the revenue proved to have a very big influence on tax successfulness. Also, the tax rate that would allow achievement of committed 42% emission reduction by 2025 needs to be set at US$30.

Another paper on this topic (Van Heerden, et al., 2006) is focusing on revenue recycling, using again the static general equilibrium model. The paper examines four types of environmental taxes and 3 revenue recycling streams in other to find a triple dividend (emissions reduction, poverty reduction and GDP increase). Results show that triple dividend is possible if revenues of environmental taxes are used for reduction of food prices.

I would like to mention one more paper which affected my work, namely (Bamidele Fakoya, 2013). The focus of this paper is on other countries' experiences with a carbon tax in order help decision

makers learn on someone else's mistakes. He also examines carbon tax effect on consumer price index in South Africa using multivariate regression analysis method. His results showed that increase in prices of energy products due to a carbon tax have a regressive influence on low-income citizens in South Africa. He suggests that other instruments addressing the same issue should be considered by the Government.

All four papers written on this topic are written before the actual adoption of a carbon tax in South Africa. No paper is published on this topic after November 15 and adoption of the Carbon Tax Bill. This is one of the reasons why I have decided for this topic. All papers were discussing potential tax designs with potential impacts on country's economy and welfare. Now, after detailed work of international and national experts to create a perfect carbon tax design for South Africa and when this design is already appointed, except the use of tax revenues, I am focusing on this one question that is the biggest concern of the Government, industry and people. Each paper highlights the importance of revenue usage, as one of the most important or even the most important part of tax design, deciding its effectiveness. The only paper suggesting that experience of other countries using a carbon tax needs to be examined in order to learn from their mistakes and prevent a tax failure is (Bamidele Fakoya, 2013). After him no one actually did this, and this is why I have decided to collect information on all countries using an explicit carbon tax and relate it to South Africa's case. Taking into account everything mentioned above, I could say that the added value of my work is the suggestion of the best revenue recycling scenario for the Government, based on the most recent information on economic and environmental situation in South Africa and on analysis of other countries having a carbon tax. Another added value is the exhaustive list of countries with the explicit carbon tax with detailed design features. Finally, this paper could be used by the South African Government in order to persuade resistant industry and people that a carbon tax is a positive step towards greener growth of the country.

3. Economic and Environmental Profile of South Africa

Official name: *Republic of South Africa*
Form of state: *Federal state*
Capitals:
- *Pretoria (executive)*
- *Cape Town (legislative)*
- *Bloemfontein (judicial)*

Area: *1 219 090 km2*
Population: *54 million*
Language: *11 official*
Currency: *South African Rand (ZAR)*
Government: *Unitary Parliamentary Republic*
President: *Jacob Zuma*

The Republic of South Africa is placed on the southern tip of African continent. It occupies the area of more than 1,2 million square kilometers, which makes it twenty fifth largest country in the world. Its geographical position is very specific, as around 2 700 km is coastline, tipping both, Indian and Atlantic oceans. South Africa also shares borders with Namibia, Botswana, Zimbabwe, Swaziland, Mozambique and Lesotho. It is very dependent of these countries and vice versa in commercial sense. It has a special relation with Lesotho, a country fully surrounded by South Africa, thus very dependent on it. South Africa is federal state and comprises of 9 provinces: Eastern Cape, Northern Cape, Western Cape, Free State, Limpopo, Gauteng, KwaZulu-Natal, Mpumalanga and North West, which are shown in the Figure 1.

All nine provinces have their own Governments, together with the overall national Government. It is important to know the location of each province as it overlaps with the electricity transmission zones, electricity load zones, industrial zones, etc. Although the smallest, Gauteng province is the most important one. Executive capital of the country, Pretoria, and largest city in the country, Johannesburg, are located in this province. Consequentially, around 23% of the country's population lives here. In addition, it is an economic hub of South Africa.

Figure 1: 9 provinces of South Africa

Next to Pretoria, there are two other capital cities in the country: Cape Town, a legislative capital located on the South Atlantic coast in the Western Cape and judicial capital Bloemfontein, located in the Free State province. Cape Town houses South African Parliament, whereas Supreme Court is hosted in Bloemfontein. Administration and National Departments are located in Pretoria. There are 11 official languages in the country. IsiZulu is spoken by biggest part of its population and it is followed by IsiNdebele, Afrikaans and English. English is also business, media and political language of South Africa, therefore is understood across the country.

South Africa has an abundance of natural resources which are exported in significant amounts. Also, South Africa is considered as a country with the world's largest underground mineral (non-energy) resources. Main resources exported are minerals, metals and diamonds along with food products, chemicals and automotive components. On the other hand, South Africa is a big importer of manufactured good, machinery, transport equipment and oil. (UNEP, 2013) Its chief trading partners are Ghana in Africa, Germany and UK in Europe, Japan and India in Asia and US. Last year's value of exports in South Africa was US$85,5 billion, almost US$10 billion lower than in 2014 and US$30 billion lower than exports in 2011. On the other side, value of imports is also lower than in 2011 and 2014, amounting around US$89 billion last year. (Focus Economics, 2016)

South Africa was classified as upper-middle income economy until the end of last year, and now is considered to belong to "newly industrialized countries". These countries' characteristic is to be in front of other developing countries but still not theoretically satisfying developed country criteria. Other countries with this classification are Mexico, Brazil, Turkey, China, India, Indonesia, Malaysia, Philippines and Thailand.[1] South Africa is also a second largest economy in the continent, right after Nigeria.

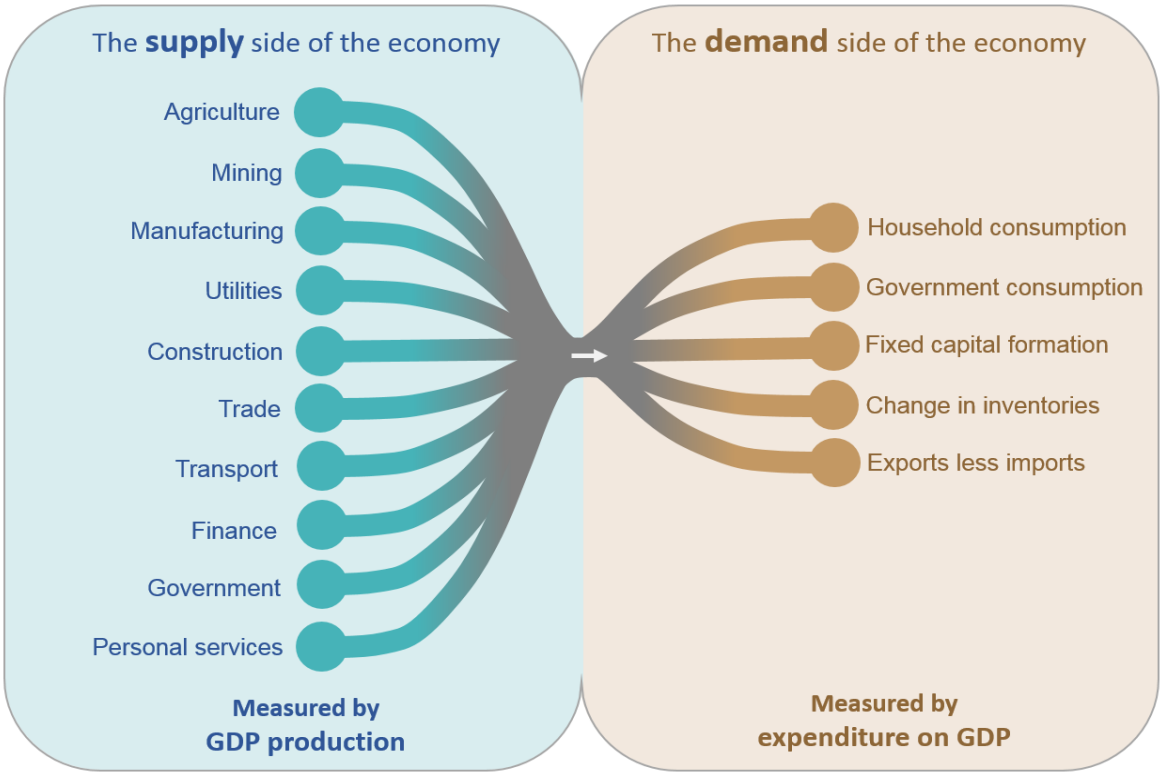
[1] https://en.wikipedia.org/wiki/Newly_industrialized_country

Despite this development, South Africa is considered to be one of the world's top countries in income inequality, whose Gini coefficient ranges from 0.6 to 0.7[2] according to the World Bank data.

Country's GDP was US$329 billion in 2015, which is the lowest GDP in last 5 years. GDP declined for 8% comparing to 2014 and 26% comparing to 2011. What is worrying is that public debt in 2015 accounts for more than 50% of GDP. Also, GDP per capita amounted US$5,994 in 2015, 9,3% lower than in 2014. (Focus Economics, 2016) Figure 2 shows main sectors in the country which are creating (supplying) GDP versus main GDP consumer sectors. Energy intensive industries such as mining are dominating the economy and account for around 10% of GDP and above 50% of country's exports. Furthermore, industries use 80% of electricity. (Zikhali, 2012) Unfortunately, solar, wind and hydro potential in the country are underused, but is the core of country's future development plan.

Figure 2: Main creators vs. main consumers of GDP in South Africa

Source: (Statistics SA, 2016)



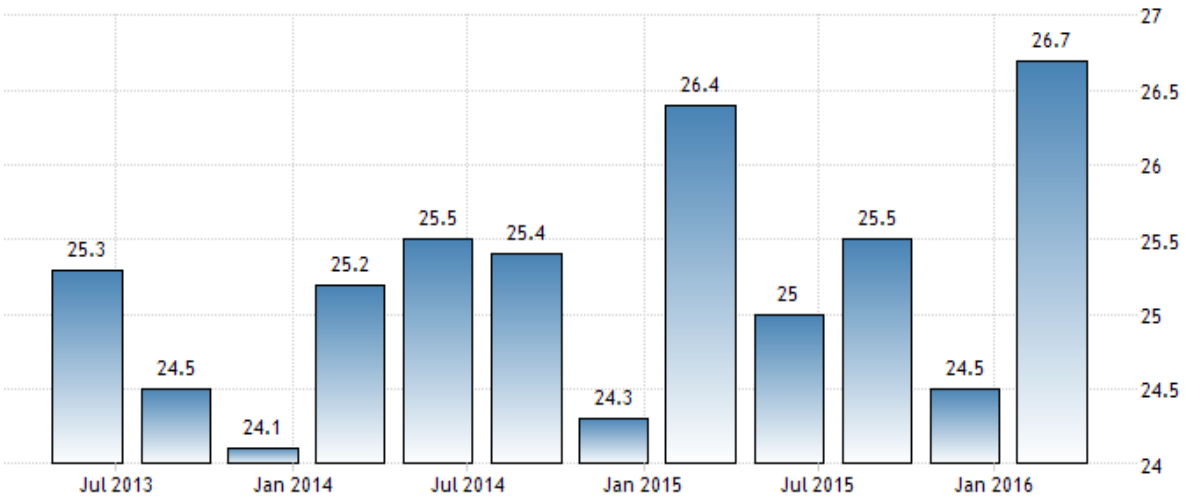
[2] http://data.worldbank.org/indicator/SI.POV.GINI?locations=ZA

South Africa had the robust growth, especially between 2003 and 2008. Global financial crisis occurred in 2008 had a strong impact on South Africa's economy. In 2009, country marked an astonishing fall in GDP. Financial crisis brought with it the biggest electricity crisis in South Africa in following years, where Eskom struggled to supply whole electricity demand and outages started occurring daily.

Another worrying topic, significantly coming under the spotlight after the financial crisis is unemployment. Namely, unemployment rate in 2015 was 25,5%, which was the highest unemployment rate in the world. (Focus Economics, 2016) Figure 3 shows marching of the unemployment rate in South Africa from July 2013 until today. The fact that rate is rising even more in 2016 is very discouraging. Since the beginning of this millennium, South Africa's lowest rate was 21,5% which is still very high. Many are associating these extreme numbers with the almost 50 years-long enforcement of apartheid in the country, which resulted in meagre education. 20 years after the fall of apartheid, in 2014 South Africa had 3,8 million skilled workers, 7 million semi-skilled workers and 4,3 million low-skilled workers, making it in total only 15 million people of 52 million living in the country at that time. Biggest percent of employed people were Black African race (73%), followed by White (13%), Colored (11%) and Asian race (3%). These numbers are very concerning and drastic changes are inevitable. This is why South Africa is currently on crossroads, setting poverty and inequality reduction, creation of jobs and reduction of unemployment as primary national goals for the future. All this needs to be achieved under the concept of Green Growth, which will be discussed in the chapter 5.

Figure 3: South Africa's unemployment rate movements since July 2013 until first half of 2016

Source: (Trading Economics, 2016)



When looking at the environmental profile of the country, it is important to know that South Africa classifies as steppe[3] climate country, but despite this classification it has very variable climate and landscape. Few types of climate are present on South Africa's territory, starting from subtropical on the east to semi-arid in central and north areas, to temperate and Mediterranean on west. This means that rain seasons in general occur in summer, from October to March, while only Western Cape province faces rainfall during winter months June to August. The fact that annual rainfall is about 450 mm and worlds average is 860mm shows that there is high potential risk of droughts. As annual rainfall in South Africa is relatively low, country is expected to reach water stress[4] level until 2025. (UNEP, 2013) In addition to that, water quality is already vastly compromised across the country, which has 22 major rivers. Another worrying fact is that only around 13% of land in the country is arable. (Zikhali, 2012)

Besides this, South Africa has 8 UNESCO World Heritage Sites, namely uKhahlamba Drakensberg Park and iSimangaliso Wetland Park in KwaZulu-Natal province, Vredefort Dome in North west, Cape Floral Region and Robben Island in Western Cape, Cultural and Botanical Landscape in Northern Cape, Mupungubwe Cultural Landscape in Limpopo province and Fossil Hominid Sites in Gauteng. Those heritages placed on the coast, such as Cape Floral Region, Robben Island and iSimangaliso Wetland Park are currently threatened by climate change impacts, in particular rising sea level. This is devastating information, as for example Cape Floral Region is holding a title of "richest plant kingdom in the world". (Zikhali, 2012) In addition, 10% of the total known plants, birds and fish in the world are located in South Africa.

The fact that 82% of river ecosystems, 34% of terrestrial ecosystems and 65% of marine zones are threatened to be destroyed, is also worrying. (UNEP, 2013) In addition, already half of the wetlands have been destroyed. All this points to the fact that natural resources in South Africa are being over exploited, and there is a desperate need for proper natural resource management. Besides destroying the ecosystem and biodiversity, atmospheric pollution in the country is causing more and more health problems for people. According to WWF, South Africa's ecological footprint is above the world's average footprint, and carbon represents the biggest part of it.

All of these are reasons why South Africa turned to Green Growth from now on. Its unsustainable development has led South Africa to the edge of economic and environmental chasm. Almost 50 years of apartheid system have certainly contributed to nowadays situation in South Africa but the basis of development after the fall of the system were wrong. Changes are inevitable and something needs to be done today.

[3] Or semi-arid climate - climate of a region that receives precipitation below potential evapotranspiration, but not extremely.

[4] Water stress refers to the ability, or lack thereof, to meet human and ecological demand for water. (Pacific Institute)

4. Electric Power Sector in South Africa

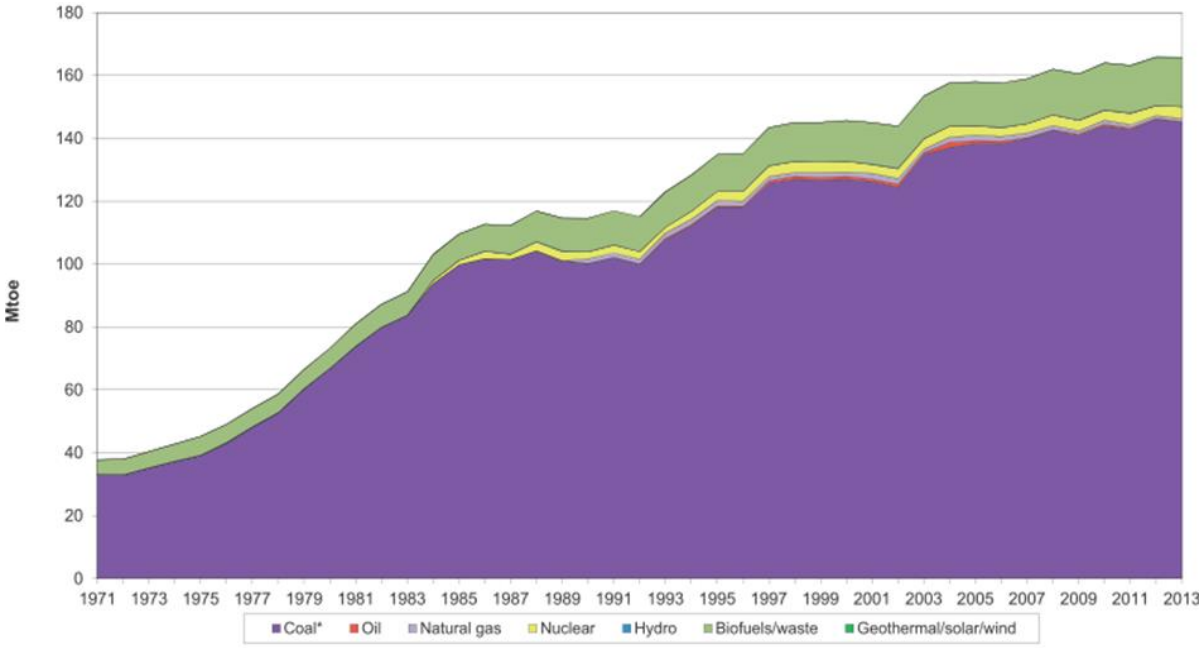
4.1. Basic Overview of the Sector

According to data collected by International Energy Agency in the "World Energy Outlook 2015", population without access to electricity in Sub-Saharan Africa was 634 million in 2013. Whereas only in South Africa, this number was 8 million, which doesn't seem much comparing to other Sub-Saharan countries such as Nigeria (96 million), Ethiopia (71 million) and DR Congo (61 million). Electrification rate in South Africa was 85% in the same year, which is one of the highest rates in Sub-Saharan countries. Only Gabon (89%) and small islands such as Mauritius (100%), Réunion (99%), Cabo Verde (94%) and Seychelles (97%) had higher rates. Within the country, urban electrification rate was 90% while rural was 77%. (IEA, 2015). North African countries (Morocco, Algeria, Tunisia, Egypt and Libya) have much more developed power sectors than Sun-Saharan Africa. The electrification rate of this region in 2013 was 99% with only 1 million people without access to electricity. (IEA, 2015)

In general, energy sector in South Africa strongly affects its economy as energy intensive mining is dominating the industry and it is the largest contributor to country's GDP. The information that 70% of its total energy supply in 2010 came from coal while the rest came from oil, solid biomass and waste is alarming. Figure 4 shows energy production per source from 1971 to 2013 in South Africa.

Figure 4: Energy Production in South Africa (1971-2013)

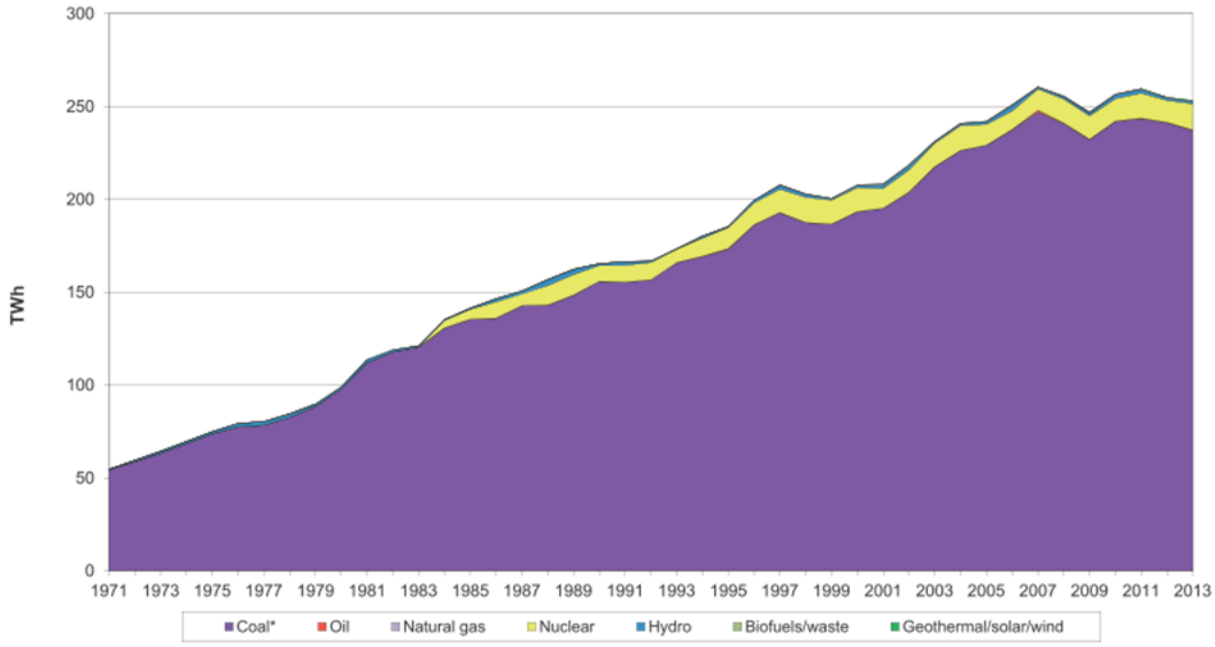
Source: International Energy Agency



Additionally, most electricity in South Africa comes from coal due to abundance of this resource in the country. Namely, South Africa is among world's main coal exporters, ranking 5th with USD 4.3 billion worth of coal in the 2015.[5] Figure 5 shows the electricity generation by fuels in South Africa since 1971 to 2013. It can be seen that coal is foremost fuel in electricity production, followed by nuclear and hydro.

Figure 5: Electricity generation by fuels in South Africa (1971-2013)

Source: International Energy Agency

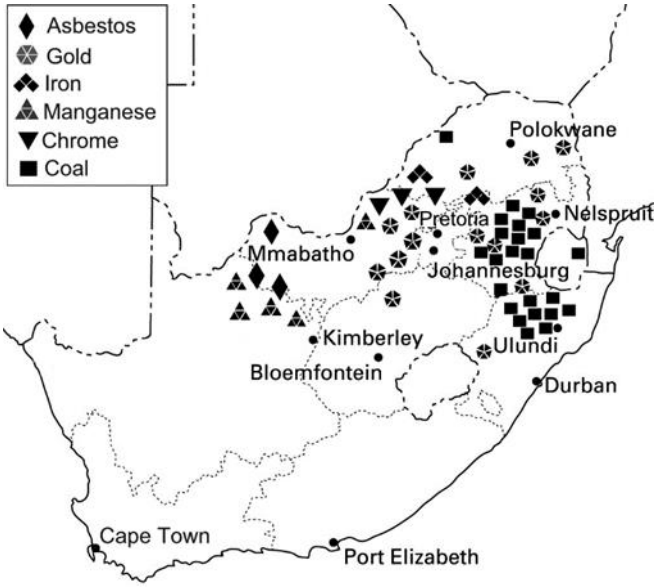


All coal fired power plants are located in the areas of coal mines, in Mpumalanga and KwaZulu-Natal provinces. These two provinces are currently largest net suppliers of electricity. Luckily, most of load is located nearby, in the Gauteng province, followed by Western Cape and KwaZulu-Natal. Gauteng province is nowadays largest net consumer of electricity in South Africa. Figure 6 shows South African map of minerals and coal mines.

[5] http://www.worldstopexports.com/coal-exports-country/

Figure 6: South African distribution of mineral wealth and coal mines

Source: (SouthAfricaProject, 2012)



South Africa's electricity sector is mainly ruled by Eskom, a vertically integrated public utility founded almost 100 years ago, in 1923 as Electricity Supply Commission (ESC) following South African Electricity Act from 1922. Eskom is dominating the generation, transmission and distribution of electricity in South Africa, generating around 95% of electricity used in the country, as well as 45% of electricity used in African continent. [6] Eskom participates on Southern African Power Pool (SAPP), comprised of South Africa, Mozambique, Botswana, Namibia, Lesotho, Swaziland, Zimbabwe and Zambia. In regards with generation of electricity, Eskom operates most of the base-load and peak capacity. Fossil fuel power plants are dominant in Eskom's capacity with almost 36 GW of coal-fired plants and 2,5 GW of gas-fired plants. There is also a minor nuclear capacity of 1,8 GW, 1,4 GW of pumped storage and 600 MW of hydro capacity. (Eskom, 2015) The African Development Bank financially supports South African public electricity utility, Eskom, in implementing RES projects, especially wind farms, as there is big, unused potential. (African Development Bank, 2012)

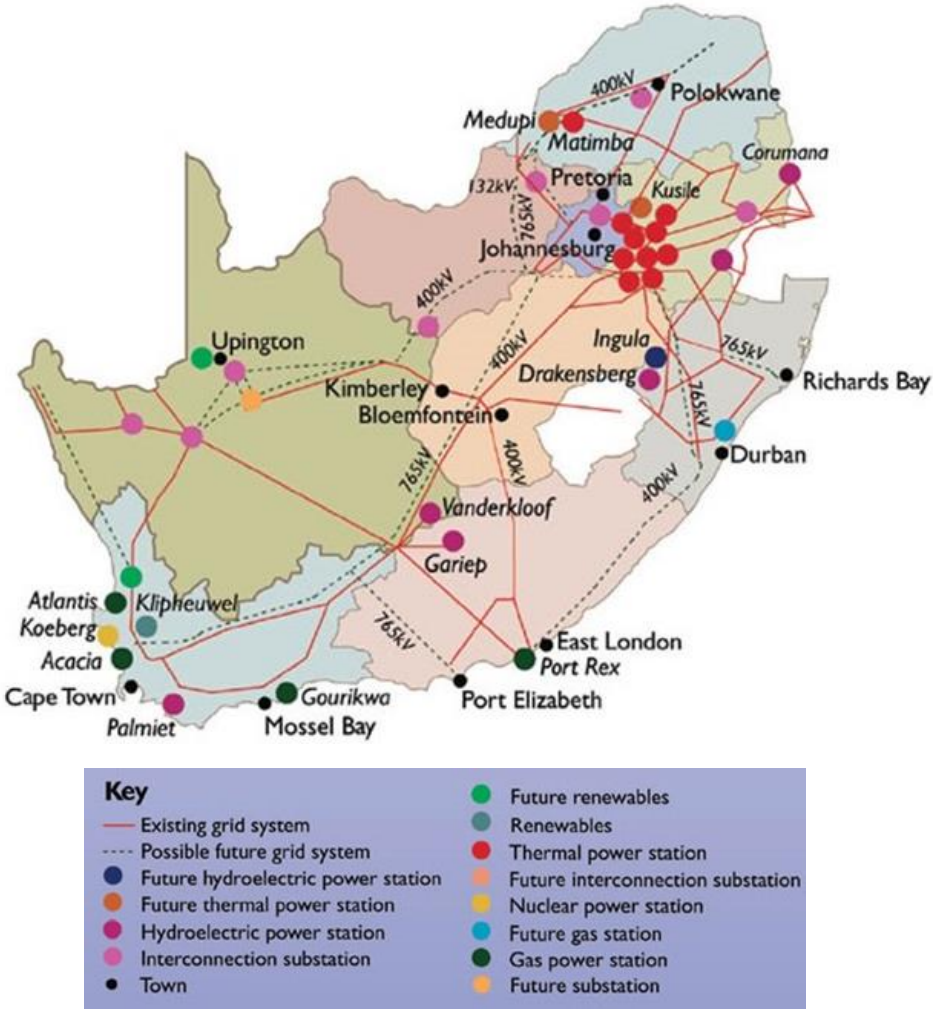
Besides, Eskom owns the transmission grid and is being a System Operator (SO), meaning it is in charge of grid planning as well. It maintains around 368.000 km of power lines, including 239.490MVA substations capacity. The distribution of electricity is split between Eskom and municipalities. As they generate electricity by themselves, buy it from Independent Power Producers (IPPs) or from international sources, Eskom distributes it all to industrial, commercial and residential sectors. They also sell electricity to municipalities and metro, which in return redistribute

[6] http://www.eskom.co.za/OurCompany/CompanyInformation/Pages/Company_Information.aspx

it within their ranges. (Eskom, 2015) The grid map of South African electricity sector is shown in Figure 7. Transmission grid is connecting only big load areas and there is significant potential for expanding the grid. Again, figure shows that all thermal power stations are located next to the coal mines. Power plants in the building process are also marked in the Figure 7.

Figure 7: South African electricity network map

Source: (Eskom, 2015)



Total installed capacity in the country is around 48 220 MW, and most of it belongs to Eskom. Only after the crisis in 2009 when Eskom faced serious problems in supplying country's demand for electricity, the Government decided it is time to introduce more Independent Power Purchasers into the system. Table 1 shows existing capacity per power plant, assumed for 2013 update of Integrated Resource Plan. Table shows that 42 330 MW of capacity is owned by Eskom while 3330 MW belongs to Independent Power Producers. 2560 MW is considered under demand response.

Table 1: Existing South African capacity assumed for IRP 2013 purposes

Source: (DoE, 2013)

	Capacity (MW)		Capacity (MW)
Eskom generation	**42330**	**Non-Eskom generation**	**3330**
Camden	1520	Cahorra Bassa	1500
Grootvlei	1080	Aggreko	90
Komati	900	Pretoria West	90
Arnot	2220	Rooiwal	180
Hendrina	1900	Sasol_Infrachem	150
Kriel	2880	Sasol_SSF	500
Duvha	3480	Steenbras	180
Matla	3480	Co-generation	360
Kendal	3840	MTPPP	280
Lethabo	3540		
Matimba	3720		
Tutuka	3540		
Majuba	3840		
Koeberg	1860		
Gariep	360	**Demand Response**	**2560**
VanderKloof	240	DR_Peaking	500
Colleywobbles	70	Interruptible Load	2060
Drakensberg	1000		
Palmiet	400		
Acacia	180		
Port Rex	180		
Ankerlig	1350		
Gourikwa	750		
		TOTAL	**48220**

The National Energy Regulator of South Africa (NERSA) regulates the electricity market since 2004 and promulgation of National Energy Regulatory Act. NERSA is in charge of issuing licenses, dealing with electricity tariffs, national grid codes, etc. Besides electricity industry, NARSA regulates petroleum and gas industries as well. This decision is rationalized by the objective to cut cost and improve efficiency.

There is a lack of institutional capacity that is delaying introduction of renewable energy sources and IPPs into system. There are constant delays in decision making and finalizing Power Purchase Agreements as Department of Energy is working alone. This will also need to be addressed in near future as electricity system is becoming more complex.

When we talk about electricity prices, it is surprising that South Africa held 10th place in the list of largest electricity prices in 2015. Table 2 shows the first ten countries with the largest electricity prices in the world according to NUS Consulting energy market survey. It can be seen that the price of electricity in South Africa increased for more than 8% since 2014 and amounted USc8,46 for kWh. What is more concerning for South African citizens is that increase for 2016 was approved by NERSA to be around 12,5%.

Table 2: 10 largest electricity prices in 2015

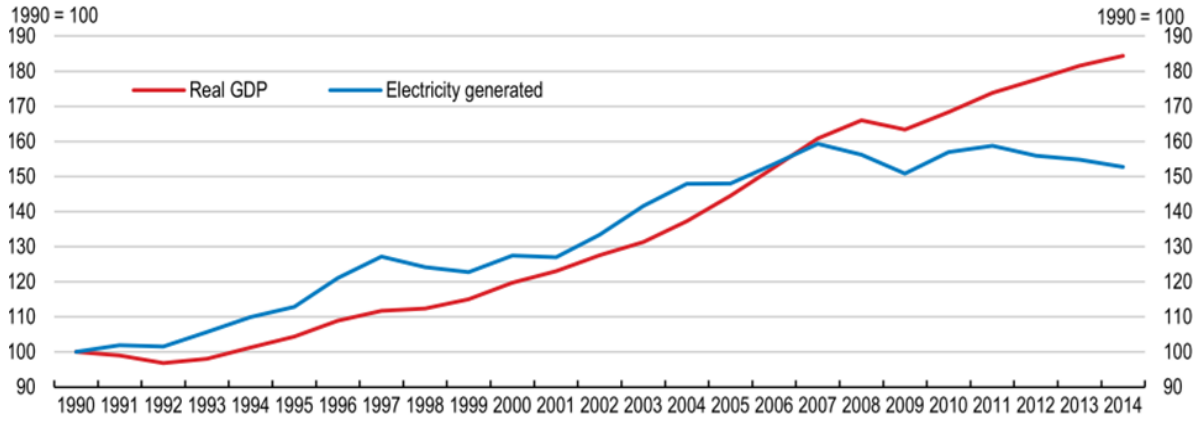
Source: (Business Tech, 2015)

#	Country	Electricity price (USD c/kWh)	Electricity price (ZAR c/kWh)	Change from 2014 (%)
1	Italy	15.70	219.12	-6.8%
2	Germany	15.22	212.42	-1.2%
3	United Kingdom	14.16	197.63	+1.3%
4	Belgium	11.17	155.90	+9.9%
5	Portugal	11.05	154.22	-0.4%
6	Spain	11.04	154.08	+1.0%
7	Slovakia	9.90	138.17	-1.6%
8	United States	9.43	131.61	-5.7%
9	France	8.97	125.19	+4.2%
10	South Africa	8.46	118.07	+8.2%

South African electricity sector was not always in the situation like today. Namely, for 30 years, until the early 2000s it had one of the lowest electricity prices in the world, having no problems with the supply of electricity. The situation abruptly changed in 2006 as rapid economic growth exhausted full generation capacity, built in 70s and 80s. This led to electricity shortages and load shedding throughout the country, as Eskom was not able anymore to meet the electricity demand. Figure 8 shows trends of both, generated electricity and real GDP from 1990 to 2014. Here is clearly shown the fall in generated electricity from 2006 and opposite patterns of both since. Country tried to respond quickly to the supply shortage by reducing the electricity demand and planning capacity expanding. The global economic crisis in 2008 has contributed to electricity demand reduction in following years, successfully keeping it under the available supply. Of course, this was not sustainable solution for long term, as GDP started to grow again in 2011, demand for electricity started increasing again. Now solutions needed to be more sustainable, such as leaning towards energy efficiency, liberalizing the electricity market, introducing renewables to electricity generation etc. (The National Treasury, 2011)

Figure 8: Electricity production and GDP in South Africa (1990-2014)

Source: (OECD, 2015)



The South African Department of Energy (DoE) has been responsible for searching the ways to confiscate supply deficit. From the beginning of 2014 they initiated construction of new coal power plants, they started the procurement of new nuclear power plants and started exploring the possibility of gas and oil usage as energy source. IPPs are now contributing more and more to electricity supply while importance of renewables (mostly residential solar PV) is increasing each year.

Claim that South Africa is still facing the electricity crisis is supported by the fact that it has experienced load shedding every 3rd day on average during the first 4 months in 2015. (The National Treasury, 2011) These problems in the electricity system are creating the problems for whole economy. Other industries, such as mining and manufacturing, services as well as export and import are strongly influenced by this situation.

It is apparent that the problem of supply deficit is due to lack of long term planning for many years in this sector. Despite the effort of making things right and publishing their first IRP, they are still missing the important fragment, grid planning. In the 2013 update of IRP, this topic was addressed superficially, acknowledging the need for new grid corridors. Information about the amount and types of capacity needed is not accompanied with the location of that capacity, neither who the producer is or will be. There is also no information on where demand is located.

This is not surprising as grid planning was historically missing from electricity sector. Namely, high demand zones were always overlapping with generation capacity areas due to geographic reasons. But, today grid planning in energy/electricity plans is necessary due to integration of distributed generation and renewable energy sources into system. These kind of capacities will probably be located far from the current load and generation zones, and will require expanding of transmission grid.

Table 3 below shows main trends affecting the electricity grid. Changes in the grid have different influence on different actors in the system. Actors affected by the changes in the electricity grid are shown in the column headings in the table. Main trends are decentralized generation capacity, intermittent solar and wind production, bidirectional electricity flows due to residential solar PV production and embedded or distributed generation taking place behind the meter. This embedded generation can't be properly documented or sold. As it can be seen in the Table 3, this affects municipalities, or better say their revenues which are mainly coming from electricity sales.

Table 3: Main trends affecting electricity grid in South Africa

Source: (Hedden, 2015)

Source: (Hedden, 2015)		**Planning**		**Operations**		**Policies**
		Energy planning	Grid planning	System Operator	Grid Operator	Municipality
Electricity Grid	decentralized		x		x	
	intermittent	x		x	x	
	bidirectional				x	
	embedded					x

It is obvious that there is conflict of interests as Eskom is main generator, system operator and owner of the grid, distributer and retailer at the same time. Because of this, in 2012 the a was proposed but it was withdrawn in 2015. This bill would have reorganized the electricity industry, separated system operator function from Eskom, as well as the whole transmission grid. The rationale behind this was to enhance competition in the electricity sector, in particular generation part. Also one of the reasons was to avoid discrimination by Eskom against IPPs in access to the grid and dispatching.

The reason behind withdrawing the bill were ominous effects the whole creation of independent system and market operator would cause. Namely, situation somewhat changed in last few years since the bill was proposed. Eskom is not anymore in the situation where they can discriminate some IPPs as there is need for each MW produced in the country. Moreover, the Government is the one who decides who will get the rights for building new capacity, as stated in IRP. Today IPPs are awarded by Minister of Energy in close consultation with Minister of Finance. Department of Energy is in charge of creating IRP as well as energy planning. Also, Eskom has connected in recent years around 500 MW of renewable IPPs, which further proves that there is no current need for segregation of these functions. (BDlive, 2015)

Even though restructuring of South African electricity sector is postponed for now, this incontestably needs to be within their long term plan. As the Government is proceeding with the liberalization of the market integrating private sector more and more, independent functions of market and system operators will become necessary to avoid collapse of the market. Otherwise, they should go back to the monopolistic model. In any case, this is the decision that needs to be made soon in order to make realistic long term planning.

4.2. Integrated Resource Plan

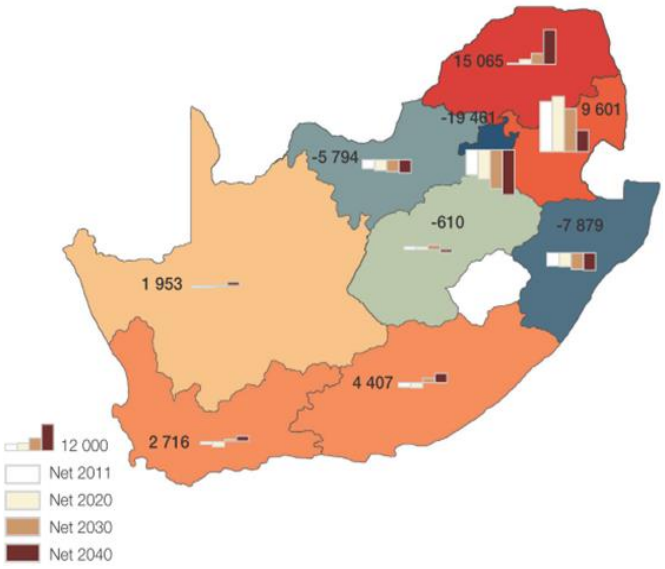
Integrated Resource Plan (IRP) is actually a national electricity plan of South Africa, created for the period of 2010-2030 and published in 2011. This is one of the most important recently published documents by the Government as it guides expansion of electricity generation until 2030. This is a long-term direction of the sector focused on sustainable development. This means that technical, economic and social constraints are included in the plan, as well as externalities. The objective of the plan is to identify investments that would result in maximization of country's objectives and investments that would equalize country's supply and demand for electricity.

In this document, the Government estimates that by 2030, around 90 GW of generating capacity will be needed to fulfill the demand. This means that South Africa needs to double its current capacity. (The National Treasury, 2011) It is clear that Eskom will not be able to accomplish this number by itself. Eskom is already struggling to cover its current costs, and has been demanding an increase of the electricity tariff few times already in last 3 years.

IRP is created in such way that could be updated from time to time. First update like that happened already in 2013. According to (DoE, 2013), there will be major changes in the provinces with electricity surplus or deficit. This is shown in Figure 9. Given their Base Case scenario and planned building of new coal fired plants, province Limpopo is likely to be the principal net supplier of electricity by 2040. Also, Northern, Western and Eastern Cape provinces are forecasted to be net suppliers of electricity due to increase in renewable and potential gas capacity. On the other hand, the demand in the Gauteng province will further increase, making already existing electricity deficit even deeper. This scenario doesn't include potential nuclear capacity, but this would probably further encourage net surplus of electricity in the Cape provinces. In pursuance of making this scenario possible, extension of the transmission grid is necessary.

Figure 9: Predicted net electricity balance for 2040

Source: (DoE, 2013)



IRP update also estimates the total capacity of the system per fuel type until 2030. This is shown in Figure 10. Considerable amount of wind and solar will be introduced in the following years, followed by nuclear in 2020s and finally gas when approaching to 2030. Significant amount of decommissioning is planned as well.

Figure 10: South Africa's total capacity by type, forecasted by IRP

Source: (DoE, 2013)

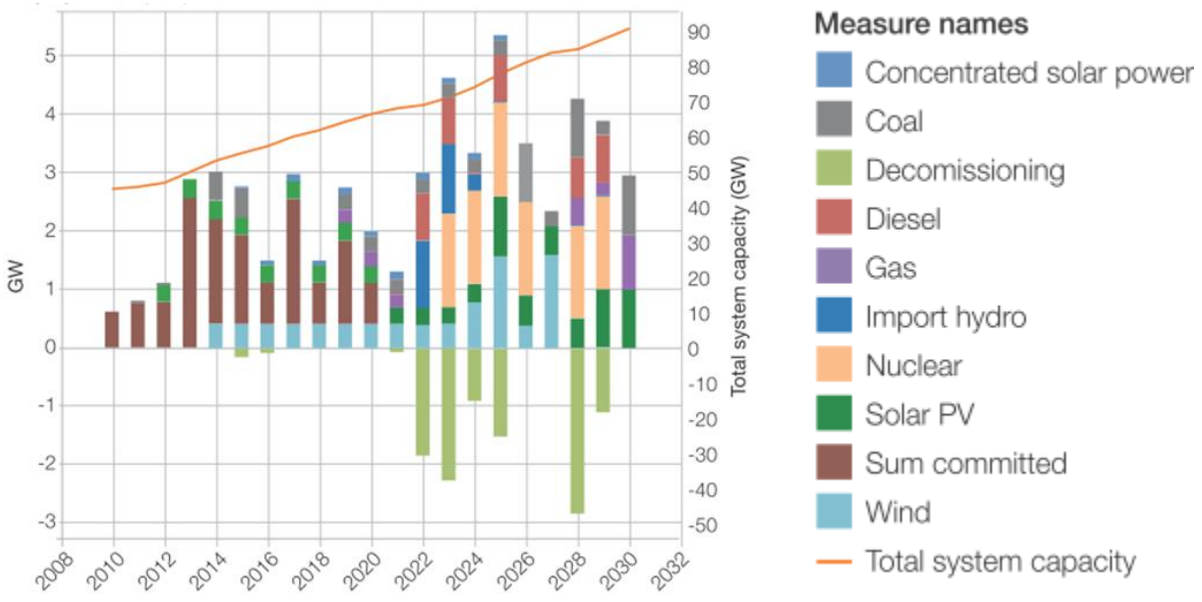


Figure 11 shows comparison between generating capacity in 2011 and the one planned for 2030. It can be seen that coal capacity is significantly reduced while wind, solar PV, nuclear and gas are experiencing more than double growth. IRP 2010 has committed to almost 18 GW (17,800 MW) of renewable energy by 2030, which is more than 20% of forecasted demand for that period. (SAWEA, 2016) Also, the overall capacity in the country increases for more than twice, reaching almost 90 GW.

Furthermore, IRP assumes that energy intensity[7] of their country's economy will decrease in the following years. This is because of South African national plan to move towards less energy intensive sectors, such as services. Figure 12 shows energy intensity in relation to the GDP per capita worldwide. Germany is clearly a leader in creating non-energy intensive GDP, while South African neighbor, Mozambique holds the worst position. South Africa's position is not very tempting as well.

[7] Energy intensity = how much energy is required for producing 1 unit of GDP

Figure 11: Total generating capacity comparison between 2011 and 2030

Source: (DoE, 2013)

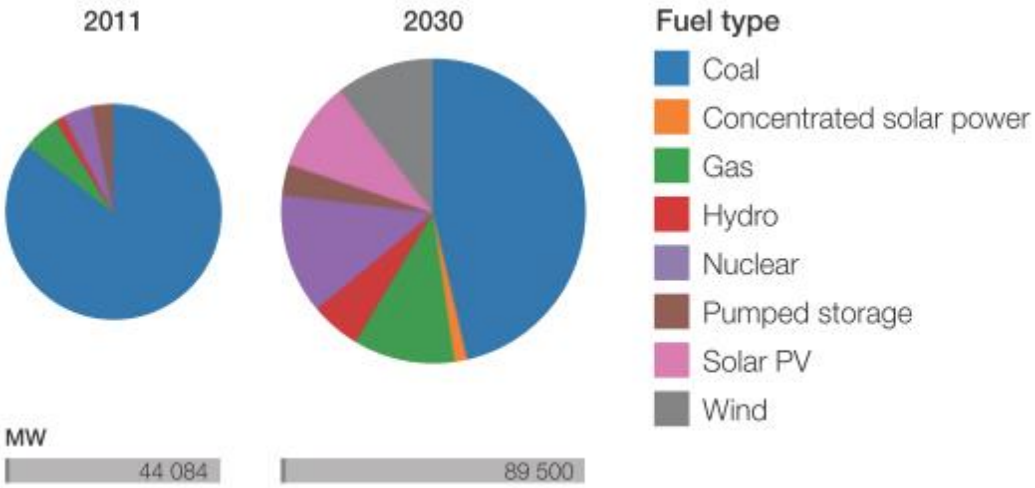
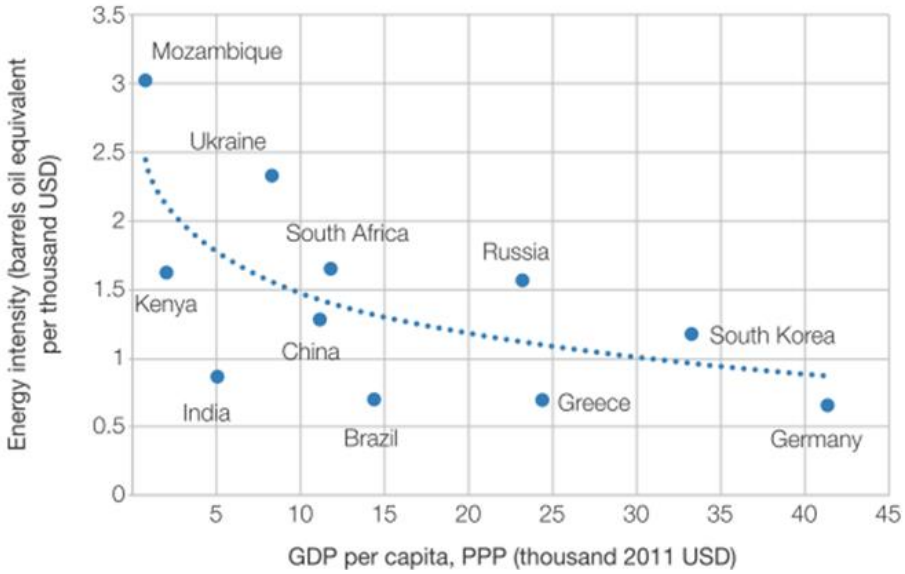


Figure 12: Energy intensity vs GDP per capita of worldwide economies

Source: (DoE, 2013)



4.3. Introduction of IPPs and renewable energy sources

In order to follow population growth and meet the increasing demand for electricity in the country, there is need for liberalization of electricity sector. Just recently the Independent Power Purchasers (IPPs) have been introduced to generation sector through various renewable energy programs under the authority of Department of Energy (DoE).

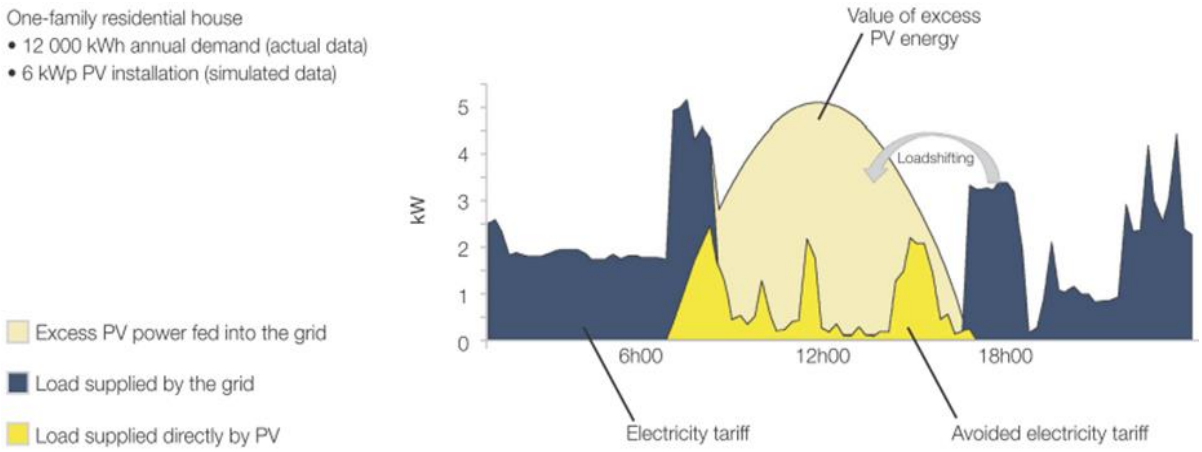
Today, it can be said that IPPs, RES and small scale distributed generation have drastically changed the picture of South African electricity sector comparing to the one before 2000s. Generation is becoming more decentralized and erratic with time, monopolistic model of the market slowly fades as new actors are entering the sector.

Previous circumstances in the country's electricity sector concerned many consumers, who in turn decided to produce their own electricity, mainly from solar PV on their rooftops. If there are no proper policies regulating this, this can further result in loss of revenues in some municipalities, as the major part of their revenue comes from electricity sales. (The National Treasury, 2011)

The picture below shows a typical winter daily load profile of a one family household with 6 kW solar PV installation in South Africa. What happens is that at the time solar power is being produced the most, household doesn't consume as much. Without appropriate regulation, these households will not be compensated for the energy excess they are producing.

Figure 13: Typical winter daily demand profile of a one-family household in South Africa

Source: (Bischof-Niemz, 2015)



As Independent Power Purchasers became more and more present in the electricity market in South Africa, the need for effective policies and instruments supporting them was necessary. In the global debate Feed-in tariffs (FiT) are widely chosen policy tool for enhancing private investments in renewable technology. Comparing to tenders, taxes, subsidies and other mechanisms, Feed-in tariffs are dominant on a global scale. Nowadays, many countries are introducing or transitioning towards auctions or tenders, particularly emerging economies[8].

Debate between these two policy mechanisms, FiT and tenders, is currently present in South Africa as well. After 2008 Feed-in tariffs were explored for the first time in the country. A Renewable Energy Feed-in Tariff (REFIT) policy was developed in 2009 by NERSA in order to promote competitiveness of renewable energy. These tariffs were covering costs of generation, adding Return on Equity (ROE) of 17%. (Kaberger & Eberhard, 2016) Table 4 below shows first Feed- in tariffs in the country. REFIT launched Phase I tariffs in March 2009, while Phase II was launched in October same year.

Table 4: REFIT tariffs in Phase I and Phase II, published by NERSA

Source: NERSA

	Technology	Tariff R/kWh	Tariff USc/kWh
Phase I	Wind power plant	1.25	16.9
	Concentrating solar power (CSP) with storage	2.1	28.3
	Small hydro power plant (<10 MW)	0.94	12.7
	Landfill gas power plant	0.9	12.1
Phase II	Biogas	0.96	13
	Biomass solid	1.18	15.9
	Concentrating solar power (CSP) without storage	3.14	42.4
	Solar photovoltaic (large ground or roof mounted)	3.94	53.2
	CSP central tower with storage capacity of 6h	2.31	31.2
1 Rand = 0.135 US Dollar on 30 December 2009[9]			

Even though the tariffs can be considered as quite generous, significant amount of uncertainty in licensing and procurement processes persisted. In addition to that, Eskom was not fully showing its support for the REFIT initiative. Further step made by NERSA also didn't help already wobbly situation. In 2011 they decided to lower FiTs, claiming that it was necessary due to increased debt and changes in the exchange rate of Rand. This time, tariffs were not indexed for the entire inflation, only the part of it. (Kaberger & Eberhard, 2016)

This is the moment when Department of Energy and the National Treasury decided to intervene. After concluding that FiTs were not showing expected results, they prohibited the use of this mechanism. The search for better policy instrument started, with the same remaining goal to reach

[8] Emerging economy is an economy with low to middle per capita income.
[9] http://www.exchangerates.org.uk/USD-ZAR-30_12_2009-exchange-rate-history.html

large scale renewable presence in the country. Both institution included all key stakeholders in the process, which proved to be a win-win situation. By the end of 2011 they announced Renewable Energy IPP Procurement Programme (REIPPPP) with competitive bidding. This is when REFIT program was terminated, after two years of unsuccessful integration of renewables into the system. Numerous RES project developers were dismayed by this happening, as they already initiated some project steps. Fortunately, it was these people who later benefited from the REIPPPP. (Kaberger & Eberhard, 2016)

The core of REIPPPP was the idea of Eskom entering Power Purchase Agreements (PPAs). The programme started running in 2011, and until today four bidding rounds are finalized. It is expected that the programme introduces around 13 GW of renewable capacity into the system by 2025. (SAWEA, 2016) These goals are consistent with South African National Development Plan (NDP) which calls for more diverse energy mix and introduction of IPPs.

Technologies considered under this programme are:[10]

- Onshore wind
- Solar photovoltaic
- Concentrated solar thermal
- Biogas
- Biomass solid
- Landfill gas
- Small hydro

The program introduces limit for each technology within renewable energy technologies, and the highest caps are for wind and solar PV. Caps are also set per projects. For instance, caps were 140 MW for wind and 75 MW for solar PV in the first bidding round.[11] Tenders for each technology are held simultaneously, and each bidder has the possibility to bid for more technologies and more projects. Bids are being accepted within three months upon Request for Proposal (RFP), and contracts need to be signed within 6 months from the moment of announcement of chosen bids. There are three, unnegotiable contracts to be signed. Power Purchase Agreements (PPA) are signed by chosen IPP and Eskom, and are lasting for 20 years. An additional contract, Implementation Agreement, needs to be concluded between Department of Energy and IPP. This agreement obliges DoE to guarantee for Eskom's payments, and in case of Eskom's non-payment, DoE needs to take it over. On the other side, IPP needs to deliver in advance set economic targets. The third contract is Direct Agreement, providing rights for lenders to step-in in the case of default. Even though all of these agreements are unnegotiable, IPPs seem to be satisfied with the overall picture. (Kaberger & Eberhard, 2016)

Requested documentation bidders have to submit is long-listed. Information on the project plan, environmental aspects, financial and legal qualifications, land and technology need to be available in proper form. All of this needs to prove that bidder has high possibility of executing the projects.

[10] http://www.ipprenewables.co.za/#page/303
[11] (Kaberger & Eberhard, 2016)

Moreover, each bidder needs to pay a registration fee of R 15 000[12] (US$985) in order to be able to submit their bids.

By virtue of REIPPPP, investments in South Africa's renewable energy grew unbelievably 25 000% in the first year of the programme, between 2011 and 2012. In 2014, South Africa found itself in the top 10 countries for investments in renewable energy according to United Nations Environment Programme (UNEP). Through REIPPP Programme, 43 projects have been implemented and are operational to date. Around 2060 MW has been added to the grid. Within these 43 projects, 27 are solar PV (995 MW), 13 are wind farms (953 MW), 2 are hydro power plants (14,3 MW) and 1 is concentrated solar power plant (100 MW). (SAWEA, 2016)

Four bidding rounds with $19 billion invested in 90 projects providing around 6 GW of generating capacity. In each round prices were falling down due to increased competition and lower transaction costs. Table 5 summarizes the details of four completed bidding rounds. (Eberhard, Kolker, & Leigland, 2014)

Table 5: Summary of basic details of 4 REIPPPP bidding rounds

Source: (Kaberger & Eberhard, 2016)

Bidding Rounds					
	1st round	2nd round	3rd round	4th round	TOTAL
Years	**2011**	**2012**	**2013**	**2014**	
Received bids	53	79	93	77	
Capacity (MW)	2128	3233	6023	N/A	
Selected bids	**28**	**19**	**17**	**26**	**90**
Solar PV	18	9	N/A	N/A	
CSP	2	1	N/A		
Wind	8	7	N/A	N/A	
Landfill gas			N/A		
Biomass			N/A	N/A	
Small hydro		2		N/A	
Capacity (MW)	**1416**	**1044**	**1456**	**2206**	**6122**
Solar PV	632	417	435	813	
CSP	150	50	200		
Wind	634	563	787	1363	
Landfill gas			18		
Biomass			16	25	
Small hydro		14		5	

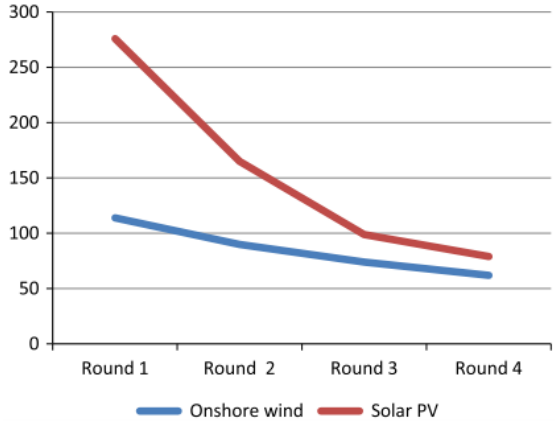
[12] http://www.ipprenewables.co.za/#page/303

The wind energy price in South Africa in the 4th round of REIPPPP bidding was R619/MWh ($40.54/MWh). This is nearly 40% cheaper than the prices predicted for Eskom's newly built coal power plants. (SAWEA, 2016) Figure 14 shows table of prices for solar PV and wind in all four rounds as well as graphical display of decreasing tendency of both types of generation within 4 rounds.

Figure 14: Prices of wind and solar capacities in all four rounds under REIPPPP

Source: (Kaberger & Eberhard, 2016)

South African Renewable Energy Programme		
Bid round	Wind ZARc/kWh	PV ZARc/kWh
Round 1	114	276
Round 2	90	165
Round 3	74	99
Round 4	62	79
Round 4		
Cheapest ZARc/kWh	56	77
Average USc/kWh	5.2	6.6
Cheapest USc/kWh	4.7	6.4



According to (SAWEA, 2016), net savings from wind energy in first six months of 2015 were R1,8 billion ($120 million). Together with solar photovoltaic this saving was R4 billion ($260 million) for the same period. (SAWEA, 2016) South African National Energy Development Institute (SANEDI) created the world's first "wind atlas", a map with indicated best locations for wind farms. The purpose of Wind Atlas of South Africa (WASA) is to facilitate data access to IPPs and accelerate their integration to the system.

Projects are being constructed in less than 2 years on average, and thanks to REIPPPP renewables are being introduced cheaper and faster than newly built coal power plants. The fact that electricity price paid to these projects declined for 68% in only 3 years is just encouraging DoE to keep going with the programme. (SAWEA, 2016)

What is interesting is that local communities are very much involved in REIPPPP projects. Their average shareholding in RES projects are 10.5%, which is a lot more than initially expected 2.5%. Moreover, job creation has escalated with REIPPPP. Manufacturing industry building wind turbines in Port Elizabeth has experienced more successful years than ever before. (SAWEA, 2016)

According to the announcement of DoE in November 2015, R91.1 billion ($5.97 billion) is devoted to development of new REIPPPP initiatives. They also stated that they selected 92 new projects which will contribute to the grid with additional 6 GW.

Even though IPPs are being integrated into the market and electricity source mix more and more, Eskom still controls majority of the generation capacity as well as the transmission grid. Together with the lack of appropriate regulation and policies, this creates confusion between roles and responsibilities in the sector. As grid operator, Eskom is obliged to integrate IPPs into the grid. Until

now they connected around 1,6 GW capacity, but now they are expressing their concerns about the future connections due to lack of the grid lines and high costs of connection. Namely, all unpretentious projects have already been connected since the beginning of the program, and the ones left are seeking expanding of the grid. (Hedden, 2015)

As much as introduction of renewable energy sources is desirable, it comes with the certain troubles. It affects reliability of the generation capacity as well as dispatching. Moreover, grid operations will need to change as well. Eskom, as system operator, will face a lot of new and more difficult responsibilities. It will have more difficult job to keep the balance between real time supply and demand, while maintaining the frequency at 50 Hz. The fact that temperature drop of only one degree Celsius in Gauteng province requires 400 MW of additional electricity supply.[13] It will need to make medium and long term forecast for wind and solar, and finally it will need to change their operating strategy.

Since neighboring countries barely have electricity to satisfy their own demands, South Africa cannot rely on their help in case of imbalance in the system. This means that, if there is no proper grid operating, there is a high possibility that South Africa will face common blackouts as their electricity system becomes more complex.

[13] Inside Eskom's National Control Centre ; http://www.bizcommunity.com/Article/196/597/97457.html

5. The Green Growth

5.1. Introduction to the Green Growth

A Green Growth Declaration was signed in June 2009 by Ministers from 34 countries at the OECD Meeting of the Council at Ministerial level. A mandate was endorsed by these countries for the OECD to create a strategy which connects development objectives with social and environmental aspects, a Green Growth Strategy. (OECD, 2011)

The idea behind the Green Growth is that in order to reach sustainable economic growth countries need to take into account social and environmental aspects as well. The best definition describing this concept in my opinion is coming from (African Development Bank, 2012): "Green growth is the selection of economic activities that, at best, promote environmental and social development and, at a minimum, do not harm the environment or human welfare." In order to choose an appropriate economic activity which will improve the quality of growth, the social and environmental impacts need to be carefully inspected.

Some other definitions of Green Growth, used by United Nations, World Bank and similar international organizations and agencies, imply economic development and job creation arising from reduction of emissions and improvement in efficiency of natural resources usage. (African Development Bank, 2012) Annex 1 shows the list of various definitions of Green Growth and Green Economy.

The Green Growth is not a "one size fits all" concept, which means every country needs to create its own green path, suitable for its economy. Also, there is no single "magic bullet" that can bring alone both growth and environmental sustainability. Therefore, there is need for use multiple policy instruments at the same time to achieve these multiple goals.

There are many ways to achieve the Green Growth, but there are some necessary components each country needs to have. Firstly, the involvement of the Government and the robust political commitment is needed. In addition, there is a need for involvement of the Ministries in charge of the sectors with green initiative. In order to do things right, the participation of a private sector is essential, as well as Public-Private Partnerships (PPP). All the stakeholders affected by this transition to a greener economy need to be taken into account as there will be some serious changes in costs/benefits distributions. This is why the implementation needs to be prudently planned ex ante.

Implementation of Green Growth faces a big number of constraints which require intensive policy changes and support. Following Table 6 shows the main constraints and appropriate policy responses.

Table 6: Green Growth constraints and corresponding policy options

Source: (OECD, 2011)

Green Growth Constraints	Policy Options
Inadequate infrastructure	- Public investment - Public-private partnerships - Tariffs - Transfers
Low human and social capital and poor institutional quality	- Subsidy reform/removal - Growing and stabilizing government revenue
Incomplete property rights, subsidies	- Review and reform or remove
Regulatory uncertainty	- Set targets - Create independent governance systems
Environmental externalities	- Tradable permits - Subsidies - Taxes
Information externalities and split incentives	- Labelling - Technology and performance standards - Subsidies
Network effects	- Strengthen competition in network industries - Subsidies or loan guarantees for new network projects
Barriers to competition	- Reform regulation - Reduce government monopoly

OECD Green Growth framework offers 4 groups of indicators for tracking the progress of greening, which is shown in Figure 15. The list of indicators proposed by OECD was based on their previous work and experience. The list will probably grow with future available data. Interpretation of listed indicators needs to be done carefully in order to avoid losing sight of cross-sectorial activities.

Figure 15: 4 groups of indicator to monitor the progress of Green Growth

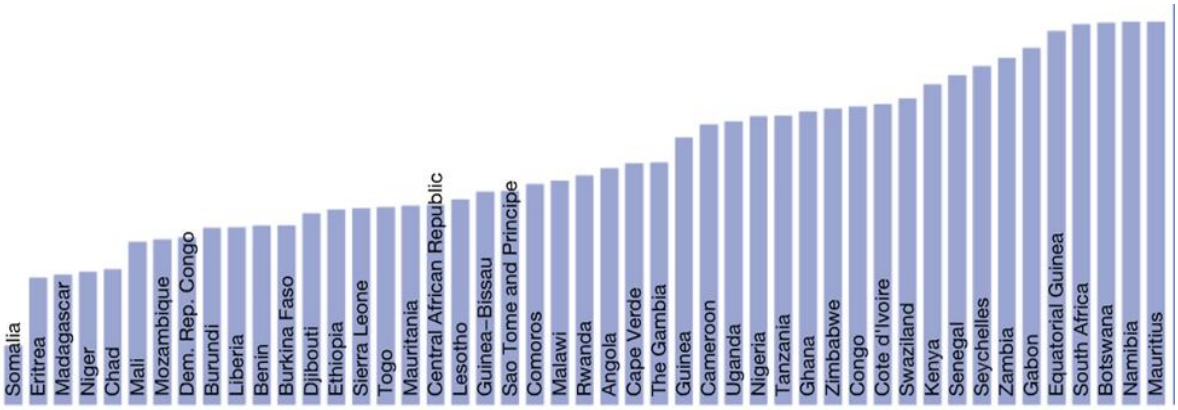
Source: (OECD, 2011)

What can be said is that GDP is not an adequate indicator for sustainability of the growth. There are some measures that could be used together with the GDP in order to have a comprehensive picture of countries development. To bridge this gap, we could use Environmental Performance Index (EPI).

Environmental Performance Index (preceded by Environmental Sustainability Index) which ranks countries upon their performance in two areas of environmental issues, protection of human health and protection of ecosystems. (Yale University, 2016) This index contains more than 20 outcome-oriented indicators that measure country's proximity to international targets, if established, or compares countries between themselves. EPI is used in evaluation of national performance regarding United Nations SDG's (Sustainable Development Goals). According to the last EPI report from 2016. South Africa is on 81st place from 180 countries with the score of 70.52/100, which is higher than the most countries in region (Yale University, 2016) This can be seen in Figure 16.

Figure 16: EPI in Sub-Saharan Africa for 2016

Source: (Yale University, 2016)



5.2. The Green Growth in Africa

Economic growth is essential in Africa to mitigate poverty, create jobs, increase social development, meaning primarily education and improve life quality overall. During the past decade, Africa has had some of the fastest economic growth rates in the world.

According to (Tani, 2016) in the period from 2001 to 2010, the African real GDP growth was 5.5%, which is few percent more than Europe and both American continents, but a bit less than Asia Pacific. Moreover, Africa and Asia have been experiencing hastening growth in both GDP and GDP per capita over the past 55 years, whereas Europe, North and South America have experienced an overall drop.

Increase in foreign investments as well as improvement in macro-economic trends were striking in the past 10 years. Unfortunately, this recent growth didn't result in much poverty alleviation and improved livelihood. Namely, this growth was patchy and unequal, focusing on few chosen sectors e.g. energy intensive industry and agriculture. Likewise, all the benefits deriving from the increased investments were not fairly distributed. (African Development Bank, 2012)

Moreover, even though its continent has an abundance of natural resources, Africa is missing an efficient management of it. Both, non-renewable and renewable resources are unequally dispersed and countries with natural resource based economies usually show faster growth. Besides, infrastructure deficit and low electrification rates are common problem to all African countries, and are also driving their economy backwards. (African Development Bank, 2012)

Furthermore, a new threat to Africa's economic growth has appeared in recent years. According to (AMCEN), African continent will be affected severely by the impacts of Climate Change. Comparing to other continents, Africa will be affected the most. Even though a lot of people could argue that my statement "in recent years" is wrong as this problem has been present for quite some time, I chose such a choice of words because only now Climate Change has been put under the spotlight in Africa.

Variability that Climate Change is bringing will be just additional, unneeded burden to already destabilized sustainable development in Africa. Africa's distinctive biodiversity, scarce arable land and the whole population will be the main victims of the Climate Change.

As it has been stated in (AMCEN), some of the projected impacts are:

- disappearance of certain coastal areas due to rise of the sea level by the end of this century;
- up to 10% of Africa's GDP will be needed to cover the costs of climate change adaptation;
- already scarce resource, water, will soon reach stress levels, which directly affects food security and population's survival overall;
- endangerment of up to 40% of mammal species due to loss of their natural habitats as ecosystems are changing;
- extreme seasonal rainfalls and droughts;
- severe drop in agricultural yields;
- appearance of new diseases and endangering of already undermined human health.

After years of favoring environmentally unsustainable economic activities and national policies, Africa is facing certain difficulties in this transition to green economy. National development plans and policies, together with regional ones need a reform. As countries are connected in many different ways (e.g. economy, trade, infrastructure, land etc.) correlation between them is needed. As I already mentioned above, changing the regulation to eliminate current market distortions that favor public sector and companies is essential. In particular, this is mostly needed in the energy and industry sectors.

The Green Growth concept is suitable for African continent as they have an infrastructure deficit, which can be overcome with the investments in the environmentally sound technologies (EST). Otherwise, it would be very expensive to replace already existing unsustainable infrastructure forced with years. Furthermore, shortage of the natural resource management leaves space for introduction of environmentally sound management (ESM). If Africa continues to exploit its natural resources at this rate, it would soon reach the limit to its natural system destruction.

Finally, the biggest incentive to go with the Green Growth in Africa is Climate Change. Mitigating emissions by using carbon efficient technologies could be Africa's main contribution to meet the global targets in this area. On the other hand, there are some unavoidable threats deriving from the Climate Change. Here, the efforts need to be focused on adaptation. (African Development Bank, 2012)

The upfront cost of the greening will, of course, be really high. This is probably the main reason why countries were avoiding this until they really felt endangered. Even though todays change will bring cost savings in the long term, not many people are able to realize that. Moreover, lack of information and knowledge about environmentally sound options is also one of the reasons why this transition hasn't been done earlier. African countries have been traditionally choosing technologies with the lowest investments, as their focus at the time was on more existential problems. (African Development Bank, 2012) For African Countries to afford greening, they will need assistance of proper international organizations as well as financial institutions.

The AfDB is currently playing a fundamental role in greening Africa's growth by helping countries to overcome this transition. AfDB's strategy for 2013-2022 is achieving high quality, inclusive and sustainable growth in Africa. According to them, the Green Growth is about reaching development targets while maximizing efficiency of natural resources, minimizing pollution and waste and building resilience of economies and people. (AfDB, 2014)

In order to support strategic planning and operational work on the Green Growth concept, a special team is created within AfDB. The team is connecting few departments and is chaired by the Climate Change Coordination Committee (CCCC) and the Energy, Environment and Climate Change Department (ONEC).

Activities under the Green Growth concept of the AfDB are organized along 3 work flows:[14]

- developing conceptual, programmatic and knowledge-based guidance;
- awareness & capacity development;
- supporting regional member countries in transitioning to a green economy.

Under the first work stream, AfDB works on Green Growth related publications for the use of decision makers and institutions dealing with development related areas. In 2012, upon the G20 Development Working Group request, AfDB has developed "A Toolkit of Policy Options to Support Inclusive Green Growth" together with the OECD, the UN and the World Bank. This toolkit provides policy-makers with the Green Growth framework, incentivizing, financing and monitoring tools as well as challenges and solutions of climate change and capacity building. (UN, OECD, AfDB, & World Bank, 2013)

In order to increase awareness and promote capacity building, AfDB is organizing thematic trainings and workshops for the key stakeholders in the member states. Besides, the Bank is working National Development Plans with its member countries. It provides its analytical and technical assistance through pilot activities. Countries such as Sierra Leone, Kenya, Mozambique, Mauritius, Morocco and South Africa have been working closely with AfDB on their Green Growth undertaking. The Bank is also providing assistance on the project level, helping countries to develop proper practices and technologies. Finally, the Bank provides the most essential, financial help, through its numerous financial instruments (e.g. African Water Facility (AWF), Congo Basin Forests Fund (CBFF), Sustainable Energy Fund for Africa (SEFA), Africa Renewable Energy Fund (AREF), Global Environmental Facility (GEF), Climate Investment Funds (CIF), etc.) (AfDB, 2014)

[14] http://www.afdb.org/en/topics-and-sectors/initiatives-partnerships/green-growth-initiative/background/

According to AfDB, the main African focal areas of the Green Growth should be those listed in Table 7.

Table 7: Green Growth Focal Areas in Africa

Source: (African Development Bank, 2012)

Green Growth Focal Areas		
Promoting sustainable infrastructure	**Efficient/Sustainable management of natural resources**	**Building resilience and adaptive capacity**
Access to renewable/low-carbon energy & energy efficiency	Land (agriculture, forests and other land uses)	Physical/Climate
Sustainable transport	Water (fresh water, marine)	Economic
Sustainable cities	Minerals	Social
Cross cutting issues: Regional Integration, Private Sector, Gender, Youth		

- Promoting sustainable infrastructure

The first pillar is dedicated to one of the main problems in Africa I have already mentioned. Both, rural and urban infrastructure should be taken into account. Within this pillar there are 3 sub-areas.

The first sub-area recognizes the problem of energy infrastructure, i.e. energy access. There is certainly a place for improvement given than 635 million Africans are lacking access to electricity, and at the same time there is a big difference between urban and rural electrification rates, 68% vs 26% respectively.[15] Additionally, Africa's abundance of renewable energy resources such as solar, biomass and wind is underused.

The second sub-area is sustainable transport. What lies under this is a change towards public transport, as well as shift from road to water transport. This is well-suited with environmental and health concerns in Africa.

The third sub-area are sustainable cities, concentrating on importance of nowadays urbanization. With better urbanization plans, comes lower disaster risk, better provision of services such as water and electricity as well as pollution reduction.

[15] (IEA, 2015)

- Efficient/Sustainable management of natural resources

The second pillar is dedicated to the land usage, water and minerals. Proper management of three sub-areas is important in order to preserve Africa's ecosystem and vast biodiversity, while upgrading its livelihoods.

Considerable amount of land degradation in Africa has some major consequences such as reduction in soil fertility, lower yields and increase in GHG emissions. According to the report (Agriculture for Impact, 2014), 65% of Africa's arable land is already damaged so much that it can't sustain viable food production. Moreover, according to the same report, this prevention of the crop yields brings 68 billion dollars of economic losses in Africa. Taking into account this disturbing numbers and information, it is clear how important is the future land management for Africa.

Furthermore, the second sub-area related to water management has some alarming numbers behind it as well. Namely, on the conference "Water Scarcity in Africa: Issues and Challenges" held in Paris in 2012 it was stated that more than 300 million people in Africa live in water stressed/scared environment. With the current climate scenarios in Africa, up to 250 million people will be living in high[16] water stress areas by 2030. (Climat Environnement Société, 2012)

- Building resilience and adaptive capacity

The third pillar focuses on climate, economic and social aspects. Building climate resilience means addressing vulnerabilities that regions, countries or communities in Africa have, with regards to climate change consequences on its environment. The other two types of resilience should deal with protection of countries' economies and populations from the shocks globalization and growth are bringing. The crucial steps in building these resiliencies is finding suitable adaptation measures and establishing efficient risk management which will prevent the loss of natural resources, incomes and lives. (African Development Bank, 2012)

- Cross Cutting issues

There are several issues spanning all focal areas. One of them is engagement of the private sector, which is a necessary ingredient for a successful transition to the Green Growth. Furthermore, the regional integration can overcome some challenges or exercise the opportunities that acting alone can't. In addition, gender mainstreaming is infallible in all thematic areas as well as the empowerment of children and youth. (African Development Bank, 2012)

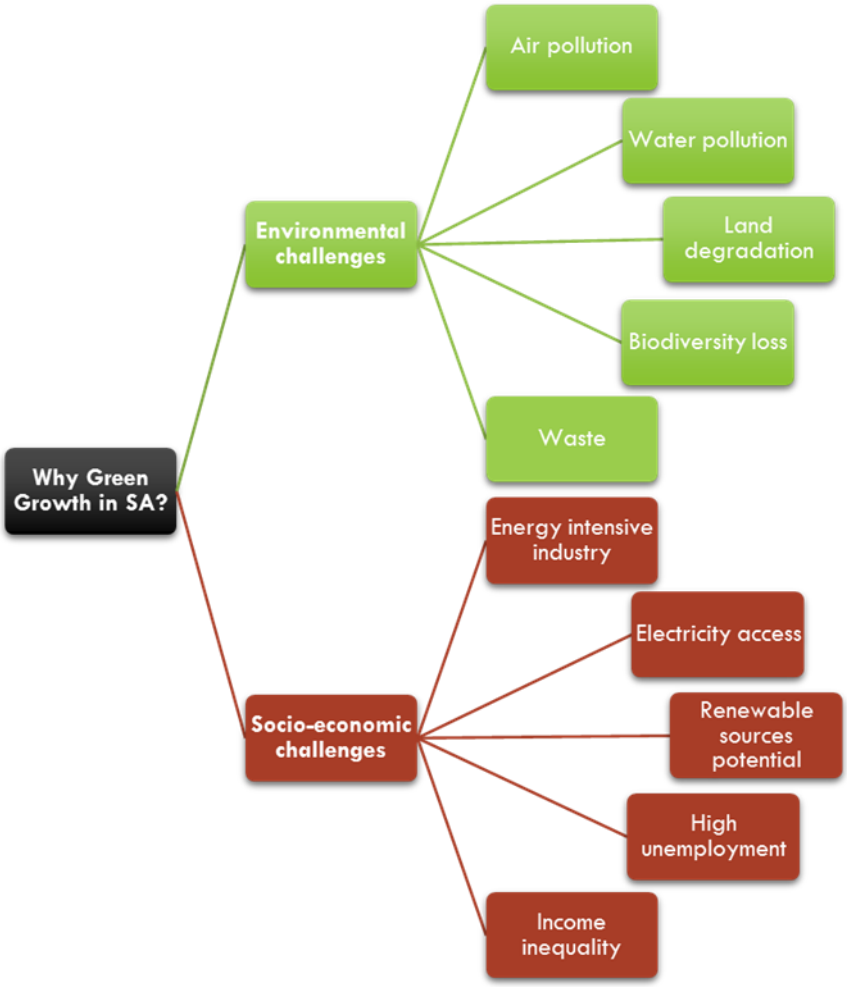
[16] 40-80% of the water available to agricultural, domestic, and industrial users is withdrawn annually, leaving businesses, farms, and communities vulnerable to scarcity.

5.3. The Green Growth in South Africa

South Africa is Africa's most industrialized economy. Its economic development is largely due to the exportation of natural resources such as coal, cotton and diamonds. Besides this it has a powerful service sector and Johannesburg's stock exchange is the largest by market capitalization on the African continent. (AFP , 2015)

The idea of sustainable, greener growth has resonated in South Africa as well. Their national goals, such as reducing very high unemployment, mitigating air pollution, in particular CO2 emission and addressing the problem of water scarcity are perfect fit with the Green Growth concept. As already mentioned above, each country needs to start the change from the policy level downwards. In order to reflect real environmental and social costs in its economy, South Africa has already made some progress in its policy reform. Figure 17 below illustrates environmental and socio-economic challenges that South Africa faces, which are the main reasons behind their Green Growth initiative.

Figure 17: Reasons for Green Growth introduction in South Africa



According to South Africa's "National Development Plan – Vision for 2030" (NPC, 2011) and "Integrated Resource Plan" (DoE, 2011), one of the key goals for the country are increasing energy efficiency and electricity supply, while addressing environmental aspects of energy use at the same time. A lot of historical mistakes of their industrial development brought them to these 2 plans published in 2011. Decades of favoring energy intensive sectors led to high dependence on fossil fuels, especially coal. While at the time this was justified by relatively cheap energy and electricity, today this makes South Africa an unsustainable economy. Looking not only at air pollution, but at energy efficiency as well, South Africa is among one of the foremost countries on the first list, and among the last ones in the second list.

If we take a look at the synergy between green and growth on South Africa's example, we can see the possibility of benefits coming from both ways. On the green side, introducing carbon taxes would increase fiscal revenues that further could be used in several ways, either as investments or to finance cuts in other, distortionary taxes. Decreased pollution leads to cleaner water, which could lead to improved health and productivity of working-age population and finally to decreased unemployment. On the growth side, if their current policies (slanted towards energy intensive industries) change, that would certainly affect GHG emissions, and make their economy more efficient. (IBRD, 2011)

- Effects on unemployment:

First of all, it is obvious that decrease in unemployment will not be easily reached just through direct growth of the certain green sector. Reaching this goal is much more complicated as expanding one green sector means markdown of the non-environmentally sustainable sector, such as energy intensive industry. For instance, transitioning from fossil fuels to renewable energy sources (RES) means reduction of jobs on one and enhancement on the other side, i.e. sector. Therefore, what needs to be a proper indicator is the net employment which includes direct and indirect effects on job creation. (IBRD, 2011)

Of course, there is a need for reforms in complementary policies as South Africa's unemployment problem is much broader than just job creation. A big percentage of unskilled labor will not allow immediate change towards skills-demanding renewable sectors. Thus, the greening needs to follow the direction suitable also for South Africa's current labor market. (IBRD, 2011)

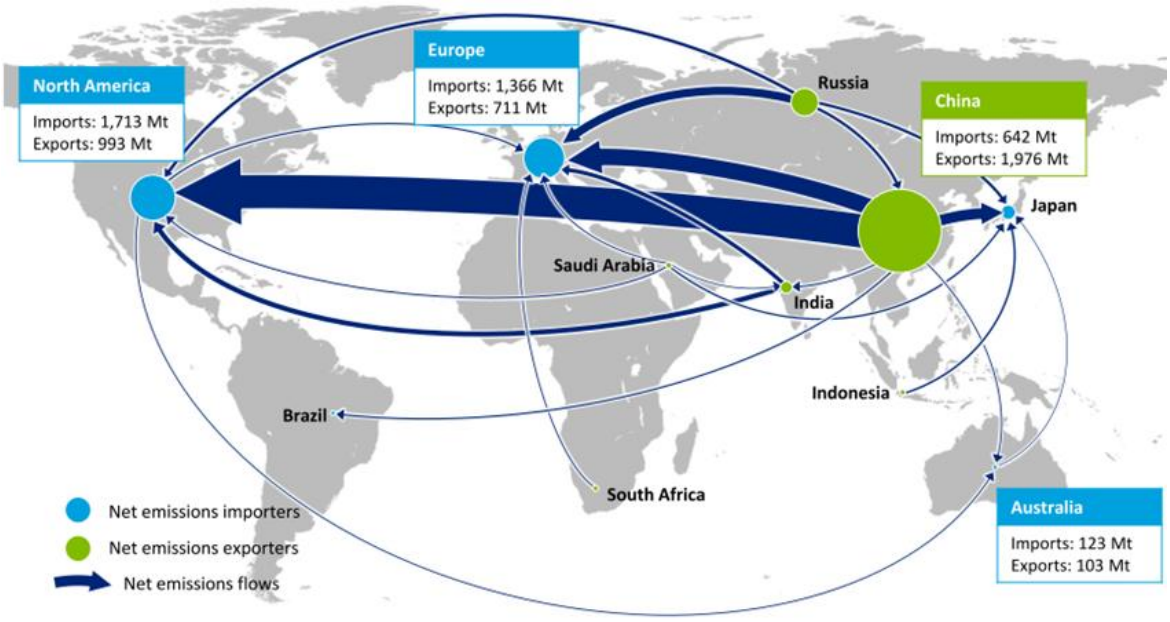
- International positioning effect:

An interesting fact is that South Africa is a net emissions exporter due to significant exports of energy. Namely, their carbon consumption is around 40% lower than carbon production. The destination of the exported carbon emissions is mainly Europe. In the Figure 18 below, taken from (Deloitte, 2015) we can see the main world importers and exporters of energy emissions in 2011.

As it can be noticed, the leader in the export is China, followed by Russia and India. This situation introduces a huge risk for South Africa, making it vulnerable to carbon pricing in European countries, its main export destination. This risk could be significantly hedged by introducing their own carbon taxes.

Figure 18: Net energy emissions flow in the G20, 2011 (Mt CO2)

Source: (Deloitte, 2015)

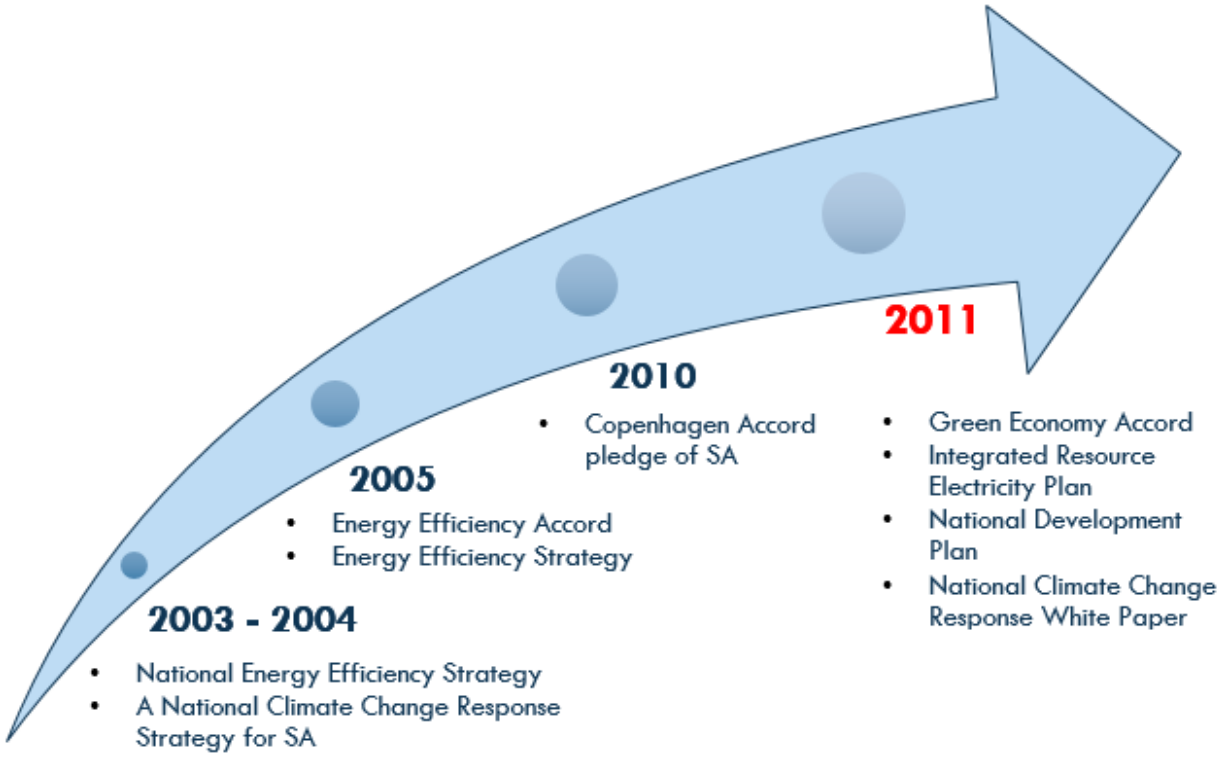


South Africa has several adopted policies with major greening potential for carbon emissions reduction and energy efficiency:

- New Growth Path Framework
- National Climate Change Response White Paper
- National Development Plan: Vision for 2030
- Integrated Resource Plan 2010-2030
- Green Economy Accord
- Copenhagen Accord pledge of South Africa
- National Energy Efficiency Strategy
- Energy Efficiency Strategy of the Republic of South Africa
- Energy Efficiency Accord

Figure 19 shows chronological order of implementation of most important policies affecting Green Growth in South Africa.

Figure 19: Main adopted policies influencing Green Growth in South Africa



The National Energy Efficiency Strategy from 2003 is the first for South Africa and it relates the development of energy sector with socio-economic development of the country. This strategy provides guidelines for the application of efficient practices within South Africa's economy. This is a framework for multiple sectors within the country, while the Energy Efficiency Strategy from 2005 is more specific one, focusing on energy sector. The objective of the strategy is to minimize the negative effects the energy use has on people and the environment, while reaching affordable energy for all. (DoME, 2005)

A National Climate Change Response Strategy for South Africa, published by Department of Energy, states that the country will have an obligatory submission of GHG emissions data by all big emitters to the National Atmospheric Emission Inventory by 2013. (IEA, 2016)

Following the Energy Efficiency Strategy from 2005, The Energy Efficiency Accord was signed between the Government and 24 major energy users. This was a voluntary commitment of the industry to work on the Government's target for energy savings. One of the targets was the 15% reduction of final energy demand of the industry as 12% increase in energy efficiency for the whole country by 2015. (IEA, 2016)

Upon 15th session of Conference of Parties in Copenhagen in 2009, the Copenhagen Accord Pledge of South Africa was published in 2010, where is stated that South Africa is committing to reduce its emissions by 34% until 2020 and 42% until 2025. (IEA, 2016)

The Green Economy Accord was signed by the Government and its social partners in 2011, as a result of The New Growth Path. The accord implies a partnership to create large number of green jobs, as one of the objectives of The New Growth Path. Namely, the goal is to create 5 million new jobs by 2020. (IEA, 2016)

The National Climate Change Response White Paper was published also in 2011 by the Department of Environmental Affairs. This is a long-term vision for climate-resilient and low-carbon economy, with mitigation and adaptation measures. It sets mitigation targets for 2020-2025. (IEA, 2016)

6. Putting a Price on Carbon

6.1. Introduction to a Carbon Tax

*A **Carbon Tax** (carbon dioxide tax or CO2 tax) is a fee based on the carbon content of fuels. Because of the strict proportionality between fuels' carbon content and their carbon dioxide emissions when burned, a carbon tax is effectively a tax on the carbon dioxide emissions from burning fossil fuels.* (Carbon Tax Center, n.d.)

*The **objective of a Carbon Tax** is not creation of revenue for government, but to decarbonize country's economy through price signals it sends to the market, meant to change demand side behaviors and stimulate supply side to shift towards low carbon options. Together with fitting revenue recycling, the bad effects transitioning period is having on economy should be trifling.* (Carbon Tax Center, n.d.)

*Carbon Tax can be implemented **"upstream"** on carbon content of fuels, **"downstream"** on emitters, or **combined** - upstream tax on fuels and downstream tax on process emissions.**Invalid source specified.***

Carbon taxes are there to internalize external effects of consumption of energy products into prices. To do so in proper way, the design of the tax is of great importance. Setting optimal tax rate means it needs to be equal to marginal external cost in situation when production and pollution levels are optimal. As this is hard to achieve in practice, countries usually set this equilibrium at the current production level. When considering GHG emissions and CO_2 emissions in particular, it is hard to estimate its external cost due to its long accumulation during decades and unknown impact on future generations. This is what makes countries to implement continuously rising tax rates, with yearly percentage increases. Many have discussed the question of optimal tax rate within a carbon tax, and across hundred different studies the optimal tax rate ranges between US$3 to US$95. (Ptak, 2013)

A carbon tax is classified under energy taxes which fall under environmental taxes. When country imposes an energy tax, it is usually considered as an implicit carbon tax. The difference is that energy taxes can be introduced for fiscal reasons only, while explicit carbon tax should be introduced for environmental purposes only. Also, energy taxes put price on energy content of fuels and are proven to be less effective in GHG reduction due to weaker incentive they create for fossil fuel substitution. If looking at implicit carbon taxes, it can be assumed that CO_2 emissions are taxed in whole Europe due to existence of various energy taxes. An implicit carbon tax rates are usually higher for motor fuels such as petrol and diesel oil while the most carbon intensive fossil fuel, coal, has very low tax rate. This is why an implicit carbon tax is considered as less effective instrument for carbon dioxide reduction comparing to the explicit one.

Two main behavioral responses are noticed when a carbon tax is introduced. Firstly, energy saving technologies are being developed and implemented due to increased fuel prices and secondly incentives are created in the energy sector primarily to shift towards less or non-carbon intensive fuels. In both cases GHG emissions are being reduced and green part of Green Growth is being achieved. The Growth is more difficult to achieve, especially in transition period. There is also third, but lower incentive for CO_2 sequestration through carbon capture and storage.

In order to achieve the Growth from Green Growth, it is necessary that a carbon tax is also cost-effective. To be cost effective means to achieve the goal at the lowest possible cost. Evaluating whether South African carbon tax is going to be cost-effective or not begs the question what is the anticipated goal and how much should it cost. The goal is clear: reduction in GHG emissions to achieve committed levels by 2020 and 2030 together with economic growth. A carbon tax is proven to be effective in achieving GHG reduction in each country that is going to be discussed in next chapter. To minimize the cost of carbon dioxide emission reduction, marginal cost of carbon dioxide abatement should be equalized across all fuels. What influences the most cost effectiveness is how revenues of a carbon tax are used.

Another important step in carbon tax design are exemptions from the tax as well as tax reductions. There are sector or fuel exemptions in each country which implemented a carbon tax. Usually those are energy-intensive industries which are most affected by the change a carbon tax is bringing. Besides these, sectors exposed to international trade should be also protected in order to save their competitive position on international market. Effect on domestic businesses limits the benefits of a carbon tax. It could create an incentive for relocation of production to other countries, without

imposed carbon taxes. In this situation, businesses should bear in mind the long term results of a carbon tax, which is possible comparative advantage against countries who didn't introduced or later introduced this kind of tax. It is becoming certain that all countries will need to implement such mechanism as collective action is needed in order to keep up with climate change impacts. Cooperation between countries and coordinating this tax internationally would evade the possibility of carbon leakage[17]. Such harmonization of a carbon tax systems would allow countries to put tax revenues into energy research and development.

With regards to revenues, another possible obstacle in carbon tax design and the biggest concern of the South African Government, is redistribution of revenues gained from a carbon tax. There are many questions asked. How should the Government use the revenues? Should they reimburse most affected people, or should they help most affected businesses? Should they use it to reduce national deficit or maybe reduce other, distortionary taxes? Should the use it for R&D of new, energy efficient technologies, or rather help IPPs to faster introduce renewables into system? There are many questions, but not a single answer. Revenue recycling is not "one size fits all" concept.

There are several ways how revenues could be distributed:

- Finance environmental investments, in particular carbon mitigation programs (this reinforces tax effects)
- Reduce national deficit
- Return it back to the taxpayers
- Fund government's budget
- Cut distortionary taxes (such as income taxes)
- Help the poorest taxpayers

Each country should make a decision according to economic situation in the country and its national goals. Smart revenue recycling can reduce resistance of certain sectors in the country, which is a stepping stone towards optimal carbon tax implementation. This means that South Africa should make a decision consistent with its National Development Plan and Integrated Resource Plan.

When considering a revenue recycling option, the Government should take into account repressiveness of the tax imposed. Studies have showed that a carbon tax, together with other energy taxes, is slightly regressive. (Ptak, 2013)The poorest, low-income household are usually affected the most since they are paying higher electricity bills. In order to create a progressive carbon tax, countries should include some policy options when designing the tax. Tax-free allowances and tax refunds are the best way to do so, next to tax exemptions. Besides, a carbon tax should be integrated into the system in phases, allowing gradual adaptation and avoiding economic shocks, such as one happened in Australia.

Significant amount of revenues could be collected from a carbon tax. An annual increase in the tax rate which includes inflation is necessary to preserve these revenues.

[17] **Carbon leakage** is the situation in which, as a result of stringent climate policies, companies move their production abroad to countries with less ambitious climate measures, which can lead to a rise in global GHG emissions. (http://carbonmarketwatch.org/category/eu-climate-policy/eu-ets/carbon-leakage/)

Another main market-based policy tool for addressing GHG mitigation, next to a carbon tax, is emission trading system (also called emission trading scheme or cap-and-trade system). As it will be seen later, this instrument exists all around the world, and the most famous one is implemented in EU, so-called EU ETS. Both mechanism can achieve same results, but under different circumstances and costs. Table 8 summarizes key differences between two instruments.

Table 8: Key differences between a carbon tax and emission trading system

	Carbon tax	ETS
Price	certain	uncertain
Quantity of emissions	uncertain	certain
Administrative complexity	low	high
Design and implementation	quick & easy	time consuming & difficult
Revenues	several streams	government
Emitters' response	high resistance	low resistance (preferred)

Namely, price is certain in a carbon tax system, and energy/electricity prices could be predicted. On the other hand, in cap-and-trade system prices are defined on the market, so it is difficult for industry and citizens to predict future energy/electricity prices. Furthermore, the amount of emissions is certain in cap-and-trade system while a carbon tax cannot assure wanted mitigation. A carbon tax requires many estimations and usually changes every year to adapt to observed emissions. Moreover, cap-and-trade system is administratively more complex as it requires constant monitoring and reporting. For a carbon tax implementation, already existing administrative system for taxes can be used. Therefore, this taxes can be introduced more quickly and easily. On the other side it is much more difficult to design and implement emission trading system. Deciding the amount and allocation of permits can bring many issues. When we compare revenues' streams in both instruments, we can notice several streams when a carbon tax is used while revenues from auctioned permits usually go straight to the Government's budget. Additionally, it can be noticed in the practice that a carbon tax has more opponents in the country, in particular energy intensive industry. This mechanism is in general more costly for these big emitters and tradable permits are more preferred.

Many countries combine both mechanisms, especially in Europe. There, EU ETS covers emissions from large sources and some countries implement carbon taxes for other, non-covered sources. In theory, equilibrium between permit price and tax rate should exist in order for this combination to function properly.

6.2. Carbon Tax Steps in South Africa

It is predicted that without proper action, Earth's global temperature could rise for 5°C by 2100.[18] Moreover, there is high certainty that countries with the low income will be primarily affected. This means African continent is the most vulnerable to threats climate change is bringing. What contributes to that is also its geographical location with mostly tropical climate. Even though South Africa is in a better position than other Sub-Saharan countries and more capable for adaptation, a comprehensive action is needed if mitigation is to be achieved. Also, the facts that other countries, such as European Union and China have already taken this global problem seriously forces South Africa to do the same in order to keep up with developed countries. Mitigation policies and regulations are being implemented all over the developed world, where South Africa wants to save a seat. These countries are working together on this problem and South Africa wants to be a part of it. If they impose taxes on imported carbon or carbon contained products and South Africa doesn't, this would affect badly its current carbon intensive economy. Besides, introduction of appropriate mitigation policies would make South Africa a continent's leader. (Alton, et al., 2013) To have clearer picture of the South African GHG emissions problem here are some emissions facts. South Africa is ranked 13th in the list of world's largest greenhouse gas emissions in 2014, with the amount of 476 $MtCO_2$ from world's total 35890 $MtCO_2$. This is shown in Figure 20, where biggest emitters are listed, with China on the first place. Moreover, when considering per capita GHG emissions, South Africa is ranked in top 20 world emitters with the emissions intensity[19] above the world average. (Global Carbon Atlas, 2014) At the same time South Africa is the largest emitter on the continent and, if not restrained, will continue to raise exponentially.

Figure 20: World greatest emitters of GHGs in 2014

Source: (Global Carbon Atlas, 2014)

Rank	Country	$MtCO_2$
1	China	9680
2	United States of America	5561
3	India	2597
4	Russian Federation	1595
5	Japan	1232
6	Germany	789
7	Indonesia	641
8	Iran	616
9	Saudi Arabia	602
10	South Korea	599
11	Canada	558
12	Brazil	507
13	South Africa	476

[18] https://www.co2.earth/2100-projections

[19] Emission Intensity is ratio of emissions to GDP;

Furthermore, according to last published Climate Change Performance Index (CCPI) 2015, South Africa is ranked 37th from 58 countries that are responsible for more than 90% of global energy related CO_2 emissions. (Burck, Marten, & Bals, 2015) Comparing to previously published CCPI 2014, South Africa improved from 40th place. In the Table 9 below are shown all newly industrialized countries from the list with their rankings and indicated colors showing the quality of ranking. Red represents very poor ranking, orange poor ranking, yellow moderate and green good ranking. South Africa is classified as poorly ranked country. In the next Table 10, South Africa is compared to other G20 countries, excluding European Union.

Table 9: CCPI 2015 for the Newly Industrialized Countries

Source: (Burck, Marten, & Bals, 2015)

Rank	Country	Score	Rank	Country	Score	Rank	Country	Score
9	Morocco	65.73	37	South Africa	54.63	49	Brazil	48.51
18	Mexico	61.30	39	Algeria	54.46	50	Singapore	47.27
23	Indonesia	59.57	45	China	51.77	51	Turkey	46.95
24	Egypt	59.19	47	Thailand	50.61	52	Malaysia	46.84
31	India	56.97	48	Argentina	49.61	54	Chinese Taipei	45.03

Table 10: CCPI 2015 for G20 countries

Source: (Burck, Marten, & Bals, 2015)

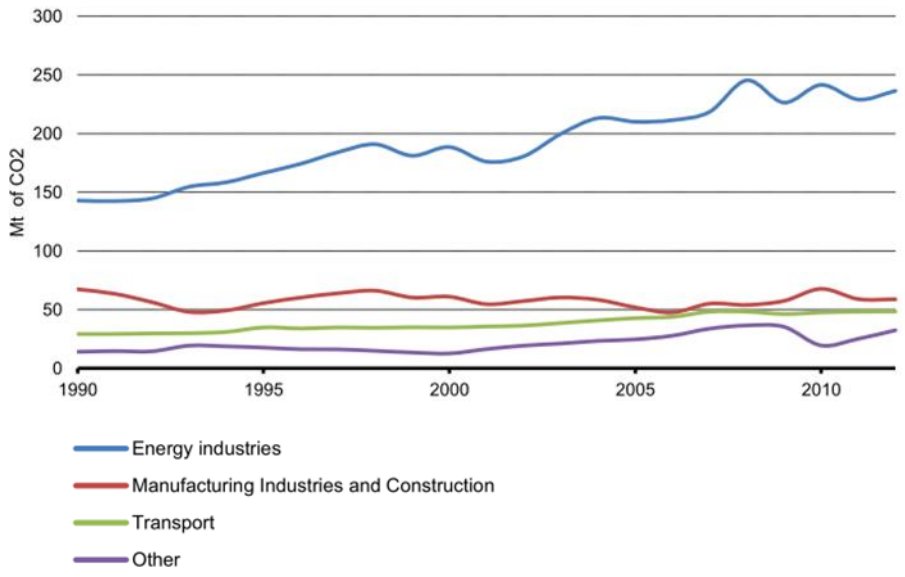
Rank	Country	Score	Rank	Country	Score	Rank	Country	Score
6	United Kingdom	70.79	37	South Africa	54.63	55	Korea	44.15
12	France	64.11	44	United States	52.33	56	Russian Federation	43.39
17	Italy	61.75	45	China	51.77	58	Canada	38.81
18	Mexico	61.30	48	Argentina	49.61	60	Australia	35.57
22	Germany	59.60	49	Brazil	48.51	61	Saudi Arabia	24.19
23	Indonesia	59.57	51	Turkey	46.95			
31	India	56.97	53	Japan	45.07			

* Not included: European Union (The European Union is part of the G20 Countries.)

Coal resource abundance as well as highly subsidized electricity sector in South Africa provoked the fact that country is amongst the world's most carbon intensive economies. This is shown in the Figure 21 below, where we can see that in 20-years trend of CO_2 emissions, energy industry was far ahead other sectors in producing emissions. Heavy industry drove South African economic growth for many decades. Evidently, this has brought them to the current situation and urgent need for emissions reduction. From this need was born the initiative for a carbon taxation in 2010.

Figure 21: 20-years trend of CO_2 emissions by sector in South Africa

Source: (UNFCCC, 2015)

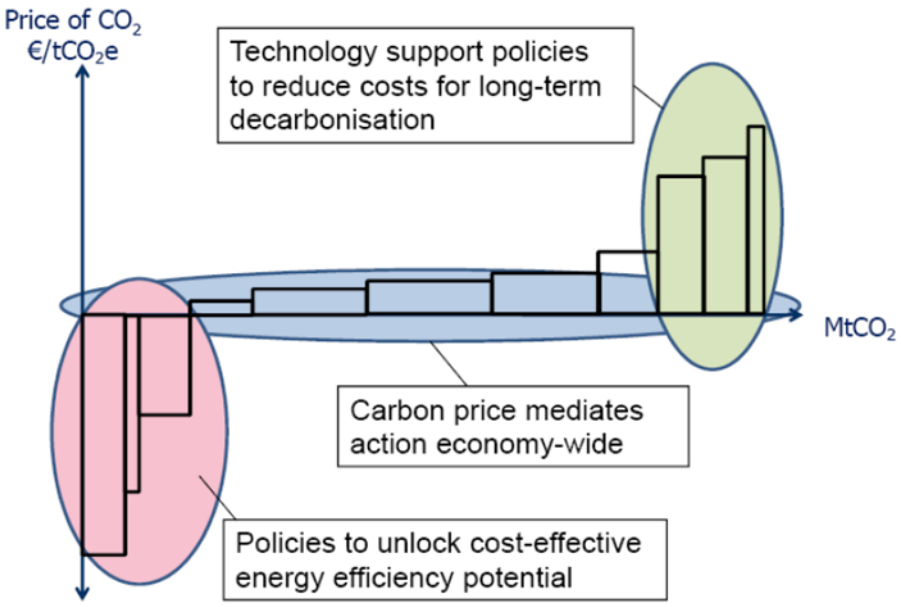


These are all incentives for South Africa to come up with a long term solution to mitigate its emissions and achieve Green Growth. South Africa's President Jacob Zuma has committed at Conference of Parties (COP15) in Copenhagen in 2009. to mitigate country's carbon emission by 34% until 2020 and 42% until 2025, under Business as Usual (BaU)[20] in relation to 1990 levels. Even under best case scenario in Integrated Resource Plan for 2010-2030 published by the Government in 2011 South Africa cannot reach the committed emissions reduction until 2025. Also, this low emission scenario would cost a fortune (around R1.25 trillion) mainly because of additional costs the use of renewables is bringing. Normally, at least part of this cost needs to be passed on to consumers of electricity, which will of course face strong reaction within community.

South Africa has 2 objectives regarding climate change response. First one is to most efficiently adapt to inevitable changes climate change is bringing. Second one is to make an effort to significantly mitigate GHG emissions, which would otherwise reach levels dangerous for human survival. In order to achieve emission reduction, there is need for strong policy mix at national level. The potential policy mix is presented below in Figure 22.

[20] http://www.wri.org/blog/2015/10/south-africa-pledges-peak-its-greenhouse-gas-emissions-2025

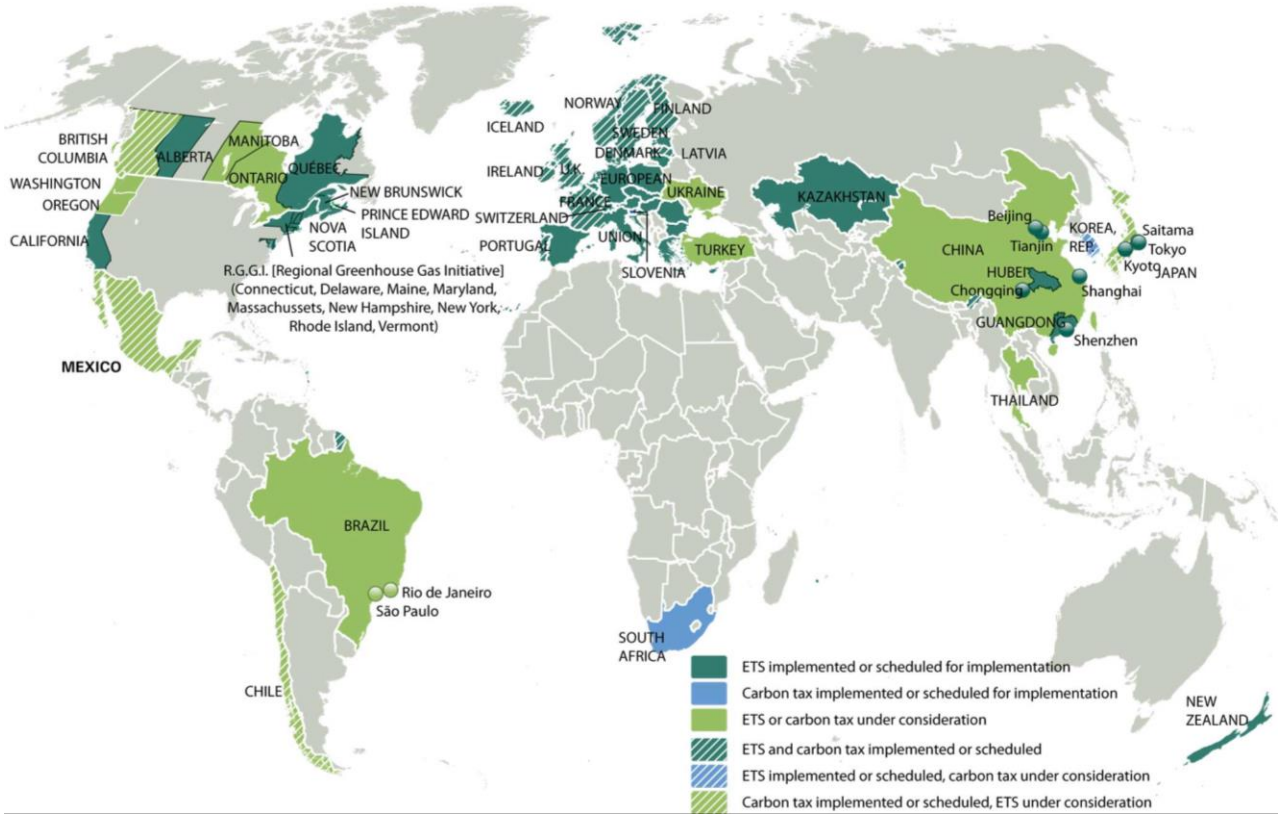
Figure 22: Policy mix needed for reduction of GHG emissions



Upon president's commitment, the country's Government considered few policy mechanisms to address this problem such as carbon trading system and a carbon tax. These two instruments for are the two main options that countries all around the world are choosing when decide to put a price on carbon. The growing number of subnational governments as well as companies are also opting for pricing the carbon. Figure 23 shows the map with indicated countries with existing, emerging or potential carbon tax and/or emissions trading system. Countries can decide for one or the other, or even for the combination of both instruments, depending on suitability for their economies. Through international cooperation, these countries manage to overcome barriers in these relatively new policies.

Figure 23: Existing, emerging and potential carbon pricing instruments around the world

Source: (World Bank & Ecofys, 2015)



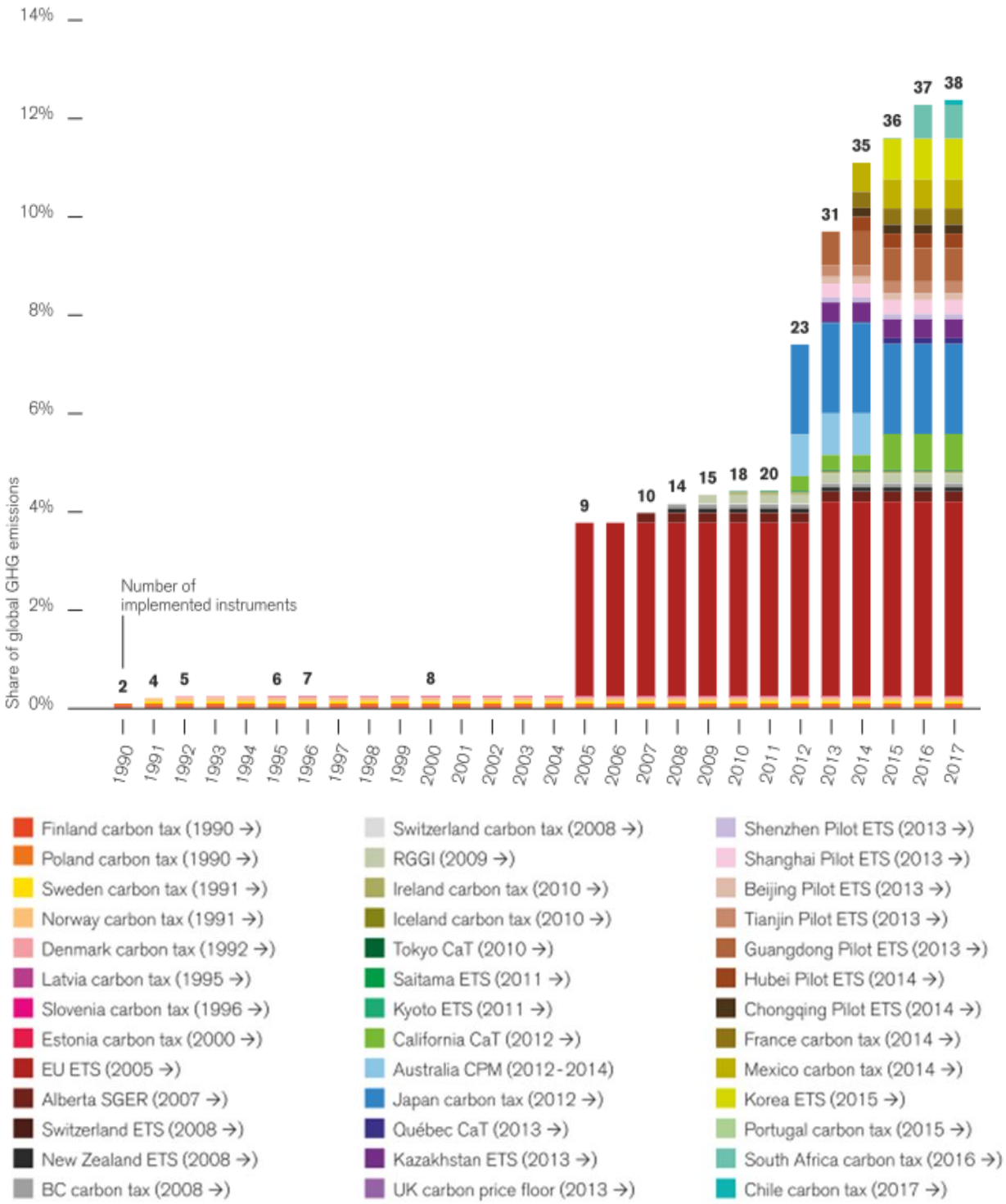
From the picture above we can see that Finland, Sweden, Norway, Netherlands, Denmark, Latvia, Slovenia, Estonia, British Colombia[21], Switzerland, Ireland, UK, Iceland, Japan, France, Mexico, Portugal and Chile decided for using a carbon tax.

In the following Figure 24 it can be seen the gradual introduction of both instruments, emission trading system and a carbon tax from the beginning of 1990s until 2017, when implementation of a carbon tax in Chile is scheduled. The figure shows number of implemented instruments each year as well as the share of greenhouse gas emissions these instruments cover.

[21] British Columbia is Canadian province.

Figure 24: Gradual introduction of market-based instruments for GHG emission reduction in the world

Source: (World Bank & Ecofys, 2015)



Finally, South Africa also opt for a carbon tax. Even though carbon trading system was preferred by South African businesses, as it would still give them some flexibility, managing this kind of system would be very complex for the Government. In this first run, there was not enough available information to propose the exact tax rate that would achieve South African goals set in Copenhagen in 2009. Also, the revenue recycling was not specified. All these uncertainties brought to general society's dissatisfaction. Everyone wanted to avoid being transitioning generation, the generation that suffers the most.

Whenever implemented this initiative will, as any other big reform, have winner and losers in the current economy, in particular during transitioning period. As it seems, people are abler to see bad effects than the good ones. This is why the carbon tax faces resistance from many interest groups in the country. The leader of opponents was Eskom, which clearly had conflict interest with the idea of pricing the carbon. The biggest emitter in the country stands strongly behind its opinion that electricity sector is already subject to carbon pricing through electricity levy. Next to Eskom's concerns, consequences such as loss of competitiveness, job losses, higher energy/electricity prices are people's biggest worries. The worry about unemployment comes as a result of negatively affected energy (carbon) intensive industry, where immense number of South Africans is currently employed. Also, affected industry, a huge exporter in South Africa will face loss of competitiveness in the international market. And finally, electricity prices will raise due to change towards renewable energy resources. On the other hand, proper design of the tax and smartly used tax revenues could turn a carbon tax in favor of economic growth with minimalized or eliminated bad effects mentioned above.

Before going deeper into carbon tax design in South Africa, here is the list of other, already existing environmental taxes in the country.

Other environmental taxes in South Africa are:

- international air passenger departure tax
- plastic bag levy,
- electricity levy,
- incandescent light bulb levy
- and CO_2 tax on motor vehicle emissions.

International air passenger departure tax is a tax introduced in 2000, imposed on international air traveling. Plastic bag levy was introduced in order to encourage re-use of plastic bags as well as to reduce waste. This levy is currently 6 cents per bag. The electricity levy brings biggest revenues within environmental taxes to the Government. This is shown in Table 11, where collections from all environmental taxes in last 5 fiscal years are presented. It was introduced in July 2009 per kWh of electricity produced from non-renewable sources, such as coal, nuclear, natural gas and petroleum fuels. This was the first step to the current carbon tax. Currently the levy is 3,5 cents per kWh and the revenue is used to finance energy efficiency projects i.e. solar water heater. To avoid overlapping, electricity levy will be slowly phased out with a carbon tax phasing in. Furthermore, incandescent light bulb levy was introduced in 2009 with the aim to facilitate energy efficiency and diminish electricity demand by use of energy-saving light bulbs. This should also have effect on reduction of GHG emissions. Current levy is R4 per bulb. Finally, CO_2tax on motor vehicle emissions

was also introduced to encourage energy efficiency of owners of the vehicles and make them be more friendly to the environment. The tax was firstly introduced in 2010 and additional vehicles were added in the tax base in 2011. Today, it amounts R90 per gCO_2/km for every gram.

Table 11: Environmental taxes; collections in last 5 years

Source: (SARS, 2015)

R million	International air departure tax	Plastic bag levy	Electricity levy	Incandescent light bulb levy	CO_2 tax on motor vehicle emissions	Total
2010/11	649	150	5 103	151	626	**6 679**
2011/12	762	161	6 323	144	1 617	**9 007**
2012/13	873	151	7 984	137	1 567	**10 712**
2013/14	879	169	8 819	72	1 711	**11 650**
2014/15	907	174	8 648	91	1 483	**11 303**

6.3. Carbon Tax Design in South Africa

In 2010, the Government started developing a carbon tax in order to address GHG emission problem and influence transition towards energy efficiency and renewable energy sources. The goal was correcting the present prices of goods and services that produce excessive emissions, so that social cost is included. This mechanism is in accordance with the Kyoto Protocol, ratified in South Africa in 2002. In South Africa, a carbon tax is defined as tax per ton of CO_2 and not on carbon itself. Usually when introduced, the tax rate is low and increases with time (typically each year), which is going to be the same in South Africa. Sure thing there are different options and designs of a carbon tax and each of them has different effectiveness, costs and ability to reduce emissions. Some would claim that the use of tax revenue is probably the most important decision in carbon tax design. (Bamidele Fakoya, 2013)

As already mentioned, the proposed tax faced resistance in many interest groups in the country. This resulted with publishing of Carbon Tax Bill only in November 2015, 5 years after the first initiative and the implementation is still postponed.

The initiative came together with National Development Plan and Integrated Resource Plan which are aiming to a greener economy. Certain tradeoff between fast development and environmental sustainability needs to exist. The National Treasury started exploring fiscal options to support greener growth. Emissions trading and a carbon tax were proposed by them in first discussion paper in 2010. Both options were deliberated in details and the result was in favor of a carbon tax, due to better price certainty, easy management and administration, permanent incentive to reduce emissions and current monopolistic situation on energy market.

When designing the tax, it was necessary to consider the fact that majority of the population are low income and poor households who will bear the burden of transitioning period. This is why a team of international and national experts was working hard to overlook all the aspects of potential

carbon tax. After addressing main concerns (loss of competitiveness, loss of jobs and higher energy prices) expressed by all interest groups, The National Treasury announced new proposal in 2012 with the potential implementation from 2013. The proposed tax rate was R120[22] per tCO_2 equivalent, with additional annual increase of 10% each year until 2020. By virtue of another group action of all interest parties, the carbon tax proposal was declined again. The text box below briefly summarizes the main features of this proposal. (SAIIA, 2013)

Objective: reduce GHG emissions by changing producer and consumer behavior; contributing to mitigation and adaptation being taken into account in investment decisions (including on infrastructure); and creating incentives for low-carbon technologies.

Tax rate: The nominal rate is R120 / t CO2-eq, set low. The effective rate is lower as a result of tax-free thresholds and exemptions. Tax was to increase 10% per year until the end of 2019. 5 – 10% off-sets would be allowed, and adjustments to reward good practice within sectors were anticipated.

Allowances: All sectors do not pay tax on 60% of their emissions in the first phase. There will be additional tax free allowances for process emissions (10%); additional relief for trade-exposed sectors (max 10%); overall tax-free allowance capped at 90 per cent of verified emissions. Thresholds to be reduced during the second phase (2020 to 2025) possibly replaced by absolute emission thresholds thereafter.

Tax base: fuel input tax: levied on coal, crude oil and natural gas inputs (not directly on GHG emissions or on energy outputs) Gases: Focused on CO2, CH4, N20 and PFCs (SF6 and HFCs also included, but not specified in sectors)

Coverage: it includes most sectors; excludes agriculture, forestry and land use, and waste

Rebates: A tax rebate for carbon capture and storage (CCS) will be considered.

Revenues: Expected to raise ZAR 8 billion to ZAR 30 billion rand a year. Initial proposal favored increased investments to protect poor households and energy intensive industries from the impact of the tax.

[22] 120 Rand = 14,16 US$ on 31.12.2012. http://www.exchangerates.org.uk/USD-ZAR-31_12_2012-exchange-rate-history.html

Noticeably, proposed tax was still missing some specifics such as who would be eligible for which rebates, emissions data supporting proposed tax rate, how would tax revenues be specifically used, certain implementation phases and steps after 2019. (Nakhooda, 2014)

As general society was happy with the decision to delay the carbon tax implementation, only minority was aware that inaction is even more expensive option than carbon pricing. The ones who could see the bigger picture, could see future climate impacts on food price, water scarcity, human health, lower productivity and vulnerability to extreme weather changes and events. Unfortunately, short term influence on profits had put a shadow over long term concerns.

The next attempt of the National Treasury to impose carbon pricing resulted in drafting the Carbon Tax Bill, released for comments on 2 November 2015. This one has caught attention of the main opponents. The fact that Carbon Tax Bill is published means that the question is not any more weather the carbon tax will be implemented but when it will be. The drafted Bill states 1 January 2017 as starting date of implementation.

GHG covered with this tax are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (C_XF_Y), hydrofluorocarbons and sulfur hexafluoride (SF_6). The tax is designed to be implemented in phases over a certain period of time to achieve smoother transitioning. The first phase is planned until 2020. The initial tax rate stayed the same as in last proposal, R120 per tCO2e, but the effective tax will amount only from R6 to R48 per tCO2e due to tax free thresholds. In this phase, waste, forestry, agriculture and land use sectors are excluded from the tax base because of the difficulty in measuring their emissions. The tax base are emissions from industrial processes and products, fossil fuel combustion as well as fugitive emissions. The calculation of the tax base will be linked to mandatory reports on GHG emissions for each sector that Department of Environmental Affairs will request. This is planned to become effective in the second half of this year. Also, an additional carbon tax will be imposed on petrol and diesel liquid fuels. National Environmental Air Quality Act will state thresholds per each source for stationary emissions.

In the first phase, to ease the transition for businesses, the 60% tax free threshold will be applied (below this tax is not payable). Even higher thresholds will be applied for steel, iron, cement, aluminum, fugitive emissions and some trade exposed industries. There is also an incentive to facilitate energy efficiency through tax deduction of 45 cents per kWh saved. Only tax payers who can prove their energy efficiency savings with accredited measurement are eligible for the deduction. South African National Energy Development Institute (SANEDI) is responsible for this endorsement. This incentive will run only in the first phase, and part of carbon tax revenue will be recycled through this incentive. (Morden & Janoska, 2014)

The additional tax free allowances:[23]

- 10% allowance for process emissions;
- a maximum 10% allowance for trade exposed sectors;
- a 5-10% (depending on the sector) allowance for carbon offsets;

[23] http://www2.deloitte.com/za/en/footerlinks/pressreleasespage/carbon-tax-bill.html

- up to 5% allowance based on performance against emissions intensity benchmarks (benchmarks are to be developed);
- additional 5% allowance for companies participating in the phase one of carbon budgeting system;

The combined effect of all of these thresholds is limited at 95%. These thresholds will be reduced in the following phase, from 2020 to 2025. The above enumerated thresholds and allowances per sector are summarized in the Table 12 below.

Table 12: Carbon tax thresholds and allowances per sector

Sector	Basic tax-free threshold (%)	Max additional allowance for trade exposure (%)	Additional allowance for process emissions (%)	Additional allowance for fugitive emissions (%)	Total (%)	Max offset (%)
Electricity	60	-	-	-	60	10
Petroleum (coal/gas)	60	10	-	-	70	10
Petroleum (oil)	60	10	-	-	70	10
Iron & Steel	60	10	10	-	80	5
Cement	60	10	10	-	80	5
Glass and ceramics	60	10	10	-	80	5
Chemicals	60	10	10	-	80	5
Pulp & Paper	60	10	-	-	70	10
Sugar	60	10	-	-	70	10
Agriculture, forestry, land use	100	-	-	-	100	0
Waste	100	-	-	-	100	0
Fugitive emissions (coal mining)	60	10	-	10	80	5
Other	60	10	-	-	70	10

In this first phase only thermal capacities of >10 MW will be taxed. The idea behind it is to exclude non industrial activities and households from the taxation. The threshold is still low enough to include most emitting industries under taxation. South African Revenue Service will be in charge of tax administration. The main concern, raise of electricity prices is addressed with this Bill. The impact on this price is suggested to be neutralized by removing current electricity levy and using carbon tax revenue to replace electricity levy revenue loss. Businesses are left an appropriate amount of time to make their strategic plans according to this bill.

7. Analysis of Carbon Tax Designs Around the World

7.1. Assessment Framework

Carbon tax design of 16 countries and 1 province are assessed. Only countries with the explicit carbon taxes are observed.

These are: Finland, Norway Sweden, Denmark, Slovenia, Estonia, Switzerland, British Columbia, Iceland, Ireland, United Kingdom, France, Portugal, Japan, Chile, Mexico and Australia.

This is an exhaustive list of countries with the explicit carbon tax currently imposed, excluding Australia which repealed a carbon tax in 2014, but it is included in this analysis as the most important example of an unsuccessful carbon tax implementation.

Each carbon tax system is checked for 10 questions:

1. Adoption date (when was first adopted)
2. Reasons for adoption (initial reasons was economic or/and environmental)
3. Tax base (which sectors, fuels)
4. Tax exemptions and reductions (which sector, fuels)
5. Tax rate (amount and planned increase)
6. Annual revenues (amount)
7. Revenue recycling (how is revenue being used)
8. CO_2 emissions reduction (decrease or increase)
9. Electricity sector characteristics (liberalized market or monopoly)
10. Green Growth adoption (OECD Green Growth Declaration signed or not)

These questions derived from explanations of the most important features of a carbon tax which are influencing its successfulness, discussed in section 6.1. of this Thesis. The most important questions for answering my Thesis' objective questions are 2nd, 7th and 8th. 2nd question is dividing the reason for imposing a carbon tax in two main streams, economic and environmental. This differentiation comes from 2 main reasons for imposing any tax, which is funding the Government's budget (economic) and addressing a specific problem by discouraging certain consumption. In the case of a carbon tax, this specific problem is an environmental concern about GHG emissions. 7th question will show different revenue recycling methods countries used, and it is strongly related to the reason behind the implementation of the tax. Finally, the question number 8 will show if carbon emissions decreased after the implementation of a carbon tax in analyzed countries. Upon answering these questions, the main questions of this Thesis will be answered in a way explained in section 1.2 Methodology & Sources.

In order to answer these questions, data is collected mostly from the World Bank, International Emissions Trading Association (IETA), Carbon Tax Center and OECD. In addition, data is also collected from other research papers such as (Karaczun, 2012), (Sumner, Bird, & Smith, 2009) and (Carl & Fedor, 2016).

7.2. Finland

Finland is the first country in the world which introduced a carbon tax. In 1990 Finland introduced a tax on a carbon content of fossil fuels despite contributing only 0,3% to the world's emissions at the time. The first tax rate was €1,12 (US$1,25) covering only electricity generation and heat. Natural gas and peat have had a special tax treatment and wood industry was excluded from the tax. Most important reforms in the carbon taxation in Finland happened in 1997 and 2011 when tax rates were increased and changed to an energy-carbon tax, respectively. Today tax covers transportation as well but it is clear that tax is not working at its full potential as electricity industry was always favored. Current tax amounts in range from US$48 to US$64 per ton of carbon dioxide. (World Bank & Ecofys, 2015) Finland is being revenue neutral, so all money earned through a carbon tax is used to reduce other taxes, in particular income tax. This was not Finland's primarily aim in the beginning, when revenues were used to fund the Government's budget.

1. Adoption date: 1990
2. Reasons for adoption: economic
3. Tax base: electricity generation, heat, transportation
4. Tax exemptions and reductions: wood industry, natural gas, peat
5. Tax rate: US$48 to US$64
6. Annual revenues: US$900 million
7. Revenue recycling: income tax reduction
8. CO_2 emissions reduction: decrease
9. Electricity sector characteristics: liberalized market
10. Green Growth adoption: yes

7.3. Norway

In 1991 Norway introduced its first carbon tax, which is today accompanied with EU emissions trading scheme since 2008. About 80% of country's emissions are covered with both mechanisms. Oil and gas industries are creating biggest part of Norway's emissions, around 30% of all emissions. Consequentially, these were the main covered sectors. Land based industries and some energy intensive, trade exposed industries are exempt from the tax. Norway has agreed to mitigate GHG emissions at least 40% below 1990 levels by 2030. Current tax rates are in range from US$3 to US$52 per ton of carbon dioxide, depending on the sector. (World Bank & Ecofys, 2015) Sectors which are using petroleum have higher rates, while sectors using mineral oils have lower tax rates. Revenues gained through the tax are mainly used to fund general budget of the Government. (IETA, 2015)

1. Adoption date: 1991
2. Reasons for adoption: economic
3. Tax base: natural gas and oil industries

4. Tax exemptions and reductions: land based industries
5. Tax rate: US$3 to US$52
6. Annual revenues: US$1580 billion
7. Revenue recycling: government budget
8. CO_2 emissions reduction: decrease
9. Electricity sector characteristics: liberalized market
10. Green Growth adoption: yes

7.4. Sweden

In 1991 Sweden introduced a carbon tax and was one of the first countries in the world who did it. Carbon tax came along with the energy tax system reform happening at the time in Sweden. The first applied tax covered coal, oil and natural gas and petrol. One of the main objectives was to shift from labor affecting taxes and to discourage oil use for heating. Sweden is a country which proves that carbon tax works. They have not only significantly reduced their GHG emissions, but they also managed to keep on going with the economic growth. The first tax rate was US$133 per ton of carbon dioxide and today is US$130. (World Bank & Ecofys, 2015)Currently, sectors such as forestry, industry, agriculture and fisheries pay only 21% of this tax rate, while energy sector, transportation sector and consumers are paying the most. CO2 emissions have decreased a lot since the introduction of the tax. Namely, Swedish Ministry of the environment reported that greenhouse gas emissions have decrease by over than 40% in period from 1970 to 2008. (Carbon Tax Center, n.d.)

1. Adoption date: 1991
2. Reasons for adoption: environmental and economic
3. Tax base: coal, oil, natural gas, petrol
4. Tax exemptions and reductions: forestry, agriculture, fisheries
5. Tax rate: US$130
6. Annual revenues: US$3665 billion
7. Revenue recycling: labor tax reduction
8. CO_2 emissions reduction: significant decrease
9. Electricity sector characteristics: liberalized market
10. Green Growth adoption: yes

7.5. Denmark

Adopted in 1991 and implemented in 1992, carbon tax was added next to already existing energy tax in Denmark. This meant consequent fall in energy tax in order to avoid overlapping. First standard tax rate was US$16.91 per tCO2, it decreased in 2005 to US$16,41 and it finally reached US$25 by 2015. All energy users are covered with the tax, while some industrial companies have different taxes due to different energy use and whether or not they agreed to apply energy efficiency programs. Companies which sign an agreement on energy efficiency with the Ministry of Transportation and Energy are entitled to 25% deduction of the carbon tax. Highest tax rate is imposed on households and their consumption of electricity which led to 10% lover energy consumption in the country. (Karaczun, 2012)Revenue collected from the tax is redistributed back

by the Government. 60% is returned to the industry while 40% is given back through environmental subsidies. (Sumner, Bird, & Smith, 2009)

1. Adoption date: 1992
2. Reasons for adoption: economic
3. Tax base: all energy users (industries and households)
4. Tax exemptions and reductions: companies which sign energy efficiency agreement
5. Tax rate: US$25
6. Annual revenues: US$1400 billion
7. Revenue recycling: 40% environmental subsidies, 60% returned to industry
8. CO_2 emissions reduction: decrease
9. Electricity sector characteristics: liberalized market
10. Green Growth adoption: yes

7.6. Slovenia

Slovenia was the first country in Central and Eastern Europe to introduce this tax. In 1996 Slovenia implemented the tax on CO2 emissions deriving from fossil fuel combustion. Companies covered with European Emissions trading scheme are excluded from the tax. Only in 2012 transportation sector and land use sectors are included under the taxation. Tax base in environmental pollution unit which is equivalent to 1kg of carbon dioxide. Initial tax rate was approximately €5,5 (US$6,13) per tCO2 and today is US$19 per ton of carbon dioxide. Primary objective of the tax, as many in Slovenia claim, is increasing the Government's budget.

1. Adoption date: 1996
2. Reasons for adoption: economic
3. Tax base: fossil fuels combustion
4. Tax exemptions and reductions: transport and land use sectors
5. Tax rate: US$19
6. Annual revenues: US$35 million
7. Revenue recycling: government budget
8. CO_2 emissions reduction: decrease
9. Electricity sector characteristics: liberalized market
10. Green Growth adoption: yes

7.7. Estonia

Estonia is the foremost country with the best tax system in international tax competitiveness ranking. Current ecological tax reform has contributed to this. It introduced a carbon tax on thermal energy generation in 2000, within broader tax reform. The tax is coexisting with energy tax and EU emissions trading scheme. The main revenue recycling option is cutting distortionary taxes such as income taxes. Current tax rate is US$2 per ton of carbon dioxide, which is one of the lowest rates in Europe next to Latvia and Poland, countries that have an implicit carbon tax.

1. Adoption date: 2000
2. Reasons for adoption: economic
3. Tax base: thermal energy generation
4. Tax exemptions and reductions: /
5. Tax rate: US$2
6. Annual revenues: /
7. Revenue recycling: income tax reduction
8. CO_2 emissions reduction: decrease
9. Electricity sector characteristics: liberalized market
10. Green Growth adoption: yes

7.8. Switzerland

Switzerland has put a price on carbon in 2008, combining emissions trading system and carbon tax. The country ambitiously committed to 50% reduction in emissions by 2030, comparing to 1990 levels. Tax base are thermal fuels with the tax rate of US$87 per ton of CO2 equivalent since January this year. Previous tax rate was US$62, which means tax increased this year for 40%. The story behind this large number is that their latest review of emissions level showed they are above the aimed level. Carbon tax revenues in Switzerland do not fund the Government's budget. Roughly 2/3 of tax revenues are redistributed to the society and businesses while 1/3 goes to funding climate friendly building renovations. In addition, one small part also goes to funding low carbon technologies. Citizens are benefiting from lower payments for health insurance while businesses through social security contributions. (World Bank & Ecofys, 2015)

1. Adoption date: 2008
2. Reasons for adoption: environmental
3. Tax base: thermal energy generation
4. Tax exemptions and reductions: /
5. Tax rate: US$87
6. Annual revenues: US$830
7. Revenue recycling: climate friendly building renovations, redistributed to taxpayers
8. CO_2 emissions reduction: decrease
9. Electricity sector characteristics: liberalized market
10. Green Growth adoption: yes

7.9. British Columbia

Even though Canada doesn't have a federal carbon taxation implemented, Canadian province British Columbia has introduced a carbon tax in 2008. The tax base are emissions from fossil fuel combustion., covering around 70% of total greenhouse gas emissions in the province. (Vivid Economics, 2012) Revenue recycling is determined by law, saying that all revenue from carbon taxation needs to be recycled through cuts in other taxes. Such taxes are income taxes, corporate

and personal, as well as specific tax credits. The interesting fact is that the tax is "revenue-negative" since the beginning of implementation, meaning that revenue recycling amounts more than revenue received from tax. Current tax rate is US$23 per tCO2e, the same rate since 2012. The fact that tax increases were set in advance and therefore removing uncertainty for businesses is probably the reason its successfulness. The Government committed to change the tax only in case of inconsistency with targeted emission mitigation. It was estimated that presence of the tax will cut emissions by 3 million Mt per annum by 2020. (Sumner, Bird, & Smith, 2009)

1. Adoption date: 2008
2. Reasons for adoption: environmental
3. Tax base: fossil fuel combustion
4. Tax exemptions and reductions: /
5. Tax rate: US$23
6. Annual revenues: US$1100 billion
7. Revenue recycling: reduction in other taxes
8. CO_2 emissions reduction: decrease
9. Electricity sector characteristics: liberalized market
10. Green Growth adoption: yes

7.10. Iceland

Iceland has committed to reduce its emissions for 40% by 2030 in comparison with levels in 1990. In 2008 Iceland joined the European emissions trading system, despite being outside of EU. Later, in January 2010, country introduced a carbon tax. Now, both mechanisms together cover over 90% of Iceland's emissions. When introduced, carbon tax supposed to exist only until 2012, but it was indefinitely extended. Tax rates are designed to recreated a price equivalent to 75% of market price in emissions trading system. The tax base is carbon content of liquid and gaseous fuels such as gas, diesel oil, gasoline, petroleum gas, fuel oil, etc. which are not included under emissions trading system. Its tax rates are in general lower than in other Nordic countries and its tax base could be expanded to more fuels so the tax can be more cost-effective and mitigation-efficient. Current tax rate amounts only US$8 per tCO2. Revenues collected with the tax are used to reduce national deficit created after financial crisis in 2008, as this was the main reason to introduce the tax in the first place. It is estimated that this tax will result in emission mitigation of 50 to 100 kilo tons of CO2 by 2020. (OECD, 2014) (Carl & Fedor, 2016)

1. Adoption date: 2010
2. Reasons for adoption: economic
3. Tax base: fuels not included in EU ETS
4. Tax exemptions and reductions: /
5. Tax rate: US$8
6. Annual revenues: US$30 million
7. Revenue recycling: government deficit
8. CO_2 emissions reduction: decrease
9. Electricity sector characteristics: liberalized market

10. Green Growth adoption: yes

7.11. Ireland

In 2010 Ireland, one of the highest European GHG per capita producers, adopted a carbon tax on oil and gas. It was a successful "killing two birds with one stone" story for them. The primary objective behind the tax in the beginning was to hinder further increase in income tax and cover national deficit. At the same time, they were obeying their legal obligations to reduce GHG emissions within EU. Today revenues are going mostly to the Government's budget and part of it goes to energy efficiency programs. The introduction of this carbon tax led to almost immediate raise of natural gas, oil and kerosene prices. Today this tax covers almost all fossil fuels and amounts US$22 per ton of CO2. (World Bank & Ecofys, 2015) The revenue it brings to the Government is approximately US$520 million per annum. In addition, Ireland has a set of other environmental taxes imposed on vehicle emissions and waste. This set of environmental taxes, with the carbon tax in front row, have delivered satisfying results from both, economic and environmental aspects. Namely, since introduction of carbon tax, emissions decreased for 7% by the end of 2014. Agriculture is the leading polluter, followed by energy and transportation sectors. This can be seen in the Table 13 below which shows GHG emissions per sector in two consecutive years. Ireland designed its carbon tax to close the gap in emission trading system implemented in EU. They consider that emissions trading mechanism does not cover all sources of emissions and addressed only large polluters.

Table 13: GHG emissions per sector in 2013 and 2014 in Ireland

Source: (EPA, 2016)

Mtonnes, CO_2 eq	2013	2014	% Change
Energy	11.323	11.105	-1.9%
Residential	6.395	5.746	-10.1%
Industry and Commercial	8.822	9.181	4.1%
Agriculture	19.502	19.290	-1.1%
Transport	11.068	11.347	2.5%
Waste	1.436	1.584	10.3%
Total	**58.547**	**58.254**	**-0.5%**

1. Adoption date: 2010
2. Reasons for adoption: economic
3. Tax base: almost all fossil fuels
4. Tax exemptions and reductions: /
5. Tax rate: US$22
6. Annual revenues: US$520 million
7. Revenue recycling: government budget and energy efficiency programs
8. CO_2 emissions reduction: decrease
9. Electricity sector characteristics: liberalized market
10. Green Growth adoption: yes

7.12. United Kingdom

UK's road towards carbon tax started already in 1993, when tax was introduced on retail petroleum products in order to cut emissions in transportation sector. Later in 2001, UK introduced a "Climate Change Levy", imposed on electricity sector, solid fuels and natural gas. Some people considered this levy as carbon tax, but the fact that levy rate was not really based on carbon content says the opposite. The aim was to facilitate energy efficiency and reduce GHG emissions. Besides this, European emission trading scheme is in place as well. Finally, in 2013 UK introduced a carbon price floor, a form of a carbon tax covering fossil fuels used in electricity production. This decision is made to create stability in the electricity market, as they were not satisfied with functioning of European emissions trading scheme. In 2014, UK accounted for 1/5 of total carbon tax revenues in the world. (World Bank & Ecofys, 2015) In that year tax rate was around US$16 per ton of carbon dioxide. Current tax rate is US$29 per ton of carbon dioxide. Revenues gained through the tax are mostly funding the Government's budget with small percentages used for cuts in other taxes and subsidies to energy-intensive industries. How serious UK is about the Green Growth says the fact that it promulgated regulation which requires all new built homes to have zero emissions in lighting, heating and hot water from 2016.

1. Adoption date: 2013
2. Reasons for adoption: environmental
3. Tax base: electricity production
4. Tax exemptions and reductions: /
5. Tax rate: US$29
6. Annual revenues: US$2700 billion
7. Revenue recycling: government budget, reduction in other taxes, subsidies to industry
8. CO_2 emissions reduction: decrease
9. Electricity sector characteristics: liberalized market
10. Green Growth adoption: yes

7.13. France

Just recently, in 2014, France has introduced a carbon tax as an additional instrument next to European emissions trading system. This was not France's first attempt to introduce a carbon tax, namely a carbon tax proposal was rejected in 2009. Tax is covering sectors and fossil fuels which are not included in the emissions trading system, such as coal, oil and natural gas. When introduced in April 2014, tax rate amounted US$8 per tCO2 equivalent. In following year tax amounted US$16 and this year is US$24 per tCO2 equivalent. It is planned that tax reaches US$100 per ton of carbon dioxide equivalent in 2030. Revenues in the first year were used to fund green energy projects. In following year percentage of revenue going towards green energy was lower, probably around 45%. For this year it is planned to devote around 35% of revenue for this purposes. Remaining revenue is to be used to cut other, distortionary taxes. France is also on its way toward Green Growth, after formal adoption of "Law on the Energy Transition to Green Growth". This Law also defines French

commitment to reduce greenhouse gas emissions by 40% until 2030, comparing to 1990 levels. (Carl & Fedor, 2016)

1. Adoption date: 2014
2. Reasons for adoption: environmental
3. Tax base: fuels not covered by EU ETS
4. Tax exemptions and reductions: /
5. Tax rate: US$24
6. Annual revenues: US$452 million
7. Revenue recycling: reduction in other taxes, green energy projects
8. CO_2 emissions reduction: decrease
9. Electricity sector characteristics: liberalized market
10. Green Growth adoption: yes

7.14. Portugal

As Portugal pledged to mitigate its CO2 emissions by 40% until 2030, the need for new policies supporting this commitment has appeared. In November 2014, Portugal has adopted a carbon taxation for fuels not covered with European emissions trading scheme. This novelty was part of the broader tax reform in the country. Tax covers around 1/4 of emissions in the country. First tax rate amounted around US$6 per ton of carbon dioxide equivalent and was implemented since 2015. Portugal is also aiming to be revenue neutral and redistribute the tax back to citizens through reduction in income taxes.

1. Adoption date: 2014
2. Reasons for adoption: environmental
3. Tax base: fuels not covered by EU ETS
4. Tax exemptions and reductions: /
5. Tax rate: US$6
6. Annual revenues: US$104 million
7. Revenue recycling: income tax reduction
8. CO_2 emissions reduction: /
9. Electricity sector characteristics: liberalized market
10. Green Growth adoption: yes

7.15. Japan

Japan introduced a carbon tax in 2012, imposed on fossil fuels in all sectors except agriculture, railways, national aviation and fishing. These immunities are not indefinite, but excepted to last until 2017. The aim of the tax is to remove the burden from specific sectors and transfer it to emissions. Besides the tax, emissions trading schemes are operating in Tokyo and Saitama regions. Current tax rate is approximately US$2 per tCO2 equivalent and is expected to amount around US$2,7 in next year. This tax is only an addition to already existing energy taxes in the country.

Japanese Government has estimated that the burden tax is creating on households will amount only around US$0,95 per month. Tax revenues are earmarked to fund energy efficiency projects, low-carbon technology projects and promotion of renewable energy on local levels. The spending of the revenue was criticized in recent years. Namely, the Government is criticized to have a lack of transparency in actual level of a carbon tax revenue and revenue spending. The line between a carbon tax and other energy taxes is blurred. Moreover, they are accused to take money to fund its own budget instead of placing it into promised funding. (Carl & Fedor, 2016)

1. Adoption date: 2012
2. Reasons for adoption: environmental
3. Tax base: all sectors
4. Tax exemptions and reductions: agriculture, railways, fishing, national aviation
5. Tax rate: US$2
6. Annual revenues: US$3 billion
7. Revenue recycling: promotion of energy efficiency and renewable energy
8. CO_2 emissions reduction: decrease
9. Electricity sector characteristics: liberalized market (this year)
10. Green Growth adoption: yes

7.16. Chile

Chile is the first country in South American continent which adopted a carbon tax. This tax is just part of broader tax reform. Even though the tax was adopted two years ago, in September 2014, the implementation is scheduled for 2017. The tax rate amounts only US$5 per ton of CO2 emitted and its designed to cover around 55% of emissions in the country. Many experts claim that 5 dollars is too low to achieve any expected results. The primary sector in the tax base is electricity sector and its capacities above 50 MW. Although this sector has opposed to the carbon tax initiative, this polemic didn't manage to get more attention as everyone was occupied by simultaneous Government's decision to raise corporate taxes. The Table 14 below shows forecasted ranges of average annual emission reduction and electricity price increase for planned tax rates in Chile. Revenue recycling is still not clear, but there are assumptions that revenues will be used to fund education system.

Table 14: Forecasted ranges of average annual emission reduction and electricity price increase for planned tax rates in Chile

Source: (Banavides, et al., 2015)

Carbon Tax Level (US/tCO_2e)	Average Annual Emission Reduction Range (Million tCO_2e)	Increase of Price of Electricity Range (US$/MWh)
5	[0.1, 1.4]	[1.9, 2.1]
10	[0.4, 3.1]	[3.8, 4.2]
20	[1.1, 8.5]	[7.5, 8.2]
30	[2.6, 10.7]	[10.7, 12.3]
40	[5.5, 12.2]	[13.8, 15.9]
50	[7.5, 13.9]	[16.8, 19.3]

1. Adoption date: 2014
2. Reasons for adoption: environmental
3. Tax base: electricity sector
4. Tax exemptions and reductions: generating capacity < 50 MW
5. Tax rate: US$5
6. Annual revenues: US$250 million
7. Revenue recycling: funding of education system
8. CO_2 emissions reduction: /
9. Electricity sector characteristics: liberalized market
10. Green Growth adoption: yes

7.17. Mexico

In the same year as Chile, Mexico has adopted a carbon tax in January 2014. The tax is imposed only on the use of fossil fuels. The tax is designed in a way to put higher rates on coal and oil use, while natural gas is exempt. The tax is coexisting with country's global carbon trading platform where big emitters of GHG can purchase "Certified Emissions Reductions Credits" and in that way obey with the carbon tax. This offset scheme and the carbon tax are proof of great Mexico's efforts to reduce their emissions, as they committed to 30% reduction under business as usual by 2020. Current tax rate is in range from US$1 to US$3 per ton of carbon dioxide but the use of revenues is not clarified. Therefore, it is assumed that revenues are going directly to the Government's budget.

1. Adoption date: 2014
2. Reasons for adoption: economic
3. Tax base: fossil fuels
4. Tax exemptions and reductions: natural gas
5. Tax rate: US$1 to US$3
6. Annual revenues: US$1 billion
7. Revenue recycling: government budget
8. CO_2 emissions reduction: decrease
9. Electricity sector characteristics: in process of liberalization
10. Green Growth adoption: yes

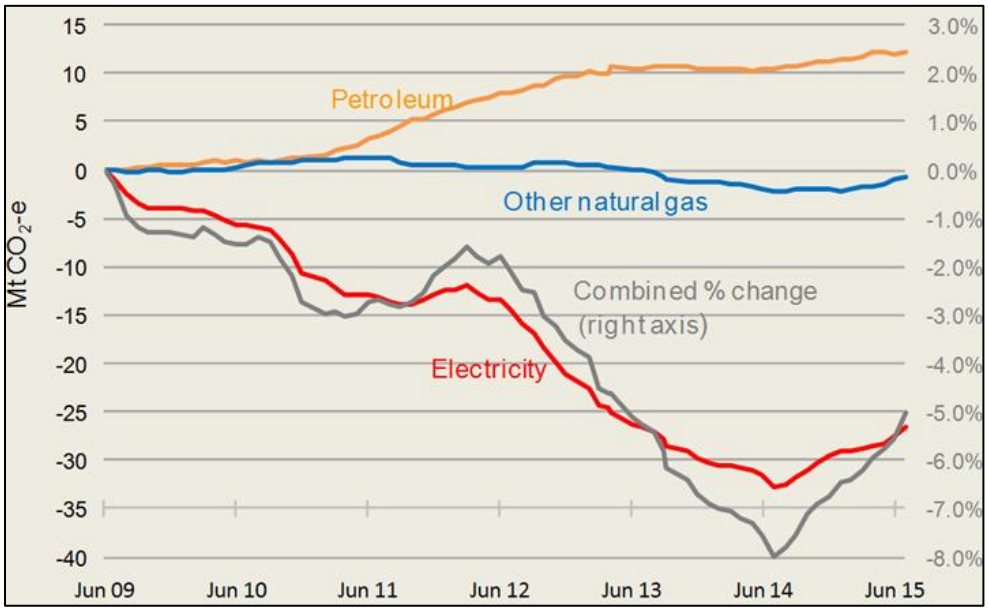
7.18. Australia

A carbon pricing mechanism was introduced in Australia in July 2012 and was designed in such way to cover 500 largest emitters in the country. These companies together emit over 25000 tons of CO2. The tax was imposed on transportation, electricity generation, waste, energy production and other industrial processes. Majority of transportation fuels was excluded. The revenues gained through the tax went to several different ways. One part is used for renewable energy projects funding and over 50% of the revenues to affected low and middle income families. In 2012/13 the tax amounted A$23 per ton on CO2, in 2013/2014 it supposed to increase on A$24,15 and finally

A$ 25,40 in 2014/15. This never happened as tax was removed in July 2014 due to dispute between two main government parties. Liberal party believed that tax increases costs of living for households too much through higher electricity and gas bills. It is interesting to know that in 2013, Australia collected the highest carbon tax revenue than any other country. (Carl & Fedor, 2016) Although per capita revenues were also very high, not much was returned to the taxpayers which was just an additional reason for tax repeal. In the Figure 25 below taken from (SMH, 2015) can be noticed that emissions have increased since repeal off the carbon tax in 2014, especially in electricity sector.

Figure 25: Emissions changes in Australia frome June 2009 to June 2015

Source: (SMH, 2015)



1. Adoption date: 2012-2014
2. Reasons for adoption: economic and environmental
3. Tax base: transport, electricity and energy production, waste and other industrial processes
4. Tax exemptions and reductions: majority of transport fuels
5. Tax rate: US$23
6. Annual revenues: US$8800 billion
7. Revenue recycling: assist households; assist energy intensive trade exposed industry; cut other taxes
8. CO_2 emissions reduction: decrease
9. Electricity sector characteristics: liberalized market
10. Green Growth adoption: yes

7.19. Summary of Analysis

	Country	Adopted (year)	Reason	Tax Base	Tax exemptions and reductions	Current Tax Rate (US$/tCO2)	Annual Tax Revenue (US$)	Revenue Stream	CO2 emissions	Signed the Green Growth declaration	Electricity sector characteristics
ETS + Carbon Tax	Finland	1990	eco	electricity, heat, transport	wood industry, natural gas, peat	48 - 64	900 million	Cut income taxes	decrease	yes	liberalized
	Norway	1991	eco	natural gas and oil industries	land based industries	3 - 52	1.580 billion	Government budget	decrease	yes	liberalized
	Sweden	1991	env & eco	coal, oil, natural gas, petrol	forestry, agriculture, fisheries	130	3.665$ billion	Cut labor taxes	decrease	yes	liberalized
	Denmark	1992	eco	all energy users (industries and households)	companies which sign energy efficiency agreement	25	1.400 billion	60 %Returned to industry; 40% environmental subsidies	decrease	yes	liberalized
	Slovenia	1996	eco	fossil fuel combustion	transport and land use sectors	19	35 million	Government budget	decrease	yes	liberalized
	Estonia	2000	eco	thermal energy generation	x	2	x	Reduce income tax	decrease	yes	liberalized
	Switzerland	2008	env	thermal energy generation	x	87	830 million	1/3 to climate friendly building renovations; 2/3 redistributed back through benefits system	decrease	yes	liberalized
	British Columbia*	2008	env	fossil fuel combustion	x	23	1.100 billion	Revenue neutral; all revenue returned to citizens through reductions in other taxes	decrease	yes	liberalized
	Iceland	2010	eco	fuels not included in EU ETS	x	8	30 million	Government deficit	decrease	yes	liberalized
	Ireland	2010	eco	almost all fuels	x	22	520 million	government budget and energy efficiency programs	decrease	yes	liberalized
	Australia	2012-2014	eco & env	energy & electricity production, transportation, waste, other industrial processes	majority of transport fuels	23	8.8 billion	Assist households; assist energy intensive trade exposed industry; cut other taxes	decrease	yes	liberalized
	UK	2013	env	electricity production		29	2.7 billion	Reduction in other taxes; government budget	decrease	yes	liberalized
	France	2014	env	fuels not included in EU ETS	x	24	452 million	green energy projects, other taxes	decrease	yes	liberalized
	Portugal	2014	env	fuels not included in EU ETS	x	6	104 million	income tax	x	yes	liberalized

	Country	Adopted (year)	Reason	Tax Base	Tax exemptions and reductions	Current Tax Rate (US$/tCO2)	Annual Tax Revenue (US$)	Revenue Stream	CO2 emissions	Signed the Green Growth declaration	Electricity sector characteristics
Carbon Tax	Japan	2012	env	almost all sectors	agriculture, railways, fishing, national aviation	2	3 billion	energy efficiency, renewable energy	decrease	yes	liberalized
	Chile	2014	env	electricity sector	generating capacity < 50 MW	5	250 milion	education system	x	yes	liberalized
	Mexico	2014	eco	fossil fuels	natural gas	1 - 3	1 billion	general funds	decrease	yes	liberalized

8. Results

After conducted analysis of 17 carbon tax designs around the world, the main thesis questions are answered using the methodology described in the section 1.2.

- **Reduction of GHG emissions**

To answer this question, I have used the information about CO_2 emissions level after the implementation of a carbon tax in 17 analyzed countries/provinces, information on current GHG emission facts in South Africa as well as information on South African electricity sector situation as biggest emitter in the country.

First of all, the analysis showed that every analyzed country has faced reduction in carbon emissions after implementing a carbon tax. There is no information regarding this for Portugal, in which tax was introduced only last year and for Chile, in which implementation starts in 2017. This result needs to be interpreted with caution, as in all countries a carbon tax is part of a broader environmental tax program. This means that reduction in emissions coming specifically from a carbon tax cannot be seen clearly. As already mentioned before, uncertainty in emissions reduction amount is one of the bad sides of a carbon tax, when comparing to other market-based instrument such as emission trading system.

Furthermore, we need to have in mind that South Africa is bigger emitter than any other country/province analyzed in previous chapter, except Japan. This fact makes the uncertainty even bigger. The successfulness of emission reduction will also strongly depend on happenings in the electricity sector of South Africa, as it is the biggest emitter of CO_2 emissions. A carbon tax should create incentives to accelerate faster transition to renewable energy sources, but the fact that Eskom is ruling the whole sector weakens these incentive. This is why an additional Government's support is needed in penetration of renewable energy sources into electricity sector. This support currently exists in form of REIPPP Programme, which proved to be very successful until today. If the programme continues to operate and to accomplish targets from Integrated Resource Plan, the fact that Eskom has a monopoly in the electricity sector will not undermined the incentives a carbon tax creates.

To sum up, taking into account that all countries experienced decrease in CO_2 emissions and that the Government's support for penetration of RES in South Africa exists, I can conclude that GHG reduction is expected to occur. The amount of reduction is uncertain.

A carbon tax in South Africa should create following incentives for sectors in order to achieve reduction of carbon emissions:

- Electricity production → Renewable energy
- Energy and Industry → Carbon capture and storage
- Iron and Steel → Switch to electric furnaces
- Cement → Reduction of clinker content of cementitious products
- Mining → Installation of energy efficient Electric motors

- Residential → Energy efficient appliances, efficient Lighting, solar water heating, improved thermal design
- Transport → Improved Petrol and Diesel engines, shift from road to rails
- Waste → Municipal gas recovery and generation

- Ideal Carbon Tax revenue recycling

To find the ideal carbon tax revenue recycling method for South Africa, I have used the information on reasons for a carbon tax introduction (economic or/and environmental) in analyzed countries/provinces and the revenue recycling methods these countries chose. Also, I have used the information about economic and environmental situation in South Africa. What needs to be taken into account is that other features of a carbon tax design for South Africa are already appointed in the Carbon Tax Bill.

As mentioned on page 51, a major concern of the Government regarding a carbon tax is its distributional effect. The reason why South Africa decided to implement a carbon tax is purely environmental (GHG emission reduction), and this also needs to be taken into account for further discussion.

When looking at analyzed countries, some of them such as Finland, Norway, Denmark, Slovenia, Estonia, Iceland, Ireland and Mexico introduced a carbon tax mostly for economic reasons. This means that revenues gained through carbon taxes in these countries are mostly used for funding the Government's budget.

Some countries like Switzerland, British Columbia, Portugal, UK, France, Japan and Chile introduced the tax for mostly environmental reasons. Countries like this are expected to be revenue neutral, meaning all the money received through the tax should be redistributed back to taxpayers. Looking at their revenue recycling methods it can be noticed that only Switzerland, British Columbia and Portugal are purely revenue neutral, while other countries devote part of a carbon tax revenue to fund the Government's budget.

Taking into account that South Africa's reason behind a carbon tax is purely environmental, country should follow the revenue neutral path such as Switzerland, British Columbia and Portugal have.

Going further into more specific revenue streams, we have to take into account current economic and environmental problems in the country. I have previously mentioned that industry and people are strongly resisting to the Government's decision to implement a carbon tax, as it will create job losses, higher electricity prices and loss of competitiveness. In order for a carbon tax to enable further economic growth, it needs to be cost-effective. A carbon tax will be cost-effective if all negative impacts are compensated through revenue recycling. Australia is the best example of this theory, where a carbon tax was revoked after two years even though it created one of the highest revenues comparing to other countries. Namely, the tax caused big increase of electricity prices which were burdened by consumers. This increase was not properly compensated through tax revenues, and tax was on the target by mass of unsatisfied people.

In the case of South Africa, we cannot forget that it has big economic and environmental problems. High unemployment and general poorness of the people should be taken into account here, meaning that people should be compensated on income basis, possibly through cuts in income taxes. This economic redistribution would help South African economy through helping most vulnerable and most affected people in the country. This means that household with high income who have high emissions will take over the burden of the tax.

Additionally, part of the revenues should be used to support faster penetration of RES and energy efficiency programmes in the country, as electricity sector will be the most affected sector by the carbon tax. In this way, job losses within traditional electricity production will be compensated by job creation within new, green programmes. Furthermore, industries exposed to the international trade should be subsidized in order to protect their competitiveness. Finally, one small part should be used for cutting electricity levy in the first phase, and in next phases this levy should be gradually phased out in order to avoid overlapping and keep industry satisfied. Addressing all this, the Government will satisfy concerns of industry and people, thus not leaving any space for further resistance and possible unsuccessfulness of a carbon tax.

To summarize, the highest and same importance should be given to low income taxpayers and promotion of RES and energy efficiency projects. After that, the industry exposed to the international trade should be protected and subsidized, and finally smallest part should be devoted to finance electricity levy reductions, leading to complete phase out in the future.

Therefore, after thorough analysis of other systems and economic and environmental situation in South Africa, I suggest the following order of importance in revenue recycling for the Phase I, where 1st should have highest percentage of devoted revenues and 4th the lowest:

1. redistribution to the poorest taxpayers (possibly through reduction in income tax)
2. RES and energy efficiency investments
3. helping international trade exposed industries
4. financing current allowances and reduction in electricity levy

- **Influence on Green Growth**

Taking into account that GHG emissions ***are expected*** to decrease due to the fact that all other countries have experienced CO_2 reduction and due to comprehensive effect of incentives carbon tax is sending and existence of renewable energy program in the country (in particular REIPPPP), the Green part of Green Growth will be achieved.

On the other hand, if South Africa follows revenue neutral path and revenue recycling is designed in such way to compensate firstly the poorest tax payers, finance energy efficiency and RES projects, helps trade exposed industry and reduce electricity levy, the carbon tax ***is expected*** to be cost-effective and thus the Growth part of Green Growth will be achieved.

9. Conclusion, Limitations & Future Work

To achieve Green Growth, countries need good policy mix to support the transition. This needs to be done with the set of instruments, as sole mechanism is not capable to achieve much. South Africa has introduced carbon tax as complementary tool to already existing environmental taxes, regulations and policies aimed at climate change mitigation and greener growth. Putting a uniform price on different carbon-contained fuels is already proven in practice as effective mechanism. Nordic countries (Finland, Norway, Sweden and Denmark) started this practice first in 1990s, and were followed by other, mostly European countries. Nowadays, new players are coming. Countries such as Mexico, Chile, Brazil, Japan and India are in process of adoption or have already adopted carbon tax. Tax rates in all of the countries are different and vary from US$1 to US$130. Harmonizing these rates would highly contribute to the achievement of set objectives. In this new movement South Africa came along, as first country on African continent to do so.

The level of its environmental and economic effectiveness depends on tax design: tax base, tax rate, tax exemptions, tax reductions, revenue recycling and trajectory of implementation. The biggest concern of the South African Government is redistribution of revenues gained from a carbon tax. Taking into account conducted analysis of 17 carbon tax designs around the world and combining their experience with economic and environmental profile of South Africa, CO_2 emissions are expected to decrease due to comprehensive effect of carbon tax and renewable energy program in the country and the fact that all analyzed countries experienced decrease as well. Moreover, if revenue recycling is designed in such way to compensate firstly poorest tax payers, finance energy efficiency and RES projects, help trade exposed industry and reduce electricity levy, a carbon tax is expected to be cost-effective. This means that both, Green and Growth will be achieved and that carbon tax has a positive influence on Green Growth.

The limitation of this Thesis is that the current carbon tax in South Africa is still not enforced, therefore without the real numbers these results are an estimation. In the future research related with this topic, the focus should be given to the real effects of carbon tax after the first year of implementation in South Africa. Only then the real effectiveness of a current carbon tax design can be assessed. Also, I have to highlight that South Africa cannot be directly comparable to most of other 17 analyzed countries/provinces which imposed a carbon tax, as the majority of those are developed, European countries. Another limitation of this work is the assumption that revenue recycling determines if tax is cost effective or not. Further research could include other parts of tax design, such as tax base and tax rate. Furthermore, this master thesis provides guidelines for future research on carbon tax designs, explained in the section 7.1.

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ANNEX 1: Various Definitions of Green Economy and Green Growth

Source: (UNDESA, 2012)

Concept	Definition
Green Economy	1. One that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. It is low carbon, resource efficient, and socially inclusive. In a green economy, growth in income and employment should be driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services **(UNEP 2011).** 2. A system of economic activities related to the production, distribution and consumption of goods and services that result in improved human well-being over the long term, while not exposing future generations to significant environmental risks or ecological scarcities. **(UNEP, 2009).** 3. An economy that results in improved human well-being and reduced inequalities, while not exposing future generations to significant environmental risks and ecological scarcities. It seeks to bring long-term societal benefits to short-term activities aimed at mitigating environmental risks. A green economy is an enabling component of the overarching goal of sustain-able development **(UNCTAD, 2011).** 4. Green economy is "a resilient economy that provides a better quality of life for all within the ecological limits of the planet." **(Green Economy Coalition, 2011)** 5. "Green Economy" is described as an economy in which economic growth and environmental responsibility work together in a mutually reinforcing fashion while supporting progress on social development. **(International Chamber of Commerce, 2011).** 6. The Green Economy is not a state but a process of Transformation and a constant dynamic progression. The Green Economy does away with the systemic distortions and dysfunctionalities of the current mainstream economy and results in human well-being and equitable access to opportunity for all people, while safeguarding environmental and economic integrity in order to remain within the planet's finite carrying capacity. The Economy cannot be Green without being Equitable **(Danish 92 Group, 2012).** 7. The green economy involves largely new economic activities and must provide an important entry-point for broad-based black economic empowerment, addressing the needs of women and youth entrepreneurs and offering opportunities for enterprises in the social economy **(Government of South Africa, 2011).** 8. Green economy can be seen as a lens for focusing on and seizing opportunities to advance economic and environmental goals simultaneously. **(Rio+20 Objectives and Themes of the Conference - UNCSD, 2011)**
Green Growth	1. Aims to foster economic growth and development while ensuring that natural assets and environmental services are protected and maintained. The approach places a premium on technology and innovation — from smart grid systems and high-efficiency lighting systems to renewable energies including solar and geothermal power — as well as on improving incentives for technology development and innovation **(Global Sustainability Panel, 2011).**

	2. Fostering economic growth and development, while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies **(OECD, 2011).** 3. A policy focus for the Asia Pacific region that emphasizes environmentally sustainable economic progress to foster low-carbon, socially inclusive development **(UNESCAP website).** 4. Is, in general terms, economic progress that fosters environmentally sustainable, low-carbon and socially inclusive development. Pursuing green growth involves outlining a path to achieving economic growth and well-being while using fewer resources and generating fewer emissions in meeting demands for food production, transport, construction and housing, and energy **(UNESCAP, 2012).** 5. Is about making growth processes resource-efficient, cleaner and more resilient without necessarily slowing them. Development that is green [which here means resources-efficient], clean and resilient **(World Bank, 2011)** 6. Is the new revolutionary development paradigm that sustains economic growth while at same time ensuring climatic and environmental sustainability. It focuses on addressing the root causes of these challenges while ensuring the creation of the necessary channels for resource distribution and access to basic commodities for the impoverished." **(GGGI website)** 7. Green growth is growth that "emphasizes environmentally sustainable economic progress to foster low-carbon, socially inclusive development". The OECD definition is similar but emphasizes also green investment as "a driver for economic growth". **(UN DESA – Rio+20 Objectives and Themes of the Conference)** 8. It is growth that is efficient in its use of natural resources, clean in that it minimizes pollution and environmental impacts and resilient in that it accounts for natural hazards **(World Bank, 2012).** 9. Is growth that is efficient in its use of natural resources, clean in that it minimizes pollution and environmental impacts, and resilient in that it accounts for natural hazards and the role of environmental management and natural capital in preventing physical disasters. And this growth needs to be inclusive. Inclusive green growth aims to operationalize sustainable development by reconciling developing countries' urgent need for rapid growth and poverty alleviation with the need to avoid irreversible and costly environmental damage **(World Bank, 2012)** 10. Growth achieved by saving and using energy and resources efficiently to reduce climate change and damage to the environment, securing new growth engines through research and development of green technology, creating new job opportunities, and achieving harmony between the economy and environment **(RoK Framework Act on Low Carbon, Green Growth, 2010).** 11. Defined as environmentally sustainable progress that fosters low-carbon, socially inclusive development **(Government of Cambodia, 2009).** 12. An emerging concept that recognizes that environmental protection is a driver of global and national economic development. It refocuses society on achieving qualitative growth rather than simply increasing GDP **(Government of Rwanda, 2011).** 13. Means "job creation or GDP growth compatible with or driven by actions to reduce greenhouse gases." **(Green Growth Leaders, 2011)**