Chapter 5: Shaping a new economic growth model for South Africa - the role of a well-managed energy transition

Overview

A key economic policy question currently is how South Africa's energy transition, can be optimally designed to promote inclusive growth, industrial development, and employment creation.

To answer this question effectively, it is necessary to have a clear understanding of the objectives, strengths and weaknesses of South Africa's current policy frameworks including policy on the restructuring of Eskom and the wider electricity sector, relevant regulatory policies, electricity-planning instruments, such as the Integrated Resources Plan, as well industrial policy, export promotion strategies, minerals exploration, minerals beneficiation, green hydrogen policy and other interventions to maximise growth and employment multipliers.

Historically, the apartheid growth model was built on two pillars. Firstly, the dispossession, oppression, and super-exploitation of the black majority. Secondly, the promotion of industrial developed based in large part on the use of the country's extensive coal reserves to provide low-cost and abundant electricity to drive mining, industry, commerce and finance.

As a result, democratic South Africa has inherited a racially fractured, unequal, and highly carbon-intensive economy. Furthermore, the democratic period has seen a lack of investment in electricity infrastructure, resulting in an electricity shortage, which is proving to be a binding constraint on investment, growth, and employment creation.

There are both threats and opportunities for South Africa as the country embarks on an energy transition towards a low carbon future. Appropriate government policy, supported by forward-looking social compacting by labour, business, communities and government, has the potential to manage and minimise the threats which the energy transition poses, and also maximise the opportunities.

A new growth model for South Africa

A most pertinent set of questions for a democratic South Africa, struggling to overcome its exclusionary and fractured legacy, would include 'Where is economic growth going to come from?'; 'How can economic inclusion be fostered?'; 'What strategies are required to accelerate the rate of employment creation?' and 'How can the energy transition best be designed to promote economic growth and job creation?'.

The answers must surely, at least in part, lie within the new investments, new industries and new products and services which will come into being due to the country's decarbonising energy transition. A transition, which will necessarily stimulate other, related transitions, such as, for mobility and urban planning, and which, if well-designed and well-managed, can be inclusive and fundamentally transformative of the livelihoods of millions of people in South Africa.

According to work done by the CSIR, South Africa's energy transition can be managed to substantively strengthen the fundamentals of South Africa's economic growth model (CSIR, 2019), as follows:

- net increase in employment
- reduced carbon emissions and reduced water consumption
- creation of new industries such as renewables and electric vehicles
- restore the competitive advantage of low-cost electricity
- enable exports of hydrogen and clean synthetic fuels
- support universal access to electricity
- increased flexibility of the economy to respond to changes in growth and energy demand, and
- increased electricity security.

A well-known insight of economic theory is that sustained rising living standards can only be achieved if economies experience a combination of increased investment in capital machinery together with technological improvements. Growth models, such as those of Solow (1956) and Swan (1956), show that it is due to the diminishing marginal returns on capital that technological advances are required to ensure that increases in productivity and living standards can be sustained.

On the other hand, such models do not provide insight into the dynamics of how productivity gains are shared over time between capital and labour, or who will be the winners and losers as technologies change and growth drivers shift. To better understand the conditional nature of such dynamics, supply-side models based in the labour market (as per Layard et al., 2005) provide helpful insights. As indicated in Figure 1, where the wage-setting curve represents the supply side of the labour market and the price-setting curve the demand side, the introduction of new technology, initially, is likely to lead to an increase in unemployment as a number of workers at 'B' are displaced from their existing jobs. During this phase, incumbent workers in old-technology firms face the risk of losing their jobs.

Due to the fact that output per worker has risen as a result of the impact of the productivity gains of the new technology, the potential for higher profits incentivizes new firms to enter the market. If the entry of new firms is relatively easy, the economy will move from 'B' to 'C' – pushing up employment levels and ultimately wages at 'D'. While the increase in employment may or may not benefit workers in old-technology firms who have lost their jobs, the overall level of employment at 'C' and 'D' is higher than before the introduction of the new technology. If, on the other hand, new firm entry is difficult and there are supply-side barriers and rigidities, the economy may get stuck at 'B' for a prolonged period. If this occurs, the net effect of the new technology will be reduced employment levels and falling real wages.

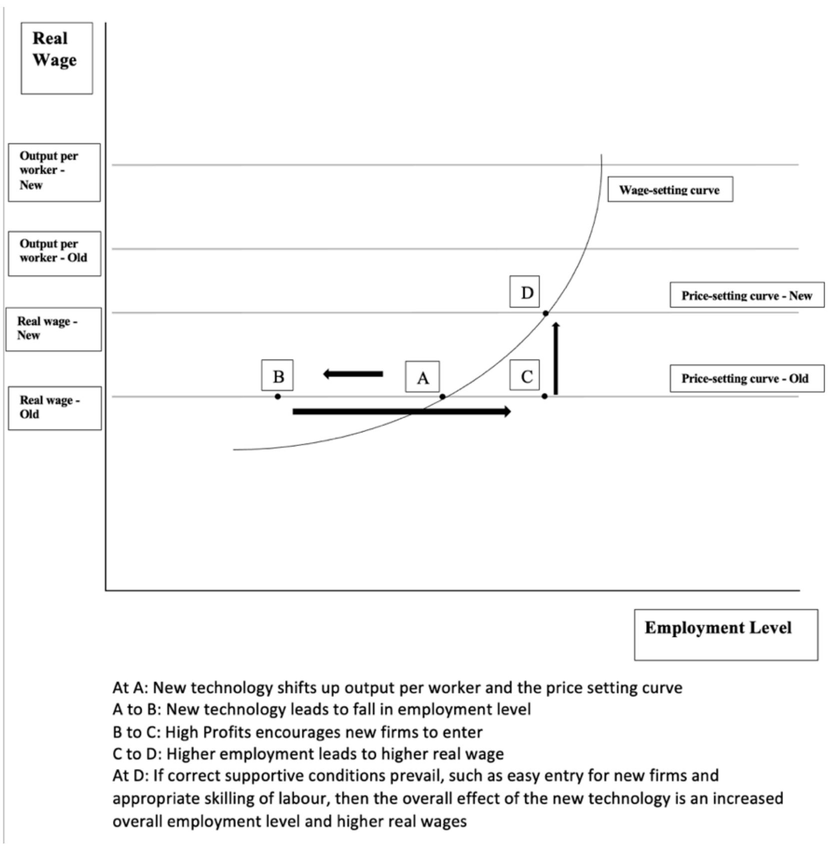

Figure 1: Conditions for technology to result in increased employment and higher wages

Source: Adapted from The Core Team's The Economy, Figure 16.9b.

It is vitally important in designing policies to guide South Africa's energy transition that these potential dynamics are fully understood. Essentially, both sides of the argument have theoretical support – it can be shown in theory that technological changes will result in more employment and higher wages, just as it can be shown that technological change will result in job losses and lower wages. The outcome which will be achieved is conditional – depending on how the supply-side of the economy actually responds to the technological change. Overall, the introduction of new technology will mean that there will be winners and losers, but whether the net effect, at an aggregate level, will be positive or negative depends on how dynamic the economy is in its response. In the language of Joseph Schumpeter's 'perennial gale of creative destruction' (Schumpeter, 1942: 82-83) - will the implementation of new technology create more firms than it destroys, and will it create more jobs than it destroys?

This is not an inevitable process but depends crucially on the institutions and government policies that guide the introduction of new technologies. Legal frameworks, public policy and the practices of trade union and employer organisations will all determine the direction and the extent to which technology changes impact on employment and wage levels. If public resources are mobilised in order to re-skill workers, if public utilities are able to repurpose ageing plants and provide new employment opportunities, then the risks to incumbent workers and affected communities will be ameliorated. If policy frameworks operate efficiently to ensure that new firms are able to gain licenses to begin deploying the new technologies and speedily commencing their operations, then the net effect may be increased employment levels and rising real wages. If such contingencies do not occur, then there is a real risk that losers will outnumber winners and that the net effect of the technology shift will be negative.

As technologies change, a supportive policy framework, buy-in by social partners in labour, business and government, as well as a clear 'just transition' programme will assist in promoting an inclusive, higher employment higher wage outcome that if the process is not carefully managed by social actors. For example, as old technologies cease to operate and new technologies come on stream, there should be the resourcing of supportive programmes for the re-training, reallocation and job-matching for affected personnel and investment in new forms of productive activity for affected regions. Ideally, workers released from failing firms and technologies should be able to move quickly to better ones.

In the context of a well-managed energy transition, with adequate planning for affected workers and communities, trade unions will find it easier to be forward-looking and will be less inclined to insist on a worker's right to keep a particular job. Rather, demands can focus on the need for adequate new job opportunities and support for training and new investments. If trade unions and government policy are backward-looking and seek to protect the status quo, this will slow the rate of diffusion of new technologies and slows the rate at South Africa will be able to put in place a new economic growth model – based on a transition to low-cost, low carbon electricity and all the related investment, export and employment linkages that hinge on such a transition.

Global context of energy transition

The global problem of environmental damage due to the phase of rapid industrialisation over the past two centuries has gained increasing recognition in recent decades for several decades. The impact of rising 'greenhouse' gases, in particular carbon dioxide, and its link to global warming and climate change has come to be scientifically well-established. The August 2021 report of the United Nation's Intergovernmental Panel on Climate Change (IPCC, 2021) has shown conclusively that human drivers have contributed to rising global temperatures in recent decades.

The IPCC report found 'multiple lines of evidence' of climate change, based not only on computer models, but also on detailed data of ongoing physical events. The report stated that climate change is already 'affecting every inhabited region across the globe, with human influence contributing to many observed changes in weather and climate extremes' (IPCC, 2021:12).

Over a decade ago, in reports such as the Stern Review on the Economics of Climate Change (Stern, 2006), the emphasis fell on the costs and constraints associated with changing the patterns of economic development to abate and mitigate environmental damage. As Kemal Dervis describes it, 'Policymakers would therefore have to consider a trade-off between more economic output in the near term and the damage caused by global warming in the longer term' (Dervis, 2021).

Due to technological change in recent years, in particular the falling price of renewable sources of electricity, the transition towards decarbonised green energy has come to be regarded as an opportunity rather than a constraint. As with all technological change, there will be winners and losers, but in the aggregate the new technologies will mean that it costs less to build renewable energy systems than traditional carbon-emitting energy systems. This means that there is no longer a trade-off where green technology must be adopted even though it costs more, rather economic forces will dictate that such technology should be adopted as it costs less. To coin a phrase, rather than what former US Vice President, Al Gore, described as *An Inconvenient Truth* of climate change (Gore, 2006), the emerging 'Convenient Truth' is that the fact that wind and solar are the lowest cost sources of electricity means that there is a direct alignment between low cost production and decarbonisation – there is no longer a trade-off, where in order to achieve one, you need to have less of the other.

As Dervis (2021:Page number) describes it:

> This new framing reflects the tremendous rate of technological change, which the old narrative had largely assumed to be constant or at least exogenous. Green innovation is now not only rapid but also endogenous. The cost of producing renewable energy from solar and wind, and of battery storage to solve the intermittency problem, has already declined substantially… The new, optimistic story… [includes] climate measures that are embedded in a vision of global growth and a profit-enhancing technological wave... Many countries are already deploying these green technologies, but continued innovation (and therefore cost reduction) crucially hinges on more and stronger policy incentives. The recent systemically important commitments by the United States and China to become carbon neutral by 2050 and 2060, respectively, promise and anchor just such incentives. And such pledges are becoming more credible as more countries complement them with shorter-term commitments contained in 10-15-year action plans.'

South Africa is one of the many countries participating in this global process. In terms of South Africa's Proposed Updated Nationally Determined Commitments (NDC) (South African Government, 2021) prepared for the upcoming 26th Conference of the Parties (COP26), as required by parties to the United Nation's Framework Convention on Climate Change, South Africa is committing to the reduction of its greenhouse gas emissions. The NDC has been updated and calls continue to be made on South Africa to be more ambitious in the regard, both to be more effective in helping to assist in the slowing down of rising global temperatures, and potentially, in the country's own direct interest, to gain access to global grants and concessionary green finance as an incentive to accelerate decarbonisation interventions.

As outlined in the NDC, (South African Government, 2021, p.15)

> South Africa has updated its NDC target ranges taking into account our status as a developing county, our national circumstances and common but differentiated responsibility and

respective capability, and the long-term temperature goal, as specified in the Paris Agreement's Article 2, in the light of the latest science.

Many countries have pledged that in future they aim to achieve net carbon neutrality, in the sense that they will remove as much CO_2 and other gases from the atmosphere as they put into the atmosphere each year. Germany has pledged net carbon neutrality by 2045, the United States by 2050 and China by 2060. As of August 2021. Although there are calls for South Africa to transition to a net-zero emission economy by 2050, the focus until mid 2020 had been to set targets, or commitments, to reduce the amount of CO_2 and other gases that it produces. It is likely that pressure will continue to mount on South Africa and other countries to make commitments to net carbon neutrality at some time in the future.

Mapping South Africa's energy transition

To gain deeper insight into the risks and opportunities of the electricity crisis and the energy transition that South Africa is currently facing it is useful to highlight certain key facts and trends about South Africa's electricity situation.

- South Africa's electricity production fell by around four per cent from 2010 to 2019 from a total production of 249 TWh in 2010 to 239 TWh in 2019 (Figure 2). If the unusual year of 2020 is included, impacted on by the COVID pandemic and related lock-down on a wide range of economic activities, electricity production fell by 8.8 per cent from 2010 to 2020, to a total of 227 TWh in 2020.

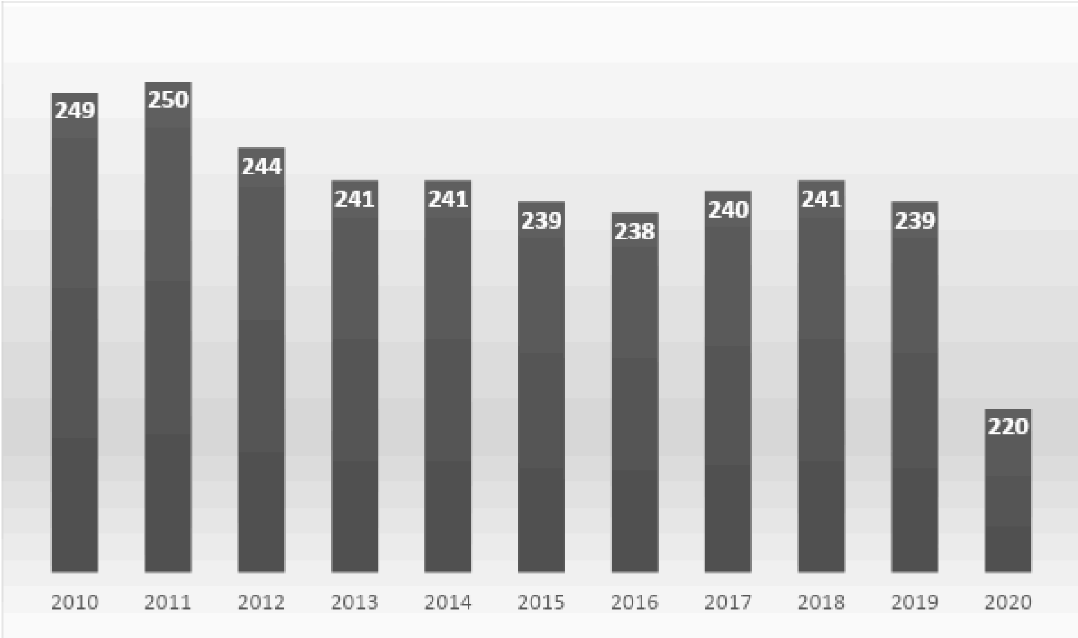

Figure. 2. South Africa's declining electricity production (TWh per year) [1]

Source: Adapted from Calitz and Wright, 2021; 16: (March 2021)

- The electricity generation mix that powers the South African economy is transitioning, with coal to be significantly replaced by wind and solar generation capacity. As per South Africa's Department of Mineral Resources and Energy's *Integrated Resources Plan* published in October 2019 (IRP, 2019), South Africa's installed electricity generation capacity in 2018 comprised 71.3 per cent coal, 3.5 per cent nuclear and 7.2 per cent wind and solar, and it is planned that by 2030 coal will account for 43 per cent of installed capacity, nuclear 2.4 per cent and wind and solar 33.8 per cent (Figure. 3). It is likely that the relative increase in renewable energy sources, like wind and solar, will be even greater than envisaged in IRP 2019 as, inter alia, power stations have performed below expectations and assumptions regarding the availability of Eskom plant have been missed, as well as the fact that the falling costs of wind and solar technology will lead to an expansion of embedded, or distributed, generation by firms.[213]

Table 1 South Africa's Integrated Resource Plan 2019

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[21] The mix in installed capacity is a distinct metric from the contribution of different technologies to overall energy production, which was at the following ratios in 2020 - coal 83.5 per cent, nuclear 5.2 per cent and wind and solar 10.5 per cent.

3

	Coal	Coal (decommissioning)	Nuclear	Hydro	Storage	PV	Wind	CSP	Diesel & Gas	Other (Distributed Energy, Cogen, Biomass, Landfill)
Current Base	**37149**		**1860**	**2100**	**2912**	**1474**	**1980**	**300**	**3830**	**499**
2019	2155	-2373					244	300		2019 to 2002 allocation to extend needed by shortage of capacity and energy gap
2020	1433	-557				114	300			
2021	1433	-1403				300	818			
2022	7111	-844			513	1400	1600			
2023	750	-555				1000	1600			500
2024			Extension of life of Koeberg				1600		1000	500
2025						1000	1600			500
2026		-1219					1600			500
2027	750	-847					1600		2000	500
2028		-475				1000	1600			500
2029		-1694			1575	1000	1600			500
2030		-1050		2500		1000	1600			500
Total Installed Capacity by 2030 (MW)	**33364**		**1860**	**4600**	**5000**	**8288**	**17742**	**600**	**6380**	
% Total installed capacity	**43**		**2,36**	**5,84**	**6,35**	**10,52**	**22,53**	**0,76**	**8,1**	
% Annual Energy Contribution	**58,8**		**4,5**	**8,4**	**1,2**	**6,3**	**17,8**	**0,6**	**1,3**	

Source: IRP 2019; 42

- The rise of renewable energy is being driven by the fact that wind and solar technologies offer the lowest cost of new electricity generation capacity. According to Eskom (Eskom 2021b) at 2020 prices, the levelized cost of energy for new energy investments was 4.1 US cents/kWh for solar PV, 5.4 US cents/kWh for wind, 7.3 US cents/kWh for gas, 15.9 US cents/kWh for coal and 19.8 US cents/kWh for nuclear. Wind and solar PV technologies also entail shorter building time and less capital expenditure than electricity generation investments based on gas, nuclear and coal technologies (Figure 4).
- Even though wind and solar power are inherently variable, depending on wind and sun, these generation technologies work together with a mix of other electricity sources, particularly flexible gas and battery storage, to meet demand requirements (Bischof-Niemz and Creamer 2019).

Table 2 Comparative Costs of building new generation capacity

Technology	Levelized Cost of Energy	Capital Cost	Build Time	Eskom Position
PV	4,1 US$c/kWh	825 US$/kW	18 to 24 months	Identified potential sites to retrofit PV to capitalise on existing infrastructure and available resources
Wind	5,4 US$c/kWh	1 450 US$/kW	24 to 36 months	Leverage sites for wind, with environmental authorisations to capitalise on existing infrastructure and available resources
Gas	7,3 US$c/kWh	1 250 US$/kW	24 to 60 months	Intend to use gas as means to enable renewables, thereby supporting the transition
Nuclear	19,8 US$c/kWh	12 500 US$/kW	12 to 15 years	Supports governments plans to roll out nuclear, will be unable to build due to inadequate balance sheet
New Coal	15,9 US$c/kWh	62 250 US$/kW	10 to 12 years	Will own and operate current coal fleet till end of life, will focus on repurposing sites to be decommissioned with renewables. No new coal projects by Eskom

Source: Eskom, 2021b; 5

- The replacement of coal by renewable energy sources also advances South Africa's global commitments to advance decarbonisation in one of the world's high carbon intensive economies.
- South Africa's constrained and unreliable electricity supply has resulted in load shedding which has imposed significant economic costs estimated at between R59-bn and R118-bn in 2019.[42]
- South Africa's electricity supply utility, Eskom, is in a debt trap which means that the government has had to inject fiscal resources to enable the company to meet its cost and interest repayment obligations. In 2021 government plans to transfer R56bn to Eskom with future transfers expected of between R23bn and R32bn per year from 2022 to 2026 (Eskom, 2021a).

Various interventions need to be undertaken in order to improve energy security, promote economic investment, employment and growth, facilitate a just energy transition and restructure Eskom. It is instructive to assess these interventions with the aim of addressing South Africa's electricity crisis, as well as the country's broader socio-economic crisis.

Allowing for larger embedded, or distributed, power investments by firms

[42] For example, load shedding in 2019 took place for a total of 530 hours and resulted in the shedding of 1352GWh of energy at an estimated cost to the economy of R59-bn to R118-bn. (Calitz and Wright, 2020)

Government's amendment of Schedule 2 of the Electricity Regulation Act of 2006 will provide for licensing exemption for electricity generation projects of under 100MW. The positive aspect of lifting the licensing exemption to 100MW, up from the previous 1MW exemption, is that the impact of the reform will be much larger in terms of the quantum of likely investment in generation capacity and in terms of the wider economic impact.

It is estimated that if the easing of regulations leads to the investment in 5 000 MW of additional electricity generation capacity by firms, this will boost South Africa's GDP by 0.5 per cent, will result in R75-billion to R85-billion in additional investment, and will create 12 000 to 16 000 direct jobs (Operation Vulindlela, 2021).

Allowing mines, farms, factories and commercial operations to install their own electricity generation capacity will ensure greater energy security for these operations and will likely also lead to lower costs and decarbonisation due to the fact the wind and solar installations will come at the lowest cost. An enabling environment that allows firms to wheel electricity over the grid and sell electricity to unrelated parties will also allow for a range of new commercial possibilities. For example, economies of scale may dictate that a firm build a bigger plant than it needs and then it can sell excess power to other firms. It could also supply three of its own operations from one of its operations where it has space to build its embedded generation plant. In both these cases, companies would require permission to link to the grid and would have to pay wheeling costs to Eskom's transmission entity or the municipality. Of course, there will also be scenarios where firms just use their generation capacity for their own needs, even when there is no load shedding these firms will be able to use their own-generated electricity as a substitute or supplement to power supplied by Eskom or the municipality, to lower their electricity costs.

The expanded investment in embedded, or distributed, power, which is planned for in the IRP 2019 will have many advantages.

Firstly, research shows that such investments can add about 5 000 MW of generation capacity in a five-year period (Steyn & Renaud 2021). Secondly, such investment will be from firms' own balance sheets rather than from the fiscus or from Eskom. Thirdly, paradoxically, even though Eskom will forego revenue as a result of firms producing their own electricity, Eskom supports the reform as it will save money for Eskom if it means a reduced resort to expensive diesel fuel sources to try and keep South Africa's lights on. Fourthly, increased investment in distributed power sources is in line with the broader transition taking place in the sector which will be facilitated by Eskom's restructuring, as Eskom's transmission entity (Gridco) will charge firms for transmitting (or wheeling) power over the network if they wish to send electricity to their own operations on other sites or if they wish to sell electricity to unrelated parties. Fifthly, the local employment and investment multipliers by enabling firms to invest in their own electricity generating plant are significant. Sixthly, it is a decentralised solution, through the cutting of red-tape, which can happen comparatively quickly, in small parts that add up, rather than waiting for the longer-running utility-scale procurement processes.

Updating the Integrated Resources Plan and accelerating investment in wind and solar capacity

The IRP 2019 is the key electricity policy planning instrument of government. The IRP is managed by the DMRE. It is an instrument which aims to predict South Africa's future electricity demand and map out plans for the country's future electricity investments.

This has been a highly contested policy area, for example, technology choices which should have technically favoured a mix of least-cost, carbon-reducing technologies have continued to be roiled by cross winds involving vested interests, forces of state capture and corruption, as well as geo-political factors arguing variously in favour of nuclear, coal, gas, or renewable technologies.

To be effective the IRP needs to be utilised as a technical planning instrument – with any policy deviations from least-cost technologies to be strictly limited and to be made explicit with due reasons provided. Furthermore, the IRP should be regularly re-calibrated and updated as relative technology costs change and as supply and demand trends and assumptions require adjustment. For example, one of the reasons that IRP 2019 needs to be updated is due to the fact that it assumes that Eskom plant will have an energy availability factor (EAF) rising from around 67 per cent in 2019 to 75.5 per cent by 2030, but due to the delays and poor performance of Eskom's new Medupi and Kusile plants as well as deterioration of the utility's ageing fleet, performance is below this expected EAF, resulting in an ongoing electricity supply gap. A recalibrated IRP would allow the government to plan to accelerate the procurement of increased electricity capacity, as well as consider the impact of relevant reforms such as reducing red-tape for non-utility-scale embedded, also known as distributed, electricity investments by private entities. The consequence of allowing a supply gap to continue, is ongoing load-shedding and lost investment, jobs and growth potential, due to the shortage of electricity.

Another reason that the IRP should be regularly reviewed and recalibrated is so that delays and adjustments to lead times in bringing on stream new capacity can be factored into planning processes. Otherwise, delays will be hard baked into the planning process, extending the period of the electricity supply gap and imposing significant costs on the wider economy.

Reaffirming corruption-free bidding processes run by the IPP Office

Based on the IRP's plans for electricity capacity investments, bid windows are opened inviting entities to bid for the right to build the required capacity. South Africa's Independent Power Producer Procurement Program Offices (IPP Office) then selects the most competitive bids to build the required technology.

It would be fatal to the process if corruption were to be allowed to take root in the electricity procurement process. This is why recent allegations by a losing bidder of corruption and political interference in the IPP Office's selection of power ships as part of the government's emergency Risk-Mitigation Independent Power Procurement Programme (RMIPPP) are most disturbing and need to be fully investigated.[53] The independence and good governance of the IPP Office must be reaffirmed if the IRP procurement processes that are currently underway are not to be fatally undermined at tremendous cost to South Africa.

Committing to an accelerated decarbonisation target to assist in alleviating Eskom debt and to fund a just transition

Electricity production is no longer a natural monopoly, where marginal costs fall the larger is the production unit. Rather system-wide electricity is more cost-effectively produced by smaller, distributed generation units - typically variable wind and solar, supported by readily dispatchable electricity sources, such as, from batteries and gas.

As part of the country's transition to a system characterised by less centralised, and more distributed, electricity generation – driven by a combination of self-reinforcing technological

[53] There has been much criticism of the design of the RMIPPP programme. Put together in haste in response to South Africa's severe bout of load shedding in December 2019, the RMIPPP specified the need for dispatchable power during peak hours. The specification was more conducive to the use of gas and diesel, or renewable sources linked to large battery storage. This design specification is likely to saddle South African with about 2,000 MW of high-cost electricity for many years to come, which could have been obviated if the programme had been better designed to meet emergency requirements by allowing for lower-cost more systemically integrated solutions.

changes, decarbonisation objectives and economic forces – to be fit for purpose Eskom, in turn, will need to be restructured into three entities, namely a Generation entity, a Transmission entity and a Distribution entity.

The Eskom Generation entity, likely for some time to be the largest supplier of electricity in South Africa, though it will be joined by a growing number of privately-owned electricity generation entities. Electricity from various sources will be supplied into a single national grid run by the Eskom Transmission entity, referred to as the Independent Transmission System and Market Operator (ITSMO), which will manage the grid and will serve as an intermediary contracting with public and private entities generating electricity, as well as those running consumer-facing distribution systems, a large part of which is likely to be Eskom's Distribution entity.

Eskom (Transmission) will be required to invest in the maintenance and extension of the national grid network. To connect the best acreage for wind and solar generation to the grid, some R188 billion will need to be invested over the next 10 – 15 years to build some 8 000 km of new transmission line by 2030.

Eskom (Distribution) will be required to invest in distribution networks, as well as battery and other storage facilities to better manage fluctuations in supply caused by the increasing proportion of variable generation capacity.

Eskom's current debt level of over R400bn is unsustainable, in that, ongoing high interest payment obligations undermine the liquidity and financial viability of the entity. As part of the wider planned restructuring Eskom, the potential exists for Eskom and South Africa's national government, working in close coordination, to gain access to concessional global Green Finance and make use of such concessional finance to effectively reduce Eskom's borrowing costs.

Using such concessional arrangements, certain Eskom-related refinancing could be undertaken which will allow for future lower, concessional interest payments on condition that a carbon reduction roadmap, including the closure or repurposing of old coal power stations, is achieved by Eskom and, relatedly, by South Africa more broadly.

Eskom has identified its coal-fired Komati Power Station, which commenced operation in 1961, as a flagship site for how the just energy transition could be managed in a way that ameliorates the potentially negative impact on affected workers and communities. As Komati's last coal-fired unit is shut down in 2022, it is envisaged that a repurposing programme will kick-in which will include the following elements: the repowering of the power station, the building of renewable energy capacity the power station's land, and the creation of local manufacturing opportunities. All of these interventions would have positive benefits for the Komati community who would otherwise only face the risk of the plant closure. Another advantage to such repurposing is that is that existing power plants – like Komati Power Station - are already linked to the national electricity, which will save time and costs for the project. An example of the kind of manufacturing activity that could be housed at repurposed Eskom plants could be that related to the building of microgrid components – including solar panels and battery components – to be deployed so to provide access to electricity to the 13% of South African off-grid households that have not historically been not serviced via the national grid.

Eskom's Just Energy Transition Transaction should be regarded as a first step towards the country mobilising concessional funds at a larger scale. A ramping-up of the process could be operationalised through government-to-government, or sovereign-to-sovereign, international financial support through which South Africa could be granted access to concessional finance, for example through significantly reduced interest payments over 25 years as the country achieves its decarbonisation milestones. This would involve agreeing on a $/t price for decarbonisation that would be realised as South Africa accelerates its decarbonisation against the IRP2019 baseline. In such a scenario, the South African government would not be required to raise debt outside of its normal borrowings programme, but would use the agreed $/t savings to reduce the interest rate on those borrowings to highly concessional levels. Such a transaction would create the fiscal space required to partly recapitalise the unbundled Eskom units and set up a Just Transition Fund to support workers and communities affected by the early retirement of coal.

The mobilisation of finance at scale would be necessary to financially stabilise a restructured Eskom and capitalise the massive investments that are required if South Africa is to achieve its just energy transition objectives. Resources are also required to assist workers and communities who would be negatively affected by the transition. This would help to unlock the process and increase the likelihood of putting the country onto a higher employment, higher wage trajectory. If the transition is approached without such resources in hand it is likely that it will fail, as it will provoke greater resistance and will not be capable of operating at a large enough scale to allow the energy transition to be able to serve as a catalyst for wider economic growth and employment creation.

Significant potential exists in South Africa's body-politic to mobilise support for plans to better manage and reduce Eskom's debt. Government, business, labour and community representatives, via a Nedlac process, agreed to the following, as outlined in their *Framework Agreement for a Social Compact on Supporting Eskom for Inclusive Growth* (released in December 2020): "[2.8.2] There is a need for a strategy to reduce Eskom's debt level… [2.8.3] social partners are committed jointly to mobilising adequate financial resources for Eskom. The precise financing mechanisms will be evaluated considering all options available." (Nedlac, 2020)

Upstream and downstream linkages for job creation

The programme to restore electricity security in South Africa together with the ongoing energy transition has the potential to stimulate large-scale investment in the country's electricity generation, transmission, and distribution infrastructure and this investment will need to be maintained for many years to come. The overall developmental objective of the energy transition should be to restore economic growth and employment creation through the restoration of reliable and widespread access to competitively priced, low-carbon electricity, as well as taking advantage of all potential backward, forward and lateral linkages that such an investment programme will entail.

Eskom estimates the job creation potential of expanded wind and solar capacity, during construction, operations and manufacturing, from 2022 to 2030, at about 38,000 direct jobs, 11,600 indirect jobs and 192, 000 induced jobs. Added to this is the significant job creation and manufacturing potential related the construction of 8,000 km of electricity transmission lines by 2030 (Eskom, 2021b). This needs to be set against the estimated decline of 22,700 jobs coal mining and 6,200 coal-fired power station jobs from 2020 to 2040 as IRP 2019 is implemented (Tyler et al.,2021).

There are significant new upstream and downstream industrialisation opportunities for South Africa. Upstream opportunities would include the need for investment in the manufacture of solar panels, wind towers and turbines, flexible gas plants, transmission infrastructure, large scale battery installations and other components. Research has indicated that 'the manufacturing, construction, services and sales sectors experience the highest gross employment gains during the construction and operations phases of adding new renewable energy capacities to the power mix' (IASS/CSIR, 2019;14).

Supportive and well-designed industrial policy will help to maximise localisation, employment, and race and gender transformation objectives. Careful sequencing and realistic programme design are very important so as not to undermine this vision. The debacle whereby the RMIPPP's local content requirements for solar panels had to be subsequently removed due to the absence of local supply capacity serves to undermine this localisation vision. Furthermore, such mismanagement is likely to result in legal challenges by those companies which decided not to bid, due to the local content criteria which could not be met, as they were unfairly disadvantaged when local content criteria were subsequently withdrawn, after bidding had been closed and winning bidders had been announced.

Tragically, a number of local wind turbine tower manufacturing plants and solar panel manufacturing facilities have been shut down in South Africa in recent years due to delays and stops and starts in procurement.[64] To succeed in maximising industrial policy and employment benefits, there needs to be certainty and credibility in the management of the country's energy transition.

Government is in the process of developing an instrument known as the South African Renewable Energy Masterplan (SAREM), to position the country as a 'globally significant' producer of inputs used in renewable-energy plants. The masterplan will consider a matrix of value chains with priority to be given to those primary materials, components and subcomponents used in the manufacture and assembly of renewable technologies including solar photovoltaic, wind and battery storage (Creamer, T, 2021a).

Interestingly, the energy transition also presents growth opportunities for the mining sector. The energy transition is projected to be metals intensive. For example, the global growth in solar power is projected to double the demand for metals like aluminium, copper and zinc by 2040. An important linkage for South Africa would be to promote mining exploration in South Africa and Africa more widely to increase market share in the provision of these critical minerals.

Once South Africa has invested in a significant renewable energy base, downstream opportunities would include a wide range of new activities including those linked to the world's mobility transition, such as, electric vehicles, green hydrogen, and green jet fuel.

A Draft Green Paper on electric vehicle production has been developed by the South African government based on the insight that it is important that South Africa does not simply become a market for electric vehicles produced elsewhere in the world, relegating the country's car making to internal combustion engines (Venter, 2021). It is also regarded as vital that South Africa maintain the

[64] In April 2019, uncertainty in the renewable energy sector in South Africa led to job losses in Nelson Mandela Bay. A wind turbine tower manufacturer, DCD wind towers, closed its factory in the Coega Industrial Development Zone (IDZ) after failing to find an equity investment partner. DCD ran into trouble in 2016 when no new orders were placed due to the planned gap in wind farm expansions. The Industrial Development Corporation took an 80 per cent stake in DCD wind towers but that did not generate renewed interest. The manufacturing facility was forced to close its doors and retrenched its 110 employees. (Fekisi, 2019)

local industry’s capacity to export to key markets, such as the European Union (EU) and the UK, both of which have set new targets and deadlines to reduce the number of fossil-fuel-reliant vehicles on their roads (Venter, 2021).

The domestic market for electric vehicles in South Africa remains nascent with very few units sold each year, but it is projected as a growth area linked to global development in the years ahead. Significant electric vehicle charging infrastructure would need to be developed as a pre-condition for the massification of South Africa’s electric car market. The electrification of public transport systems, such as, taxis and buses would require specific plans, interventions and related incentives.

Risks associated with South Africa’s carbon-intensive industrial base

If decarbonisation of South Africa’s electricity base does not happen at an acceptable pace and scale, the risks to investment and trade are significant. For example, Amazon recently invested in South Africa strictly on condition that all its electricity requirements had to be served by renewable energy sources. The project will see 28 GWh of solar energy wheeled via State-owned power utility Eskom’s grid from a solar farm in the Northern Cape to Amazon’s facilities each year (Liedtke, 2020).

Research has indicated that South Africa’s export of Green House Gas (GHG) emissions are closely linked to the country’s export profile. As such (Montmasson-Clair, 2020; 21):

> ‘China captures the largest share of South Africa’s exported GHG emissions, followed by the EU, India, the USA and Japan. At a sectoral level, South Africa’s exported GHG emissions are concentrated on the mining value chain exports. Basic metals, mining and quarrying products accounted for more than half of exported GHG emissions (53 per cent) in 2015. Motor vehicles, utility services, chemicals and chemical products, and machinery and equipment followed’

A risk is that if South Africa does not begin substantially to reduce the country’s carbon intensity, our trading partners will begin to erect tariff and non-tariff barriers, which will have the effect of curbing exports and reducing South Africa’s international competitiveness. The European Union (EU) is taking the lead in this matter as the body has proposed ‘a carbon border adjustment mechanism’ as a tool to scale up the EU’s climate ambitions. Essentially, this would entail the imposition of a carbon tax on South Africa’s goods, such as, cars and fruit intending to be exported into the EU (Oharenko, 2021). Although it is not clear at this stage whether such practices will be found to be acceptable under

World Trade Organisation (WTO) rules, and what positions will be taken on the matter by other powerful geo-political decision-makers, such as, the US, China, Japan and the AU.

On the positive side, there may be emerging opportunities for South Africa to gain export advantage through the creation of new products such as so-called 'green iron' for export to international steelmakers seeking to transition away from the use of carbon-intensive coking coal in the production of the basic material. Should green-iron technologies, such as hydrogen direct-reduced iron (HDRI), be proven commercially over the coming decade, dedicated renewable-energy plants could be developed to produce green hydrogen through a process known as electrolysis, which uses electricity to split water into hydrogen and oxygen. The hydrogen could then be used to convert South African iron-ore into HDRI and used by international steelmakers with net-zero emission commitments to produce carbon-free steel.

The production of green iron in South African, for export to the EU, could have substantial financial and economic benefits for both South Africa and Europe, as it will reduce the overall cost of EU decarbonisation, while making its steel industry more competitive. Furthermore, ArcelorMittal South Africa's mothballed Saldanha steel plant, on the West Coast, includes a direct reduced iron plant that could be modified to be supplied with green hydrogen.
(Creamer, 2021b):

> This would provide a new business model for a plant that was unable to compete with cheap Chinese steel supply, and would be synergistic with the Saldanha port, now reconfigured for green hydrogen and power fuels production and export.

In another initiative, mining company Anglo American has signed a memorandum of understanding with German steel product manufacturer Salzgitter Flachstahl to collaborate on decarbonising of the steelmaking industry. 'The companies will conduct research into feed materials, including iron-ore pellets and lump iron-ores, that are suitable for use in direct reduction steelmaking – based on natural gas and hydrogen – which is a less carbon-intensive production method compared with conventional blast furnaces' (Arnoldi, 2021).

It would be prudent for South Africa to fully appreciate the linkage between the decarbonisation of the country's energy profile and its export competitiveness. As Montmasson-Clair has suggested:

> Montmasson-Clair, 2020;27:
> This situation calls for decisive action to reduce the carbon intensity of the South African economy as well as diversify the structure of exports to low(er)-carbon products. This is

essential to maintain South Africa's competitiveness and market access going forward. Despite some progress (for instance, in grid decarbonisation and energy efficiency efforts), much more is required to reduce South Africa's vulnerability to climate change regulations and to set the country on a sustainable pathway

Conclusion

In response to global warming, world-wide policy is shifting towards low-carbon energy, and this, coupled with the need for investment in new electricity infrastructure in South Africa, in the context where low-carbon renewable energy sources are the lowest-cost source of new capacity, means that South Africa has the opportunity to embark on a deep-rooted and extensive energy transition which has the potential to change the economy – and drive growth, employment and inclusion.

Along with this opportunity, there are threats of dislocations and losses for those in coal-producing areas and for those working in the coal sector's value chain, which threats need to be managed and ameliorated for the energy transition to be inclusive and just. Social compacting should be viewed as an important instrument to mitigate the negative impact, of the overall net-positive, energy transition.

For such social compacting to be effective each social partner has a particular role to play. Government needs to provide a clear and rational set of policy frameworks to guide the South African economy through a just energy transition. With the exception of the national grid, in most instances, it is not necessary for the state to own all the elements of the electricity system to achieve desirable public policy objectives, rather these objectives can best be achieved via appropriate legislative, regulatory, restructuring and coordination mechanisms. Government also needs to be effective in providing wide access to appropriate skills, especially for young people, as well as sustaining an environment of safety, security, public health and social cohesion.

Worker, community and business representatives engaged in social compacting for a just energy transition need to be forward looking and embrace technological change in a manner that protects those who are threatened by the change mainly through retraining, the facilitation of new investments and by allowing ease of firm entry and increased competition, so that South Africa can move onto a higher productivity, higher wage and higher employment growth path.

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