

# SADC Futures of e-Mobility: EVs as Enablers of a New Energy Paradigm

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## 1. The SADC Energy Landscape

The global energy landscape has changed dramatically over the past 25 years, but there are potentially much larger and rapid changes in store in the future. *Resources for the Future* recently released a game-changing report<sup>1</sup> that compares “apples-with-apples” through a unique methodology that provides an integrated analysis of the long-term energy projections of various governmental, intergovernmental, and private organisations.<sup>2</sup> The report entitled *Global Energy Outlook 2019: The Next Generation of Energy* states that global energy consumption is poised to grow by over 20-30% through 2040 and beyond.<sup>3</sup> In the absence of ambitious climate change targets, this growth would be largely driven by the increased consumption of fossil fuels.

The outlook is largely framed by the increased energy consumption needs that are included in the economic and population growth projections of the global ‘East’,<sup>4</sup> whereas consumption levels in the ‘West’<sup>5</sup> are projected to remain largely fixed at current rates. Carbon dioxide (CO<sub>2</sub>) emissions also continue to grow if policymakers fail to introduce changes in the energy mix or make use of new technologies that would engineer greater energy efficiency in the long run. The comparative scenarios hold positive news for the renewable energy sector, where the rapid growth in wind and solar power drives the expansion of RE but does not significantly displace the consumption of fossil fuels unless more robust climate policies are put in place.

The role of electricity in all forms of energy consumption becomes increasingly prominent, especially where scenarios integrate a rapidly growing electric vehicle (EV) market into their parameters. However, while EVs fulfil an increasingly significant role in the future of transportation, they are not the sole solution in reaching a zero-carbon economy. However, EVs might be the initial difference that makes a difference in that they offer a viable alternative in various forms of mobility in the face of a global decline in oil demand. This is of course exacerbated by the coronavirus pandemic. Large-scale adoption of electric vehicles could change the energy landscape radically. More and more major cities and countries are adopting congestion restrictions to lower air and noise pollution. Urban designers are employing new tactics that include carless areas where only cycling, walking and forms of micro- mobility is allowed.

The Global Energy outlook shifts significantly under ambitious climate policies. The global economy not only becomes more energy-efficient, but there is a 50% decline in global coal consumption relative to current levels. Furthermore, global oil use falls by 20%, natural gas increases in a modest fashion, while nuclear energy grows by more than 50%. Finally, the scenarios highlight that the renewable energy sector doubles and improves when carbon capture and storage (CCS) technologies are deployed at scale by 2040.

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<sup>1</sup> Richard Newell, Daniel Raimi, Gloria Aldana, 'Global Energy Outlook 2019: The Next Generation of Energy,' (2019).

<sup>2</sup> The outlook of 11 organisations/authors/institutions were considered in the preparation of the 2019 Global Energy Outlook. Ibid.

<sup>3</sup> [Ibid.](#)

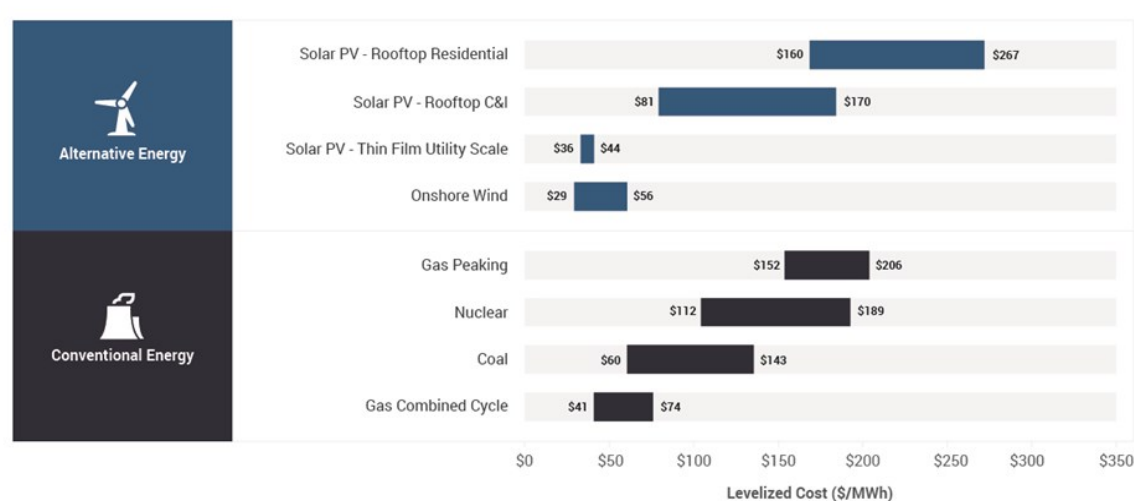
<sup>4</sup> East meaning Africa, Asia-Pacific, and the Middle East.

<sup>5</sup> West pointing to Europe, Eurasia, North America, South and Central America.

In its 2018 report *Renewables 2018: The Global Status Report*,<sup>6</sup> the Renewable Policy Network for the 21<sup>st</sup> Century (REN21) found that the renewable energy sector is rapidly moving ahead to achieve record levels of new installations and investments. It attributes this progress to years of active policy support and technological advances.

This rapid growth driven by the dramatic reduction in the cost of solar photovoltaics (PV) and wind-generated electricity means that globally, renewables are now less expensive than newly installed fossil and nuclear energy. This trend is accelerating, meaning that in coming years renewable energy will become even more affordable and the need to rely on fossil and nuclear energy generation methods would be significantly reduced.

Figure 1: Levelized Cost of Energy Analysis: Declining costs of alternative electricity technology generation



Source: Lazard<sup>7</sup>

The REN21, however, cautions that a switch in energy generation alone will not enable the world to reach its Paris Agreement commitments or Sustainable Development Goal 7 (SDG7) that commits the world to provide affordable, reliable, sustainable and modern energy for all. The heating and cooling industry, as well as the transport sector, will have to make a drastic shift towards renewable sources of energy for these ambitions to be realised. The infographic below shows the contribution that heating/cooling, transport and energy generation makes to CO<sub>2</sub> emissions and clearly shows that much work still needs to be done to shift the

<sup>6</sup> REN21 is a multi-stakeholder network that is built on an international community of over 900 experts from governments, inter-governmental organisations, industry associations, non-governmental organisations, and science and academia. It grows from year to year and represents an increasing diversity of sectors. REN21 provides a platform for this wide-ranging community to exchange information and ideas, to learn from each other and to collectively build the renewable energy future. REN21, 'Renewables 2018: The Global Status Report'. URL: [https://www.ren21.net/wp-content/uploads/2019/05/gsr\\_2019\\_full\\_report\\_en.pdf](https://www.ren21.net/wp-content/uploads/2019/05/gsr_2019_full_report_en.pdf), site accessed 12 July 2019.

<sup>7</sup> Lazard, 'Levelized Cost of Energy and Levelized Cost of Storage'. URL: <https://www.lazard.com/perspective/levelized-cost-of-energy-and-levelized-cost-of-storage-2018/>, site accessed 08 August 2019.

transport sector towards a renewable model that addresses the Paris Agreement requirements.

A report released by the Climate Transparency Organisation in 2018, *Brown to Green: The G20 Transition to a low-carbon Economy*,<sup>8</sup> paints a bleak picture regarding G20 members reaching their Paris Agreement commitments. In sum, they find that the G20 countries roughly need to halve emissions by 2030 but that adequate strategies to do so are still lacking. Alarming, in 15 of the G20 countries, energy-related CO<sub>2</sub> emissions increased in 2017, and 82% of the G20's energy supply still comes from fossil fuels.

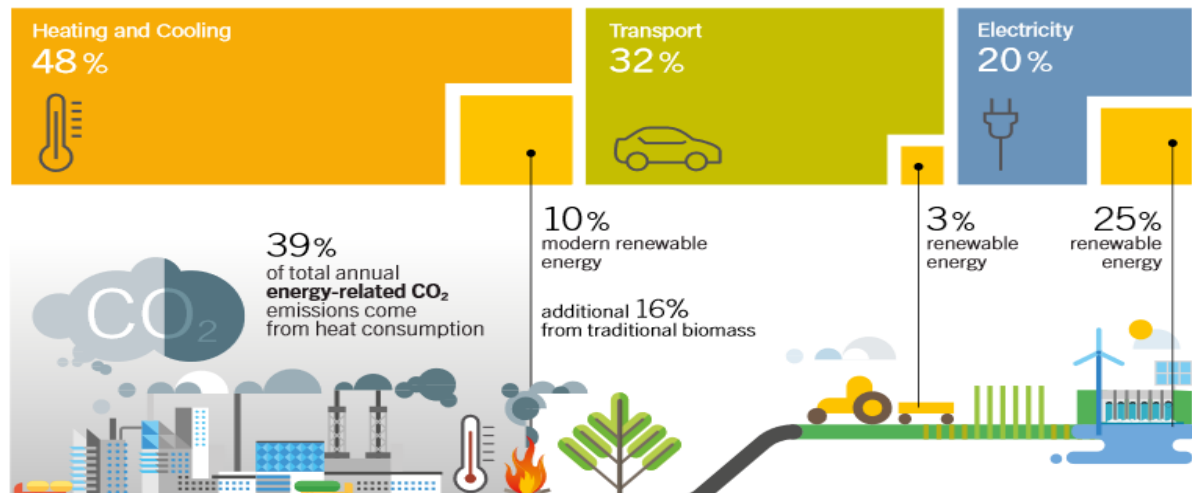
Figure 2: Renewable Energy Transition

## RENEWABLE ENERGY TRANSITION

### WE MUST MOVE FROM AN ELECTRICITY TRANSITION TO AN ENERGY TRANSITION

#### ■ WE CONSUME THE MOST ENERGY FOR HEATING, COOLING, AND TRANSPORT

Modern Renewable Energy in Final Energy Use by Sector, 2015



Source: REN21 Global Renewable Status Report 2018.

They also found that countries that need to do the most in transforming their power and transport sectors lack concrete actions towards developing a strategy. Finally, they also point out that G20 countries provided \$147 billion in subsidies to the coal, oil and gas industries in 2016.<sup>9</sup>

The electric vehicle will thrive in an environment where energy becomes cheap and abundantly available. Whereas global studies show that the oil industry should survive a decline in oil demand for ICE cars by moving into petrochemicals and focusing attention on the ever-growing aviation industry, the future of the coal industry is far less certain. Futurists expect that the cost of energy generated from renewable sources will continue to fall, making electricity available to all. New technologies are also starting to overcome the storage challenge previously presented by wind and solar energy. Ever bigger and stronger batteries are being developed, allowing for greater energy harvesting and applicability, which in turn

<sup>8</sup> Climate Transparency, 'G20 Brown to Green: The G20 Transition to a low-carbon Economy,' (2018).

<sup>9</sup> Ibid.

makes the RE sector ever more competitive. RE has the added advantage that it offers off-grid solutions, much like the cell phone provided a solution to connect people in far-flung rural areas without having to roll out landline infrastructure at a high cost.

The SADC Energy baseline report of 2016 shows that the members of the Southern African Power Pool (SAPP)<sup>10</sup> use a diverse mix of energy sources to power the region. South Africa remains the most significant contributor to the Power Pool. However, its power utility, Eskom, relies primarily on coal-generated power production and thus coal also dominates the region's energy mix and in turn represents around 76% of all energy produced in the region. The SADC Energy baseline shows that three countries rely largely on coal-generated electricity: South Africa (86%), Botswana (82%) and Zimbabwe (63%). Hydropower is the second most significant contributor to SADC's energy mix, with four countries relying exclusively on hydropower: the DRC, Lesotho, Malawi and Zambia; while Mozambique, Namibia, eSwatini and Tanzania have a significant hydro-generated electricity portion in their energy mix. Diesel, nuclear and combined-cycle gas turbines also contribute to SADC's available energy, but to a far lesser extent. Solar and wind-generated energy is only starting to take off in SADC member states.<sup>11</sup>

The SADC region has considerable potential to source almost all of its energy from renewable sources. Between solar, wind, hydro, biomass and geothermal electricity generation, the region could in the foreseeable future distance itself from all fossil and potentially nuclear energy generation. However, the coal industry in South Africa and its power utility Eskom, have a near-monopoly on energy generation in the country and across the region.

South Africa has set itself a target of moving to a 30% renewable energy contribution to its energy mix by 2030 in its Integrated Resource Plan of 2019 and introduced the Renewable Energy Independent Power Producers Procurement Programme (REIPPPP) in August 2011. The REIPPPP was initially deemed to be very successful as it attracted diverse international and local investment and developers. Competition among them also resulted in rapid price reductions.<sup>12</sup>

By 2015, the programme was contributing around 15% of the national energy grid, and expectations were that the REIPPPP was growing. However, as President Zuma sought to address South Africa's energy needs via a nuclear deal with Russia, the programme fell out of favour. It certainly made no sense for South Africa as a whole to abandon the REIPPPP given its early successes and the fact that the costs of RE were constantly falling. It did, however, make business sense to the power utility Eskom to abandon the REIPPPP, because the cheap electricity produced through the REIPPPP was adversely affecting its revenue streams.<sup>13</sup> A

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<sup>10</sup> The SAPP currently has twelve member states, which are the continental members of SADC: Angola, Botswana, the DRC, eSwatini, Lesotho, Malawi, Mozambique, Namibia, South Africa, Tanzania, Zambia and Zimbabwe.

<sup>11</sup> SADC Energy Monitor, 'Baseline study of the SADC energy sector,' Gaborone, Botswana, Harare, Zimbabwe, 2016.

<sup>12</sup> Anton Eberhard, Joel Kolker, James Leigland, 'South Africa's Renewable Energy IPP Procurement Program: Success Factors and Lessons,'.

<sup>13</sup> Oliphant, John, 'Too much power in Eskom's hands undermines potential of green energy'. URL: <https://www.businesslive.co.za/bd/opinion/2016-11-24-too-much-power-in-eskoms-hands-undermines-potential-of-green-energy/>, site accessed 20 November 2018.

study on the coal transition in South Africa found that Eskom's coal costs had increased by 300% in real terms over the past 25 years from R42,79/ton in 1999 to R393/ton in 2017.<sup>14</sup> Jesse Burton from the Energy Resource Centre also confirmed that "new renewable energy capacity is now considerably cheaper than either the new Eskom coal-fired power plants that are currently under construction, such as Medupi or Kusile, or the privately-owned coal plants proposed in the Integrated Resource Plan (IRP 2018)".<sup>15</sup>

Research done by Mark David Sklar-Chik in 2017 provides a comprehensive capex comparison of the total system costs of energy generation for South Africa, as demonstrated in Table 5.<sup>16</sup>

*Table 1: Capex Comparisons: System Cost of Energy Generation for South Africa*

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<sup>14</sup> Jesse Burton, Tara Caetano, Bryce McCall, 'Coal transition in South Africa - Understanding the implications of a 2°C-compatible coal phase-out for South Africa,' (2018).

<sup>15</sup> Moyo, Admire, 'Study reaffirms renewables now cheaper than coal'. URL: <https://www.itweb.co.za/content/JN1gP7O1gVJqjL6m>, site accessed 18 January 2019.

<sup>16</sup> Mark Sklar-Chik, 'System Cost of Energy Generation Scenarios for South Africa: Understanding the real cost of integrating energy generation technologies,' (2017).

Type	Capacity (MW)	Average Capex (R/kW)	CAPEX [R]	Lifespan	Interest (over loan term)
Wind	14000	R 16 982.50	R 237 755 000 000.00	20	R 484 317 438 174.96
PV	17000	R 12 162.50	R 206 762 500 000.00	25	R 452 212 720 456.54
Existing Coal	27430	R 34 916.00	R 0.00	60	R 0.00
New Coal	9560	R 34 916.00	R 333 796 960 000.00	60	R 1 119 690 678 960.18
CCGT	4000	R 8 616.00	R 34 464 000 000.00	30	R 80 713 636 031.18
Existing OCGT	2175	R 5 676.50	R 0.00	30	R 0.00
New OCGT	5505	R 5 676.50	R 31 249 132 500.00	30	R 73 184 514 475.83
Existing pumped storage	1400	R 40 409.50	R 0.00	50	R 0.00
New pumped storage	1500	R 40 409.50	R 60 614 250 000.00	50	R 182 031 518 511.40
Hydro	2100	R 0.00	R 0.00	60	R 0.00
New hydro	1590	R 20 192.50	R 32 106 075 000.00	60	R 107 696 825 386.00
CSP	8000	R 46 979.12	R 375 832 957 778.28	30	R 880 189 315 303.97
Existing nuclear	1800	R 73 877.00	R 0.00	60	R 0.00
New Nuclear	0	R 73 877.00	R 0.00	60	R 0.00
Total	96060		R 1 312 580 875 278.28		R 3 380 036 647 300.05

Source: Sklar-Chik, 2017. Key: PV=Photovoltaic; CCGT= Combined Cycle Gas Turbines; OCGT= Open Cycle Gas Turbines; CSP= Concentrating Solar Power.

After the removal of President Zuma in 2018, President Ramaphosa reintroduced the REIPPP. However, it continues to face stiff opposition and criticism from the labour unions, given fears that the renewable energy sector could hurt jobs in Eskom and its supply chain. But the government also argues that the renewable energy sector could become a significant contributor to job creation.<sup>17</sup>

The South African National Development Plan (NDP)<sup>18</sup> uses four different frameworks through which it considers economic and industrial development (Figure 14) in trying to address the quandary of growth and job creation. Although the use of natural gas as an energy source is preferable to the burning of coal, in essence, the investment in oil and gas

<sup>17</sup> Omarjee, Lameez, 'Radebe: Renewable IPPs to create over 114 000 'job years''. URL: <https://www.fin24.com/Economy/radebe-renewable-ipp-to-create-over-114-000-job-years-20180705>, site accessed 20 November 2018

<sup>18</sup> South African Government, 'National Development Plan 2030'. URL: <https://www.gov.za/issues/national-development-plan-2030>, site accessed 18 October 2019.

exploration and production falls within the good for growth and not great for jobs category. Importantly, it would also not catalyse the transition to a Green Economy<sup>19</sup> or stay within the parameters of the Paris Climate Agreement. As argued by Janet Solomon in the Mail & Guardian in commenting on the Brulpadda find:

The Intergovernmental Panel on Climate Change has warned that all nations must stop burning fossil fuels by 2030 to avoid catastrophic warming. By 2027 climate change will be a fully-fledged reality, and Brulpadda will become a stranded asset. Further development of gas infrastructure is incompatible with the Paris agreement target.<sup>20</sup>

Figure 14 highlights why the things that drive growth are not always the things that drive job creation, and conversely, the things that are good for job creation are not always good for growth. As noted by the NDP Commission:<sup>21</sup>

efforts should focus on growing exports and building the linkages between export earnings and job creation, which often occur in domestically focused small- and medium-sized firms, most often in the services sector. South Africa has to exploit its existing strengths to increase exports. This means using the country's advantages - its skills, technologies, firms, mineral wealth, underutilised labour and geography. If the economy is less competitive in one area, it will have to do better in others.

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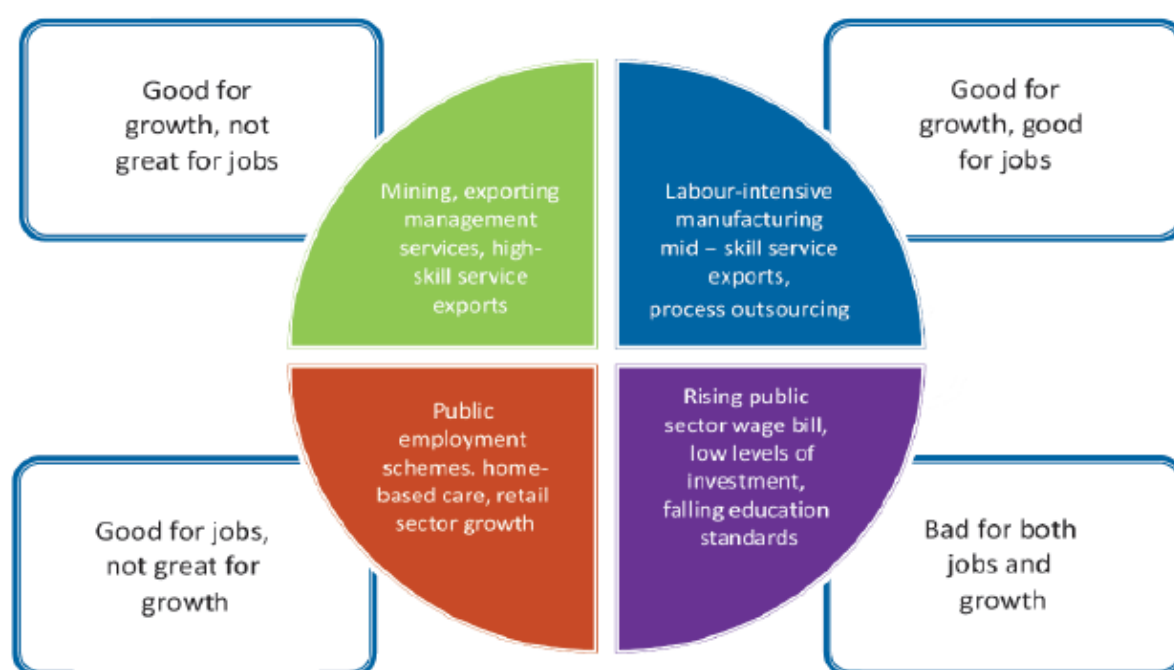
<sup>19</sup> See the government programme on the Green Economy for Sustainable Development Department of Environmental Affairs, 'Green Economy for Sustainable Development'. URL: <https://www.environment.gov.za/projectsprogrammes/greeneconomy>, site accessed 18 October 2019 and the CSIR guide on the Green Economy CSIR, 'CSIR creates a guide for South Africa's Green economy'. URL: <https://www.csir.co.za/csir-creates-guide-south-africa%E2%80%99s-green-economy>, site accessed 18 October 2019; CSIR, 'CSIR creates a guide for South Africa's Green economy'.

<sup>20</sup> Solomon, Janet, 'Looking the Brulpadda in the mouth'. URL: <https://mg.co.za/article/2019-03-01-00-looking-the-brulpadda-in-the-mouth>, site accessed 10 May 2019.

<sup>21</sup> National Planning Commission, 'What the National Development Plan proposes'. URL: <https://www.politicsweb.co.za/documents/what-the-national-development-plan-proposes>, site accessed 18 October 2019.



Figure 3: The quandary of growth and job creation framework, National Development Plan, 2010



Source: SA National Planning Commission, 2010

A 'Co-benefits study'<sup>22</sup> assessing the co-benefits of decarbonising the power sector in South Africa, highlights the future skills and job creation potential through the development of renewable energy in South Africa. The report points to the following key statistics, as illustrated in Figure 15:

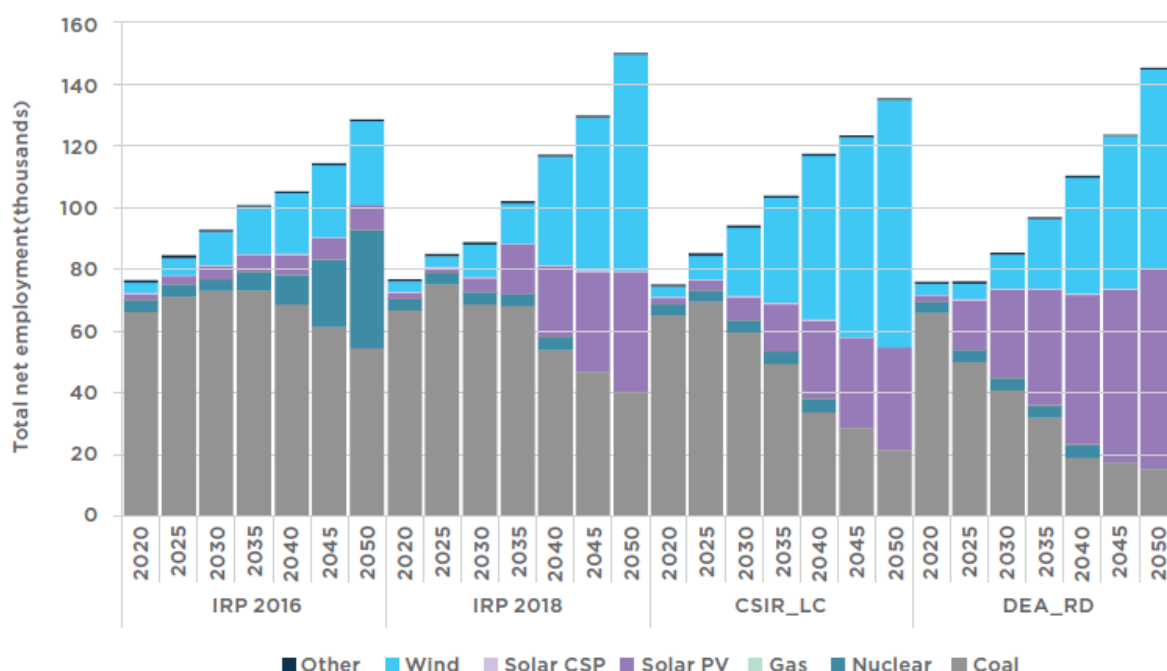
- By 2050, more than 150,000 new jobs (+17%) will have been created in the power sector in net terms (i.e., including job losses in the coal sector), by the shift from IRP 2016<sup>23</sup> to IRP 2018<sup>24</sup>.
- Up to 1.6 million additional jobs can be created economy-wide through the power sector transformation by 2050.
- Across all scenarios, around 70% of new power-sector jobs associated with renewable energy are categorised as highly skilled.
- Jobs in the coal sector will decline by 35 – 40% between 2020 and 2050, with expected reductions in global demand and exports being the main driver behind this transformation.

<sup>22</sup> Okunlola, A. Jacobs, D. Ntuli, N. Fourie, R. Borbonus, S. Nagel, L. and Helgenberger, S, 'Future skills and job creation through renewable energy in South Africa'. URL: <https://www.cobenefits.info/resources/cobenefits-south-africa-jobs-skills/>, site accessed 01 August 2019..

<sup>23</sup> Department of Energy, 'Integrated Resource Plan: Update assumptions, base case results and observations Revision 1'. URL: <http://www.energy.gov.za/IRP/2016/Draft-IRP-2016-Assumptions-Base-Case-and-Observations-Revision1.pdf>, site accessed 15 September 2019.

<sup>24</sup> Department of Energy, 'Integrated Resource Plan Update: Assumptions, base case results and observations'. URL: <http://www.energy.gov.za/IRP/irp-update-draft-report2018/IRP-Update-2018-Draft-for-Comments.pdf>, site accessed 17 September 2019.

Figure 4: Evolution of net employment in the power sector by the different technologies (2020-2050)



Source: Co-benefits Study, 2019

Also, the report finds that “South Africa can significantly boost employment by increasing the share of renewables”. If the government decides to increase RE in the energy mix, employment in the energy sector can be expected to grow by 40% from 2018 to 2030, as seen in Figure 15, which equates to 580,000 jobs years. In contrast, the president said in the SONA that the private sector has committed to creating 155,000 new jobs in total over the next five years. This is just to show the potential for job creation in the RE sector. The CSIR’s recommendation to the government is to follow the “least-cost pathway”, which estimates that job numbers could be doubled to more than 1.2 million job-years under their scenario.

An often misunderstood perspective is that RE power generation jobs are only concentrated in the services, construction and manufacturing sectors, but they actually permeate almost all industries. This includes the mining sector: even though there are expected losses in coal mining, there will be a net increase in employment due to more jobs in the energy sector and associated development minerals as used for battery manufacturing. The co-benefit of the RE industry is that it has an economy-wide effect and by shifting from IRP 2016 to IRP 2018, an additional 1.3 million jobs could be created by 2050. The rapid decarbonisation pathway of the Department of Environmental Affairs (DEA) will have a similar impact on jobs, with the CSIR’s least-cost pathway estimating an additional 300,000 economy-wide jobs.

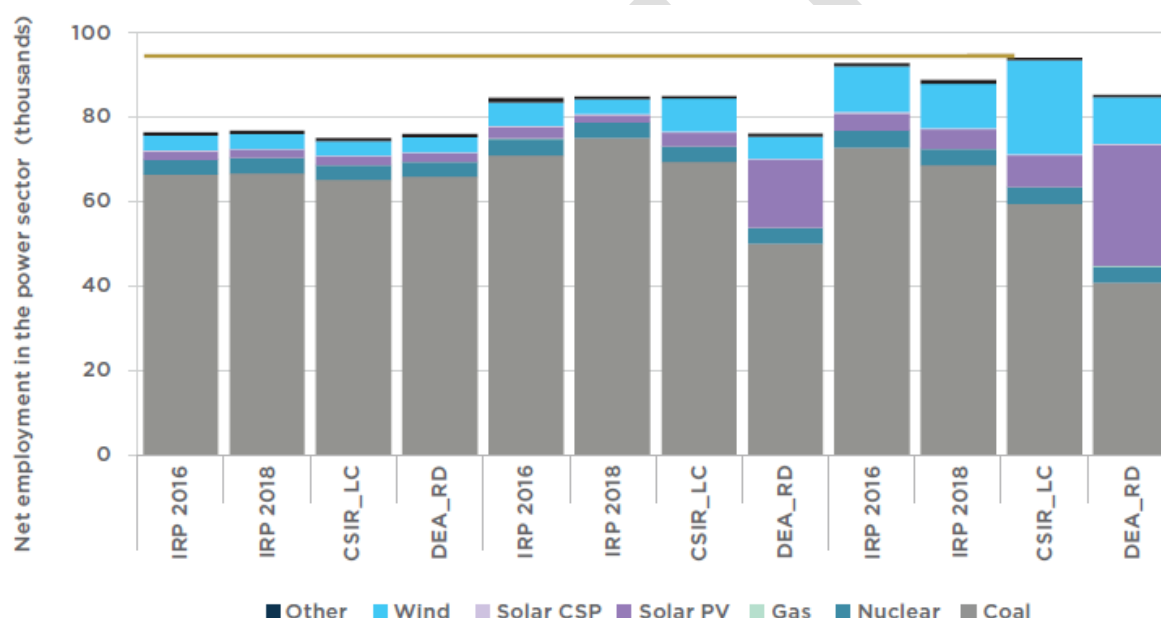
In the combined scenarios of the CSIR Least Cost Scenario (CSIR\_LC) and DEA Rapid Decarbonisation Scenario (DEA\_RD)<sup>25</sup> aggregated net employment in the electricity sector,

<sup>25</sup> Four scenarios for the future development of the electricity sector in South Africa were analysed: Council for Scientific and Industrial Research Least Cost planning scenario (CSIR\_LC); Department of Environmental Affairs Rapid Decarbonisation scenario (DEA\_RD); Integrated Resource Plan 2016 (IRP 2016); and Integrated Resource Plan Policy Adjusted scenario 2018 (IRP 2018).

solar PV and wind together account for more than 80% of total net employment in the electricity sectors.

Figure 16 illustrates the transition from IRP 2016 to IRP 2018 point to a further 17% rise in new jobs in the power sector by 2050. This means an additional 150,000 (net) new jobs under the scenarios. In all the scenarios, higher shares of renewables lead to an increase in net employment figures. Also, if the government adopts the CSIR's least-cost pathway, it could enable the highest number of additional jobs in the energy sector by 2030, accounting for 94,000 new jobs (net). In contrast, to the IRP 2018 scenario, the CSIR's scenario has an added benefit of the highest number of economy-wide additional jobs at 300,000. According to the report "the CSIR's least-cost pathway performs best in terms of economy-wide jobs at both the 2030 and 2050 horizons".

Figure 5: Net employment in the power sector by the different technologies by the year 2030



Source: Co-benefits Study, 2019

The most substantial volume of jobs in the RE industry falls within the high-skilled labour bracket and will require workers that have the educational background of Grade 12 and above, but there is also space for other skill groupings. The overarching scenario paints a picture of the creation of around 70% new high-skilled (> Grade 12) jobs in the RE sector. The largest increases in the job creation scenarios are seen to rise to 76 % in 2050 under the DEA's rapid decarbonisation pathway and CSIR's least-cost pathway.

The report also describes the potential of the REIPPPP to contribute to significant localised job creation through renewable energy deployment in South Africa. However, the enablement or constraint of the growth of the REIPPPP is linked to whether the government is willing to make continuous and long-term commitments to the deployment of renewable energy.

A significant factor often overlooked is the localisation benefit requirements of the REIPPPP that has resulted in the growth of manufacturing of essential RE technologies and associated

components. For instance, the World Economic Forum estimates that the global battery market would be worth around US\$100 billion by 2025, which highlights the potential across the battery supply chain for job creation.

At the regional level, the SADC Industrialisation Strategy and Roadmap calls for increased use of renewable energy sources and to aim for a still very low target of 10% of rural communities having access to renewable energy sources. The SAPP target of 35% renewable energy contribution by 2030 is similar to South Africa's target and reflects the country's important role in the setting and reaching of this target.<sup>26</sup> In the clearest indication yet of a shift in commitment to a just energy transition towards renewables President Ramaphosa said the following at the United Nations Climate Summit in 2019:<sup>27</sup>

To ensure equity in the energy transition, we call upon you to champion initiatives that ensure not only that investment in renewable energy technologies is fast-tracked in developing countries, but that a large share of the value chain is located in these countries to support national development objectives. Africa is endowed with mineral resources critical to the production of renewable energy technologies. Therefore, consideration should be given to the establishment of a global regime for investment in relevant patent pools – technology buy-outs for the global common good.

The drive to introduce renewable and off-grid energy solutions in Southern Africa is motivated by the need to offer access to energy for millions of households that still rely on biomass for heating and cooking. Reliable energy to rural communities to power clinics, schools and industrial jobs are critical for the region's development.

As the leading economy in SADC and also its largest emitter, the South African government is setting the pace regarding the adoption of policies<sup>28</sup> towards a green economy. From a national perspective, South Africa's current position is that the introduction of EVs goes hand in hand with the roll-out of renewable energy. The DTIC believes that the benefit of zero-emission EVs cannot be erased by charging them with electricity produced by coal, and therefore clean energy justifies the purchasing of zero-emission EVs (ZEVs). In a recent report to NAAMSA and the DTIC,<sup>29</sup> there are indication that government and industry are taking the necessary steps to adopt policies that kick-start the production of EVs in SA, while also growing the market share of EVs locally. For example, policy suggestion that NAAMSA<sup>30</sup> is taking to government are:

- to reconsider reducing import duties in order to stimulate demand, with import duties to be zero per cent for a three-year period in order to kick-start demand;

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<sup>26</sup> SADC Energy Monitor, *Baseline study of the SADC energy sector*.

<sup>27</sup> Presidency of the Republic of South Africa, 'Statement by H.E. President Cyril Ramaphosa of South Africa to the United Nations Secretary-General's Climate Summit'. URL: <http://www.dirco.gov.za/docs/speeches/2019/cram0923.htm>, site accessed 18 October 2019.

<sup>28</sup> This report does not evaluate policy implications for the development of renewable energy specifically to feed the increasing use of EVs in South Africa.

<sup>29</sup> Montmasson-Clair, Gaylor; Dane, Anthony; Moshikaro, Lesego, 'Harnessing electric vehicles for industrial development in South Africa: Report by TIPS and Change Pathways for the DTIC and NAAMSA'. URL: <https://tips.org.za/research-archive/sustainable-growth/green-economy/item/3876-harnessing-electric-vehicles-for-industrial-development-in-south-africa>, site accessed 30 September 2020.

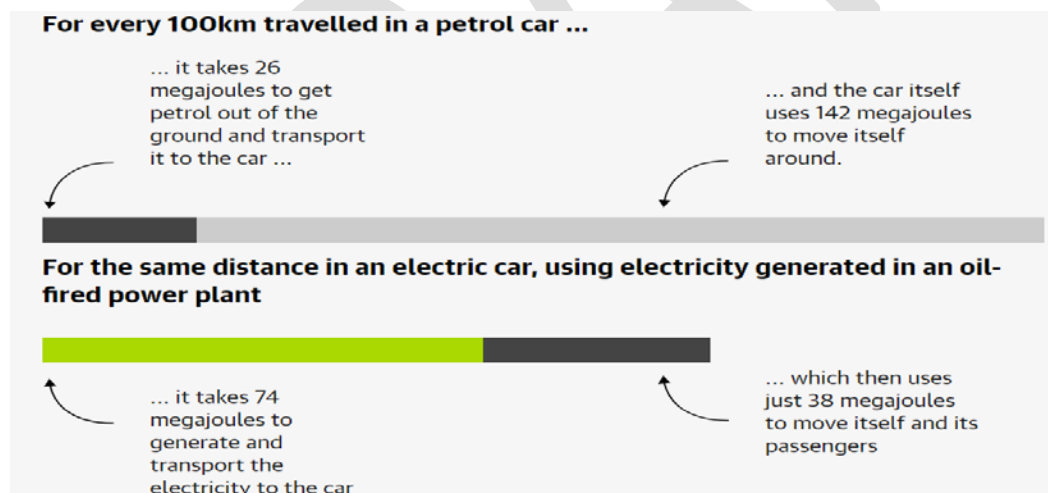
<sup>30</sup> Venter, Irma, 'Auto industry's EV roadmap aims to accelerate sales and production'. URL: <https://www.engineeringnews.co.za/article/auto-industrys-ev-roadmap-aims-to-accelerate-sales-and-production-2020-10-09>, site accessed 09 October 2020.

- the battery cost to be excluded from the ad valorem tax charged on motor vehicles, ie, if a car costs R250 000, and the battery is R50 000 of that, say, then government should only charge ad valorem on the R200 000;
- they will not request a VAT reduction, as we understand that government is currently under pressure owing to the Covid-19 crisis.

Although ZEVs are the end goal, it does not mean that the transition to EVs can only begin when RE can be supplied at source manufacturing and generation level. This might be preferable, but reduced air, noise and water pollution would significantly benefit the general public, as well as underscore South Africa's commitment to lowering its carbon footprint in line with its commitments to the Paris agreement. In fact, multiple studies have found that EVs are more efficient, and hence emit less greenhouse gas (GHG) and other emissions than cars powered solely by internal combustion engines.

As demonstrated in figure 17, an EU study based on expected performance in 2020 found that an electric car using electricity generated solely by an oil-fired power station would use only two-thirds of the energy of a petrol car travelling the same distance.<sup>31</sup>

Figure 6: EVs using electricity in coal-powered plants



Source: The Guardian<sup>32</sup>

Since South Africa's energy supply will for the foreseeable future be coal-based, sceptics<sup>33</sup> argue that EVs will not dramatically reduce GHG emissions or assist in achieving the Paris Agreement or SDGs. However, the Global EV Outlook 2019<sup>34</sup> published by the International Energy Agency (IEA) argues that EVs progressively lessen GHG emissions if the electricity mix is not carbon-intensive.

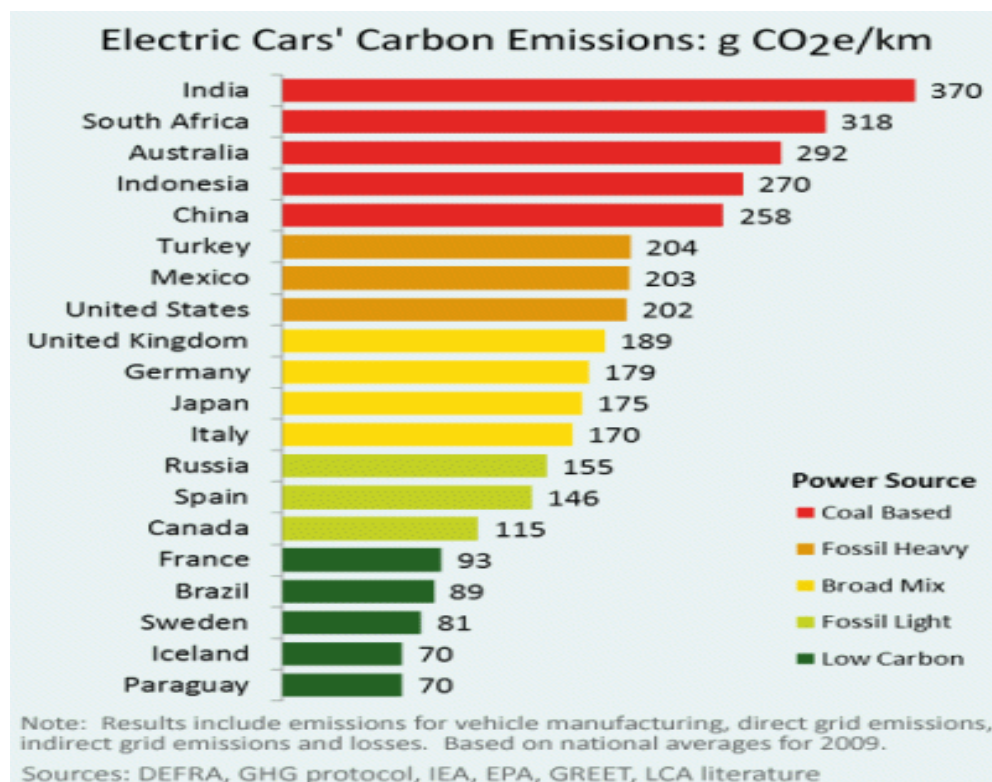
<sup>31</sup> Clarke, Seán, 'How green are electric cars?'. URL: <https://www.theguardian.com/football/ng-interactive/2017/dec/25/how-green-are-electric-cars>, site accessed 18 September 2019.

<sup>32</sup> [Ibid.](#)

<sup>33</sup> Matousek, Mark, 'Electric cars may be the future, but they're still critically flawed in a key area'. URL: <https://www.businessinsider.com/building-electric-cars-how-much-pollution-versus-gas-powered-vehicles-2019-11?IR=T>, site accessed 17 November 2019.

<sup>34</sup> International Energy Agency, 'Global EV Outlook 2019: Scaling up the transition to electric mobility'. URL: <https://www.iea.org/publications/reports/globalevoutlook2019/>, site accessed 10 September 2019.

Figure 7: Electric Cars' Carbon Emissions: gCO<sub>2</sub>e/km



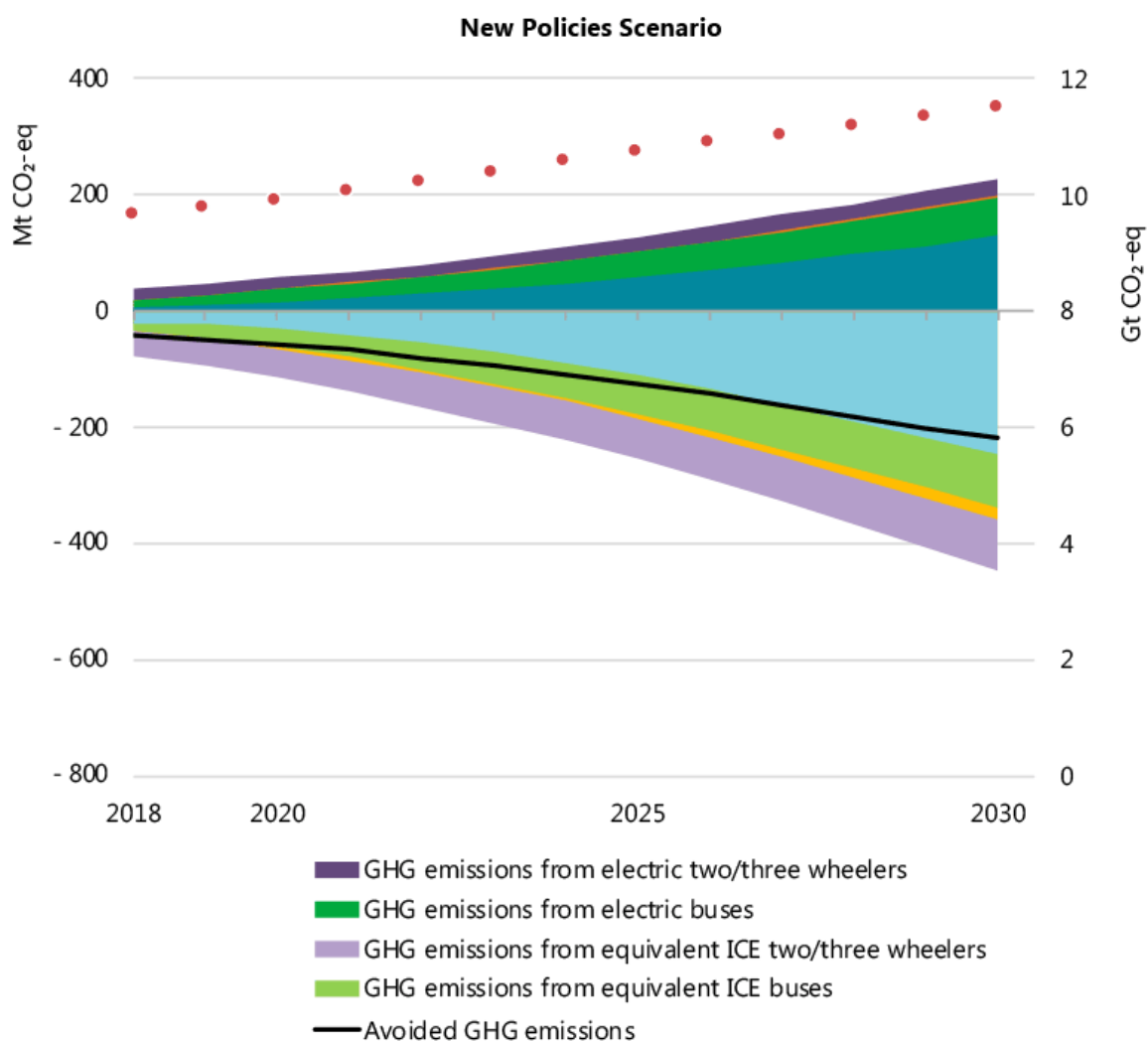
Source: Shrinkfootprint Blog<sup>35</sup>

Calculating the well-to-wheel (WTW) GHG emissions of an EV fleet shows that WTW emissions from a global average EV are lower when compared to the global average ICE vehicle powered by fossil fuels. Figure 19<sup>36</sup> points to the New Policies Scenario, where GHG emissions by the generation of energy for an EV fleet are projected at roughly 230 Mt CO<sub>2</sub>-eq in 2030, but it would nearly double (450 Mt CO<sub>2</sub>-eq in 2030) in the case of an ICE powertrain vehicle fleet.

<sup>35</sup> Shrink that Footprint, 'Shades of Green: Electric Cars' Carbon Emissions Around the Globe'. URL: <http://shrinkthatfootprint.com/electric-car-emissions>, site accessed 18 October 2019..

<sup>36</sup> Notes: Mt CO<sub>2</sub>-eq = million tonnes of carbon-dioxide equivalent; Gt CO<sub>2</sub>-eq = gigatonnes of carbon-dioxide equivalent. Positive values are net emissions from the global EV fleet. Negative values are avoided emissions due to the global EV fleet, calculated as the difference between the emissions from an equivalent ICE fleet and the EV fleet. The WTW GHG emissions from the EV stock are determined in each country/region modelled as electricity consumption from the EVs times the carbon intensity of the power system from the IEA World Energy Outlook for the New Policies Scenario and its Sustainable Development Scenario for the EV30@30 Scenario. The WTW GHG emissions for the equivalent ICE fleet are those that would have been emitted if the EV fleet was instead powered by ICE vehicles with diesel and gasoline shares and fuel economies representative of each country/region in each year.

Figure 8: EV GHG Emissions - New Policies Scenario

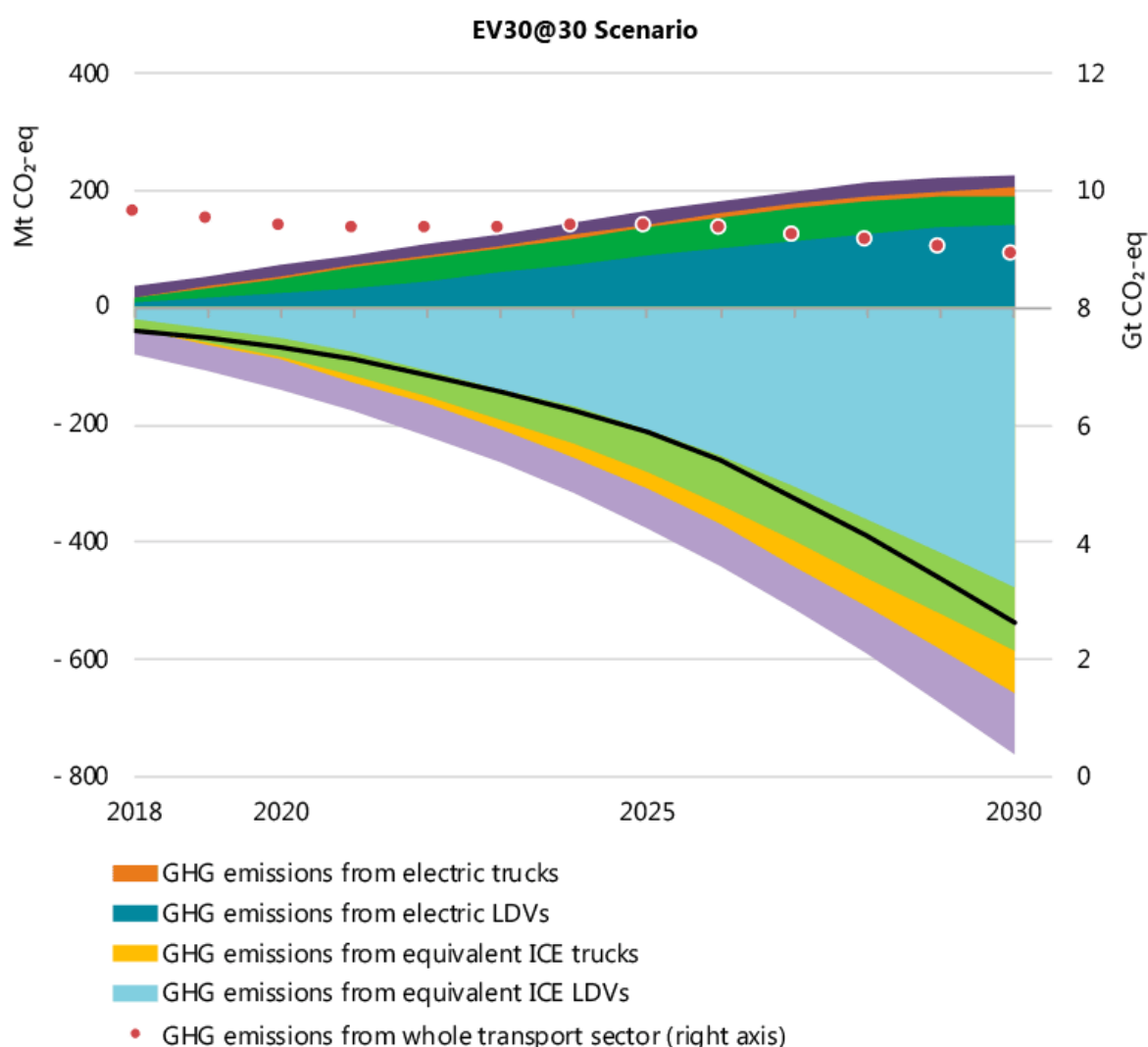


Source: IEA analysis developed with the IEA Mobility Model; carbon intensities from the IEA World Energy Outlook 2018.

However, does the adoption of EVs even with a carbon-intensive energy mix allow for a gradual transition to lower emissions? An even better scenario emerges when adopting the IEA's Sustainable Development Scenario, or the EV30@30 Scenario (Figure 20), where there is an adoption of accelerated deployment of EVs coupled with a trajectory for decarbonisation of power generation. In this scenario, the increase in EV uptake stabilises the emissions at 230 Mt CO<sub>2</sub>-eq in 2030, where there is a sharp rise in what an equivalent ICE vehicle fleet would emit at about 770 Mt CO<sub>2</sub>-eq in 2030.



Figure 9: EV GHG Emissions - EV30@30 Scenario



Source: IEA analysis developed with the IEA Mobility Model; carbon intensities from the IEA World Energy Outlook 2018.

As the growth in sales of EVs rise, it is as vital to rapidly decarbonise power generation, according to the envisioned EV30@30 Scenario, because it limits the increase of GHG emissions at the same time. In these comparisons, EVs reduce WTW GHG emissions by half from an equivalent ICE fleet in 2030, offsetting 220 Mt CO<sub>2</sub>-eq in the New Policies Scenario and 540 Mt CO<sub>2</sub>-eq in the EV30@30 Scenario.

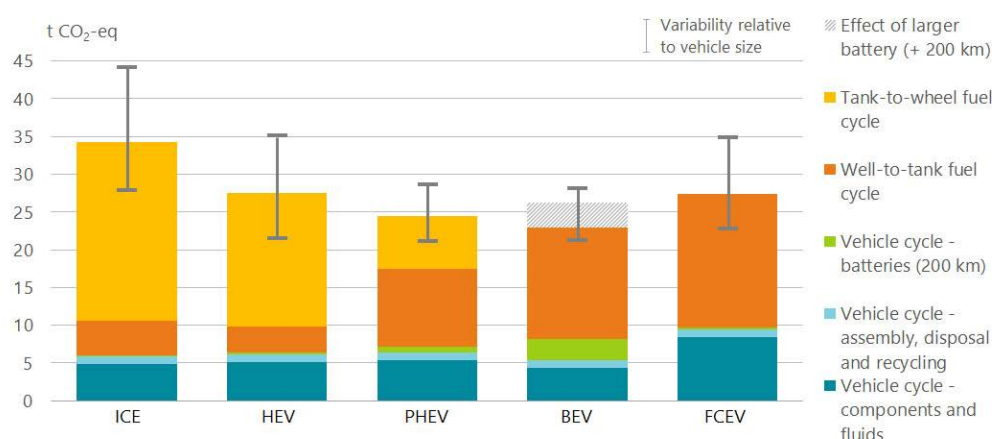
The comparisons of the IEA scenarios above highlight the need to not only increase the net benefits of EVs to reduce GHG emissions but to also focus on minimising emissions throughout the entire value chain, i.e. the complete life cycle of EVs compared with other options. These include the development of new mining and energy plants or battery and automotive manufacturing facilities.

It, therefore, stands to reason that the most significant potential reduction in GHG emissions over the vehicle lifecycle of EVs is the decarbonisation of power generation systems. If South Africa does not adopt the appropriate carbon intensity generation mix, we will not be able to



fully benefit from the contribution of EVs to lower GHG emissions, unless charging infrastructure is predominantly supplied by renewable energy sources. However, if South and southern Africa decide to decarbonise their electricity generation mix rapidly, we will have a significant advantage in attracting EV investment benefits for BEVs and PHEVs over other powertrain technologies. Because the SADC region predominantly relies on coal for electricity production, transitioning towards a lower carbon generation mix is essential to deliver GHG savings from the electrification of road transport. The fact that the fuel cycle is the largest component of lifecycle GHG emissions (Figure 21) of all powertrains underlines the argument for EVs, FCEVs and HEVs.

Figure 10: Comparative lifecycle GHG emissions of a mid-size global average car by powertrain



Source: International Energy Agency, Global EV Outlook 2019.

Looking at the South African policy environment, the DTIC acknowledges that the current market share of EVs in South Africa is minimal (approximately 876 vehicles); nonetheless, the potential exponential growth in the market would contribute meaningfully towards accomplishing GHG reduction targets.<sup>37</sup> This is the case despite the fact that the energy grid is largely driven by fossil fuels. The current pressure on the grid means that EVs that are charged via renewable solar sources may in the future have an important role in providing back-up power to households and the grid.

In conclusion, EVs fall within the good for jobs and growth category and side-step the short-termism of the heavy industrial complex, associated with the oil and gas industries, which is a business-as-usual perspective. Introducing EVs powers South Africa and the SADC region members into an alternative and sustainable transition with bold, hopeful and preferable futures. The e-mobility revolution promises labour-intensive manufacturing with mid-skill service sectors, an increase in a variety of exports and significant process outsourcing among SADC members. The EV landscape thus provides the opportunity to co-create a unique southern African 'Green New Deal' that could lead to a flourishing regionally integrated community.

<sup>37</sup> Department of Transport, 'Green Transport Strategy for South Africa: (2018-2050),' (2018).

In the next section, the report considers how the catalytic potential of EVs could be leveraged to create deep systemic innovation in Southern Africa.

## 2. Co-creating Systemic Innovations in the Energy Sector

The world's largest EV manufacturer, BYD,<sup>38</sup> claims that "the world is on the cusp of a permanent shift to electric mobility".<sup>39</sup> Although many experts are sceptical of the imminent demise of ICE vehicles, the question is whether South and Southern Africa will be left behind by the rest of the world, or whether they will embrace the impending electric mobility revolution. Will SADC muster the courage to reinvent the whole industrial regional value chain fed by its oil and coal dependency to create conditions for enabling a just e-mobility transition? Can SADC develop a home-grown, unique version of a regional 'Green New Deal' that re-imagines the impending climate crisis and that uses the critical challenges embedded in the EV debate as leverage points to enable systemic change and innovation?

Irrespective of which policy position the government and private sector decide to take, the global landscape will be affected by the e-mobility revolution. In this context, it is crucial to recognise the large-scale movement and evolution of the digital into the physical.<sup>40</sup> Apart from spurring mobility through electrical means, foresight practitioners also foresee the integration and merger of the digital and the physical world, i.e. an even more integrated future.<sup>41</sup> This revolution means a movement away from mere physical products to digitally integrated services in the physical world.

By being proactive SADC countries can avoid the inevitability of the business as usual scenario, of becoming a dumping ground for old ICE technology, and/or the owners of non/low-value resources like coal which might become redundant<sup>42</sup> or prohibited<sup>43</sup> in South Africa and the global market in the future.

A recent analysis of EV adoption<sup>44</sup> and transitions shows that it is essential that critical decision-makers, policymakers and stakeholders to identify those leverage points that would

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<sup>38</sup> BYD is an EV manufacturer based in China and listed on the Hong Kong and Shenzhen Stock Exchanges. See <http://www.byd.com/en/CompanyIntro.html>

<sup>39</sup> Campbell, M; Ying, T., 'The World's Biggest Electric Vehicle Company Looks Nothing Like Tesla'. URL: <https://www.bloomberg.com/news/features/2019-04-16/the-world-s-biggest-electric-vehicle-company-looks-nothing-like-tesla>, site accessed 21 August 2019.

<sup>40</sup> Please see Appendix A for the grid that points to the shift from the physical services orientated to the digitalisation of the physical, and the evolution of the digital/physical environment.

<sup>41</sup> Small, Justin, 'The Future is Integrated'. URL: <https://medium.com/@JustinKSmall/the-future-is-integrated-93ac46c70bb3>, site accessed 21 October 2019.

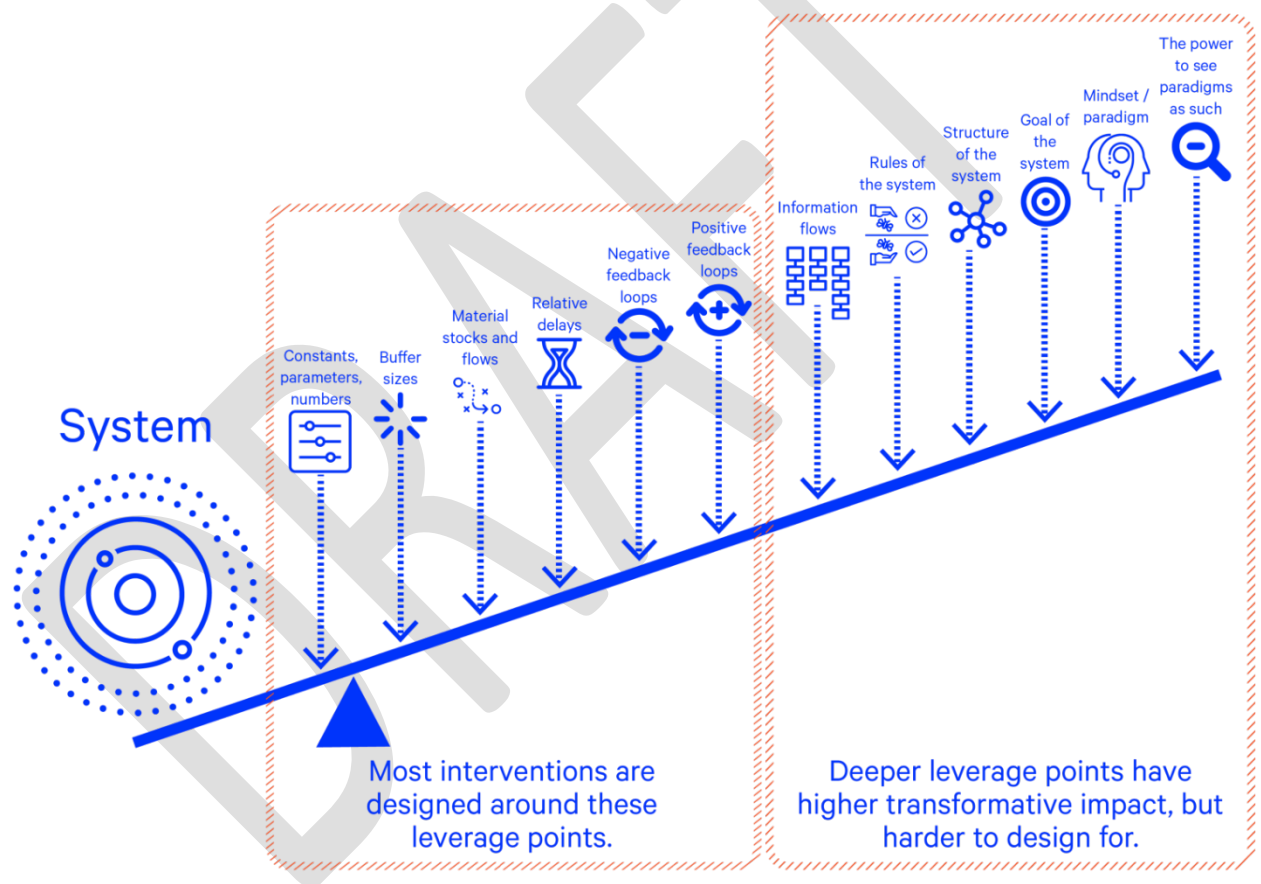
<sup>42</sup> Carrington, Damian, 'Global 'collapse' in number of new coal-fired power plants'. URL: <https://www.theguardian.com/environment/2019/mar/28/global-collapse-in-number-of-new-coal-fired-power-plants>, site accessed 21 October 2019.

<sup>43</sup> The 'Deadly Air' case pointing to thousands of deaths and tens of thousands chronic illnesses between NGOs and government currently in battle in the Pretoria High Court might become a landmark case against the government and the president due to the high levels of air pollution that is linked to the open-cast coal mines and coal-fired power stations in the Highveld.

<sup>44</sup> McDonald, L., 'EV Adoption 15 Shifts: How The Transition to Electric Vehicles Will Transform Industries, Jobs and the Environment'. URL: <https://evadoption.com/15-shifts-how-the-transition-to-electric-vehicles-will-transform-industries-jobs-and-the-environment/>, site accessed 21 October 2019.

ensure the achievement of preferable futures for the impending e-mobility revolution in South Africa and SADC. Leverage points are the: “places within a complex system [...] where a small shift in one thing can produce big changes in everything.”<sup>45</sup> What will it take to transition from a business-as-usual mindset to alternative, co-created preferable futures? When developing complexity-informed policies, it is critical to know where to intervene as systems grow, adapt or change. According to the systems change specialist, Donella Meadows, there are twelve strategic places to intervene in complex social, political, economic and environmental systems.<sup>46</sup> See Appendix E for a more detailed explanation of the Meadows’ model.

Figure 11: Places to intervene in a system



Adapted from Meadows (1977): Leverage Points: Places to Intervene in a System

Source: Corina Angheloiu<sup>47</sup>

The effectiveness of the interventions can be viewed on a scale from weak to strong. Strong interventions have the potential to create broad, durable improvements and therefore increase the resilience and sustainability of the entire ecosystem. Weaker interventions are helpful but do not necessarily create systemic change in a way that radically re-imagines and transforms the underlying structure, power dynamics and paradigms of the entire ecosystem.

<sup>45</sup> Donella Meadows, 'Leverage Points: Places to Intervene in a System,' (1999)..

<sup>46</sup> Meadows, 'Leverage Points: Places to Intervene in a System'.

<sup>47</sup> Angheloiu, Corina, 'IPCC: a site for innovation in its own right?'. URL: <https://medium.com/the-shape-of-things-to-come/ipcc-a-site-for-innovation-in-its-own-right-4a321e5b6d22>, site accessed 21 October 2019.

Weak interventions normally consider the individual capacity of actors and use predictive measures as a way to arrive at an envisioned system. However, leveraging systemic change comes to life when system change agents start changing the information flows, rules and structure of systems, by transforming the way leadership and power are conceived and acted upon. As soon as the information flows, rules, structure and goals of the systems are critically transformed, change actors are able to engage with more profound leverage points that have a higher transformative impact. Systemic innovation in the context of EVs thus means that all possible leverage points should be critically explored from a systems innovation thinking mindset to co-create strong interventions with high transformative impact that enables resilient and sustainable systemic change. In assessing the appropriateness of interventions, it is important to consider the challenges inherent in system innovation relative to other traditional approaches. These are juxtaposed with the traditional policy rationales for intervention in the case of market or structural systems failures. See Table 6 below:

*Table 2: Different kinds of Failures and Policy Rationales in different analytical approaches: Neo-classical, Innovation systems and System Innovation*

<b>Market Failures (Neo-Classical)</b>	<b>Structural System Failure (Innovation Systems)</b>	<b>Transformation System Failures (System Innovation)</b>
Too little investment in R&D, because of the public good character of knowledge (and leakage) and uncertainty about outcomes (which hinders cost-benefit calculation).	Infrastructural failure: Limited investment in physical infrastructure because of risks (large-scale investments and long-time horizons) and low return on investment.	Directionality failure: Transformation process will be hindered by: 1) lack of a shared vision regarding goal and direction, 2) inability of collective coordination of distributed agents involved in shaping systemic change.
Negative externalities: private actors do not take negative consequences into account if they can externalise costs.	Institutional failures: Problems in formal institutions (laws, property rights, regulations) creates uncertainty that hinders investment and innovation, Informal institutions (norms, values, attitudes, trust, risk-taking) may also hinder innovation.	Demand articulation failure: The exploration of new user patterns and opening up of new markets will be hindered by: 1) insufficient spaces and opportunities to learn about user needs, 2) absence of orientating signals from public demand (eg public procurement), 3) lack of demand-articulation capabilities.
Over-exploitation of commons, leading to over-use of public resources in the absence of regulations.	Interaction or network failure: Very strong cooperation may lead to lock-in and inward-looking behaviour. Too limited interaction hinders knowledge exchange and interactive learning.	Policy coordination failure: transformation will be hindered by; 1) lack of multi-level policy coordination (national, regional, global), 2) lack of horizontal coordination between innovation policies and sectoral policies (e.g. transport, energy, agriculture), 3) lack of vertical coordination (between Ministries and implementation agencies)
	Capabilities failure: Lack of appropriate competencies	Reflexivity failure: transformation will be hindered

	prevents access to new knowledge and inability to adapt and compete.	by a lack of monitoring, learning, open debate, adjustment and reflection about direction and speed.
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Source: OECD Adapted from Weber and Rohrer, 2012.<sup>48</sup>

The challenges inherent to system innovation frame the context in which system innovation policy interventions are undertaken. It is important to recognise that system innovation is difficult to direct and manage because it is an uncertain, open and complex process where the state, and government more specifically, is neither all-powerful nor all-knowing. The process itself involves multiple groups of which government is but one and entails a co-creation or co-evolution among a variety of system elements. It is dependent on firms and businesses (for knowledge, innovation, taxes, jobs and resources) and on wider civil society support (for legitimacy and consent).<sup>49</sup> Nonetheless, providing systems-wide steerage and direction is critical and as noted by the OECD, the likelihood of successful system innovation 'increases when the policymakers at the top of decision-making hierarchies (in government, firms as well as intellectual and opinion leaders in civil society) adopt it *first*.'<sup>50</sup> In government this highlights the importance of central coordinators (like the President's office and other key planning offices in government such as Treasury), but it also flags the importance of vertical coordination between government departments, and at various levels, i.e., international, national, sub-national and local. There is an arsenal of policy instruments to support system innovation. Table 7 defines some of these while it is not exhaustive.

Table 3: Possible Policy Instruments for System Innovation

Type	Description
Transfer of Authority and Organisational Redesign	The transfer of authority for decision-making to other parts of government or outside government has significant potential to affect the efficiency and effectiveness of policy. It creates opportunities to enhance innovation without necessarily increasing the burden on the state and varies from total ownership to arm's length coordination or advice on a voluntary basis. (Examples of these include, establishment of new organisations, mergers or transfer of ownership (privatisation)). It is a powerful tool to break down concentration of systemic power, to locate responsibility and improve accountability and to provide checks and balances.
Policy Intelligence	These range from mapping interdependencies, gathering detailed case studies and reliable statistics, using strategic foresight to detect impulses for change and identify vulnerabilities, sharing information and experiences internationally, supporting policy learning, and ongoing monitoring and evaluation to improve impact. All of these require significant resource allocations by policy-makers.

<sup>48</sup> Matthias K Weber, Harald Rohrer, 'Legitimizing research, technology and innovation policies for transformative change: Combining insights from innovation systems and multi-level perspective in a comprehensive 'failures' framework,' in *Research Policy*, vol. 41, no. 6 (2012): 1037–47.

<sup>49</sup> OECD, 'Draft Synthesis Report on System Innovation, Working Party on Innovation and Technology Policy, Directorate for Science, Technology and Innovation, Committee for Scientific and Technological Policy, DSTI/STP/TIP'. URL: [https://one.oecd.org/document/DSTI/STP/TIP\(2014\)12/en/pdf](https://one.oecd.org/document/DSTI/STP/TIP(2014)12/en/pdf), site accessed 28 November 2019.

<sup>50</sup> Ibid. p. 45.

Socio-economic Visions and Strategies	The use of visions to provide a long-term framework has many uses. On the one hand it serves to coordinate action, but also to help identify barriers to progress (for example regulations or outdated technologies). On the other hand, the purpose of a vision may not only be to direct the allocation of resources, but also to enable an environment to test various policy paths. Finally, an ambitious and well-articulated and differentiated forward-looking future vision whose objectives are also adaptive and framed within co-decisionmaking approaches such as through public-private partnerships, creates the scope to move beyond current paradigms and current leaders. This avoids the trap of constantly being in catch-up mode or stuck in a political dead-end.
Funding for R&D and Innovation	This requires carefully directing funding during the transition to both reduce uncertainty and to assist in crucial decision-making processes. Apart from conventional R&D funding, it is also important to dedicate resources towards understanding the social drivers and social implications (such as job-creation/losses) of system innovation interventions.
Funding for Infrastructure	Public-private partnership is critical here and at least in two areas during the early transition phase is it important to consider the implications of infrastructure decisions. First, delineating the role of government and consulting widely and deeply to ensure that investment decisions have the largest multiplier effect is critical. It goes without saying that apart from consulting with experts, the business sector has a critical and central role. Second, the timing of interventions is critical given that early interventions might accelerate a transition, but also run the risk of locking in a particular trajectory. Hence interventions that keep alternative options open are more preferable than those that very early channel decision-making towards a narrow trajectory. There is a risk here, as certainty is a key dimension of locking in private sector support, but attention should here be given to the overall design and learning from international experience. Once a dominant design emerges it is easier to crowd in private sector support. Throughout this process it is important to be open to private sector inputs.
Skills Provision	Based on historic international experience there is generally a critical skills shortage at the emergence point of a new technology or industry, requiring special policy actions to ensure that the demand for skills can be met rapidly enough to support the take-off the sector. This is often only possible in the initial phase through imported labour and policymakers have a critical role to ensure that this type of mobility is possible. At the same time it requires significant flexibility and responsiveness of the education system to ensure that it is open to industrial demands and aware and positioned to respond to global industry developments across a variety of sectors. Actively pursuing the internationalisation of education policies to support competitive innovation and learning is essential, as is the ability of the system to deliver short-term, <i>ad hoc</i> interventions to deliver relevant skills or to support on-the-job training.
Public Procurement	Public procurement is an important policy tool to create or emulate 'lead markets'. Lead markets comprise 'early adopters, who tend to be technically proficient and are willing and able to pay price premia.' <sup>51</sup> This requires an exceptional technical competency in government and its procuring agencies to both assess and justify

<sup>51</sup> Ibid. p. 51.

	spending on goals that are not necessarily cost-effective. It is also important to avoid the negative dimensions of demand concentration through monopsony, especially considering its impact on the lack of specialisation and diversity – important dimensions of long-term resilience in any system. This implies a clear time-horizon and exit strategy, but also a very clear understanding of latent demand, including demand for complementary products and services.
Standards, regulation and legislation	Standards are critical to creating new markets, reducing uncertainties and supporting the division of labour.
Legislation, regulation and institutional changes	Legislation is critical to address market and coordination failures that cannot be addressed through the price mechanism or to regulate certain activities. It also has an important role in providing clarity about liability and hence apportioning of risk.
Support for Networks and PPPs	This instrument has the role of ensuring participation by a specialist community especially in the early phases of a transition where the incentive to cooperate, contribute or participate might still be very low. The seeding of such networks until they develop their own dynamic is an important policy contribution.
Public Consultation	The importance of public consultation as a policy tool in system design goes without saying and is an important instrument to receive input on social demands and expectations of policies, to support the legitimacy of the transition and long-term framework, and finally, to create a public space for debate and discussion.
Innovation Programmes	Innovation programmes are important piloting mechanisms or prototypes whose application in smaller parts of the system can be utilised to test the robustness of the system, its legitimacy and efficiency or to establish new areas for innovation and learning. However, in this context it is also important to pay attention to the fact that the long-term success of the system is dependent on social change. Hence an understanding of social technologies (i.e., technologies that are rooted in the behaviour of people) is critical to assessing whether one can truly generalise from pilot studies and whether best practices in system innovation are transferable.

Source: OECD, 2014

In the context of the e-mobility revolution and SADC's road map towards EV adoption, the report next discusses various places to intervene in each of the sectors identified. This approach is chosen because a systems innovation perspective helps identify the possible leverage points<sup>52</sup> in policymaking that could be crucial catalytic interventions on the road towards developing a more sustainable, economically viable and technologically progressive region, while also dealing with the underlying causes of the current climate crisis, biodiversity collapse and pollution, and over-exploitation of resources.

<sup>52</sup> A note of caution, the leverage points are not a recipe to find places to intervene, but rather should be seen as an invitation to think more broadly about the complex unfolding change process and underlying system change interventions.



### 3. Systemic Innovations towards a New Energy Paradigm

#### 3.1 Build Infrastructure that Lowers the Costs of Acting

##### *Automakers Become Energy Companies, Utilities Adopts E-mobility Battery Leasing Models*

When cars run on petrol or diesel, oil company ecosystems that are focused on oil exploration are separate from those in refining/production and distribution. But with electricity and batteries that fuel transport, the battery ecosystem production causes an overlap with a plethora of possible future commercial and residential battery storage systems. The same battery system that powers a car's electric motor may store clean energy, supplement the grid and also power a home or business – which means that almost by default, most automakers will enter the energy storage and vehicle to grid/home/building business.

Crucial policy instruments include fuel economy standards, zero-emissions vehicle mandates and ratcheting up the ambition of public procurement programmes. Government could consider the creation of a zero-emission vehicle (ZEV) mandate and action plan along with the Green Transport Strategy. This would create a reinforcing feedback loop where the green energy transition could open accessibility to low-income markets to purchase affordable and fit-for-purpose vehicles by investment in manufacturing of Low-Speed EVs (LSEVs) under \$3000 or new business models that follow shared use, or subscription models without purchasing. LSEV procurement programmes are essential instruments to kick-start demand for electric cars and stimulate automakers to increase the market availability of EVs to all market segments, and not only to the middle class and the rich. A strategically orchestrated ZEV action plan with accompanying procurement plan could also help to enable an initial roll-out of publicly accessible infrastructure.

With the electric mobility transition Eskom could attract the necessary investment. If framed correctly, with a clear commitment to a much faster RE transition through using the massive network of existing fuel stations along public roads<sup>53</sup> and connecting those to the regional electricity distributors (REDs), investors might revisit the utility's potential. Eskom could also enter the transport industry, by leasing batteries to customers. This will enable Eskom to dictate bulk charging times, stabilise the grid, level the demand curve and become more energy efficient resulting in lower tariffs. This will also lower the EV price by the cost of the battery and get rid of luxury tax. Also, with the invention of solar tiles, panels, geysers and other new RE technologies, Eskom could enable home and business users to become RE generators to enhance the energy mix generation and distribution. This would mean that Eskom starts focusing on electric power transmission wheeling rather than generation, which in turn would enable third-party access and connectivity. These are crucial steps in laying the foundations for an e-mobility revolution in the SADC region.

The fourth industrial revolution can change the role of utilities. Utilities should embrace the digital revolution in the energy industry. A McKinsey & Company report<sup>54</sup> on future digital

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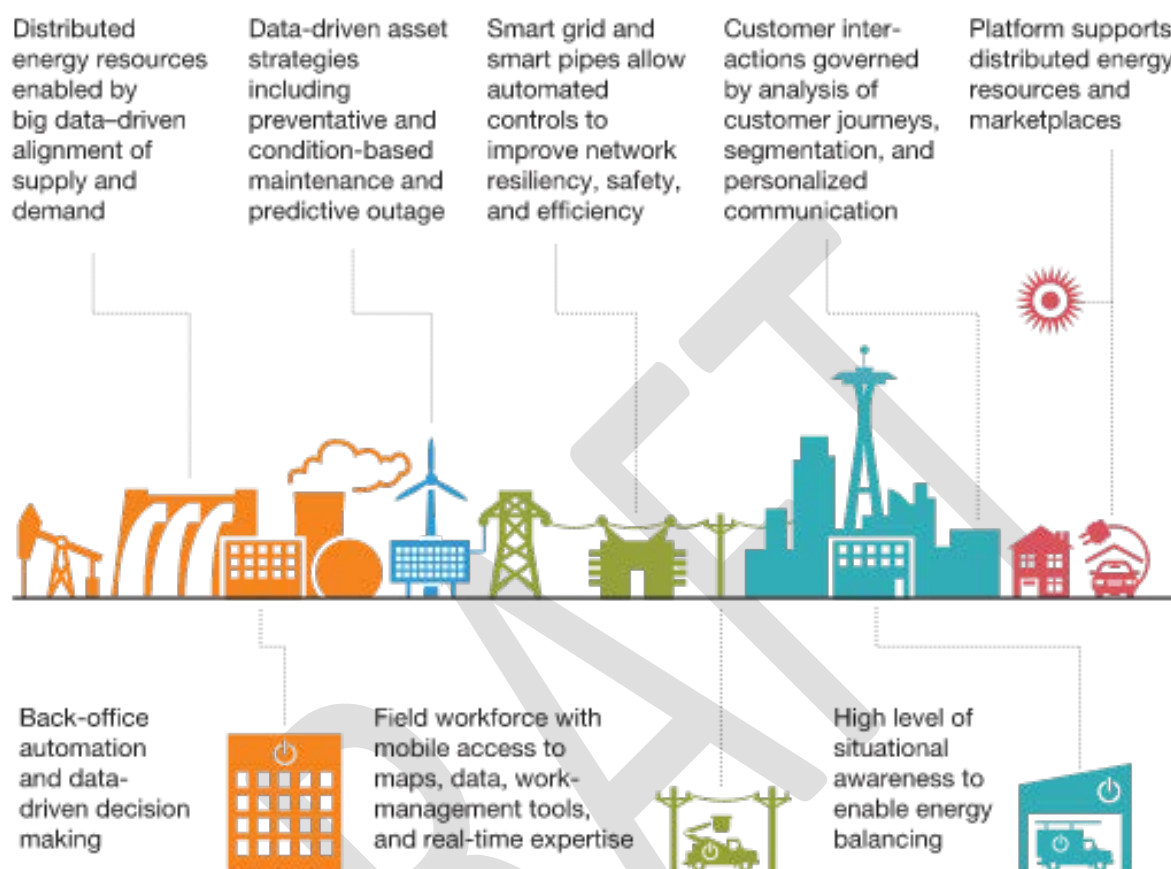
<sup>53</sup> Please see Appendix B that points to the current road networks in comparison to existing transmission grid networks

<sup>54</sup> Booth, Adrian; Mohr, Niko; Peters, Peter, 'The digital utility: New opportunities and challenges'. URL: <https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/the-digital-utility-new-opportunities-and-challenges#>, site accessed 23 October 2019.



utilities outlines how energy providers could benefit from a variety of opportunities along the energy value chain (Figure 27).

Figure 12: The future digital utility value chain



Source: McKinsey&Company, 2016.

A just e-revolution (a just electric-mobility revolution) in the Southern African economy will change the traditional role of utility companies in the supply of energy. Utilities will transform into the “new oil companies” that ensure the exploration of new technologies for electricity generation, infrastructure, distribution and most importantly regulation. At the same time, utilities will have to navigate the rise of automakers that is entering the energy space through EVs, power walls and associated a range of electric vehicle technologies like vehicle-to-home and vehicle-to-grid applications. Automakers will either been seen as partners to utilities or competition depending on the business model direction utilities pursue.

#### *Seeds of the preferable just transition:*

- African Alliance for Energy Productivity<sup>55</sup> which seeks to double energy productivity by 2030 and become a leading energy productivity partner that connects decision-makers, enables policy-making processes and ensures proactive information to tackle climate change and promote environmental sustainability.
- Eskom’s crisis is already becoming its greatest strength by unbundling the SOE into three business units and transforming from a coal-powered generation focused utility

<sup>55</sup> AAEP, 'About Us AAEP'. URL: <http://www.aaep.org.za/about-aaep/#ourstory>, site accessed 23 October 2019.

to an electricity wheeling, coordinator, integrator and SADC regional infrastructure company, e.g., the recent announcement to invest in a massive battery project.<sup>56</sup>

*Suggested Leverage Points for Policy Action:*

The policy suggestion for government include:

- Convene a broad coalition of energy producers to build infrastructure, products and processes that lower the costs of maintaining and generating electricity for EVs, by re-imagining the roles of Eskom and automakers to collaborate as energy innovators, brokers and partners, and not merely product or service suppliers.
- Provide buffers to Eskom to move from a centralised organisation to incorporate decentralised electric power transmission wheeling through third-party investments, public-private-partnerships (PPPs) and collaborations.
- Build “cognitive bandwidth” for unstructured time and funds to increase the use of new smart technology solutions to enable new products and services for partnerships in balancing the grid, integrating new variable and distributed resources, improving operating efficiency, and reducing costs for all customers.
- Educate consumers and government of the benefits of supporting “domestic fuel sources” (rather than imports of fossil fuels) and incentivise EV purchases by investing in public-private-partnerships (PPPs) to grow charging infrastructure and smart load management solutions.
- Engage National Treasury to invest in domestic energy generation (Eskom electricity, especially renewables) by encouraging the public to replace one-million ICE vehicles with BEVs to improve the trade balance by \$1 billion (yearly foreign exchange outflow per ICE vehicle is about \$1 000). Build capacity for Eskom and SADC utility companies to embrace their new role of “energy cross-scale coordinators and integrators” with an “OPEC-like” role to stabilise, secure and monitor regular supply; and improve efficiency and environmental sustainability in the regional energy market. These new services could include developing domestic bi-directional vehicle-to-grid, smart-charging technologies, thereby lowering the cost of electricity and SADC’s dependence on coal-generated power.
- Increase the size of the RE energy mix (currently at 30% by 2025) and speed of achieving the REIPPPP targets by installing RE electricity substations/microgrids (solar) and introduce an incremental transition programme that replaces petrol pumps with e-mobility recharging stations.
- Convene a community of practice to create a zero-emission vehicle (ZEV) mandate.
- Create diverse partnerships to develop and execute an LSEV action plan along with the Green Transport Strategy.
- Create an LSEV watchdog that ensures accountability and equity in the ZEV transition through the collection of data of the decisions made by the dominant actors and make it public.

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<sup>56</sup> Business Tech SA, 'Eskom is working on a massive new battery project – here’s what you need to know'. URL: <https://businesstech.co.za/news/energy/343147/eskom-is-working-on-a-massive-new-battery-project-heres-what-you-need-to-know/>, site accessed 23 October 2019.

### 3.2 Seek Inclusion and Enable Weaker Actors to Influence Decisions

Utilities become the partner of less powerful actors through EV enabled demand-side response (DSR) services

Eskom plays a crucial part in who has access to electricity and allowing those to become paying consumers. A high EV uptake, with uncoordinated charging, can pose a challenge for Eskom if this demand coincides with peak demand periods and pushes the peak demand beyond supply markers in the system. Clustering effects in the increased uptake of EVs can also lead to local overloading of distribution networks, resulting in the need to upgrade the distribution network, but this can be avoided by decentralised generation – roof top PV feed-in to the grid – if made attractive to home owners. This includes the replacement of transformers and reinforcement of lines. All of the above are costly and challenging exercises amid the power utility's current turmoil.

However, controlled EV charging enables access to a range of solutions for Eskom through the provision of demand-side response (DSR) services. The European Network of Transmission System Operators for Electricity (ENTSOE)<sup>57</sup> defines DSR as the load demand that can be actively changed by a trigger. Demand Side Management (DSM) is the utilisation of DSR for a purpose such as system security (i.e. balancing and congestion), or system adequacy. The uptake of DSR should be wide-ranging and intensive if Southern Africa is to achieve decarbonisation in the energy transition. ENTSOE<sup>58</sup> also argues that DSR creates numerous benefits:

- It creates value for consumers and society by allowing consumers to be rewarded for changing their consumption behaviour and therefore reduces the costs of energy.
- It provides flexibility to system operators, helping them to maintain the security of supply and system adequacy. It also optimises the utilisation of infrastructure and investments in the grids.
- It can be a competitive alternative to other power sources, thereby enhancing competition and improving the emission target for electricity markets.

A just e-volution includes EV charging capacities that help utilities build their resilience through partnerships with IPPs. To enable a just energy transition, the Global EV Outlook Report 2019 outlines the following solutions:<sup>59</sup>

- EVs can minimise impacts on the grid by shaping the electricity demand pattern through changes in the timing of charging events to low-demand periods.
- EVs have the potential to provide energy into the power system when needed. The properties of EV batteries allow speedy and precise response to control signals, as well as the ability to shift demand across more extended periods. These capabilities enable EVs to provide DSR services to the system across a wide range of time scales and to participate in electricity markets. This is a significant advantage EVs have compared with other sources of DSR.

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<sup>57</sup> European Network of Transmission System Operators for Electricity, 'Demand Side Response Policy Paper,' (2014).

<sup>58</sup> Ibid.

<sup>59</sup> International Energy Agency, 'Global EV Outlook 2019: Scaling up the transition to electric mobility'.

- EV batteries can store energy that may be used for other purposes than powering the vehicle, thanks to the opportunities offered by vehicle-to-grid (V2G) and similar technologies (V2X, for example, vehicle-to-home). With V2X, EVs can discharge energy to buildings and, more generally, the power grid to maintain system stability. This feature can have significant advantages to address challenges at a local level, avoiding overload of distribution grids, as well as at the main network level.

The Eskom advisory board should look into how the e-mobility revolution can be an opportunity to create the conditions for a re-imagining of the role of the utility. If Eskom refinanced its existing assets it could develop the necessary capacities to become a partner of recharging stations through a third-party organisation like Gridcars<sup>60</sup> and other new e-mobility entrepreneurs. This shift from energy dominator to decentralised partnership building will allow for new opportunities, agility and job creation in the utility. Other options could include the manufacturing of new innovative battery storage and renewable energy supply technologies. A partnership with the likes of the Tesla powerpack systems, or Southern African start-ups that provide large scale distributed battery storage for peak demand management would be ideal. These systemic innovations would minimise load and capacity charges in municipalities to facilitate energy resilience and stability of distribution.

The suggested energy innovations above, show how Eskom can start working with IPPs and build energy system resilience while also progressing with the achievement of the REIPPPP. For instance, one of Tesla's inventions is their renewable microgrids that offer turnkey energy solutions that combine renewable energy and storage to provide communities with clean, resilient and affordable power.

*Seeds of the preferable just transition:*

- CSIR has suggested DSR services<sup>61</sup> as part of Eskom's solutions to its significant energy planning risks. DSR becomes a critical approach to help Eskom delay some of its capacity investment through the likes of EVs that will predominantly charge at night and also deploy slightly more solar PV energy during the day.
- Kaua'i Island Utility Cooperative that dispatches solar energy helps the island meet peak demand daily.<sup>62</sup>
- Connecticut Municipal Electric Energy Cooperative reduced their load and capacity charges with a solar and Powerpack system.<sup>63</sup>
- The island nation of American Samoa replaced their diesel energy with Tesla's renewable microgrid,<sup>64</sup> which demonstrates that RE microgrids are a cost-competitive option for energy supply in remote locations.

<sup>60</sup> GridCars, 'Powering SA's eMobility Revolution'. URL: <https://www.gridcars.net/>, site accessed 22 October 2019.

<sup>61</sup> CSIR Energy Centre, 'Formal comments on Integrated Resource Plan (IRP) 2018,' (2018).

<sup>62</sup> Tesla, 'Tesla KIUC Case Study,' (2017).

<sup>63</sup> Tesla, 'Tesla CMEEC Case Study,' (2016).

<sup>64</sup> Engerati Network, 'The Tesla microgrid – American Samoa shows the way'. URL: <https://www.engerati.com/article/tesla-microgrid-%E2%80%93-american-samoa-shows-way>, site accessed 24 August 2019.

- Eskom launched its pilot solar-powered microgrid<sup>65</sup> at Wilhelmina Farm, Ficksburg, in the Free State. The microgrid demonstration plant, which was completed in November last year, provides electricity to 14 households with 81 family members that make up the Wilhelmina community.

*Suggested Leverage Points for Policy Action:*

- Enable less powerful renewable energy actors to influence decisions on the electricity demand and generation capacity, i.e., build distributed energy resources (DERs). DERs are small-scale units of local generation connected to the grid at distribution level.
- Provide resources to build national policy frameworks for enhancing a target programme to retrofit existing buildings to a high-efficiency standard, promoting measures to inform consumers and fostering social tariffs or energy subsidies for low-income households.
- Build inclusive and open communication networks that agree on the roles and responsibilities between transmission system operators (TSOs) and distribution system operators (DSOs), organising data handling procedures, ensuring the security of supply, configuring market mechanisms, and defining a common SADC energy transmission framework.
- ENTSOE<sup>66</sup> suggests the following policy recommendations to empower a successful transformation of the power system:
  - Set clear roles and responsibilities of relevant parties to facilitate and enable the delivery of DSR and customer engagement. In particular, this requires significant collaboration between TSOs and DSOs.
  - Develop a framework that optimises the use of DSR across multiple parties (e.g. DSR sharing), facilitated through the role of a future data handling body (or bodies). This will ensure TSOs, DSOs, suppliers and other market participants are able to gather the data required to fulfil licence/regulatory/commercial obligations.
  - Seek agreement between SADC countries on the security of supply needs from the networks and the development of network planning and operational standards to reflect a new network paradigm with DSR. This will entail defining and ensuring performance criteria for DSR.
  - Pursue integration of DSR as a market participant on equitable and transparent terms with generation and storage rights. These DER services will require opening all markets to DSR on a non-discriminatory basis and creating generic “DSR friendly” products to allow markets to deliver appropriate price signals and incentives to develop DSR in the system.
  - Adopt a common SADC energy framework for DSR with regional/national settings. These should set clear and consistent ground-rules and roles for all

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<sup>65</sup> Crown Publications, 'Eskom launches ground-breaking microgrid pilot plant'. URL: <https://www.crown.co.za/latest-news/electricity-control-latest-news/8324-eskom-launches-ground-breaking-microgrid-pilot-plant>, site accessed 24 October 2019.

<sup>66</sup> Ibid.

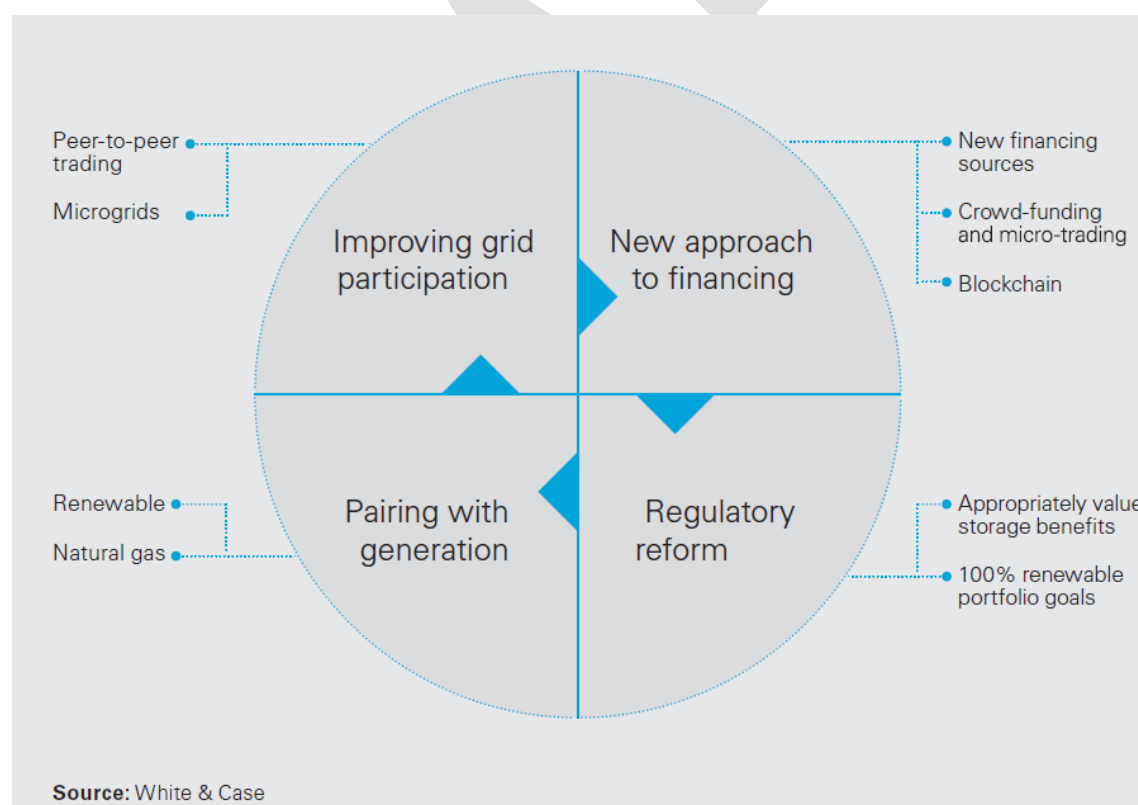
relevant parties to deliver DSR while creating flexibility for pilot projects at a regional or national level.

### 3.3 Create Enabling Constraints, Equalise Access to Information and Data Transparency by adding Feedback Loops

From electricity consumers to prosumers, peer-to-peer traders, and micro-generators

Eskom's energy supply woes have triggered the shift by electricity users to alternative forms of energy. Those with the capital to do so have installed various sources of electricity in their homes or businesses to safeguard against load shedding. The large-scale adoption of 'anything-but-Eskom' electricity in private homes or businesses has contributed to the revenue losses of the utility. A shift has occurred to microgrids and prosumerism (customers who consume goods aimed at the professional market).<sup>67</sup> The delay in the provision of reliable electricity supply to consumers is a systemic leverage point and has become a core growth opportunity for the battery storage industry at the micro-level.

Figure 13: Next steps in Battery Energy Storage



South Africans become more energy-empowered because of the delay in the rate of systems change at the utility creates an opportunity to decentralise the energy grid and to make the entire energy system more resilient. One way of doing this is to facilitate a shift to peer-to-

<sup>67</sup> White & Case LLP, 'Energy storage: Opportunities, key trends and market drivers'. URL: <https://www.whitecase.com/publications/insight/energy-storage-opportunities-key-trends-and-market-drivers?s=tesla>, site accessed 23 October 2019.



peer trading among micro-generators. This approach is already evident in the UK's first blockchain-backed energy trade between housing blocks in London in April 2018.<sup>68</sup> Allowing for this type of trading to take place on an open and transparent ledger may be a significant opportunity for the provision of battery services in exchange for a small flat fee or on a charge-per-use model. This would allow prosumers to connect to microgrids, which in turn might further Eskom's energy goals and address current woes by linking these microgrids with the national system. This would enable a smoothing out of the peaks and troughs in the energy generation-distribution system that could potentially build resilience in the utility's energy crisis and safeguard South Africa's too-big-to-fail SOE.

*Seeds of the preferable just transition:*

- The ANC National Executive Committee (NEC) position on an energy transition opting for the lowest-cost option for the future energy mix is:  
"The NEC agreed to develop a strategy on a just transition to a low-carbon path of development that takes into account the interests of workers, communities and broader society. This should include such new technologies as fuel cell applications which require platinum group metals (PGM) which South Africa has in abundance."
- Rwanda launched its first African-made smartphone factory,<sup>69</sup> showing fellow African countries that it is possible to build a gigafactory linking to the global battery supply chain.

*Suggested Leverage Points for Policy Action:*

- Incentivise Eskom to build decentralised recharging infrastructure that enables access and provides demand-side response (DSR) services. These services could include vehicle-to-grid (V2G) and vehicle-to-home (V2X) technologies that ensure the energy systems' resilience and allows for new products that can be sold to electricity consumers at their homes.
- Provide buffers to utilities that enable unstructured time and funds to increase the research and innovation capabilities through broad coalitions of private, public and academic actors to grow domestic technological innovation and skills capabilities.
- Co-create feedback loops that collect data on the consequences of the e-mobility transition on the energy sector to ensure negatively affected stakeholders are included and accounted for and ensure just and equitable actions are taken that allow for democratic feedback to the disaffected economic sectors.
- Introduce programmes that assist utilities to move from centralised generation to regional generation hubs with Regional Electricity Distribution System (REDS) which function as decentralised affiliated hubs to Eskom. This will ensure broader access, local procurement and job creation, as well as systems network and grid resilience.<sup>70</sup>

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<sup>68</sup> [Ibid.](#)

<sup>69</sup> Mbewa, David Ochieng, 'President Kagame launches first smartphone factory in Rwanda'. URL: <https://africa.cgtn.com/2019/10/07/president-kagame-launches-first-smartphone-factory-in-rwanda/>, site accessed 01 November 2019.

<sup>70</sup> NREL, 'Connecting Electric Vehicles to the Grid for Greater Infrastructure Resilience'. URL: <https://www.nrel.gov/news/program/2017/connecting-electric-vehicles-to-the-grid-for-greater-infrastructure-resilience.html>, site accessed 23 October 2019.

## From centralised energy generation, transmission and distribution to dynamic localised distributed energy resources (DERs) networks

Historically the energy relationship between the public and governments have been dominated by the state. However, new technologies like blockchain<sup>71</sup> provide enormous opportunities to equalise access to energy information, income and resources and thereby allow home users more control over how they consume energy. The main reason for this equalisation of the power relationship between utilities and consumers is that blockchain has the potential to tokenise renewable energy. The blockchain enables a distributed system, thus removing the middleman, allowing wind, solar and hydro producers to seamlessly connect with investors, who are willing to pay upfront for the right to consume renewable energy. The application of blockchain will accelerate the Internet of Things (IoT), increasing interconnectivity and enhancing smart technology integrations. By creating a more inclusive ecosystem of data, blockchain technologies equalise the information flows for more high-quality data to be exchanged freely between devices. This development should be welcomed as a critical opportunity for SADC states who seek integrated solutions that inherently increases transparency and equality towards a just energy transition. Energy experts point to several possible benefits of employing blockchain technology to solve many of the pressing challenges in enabling a just energy transition.<sup>72</sup>

- Blockchains provide privacy, enhance cybersecurity, and are a low-cost way of managing DER-focused transactions at the edge of the distribution grid.
- Blockchains provide a more transparent and, at the same time, a more secure way of tracking energy flows than the status quo.
- Blockchains enable small-scale and low-credit customers to participate in business models focused on DERs and renewable energy.
- Blockchains are a key enabler of balancing and managing the grid from the bottom up versus today's top-down approach.

But how can this work practically in Southern Africa? SADC members will need to invest in distributed energy resources (DERs)—such as rooftop solar, demand response, and electric vehicles. This will require setting up innovation labs that experiment along with governments, utilities, and other stakeholders from across the globe to find new ways to better regulate and manage the electricity grid. According to the Rocky Mountain Institute (RMI) these experiments currently face four main issues regardless of their geography:<sup>73</sup>

- Controlling demand is difficult: Customers are concerned about privacy and sometimes loathe to share data—let alone allow third parties to control DERs that they own.

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<sup>71</sup> A blockchain is essentially a distributed ledger that is hosted on the internet and is a digital means of handling secure and trustworthy transactions between various parties involved. A transaction is an exchange of value that is then encoded as a digital exchange of information on a blockchain. The transactions can range from monetary transactions such as the trading of bitcoins, to others like trading electricity.

<sup>72</sup> Morris, Jesse, 'The Energy Web Foundation: Bringing Blockchain Technology to the Grid'. URL: <https://www.renewableenergyworld.com/2017/02/23/the-energy-web-foundation-bringing-blockchain-technology-to-the-grid/>, site accessed 24 October 2019.

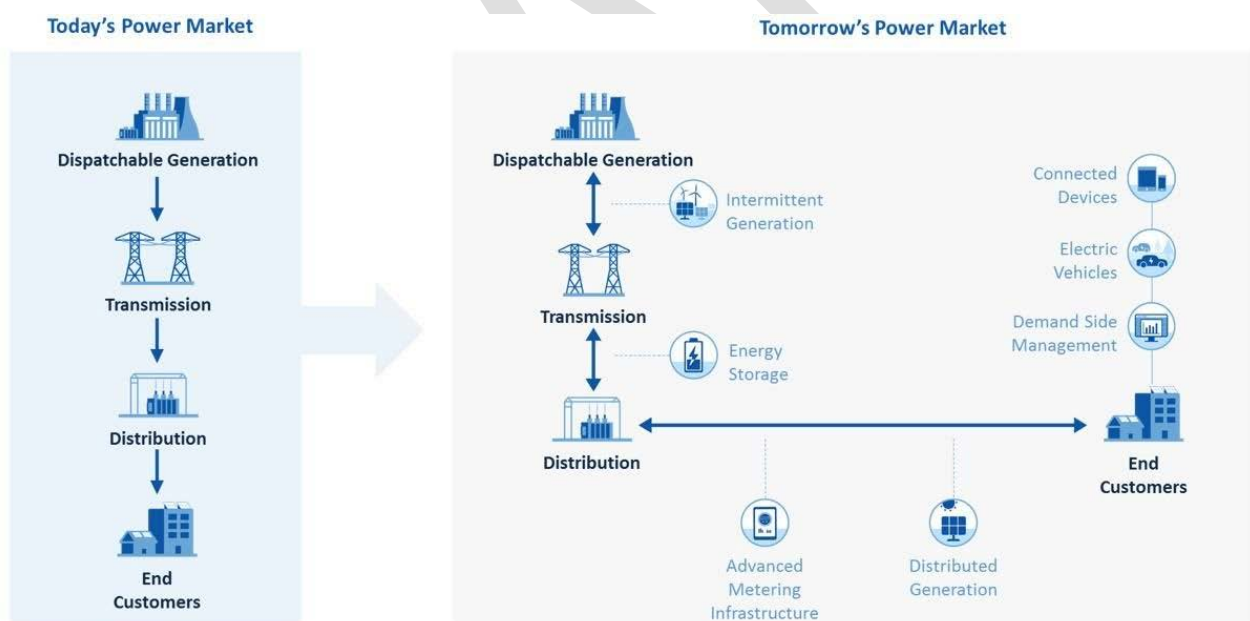
<sup>73</sup> Kortenhorst, Jules; Creyts, Jon, 'Energy Web Foundation Launches Pioneering Blockchain to Accelerate a Low-Carbon, Customer-centric Energy System'. URL: <https://rmi.org/energy-web-foundation-launches-pioneering-blockchain-to-accelerate-a-low-carbon-customer-centric-energy-system/>, site accessed 24 September 2019.



- Tracking flows of energy is imperfect: Energy markets and markets for the attributes of energy (e.g., renewable energy credits) can be expensive to run, can be subject to double spending, and can usually be accessed only via intermediaries.
- Not everyone can participate in the grid's evolution: In developed economies, only large, sophisticated businesses are able to enter into off-site power purchase agreements for renewables. In emerging economies, access to capital is a major barrier to accessing DERs and renewable energy, even if these technologies are capable of generating cost savings.
- Putting customers and DERs first is challenging: The entire grid was originally designed from the top down, making it challenging to put customers and DERs first.

To enable the just e-volution there needs to be a shift from centralised linear approaches of infrastructure design with the underlying premise of supporting predictable, unidirectional power flows, by means of centralised generators through transmission and distribution systems to passive customers. The distributed energy resources (DERs) approach presents a more complete alternative due to its combination of increased availability of granular data and communications. The DERs in many ways are a reinvention of electricity networks and delivery. The use of DERs creates an equalised platform for interconnectivity; from power plants, DERs, consumers to aggregators, which ultimately becomes a transactive, resilient, efficient network.

Figure 14: Decentralisation of the energy system



Source: GTM Research

Source: Green Tech Media Research<sup>74</sup>

All of this requires updated infrastructure, regulation, business models, technologies and markets. The just energy transition in SADC needs to occur without sacrificing the reliability and affordability of energy to customers.

<sup>74</sup> Kann, Shayle, '4 Trends Reshaping the Power Sector'. URL:

<https://www.greentechmedia.com/articles/read/four-trends-reshaping-the-power-sector>, site accessed 24 September 2019.

The just e-evolution plays a significant role in enabling the decentralisation of the energy system. The growing Southern African EV and charging infrastructure market creates opportunities for operators and utilities to experiment with two-way communications, control and charging/discharging technologies like vehicle-to-grid. Ultimately, the decentralised future in conjunction with EVs and the conjoining infrastructure can act as flexible demand response that adjusts to load patterns assisted by energy storage for excess non-dispatchable generation. This is especially true for remote and rural locations where energy provision is best facilitated by decentralised sources in the form of microgrids or off-grid power options. In other cases, a mixed approach via the extension of the existing centralised grid infrastructure will be required, where energy access could become both a driver and a beneficiary of a global decentralisation trend.

*Seeds of the preferable just transition:*

- Enel Foundation – Open Africa Power 2020, Power Futures Lab & MIRA<sup>75</sup> where students can enrol in training modules to acquire holistic know-how of the electricity sector, enhancing their technical, regulatory and business skills to work in the private and public sector towards the electrification of Africa. This flagship training initiative is done in partnership with the Graduate School of Business at the University of Cape Town.
- The US Department of Energy's (DOE), Office of Science, awarded a \$1.05 million grant<sup>76</sup> to start-up IoT company BEM Controls for a blockchain project to create the "Energy Internet". The transactive energy platform aims to enable building owners to buy energy from distributed sources such as solar generators or wind farms. Energy utilities and grids will also participate in the platform.
- Bitcoin mining as a revenue increasing mechanism for Eskom.<sup>77</sup>

*Suggested Leverage Points for Policy Action:*

Adedayo Adebajo makes the following suggestions regarding the design of energy policy under a Blockchain-led industrial revolution in Africa: <sup>78</sup>

- Lease unused or available lands in less congested areas and rooftops in association areas for power supply projects.
- Build micro-grids in such areas where renewable energy sources have advantages.

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<sup>75</sup> Enel Foundation, 'Open Africa Power 2020: Call for applications'. URL: <https://www.enelfoundation.org/news/a/2019/10/open-africa-power-2020--call-for-applications>, site accessed 24 October 2019

<sup>76</sup> Ledger Insights, 'US Department of Energy makes blockchain grant'. URL: <https://www.ledgerinsights.com/departments-of-energy-blockchain-bem-comed/>, site accessed 24 October 2019.

<sup>77</sup> Jager, Carel de, 'Bitcoin mining as a revenue increasing mechanism for Eskom'. URL: <https://medium.com/@careldj/bitcoin-mining-as-a-revenue-increasing-mechanism-for-eskom-407cd134b648>, site accessed 24 October 2019.

<sup>78</sup> Adebajo, Adedayo, 'Blockchain Industrial Revolution in Africa'. URL: <https://medium.com/coinmonks/blockchain-industrial-revolution-in-africa-a624b908c613>, site accessed 24 October 2019.

- Prepare a token remuneration plan for leased spaces where a certain percentage of the generated energy in token value is transferred to their meter wallet to be used for free power supplies.
- Connect nearby shelters to the supply, services of which will be paid for depending on usage using the smart meters.
- Based on the demand in certain areas, increase microgrid productions.
- Give individual investors a chance to procure the facilities to supply power to some areas to reduce the efforts of monitoring, thereby increasing returns from percentage-based energy profits and maintenance services.
- Facilitate the construction of renewable energy supply to the main grid in certain congested areas to reduce losses to resistance. The actionable options include the construction of new distribution grids or transporting the older grids to new locations to reduce the span of supply cables and resistance losses.
- Focus on the use of smart meters to channel energy supply based on requirements in various locations.
- Implement a blockchain voting system to reward energy enhancement projects using lightweight contracts which will be monitored by the end-users.
- Install nodes in every facility and introduce incentives to enable forging,<sup>79</sup> which includes encouraging 24/7 power demand and keeping account with forging balance.
- Introduce a user damage control and remuneration programme. This is a blockchain insurance programme for end-users which utilises lightweight contracts to remunerate high tariff payers for events such as blackouts, high/low voltage supply which can cause damage to goods, houses and infrastructure. This is a step ahead of competitors. The remuneration is best issued in tokens to be used for metered energy payments which can also be sold to other customers through P2P transactions.

### 3.4 Organise Alliances and Change the Rules of the System

From analogue carbon-based energy to digitalised low carbon distributed electricity systems

In conjunction with 4IR technologies like blockchain, the just e-volution creates new ways for how people network around energy that ultimately changes the rules of energy systems. The

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<sup>79</sup> Forging (or minting) in cryptocurrencies is the creation of new blocks in blockchain based on the Proof-of-Stake (POS) algorithm with the opportunity to receive a reward in the form of new cryptocurrencies and commission fees. But forging is not the only technology for creating new blocks. An alternative is mining, which is based on the Proof-of-Work (POW) algorithm. Usually only one technology is used, but some cryptocurrencies use combinations of them. Different cryptocurrencies may have additional conditions for participation in forging. For example, only those amounts that have at least 1 440 confirmation blocks, can join forging. Coinstelegram, 'What is forging?'. URL: <https://coinstelegram.com/2018/07/07/what-is-forging/>, site accessed 18 November 2019. Thus, forging is the activity to make passive income with the use of block-chain. In Proof of Work (POW) environments the block-chain is secured by the miner through adding a new block to the block-chain, thereby making sure of its integrity. In the Proof of Stake (POS) environment the activity is done by what is called forging, where the user uses the balances to confirm transactions and add new block to the block-chain providing the network with the security and resources needed. Apollo Wiki, 'Forging'. URL: <https://www.apollowiki.net/index.php?title=Forging>, site accessed 18 November 2019.

global non-profit organisation, Energy Web Foundation (EWF),<sup>80</sup> which was founded by RMI<sup>81</sup> and Grid Singularity<sup>82</sup>—is focused on capturing open-source blockchain infrastructure to serve as the standard industry platform for blockchain applications in the energy sector. The purpose is to accelerate the deployment of renewables and distributed energy resources (DERs).

The EWF community has organised more than 100 alliances, making it the world's largest energy blockchain ecosystem and a critical leverage point in the energy ecosystem. The growth in the Energy Web Chain is a significant development because it demonstrates the global shift in alliances and lobby groups to change the rules of the energy system. The RMI states that the Energy Web Chain is noteworthy for several reasons:<sup>83</sup>

- Public, open-source: The EW Chain is a public blockchain, designed to foster innovation and interoperability while encouraging adoption.
- Fast, efficient, scalable: Thanks to a blockchain approach known as proof-of-authority, the enterprise-grade EW Chain is energy-efficient and highly scalable, two requisite qualities for an energy-sector blockchain.
- Corporate validators: Unique among blockchains, the EW Chain's validator nodes that maintain copies of the blockchain database and agree on adding new blocks of transactions to the chain are respected energy companies (rather than anonymous computer "miners" common in other blockchains), a key design decision that should help the EW Chain gain favour among regulators and boost energy-sector confidence in the technology.

The EWF, along with affiliate companies, has identified and prioritised four blockchain application domains in the energy sector:<sup>84</sup>

1. Utility Billing: Any blockchain application where utilities and third parties use cryptographic identities to manage metering, customer settlement, advanced rate implementation, or customer switching.
2. Certificates of origin: Any blockchain application where renewable energy generators and certificate buyers interact directly and use smart contracts to streamline the overall process through the automation of certificate issuance, tracking, and retirement.
3. Demand response: Any blockchain application where demand response aggregators (i.e., utilities and third parties) use secure smart contracts to conduct aggregation, real-time measurement and verification (M&V), settlement, and trading for energy efficiency and demand response programs.
4. Transactive energy: Any blockchain application where devices automatically respond to local conditions on the distribution grid in real-time, engaging in two-way price negotiation based on a combination of user preferences and grid needs.

These applications are recreating energy markets, and facilitate security, robustness, lowering costs, and integration, while at the same time enabling increased collaborations among renewable generators and certificate buyers of varying sizes. Many of these benefits can be facilitated by smart contracts<sup>85</sup> that are directly issued to consumers and which radically simplify and lower the cost for certificates of origin to be issued. The shift from

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<sup>80</sup> Energy Web Foundation, 'About Us'. URL: <https://www.energyweb.org/>, site accessed 24 October 2019.

<sup>81</sup> Rocky Mountain Institute, 'About Us'. URL: <https://rmi.org/about/>, site accessed 24 October 2019.

<sup>82</sup> Grid Singularity, 'About : Grid Singularity'. URL: <https://gridsingularity.com/about/>, site accessed 24 October 2019.

<sup>83</sup> Miller, Douglas; Henly, Claire, 'Blockchain Is Reimagining the Rules of the Game in the Energy Sector'. URL: <https://rmi.org/blockchain-reimagining-rules-game-energy-sector/>, site accessed 24 October 2019.

<sup>84</sup> [Ibid.](#)

<sup>85</sup> RMI states that a smart contract is a string of code, shared between participants, that executes an action when a set of predetermined conditions are met—to streamline the overall process through the automation of certificate issuance, tracking, and retirement.

one-way utility-consumer relationships to peer-to-peer trading systems also improves the process of “real-time settlement, eliminating the need for intermediaries and related process steps, lowering internal administration and auditing costs, and increasing confidence in the traceability of renewable energy generation”.<sup>86</sup>

The systemic innovation of blockchain technology applied to the energy system is a critical leverage point in the e-mobility revolution to shift the rules underlying the energy sector. The data “immutability” of blockchain-based systems enhances the leveraging capacity of the intervention because data on distributed ledgers are challenging to tamper with due to a combination of strong cryptography, the interdependent relationship between each block of data, and distributed consensus.<sup>87</sup> The use of smart contracts to create systemic innovations as a way to interact helps with the elimination of risks such as double-counting practices. It automates certificates to retire when obsolete and executes retirement “events” in real-time full public transparency.

Blockchain in the energy sector thus opens the opportunity to create global standardisation procedures across geographies. It creates an appropriate platform for the buying and selling of electricity by enabling frictionless trade through certificates of origin in any location accessible to the internet. The new platform would hasten the entry of renewable generators and buyers to the market by sidestepping current institutional inertia and high utility transaction costs.

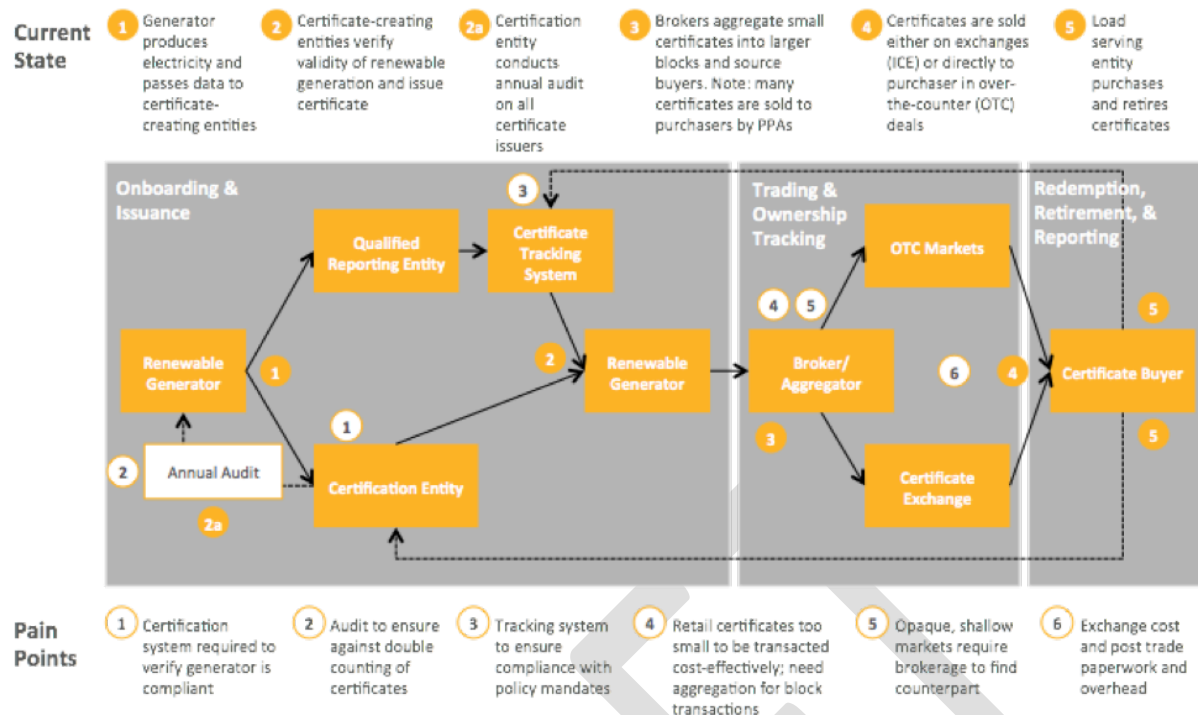
The rules of the energy sector change when the use of blockchain transforms the overly complicated and costly institutional design into elegant and efficient relationships, interactions and an interconnected whole. The traditional energy arrangement pointing to the schematic features of typical current certificates of origin system is depicted in Figure 30 and Figure 31 points to the EWF’s schematic of a future blockchain-based certificates-of-origin system.

*Figure 15: Schematic of a typical current certificates of origin system*

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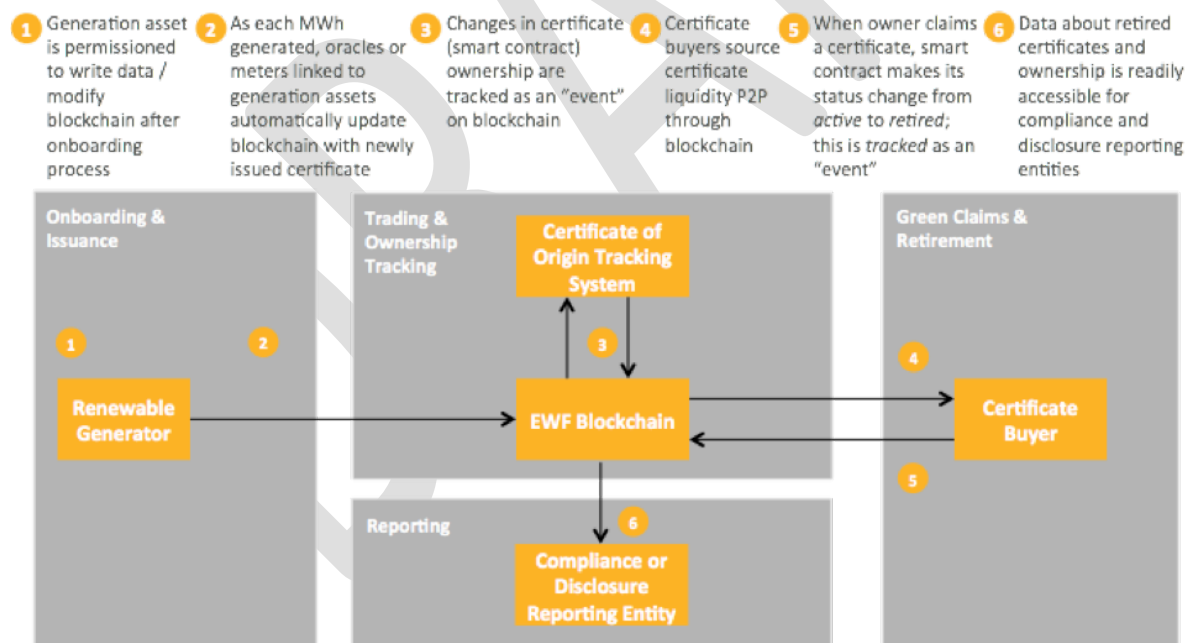
<sup>86</sup> Miller, Henly, 'Blockchain Is Reimagining the Rules of the Game in the Energy Sector'.

<sup>87</sup> Ibid.



Source: EWF & RMI

Figure 16: EWF's schematic of a future blockchain-based certificates of origin system



Source: EWF & RMI

The EWF work on blockchain solutions in the energy sector is a game-changer and needs scaling up in its possible delivery of solutions to utility billing and demand response that would streamline and enhance their functioning.



#### *Seeds of the preferable just transition:*

- The EWF's Brooklyn Microgrid Project<sup>88</sup> where all transactions are managed and stored on blockchain demonstrates the usefulness and scalability of smart meter technology and blockchain software, where transactions are easily made from neighbour to neighbour. This project is proving the concept that blockchain can create a local community market for renewable energy.

#### *Suggested Leverage Points for Policy Action:*

- Organise SADC member energy alliances to call for investment in net-zero carbon emissions energy generators in line with the worldwide shift to investment in sustainable business practices, that include environmental, social, and governance (ESG) considerations.
- Educate energy providers that advances in renewable energy and DERs offer lower rates and emissions-free energy while delivering all the grid reliability services that new fossil fuel-fired power plants can.
- Build a SADC energy cooperative that seeks to transition to novel decarbonised grid solutions supported by utilities deploying not only renewable energy but also other so-called non-wires solutions (NWS)—like energy storage, energy efficiency, and demand response—to cost-effectively meet growing grid needs.
- Create a SADC MS affiliate programme with EWF to build regionally formed affiliate taskforces focused on each application domain to test the value of blockchain within the domain, and where value is identified, deliver a foundation for commercial applications. Taskforces should unpack the challenges in existing systems, identify how blockchains can overcome those challenges, build a technical architecture for blockchain-based applications, and, critically, accelerate the implementation of commercial projects in the real world.

### 3.5 Build or Defend Desirable Institutions that Embed Fairness and Enable the Weak

#### *Electrical and Technical Jobs Replace Many Auto Industry Jobs*

With rapid urbanisation comes urban electrification and high demand for electricians and technically skilled jobs intertwined with the ICT industries' latest skills for 'smart technologies', e.g. smart homes and cities. The EV transition might generate large-scale employment that facilitates 4<sup>th</sup> industrial revolution ICT software programmers coupled with electricians/installers, vehicle/battery repairs and vehicle factory workers.

There are roughly 350 million households in the SADC region, which is a considerable number of homes, condominiums and apartments that will need EV charging stations installed and in many cases updates of electrical systems. Therefore, the need for electricians, EV charging stations, battery storage and solar panel installers will become one of the most significant areas of job growth beginning in the next decade. Figure 32 demonstrates the required skills

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<sup>88</sup> Runyon, Jennifer, 'How Smart Contracts [Could] Simplify Clean Energy Distribution'. URL: <https://www.renewableenergyworld.com/2017/05/15/how-smart-contracts-could-simplify-clean-energy-distribution/>, site accessed 24 October 2019.

across the labour force and the estimated medium- to high-skilled occupations, according to the International Labour Organisation (ILO).

DRAFT



Figure 17: Main core skills required for green jobs, by skill level of occupation

REQUIRED ACROSS THE LABOUR FORCE	REQUIRED IN MEDIUM-TO HIGH-SKILLED OCCUPATIONS
<ul style="list-style-type: none"> <li>• Environmental awareness and protection; willingness and capability to learn about sustainable development</li> <li>• Adaptability and transferability skills to enable workers to learn and apply the new technologies and processes required to green their jobs</li> <li>• Teamwork skills reflecting the need for organizations to work collectively on tackling their environmental footprint</li> <li>• Resilience to see through the changes required</li> <li>• Communication and negotiation skills to promote required change to colleagues and customers</li> <li>• Entrepreneurial skills to seize the opportunities of low-carbon technologies and environmental mitigation and adaptation</li> <li>• Occupational safety and health (OSH)</li> </ul>	<ul style="list-style-type: none"> <li>• Analytical thinking (including risk and systems analysis) to interpret and understand the need for change and the measures required</li> <li>• Coordination, management and business skills that can encompass holistic and interdisciplinary approaches incorporating economic, social and ecological objectives</li> <li>• Innovation skills to identify opportunities and create new strategies to respond to green challenges</li> <li>• Marketing skills to promote greener products and services</li> <li>• Consulting skills to advise consumers about green solutions and to spread the use of green technologies</li> <li>• Networking, IT and language skills to perform in global markets</li> <li>• Strategic and leadership skills to enable policy-makers and business executives to set the right incentives and create conditions conducive to cleaner production, cleaner transportation</li> </ul>

Source: “Skills for green jobs” country reports, ILO, 2018.

#### *Seeds of the preferable just transition:*

- AfterOil<sup>89</sup> is an investment crowdfunding-based platform on blockchain to meet renewable energy needs beyond oil, coal and gas for a healthier world for everyone who wants to get profits while increasing energy efficiency and environmental sustainability.
- South Africa’s renewable energy independent power producer programme, for example, has attracted approximately \$14 billion in private sector investment in 102 projects and created around 40,000 jobs.<sup>90</sup>

#### *Suggested Leverage Points for Policy Action:*

- Strengthen the action planning for skills development of unions and labour organisations and the integration of these with key climate and environmental policies and regulations, including NDCs, to ensure that skills needs are met, and climate commitments are implemented.

<sup>89</sup> After Oil, 'About Us'. URL: <https://afteroil.id/home>, site accessed 10 October 2019.

<sup>90</sup> South African Government, 'President Cyril Ramaphosa concludes Financial Times Africa Summit visit in London'. URL: <https://www.gov.za/speeches/president-cyril-ramaphosa-concludes-financial-times-africa-summit-visit-london-14-oct-2019>, site accessed 21 October 2019.

- Enable governments to develop skills policies and training measures that adopt a longer-term and systematic approach to skills development in the context of EV transition.
- Train and onboard auto industry workers to become electricians, technicians, repairers or ICT professionals, with jobs in EV repair, charging, battery storage and renewable energy installers.

## 4. Enabling a New Energy Paradigm

### 4.1 Change the paradigm out of which the system arises

From climate crisis to climate emergency as a prominent feature of Post-COVID-19 green recovery

A paradigm shift in Southern Africa would be when politicians stop talking about climate change and act in tandem with society to address the climate emergency. The Club of Rome has led the thought leadership on sustainable development since its influential Limits to Growth report<sup>91</sup> in 1972. Their most recent publication makes the call that “Nations should declare a Planetary Emergency”<sup>92</sup> and is supported by their Planetary Emergency Plan<sup>93</sup>.

A fundamental shift in mindset is brought about through growing awareness in behaviour and critical reflection on ways of thinking. Complexity and systems thinking<sup>94</sup> hold the promise of fundamentally changing the way of thinking out of which the current dominant systems arise. This new way of thinking that embraces the inherent complexity of our world engages with a relational worldview and recognises change as episodic rather than linear or static. Traditional understandings of the beliefs that guide behaviour assume the world to be controllable through rational and purposeful decisionmakers who act in each other’s best interests. Complexity thinking provides a more complete alternative and offers a new way of thinking that can alter the paradigm out of which current political-economy of the current energy paradigm arise.

Experts point to the considerable influence on the political economy that the invisible and qualitative characteristics shaping our society have. The political economy is built on the measurement of visible constants, parameters and numbers like inflation, interest rates and GDP, but while these measures influence lives, a shift in the petrol price and the introduction of the carbon tax will hardly shift consumer behaviour towards larger systemic issues like climate change. However, a change in what is measured through new complexity-informed

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<sup>91</sup> Donella H Meadows, Dennis L Meadows, Jorgen Randers, William W Behrens, 'The limits to growth: A report for the Club of Rome's project on the predicament of mankind,' New York: Universe Books, 1972.

<sup>92</sup> Club of Rome, 'Nations should declare a Planetary Emergency says Club of Rome'. URL: <https://www.clubofrome.org/2019/09/24/nations-should-declare-a-planetary-emergency-says-club-of-rome/>, site accessed 19 November 2019.

<sup>93</sup> Club of Rome, 'Planetary Emergency Plan: Securing a New Deal for People, Nature and Climate'. URL: [https://www.clubofrome.org/wp-content/uploads/2019/09/PlanetaryEmergencyPlan\\_CoR-4.pdf](https://www.clubofrome.org/wp-content/uploads/2019/09/PlanetaryEmergencyPlan_CoR-4.pdf), site accessed 19 November 2019.

<sup>94</sup> Jean Boulton, Peter Allen, Cliff Bowman, 'Embracing complexity: Strategic perspectives for an age of turbulence,' Oxford University Press, 2015.

approaches could enable a paradigm shift when it prompts a move from traditional monitoring and evaluation to re-evaluation.<sup>95</sup>

Global shifts towards protectionism and populism have seen the world become increasingly self-absorbed. Complexity thinking invites one to use the future in new ways to anticipate and re-imagine the relations and interconnections in systems. Complexity thinking invites a questioning of paradigmatic assumptions about the political economy and the role of the e-mobility revolution against the backdrop of a new paradigmatic framework for social change and economic well-being. Complexity approaches also enable the conditions for systemic change and innovation that build behavioural awareness and new thinking.

The business as usual paradigm has brought about a global economy enveloped in a 'triple crunch' even before the COVID-19 pandemic. The combination of the credit-fuelled financial crisis embedded in deep income inequalities; the unfettered extraction of resources, climate emergency, unprecedented destruction of the environment and species extinction; and growing youth unemployment against the backdrop of a seismic shift in traditional industrial organisation and business practices are closing in from all sides. The interlocking nature of these threatening developments is creating a perfect storm, and echoes some of the conditions that gave rise to the Great Depression. It has also prompted a rethinking globally of the entire premise on which the global economy is organised. This has given rise to new economic models that take into account planetary boundaries when calculating externalities in traditional economic modelling<sup>96</sup> as well as reconsidering the guiding rules of the multilateral system.<sup>97</sup> It is in this context that it is critical to reimagine the future against the backdrop of the myriad challenges facing Southern Africa. Hence an approach that embraces key tenets of a Green New Deal (GND) and that secures a more sustainable future for the region using foresight, futures thinking, and system innovation is proposed.

*Seeds of the preferable just transition:*

- Cities worldwide taking up a stance on the climate change emergency<sup>98</sup> and leading the charge to ban ICE vehicles in cities and also minimising the use of any vehicles within city centres.
- National governments, jurisdictions and local governments declaring the climate emergency as national emergencies.<sup>99</sup>

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<sup>95</sup> Alternatives to traditional evaluation methodology have been developed such as Revaluation Darnton, Andrew; Harrison, Andrew, 'Revaluation Methodology'. URL: <https://www.revaluation.org.uk/>, site accessed 24 October 2019

<sup>96</sup> Kate Raworth, 'Doughnut economics: Seven ways to think like a 21st century economist,' White River Junction, Vermont: Chelsea Green Publishing, 2017.

<sup>97</sup> Gallagher, K P; Kozul-Wright, R, 'A New Multilateralism for Shared Prosperity: Geneva Principles for a Global Green New Deal'. URL: <https://www.ituc-csi.org/A-New-Multilateralism-for-Shared-Prosperity-Presentation>, site accessed 19 November 2019.

<sup>98</sup> Koop, Fermin, 'These 30 cities are leading the way in climate action -- their emissions are already dropping'. URL: <https://www.zmescience.com/science/cities-climate-change/>, site accessed 22 October 2019.

<sup>99</sup> Climate Emergency Declaration, 'Climate emergency declarations in 1,143 jurisdictions and local governments cover 287 million citizens'. URL: <https://climateemergencydeclaration.org/climate-emergency-declarations-cover-15-million-citizens/>, site accessed 22 October 2019.

- Broad coalitions for a Green New Deal in the USA<sup>100</sup> and Europe.<sup>101</sup>

*Suggested Leverage Points for Policy Action:*

- Building greater transnational institutional capacity in SADC MS for far greater autonomy over domestic monetary policy (interest rates and money supply) and fiscal policy (government spending and taxation).
- SADC and the South African government to set the example of showing that economic growth is compatible with low-carbon and climate-resilient pathways, which will avoid lock-in to high carbon-intensive infrastructure. This will allow for SADC countries to commit to ratify Nationally Determined Contribution (NDC) in line with the Paris Agreement.
- Giving poorer communities the opportunity to escape poverty without fuelling global warming by helping to finance massive investment in climate change adaptation and renewable energy.
- Supporting the free and unconstrained transfer of new energy technologies to developing countries.
- Transforming the thinking and language on climate change to become climate emergency focused.
- Transforming the thinking and language on the role of governments, politics, law and education in the context of a GND.
- Transforming the thinking and language to include complex adaptive systems approaches, futures and foresight methods to become embedded in anticipatory governance networks.

## 5. Fostering a Southern African Green New Deal

### *From the Green New Deal to Fostering Seeds of Good Southern African Futures*

A critical reflection on the current era has seen scientists agree that humans are now the most significant drivers of earth systems change.<sup>102</sup> This new geological era<sup>103</sup> is called the Anthropocene, or human era or epoch, because it outrivals geological forces and is marked by massive patterns of human production, consumption and population growth that are materially reshaping the earth's landscape and that are also unsustainable.<sup>104</sup> The Anthropocene points to a significant shift in humanity's impact on the planet on a global scale with local and regional effects for socio-ecological systems services on which humans

<sup>100</sup> Green New Deal Coalition, 'The Green New Deal'. URL: <https://www.greennewdealforall.org/>, site accessed 24 October 2019.

<sup>101</sup> The Green New Deal for Europe, 'A Blueprint for Europe's Just Transition,' (2019).

<sup>102</sup> Paul J. Crutzen, 'The "Anthropocene"', vol. 12 (2002): 1–5.

<sup>103</sup> Will Steffen, Åsa Persson, Lisa Deutsch, Jan Zalasiewicz, Mark Williams, Richardson Katherine, Carole Crumley, Paul Crutzen, Carl Folke, Line Gordon, Mario Molina, Veerabhadran Ramanathan, Johan Rockström, Marten Scheffer, Hans Joachim Schellnhuber, Uno Svedin, 'The Anthropocene: From Global Change to Planetary Stewardship,' vol. 40, no. 7 (2011): 739–61.

<sup>104</sup> W. Steffen, R. A. Sanderson, P. D. Tyson, J. Jäger, P. A. Matson, B. Moore III, F. Oldfield, K. Richardson, H. J. Schellnhuber, B. L. Turner, 'Global change and the earth system: A planet under pressure,' Berlin, New York: Springer, 2004.

depend.<sup>105</sup> Scholars agree that this distinct shift has occurred since the onset of the industrial era in the 19th century and can be distinguished particularly from the 1950s onwards.<sup>106</sup>

Humanity has to reflect on whether our world and paradigms that are shaping us have kept pace with the changing planet. One could argue that Southern Africa is still living in an industrial revolution or 20<sup>th</sup> century lifestyles even though the world has now entered a completely different era. The way that citizens of Southern Africa acquire food, obtain energy, use water, travel, relate to wildlife, plan new infrastructure, organise human populations, and make global decisions has remained the same as in the previous century. Such a state of affairs may have been appropriate for a time of low human population, plentiful resources, a stable climate and abundant supplies of combustible fuels. But the challenges of the Anthropocene demand a rethink, a questioning of established paradigms, a new approach to the design of societies, ways of relating, cooperation, cultures and lifestyles.

There is a need for a transformative and strategic envisioning of alternative southern African futures or paradigms that will facilitate regional coordination and integration. Africa has a strong storytelling tradition that is useful in voicing meta-narratives to offer wayfinders in navigating the challenges that are facing SADC and its citizens. Pereira *et al.* highlight the importance of the African oral tradition and the role it plays in creating alternative bold stories to re-imagine the future to provide a decarbonised, creative and genuine African hopeful visions.<sup>107</sup>

Such visioning processes cater for the southern African context and aim to draw on these vibrant African story-telling cultures to enable a radical departure from conventional scenario narratives that shape our deeply held myths and metaphors. Creating systemic innovation and leveraging the power to transcend paradigms means SADC will have to develop the capability of moving beyond fixed mindsets and embrace paradox and uncertainty by offering meaningful opportunities where people can let go of their preconceived truths, their political positions, and their sense of otherness, and instead engage with those who may be very different than themselves.

Although EVs can catalyse the electric-mobility revolution, the larger challenge is for the interchangeably connected southern African nations to draw one another closer, transcend our current nation-state paradigms and work together on a common vision to secure the prosperity and welfare of our society. This might mean finding the boldness and courage to envision a hopeful story (vision) such as a Green New Deal for the SADC region to cultivate and foster it as an initial step in a larger conversation that leads to brighter, bolder and hopeful emerging futures. A southern African Green New Deal should speak for Africa and embrace Africa's values to enable alternative forms of organising, cooperation and collaborations that draw the preferable future we want closer to our current challenges.

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<sup>105</sup> Reinette Biggs, Maja Schlüter, Michael Schoon, 'Principles for Building Resilience: Sustaining Ecosystem Services in Social-Ecological Systems,' Cambridge, 2015.

<sup>106</sup> Smith. Bruce, Melinda Zeder, 'The onset of the Anthropocene,' vol. 4 (2013): 8–13.

<sup>107</sup> Laura M. Pereira, Tanja Hichert, Maike Hamann, Rika Preiser, Reinette Biggs, 'Using futures methods to create transformative spaces: visions of a good Anthropocene in southern Africa,' in *Ecology and Society*, vol. 23, no. 1 (2018).

*Seeds of the preferable just transition:*

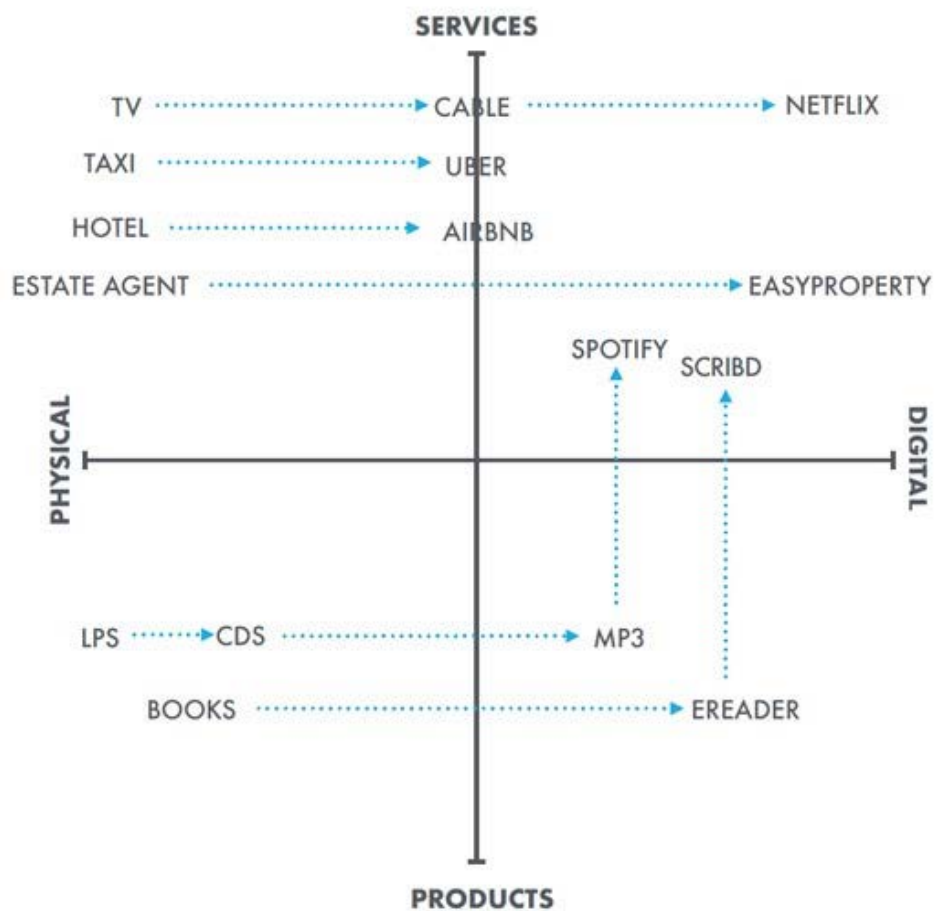
- The AU's vision<sup>108</sup> of "An Integrated, Prosperous and Peaceful Africa, driven by its citizens and representing a dynamic force in the global arena."
- The SADC vision<sup>109</sup> to "achieve development, peace and security, and economic growth, to alleviate poverty, enhance the standard and quality of life of the peoples of Southern Africa, and support the socially disadvantaged through regional integration, built on democratic principles and equitable and sustainable development".

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<sup>108</sup> African Union, 'About the African Union'. URL: <https://au.int/en/overview>, site accessed 24 October 2019.

<sup>109</sup> SADC, 'SADC Overview'. URL: <https://sadc.int/about-sadc/overview/>, site accessed 24 October 2019.

## Appendix A - The Evolution of Digital/Physical Integration



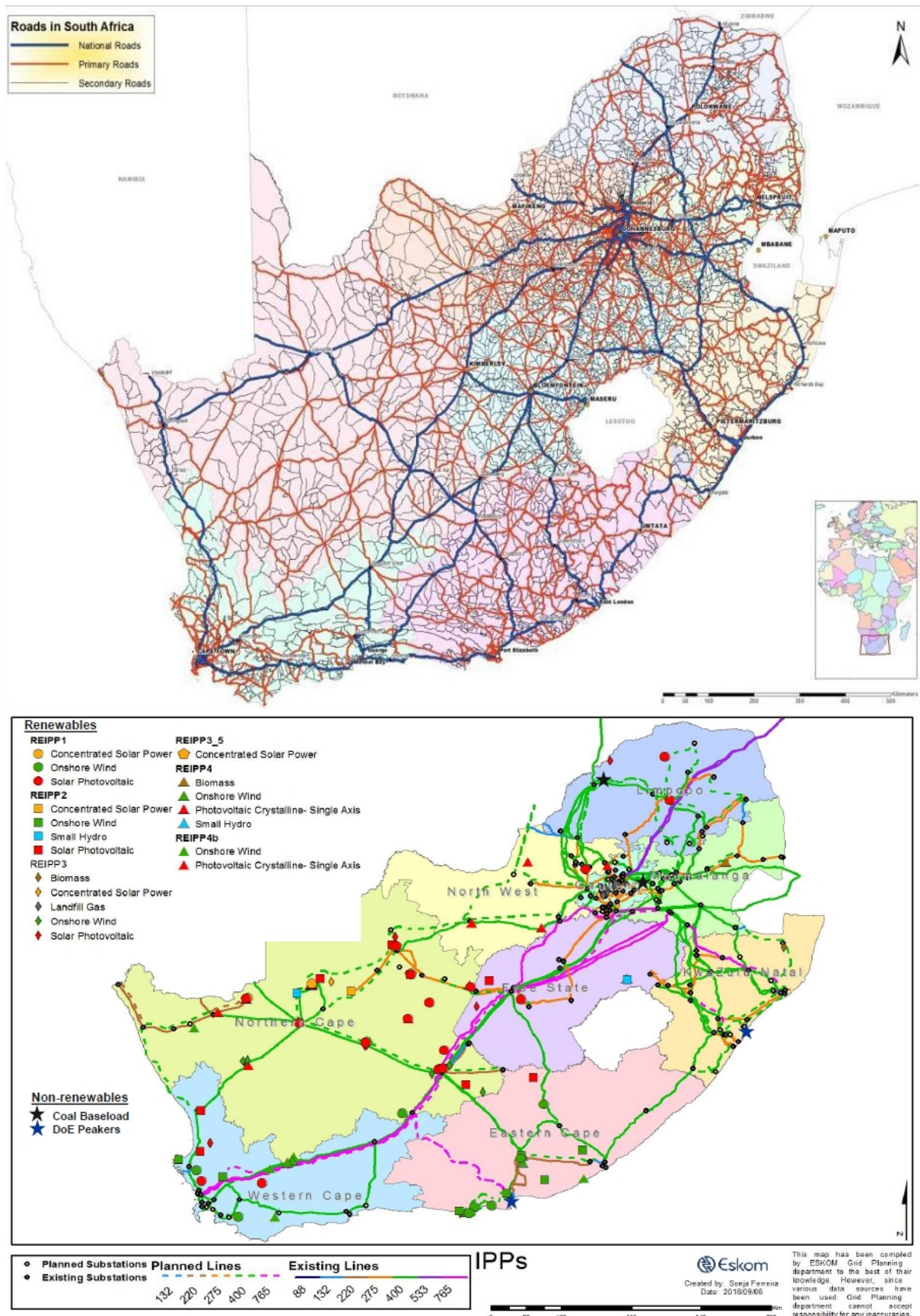
### THE EVOLUTION OF DIGITAL/PHYSICAL INTEGRATION

Digitally integrated physical space removes the interface blockers to creating truly immersive innovative 4D and five-sense experiences that faithfully deliver the experiential promise of digital and physical combined.

	1800s	1990s	2010s	2020s
<b>INTERACTIVE SPACE</b>	SHOWROOM	SCREEN	AUGMENTED	INTEGRATED
<b>INTERACTION</b>	4D Immersive	2D	3D	4D Interactive
<b>SENSE</b>	Hear/See/Touch/Smell/Taste	Hear/See	Hear/See	Hear/See/Touch/Smell/Taste
<b>TYPE</b>	Physical	Digital	Augmented Physical	Interactive Physical
<b>TECH</b>	Store Design	Internet/Apps/Interactive Screen	Oculus Rift/Google Glass	Hologram/ Interactive 3D Projection/ Haptic/Olfactory Technology/ Binaural & Directional Sound



## Appendix B - Road vs Transmission Grid Networks





## Authors

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Talitha Bertelsmann-Scott is an independent trade policy, regional integration, private sector development and a monitoring and evaluation expert and the former head of the Regional Observatory Programme (the pre-cursor of the SAIIA Futures Project) at SAIIA. She has extensive experience in the area of the regional integration and the regional economic communities of Southern, Western and Eastern Africa, including SADC, SACU, COMESA, ECOWAS and the EAC. Her experience follows from closely researching and advising on the SA-EU TDCA and she has worked closely with private sector organisations in preparing for the EPAs and using them as a tool towards Private Sector Development.

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