Eskom: A roadmap to powering the future

The future role of Eskom in the transition process of the South African electricity sector

GREENPEACE AFRICA

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Executive Summary

Serious financial and institutional problems, which have steadily worsened in recent years and will continue to worsen without fundamental reforms, are forcing both Eskom and the South African government to act. This is not only about the future of the company, its public mission and jobs, but also about securing affordable energy for the South African industry and private households. In addition, it concerns South Africa's contribution to limiting global temperature rise to 1.5 degrees Celsius.

While more and more countries and companies worldwide are realising that the age of coal is coming to an end and that renewable energies are becoming the most important and cost-effective pillar of energy supply, South Africa and Eskom are lagging far behind, as many global statistics show. This poses a major threat not only to Eskom, but also to the South African economy and the public budgets.

Based on international experiences of states and companies, this study is intended to help guide the necessary transition of the South African electricity sector and the business model of Eskom.

Essential recommendations for this include:

- the transfer of the gradual phase-out of coal-fired power generation from Eskom to new generation companies (GenCos), which will operate the power plants for the remainder of their operating time on the basis of precisely defined conditions, including a coal phase-out by 2040;
- the decommissioning of Eskom's oldest coal-fired power stations in the near future, and the refinancing of Eskom through the sale of all remaining coal-fired power stations;
- the retention by Eskom of the important role of the transmission system operator (TSO) with the possibility of operating its own grid-supporting (non-coal) power plants;
- the opening of the IPP auctions for renewable energies to Eskom as well in order to make it a significant part of Eskom's business model;
- the possibility for Eskom to participate in the six newly created regional electricity distributors (REDs); and
- the opportunity for Eskom to create new services for end-use customers on the basis of the digital revolution that continues to evolve all over the world.

The character of Eskom will then no longer be that of the sole integrated state-owned company dominating all stages of the value chain, but that of a strategic key player of the South African electricity system who:

- guarantees security of supply by owning and operating the transmission network;
- coordinates the various generation companies as a market operator as long as no power exchange/pool model will be introduced by the government;
- cooperates closely with the municipal utilities and other players at the distribution/supply level; and
- ensures that renewable energies replace stepwise conventional power plants without jeopardising security of supply.

This will not happen without a strong political will to shape the future.

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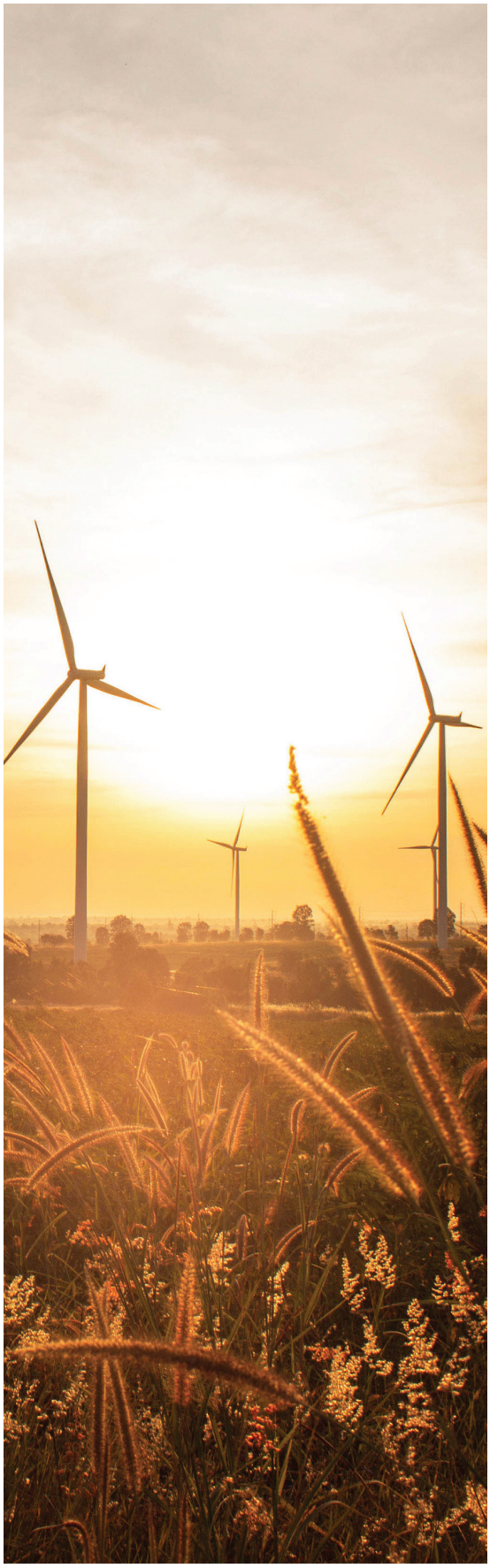
1 Introduction

In the World Economic Forum's latest annual Energy Transition Index, South Africa ranked 112th out of 114 nations evaluated. The large state-owned energy utility Eskom is threatened with insolvency if it continues to pursue its old business model. In short, South Africa and Eskom urgently need to redirect their electricity policies to meet the standards of the global energy transition and evolution of the electricity markets.



On the one hand, the global transition is essentially shaped by international climate commitments, which must eventually lead to the complete phase-out of coal-fired power generation. On the other hand, the striking decrease in the price of renewable energies also suggests the rapid economic replacement of fossil and nuclear power generation.

This brief study is intended to help shape this inevitable transition in a prudent and just manner. It derives recommendations for South Africa and for Eskom from two analyses:

- It identifies the main drivers that have motivated transitions in the electricity sectors worldwide for years. It distinguishes between political, economic and technical drivers and the resulting consequences through political/regulatory and/or market pressure.
- It translates the experiences of other major energy companies worldwide with the transition into fruitful lessons for South Africa and Eskom. The selected companies are mostly in public hands and are highly dependant on coal-fired power generation.

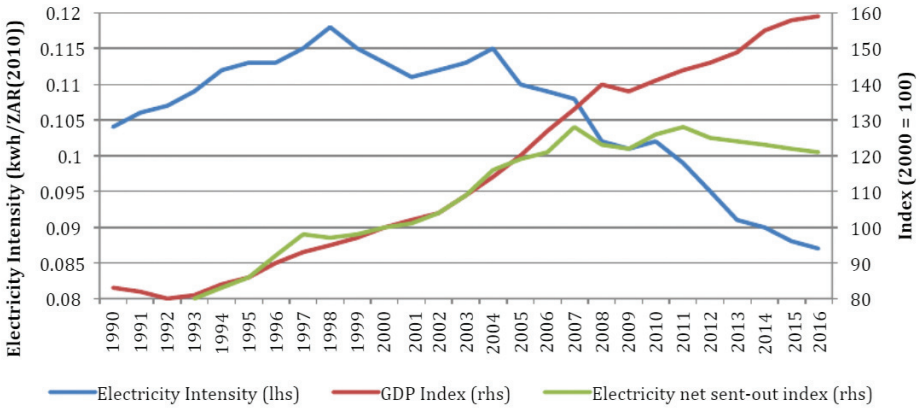
The study benefits from the available literature on the necessity of an electricity sector transition in South Africa. Most scientific reports and articles available are much more comprehensive and detailed than the present study. The main objectives of this study are therefore to summarise the former findings and to address directly the proposals of the South African government, which recently suggested the unbundling of generation, transmission and distribution/supply activities at Eskom. Similar proposals have been made several times in the last 20 years - now it is important to implement them in an intelligent, sustainable and fair way.

2 The electricity sector of South Africa: data and developments in brief

a) Overall developments

South Africa's gross domestic product (GDP) has increased by more than 60% since 1990, while electricity intensity – the number of kWh per unit of GDP output – reached a peak in 1998 and fell for the two decades that followed. Nevertheless, South Africa's energy and electricity intensities are still among the world's highest partly because of its heavy industry (Eberhard and Lovins, 2018, p.16).

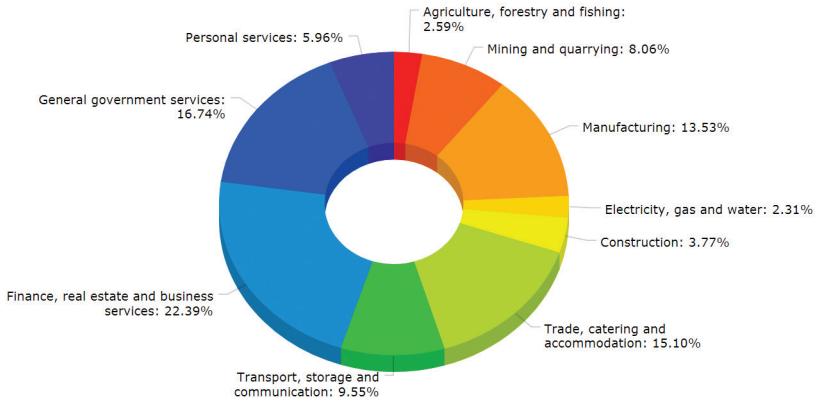
Figure 1: South Africa's GDP growth, electricity intensity and electricity consumption



Source: Eberhard and Lovins, 2018, p.15

Together with the gas and water sectors, the electricity sector accounts for only 2.3% of South Africa's GDP.

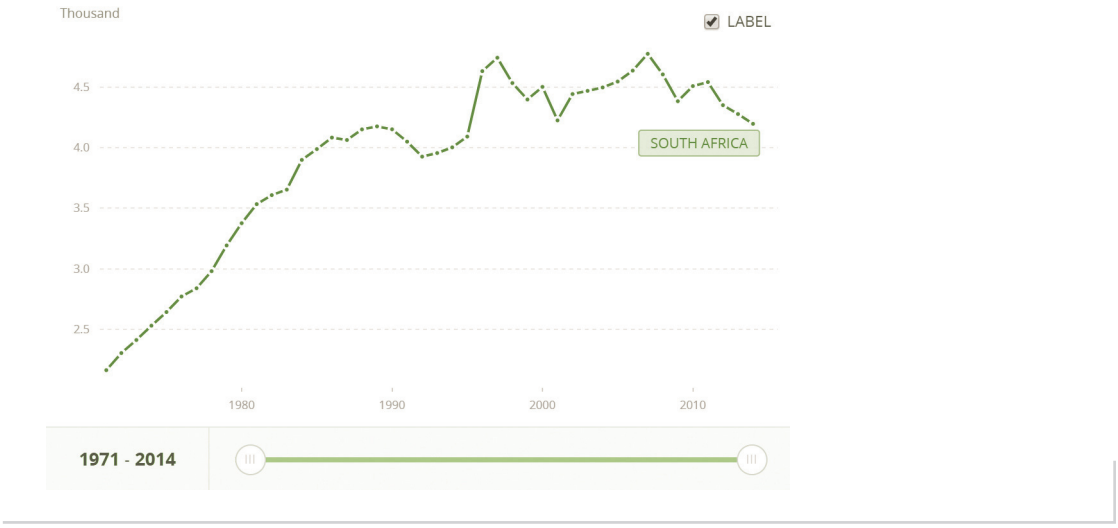
Figure 2: Relative contribution of the various industries to South Africa's GDP



Source: https://www.southafricanmi.com/south-africas-gdp.html

Electricity consumption per capita peaked in 2007 with almost 4 800 kWh, and decreased since then to a level well below 4 200 kWh. One of the reasons for the decrease could be sharply rising prices since 2008.

Figure 3: Electric power consumption in South Africa (kWh per capita)



Source: World Bank (https://data.worldbank.org/indicator/EG.USE.ELEC.KH.PC?end=2014&locations=ZA&start=1971&view=chart)

b) Generation

South Africa supplies approximately 40% of Africa's total electricity, but still 2.2 million South African households (14%) are not connected to the electricity grid.

As of the end of 2017, roughly 53 GW of power plant capacity have been installed with the vast majority being comprised of coal power plants. The following table shows the shares of the different energy sources for both installed capacity and electricity generation.

Table 1: Installed capacity and electricity generation in 2016/2017

	Installed Capacity 2017	Share	Generation 2016	Share
	MW	%	GWh	%
Coal	40 142	75.5%	203 054	85.7%
Nuclear	1 940	3.7%	12 305	5.2%
Gas/liquid	2 426	4.6%	11 580	4.9%
Hydro	661	1.2%	783	0.3%
Pumped Storage	2 372	5.2%	2 934	1.2%
Other Renewables	100	0.2%	6 350	2.7%
IPPs	5 027	9.5%		
Sum	**53 028**	**100%**	**237 006**	**100%**

Sources: Energy Information Administration, 2017; Statistics South Africa, 2018

The installed coal capacity is spread over 90 power plants at 15 different locations; their average age is 40 years with the exception of three plants, which have been commissioned in the last 3 years.

Table 2: Installed capacity of coal power plants 2017

Location	Installed Capacity	Plants	Age	CO_2 2017
	MW	#	years	Mt/year
Arnot	2 352	6	44-48	8.9
Camden	1 561	8	50-52	6.1
Duvha	3 600	6	35-39	13.7
Grootviel	1 180	6	42-50	4.5
Hendrina	1 893	10	43-49	7.6
Kendal	4 116	6	27-31	15.6
Komati	990	9	53-58	3.8
Kriel	3 000	6	40-43	11.4
Kusile	800	1	new	4.3 (estimate)
Lethabo	3 708	6	29-34	14.1
Majuba	4 110	6	18-23	15.7
Matimba	3 990	6	28-32	15.2
Matla	3 600	6	36-40	13.7
Medupi	1 588	2	new	8.7
Tutuka	3 654	6	29-34	13.9
	40 142	**90**	**⌀ 40**	**157.1**

Source: Department of Energy, 2018a, https://www.carbonbrief.org/mapped-worlds-coal-power-plants

In recent years, renewable energy technologies have seen a significant rise in popularity and demand. The Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) is a competitive tender process that commenced in 2011 to facilitate private sector investment into grid-connected renewable energy generation in South Africa (Eberhard and Naude, 2016).

Since then the Department of Energy (DoE) has procured 6.4 GW from 112 Independent Power Producers. By the end of June 2018, 3 801 MW of the procured capacity started operations and delivered 3 776 MW of actual capacity (Department of Energy, 30 June, 2018). According to the Integrated Resource Plan 2018 (Draft), the installed capacity, the committed/already-contracted capacity and the planned additional capacity until 2030 are divided among the individual renewable energies as follows:

Table 3: Installed, committed/contracted and planned renewable energy capacities in South Africa (in MW)

	Wind	Photovoltaics (PV)	Concentrated Solar Power (CSP)
Installed	1 980	1 474	300
Committed / Contracted	1 362	814	300
Planned	8 100	5 670	0
Sum	**11 442**	**7 958**	**600**

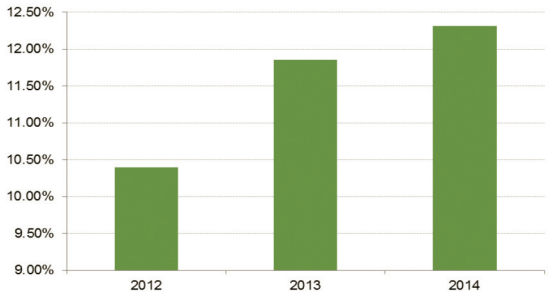
Source: Department of Energy, 2018a

So far, the role of cogeneration plants can be considered negligible with no plans to increase the existing small capacity.

Peak demand in South Africa has been around 35.3 GW in 2016/17, an increase from 36.5 GW in 2007.

Due to underinvestment in generation capacity, unplanned outages increased between 2007 and 2014 (see figure below), and load shedding could not be avoided.

Figure 4: Unplanned outages (2012-2014)



Source: Genesis Analytics, 2016, p.9

Load shedding continues to be a significant burden; in February 2019, Eskom implemented stage 4 load shedding (stage 4 allows 4 000 MW to be shed from the national grid).

What load shedding means

As a last resort and preventative measure, consumers are cut off on a rotational basis for 2-4 hours to protect the electricity grid from collapse. Eight stages can be distinguished: Stage 1 (where < 1 000 MW are shed from the grid) to Stage 8 (where < 8 000 MW are shed from the grid). Load shedding is the final step to prevent a blackout; the measures before forced shutdowns embrace voluntary or contracted emergency demand reduction.

The following figure shows the tense capacity situation of Eskom in autumn 2019:

Figure 5: Eskom's three-month forecast of available capacities

Three Month Outlook

This is the forecast demand vs. available generating capacity for each week for 3 months ahead. Colour codes ranging from green (no shortage) to orange (worst case) are used to indicate the absence or presence of a capacity constraint.

		MW	MW	MW	MW	MW	MW
Week Start	Week	Forecast	Available Capacity	Available Capacity (Less OR and UA)	Planned Maintenance	Planned Risk Level (-10 200 MW)	Likely Risk Scenario (-12 200 MW)
04-Feb-19	6	29 830	41 479	31 279	4 813		
11-Feb-19	7	29 497	40 347	30 147	5 945		
18-Feb-19	8	29 356	40 417	30 217	5 875		
25-Feb-19	9	29 324	40 390	30 190	5 902		
04-Mar-19	10	29 857	40 495	30 795	5 797		
11-Mar-19	11	29 908	41 164	31 464	5 128		
18-Mar-19	12	29 816	40 742	31 042	5 550		
25-Mar-19	13	29 837	40 890	31 190	5 402		
01-Apr-19	14	30 032	39 464	30 764	6 828		
08-Apr-19	15	30 270	39 756	31 056	6 536		
15-Apr-19	16	30 349	39 756	31 056	6 536		
22-Apr-19	17	30 608	40 334	31 634	5 958		
29-Apr-19	18	30 759	40 144	31 444	6 148		
06-May-19	19	32 023	40 719	32 019	5 573		

Notes - Critical assumptions:

The maintenance plan included in these assumptions includes a base scenario of outages (planned risk level). As there is opportunity for further outages, these will be included. This "likely risk scenario" includes an additional 2 000MW of outages on the base plan.

The expected import at Apollo is included.

Avon and Dedisa not included.

The forecast used is the latest operational weekly peak.

Operating Reserve (OR) from Generation:

2 200 MW

Unplanned Outage Assumption (UA):

8 000 MW (7 500 MW 1 March '19, 6 500 MW 1 Apr '19)

Reserves: OR + UA = 10 200 MW

Installed Capacity:

46 292 MW

Source: https://www.moneyweb.co.za/news/south-africa/loadshedding-outlook-not-good/

KEY	Risk Level	Description
		Adequate Generation to meet Demand and Coverage
		<1 000MW Possibly short to meet Reserves
		1 001 MW - 2 000MW Definitely short to meet Reserves and Possibly Demand
		> 2 001MW Short to meet Demand and Reserves

The energy availability factor (EAF) was roughly 77% in 2017/18 while Eskom is now forecasting 78% for 2019/20.

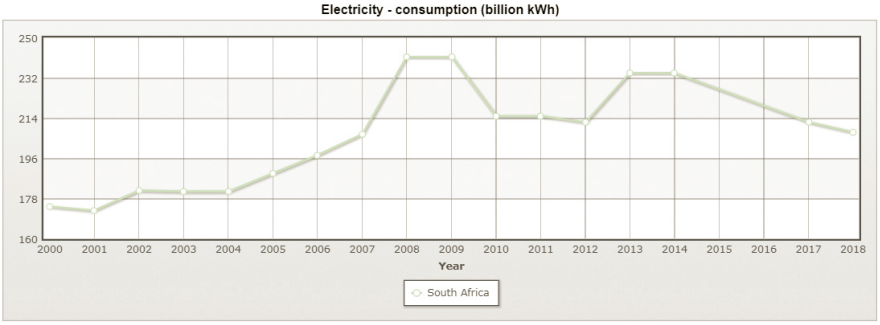
Electricity generation did not differ significantly in recent years: if the base is set to 100% in 2015, it only rose to 102% in 2017.

c) Consumption

Total electricity consumption can be calculated as total electricity generated annually plus imports minus exports minus transmission and distribution losses.

The export of electricity is usually larger than the import, and the net total differed between 3 and 6 TWh in the last 10 years. Network losses accounted for 9.15% in 2017/18. Today total electricity consumption is slightly higher than 205 TWh, with a low of 172 TWh in 2001 and a high of more than 240 TWh in 2008 and 2009.

Figure 6: Total electricity consumption from 2000 to 2018 (in TWh)



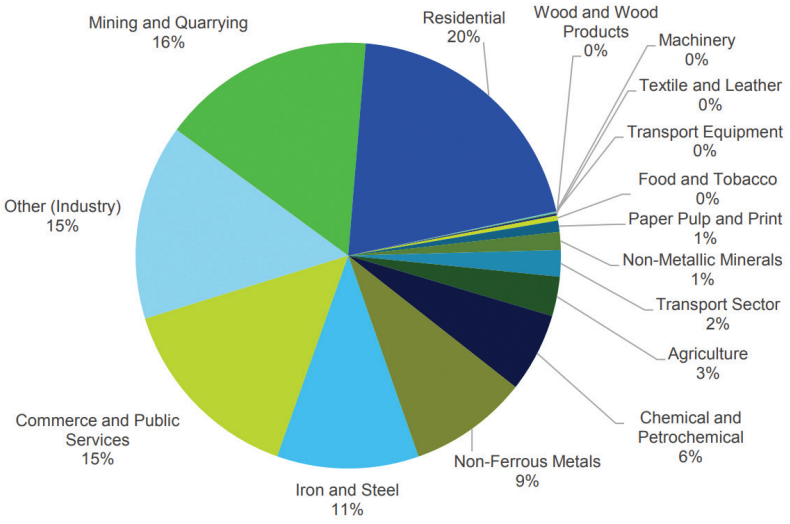
Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2017	2018
South Africa	174.49	172.39	181.52	181.2	181.2	189.4	197.4	207	241.4	241.4	215.1	215.1	212.2	234.2	234.2	212	207.7

Source: https://www.indexmundi.com/g/g.aspx?c=sf&v=81 (CIA World Factbook)

Eskom is forecasting sales of 211 TWh for 2019/20 and the following years.

When distinguishing electricity consumption by the type of end users, industrial and residential users account for nearly 80%.

Figure 7: Electricity consumption by sector, 2012



Source: Deloitte, 2017, p.20

The country's 31 energy-intensive users consume 44% of the country's electricity. This group includes five major mining companies who also supply 80% of the coal used by Eskom (Baker, 2017; Eberhard, 2011).[1]

[1]For more information, see http://eiug.org.za/, the homepage of the Energy Intensive Users Group (EIUG) of Southern Africa.

d) Networks

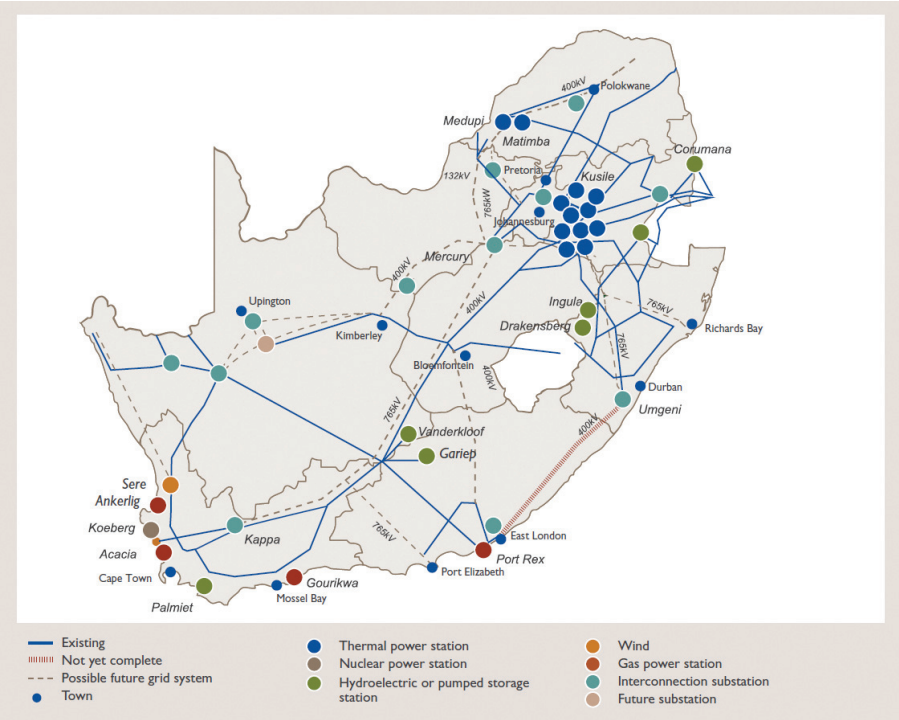
The transmission grid consists of roughly 32 000 km of power lines and substations with a cumulative capacity of nearly 150 GVA. Eskom, who consequently provides 100% of transmission services, owns the whole transmission grid.

In addition there are 48 805 km of distribution lines, 296 188 km of reticulation power lines[2] and 7 499 km of underground cables in South Africa, representing the largest power-line system in Africa (Department of Energy, 2018b).

Revenues from implicit network charging are approximately R32 billion (or €2 billion) per year for Eskom alone (Statistics South Africa, 2018); estimates for the total amount of network charges in South Africa are not available due to lack of transparent unbundling of accounts.

The following figure summarises the technical structure of the South African electricity system:

Figure 8: Technical structure of the South African electricity system



Source: Eskom, 2018b

The South African electricity system is a part of the Southern African Power Pool (SAPP), which is a cooperation of the national electricity companies in Southern Africa under the auspices of the Southern African Development Community (SADC) and was founded in 1995. The members of SAPP have created a common power grid between their countries and a common market for electricity in the SADC region. SAPP members include Namibia, Lesotho, Mozambique, Botswana, Zimbabwe, Swaziland, South Africa and Zambia.

A recent SAPP plan, finalised in 2017 for the period until 2040, anticipates that renewables (and, specifically, hydro) and gas generation will fulfil a substantially increased component of overall generation capacity in the whole region. In order to facilitate the controversial Grand Inga Hydropower Project Treaty between South Africa and the Democratic Republic of the Congo, 2 500 MW of hydropower are included in the Department of Energy's 2018 draft of the Integrated Resource Plan (IRP).

Eskom is by far the largest company in the SAPP generating more electricity than the other 11 state-owned companies do combined.

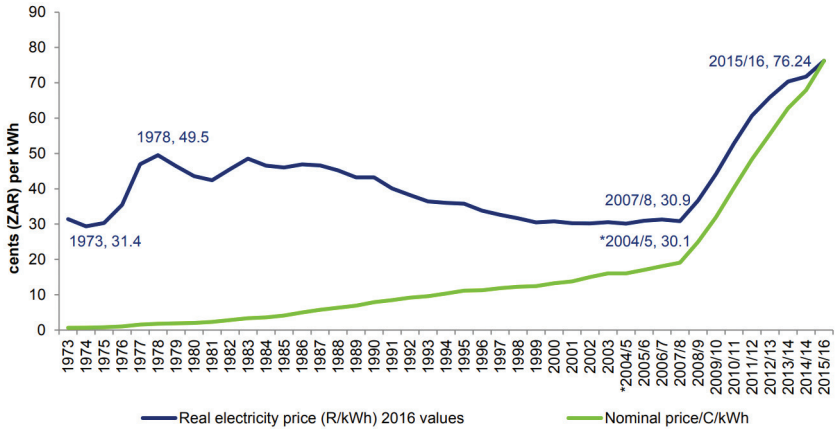
[2]Reticulation differs from distribution in that it includes only power lines equal to or lower than 22 kV.

e) Electricity prices

Electricity is distributed either directly by Eskom or by municipalities who buy it from Eskom at a tariff set by the National Energy Regulator of South Africa (NERSA).

The tariffs from Eskom began to increase dramatically in 2008 when the utility was forced by the Department of Energy to invest in new capacities. Since Eskom had neither cash reserves nor enough expected revenue streams to cover the cost of the new plants, NERSA approved several sharp increases in annual tariffs. From 2008 to 2013, the electricity prices more than doubled in real terms (inflation-adjusted).

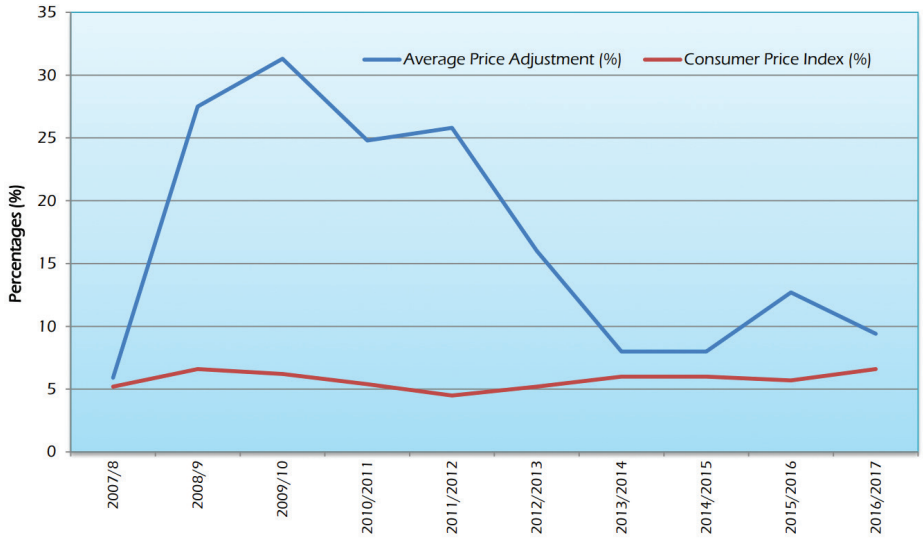
Figure 9: Trend in Average Electricity Prices realised by Eskom per kWh



Note: In 2004/05 Eskom changed the financial year from calendar year to year-ending 31 March
Source: Deloitte, 2017, p.40

The following figure shows the annual year-on-year Eskom average tariff adjustments in relation to the development of the consumer price index (CPI):

Figure 10: Annual Eskom Average Tariff Adjustment



Source: Department of Energy, 2017, p.37

Currently Eskom is seeking yearly tariff hikes of 17.1% (2019/20), 15.4% (2020/21) and 15.5% (2021/22) due to lower sales forecast, delays in the completion of the new coal power plants, and a higher use of the expensive gas turbines.[3]

[3] See Creamer Media's Engineering News, 1st February 2019.

Electricity prices differ between the different customer categories with domestic customers controversially paying the highest and industrial customers paying the lowest prices.

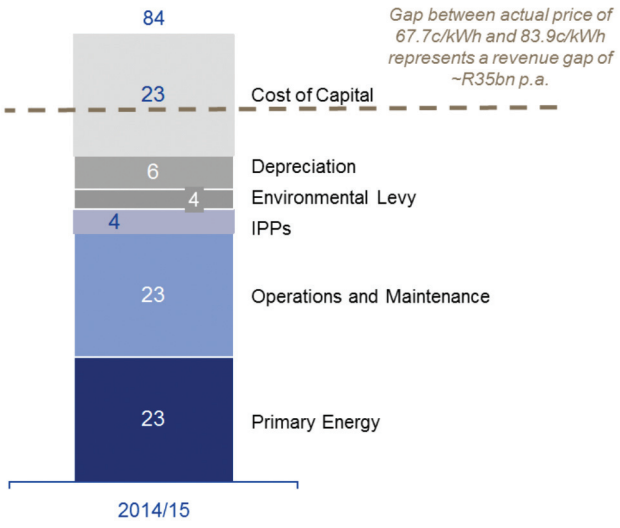
Table 4: Annual Average Eskom Prices by Customer Category in cents per kilowatt per hour (2007/8-2016/17)

Period	Bulk	Domestic and street lighting	Commercial	Industrial	Mining	Rural/ Farming	Traction/ Rail	International	Average for all categories
2007/2008	18.21	44.56	24.85	17.28	17.99	35.91	23.31	14.17	19.60
2008/2009	23.29	53.43	31.61	21.69	23.12	45.78	29.78	18.45	24.97
2009/2010	30.84	63.98	40.97	27.03	30.25	58.96	38.23	22.47	32.00
2010/2011	39.53	66.45	52.63	34.34	39.78	72.72	48.55	31.04	40.31
2011/2012	49.96	79.52	65.92	42.13	50.11	89.22	58.23	37.53	50.27
2012/2013	54.59	87.05	73.24	45.56	55.75	99.75	68.66	42.72	55.50
2013/2014	60.67	92.41	82.67	51.79	64.66	108.75	77.34	47.56	62.22
2014/2015	65.92	98.06	89.16	56.81	69.52	115.66	83.63	52.55	67.68
2015/2016	74.11	108.11	100.07	62.64	78.01	128.19	96.60	59.82	75.98
2016/2017	81.38	118.60	109.09	67.71	84.80	141.70	104.95	70.77	83.32

Source: Department of Energy, 2017, p.34

The electricity price consists of different components, which are roughly indicated for Eskom's 2014/15 tariff:

Figure 11: Components of Eskom's 2014/15 tariff



Source: Deloitte, 2017 on basis of Eskom, p.73

The purchasing of primary power, the cost of capital and operations and maintenance in particular for the networks all have an equal share of 23% of the total each, while the payments for the Independent Power Producers and the environmental levy account for less than 10% of the total.

f) CO_2 emissions

South Africa's aggregated greenhouse gas (GHG) emissions increased by 22.4% from 2000 to 2014 while CO_2 emissions increased by 21% from 2000 to 2017. The contribution to the global CO_2 emissions is 1.2%, according to the latest BP Statistical Review of World Energy from June 2018 (BP, 2018). Together with the United Kingdom, Turkey and Australia, South Africa ranks 14th in the global country ranking of greenhouse gas emissions polluters.

Electricity generation (plus heat production) is responsible for around 220 Mio. t CO_2/year which is almost half of total CO_2 emissions in South Africa while CO_2 emissions contribute two thirds of total GHG emissions.

The share of coal power generation to total CO_2 emissions in South Africa is almost 44% while it represents 30% of total GHG emissions.

Eskom was responsible for more than 205 Mio. t CO_2/year in 2017, which can mainly be attributed to their coal power plants since their gas turbines did not generate significant amounts of electricity and all other contributions were CO_2 free. In total, this means that Eskom's coal-fired power plants are responsible for around 30% of total GHG emissions in South Africa.

3 The electricity sector of South Africa: companies, framework conditions and governance

a) Generation companies

South Africa has four groups of electricity generators:[4]

- Eskom, the national public utility
- Municipal generators[5]
- Independent Power Producers (IPPs)
- Self-generators

Eskom owns more than 90% of the total nominal generation capacity (i.e. 45 600 MW) with 15 coal power stations, 1 nuclear power plant, 4 gas/liquid fuel turbine stations, 3 pump storage schemes, and 6 hydroelectric stations. Recently it commissioned a 100 MW wind farm as well.

Municipalities own 22 small power stations and back-up gas turbines, totaling a little more than 800 MW of total nominal capacity (RECP, 2017).

Private generators – known as Independent Power Producers – contribute a rising share to total nominal generation capacity, mainly renewable energies. About a quarter of the financing of the IPP projects is provided by foreign investors (Department of Energy, 30 June, 2018).

The self-generators are industries which generate electricity for their own use. These include pulp mills, sugar refineries, and metallurgical industries (Department of Energy, 2018b).

Despite the absence of an appropriate national legal and regulatory framework thus far, commerce, industry and wealthy households – primarily in response to the current crises of electricity supply and rising tariffs, and rapidly declining prices for solar PV technology – have installed small-scale embedded generation (SSEG) or rooftop solar. Nevertheless the level of electricity generated by SSEG is minimal in comparison to overall national generation (Baker and Phillips, 2019).

b) Network/distribution companies

Eskom owns, operates and maintains the national transmission network and shares the distribution network with licensed municipal distributors.

Section 155 and Schedule 4B of the Constitution lists electricity reticulation (low voltage distribution) as a competence of municipalities in South Africa. Each municipality is a service authority for the “electricity reticulation” function for the whole of its jurisdictional area and has the right to set tariffs in respect of its sale of electricity in its areas of jurisdiction (Fontana et al., 2016).

Of 257 metropolitan, district and local municipalities, approximately 174 municipalities have been licensed by NERSA to serve as electricity distributors, a role which includes maintaining infrastructure, providing new connections, and setting minimum service level standards and pricing and subsidy levels for poor consumers (Baker and Phillips, 2019; South African Local Government Association, 2014).

[4] In addition, there are some government-owned peaking power stations that operate during peak periods or when the system is under stress.
[5] It is not clear whether municipalities are legally permitted to generate electricity in the future.

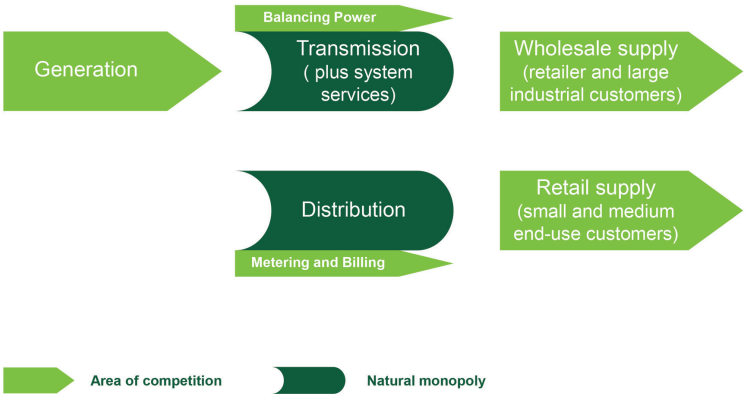
Baker/Phillips characterise the relationship between Eskom and the municipalities as follows:

> Though both Eskom and municipalities are responsible for electricity distribution, there are long-standing tensions and little coordination between them and a dual system therefore exists ... Despite the fact that Eskom controls 60% of electricity distribution, under the post-apartheid constitution, 'electricity reticulation' is listed as a local government responsibility ... Such legislation lies at the heart of tensions between these two institutions, firstly because of Eskom's apparent objection to municipalities using electricity tariffs for cross-subsidy … and secondly due to the debt owed to Eskom by many municipalities … Under the 2006 Electricity Regulation Act and the supply agreement with municipalities, Eskom is entitled to disconnect the supply of electricity to municipalities that have defaulted and has recently done so ... The politics of distribution are also complicated by the fact that in some cases Eskom distributes directly to customers within the licensed municipal distributors though an accurate picture is difficult to acquire due to lack of publicly available distribution data ... In either case, customers have no choice over who they are supplied by and both Eskom and municipalities effectively operate as 'geographic monopolies' (Baker and Phillips, 2019).

c) Framework conditions and governance

For a better understanding of the electricity sector, it is helpful to distinguish between the individual stages of the value chain and between competition and monopoly areas. The following figure shows a differentiated picture of the sector, which has been regarded and treated as a monopoly-like black box for many decades:

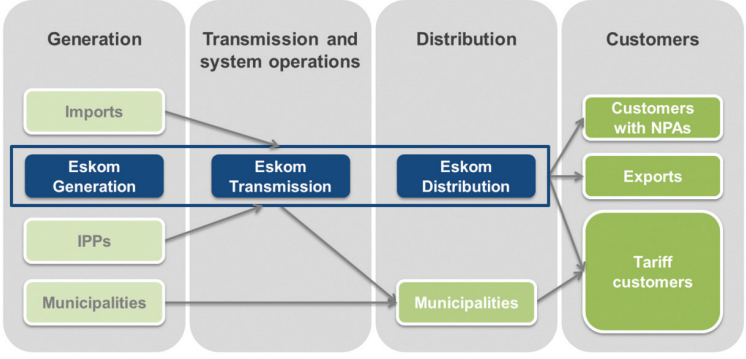
Figure 12: The value chain of the electricity sector



Source: Own illustration

The current electricity sector in South Africa can best be described as a single buyer model with some specific features:

Figure 13: Structure of the South African electricity sector



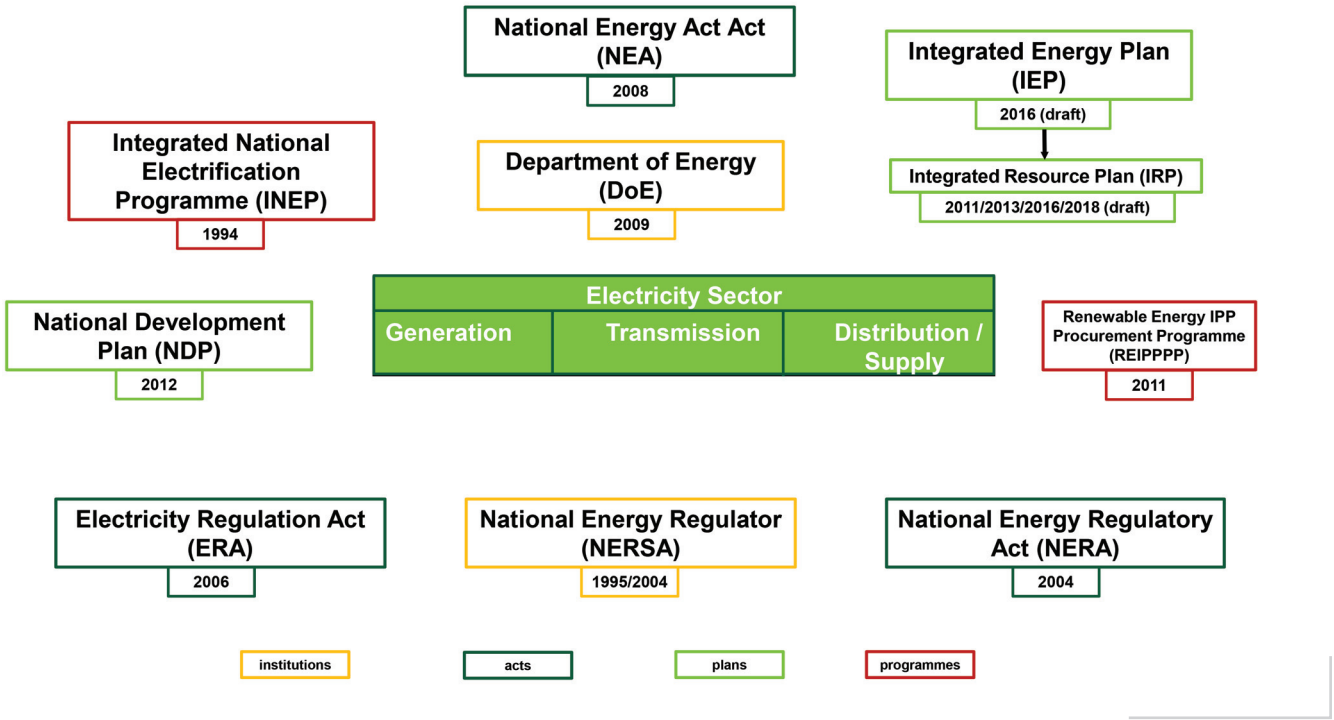
Source: Genesis Analytics, 2016, p.7

Specific features include:

- Negotiated Pricing Agreements (NPAs): customers with NPAs are those who have arrangements with Eskom.
- Imports and exports: in 2016, roughly 13.5 TWh were supplied to other countries while 9.8 TWh were supplied from other countries, all within the SAPP region.
- Potential customers, not all of whom are served; 14% of all households are not connected to the grid.

The following figure gives an overview of the most important framework conditions of the South African electricity sector:

Figure 14: The main institutions, acts, plans and programmes of the South African electricity sector



Source: Own illustration

To highlight some of these framework conditions: (see especially Genesis Analytics, 2016, pp. 3-6):

- Under the amended Electricity Act of 1995, the National Electricity Regulator (NER) was established. The NER's mandate included licensing and monitoring of the industry as well as tariff determination. The NER was subsumed into the diversified National Energy Regulator of South Africa (NERSA) in 2005 following implementation of the National Energy Regulator Act of 2004.
- The Electricity Regulation Act of 2006 provides NERSA with a wide-ranging mandate including licensing, registration, price and tariff regulation, monitoring and enforcement, dispute resolution, and mediation and arbitration powers, whilst entrusting the Minister of Energy with the responsibility of planning and procurement of new generation capacity.
- The Integrated Resource Plan (IRP) is legally subordinated to the Integrated Energy Plan (IEP) of the Department of Energy. The latter serves the government as the master plan for the entire energy system. The first IRP from 2010 outlined the South African government's strategy for investment in generation and transmission for the period 2010 to 2030, aiming at doubling generation capacity compared to 2010 and utilising a mix of different power plants, mainly coal-fired, gas-fired and nuclear, as well as renewables and large-scale hydro imports from other Southern African countries (Fontana et al., 2016). Since then the IRP was due to be updated in 2013, but the update did not materialise. Another update was proposed in 2016, but was not approved. Now the next IRP draft (2018) is in process.
- The South African Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) and its results have already been mentioned (see page 10).

- The National Development Plan (NDP) is targeting a greenhouse gas emissions trajectory that peaks at 34% below a "business as usual" case in 2020, 42% below in 2025 and from 2035 declines in absolute terms. These targets are part of the nationally determined contribution (NDC) of South Africa and are consistent with the pledge under the Copenhagen Accord.

The most important recent developments in the South African electricity sector include:

- The publication of the updated IRP draft for public comment in August 2018. It has a significant allocation of renewables (most of all wind and solar), however the IRP draft retains the artificial limits on renewable energy seen in previous versions.
- The draft IRP also does not include any additional nuclear power plant apart from the installed capacity provided by the Koeberg nuclear power station due to cost concerns.
- A new bid round (Bid Window 5) under the REIPPP Programme was announced by the Minister of Energy and was expected to be launched in the first quarter of 2019 after the approval of the Draft IRP 2018. The newest draft has yet to be approved. It is anticipated that 1 000 MW of solar PV and 1 600 MW of wind will be procured (Behr and Sikhwari, 2018).
- An intensive discussion around reforming Eskom, specifically the unbundling of the different segments of the value chain (generation, transmission, distribution) (see Chapters 4, 7).

Previous struggles to reform the electricity sector – failures and success

Failures:

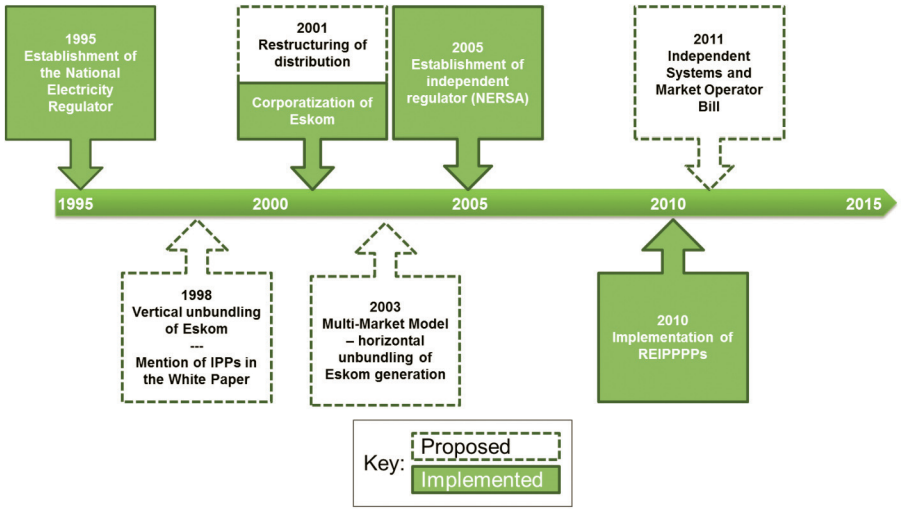
- In 1998, the White Paper on Energy Policy put forward the unbundling of South Africa's electricity sector into separate transmission, distribution and generation companies.
- The White Paper was followed by a cabinet memorandum in 2001 announcing that 30% of electricity generation, including renewable energy, would come from Independent Power Producers, in turn followed by a cabinet ruling that Eskom no longer be allowed to build new electricity generation (Eberhard, 2007). This was revised in 2008, when the DoE forced the company to invest in new capacities.
- A subsequent process initiated in 2003 was to have integrated Eskom's electricity distribution business with the country's municipal distributors in order to create six regional electricity distributors (REDs). Although the first RED was established in Cape Town in 2004, the process was halted due to constitutional challenges regarding the executive authority of local government, and the lack of support for the constitutional amendment, which would have been required to remedy the situation. The failure of the process was fired by the resistance of many municipalities who feared that the formation of REDs would threaten the revenue they generate from on-selling bulk electricity to end users (Baker and Phillips, 2019).
- As mentioned above, the 1998 White Paper considered a separation of generation and transmission to be necessary to allow the introduction of competition in electricity generation. This consideration led to the presentation of the Independent Systems and Markets Operator (ISMO) Bill in 2011 with the aim of establishing an ISMO independent of Eskom. This entity would "operate or coordinate operation of the transmission system" and "trade in electricity at wholesale level," thus separating the generation and transmission functions of Eskom. However, as with the REDs, this reform was never implemented (Genesis Analytics, 2016, pp. 5-6).

Success:

- The White Paper proposed the introduction of IPPs as additional actors for power generation. However, it did not provide sufficient clarity on how IPPs should access the market. Together with the reluctance of the private sector due to relatively low electricity prices, this initiative initially failed. However, with rising electricity prices and shrinking reserve margins, larger renewable energy projects became the focus of attention, and in 2009 NERSA introduced feed-in tariffs for renewable energies. These were then replaced in 2011 by the Department of Energy through the REIPPP Programme which, over the last few years, has led to a significant expansion of wind and solar power in South Africa (Genesis Analytics, 2016, p.5) (see also Chapter 2a).

The following figure summarises the reform efforts of the last decades:

Figure 15: Implemented and planned reforms in the South African electricity sector



Source: Genesis Analytics, 2016, p.6

© Greenpeace, Mujahid Safodien, 2016.

4 **Eskom:** structure, developments and problems

Eskom is an electricity company which is wholly owned by the South African State. As one of the top utilities in the world by generation capacity, it generates approximately 90% of the electricity used in South Africa and approximately 40% of the electricity used in Africa.

Eskom generates, transmits and distributes electricity to nearly 6.3 million customers, including approximately 3 000 industrial customers, 1 000 mining customers, 52 000 commercial customers, 82 000 agricultural customers and more than 6 million residential customers (of whom the majority are prepaid customers).

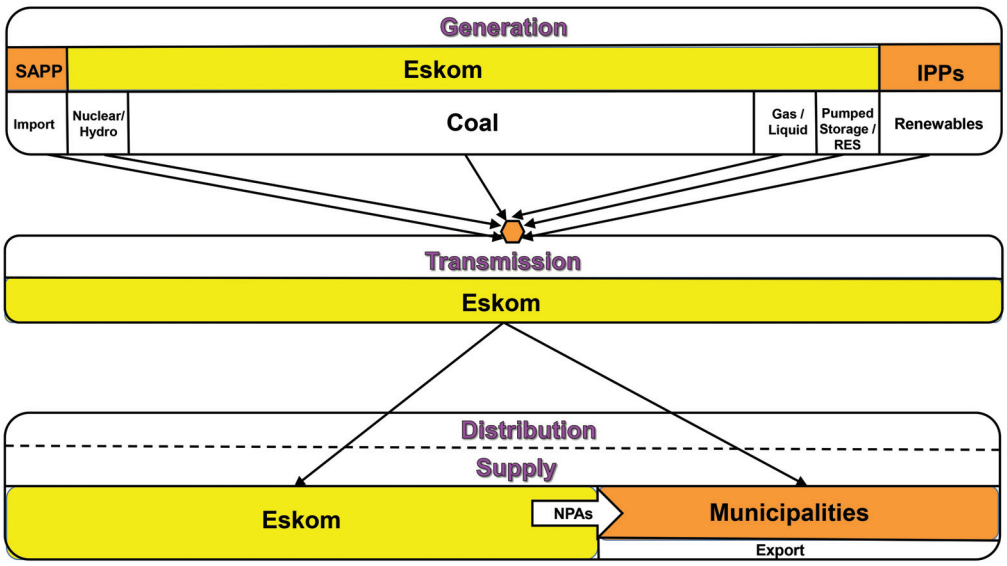
Its mandate is "to provide electricity in an efficient and sustainable manner, including generation, transmission and distribution and retail. The company also has a developmental role and will promote transformation, economic development and broad based black economic empowerment."[6]

The 2001 Eskom Conversion Act converted the utility from a statutory body to a public company: Eskom Holdings Ltd. The shareholder ministry is the Department of Public Enterprises.

Governance of the group is vested in a unitary board, supported by several Board committees. The Board must consist of a minimum of three and a maximum of 15 directors, the majority of whom must be non-executive directors. These are appointed to the Board by shareholders for a period of three years, reviewable annually, and may not serve more than three consecutive terms. Currently there are 13 non-executive and two executive directors in the board.

The following figure shows Eskom's current structure in relation to the other players in the South African electricity sector.

Figure 16: Eskom's current organisational structure in relation to the other sector players in the electricity sector



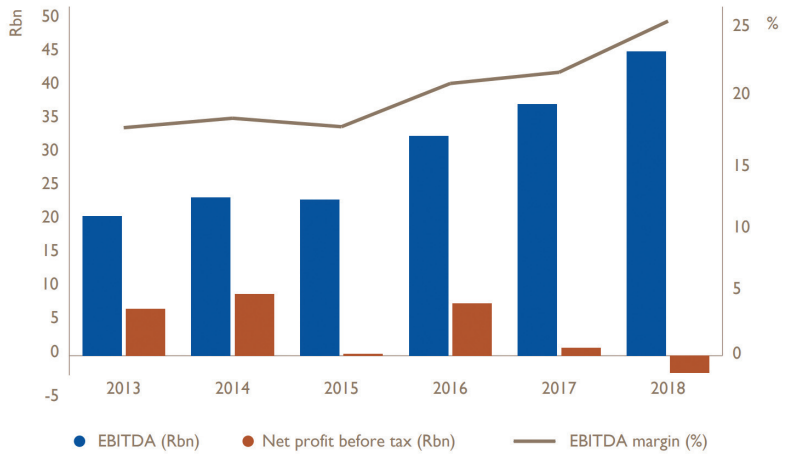
Source: Own illustration; NPA = Negotiated Pricing Arrangements

As Eskom is still a vertically integrated utility, it is difficult to get a clear picture of the financial situation of the different sectors of the value chain.

[6] See http://www.eskom.co.za

The overall picture of the development of the financial results from 2013 to 2018 can be seen in the following figure:

Figure 17: Development of the financial results of Eskom from 2013 to 2018



Source: Eskom, 2018a, p.4 (Rbn – billion Rand)

Although the EBITDA[7] and the EBITDA margin increased in the last five years, the net profit shrank dramatically and finally turned negative in 2018. This is mainly due to a substantial increase in depreciation and net finance cost.

In any case, the company's rising level of indebtedness gives cause for concern. According to Eskom's current annual report, it is already foreseeable today that the gearing (debt/equity ratio) as the most meaningful indicator will deteriorate from 68% today to 77% in 2022/23 (Eskom, 2018b).

Future financing costs will be massively influenced by the decisions made by rating agencies. The following figure shows the ratings of the three largest rating agencies as of March 2018 which are all at a very low level:

Figure 18: Summary of Eskom's ratings at 31 March 2018

Rating	Standard & Poor's	Moody's	Fitch: local currency
Foreign currency Local currency Standalone	CCC+ CCC+ ccc-	B2 B2 caa2	n/a BB- CCC
Outlook	Negative	Negative	Ratings Watch Negative
Last rating action Last action date	Downgrade 27 February 2018	Downgrade 28 March 2018	Downgrade 31 January 2018

Source: Eskom, 2018b, p.76

Since then Moody's has further downgraded the rating to BAA3, one level above sub-investment grade, at the beginning of 2019.

To identify the segments of the business model that are responsible for this negative development, a detailed analysis of the profit/loss situation is beneficial.

The following table shows the breakdown of revenues according to the financial statements of Eskom:

Table 5: Total revenues of Eskom by segments 2017 and 2018

	2017		2018	
	RM	%	RM	%
Generation	116 030	67.7%	118 250	68.2%
Transmission	7 608	4.4%	8 765	5.1%
Distribution	24 174	14.1%	23 503	13.5%
Sales	23 588	13.8%	22 984	13.2%
Sum	**171 400**	**100%**	**173 502**	**100%**

Source: Eskom, 2018a, pp.64-65

[7] Earnings before interest, taxes, depreciation and amortisation

The next table shows the profits/losses after tax (which are equal to those before tax since no income tax was paid in 2017 and 2018).

Table 6: Profits/losses after tax for the different segments in 2017 and 2018

	2017	2018
	RM	RM
Generation	- 2 207	-3 069
Transmission	115	-573
Distribution	1 939	1 628
Sales	1 505	-1 388
Sum	**1 352**	**-3 402**

Source: Eskom, 2018a, pp.64-65

Notably, the generation segment provides the biggest problems, followed by the sales segment. Why the transmission part of the business contributes to the losses as well in 2018 cannot be understood without further information.

In order to identify solutions to the Eskom crisis and to develop new business models, it is important to know in which segments and for what reasons losses are made and how this could theoretically be changed. One of the reasons for the losses in the sales area could be that Eskom offers special tariffs for large industrial customers that may not cover costs. And there can only be losses in the transmission segment if transparently calculated network charges are not sufficient to operate the grid safely and efficiently.

In the beginning of 2019, Eskom faces severe problems, which jeopardise the company as a whole:

- The Department of Public Enterprises announced in February 2019 that Eskom is "technically insolvent and will cease to exist at current trajectory by April 2019." Eskom's R420bn (roughly US$30bn) debt burden represents 15% of the state's debt and around 8% of the gross domestic product.
- Eskom is therefore seeking significant yearly tariff hikes to survive. This could trigger the dreaded utility death spiral where price increases lead to lower demand through more efficiency and/or self-generation, which again leads to higher prices because of the utility's high fixed costs.
- The era of coal-fired power plants is nearing its end because of the Paris Agreement on climate change, sharply decreasing costs of renewable energies and the growing number of flexible renewable facilities that undermine outdated baseload business models and force all other facilities to follow suit.
- Eskom seems not to be prepared for the coming age of renewable energies, namely wind and solar generation facilities. In its latest integrated report they claim: "We create value by transforming inputs from the natural environment – ***coal, nuclear and liquid fuels***, while also using significant amounts of water in the process – into electricity, which is used to power homes and businesses" (Eskom, 2018b). Even in 2018, Eskom does not yet seem to pay much attention to renewable energies.
- Between April 2016 and December 2017 Eskom's coal-fired power stations reported nearly 3 200 exceedances of applicable daily Atmospheric Emissions Licenses (AEL) limits for particulate matter (PM), sulfur dioxide (SO_2), and oxides of nitrogen (NOx). There is clear evidence that these stations are having huge impacts on the air quality in the region and that they are not complying with emissions standards in force (Greenpeace Africa, 2019).
- A report seen by the Business Tech newspaper stated recently that coal shortages will continue until 2025, and hence load shedding might become common practice.[8]
- The recent Eskom Inquiry has resulted in a body of evidence showing widespread corruption in the management of Eskom's operating expenditure which leads to the replacement of parts of the management and to considerable reputational damage (Eberhard and Godinho, 2017).

Against this background, fundamental reforms of the South African electricity sector and Eskom's business model appear inevitable and urgent.

[8] See https://businesstech.co.za/news/energy/288656/south-africa-facing-years-of-load-shedding-report/

5 Global transition of electricity sectors: drivers, targets and recommendations for South Africa

The global electricity sector has been undergoing a dramatic process of change over the last 30 years, the end of which is not yet in sight. At the end of this process, the sector will be fundamentally transformed, but currently most countries are still in the middle of the process - some even at the beginning. This chapter will therefore deal with the design of this process and the individual transition steps with the aim of learning from the experiences of other countries.

According to the World Economic Forum, “effective energy transition is a timely transition towards a more inclusive, sustainable, affordable and secure global energy system that provides solutions to global energy-related challenges, while creating value for business and society, without compromising the balance of the energy triangle” (World Economic Forum, 2018).

Transition is to be understood here as the shaping of a transitory phase, at the end of which there is a comprehensive transformation of the whole system.

a) Transition drivers

The major drivers for the transition of the electricity system have been **politically** enforced first and foremost. The first major driver was restructuring - essentially, the opening of the sector to competitive elements. The aim of this reform, which had been pursued worldwide since the early 1980s, was to improve economic efficiency and thus reduce and stabilise electricity prices on the one hand, and on the other, to open up the sector to private capital.

The OECD or ‘standard’ model of electricity sector reforms (or parts of it) have been widely adopted since the 1990s. It originated in the experiences of a group of OECD countries, primarily the United Kingdom (England and Wales), Norway, the USA, Australia, and Chile (Sen et al., 2016). The starting point in many countries was a state-owned, vertically integrated utility which was separated into different entities. Some or all of them were usually privatised which was either driven by the prospect of economic benefits or by ideological reasons (Sen et al., 2016).

Based on my experiences in Germany and more broadly in Europe, I distinguish between eight stages of a comprehensive reform process of the electricity sector: (Leprich, 2012).

Table 7: Reform steps and main objectives of restructuring of the electricity sector

	Reform steps	Main objective
1	Corporatisation	Utilities as stand-alone legal entities should become commercial enterprises
2	Passage of the requisite energy legislation	A legal mandate for restructuring should provide reliability to all involved parties and companies
3	Restructuring	Different forms of unbundling should break up the former integrated natural monopoly and thus separate interests and business cases of the different stages of the value chain
4	Establishment of an (independent) regulator	Prices/Network charges should be regulated in order to control monopoly profits; the regulation should ensure non-discriminating access to the network
5	Commercialisation	Each business (generation, transmission, distribution, supply) should stay on its own feet without public subsidies or cross-subsidisation
6	Competition in generation through a power exchange or a pool model (wholesale market)	Generation companies should bear operating risks as well as investment risks in order to become as efficient as possible
7	Competition in supply through third party access and transparent non-discriminating network charges (retail competition)	Supply companies should attract customers through lower prices, green electricity, good services etc. since they can easily change suppliers
8	Competition in balancing markets, metering and billing, network related services, etc.	Wherever competition is possible in the electricity sector markets should be designed in order to increase efficiency, transparency and the diversity of actors

This table differs from other characterisations of the 'standard' model of electricity sector reforms (see e.g. Gratwick and Eberhard, 2008; Nepal and Jamasb, 2013) in terms of sequence and scope because it recognises more recent developments and discussions.

The restructuring driver for a transition in the electricity sector is still fairly high on the political agenda, but it has to share its political attention by now with another driver: the decarbonisation promise. Following the adoption of the Kyoto Protocol in 1997, global efforts to decarbonise energy systems were intensified. Since the 2015 Paris Agreement, more and more companies, financial institutions and investors have set the course for a CO_2-free economy:

- The World Bank is set to avail about US$200bn to fund action on climate change from 2021-25, helping countries adapt to the effects of warming and reduce greenhouse gas emissions. The sum represents a doubling of the five-year investment plan put in place after the landmark Paris Agreement.[9]
- The Portfolio Decarbonisation Coalition (PDC) is a multi-stakeholder initiative that will drive GHG emissions reductions on the ground by mobilising a critical mass of institutional investors committed to gradually decarbonising their portfolios. By now the PDC convenes 32 investors overseeing the decarbonisation of US$800bn in commitments.[10]
- As of June 2018, 42 institutions around the globe have joined the Climate Action in Financial Institutions Initiative and endorsed 5 voluntary principles for mainstreaming Climate Action (including commitment to climate strategies and improved climate performance[11]) by, for instance, the World Bank, BMCE Bank of Africa or the European Investment Bank.
- The Powering Past Coal Alliance now has 80 members, including 30 national governments such as the UK, Mexico, Costa Rica, and Angola, 22 subnational governments, and 28 businesses[12] and organisations such as Iberdrola, Salesforce, and Unilever. They describe their "commitment to working together [as being] informed by science-based benchmarks that show that EU and OECD countries must phase out unabated coal-fired electricity generation no later than 2030, with the rest of the world no later than 2050 to limit global warming and the impacts of climate change."[13]
- Climate Action 100+ is an investor initiative to ensure the world's largest corporate greenhouse gas emitters take necessary action on climate change. More than 320 investors with more than US$33 trillion in assets collectively under management are engaging companies on improving governance, curbing emissions and strengthening climate-related financial disclosures. The companies include 100 systemically important emitters, accounting for two thirds of annual global industrial emissions, alongside more than 60 others with significant opportunity to drive the clean energy transition.[14]

[9] https://www.theguardian.com/environment/2018/dec/03/world-bank-invest-climate-change
[10] https://unepfi.org/pdc/
[11] https://www.mainstreamingclimate.org/initiative/
[12] https://poweringpastcoal.org/
[13] https://poweringpastcoal.org/about/Powering-Past-Coal-Alliance-Mission
[14] http://www.climateaction100.org/

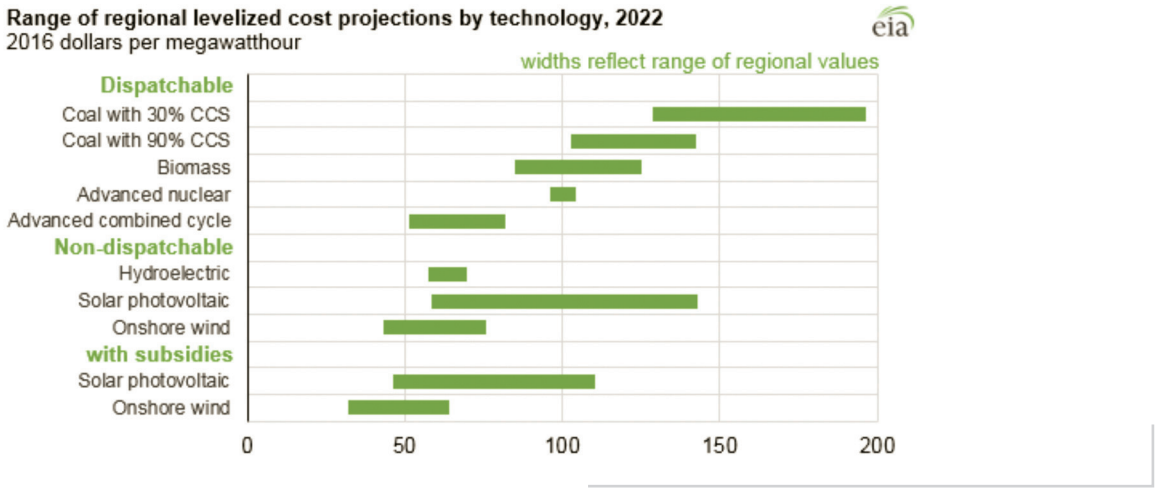
The coal transition is currently a hotly debated issue, and a growing number of studies gives indications on how this transition can be ensured to be just and equitable (Burton, 2018; Caldecott et al., 2017).

In Germany, the Commission on Growth, Structural Change and Employment agreed at the end of January 2019 on a concrete timetable for the phase-out of coal-fired power generation, which provides, among other things, aid for coping with structural change in coal regions (Kommission "Wachstum, Strukturwandel und Beschäftigung", 2019).

Finally, it should not be overlooked that the stricter regulations for air pollution reduction at power plants – based on increasing levels of research indicating that the air pollution from coal power plants is responsible for various health problems and even premature deaths - have also significantly impaired their economic efficiency and have thus also become an important transition driver.

The next driver on the transition agenda is of an ***economic*** nature: the costs of renewable energies, especially wind and solar energy, have fallen so sharply within a decade that they now represent the most cost-effective way of generating electricity in many locations in the world.

Figure 19: Levelised cost of energy (LCOE) of electricity resources



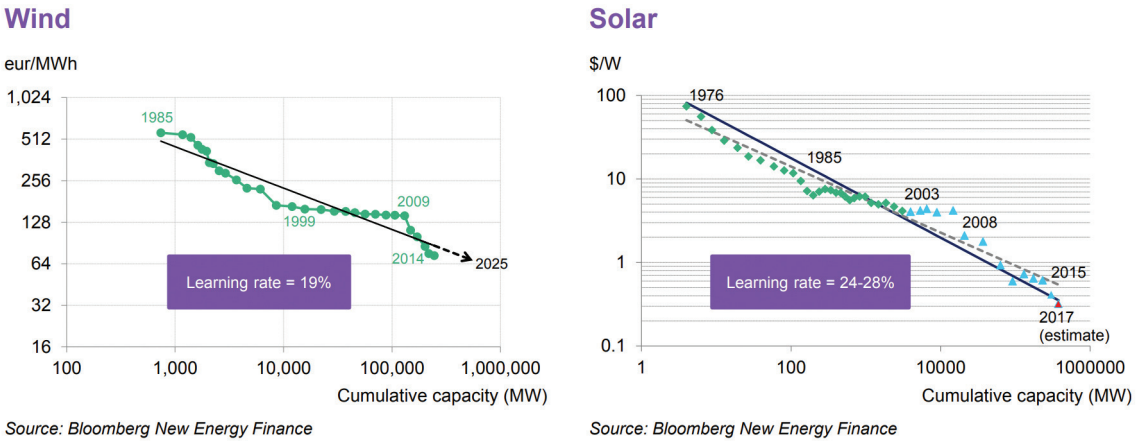
Source: https://www.flickr.com/photos/eiagov/34427028515; from www.eia.gov/todayinenergy/detail.php?id=31052, May 3, 2017

Levelised cost of energy (LCOE) considers a plant's expected lifetime and operation cycle and amortises those costs over an assumed financial lifetime.

It can be seen that even the cheapest new coal-fired power plants are more expensive than the most expensive wind or large solar PV plants, and that the favorability of wind turbines at very good locations is unrivalled.

The learning curves of the two technologies have been virtually revolutionary over the last 40 years: while the costs for wind energy have fallen by 19% with every doubling of production capacity, the figure for photovoltaics has even risen to 24-28%, and an end to cost declines is not in sight.

Figure 20: Learning curves of wind and solar energy



Source: Bloomberg New Energy Finance

Source: Bloomberg New Energy Finance

Source: Liebreich, 2017

The cheaper renewable energies become and the more they are expanded in the future, the more risky it will be to build large-scale fossil-fuel power plants whose economic viability stands or falls with high capacity utilisation. However, both wind and solar power plants prevent high capacity utilisation by always being at the top of the merit order with marginal costs close to zero and forcing fossil plants to cut back or, in extreme cases, to shut down completely in the event of high wind volumes and/or solar supply.

On the demand side, too, the economy is driving the transition: stagnating or shrinking demand in the existing fields of application is accompanied by rising demand in new fields of application such as e-mobility or heat pumps. These require intelligent control technologies in order to be able to safely cover the required load without having to build too many power plants with low capacity utilisation. In addition, there is the development of consumers towards prosumers[15], who cover an increasing proportion of their demand via their own generation including storage and only have to purchase the residual demand. These developments in demand, together with the addition of variable renewable energies, lead to the need for flexible backup systems that have to be amortised relatively quickly in economic terms.

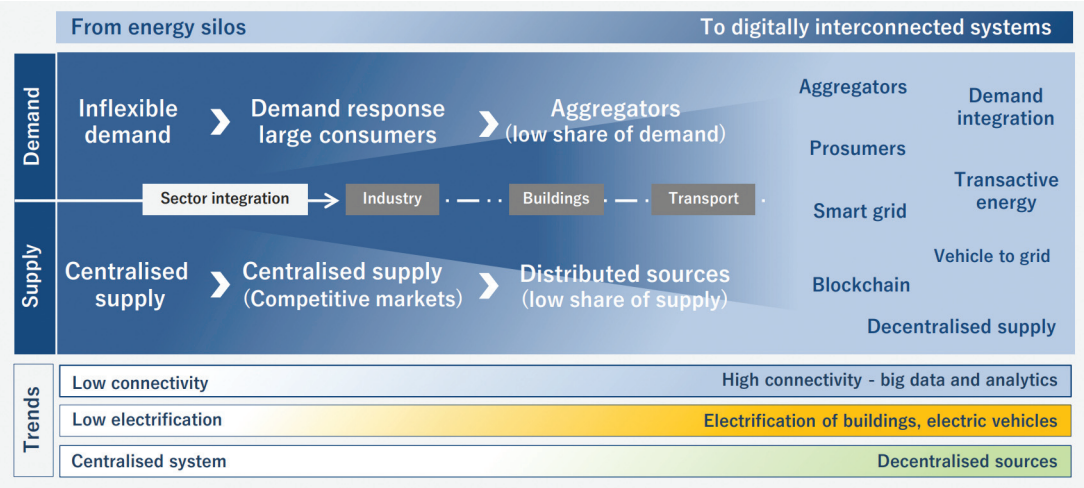
The last essential driver to be considered here is of a ***technical*** nature: In addition to the breakthroughs in wind and solar energy already mentioned, more and more technologies are being developed for decentralised systems often called distributed resources (DRs): small cogeneration plants including fuel cells and organic rankine cycles (ORC), electricity and heat storage systems, control systems for smart homes, smart grids and power-to-x technologies (e.g. power-to-heat, power-to-gas) for converting renewable electricity into heat, gas and fuel.

Furthermore so-called Fourth Industrial Revolution technologies, and digitalisation in particular, will allow for open, real-time, automated communication and operation of a more efficient energy system. The combination of DRs and digitalisation will allow traditional consumers to change their role in the energy system and become prosumers. New tools such as blockchain could help to facilitate peer-to-peer electricity trade within local energy communities.

Growing distributed resources offer an alternative to the current grid to deliver power. This is particularly relevant as access to energy increases in remote locations currently outside of the grid (World Economic Forum, 2018).

The following figure summarises possible steps in the digital transformation of the electricity system as it is expected by the International Energy Agency (IEA). They clearly expect a development towards more decentralised solutions and greater scope for consumer action.

Figure 21: Possible steps in the digital transformation of the electricity system



Source: International Energy Agency, 2017, p.86

[15] A prosumer is a person who consumes and produces a product, in this case, electricity.

The following table summarises the different transition drivers and their main consequences for the electricity sector.

Table 8: Transition drivers and main consequences for the electricity sector

Transition Drivers \ Consequences	Political/Regulatory Pressure		Both		Market Pressure	
	Allow for competition in acquiring new capacities	Unbundle network from generation	Phase-out coal	Increase share of renewable energies	Prepare for more competition on the retail level	Create new business models on- and off-grid
Political: • Restructuring/Competition • Decarbonisation • Air Pollution Reduction	X	X	X	X		
Economic (supply side): • Low cost renewables • High risk fossil fuel investment	X		X	X		
Economic (demand side): • Demand Changes (Volumes and structure) • Prosumers					X	X
Technical: • Distributed Resources (DR) • Digitalisation • Platforms					X	X

b) Transition targets

There is no standard model - no one-size-fits-all blueprint - for the sustainable transition of a country's electricity sector. It depends very much on the initial situation, the stability of the institutions and the legal system, historical legacies and the culture of a country.

The starting point for any system transformation is a country's problems and the targets to be achieved by the transition.

The following table lists the most pressing problems of the South African electricity sector, their causes and implications, and compares them with the main targets to be achieved by the transition.

Table 9: Main problems of the South African electricity sector and main targets to be achieved by the transition

Main problems		Implications	Targets	Corresponding Transition drivers
Financial instability of Eskom; high level of debt	• Cost overrun of new power plant projects and delays in completion • Declining demand • Poor management	• Capital shortage • Poor ratings leads to high interest rates • Sharp rise in prices	• Improve capital attraction • Enhance transparency • Sharpen business models	• Restructuring
Inadequacy of supply	• Antiquated power plants • Capacity shortages • Poor quality of maintenance	• Load shedding • Sunplanned outages	• Invest in new climate-friendly capacities	• Low cost renewables • Restructuring
Coal dominated generation sector	• Large domestic coal reserves	• High CO_2 emissions • High NOx, SO_2, PM • Inflexibility of the system	• Meet the Paris targets • Increase the share of renewables	• Decarbonisation • Low cost renewables
14% of all households still not connected to the grid	• Lack of capital at Eskom	• Persistence of poverty	• Dissemination of off-grid solutions	• Low cost renewables • Digitisation
Corruption, fraud	• Manifold	• Bad governance	• Less corruption	• Restructuring

c) Recommendations for South Africa

As already mentioned, there is no standard model for a successful transition of the electricity sector. What is certain, however, is that no state can escape this challenge, as several drivers are simultaneously and strongly working towards it.

For South Africa, the pressure for change is particularly great, as many proposals have not been implemented in recent years and Eskom is experiencing considerable difficulties (see Chapter 4).

The following recommendations build on diverse experiences of other countries and attempt to take into account the current situation in South Africa.

Table 10: Recommendations for the transition of the electricity sector in South Africa

Transition consequences	Recommendations	Accompanying measures
Allow for competition in acquiring new capacities	• Continue with the IPP programme, but let Eskom participate so that the company can grow into new businesses • Let the new transmission company (s. below) conduct auctions for acquiring new (flexible) capacities because it should be responsible for security of supply	• Ensure that the remuneration of the existing plants is determined competitively
Unbundle network from generation	• Ownership unbundling of the transmission network would help ensure neutrality towards all generators • At least the majority of the new transmission company should remain in public hands in order to ensure public control of the system • At this stage legal unbundling between generation and distribution is sufficient because of the single buyer status of the combined distributors/suppliers	• Ensure that the network charges are calculated in a cost-oriented, transparent, manner
Phase-out coal	• Pass legislation to allow each coal power plant a capped CO_2 budget for the remaining operating time that is compatible with a target of 1.5 degrees Celsius • Pass legislation to prohibit the building of new coal power plants	• Ensure that the structural change of the coal mining regions will be actively reshaped (i.e. implement a just transition programme)
Increase share of renewable energies	• Continue with the IPP programme, but let Eskom participate so that the company can grow into new businesses • Provide assistance to small-scale embedded generation (SSEG) on the basis of PV	• Ensure that in general the renewable facilities have access to the grid and are invoiced fair connection charges
Prepare for more competition on the retail level	• Give assistance to prosumers who install PV systems for their own generation	• Ensure that prosumers contribute fairly to the network charges and are also compensated fairly for contributing to the grid
Create new business models on- and off-grid	• Give assistance especially to municipalities so that they can catch up with digitalisation	• Make sure that data protection will be taken care of from the beginning

In the following chapter, the transition of traditional energy companies will be analysed and discussed. The question of how Eskom must position itself to survive in the future and whether the company can benefit from the experience of other utilities with similar problems in the transition process will then be tackled.

6 Utilities in transition: drivers and consequences

This chapter attempts to make the experiences of other major energy companies fruitful for Eskom.

A total of four companies were considered, which

- are among the largest and most influential in their country,
- (with the exception of one company) have significant public participation,
- are highly dependent on coal-fired power generation, and
- operate under different regulatory conditions.

According to a classification of the Carbon Tracker Initiative (Carbon Tracker Initiative, 2018), these four companies operate in a

- liberalised market (EnBW/Germany; AGL Energy/Australia),
- semi-regulated market (PGE/Poland), and
- regulated market (NTPC/India).

The following table gives an overview of the main data and characteristics of these companies; for comparison, Eskom is placed in the first row.

Table 11: Selected companies compared to Eskom

Company	State	Market Structure		State Participation / %	Operating Coal Capacity / ~MW	Share of coal generation / %	Total Revenues / US$ b	Business Model
Eskom	South Africa	Market concentration	Very high	100	38 000	~90	12.7	Electricity
		Unbundling	By accounting					
		Indep. Regulator	Yes					
		Cross-subsidies	Yes, social tariffs					
		Wholesale Market	No					
		IPP Auctions	Yes					
		Retail Competition	No					
EnBW	Germany	Market concentration	Medium	100	4 400	33	25	Electricity, gas
		Unbundling	Legal					
		Indep. Regulator	Yes					
		Cross-subsidies	No					
		Wholesale Market	Yes, power exch.					
		IPP Auctions	Yes					
		Retail Competition	Yes					
AGL Energy	Australia	Market concentration	Medium	0	5 200	86	18	Electricity, gas
		Unbundling	Legal					
		Indep. Regulator	Yes					
		Cross-subsidies	No					
		Wholesale Market	Yes, power exch.					
		IPP Auctions	Yes					
		Retail Competition	Yes					
PGE	Poland	Market concentration	High	57.4	9 700	91	6	Electricity
		Unbundling	(formally) legal					
		Indep. Regulator	Yes					
		Cross-subsidies	No, but max. Prices					
		Wholesale Market	Yes, power exch.					
		IPP Auctions	No					
		Retail Competition	Yes					
NTPC	India	Market concentration	High	62.3	43 100	85	13	Electricity
		Unbundling	By accounting					
		Indep. Regulator	Yes					
		Cross-subsidies	Yes					
		Wholesale Market	No					
		IPP Auctions	Yes					
		Retail Competition	No					

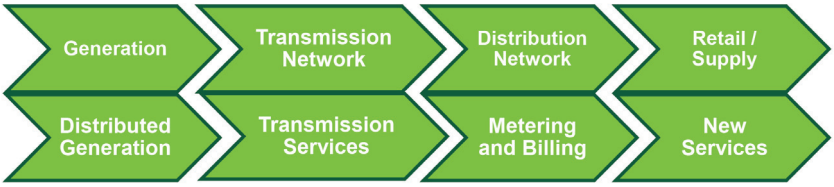
In the following sections, the four selected companies are analysed in more detail.

a) EnBW (Energieversorgung Baden-Wuerttemberg)

EnBW is the third largest utility in Germany. It covers both electricity and gas businesses. Roughly one third of the generation portfolio and of the total electricity generation is still from coal power plants.

The following figure shows the simplified organisational structure of EnBW for operations in the electricity sector:

Figure 22: EnBW's organisational structure for operations in the electricity sector



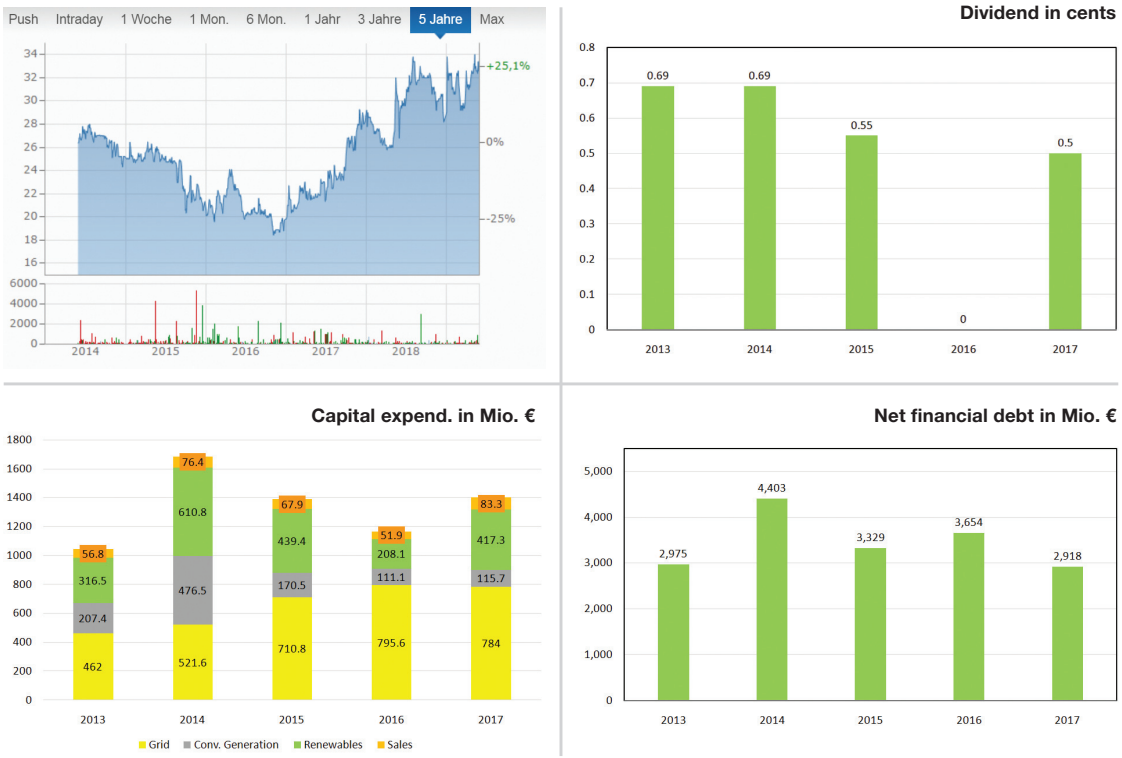
Source: Own illustration (activities of the current business model are filled areas; striped areas indicate future activities; white areas are not part of the business model)

It is obvious that EnBW is active at all stages of the value chain in the electricity sector.

The following figure shows that:

- the share price has risen by 12,3% in the last five years;
- the dividend payment has slightly decreased since 2014;
- capital expenditures are nearly stable with increasing shares of grid and renewables investments and a decreasing share of conventional generation investment; and
- (net) financial debt has decreased slightly since 2014.

Figure 23: The economic situation of EnBW



Sources: https://www.finanzen.net/aktien/EnBW-Aktie, 11 March 2019
EnBW Energie Baden-Württemberg AG, 2018a, EnBW Energie Baden-Württemberg AG, 2018b

The ratings are stable at a high level, with A- from Standard & Poor's and Fitch, and A3 from Moody's.

As an almost entirely publicly-owned company since 2010, with the federal state of Baden-Wuerttemberg being one of the largest shareholders, it must take into account the political will of the state government. Since 2011, the Green Party provides the head of government there, and since then EnBW has made great efforts to master the challenge of a comprehensive transformation of the company. This means first and foremost a gradual phase-out of nuclear and coal-fired power generation and an ambitious programme for the extension of renewable energies (Leprich, 2011). This course is also in line with that of the federal government, which recently set itself the goal of phasing out coal by 2038 at the latest, since the phase-out of nuclear energy will already be completed in 2022.

The following table summarises the main transition drivers of the ongoing transition process in Germany as well as the adjustments and strategic reactions by EnBW.

Table 12: Adaptation and strategic course setting of EnBW in the transition process

Pressure / Reaction / Transition Drivers	Political/ Regulatory Pressure	Market Pressure	Current Adaptation	Strategy
Restructuring/ Competition	EU Directive concerning common rules for the internal market in electricity	Wholesale prices have fallen sharply in recent years, end customer switching rates are on the rise	At current wholesale prices, EnBW does not plan to build any new power plants and is concentrating on investments in renewable energies, the financing of which will continue to be secured through the Renewable Energy Law, but in some cases also solely through wholesale prices	Withdrawal from B2B business already in 2016 because of low sales margins; no new power plant investments unless the introduction of capacity payments occurs
Decarbonisation	EU Emissions Trading System (ETS); EU Effort Sharing Regulation National GHG reduction targets	CO_2 certificate prices rose sharply last year; possible introduction of a CO_2 tax	The goal of EnBW is to actively contribute to climate protection by successively reducing the CO_2 intensity of its own electricity generation (excluding nuclear power) by 15 to 20% by 2020 compared to 606 g/kWh in the base year 2015	The central focus in the medium- and long-term is low CO_2 or zero emission electricity generation (without nuclear power)
Air Pollution Reduction	European Industrial Emissions Directive (IED)	Expensive retrofitting of power plants to meet European requirements is often not economical; decommissioning of power plants is often the only solution	EnBW implements all European requirements in its own power plants and retrofits them if necessary	Phasing out power generation from coal-fired power plants
Low Cost Renewables	European Renewable Energy Directive |+|| National target of 65% renewable generation in 2030	The considerable cost degression of renewable energies has led to the fact that construction of several new plants without subsidy programmes can be financed solely via the wholesale market	Currently, renewable energies account for around 26% of electricity generation with an installed capacity of 2 GW (excluding pumped storage)	Expansion of renewable energies (e.g. onshore and offshore wind) to more than 3.5 GW in the medium term
High risk coal investment	Recommendation of the Coal Commission to the Federal Government to phase out coal-fired power generation by 2038	There will be no further construction of coal-fired power plants in Germany	Gradual shutdown of the coal-fired power plants in coordination with the decisions of the Federal Government to phase out coal	There will be no further construction of coal-fired power plants by EnBW
Technical Developments at the customer's site	Several public support programmes for self-generation and demand management	Relatively high electricity prices combined with falling costs, especially for PV systems and battery storage, are leading more and more end customers to think about self-generation	Alongside the supply of electricity, EnBW offers its customers smart, networked products and services, including photovoltaic plants, heat pumps, electricity storage systems, electromobility and e-car sharing	Reorganisation and digitalisation of B2C sales, expansion of the solution portfolio (e.g. e-mobility, photovoltaic/battery and heat); new infrastructure-related business areas beyond energy (e.g. public security)

Conclusions:

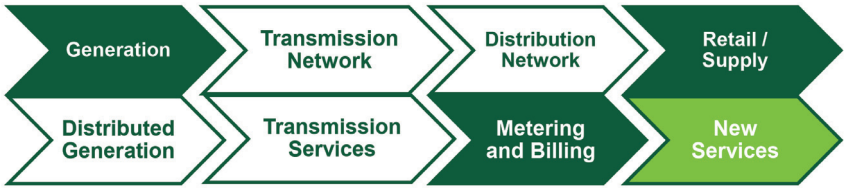
- **Economic standing:**
  As can be seen from the economic development of the company in the last few years, it is on a clear path to achieving the turnaround and positioning itself well for the future. A proactive response to changing political and economic conditions is obviously beneficial.
- **Political climate:**
  In line with the targets of the state and federal governments, EnBW has positioned itself as a pioneer in the transition process away from nuclear and fossil fuel power generation to renewables. As a public company, it should accept the political will of the public shareholders.
- **Economic pressure generation:**
  The gradual transition is facilitated by the deteriorating framework conditions for coal-fired power plants and the constantly improving economic conditions for renewable energies which might even allow economic investment in renewables (especially offshore wind) without support mechanisms. A management that realistically assesses the economic future of fossil fuel and nuclear power generation must actively promote a transition.
- **Economic pressure of retail/supply:**
  The increasing competitive pressure and the accompanying shrinking margins in the retail sector are being countered with new service offerings for end customers, including support for self-generation. This seems the only way to stabilise revenues in the retail sector in the medium and long term.

b) AGL Energy

AGL Energy owns the largest portfolio of electricity generation assets in Australia and is a major electricity and gas retailer. It is the largest producer of carbon dioxide in Australia because of its coal-fired power plants.

The following figure shows the simplified organisational structure for operations in the electricity sector:

Figure 24: AGL Energy's organisational structure for operations in the electricity sector

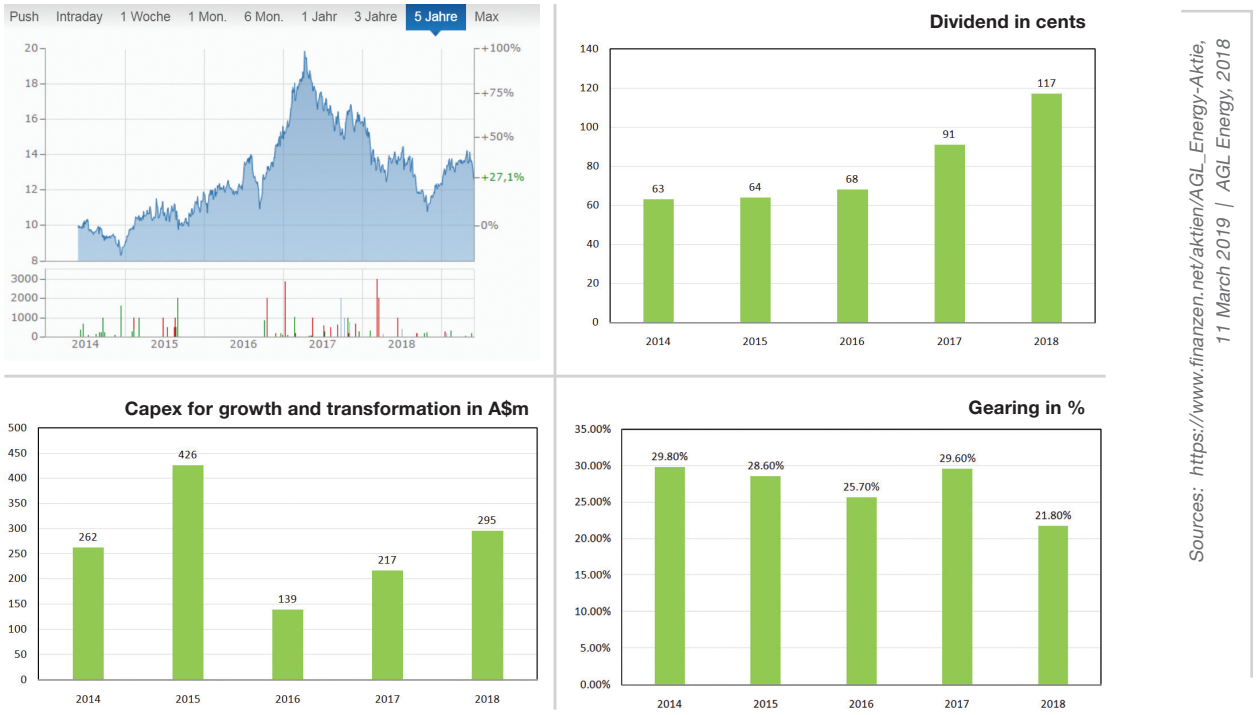


Source: Own illustration (activities of the current business model are dark green areas; light green areas indicate future activities; white areas are not part of the business model)

The following figure shows that:

- the share price has fallen by one third since march 2017, but has increased by 42.5% since 2014;
- the dividend has risen continuously since 2014;
- capex for growth and transformation (including renewables) had suffered from political resistance against renewables; and
- (net) debt has decreased since 2014.

Figure 25: Economic situation of AGL Energy



Sources: https://www.finanzen.net/aktien/AGL_Energy-Aktie, 11 March 2019 | AGL Energy, 2018

AGL maintained its credit rating of Baa2 throughout the year 2017-18 as provided by Moody's Investors Service.

The financial situation of AGL Energy has significantly improved in recent years because of a substantial rise in wholesale prices which was due in part to a tripling of wholesale gas prices and the closing of a large coal power plant from a competitor (Engie S.A.) as part of its global move away from coal (IEEFA, 2017).

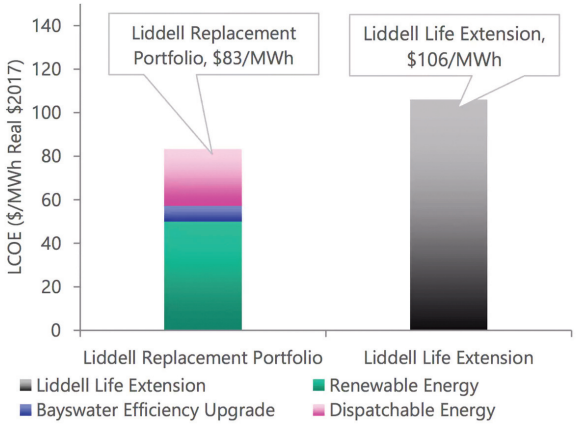
Although the Australian government is still very much committed to coal, a new CEO of AGL Energy has set the course for renewable energies in 2015. The short-term goal was to build 1 GW of renewable capacity by 2020, and a newly established Powering Australian Renewables Fund was endowed with A$450m (IEEFA, 2017).

A key decision was the plan to shut down the Liddell coal power plant in 2022 despite the ambitions of the Australian government to run it longer. Investments in new, low-emissions generation and upgrades to existing generation are planned to replace the 1 000 MW of coal-fired power by:

- increasing the capacity of AGL's Bayswater coal-fired power station by 100 MW;
- installing 750 MW of high-efficiency gas power;
- adding 1 600 MW of new renewable generation capacity (wind and solar farms); and
- providing 100 MW of firm capacity from demand response and 250 MW from battery storage.

Calculations have shown that the total cost of replacing the power plant by this portfolio is lower than the life extension of Liddell:

Figure 26: Levelised Cost of Energy and portfolio contribution (by technology) of the Liddell plant



Source: https://theconversation.com/agls-plan-to-replace-liddell-is-cheaper-and-cleaner-than-keeping-it-open-94651

The following table provides an overview of the company's current adaptation and strategic course to the different transition drivers:

Table 13: Adaptation and strategic course setting of AGL Energy in the transition process

Pressure Reaction / Transition Drivers	Political/ Regulatory Pressure	Market Pressure	Current Adaptation	Strategy
Restructuring/ Competition	Australia has a fully liberalised electricity sector with a power exchange, retail competition and an independent regulator	Increased competition from domestic and overseas retailers has resulted in increased price pressures and declining margins	Business optimisation plan to target A$120m operating cost reduction in 2019. Automatic loyalty discounts and debt relief packages to customers	Develop disruptive capabilities to respond to emerging customer needs
Decarbonisation	The Australian government has turned its back on global climate action by dismissing the findings of the IPCC Special Report on Global Warming of 1.5C	The financial markets become more and more aware of the risks of global warming	First step towards coal-phase out through planned closure of Liddell coal power plant, new investments only in gas-fired power plants and renewable energies	AGL will not build, finance, or acquire new conventional coal-fired power stations in Australia (i.e. without CCS) nor extend the operating life of any of its existing coal-fired power stations and will close all of them by 2050
Air Pollution Reduction	Australia does not have national air quality emissions standards. Instead Environment Protection Authorities in the States and Territories set such standards	None	Comply with the law, be transparent	No specific strategy; see high risk fossil fuel investment
Low Cost Renewables	All states and territories (except Western Australia) have strong renewable energy targets and/or zero emissions targets in place	The increase in wholesale prices due to the increase in gas prices has improved further the competitiveness of renewable energies	The share of renewable energies in total electricity generation is currently around 9% including plants that are only operated by AGL. In 2016, the company launched a new investment vehicle called the Powering Australian Renewables Fund (PARF). The fund is aimed at facilitating the construction of approximately 1 000 MW of renewable generation. AGL Energy contributes roughly one fifth.	The decision to shut down the Liddell coal power plant and replace it by gas plants, renewables and demand side management can be interpreted as a strategic fundamental decision. This opens the door for an increasing share of renewables
High risk coal investment	Being one of the largest coal countries in the world, Australian governments usually give unconditional support for coal power plants despite climate protection arrangements	The financial markets become more and more averse to new coal-fired power plants	AGL will shut down the Liddell coal-fired power plant in 2022 despite ambitions of the Australian government. It will be partly replaced by investments in new gas-fired power plants	AGL will not build, finance, or acquire new conventional coal-fired power stations in Australia (i.e. without CCS) nor extend the operating life of any of its existing coal-fired power stations and will close all of them 2050
Technical Developments at the customer's site	None	The electricity industry is experiencing significant growth in self or embedded generation, in particular from renewable energy sources. For many customers, self-generation is desirable for additional energy security and flexibility, and their own clean energy supply	None	None

Conclusions:

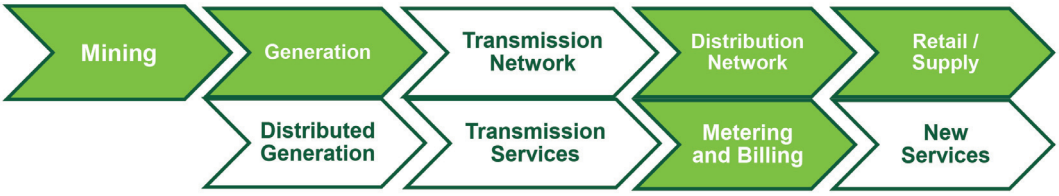
- **Economic standing:**
  AGL Energy is in a relatively stable economic situation and thus has good preconditions to face the transition actively. In such a situation it is easier to make strategic decisions.
- **Political climate:**
  The biggest challenge for AGL Energy is to prepare for a stepwise phase-out of coal power plants combined with investments in renewable energies and gas power plants against the will of the current government. A prudent management will not be influenced by temporary irritations of the government and will make resilient decisions with regard to the interests of the shareholders.
- **Economic pressure generation:**
  The financial markets are increasingly moving away from investments in fossil fuel plants. It is helpful to have private shareholders who are interested in a business model that is also successful in the long term.
- **Economic pressure of retail/supply:**
  In addition, there are competitive challenges in the retail sector, which are driven by new competitors (e.g. IT and platform companies) and by customers' increasing self-generation (PV, small CHP plants, etc.). Without new service offerings for customers, it will not be possible to absorb the declining revenues.

c) PGE (Polska Grupa Energetyczna S.A.)

PGE is the largest power producing company in Poland, heavily dependent on coal (lignite and black coal) and one of the biggest CO_2 polluters in Europe.

The following figure shows the simplified organisational structure of PGE for operations in the electricity sector:

Figure 27: PGE's organisational structure for operations in the electricity sector



Source: own illustration (activities of the current business model are filled areas; striped areas indicate future activities; white areas are not part of the business model)

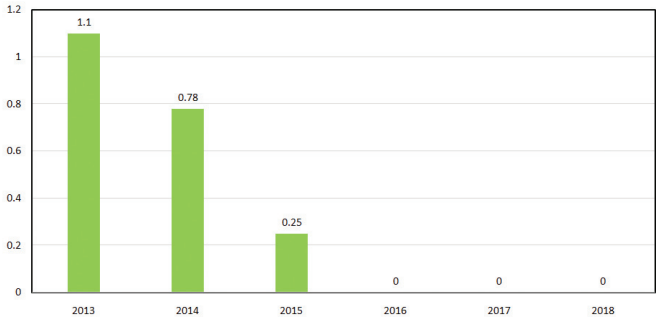
Beyond the classic activities in the electricity sector PGE runs two lignite mines with an output of approximately 50 million tons p.a.

The following figure shows that:

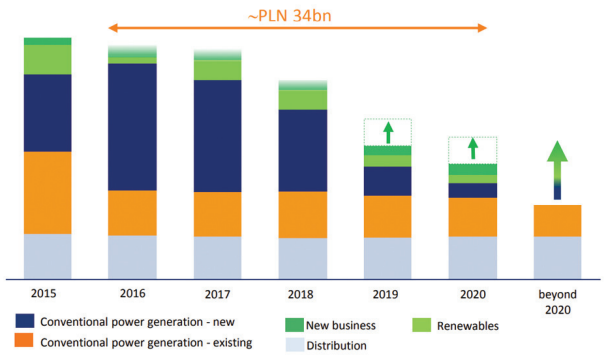
- the share price has fallen by 42.3% in the last five years;
- the dividend payment was stopped in 2016;
- capital expenditures are declining and are expected to shrink further, including investments in renewables, which accounted for just 1.5% of total investment in 2018; and
- (net) debt has increased significantly since 2015.

Figure 28: The economic situation of PGE

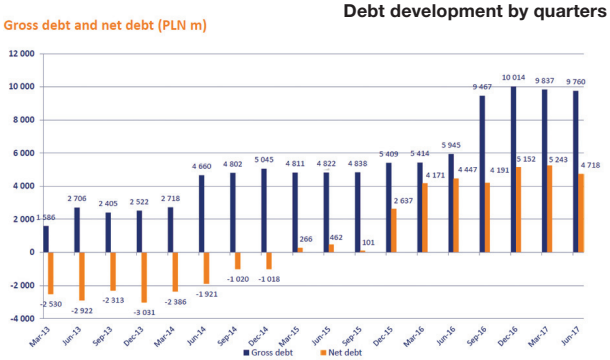
Dividend in PLN



Planned capital expenditures of PGE Group



Debt development by quarters



Sources: https://www.finanzen.net/aktien/PGE_Polska_Grupa_Energetyczna-Aktie, March 11, 2019 Polska Grupa Energetyczna, 2017b; Polska Grupa Energetyczna, 2017a

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The long term company rating has been stable in recent years with Baa1 as provided by Moody's Investors Service and BBB+ (Fitch Ratings).

As a member of the European Union, Poland has to implement the legal requirements of the EU, but expresses reluctance in the areas of competition in the electricity sector, and climate protection and renewable energies. This has led to a defensive business policy of PGE, in which the expansion of renewable energies is progressing very slowly and is almost negligible with a total share of less than 5% of total electricity generation. Overall, PGE has so far been poorly prepared for the challenges posed by the transition drivers, as shown in detail in the table below:

Table 14: Adaptation and strategic course setting of PGE in the transition process

Pressure / Reaction / Transition Drivers	Political/ Regulatory Pressure	Market Pressure	Current Adaptation	Strategy
Restructuring/ Competition	EU Directive concerning common rules for the internal market in electricity	The key participants of the electricity market in Poland are four nationwide, vertically-integrated energy groups with separate territories	Legal unbundling of the different businesses of the value chain	Keep strong positions in all sectors
Decarbonisation	EU Emissions Trading Systems (ETS) EU Effort Sharing Regulation	CO_2 certificate prices have recently risen sharply due to new regulations at EU level	PGE hopes for European exemptions; utilisation of new lignite deposits in case there is a significant easing of the climate policy of the EU; the issue of coal phase-out does not play a role so far	PGE pushes for a nuclear project, which would be the first in Poland; also considering offshore wind
Air Pollution Reduction	European industrial Emissions Directive (IED)	It is easier and less expensive for gas-fired power plants to comply with the requirements	PGE assured compliance with IED - existing large combustion plants will fulfil standards from 2016	Environmental upgrades of the plants to meet the standards, eventually financed through the new capacity markets
Low Cost Renewables	Regulation of the Minister of Energy that introduced an obligation to redeem green certificates from 15.4% in 2017 to 17.5% in 2018 and to 18.5% in 2019	Further increase in wholesale prices due to rising CO_2 prices could encourage customers to generate their own electricity from PV plants	PGE has reduced spending on renewable energy investments in recent years and sees them as undesirable competition for its coal-fired power plants	PGE tries to defy the global trend to replace fossil fuels with renewable energies
High risk coal investment	Capacity market notification (Act on capacity market) by the national government	Relatively high wholesale prices compared to the neighbouring countries	PGE hopes for easing of the climate policy in the EU, for payments from the new capacity market, and does not push renewables because they lower the wholesale prices	PGE unwaveringly adheres to maximum coal-fired power generation
Technical Developments at the customer's site	None	The development of the market for electric vehicles and prosumer installations (PV+storages) is progressing slowly	Monitoring of the development	None so far

Conclusions:

- **Economic standing:**
  PGE's economic state has been deteriorating for several years with no end in sight. In such a situation, the company would be well advised to reconsider its strategy.

- **Political climate:**
  PGE is trying to continue its old business model of electricity generation, which is mainly based on coal.[16] As long as the national government supports this course, the risks will be limited.[17] However, as a member state of the European Union, Poland cannot permanently ignore international and EU requirements without risking penalties in the medium and long term. A far-sighted management would plan the stepwise decommissioning of coal-fired power plants and set the course for an ambitious expansion of renewable energies in order not to be overwhelmed by developments and not to enter a dangerous downward spiral at the end of which the existence of the company is at stake.

- **Economic pressure generation:**
  Due to the interconnection of the markets in the European electricity system, PGE cannot escape the economic developments that will endanger the economic viability of coal-fired power plants in the foreseeable future. Prudent management must set the course in good time for a gradual phase-out of coal-fired power generation by transitioning to renewable energies, thereby securing a new area of business for itself.

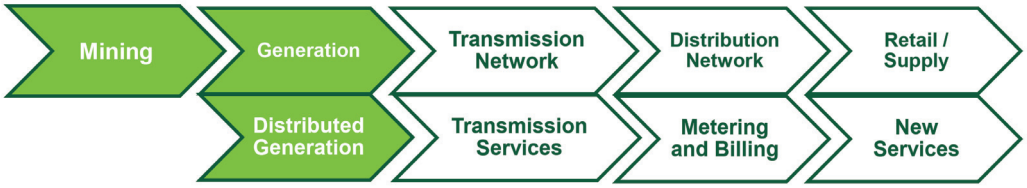
- **Economic pressure of retail/supply:**
  A well-developed electricity grid in combination with low competition in the retail/supply sector can lead to customers being regarded as captive in the long term. Nevertheless, the development of end customers' own generation should be closely monitored so that one does not miss the opportunity to enter the market with one's own business models.

d) NTPC (National Thermal Power Corporation)

NTPC provides 25% of India's electricity supply and plays a critical role in its economy. Behind six Chinese power plant operators, NTPC is the seventh largest coal-fired power plant operator in the world.[18]

The following figure shows the simplified organisational structure for operations in the electricity sector:

Figure 29: NTPC's organisational structure for operations in the electricity sector



Source: Own illustration (activities of the current business model are filled areas; striped areas indicate future activities; white areas are not part of the business model)

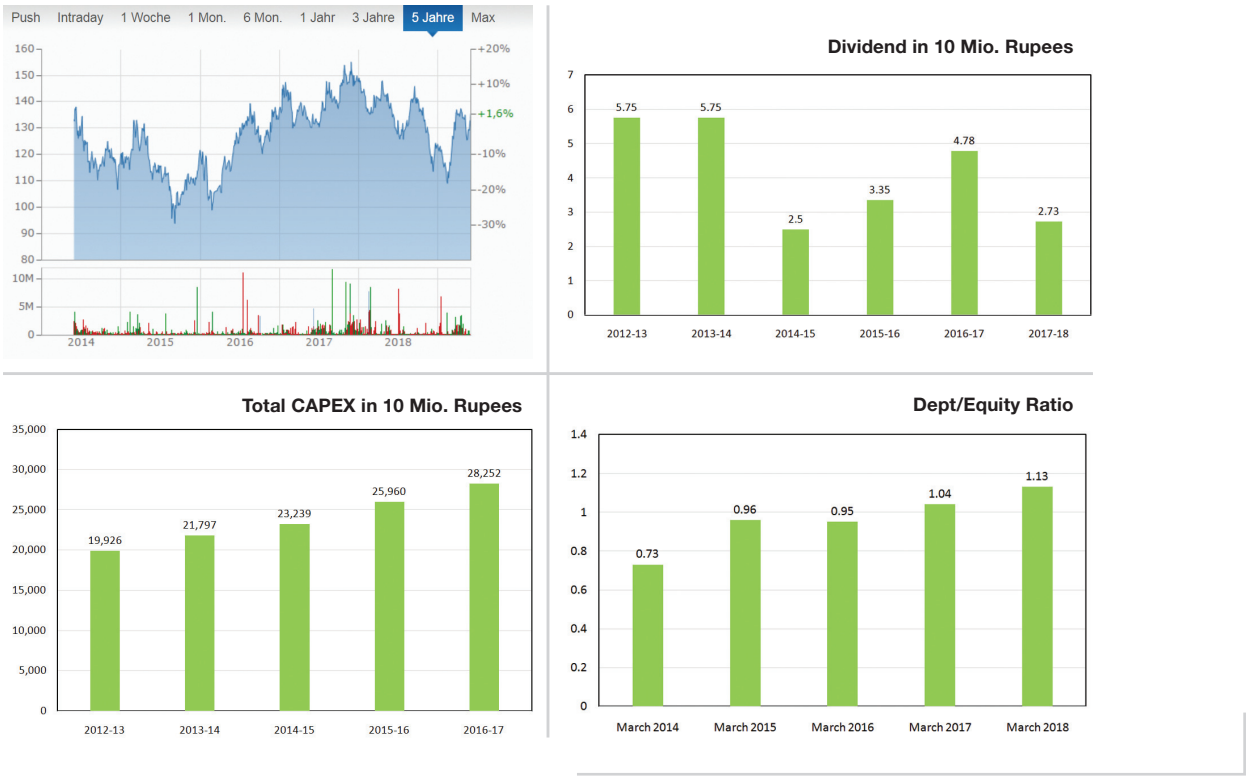
Clearly, NTPC's core business is generation and sale of electricity to state-owned power distribution companies and State Electricity Boards in India.

[16] In view of the economic data of new nuclear power plants, such plans by PGE seem currently downright daring.
[17] The upcoming elections in the second half of 2019 could already lead to significant changes if the opposition parties that have a different attitude to coal and renewable energies win.
[18] https://endcoal.org/wp-content/uploads/2017/10/July-2017-Coal-Companies.pdf

The following figure shows that:

- the share price has risen by 29.5% in the last five years but has decreased by 8.8% in the last year;
- the dividend payment has decreased since 2014;
- capital expenditures have steadily increased in recent years, partly due to investments in renewable energies; and
- debt has slightly increased in the last years, but is still in a comfortable range.

Figure 30: The economic situation of NTPC



Sources: NTPC Annual Report 2017-18
https://www.finanzen.net/aktien/NTPC-Aktie, 11 March 2019
https://www.moneycontrol.com/financials/ntpc/ratios/NTP

The credit ratings are stable at Baa2 by Moody's and BBB by Standard & Poor's and by Fitch.

Behind China and the USA, India is the country with the largest installed capacity of coal-fired power plants. However, the Indian government is not currently planning to add any more coal-fired power plants, with the exception of those that are already under construction. Instead, India aims to install 175 GW of renewable energy by 2022, of which 100 GW will be solar and 60 GW wind. This means more than a tripling of today's installed capacity (IEEFA, 2017).

Based on a financially stable situation in which NTPC can continue to expect significant annual growth in consumption, the company plans to increase the share of renewable energies in its electricity generation from around 1% today to 28.5% by 2032. The target is 37 GW of installed capacity, comprised mostly of solar. A key driver for this is the fact that solar auctions in India as early as 2017 already resulted in significantly lower prices than the average prices of existing coal-fired power plants (IEEFA, 2017).

The following table provides an overview of the company's current adaptation and strategic course to the different transition drivers:

Table 15: Adaptation and strategic course setting of NTPC in the transition process

Pressure Reaction / Transition Drivers	Political/Regulatory Pressure	Market Pressure	Current Adaptation	Strategy
Restructuring/ Competition	The Electricity Act 2003 restructured the electricity sector into separate generation, distribution and transmission sectors which are mainly in the hands of public companies. Since all tariffs are regulated, competition does not play a major role in the sector.	None	Since NTPC is mainly a generator, unbundling is not an issue. Competition in generation is not an issue either.	NTPC has integrated both backwards and forward into coal mining and power trading
Decarbonisation	After adopting its final National Electricity Plan (NEP) earlier in 2018, India remains on track to overachieving its "2C compatible" rated Paris Agreement NDC climate action targets	Wind and solar power tariffs are now lower than the average tariff of coal-based power that is currently being sold on India's power exchanges	NTPC has increased "zero emission generation" to 3.2% of total generation, starting with 0%. Beyond that it has taken up extensive renovation and modernisation of its older power plants to upgrade their efficiencies.	Low carbon strategy: extend zero emission generation to 28.5% in 2032
Air Pollution Reduction	To tamp down pollution, India's government notified the country's coal generators they would need to meet new emissions limits for nitrogen oxides (NOx), sulfur dioxide (SO_2), and mercury, as well as tightened limits for particulate matter (PM) and water consumption	None	NTPC is maintaining all emission parameters as specified by the regulatory bodies	Ambient air quality and emission monitoring, renovation and modernisation of old power plants
Low Cost Renewables	Government of India has targeted to achieve 175 GW capacity by 2022, comprising of 100 GW Solar, 60 GW Wind, 5 GW Small Hydro and 10 GW Bio-power (including biomass)	Wind and solar power tariffs are now lover than the average tariff of coal-based power that is currently being sold on India's power exchanges	NTPC already commissioned 928 MW of renewable projects as of 30 June 2018 comprising 870 MW of Solar, 50 MW of wind and 8 MW of small hydro power projects; a rooftop solar project of 1.5 MW capacity is under execution	As per its long-term corporate plan, NTPC has targeted to achieve 37 GW of renewable energy sources by 2032 which will be 28.5% of total installed capacity
High risk coal investment	India's draft Third National Electricity Plan (NEP3) for the new two five-year periods, to 2027 unambiguously concludes that beyond the half-built plants already under construction, India does not require any new coal-fired power station	Wind and solar power tariffs are now lower than the average tariff of coal-based power that is currently being sold on India's power exchanges	Roughly 20 GW of coal power plants are still under implementation, partly as joint ventures with third parties and subsidiaries; some are however in the pipeline for years	NTPC is increasingly switching to renewable energies
Technical Developments at the customer's site	The government supports so-called captive power plants where the captive power user should consume at least 51% of the annual aggregate electricity generated by such power plant	Wind and solar power tariffs are now lower than the average tariff of coal-based power that is currently being sold on India's power exchanges	NTPC sees distributed generation as the solution to the challenge in providing power to the off-the-beaten track village clusters. Currently 16 decentralised distributed generation power projects with a combined capacity of 340 KW have been commissioned for benefitting 2 280 households with a population of 12 500 in four states	Not yet developed

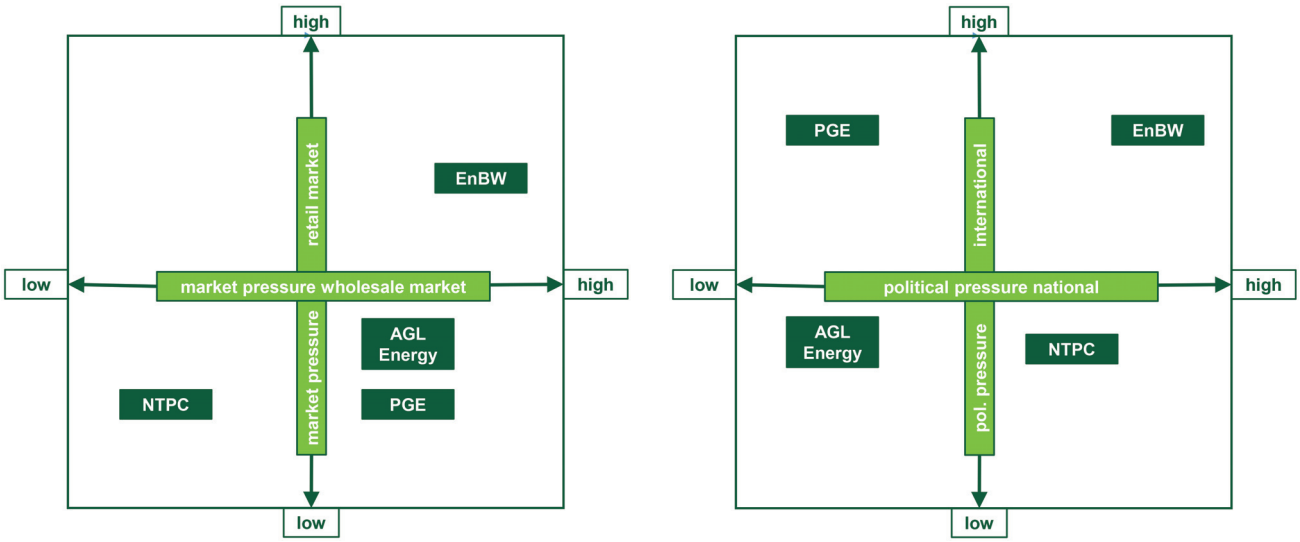
Conclusions:

- **Economic standing:**
  As primarily a generator of electricity, NTPC finds itself in the comparatively comfortable situation of a further increase in electricity demand, a tense capacity situation in the country and strong government support for its expansion plans for renewable energies. This favorable situation should be actively utilised.
- **Political climate:**
  The government is intensifying efforts to address climate protection and air pollution control. The operation of individual coal-fired power plants may be jeopardised or restricted by the national GHG reduction targets and the planned stricter environmental regulations. From an economic point of view, it therefore makes sense to set the course for a stepwise shutdown of old coal-fired power plants in good time.
- **Economic pressure generation:**
  New renewable plants can now produce electricity more cheaply than many existing fossil-fuel power plants. The company must adapt to this new competitive situation with regard to potential competitors, increasing own generation and its own investment plans.
- **Economic pressure of retail/supply:**
  The more attractive distributed generation becomes for end customers, the more NTPC should be concerned with supporting them and developing an integrated business model.

e) Lessons learnt

All four companies are exposed to different political and market pressures. In this context, political national pressure can be distinguished from international pressure and, in the case of market pressure, the wholesale market can be distinguished from the retail market. The following figure summarises this for all of them at a glance:

Figure 31: Political and market pressure for the four companies



The following table gives a comprehensive overview of the main lessons that could be learnt, based on very different situations of political and/or market pressure for the companies:

Table 16: Lessons learnt from companies with different pressures in the transition process

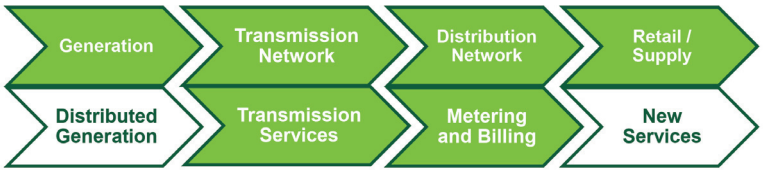
Lessons learnt / Transition Drivers	Degree of pressure: political	Degree of pressure: market	EnBW	Degree of pressure: political	Degree of pressure: market	AGL Energy
Restructuring/ Competition	high	high	With high pressure from politics and from markets the transition process has to be actively addressed	medium	high	There is low pressure from politics, but growing pressure from markets; thus the transition process has to actively addressed
Decarbonisation	high	medium		low	medium	
Air Pollution Reduction	high	low		low	low	
Low Cost Renewables	high	medium		low	medium	
High risk coal investment	high	high		low	medium	
Technical Developments at the customer's site	medium	medium	Declining margins for end use can only be countered with attractive services	low	medium	New services are important to develop when customers are no longer captive; technical developments can make this happen relatively quickly
Lessons learnt / Transition Drivers	Degree of pressure: political	Degree of pressure: market	PGE	Degree of pressure: political	Degree of pressure: market	NTPC
Restructuring/ Competition	medium	high	With low pressure from politics and medium pressure from markets, management tends to keep to the old business model and thus miss out on future-oriented decisions	low	low	There is low pressure from politics, but growing pressure from markets; thus the transition process has to actively addressed
Decarbonisation	low	medium		medium	low	
Air Pollution Reduction	high	low		low	low	
Low Cost Renewables	medium	medium		medium	medium	
High risk coal investment	low	high		low	medium	
Technical Developments at the customer's site	low	medium	Declining margins for end use can only be countered with attractive services	low	medium	New services are important to develop when customers are no longer captive; technical developments can make this happen relatively quickly

Overall, the willingness to actively shape the transition process depends heavily on the pressure exerted on the company by policymakers and/or markets. The less pressure there is, the more management has the discretion to accept or resist change. A relaxed economic situation is certainly helpful for management to actively shape the transition process; conversely, in a tense economic situation there is a danger that management will not dare to set a new course, although the cause of the tension is often to be found in the old business model.

7 Recommendations for Eskom

Considering Figure 12 in Chapter 4, Eskom's current organisational structure can be simplified as follows:

Figure 32: Eskom's organisational structure for operations in the electricity sector

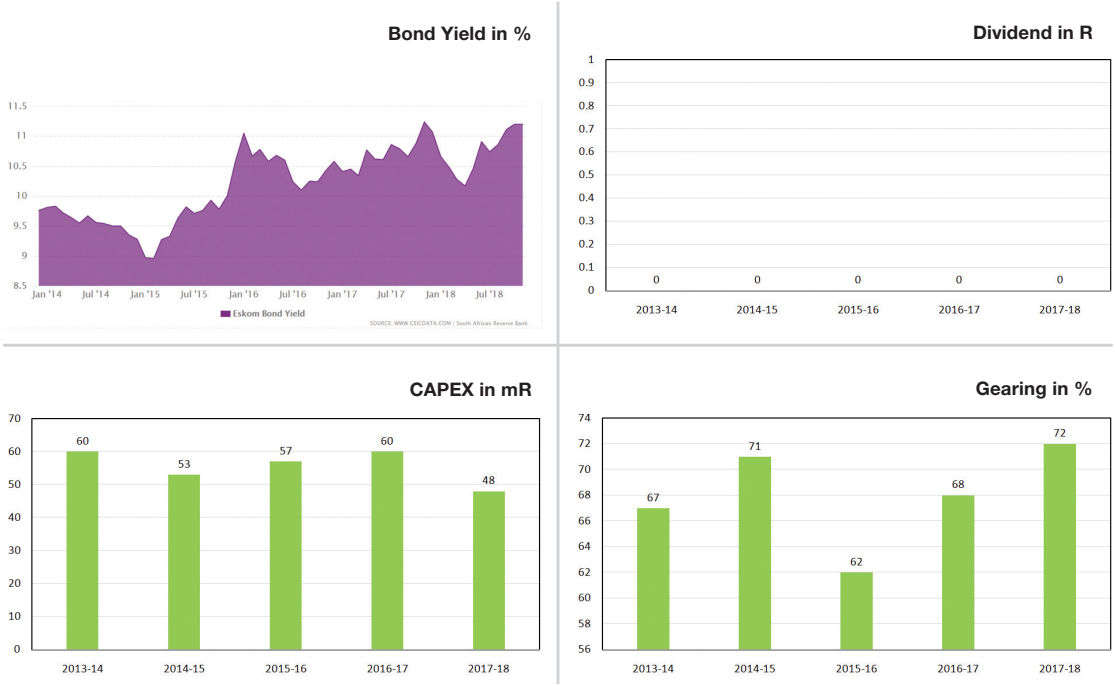


Source: Own illustration (activities of the current business model are filled areas; striped areas indicate future activities; white areas are not part of the business model)

As with the other companies in Chapter 6, the following figure shows Eskom's economic situation based on significant developments:

- the bond yield has stabilised in the last three years at a high level which means that debt is very expensive;
- there has been no dividend payment for years;
- capital expenditures have been nearly stable but shrunk in 2017-18 and might shrink further in the next years due to the debt situation; and
- gearing[19] has increased significantly in the last 3 years to a high 72%.

Figure 33: The economic situation of Eskom



Sources:
https://www.ceicdata.com/en/south-africa/government-bond-yield/eskom-bond-yield
Parliamentary Budget Office, 2017; Eskom, 2018a Eskom, 2018b

As described in Chapter 4, the overall economic situation for Eskom is grave.

[19] Gearing is a meaningful indicator of a company's indebtedness. Gearing refers to the ratio of a company's debt to equity.

In the same way as for the companies considered above, the following table summarises the political, regulatory and market pressure in South Africa and Eskom's current adaptation and strategic response to it:

Table 17: Adaptation and strategic course setting of Eskom in the transition process

Pressure / Reaction / Transition Drivers	Political/Regulatory Pressure	Market Pressure	Current Adaptation	Strategy
Restructuring/ Competition	After previous efforts had been of no consequence, the current government is strongly pursuing a legal unbundling of generation-transmission-retail/supply	A growing number of auctions of IPPs for renewable energy investments will reduce Eskom's market share continuously	Not visible	None
Decarbonisation	South Africa has pledged to peak its emissions between 2020 and 2025, allowing them to plateau for roughly a decade before they start to fall	Fossil power plants are coming under increasing pressure due to a sharp drop in the price of renewable energies	Almost no adaptation	None
Air Pollution Reduction	Many of the power plants do not comply with emissions standards in place, therefore the government might increase pressure	None	Eskom tries to comply with the standards with retrofits in a very limited way	None
Low Cost Renewables	The draft of the new Integrated Resource Plan 2018 plans for 14 GW additional renewable capacity till 2030	The tariffs of the winners of the IPP auctions continue to fall and in some cases are already lower than the running costs of coal-fired power plants; in addition, more and more end consumers are installing increasingly inexpensive PV systems on their roofs	Not visible	None
High risk coal investment	South Africa has pledged to peak its emissions between 2020 and 2025, allowing them to plateau for roughly a decade before they start to fall	More and more financial players are withdrawing financing coal-fired power plants	Not visible	None
Technical Developments at the customer's site	The government has great interest in offering the 2.2 million households that are not supplied with electricity so far an opportunity for electrification	More and more end consumers are installing increasingly inexpensive PV systems on their roofs	First project: Installation of distributed battery storage with distributed solar PV at Eskom sites, close to renewable IPP plants and Sere Wind Farm	Still in progress

It is obvious that Eskom has not yet developed a viable future strategy and has so far largely ignored the transition of the sector.

If the risks of this non-strategy are not to be passed on to the general public and thus to the taxpayers, Eskom must urgently develop a resilient and comprehensive strategy that offers the company a chance of survival, meets international trends and does justice to the global goal of climate protection.

The following recommendations are derived from the recommendations for South Africa in Chapter 5 and the strategic responses of the four companies considered to the different transition drivers in Chapter 6. They also follow on in particular from the extensive and fruitful works of *Bischof-Niemz/Creamer, Baker, Eberhard* and *Steyn* (Bischof-Niemz and Creamer, 2018; Baker, 2017; Eberhard, 2011; Steyn, 2018).

a) Generation

The reorganisation of the South African generation sector is certainly the greatest challenge of the transition of the electricity sector in South Africa.

The core of my recommendations concerns the existing coal-fired power plants. Here I follow largely Bischof-Niemz and van den Berg (2018), who have proposed the following unbundling and coal phase-out plan:

- Apart from the oldest coal-fired power plants, which should be decommissioned in the short term, Eskom would separate itself from all other coal-fired power plants. Three categories would have to be distinguished:
  - **Category 0** – the oldest power stations[20] - would remain with Eskom for controlled decommissioning over the next five years.
  - **Category 1** - comprising all other stations except Medupi and Kusile - would be sold by Eskom in a staggered manner, one-by-one, over the next five years in competitive auctions.
  - **Category 2** – Medupi and Kusile units in operation[21] - would be sold in a package which would make transparent to the investors the fact that enough capital must be raised through the sale to be able to pay back Eskom's associated loans.
- What is up for sale in the category 1 auctions is the power station itself, all its power station-specific obligations (staff contracts, coal-supply contracts, supplier contracts, environmental obligations, etc.), together with a Power Purchase Agreement (PPA) at a predefined, power station-specific tariff.
- The PPA is a contract that entitles the new power station owner to supply a specific amount of electricity annually (an 'electricity budget') over the remaining lifetime of the power station, which has to be fixed in a specific law.
- To prevent anti-competitive behavior, no generation company (GenCo) may own more than 20% of the overall coal plant capacity.
- In principle, it must be considered whether private companies should also be invited to buy shares of the coal plants, or whether only public companies should have the right to participate in the auctions for the plants.

The following arguments are in favor of private participation in GenCos:

- The offers made by experienced private bidders offer a realistic indication of the residual value of the power plants up for sale.
- Private operating companies have a very high incentive, based on their business model, to operate the power plants as efficiently as possible and in strict compliance with the law for the remainder of the operation term, which does not offer the option for lifetime extensions.
- Private shareholders would bring additional money into the South African economy, thereby improving the financial situation of both Eskom and the South African budget.

This is countered by the following arguments in favor of the exclusive participation of public shareholders:

- Public ownership could principally reduce the risk of utilising the power plants as long and comprehensively as possible in order to maximise the returns, which would jeopardise the achievement of the Paris Agreement climate goals.
- It could also be a guarantee that the gradual phasing out of coal-fired power generation and the closure of coal-fired power plants will be socially beneficial, taking the form of what is now termed a Just Transition.
- Public acceptance, especially the acceptance of trade unions for such a transaction, could be higher if public sector entities (such as the Public Investment Corporation or municipalities) take over, which are not suspected of merely maximising returns.

Which solution would be the better one remains open for discussion. This will depend first and foremost on the public debate on such a far-reaching reform proposal.

By selling the coal-fired power plants, Eskom could significantly reduce its debt burden and turn to sustainable segments of the electricity sector.

[20] This would be at least all power stations older than 40 years.
[21] The completion of the units not yet in operation should be stopped in order to avoid the risk of finding no buyers for them.

The development of renewable energies should be further promoted within the framework of the proven REIPPPP and at least to the extent proposed in the draft of the Integrated Resource Plan 2018 for 2030. It should be noted that a good mixture of wind and solar plants can also make a considerable contribution to security of supply and thus significantly weaken the possibility of load shedding.[22]

In the future, Eskom should play just as much a role in renewable energies as it should in the construction of new flexible capacities to support renewable energies. While the IPP auction system has proven its worth in renewables, no new coal should be allowed, and only a limited number of new flexible fossil-fuel plants should be put out to tender by an independent Transmission System Operator (see below).

The following table summarises Eskom's role in future electricity generation.

Table 18: Eskom's role in future electricity generation

	Most important targets of transition	Recommendations			Recommended political/ regulatory action	
		Preferred unbundling option	Preferred ownership	Preferred cost recovery	Most important measure short term	Most important measure medium/ long term
Generation	• Create risk for future power plant investments • Ensure a transparent and uniform price	Legal	Mixed	Medium term: Wholesale market or integrated auctions		
Old Fossil	• Phase-out coal in order to reach the Paris target • Reduce market power of incumbent monopolies	Create legally unbundled GenCos with a market share of less than 20%	The winners of PPA auctions (Eskom is excluded from participation)	Bid price of the PPA auction	Legal fixing of a maximum amount of electricity generated over fixed remaining life (a phase-out law)	Compensation law
New Fossil	• Allow only flexible facilities to enter the system • Minimise GHG emissions	Prevention of market dominance through competition supervision	The winners of TSO auctions (Eskom GenCO can participate)	Bid price of the TSO auction	Creation of an independent TSO who is responsible for security of supply	Clear rules for TSO auctions
Renewables/ IPPS	• Increase share of low cost renewable energies	Prevention of market dominance through competition supervision	The winners of IPP auctions (Eskom GenCO can participate)	Remuneration	Remuneration law (including shallow connection charges)	

b) Transmission

There is no doubt that the transmission grid is the heart of the electrical system. It is of crucial importance not only for security of supply, but also for the access of the various players to the specific submarkets.

Because of its importance for the economy as a whole, it should be in public hands and the owner should not have any interests of its own in the areas of generation and supply.

The most important task of the transmission system operator is to ensure security of supply. In order to avoid unplanned outages and load shedding,[23] the TSO must ensure that sufficient generation and grid capacities are available. While the TSO itself has to invest sufficiently in the networks, it can ensure that the necessary generation capacities are built by means of auctions. For instance, open cycle gas turbines (OCGTs) are a relatively inexpensive way of avoiding generation shortfalls.

[22] See e.g. https://energy.economictimes.indiatimes.com/energy-speak/taking-the-load-off-load-shedding-through-solar-power/3069.
[23] Load shedding in particular is currently a huge problem in South Africa and poses a threat to further economic development. See also Chapter 2a.

If neither a power exchange nor a pool model for an electricity wholesale market is sought, the Transmission System Operator could also assume the additional role of a Market Operator (MO). In this case, they would facilitate the link between the generators and the electricity suppliers. From the point of view of regulatory policy, however, it seems advisable to separate the roles of the TSO and the MO, since the former focuses on the technical task and the latter on the commercial task.

The prerequisite for Eskom to continue to take on the role of the TSO and act as an independent facilitator is the separation from existing electricity generation, namely the coal power plants (see above).

The refinancing of the transmission grid through network charges ensures Eskom a stable cash flow on a permanent basis and is thus part of a sustainable business model.

The following table illustrates the objectives and framework for an independent TSO and Eskom's role.

Table 19: Eskom's role as transmission system operator (TSO)

	Most important targets of transition	Recommendations			Recommended political/ regulatory action	
		Preferred unbundling option	Preferred ownership	Preferred cost recovery	Most important measure short term	Most important measure medium/ long term
Transmission and System Operation	• Ensure security of supply through enough investments in the network, capacity, dispatch etc. • Minimise monopoly profits through regulated network • Make TSOs more efficient through performance-based regulation • Allow newcomers to enter the market	By ownership; legal is sufficient if the existing power plants are sold to several separate GenCos (see above)	Eskom Transmission as part of the Eskom holding company	Regulated network charges	Creation of an independent TSO who is responsible for security of supply	Network development plan with public participation

c) Distribution

Electricity distribution grids will become even more important in the future, as they not only form the link between power plants, the transmission grid and end consumers, but also have to be equipped to absorb increasing volumes of decentralised generation ("smart grids").

In order to cope with these increasingly demanding tasks, the distribution companies should have a minimum size. The proposal made in 2003 to set up six regional electricity distributors (REDs) in South Africa seems to be the right one.

In order to dispel any concerns of the municipalities and to further complete Eskom's viable business model, the six REDs should remain publicly owned with shares from Eskom, the municipalities, cities and possibly other public companies.

The refinancing of the distribution networks through regulated network charges would ensure a stable permanent income stream for all shareholders, and intelligent regulation could provide incentives for innovations that would allow the REDs to further develop their network management, including decentralised options such as PV, small CHP plants and storage.

The following table summarises the possible design of the distribution segment and the role of Eskom:

Table 20: Eskom's role in the distribution business

	Most important targets of transition	Recommendations			Recommended political/ regulatory action	
		Preferred unbundling option	Preferred ownership	Preferred cost recovery	Most important measure short term	Most important measure medium/ long term
Distribution	• Minimise monopoly profits through regulated network charges • Make DSOs more efficient through performance-based regulation • Allow newcomers to enter the market	Legal, but create six regional electricity distributors (REDs) in order to ensure efficient network management and regulation	Public shareholders, i.e. Eskom, municipalities, cities	Regulated network charges	Strong regulation that ensures network access and prevents cross subsidisation of the supply	Legal provisions for decentralised network management optimisation including DSM, distributed generation etc.

d) Retail/Supply

As already mentioned in Chapter 5c, unbundling between distribution and supply does not currently appear to be a necessity as long as the regional electricity distributors have single buyer status and no introduction of retail competition is planned. However, to ensure that this de facto monopoly situation is not exploited to the detriment of consumers, it is necessary for NERSA to regulate not only the network charges for the distribution grid but also the level of the sales margin.

The possibility for Eskom to take shares in the combined distribution/supply companies (REDs) will open up another stable source of income for the company, which can also be used to develop new services for customers who are still captive thereby allowing Eskom to prepare itself for increasing competitive pressure, particularly from self-generation and digital products.

The table below gives an overview of the future framework conditions for the retail/supply segment in the electricity sector and thus of Eskom's possible role as shareholder of one or more of the REDs:

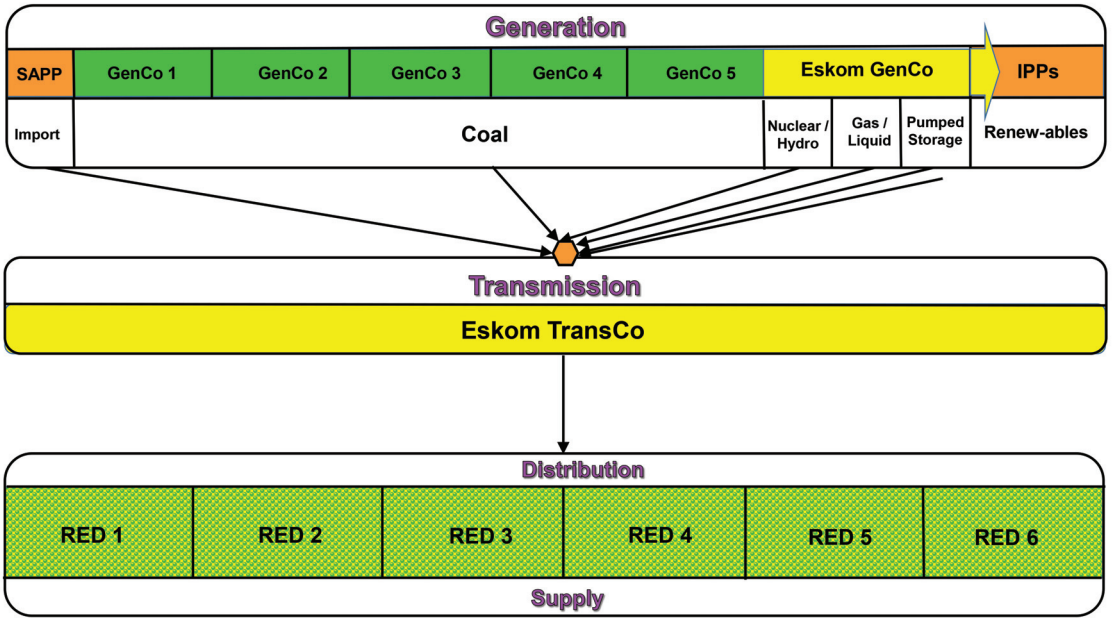
Table 21: Eskom's role in the retail/supply business

	Most important targets of transition	Recommendations			Recommended political/ regulatory action	
		Preferred unbundling option	Preferred ownership	Preferred cost recovery	Most important measure short term	Most important measure medium/ long term
Retail/Supply	• Allow retail competition for cheaper prices, “green” electricity etc. • Allow self-generation	Organisational/ by management	Public shareholders, i.e. Eskom, municipalities, cities	Regulated margin	Strong regulation to ensure market access (s. above) Clear rules for allowing self-generation	Legal labelling obligation

e) New organisational structure of Eskom

Based on Eskom's original organisational structure presented in Chapter 4 (figure 12), and taking into account the above recommendations, the following figure summarises Eskom's future organisational structure in relation to the other actors in the South African electricity sector:

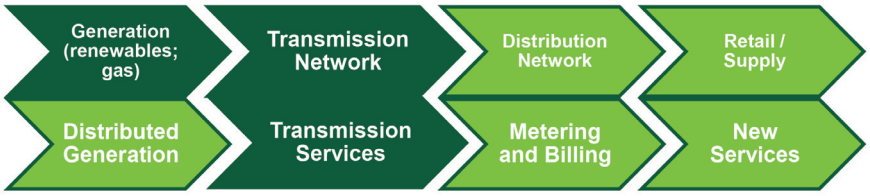
Figure 34: New organisational structure of Eskom in relation to the other sector players of the South African electricity sector



Source: own illustration (Eskom activities of the future business model are yellow areas; the dotted green-yellow areas are activities that Eskom shares with other public companies)

In the simplified version of this illustration used in the presentation of the other utilities under consideration, the future organisational structure can be presented as follows:

Figure 35: Eskom's future organisational structure at a glance



Source: own illustration (standalone activities of the future business model are dark green areas; light green areas indicate activities in companies with other public shareholders)

With the cornerstones of the future business model being transmission and distribution networks, growing investment opportunities in renewable energies and flexible complementary power plants, primarily gas-based,[24] and new retail services for end consumers, Eskom should have a good opportunity to stabilise its economic situation, reduce its debt, secure its jobs and become a constructive promoter of the necessary transition of the electricity sector in South Africa.

[24] Natural gas has less than half of the specific CO_2 emissions compared to coal-fired power plants and can therefore make a contribution to CO_2 reduction in South Africa in the medium term. In the long term, however, natural gas will have to be minimised in the future, given the goal of limiting global temperature rise to 1.5 degrees Celsius.

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