groundWork

Environmental justice action

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Integrated Resource Plan 2018 – groundWork comment

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Climate change imperative

The IRP 2018 appears oblivious to the immediate urgency of responding to climate change. In July this year, scientists from leading climate institutions warned of "the risk that self-reinforcing feedbacks could push the Earth System toward a planetary threshold that, if crossed, could prevent stabilization of the climate at intermediate temperature rises and cause continued warming on a 'Hothouse Earth' pathway even as human emissions are reduced".[1] They emphasise that cascading feedbacks – where crossing one tipping point sets off the next – may be triggered at between 1.5° and 2°C warming above pre-industrial temperatures. This is runaway climate change leading to unliveable 'hothouse earth' conditions.

Warming is now at over 1°C above the 1850-1900 average. If pre-industrial is taken to be 1750, as used to be the case, warming is now at 1.2°C. This is already dangerous climate change: people are experiencing extreme heat, drought, hurricanes and floods; and some critical tipping points may be tipping but we won't know for certain until after the event. The impacts at 1.5°C will be much more severe, particularly for the poorest half of the world's people, and the impacts at 2°C exponentially more severe, as International Panel on Climate Change Special Report on 1.5°C, due out in early October, will show. The collapse of agriculture is already threatened in some regions – notably in Africa, including the Western Cape – and the collapse of global fisheries from ocean warming and acidification, as well as industrial over-fishing, is in process.

[1] Will Steffen, Johan Rockström, Katherine Richardson, Timothy Lenton, Carl Folke, Diana Liverman, Colin Summerhayes, Anthony Barnosky, Sarah Cornell, Michel Crucifix, Jonathan Donges, Ingo Fetzer, Steven Ladea, Marten Scheffer, Ricarda Winkelmann, and Hans Joachim Schellnhuber, Trajectories of the Earth System in the Anthropocene, www.pnas.org/cgi/doi/10.1073/pnas.1810141115

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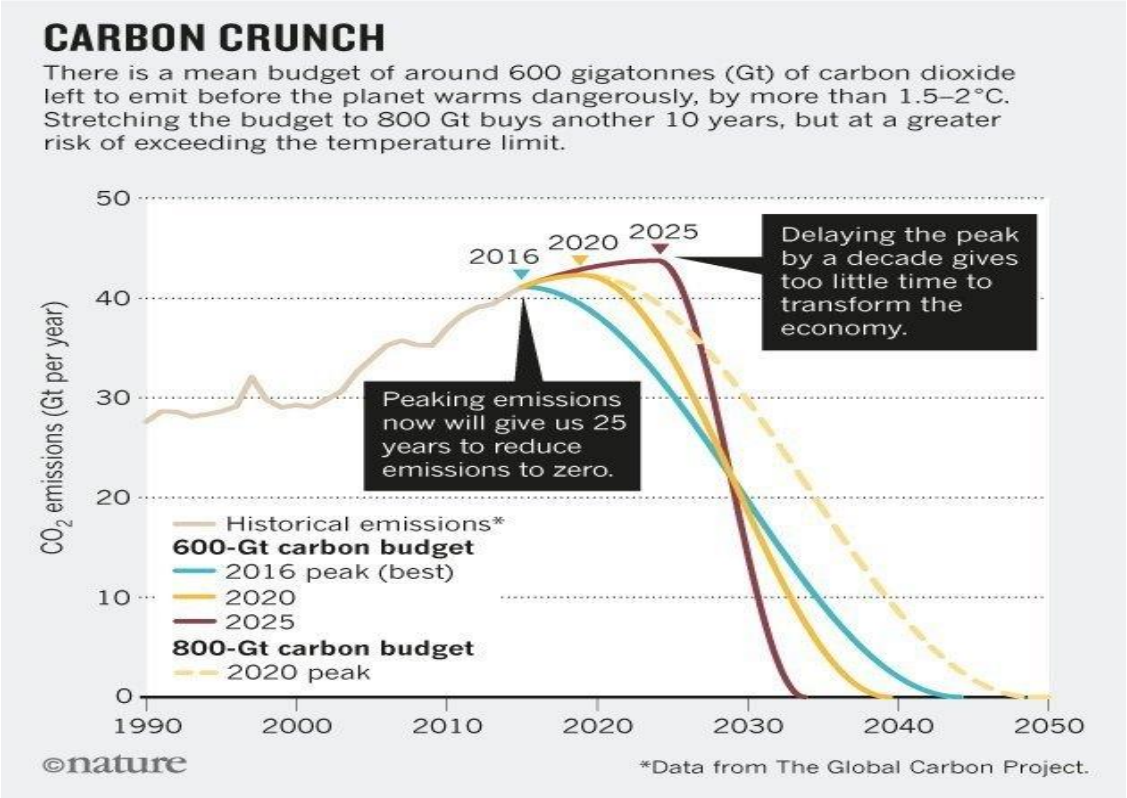
The IPCC's Fifth Assessment Report (IPCC AR5) showed that the global carbon budget for a one-in-two (50%) chance of avoiding 1.5°C is all but used up. These calculations did not account for feedbacks or for the reduction of sulphur aerosols – which have a cooling effect – that necessarily accompany the reduction in carbon emissions. The budget for a two-in-three (66%) chance of avoiding 2°C is similarly depleted. If global emissions peak by 2020, they will need to decline to zero before 2040, as shown in the figure below – also without accounting for feedbacks or the reduction in sulphur aerosols.[2]



This means that all countries, including South Africa, have less than twenty years to get to zero. Effectively, there is no carbon budget left to share out. Hence, equity in terms of 'common but differentiated responsibilities' must now be pursued through financial and technology transfers. This may be considered as part payment of the climate debt owed by the rich world to the poor world. But it must also be remembered that there is a climate debt from rich to poor in Africa and within South Africa. Finally, energy planning must be about a rapid transition from coal to renewables and it must be embedded in the larger conception of a just transition to a society that provides for all.

[2] Rahmstorf, S. and A. Levermann, 2017. *Why global emissions must peak by 2020*, Preface to *2020: The Climate Turning Point*, Carbon Tracker, Climate Action Tracker, Potsdam Institute for Climate Impact Research, Yale University. Note that 600 Gt is the mean. The range is 150 to 1050 Gt, so the bottom end will be overtaken by 2020.

The IRP has no limit on carbon emissions

IRP 2018 says it does not count the externality costs of carbon emissions because "the CO_2 emissions constraint imposed during the technical modelling indirectly imposes the costs to CO_2 from electricity generation" [25]. There is, however, no carbon constraint – merely the pretence of one.

The IRP claims to have two approaches to imposing a carbon constraint. The first is to follow the 'peak, plateau and decline' [PPD] trajectory adopted by IRP 2010. The PPD has a wide range with an upper and a lower limit. IRP 2010 ignored the lower bound and took the upper limit to define its trajectory. IRP 2018 simply repeats this and so allows power sector emissions of 275 Mt CO_2 a year through to 2035. The second approach is to allocate a carbon budget to the power sector for each decade. For 2021-2030, the budget is 2 750 Mt CO_2 – 275 Mt a year.

Eskom's emissions in the year to March 2018 were 205 Mt CO_2. Emissions from non-Eskom generators (mainly Sasol) less than 10 Mt/y. So the IRP allows 60 Mt/y more than the sector emits at present for the whole decade of the 2020s. In this period, the IRP adds the remaining Medupi and Kusile units as well as two IPP coal plants (6 732 MW in total) while six of Eskom's plants (12 600 MW) are scheduled for end-of-life closure. The IRP produced several scenarios which mostly put emissions in 2030 at around 215 Mt.

For the decade of the 2030s, upper PPD keeps emissions at 275 Mt/y to 2035. In the five years from 2036, it reduces emissions by 5 Mt each year. It thus allows a total of 2 675 Mt CO_2 for the decade. The carbon budget approach allows 1 800 Mt. None of the IRP scenarios come close to reaching either limit so there is no constraint.

For the next decade, upper PPD starts at 243 Mt in 2041 and declines to 192 Mt in 2050 for an average of 217 Mt/y over the decade, which is no reduction on present emissions. Under the carbon budget approach, the IRP allows 920 Mt for the decade. Two scenarios exceed this limit. But the 'least cost' scenario comes in below this limit and also below the 'carbon budget' scenarios. The 'least cost' scenario is the one that does not place an arbitrary constraint on how much renewable energy is built each year. So government can improve on its 'carbon budget' simply by removing the constraint on renewables. A normal IRP process would designate 'least cost' as 'business as usual'. Spending more than this to further reduce carbon emissions makes sense. Spending more than this to increase carbon emissions does not.

Again, this does not put a serious limit on carbon emissions. The carbon budget scenarios merely pretend to one. These scenarios retain the constraint on how much renewable energy can be built each year and introduce new nuclear plants to meet the limit on emissions. We conclude that this is their real function – they serve to keep nukes on the table.

The climate imperative is to reduce to zero emissions by 2040 not just for the power sector but for the whole economy. Recall that this is for a mere two-in-three chance of avoiding 2°C. Recall too, that these odds do not take account of climate feed backs or the reduction in sulphur aerosols. Finally, recall that much of the earth will become unliveable within what might otherwise be the life-time of today's youth. This is what it means to take climate change seriously. The IRP fritters the time away. It represents the refusal to recognise the real consequences of emissions from burning coal, oil and gas. It is a form of climate denial.

Other 'externalities'

The IRP gives the following table for the externalised costs of emissions of nitrogen oxides (NO_x), sulphur dioxide (should be SO_2, not SOx), mercury (Hg) and particulate matter (PM). It says, "These externality costs reflect the cost to society because of the activities of a third party [i.e. Eskom and other electricity generators] resulting in social, health, environmental, degradation or other costs" (sic) [25]. In other words, these numbers represent people dying prematurely or living with debilitating diseases caused by emissions. The IRP is, however, too discrete to tell us how many people's lives are ruined or what value it puts on their lives.

Table 1: IRP local emission externality costs

NOx (R/kg)	SOx (R/kg)	Hg (Rm/kt)	PM (R/kg)
4.455	7.6	0.041	11.318

The figure for mercury is wrong. It should read Rm/kg – i.e. million rand per kilogram (kg) rather than million rand per thousand (kilo) tonne – which amounts to R41 000 per kg and is rounded down from the R41 484/kg given in the Integrated Energy Plan (IEP) 2016 [67]. It is, of course, not possible to tell what figure was actually used in the modelling for this IRP.

The equivalent low-end figures from the European Environment Agency, converted to rand, are:[3]

Table 2: Equivalent EEA values

	NOx (R/kg)	SO_2 (R/kg)	Hg (R/kg)	PM (R/kg)
	82.7	198.48	47 304	413.5
Ratio EU/SA	18.56	26.12	1.15*	36.53

*** Assumes that IRP Hg externality is R41 000/kg.**

[3] Thanks to Mike Holland for comments and comparison with European numbers. Conversion is at €1= R16.54.

The implication is that European lives are valued at between 18 times more (NOx) and 36 times more (PM) than a South African life. Comparisons of this sort are always invidious because the lives of the rich are given a higher value than the lives of the poor. But even if we allow for the fact that Europeans are 5.5 times richer than South Africans (GDP per person), the South African government still puts a very low value on the lives of its people.

The real costs to people are appalling as Mike Holland shows. Emissions of just one species of pollution – fine particulate matter – from Eskom result in over 2 200 premature deaths every year. Tens of thousands more people are afflicted with asthma and bronchitis. Thousands are, or should be, admitted to hospital, many more suffer 'restricted activity days' – days when they cannot function normally – and every year about a million working days are lost. This costs the economy some R33 billion but the human costs are much higher and are not evenly distributed. As Holland observes, "air pollution most affects those whose underlying health condition is worst, and hence that any improvement in air quality will most benefit those who are most disadvantaged".[4]

The IRP externalities are only for emissions to air from the power stations. They do not take account of the pollution of water and land from coal stockpiles, ash heaps and acid deposition. Nor do they take account of the massive impacts of the coal mines on air, water and land as well as on people's health.

A rapid phase out of coal will immediately clean up the air and create the conditions for restoring earth. This is why the Lancet Commission on Health and Climate Change says that "tackling climate change could be the greatest global health opportunity of this century".[5] Fixing the damage – rehabilitating not just mines but whole mining regions – would also require much work and should be conceived as an integral part of a just transition.

[4] Holland, M. 2017. *Health impacts of coal fired power plants in South Africa*. Report to groundWork and Health Care Without Harm, p.17.

[5] Watts, N., W. Adger, P. Agnolucci, J. Blackstock, P. Byass, Wenjia Cai, S. Chaytor, T. Colbourn, M. Collins, A. Cooper, P. Cox, J. Depledge, P. Drummond, P. Ekins, V. Galaz, D. Grace, H. Graham, M. Grubb, A. Haines, I. Hamilton, A. Hunter, Xujia Jiang, Moxuan Li, I. Kelman, Lu Liang, M. Lott, R. Lowe, Yong Luo, G. Mace, M. Maslin, M. Nilsson, T. Oreszczyn, S. Pye, T. Quinn, M. Svensdotter, S. Venevsky, K. Warner, Bing Xu, Jun Yang, Yongyuan Yin, Chaoqing Yu, Qiang Zhang, Peng Gong, H. Montgomery, A. Costello, 2015. *Health and climate change: policy processes to protect public health.* Lancet Commission on Health and Climate Change, p.1.

The plan

Demand – wrong again

IRP 2010 forecast rapid economic growth and substantial growth in demand for electricity. In fact, the economy stalled and electricity demand declined. IRP 2018 sees several reasons for this including: the failure of GDP growth; Eskom's supply shortage from 2011 to 2015; and improved energy efficiency largely in response to escalating tariffs. Tariffs are nearly five times what they were in 2007.

Until the power went out in 2008, energy intensive industrial users were indifferent to energy efficiency. Since that time, electricity costs have increased from less than 10% to about 20% of total input costs. Eskom's power conservation programme also restricted the supply to big industry prompting further efficiency. The Energy Intensive Users' Group (EIUG) now says this represents a structural change with reduced energy intensity and lower demand growth in the future.[6]

Given the reduced demand, Eskom flipped from shortage to surplus when the first Medupi unit came on line in 2015. It is now desperately trying to boost sales to soak up its surplus capacity and increase revenues – much as we predicted, in 2009, that it would do.[7] In August, CEO Phakamani Hadebe told parliament that Eskom had signed nine deals intended to boost sales. It seems that these deals offer cut price power to energy intensive industries. In short, Eskom has dropped demand side management and the IRP has followed its lead – demand side management appears only in the glossary of this plan.

Meanwhile, Eskom is applying for another round of big tariff hikes of 15% a year for the next three years. It seems that this application is built into the IRP 2018 which shows a massive 40% real increase in the next three years. The IRP is thus caught by the contradictions into which the new build has pulled Eskom – punting sales while escalating tariffs. This produces contradictory and incoherent results:

- As with all previous IRPs, the demand projection is more wishful than realistic.
- Deals for big industry leaves the bill for the new build with residential and commercial consumers.
- Rising tariffs inadvertently drive demand side management. Leaving DSM to price favours the rich, who have options, against the poor who do not.

[6] EIUG comment on the IRP 2016, March 2017.
[7] groundWork, The World Bank and Eskom: Banking on Climate Destruction! Written by David Hallowes, December 2009,

- This will provoke accelerated grid defection by commerce and the middle classes as the cost advantage of small-scale dispersed ‘embedded’ renewables increases.
- Municipalities and poor people will then be left with an overpriced slum grid. Over 56% of people in South Africa are poor and many who have ‘access’ to electricity are cut off – either disconnected or without money for pre-paid meters.
- The IRP does forecast an increase in embedded energy generation but effectively treats it as outside the national power system and hence as reducing demand from that system. It does not conceive a system that integrates small-scale dispersed generators and household ‘prosumers’.
- And it does not conceive a system that integrates the poor majority of the country.

Supply

IRP 2018 specifies what new plant will be needed from now to 2030. It models requirements through to 2050 but argues that things are changing too fast for concrete planning beyond 2030. Regular IRP updates should modify these plans for the 2020s as well as extending the planning horizon.

Figure 1 shows the IRP’s ‘recommended plan’ [41] with: existing capacity in 2018; the completion dates for new plant that is already ‘committed’; completion dates for new plant beyond that; and ‘embedded’ generation installed for own use at businesses or homes. It does not give annual figures for carbon emissions, water use, total capacity, the share of production for each technology, projected peak demand, reserve margins or DSM savings.

	Coal	Nuclear	Hydro	Storage (Pumped Storage)	PV	Wind	CSP	Gas / Diesel	Other (CoGen, Biomass, Landfill)	Embedded Generation
2018	39 126	1 860	2 196	2 912	1 474	1 980	300	3 830	499	Unknown
2019	2 155					244	300			200
2020	1 433				114	300				200
2021	1 433				300	818				200
2022	711				400					200
2023	500									200
2024	500									200
2025					670	200				200
2026					1 000	1 500		2 250		200
2027					1 000	1 600		1 200		200
2028					1 000	1 600		1 800		200
2029					1 000	1 600		2 850		200
2030			2 500		1 000	1 600				200
TOTAL INSTALLED	33 847	1 860	4 696	2 912	7 958	11 442	600	11 930	499	2600
Installed Capacity Mix (%)	44.6	2.5	6.2	3.8	10.5	15.1	0.9	15.7	0.7	

Installed Capacity
Committed / Already Contracted Capacity
New Additional Capacity (IRP Update)
Embedded Generation Capacity (Generation for own use allocation)

Figure 1: IRP Proposed Updated Plan for the Period Ending 2030

Coal

Coal starts with 39 126 MW. The committed plants are the remaining eight units (5 732 MW) of Medupi and Kusile with three due for commissioning in 2019. In fact, two of these plants are already spinning but Eskom seems to be delaying formal commissioning. The new plants are the coal 'base-load' independent power producers (BLIPPs) – Thabametsi and Khanyisa – to be procured by the Department of Energy.

In building Medupi and Kusile, Eskom was trying to reproduce the energy model of the minerals energy complex (MEC). This effort has broken Eskom – putting it into a utility death spiral – and puts South Africa at risk. Corruption clearly contributed to the escalation of costs at these two plants but Eskom was already in crisis in 2009 when it called on the World Bank for a loan for Medupi. Research by Meridian Economics shows that the levelised cost of electricity – the cost of production over the life time of the plant in today's money – from these plants is exorbitant at R1.70 for Medupi and R1.91/kWh for Kusile. It also shows that Eskom could save R4

billion by not completing the last two units of Kusile.[8] More money could be saved by not completing Medupi since the last three units there must be stranded unless an expensive water transfer scheme is constructed, [9] starting with a new dam in the Lesotho Highlands to transfer more water into the Vaal system, transfers from the Vaal into the Crocodile and a long pipeline from the Crocodile to Lephalale.

These plants have a 60 year life span taking them to 2080. But they will be abandoned long before then either because running coal plants will become unacceptable or because the heat, droughts and floods brought on by climate change will make it physically impossible to run them.

The IRP's 'recommended plan' forces the inclusion of the first units of Thabametsi (630 MW) and Khanyisa (300 MW) to come online in 2023-24 – two years later than scheduled at present. Both plants were originally justified as addressing Eskom's supply crisis. That crisis ended in 2015 so they will be eight or nine years late. And the fact that they had to be forced into the plan shows that they are not needed to replace Eskom plant due for decommissioning.

Power from these plants was bid at R1.03/kWh while carbon emissions are comparable with Eskom's oldest and dirtiest plants. Energy minister Jeff Radebe has suggested that any new coal plants must to incorporate the latest technology to reduce emissions. This would increase the bid price but make little difference to the climate impact of the plants. Rather, the Energy Research Centre (ERC) shows that they will displace renewable energy at an additional cost to the energy system of around R20 billion and additional emissions of 170 Mt CO_2 over their 30 year life span.[10] As with the Eskom plants, however, they will likely be stranded well before then.

The IRP schedules decommissioning of Eskom's old plant from 2020 onwards. By 2030, Camden, Hendrina, Arnot, Komati, Grootvlei and Kriel are all closed along with the first two units at Matla and one unit at Duvha [61]. At present, Duvha has one unit out following a boiler explosion in 2014. The project to replace it has been held up in litigation by would be contractors who allege that the contract was improperly awarded. In the circumstances, it is difficult to see why Eskom should not save itself another R3 or R4 billion, together with lawyers' fees, and close the unit now – or repurpose the turbine as a flywheel.

At the end of the period, in 2030, installed coal-fired capacity is 33 847 MW. By then, the coal alone will cost more than electricity from renewables.

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[8] Grové Steyn, Jesse Burton and Marco Steenkamp, 2017, *Eskom's financial crisis and the viability of coal-fired power in South Africa: Implications for Kusile and the older coal-fired power stations*, Meridian Economics.

[9] Eskom Annual Report 2018, p.86.

[10] Gregory Ireland & Jesse Burton, 2018, *An assessment of new coal plants in South Africa's electricity future: The cost, emissions, and supply security implications of the coal IPP programme*, Energy Research Centre, UCT.

Renewables

In 2018, installed PV capacity is 1 474 MW. 814 MW is committed to be commissioned between 2020 and 2022 and, following a two year hiatus, another 5 670 MW is to be installed from 2025 to 2030. In 2030, total installed PV is 7 958 MW.

Existing wind is 1 980 MW in 2018. 1 362 MW is committed to be commissioned by 2021. There is then a three year gap with another 8 100 to be installed from 2025 to 2030 adding up to a total of 11 442 MW.

The gaps in commissioning PV and wind will likely deter investment in factories producing components for the renewable industry.

There is 300 MW concentrating solar power (CSP) with another 300 committed for commissioning in 2019. No more is added during the period.

The plan also assumes that 2 600 MW of 'embedded' power – mostly PV – will be added by households and businesses for their own use at the rate of 200 MW a year. For the most part, power from small-scale PV is already cheaper than municipal prices and only the capital costs deter installation.

For renewables, the IRP 2018 uses the costs from bid window 4 expedited – the latest round of government's renewables IPP programme before Eskom shut it down in 2015. At 62c/kWh, it costs a third less than the dirty coal BLIPPs. Internationally, renewable costs are still falling rapidly so this cost is still inflated. This makes no difference to the fact that renewables are cheaper than any other new plant. However, the cost of renewable power per kWh is already below Eskom's cost of production (63c/kWh excluding depreciation and debt) and, as Grové Steyn points out, will soon fall below the cost of coal needed to produce a kWh.[11]

Gas /diesel

There are now 3 830 MW open cycle gas turbines (OCGT) – which actually run on diesel but can be converted to gas. These are peaking power plants – cheap to build but very expensive to run – designed to run for short periods when peak demand exceeds supply from other sources. The 'recommended plan' calls for another 8 100 MW of new gas though it is not clear how much is OCGT and how much is closed cycle gas turbine (CCGT) which is much more efficient and runs more like a conventional plant. Gas is held to be a good companion to renewables because it is more flexible than coal or nuclear – it can be turned up or down according to the weather.

[11] Grové Steyn, *Energy plan's drafters are stuck in a coal hole and have just kept digging*, Business Day, 3 September 2018.

The large increase in gas implies either that it is imported or that a source is discovered and developed in South Africa. Sasol already has a gas pipeline from Mozambique and has built two gas plants – alongside its existing coal plants – to produce power for its own use. The pipeline and power plants were constructed with government subsidies. Hence, Sasol stands to benefit handsomely from an expansion of gas, whether as a vendor of gas or as a gas IPP. The next options for gas include fracking shale in the Karoo or fracking coal in places where it cannot be mined. It is doubtful that there is much gas to be had. Be that as it may, these options are excessively polluting of water and very prone to leaking gas at the well heads.[12] Government has also parcelled out concessions for offshore oil and gas exploration all around the coast. Big oil corporations, including ExxonMobil, Sasol and ENI, have already run several seismic campaigns. As the military metaphor implies, these campaigns amount to an all out assault on marine life.

Finally, imports of liquified natural gas (LNG) have been proposed. South Africa's export credit agency has invested in an LNG project in Mozambique owned by Anadarko, a US transnational corporation. This project has already caused the dispossession of local people and severe environmental impacts on local fisheries. The presumed benefits of this investment to South Africa are obscure.[13]

All extracted gas is methane. At the power station, it burns cleaner than coal and produces less than half the carbon emissions. But leaks from well heads, pipelines and storage tanks will eliminate the advantage. Particularly high concentrations of methane have been measured over the fracking fields of the USA.[14] Methane is a very potent greenhouse gas. Over a twenty year time horizon, each tonne is equivalent to around 86 tonnes of CO_2. It is also a toxic gas at ground level.

Hydro

IRP 2018 sees 2 500 MW of new hydro imported in 2030. This is supposed to come from the Inga project in the Democratic Republic of Congo. The DRC, of course, is not very democratic. People dispossessed by the original Inga project, developed in the 1970s but now barely functional, have never been compensated. The new Inga projects have been on and off for a decade or two.

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[12] Scholes, R., Lochner, P., Schreiner, G., Snyman-Van der Walt, L. and de Jager, M. (eds.). 2016. *Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks.* CSIR

[13] Ilham Rawoot, *The SA export credit agency that can invest billions in public money on shadowy projects*, Daiy Maverick, 3 September 2018.

[14] Christian Frankenberg, Andrew Thorpe, David Thompson, Glynn Hulley, Eric Kort, Nick Vance, Jakob Borchardt, Thomas Krings, Konstantin Gerilowski, Colm Sweeney, Stephen Conley, Brian D. Bue, Andrew Aubrey, Simon Hook, and Robert Green, 2017, *Airborne methane remote measurements reveal heavytail flux distribution in Four Corners region*, PNAS; and
Lena Höglund-Isaksson, 2017, *Bottom-up simulations of methane and ethane emissions from global oil and gas systems 1980 to 2012*, IOPscience, doi:10.1088/1748-9326/aa583e

Existing hydro (2 196 MW) is from Cabora Bassa in Mozambique. About 5 000 people were dispossessed in the 1970s to make way for it. It has had severe impacts on flood recession agriculture downstream and on erosion of the delta and adjacent coast.

Storage

All energy systems need storage. Base plant, such as Eskom's coal and nuclear stations, are rigid in operation as they need to keep going at a constant rate. They produce surplus electricity at night as demand drops but not enough to meet peak demand. Pump storage dams use the surplus to pump water up hill at night and release water at peak hours to supplement the supply of base load. The OCGT peaking plants are also required to supplement the base plants.

For a system based on variable renewables, the surplus is produced by solar during the day. Such a system needs more storage and/or supplementary flexible plant than a conventional system. Hence, it needs a larger reserve. Previous IRP's have assumed that there must be enough 'reliable' power to cover peak demand with an additional reserve. IRP 2018 does not appear to follow this line but we cannot see what it does do because it does not show the reserve margin.

The IRP shows 2 912 MW of existing pumped storage in 2018 and does not add storage of any kind before 2030. It is widely observed that the cost of battery storage is falling fast. If the IRP were to treat dispersed energy as part of the national system, it is likely that considerable storage will be created by the sum of micro systems. Smart grid operations would create additional virtual storage. The grid could also be balanced by storing gas produced in municipal bio-digesters for peak use. Bio-digesters should be built to replace crumbling municipal sewage works. Finally, decommissioned steam generators can be converted for use as fly-wheels both for storage and grid stability. The determined pursuit of these options would obviate the need for extractive gas.

Another IRP is necessary

IRP 2018 says that it aims to "balance a number of objectives, namely to ensure security of supply, to minimize cost of electricity, to minimize negative environmental impact (emissions) and to minimize water usage" [10]. It is difficult to see how forcing in the addition of 1 000 MW of privatised coal-fired plant fits with this balance. Health objectives are perhaps included under environmental impacts but should be made explicit along with the health impacts of the plan. It should make clear how much death and disability is acceptable to government.

Beyond this, we observe that the climate cannot be balanced against competing objectives. The issue is simple: the more carbon that is pumped into the atmosphere, the worse the impacts will be irrespective of balance against security of supply or

cost. Without very serious reductions in emissions, the impacts will take down the power system followed by the national and international state system.

South Africans can create another energy future based on renewables or we can go down tied to the old energy model. This is the model of the 'minerals energy complex' that has shaped South Africa's development for over a century. It is based on cheap coal, cheap labour and heavy duty pollution. It is unsustainable economically and is socially and environmentally catastrophic. It is now collapsing.

This IRP shows the DoE's reluctance to untie from this model. It plans for a world that plays the numbers but does not seriously address climate change. A world that is seriously addressing climate change is a world which changes the economic and associated energy system. Energy planning should be made compatible with this world. Alternatively, it must anticipate catastrophic climate change. The IRP 2018 does neither.

Transforming power

Energy is situated by what people need to do with it in their homes and settlements and by what businesses do in mines, factories, shops and offices. The first priority must be to minimise consumption – cutting profligate consumption while ensuring that all people have enough. This cannot be left to pricing and a market which dictates that poor people are cut off.

Enough is a lot less if homes are built for thermal efficiency. In most townships houses are badly built and the infrastructure is in disrepair. Roads are potholed, drains are blocked, water pipes leak, sewage spills into the streets and rubbish piles up on the corners. This makes people more vulnerable to the heavy weather of climate change. Planning for resilience is also about ease of living – amongst other things, how much energy is needed for a full life.

The system must move off coal and onto renewables as fast as possible and this must be planned and carried through as part of a just transition that provides for workers and communities. That means no new coal stations, private or public, not completing Kusile, early decommissioning of Eskom's stations and no new extractive gas. The renewables system constructed in place of coal should be socially owned with a national grid controlled by a publicly owned system operator separate from Eskom. The latter must, however, be allowed and indeed required to move to renewables.

The Million Climate Jobs campaign looks to build enough to supply all South Africa's electricity demand from renewables by 2038. That means building 15 000 MW a year of wind and solar power. That's enough to attract considerable manufacturing capacity. It will also sustain a large number of construction jobs and growing numbers of maintenance and operations jobs. Creating a 'smart grid' to go with renewables will also require more jobs than the conventional grid. The Million

Climate Jobs team calculates 250 000 jobs at the start of a determined renewable build programme with another 88 000 maintenance and operations jobs by the end of the period.[15] Eskom at present employs 48 000 people and intends reducing that to about 33 000. The coal mines, including exports, employs about 80 000.

The bulk of generation should be dispersed through households, community scale mini-grids and municipal scale local grids. Mini-grids should be interlinked with each other and through the municipal and national grids and dispersed generators should be backed up with national scale generators to moderate variability. Off-grid mini-grids should be engineered to link to the main grid, or neighbouring mini-grids, when this becomes practicable. In this way, off-grid systems would be seen to attract rather than repulse the grid.

Over the last 30 years, transport has been made ever more dependent on liquid fuels. Rail has been neglected with the exception of the lines carrying mineral and energy resources for export – starting with coal. The capacity of pipelines to carry imported oil and refined fuels – from Durban and Maputo to Gauteng – has also been expanded. Everything else goes by road at ever increasing cost. A just transition must create a public transport system which is safe, comfortable, affordable, preferable to using cars and powered by electricity from renewables in place of petroleum. It should also create space for walking and cycling.

In sum, if government wants to 1) uphold people's constitutional rights, 2) supply the energy needs of its people, 3) avoid catastrophic climate change while ensuring a just transition to a low carbon and egalitarian society that provides for all, 4) clean up air pollution to let people breathe, 5) conserve land and water and prevent the further destruction of whole watersheds, and 6) avoid bankrupting itself, it is imperative to focus national resources on developing renewables under democratic control while shutting down coal plants.

[15] Brian Ashley, Dick Forslund, Thembeka Majali, Lucia Winkler, Jonathan Neale, Jeff Rudin and Sandra van Niekerk, 2017. *One Million Climate Jobs: Moving South Africa forward on a low-carbon, wage-led and sustainable path*. Alternative Information and Development Centre.