Integrated Energy Plan (IEP) and Integrated Resource Plan (IRP) 2016.

Comments by groundWork, Friends of the Earth, South Africa and Earthlife Africa Jhb

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Introduction

The IEP is the overall energy plan for liquid fuels (petrol, diesel, paraffin), gas and electricity. The IRP is the more detailed plan for electricity. Both plans make projections of energy / electricity demand through to 2050 and consider how to supply that demand. The IEP contains four different scenarios which result in different levels of demand. The IRP does not refer to these scenarios but uses electricity demand projections developed by the CSIR.

The final 'policy adjusted' version of the IRP, as approved and promulgated by cabinet, will provide the legal basis for 'ministerial determinations' on what capacity should be added to the electricity system in the following years. The new plans have been much delayed. At present, the IRP 2010 (actually approved in March 2011) provides the legal basis for decision making. The first paragraph says:

> 1.1 The Integrated Resource Plan (IRP) is a living plan that is expected to be continuously revised and updated as necessitated by changing circumstances. At the very least, it is expected that the IRP should be revised by the Department of Energy (DoE) revision in 2012.

In 2013, the DoE produced a draft of the first IEP and an 'IRP 2010 update' and invited public comment. The 'changing circumstance' noted in the 'update' was a substantial reduction in forecast energy demand. (groundWork observed that the 2010 forecast was grossly exaggerated and the 2013 forecast was still way too high.) In consequence, new nuclear power should be delayed for a decade if not forever.

Following public workshops, however, the 2013 process disappeared. The DoE made no announcement that the process was delayed or suspended or terminated. It said nothing at all. Over the next two of years, the circumstances kept on changing. Not only did demand grow less rapidly than forecast, it shrank. And the cost of renewables declined faster than was

expected. Meanwhile, it leaked out that President Jacob Zuma had led clandestine negotiations with Russia's President Putin for Russia to supply a fleet of nuclear power stations. This confirmed suspicions that the 2013 process was stalled because it was likely to result in nuclear power being deleted from South Africa's energy plans.

In 2014 and 2015, perhaps as a way of managing civil society demands, it was variously rumoured that the process would be revived. In early 2016, it was said that the plans would be presented to cabinet for approval ahead of public consultations. In October, a version of the IEP was presented to the parliamentary committee and, on 17 November, cabinet announced that it had discussed, amended and approved a version for public consultation.

Over three years after stalling the 2013 process, the Department of Energy (DoE) presented the IEP and IRP 'base case' at a press conference on 22 November 2016. They posted the actual documents on the website on 25 November. They then also posted a schedule of consultations in Johannesburg, Durban, Cape Town and Port Elizabeth beginning Wednesday 7 December – two weeks after their presentation and just eight working days after the documents were posted. The DoE asked for comment on the assumptions behind both plans and on the IRP base case. Some background papers on the assumptions were posted only on 7 December. Others are yet to be posted and a DoE paper on nuclear costs is apparently secret. This looked like a dishonest process designed to limit rather than facilitate participation.

The substance of the plans was equally problematic. In particular, the IRP inflated the known costs of renewables while depressing the costs of coal and nuclear. It also put an arbitrary limit on how much renewable energy could be added each year. Most observers concluded that the DoE had distorted the data to favour coal and nuclear and were steamrolling the process to limit debate.

During the consultation workshops, the DoE repeatedly said that this was not their intention. They said they would consider extending the time periods for consultation. In particular, they said they would ensure that communities affected by the energy system – that is the fenceline communities next to coal mines, power stations, coal-to-liquid plants and oil refineries – would be able to comment on the plans. On 23 December, the DoE posted a new schedule for consultations in Kimberly, Polokwane, Nelspruit, Mafikeng and Bloemfontein starting 23 January. groundWork emailed the DoE to note that this did not enable comment by communities on the Highveld, the Vaal and the Waterberg but did not receive a response.[1] At the same time, the DoE extended the deadline for written comments from 15 February to 31 March 2017.

[1] E-mail from gW to DoE: RE: IEP and IRP public consultation notices, 29 December 2016.

The IEP

Objectives, scenarios and assumptions

The policies that shape the IEP starts with energy policy, and includes: 'overarching national policies' – the National Development Plan (NDP) and the New Growth Path; industrial action plans and policy for beneficiation; the National Transport Master Plan; and the Climate Change Response Policy and the carbon tax proposal.

From this, the IEP identifies eight objectives supposed to be of equal weight. Some, however, seem more equal than others. First up is 'security of energy supply' (demand must be met) followed by: minimise cost; increase access; diversify energy sources; minimise CO_2 emissions (other pollutants are not included); improved energy efficiency; economic localisation, technology transfer and job creation; and water conservation.

The IEP creates four scenarios to describe potential energy futures for South Africa:

- The 'Base Case' is business-as-usual and assumes "existing policies are implemented";
- 'Resource Constrained' comes with high fossil fuel prices "due to limited supply";
- 'Environmental Awareness" comes with tighter emission limits and higher costs for externalities;
- 'Green Shoots' sees the successful implementation of the NDP with high economic growth and a shift from primary minerals to manufacturing and services.

Macro-economic assumptions include a discount rate of 8.4%, down from a very high 11.3% used in 2013. A high rate has two major implications: first, investing now to avoid the future impacts of climate change just doesn't make economic sense; second, investments with high upfront costs but low future costs (such as renewables) are discouraged.

The second economic assumption concerns the rate of GDP growth which is critical to calculations of future demand. The top part of table 1 is taken from the IEP Annexure B: Macroeconomic Assumptions [3]. It says the figures are "based on National Treasury's most recent in-house estimates of growth". Since the paper is not dated, it is not clear when 'most recent' was. The bottom line in the table is taken from a Treasury presentation made in November 2016.

Table 1: Forecast GDP growth and actual growth (%).

	Short term				Medium term	Long term
	2014	2015	2016	2017	2018-2022	2023-2050
Low growth	1.5	1.8	2.3	2.5	2.8	3.0
Moderate growth	1.8	2.7	3.2	3.5	3.7	4.2
High growth	2.0	3.3	3.7	4.0	4.9	5.5
Actual growth	1.6	1.3	0.5			

Source: IEP Annexure B: Macroeconomic assumptions (not dated).
Actual from Treasury Investor Presentation, November 2016.

The IEP uses the moderate growth forecast in all scenarios except 'Green Shoots' which is based on the NDP's wished for growth of 5.4% till 2030. Actual growth, however, has fallen well below the 'low growth' forecast. As usual, Treasury sees recovery around the corner but its November forecasts for the next three years still come in below 'low growth': 1.3% in 2017, 2.0% in 2018 and 2.2% in 2019.

In the longer term, the low growth projection still looks optimistic. There are three major reasons for this. First, the so called 'great recession' is not over. Outright depression has been kept at bay only by the big central banks blowing bubbles and inflating stock prices. This will not be sustained but the costs are meanwhile pushed onto those who the global economy makes vulnerable. Second, the economic impacts of climate change and environmental damage will increase exponentially. Third, the social costs of maintaining capital on the one hand and of climate change on the other will increasingly destabilise society.

The third economic assumption concerns fuel prices. The IEP assumes future oil and gas prices based on International Energy Agency (IEA) forecasts, shale gas prices based on PetroSA data and coal prices based on data from the Electric Power Research Institute (EPRI), a consultancy from California. The IEA represents establishment views and its forecasts generally give a rose tinted view of future energy market growth. It is not clear what credibility should attach either to PetroSA or EPRI. The IEP fixes coal and shale gas prices for the entire period to 2050. This may reflect the difficulty of price forecasts but creates a false stability. We think it rather more likely that international markets will be defined by price volatility with shortening boom-bust cycles. Despite Eskom's dominance, the churn will enter the local coal market for three inter-related reasons: first, the break-up of the MEC is both symptom and cause of instability; second, Eskom is favouring short term contracts and spot buying at the expense of long term agreements; and third, the central coal fields of the Highveld are in decline.

Demand

Security of energy supply is the first named of the IEP's objectives. "A fundamental objective of the IEP is to ensure that all projected future energy demand is met" [42]. Meeting demand is thus an absolute imperative.

The IEP discusses demand in relation to economic sectors: industry (including mining), commerce, agriculture, transport and residential. For each sector, it gives a breakdown of:

- The uses of energy in 2010 (e.g. heating, cooling, pumping);
- What energy is used (e.g. electricity, petrol, coal, gas);
- What has driven increased energy use between 1993 and 2010 (2000-2010 for industry);
- Projected energy demand from 2013 to 2050 for each scenario.

Figure 1 shows the projection for all sectors through to 2050. This likely exaggerates demand growth since it assumes 'moderate economic growth' given in Table 1 above. The 'Green Shoots' scenario is the exception and more fantasy than plausible future. It assumes high growth through to 2030 after which the rate of growth tapers off. Hence, energy demand rises more quickly than in other scenarios until about 2030 and it levels off after 2035. All the other scenarios show energy demand rising more steeply with time.

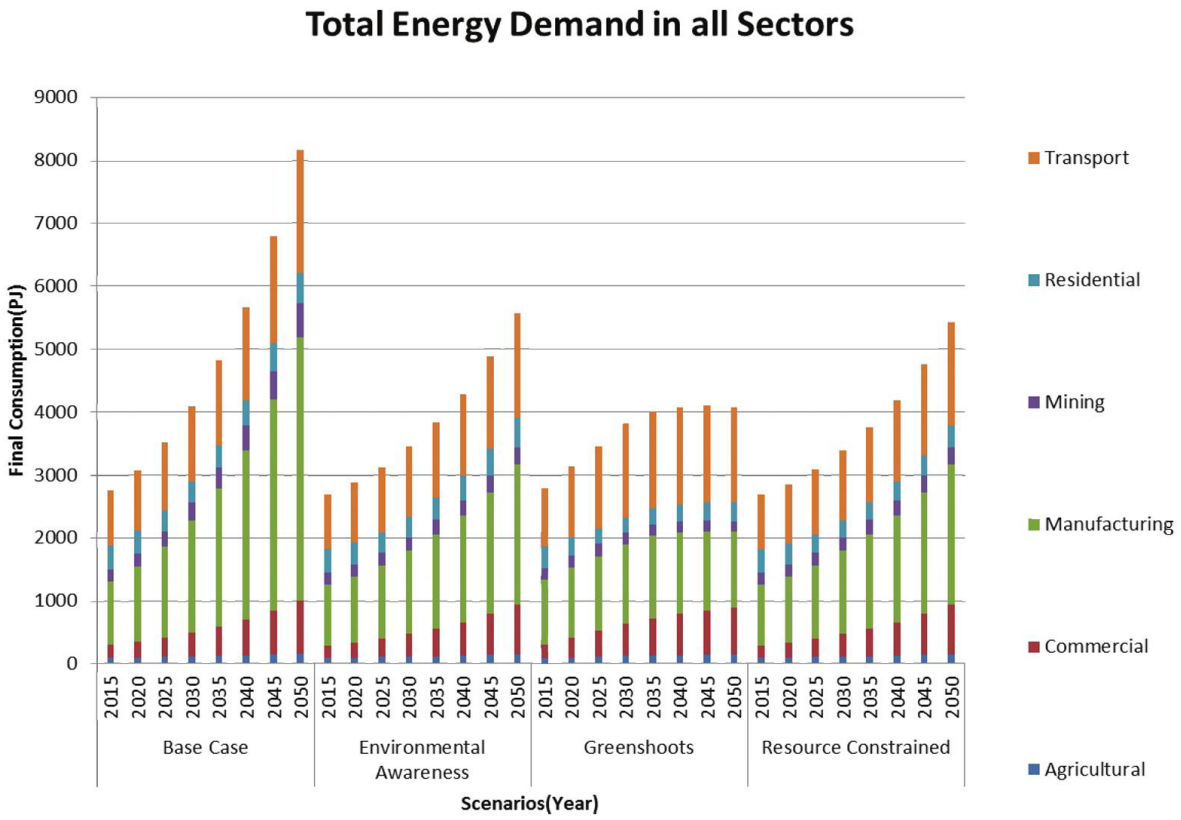

Figure 1 [IEP 107 Fig. 0-27].

Table 2 puts numbers to the projected increase in energy demand from 2010 to 2050. For the most part, outcomes for 'Environmental Awareness' are more or less identical with 'Resource Constrained'. This is because the model treats internalised environmental costs in the same way that it treats price increases but does not account for the benefits of reduced pollution. We'll call it RC/EA. The IEP mostly shows just the three scenarios.

Table 2: Energy demand in 2050 (PJ) relative to 2010 (%).[2]

		Base Case		Green Shoots		RC/EA	
	2010	2050	%	2050	%	2050	%
Total	**2850**	**8100**	**284**	**4050**	**142**	**5500**	**192**
Industry	1200	4550	379	1350	112	2500	208
Commerce	200	850	425	800	400	800	400
Agriculture	95	155	163	145	153	150	157
Residential	375	480	128	300	80	345	92
Transport	800	1750	218	1350	168	1450	181

Energy intensity

The IEP shows reduced energy intensity (energy use per unit of GDP) in all sectors – with the partial exception of commerce – as machines and processes are made more efficient. But the largest reduction in the energy intensity of the economy as a whole results from higher economic growth in the tertiary sector (commerce and transport) than in the secondary sector (industry) and primary sectors (agriculture and mining). According to the IEP, "Since the 1990s, economic growth has been driven mainly by the tertiary sector and more recently South Africa is moving towards becoming a knowledge-based economy, with greater focus on technology, e-commerce and financial and other services" [79]. Going forward, this trend is most pronounced in Green Shoots.

Hence, the IEP shows commercial demand growing fastest. In our view, this 'shift to services' is overdone: first, many services are dependent on heavy industry (such as Sasol's chemical engineering design services and the whole host of services got up to create the 'clean coal' story); second, the shift to services in the North was accompanied by the outsourcing of dirty industry to the South and is not a model that can be followed; third, the growth of financial and related services is a symptom of financialisation which sucks value from the economy rather than adding it. Some of the consequences are evident in the unsecured debt crisis exposed at Marikana. Globally, the economic crisis created by financialisation is not close to over.

Energy efficiency is the other driver of reduced intensity. From 1993 to 2010, however, commercial use of energy was increasingly inefficient – so much so that inefficiency adds more than increased activity (i.e. economic growth) to commercial energy use. In the Base Case and Green Shoots scenarios, this trend of increasing energy intensity is carried through to the 2030s. Two reasons are given: Energy efficiency regulations apply to new buildings but not to existing buildings and retrofits are superficial. Second, climate change will bring hotter temperatures and increased use of air conditioners. Higher costs in the RC/EA scenario result in the early reversal of inefficiency.

[2] Petajoules (PJ) is a very large measure of energy. The DoE has not posted a technical paper giving actual numbers. I've read the numbers off the IEP bar charts so they are approximations and this is why sectoral numbers do not add up to the totals. It is not possible even to estimate numbers for industry sub-sectors: mining, iron & steel, other metals, chemicals and manufacturing.

Historically, cheap energy has produced a grossly inefficient industrial sector. However, the IEP shows substantial efficiency improvements between 2000 and 2011. Given the series of electricity price hikes since 2008, it is likely that most improvements date from then. The IEP's actual data is very dated. It goes only to 2011 and, in consequence, misses the most significant change in South Africa's energy economy. Between 2012 and 2014, the Energy Intensive Users Group (EIUG), representing the biggest 32 industrial consumers, showed a dramatic decline in electricity demand. We will discuss this in more detail in our IRP comment but note here that the IEP lacks credibility if it cannot update actual data to at least 2014.

The IEP shows reduced residential energy demand in all scenarios to 2030. This is due to solar water heater (SWH) programme with 1 million SWH installed in the Base Case, 5 million in RC/EA and 10 million in Green Shoots. In all scenarios, but without explanation, the programme ends in 2030 and energy demand then rises again in line with projected GDP growth. The IEP does not comment on the distribution of GDP but says: "Despite increased electrification, … coal will remain dominant in certain low-income households for the foreseeable future" because it is "relatively affordable … (especially for communities close to mines)" and "provides space heating and cooking simultaneously" [95]. We must conclude that the DoE does not have much faith in the Department of Environmental Affairs' (DEA) latest initiative to address domestic emissions.

Agricultural demand is from high input industrial agriculture using diesel followed by electricity. IEP says that most "efficiency gains from improved machinery, equipment and production practices have been realised" [76] but later shows substantial reductions in energy intensity [78, fig. 0-4]. It sees the Biofuels Industrial Strategy pushing the expansion of industrial agriculture. "The strategy targets new and additional land which is approximately 1.4% of arable land in South Africa …" [77]. It does not tell us that this amounts to a land grab displacing small scale low energy farming in the former bantustans. It replays the notorious apartheid 'betterment' schemes.

Transport demand rises inexorably in all scenarios. The IEP notes various government plans for "integrated rapid public transport networks" but sees more people moving public transport to private cars following "improvements in GDP per capita" [99]. The passenger vehicle fleet runs mostly on petrol and the expansion in traffic is partially offset by increased efficiency. The IEP sees little potential for a shift to electric vehicles. It does not mention walking and cycling – despite the fact that more people in SA walk than drive to work.[3]

Freight transport efficiency has scarcely improved. The IEP sees tonnage increasing by four times and almost everything goes by road except coal and iron ore. The IEP says road is preferred by business because it is more reliable, more convenient and faster. In contrast, rail is cheaper, uses less energy and does less damage to infrastructure and to the environment. The 2013 draft IEP said 'further analysis' was needed to see if Transnet's freight rail

[3] [xx SEA reference]

investments would shift some of the load to rail. IEP 2016 drops the subject. As we noted in 2013, there is lots of planning going on to expand road capacity on the Durban-Johannesburg route but little evidence that Transnet is in fact doing real planning to expand rail freight – this despite present congestion and Transnet's over-ambitious plans to expand port capacity by about nine times. Instead, the coal, iron ore and manganese lines are given precedence.

Apart from the SWH programme, the IEP does not progress beyond efficiency in its treatment of demand side management. Reduced energy and carbon intensity is necessary but does not of itself address climate change. Throughout the 20th Century, energy intensity has decreased but overall demand has increased. In fact, in a capitalist system, increased efficiency leads to expanded demand as savings in energy increases profits and further investment. Addressing climate change requires an absolute and rapid reduction in carbon emissions, not more production per tonne emitted.

Supply

Having projected demand, the IEP models supply options for electricity and liquid fuels in each scenario.

In the power sector, new plant must compensate for decommissioning old plant as well as supplying increased demand. The IEP shows a substantial increase of power generation capacity from about 50 GW in 2015. By 2050, it is increased to165 GW in the Base Case, to 120 GW in RC and EA and to 85 GW in Green Shoots. All scenarios increase sharply to 70 GW or more by 2030 reflecting the inflated demand projections. It has been evident since at least 2014, however, that the completion of Medupi and Kusile will create surplus capacity – unless the dirtiest old coal plants are closed early. Indeed, the recent collapse in demand is such that the system appears to be in surplus with just one unit operating at each of these plants.

Figure 2 gives a breakdown of the new capacity. The independent power producer (IPP) programme has demonstrated that new renewable energy – wind and solar PV – is cheaper than any other new plant including coal. Subsequent international prices confirm that they will get cheaper still. The IEP, like the IRP, evidently relies on dated information to secure a place for more coal after Medupi and Kusile. Similarly, it secures a place for new nuclear. The numbers in the bar chart are in addition to the 9.5 GW nuclear build authorised by a ministerial determination. This is counted as 'existing' although the procurement process has barely started. The IEP also assumes that South Africa will hit the fracking jackpot with shale gas or coal bed methane or both. (Electricity will be discussed in more detail in our comment on the IRP.)

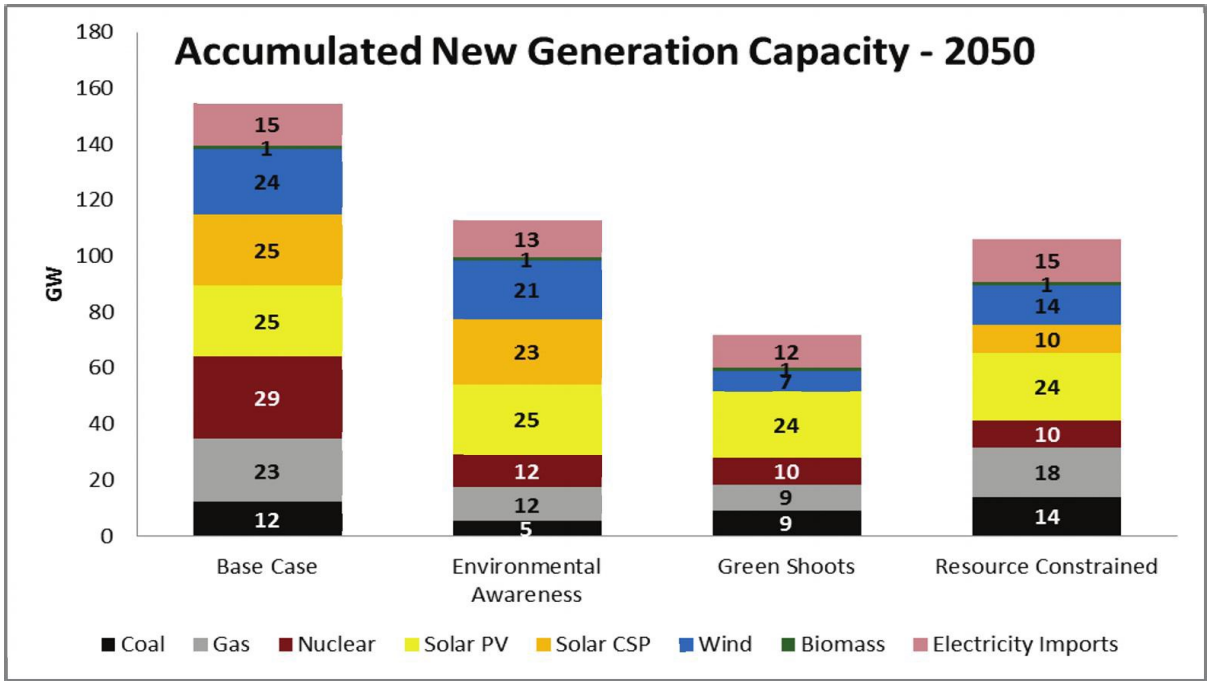

Figure 2 [IEP 116 Fig. 0-4].

Under liquid fuels, the presumed gas boom also provides feedstock for new gas-to-liquids plants. Existing coal-to-liquids is also "likely to be maintained throughout the period" in all scenarios except 'environmental awareness' [118]. On the other hand, the IEP finds that cheap gas makes new crude oil refining unviable and importing petrol and diesel is the "more cost effective option" [117].

Imported fuel costs are nevertheless the largest component of total energy system costs for 2014-2050 but a little cheaper than present oil and fuel import costs.

Alongside shale gas, the IEP punts underground coal gasification (UCG) and coal bed methane (CBM) as 'clean coal' technologies. Both technologies demonstrate that clean coal is a contradiction in terms. Both have severe impacts on water and are prone to venting methane along with sundry volatile organic compounds.[4] UCG has been banned on environmental grounds in Scotland and even in the pro-coal Australian state of Queensland.[5] In South Africa, the IEP cites Eskom's Majuba project as a working example but this plant has been shuttered.

The real motivation for both UCG and CBM is to expand the resource. In the words of the IEP, "Since up to three quarters of South Africa's coal may not be mineable, UCG could help to increase South Africa's 'coal supply'…" [46]. That would mean an extra 80 and 160 Gt CO_2 depending on whose estimate of the conventional coal reserve one believes. By

[4] The groundWork Report 2016, The Destruction of the Highveld, Part 1: Digging Coal, written by David Hallowes and Victor Munnick, groundWork, p.176 ff.
[5] Severin Carrell, Scotland bans controversial gas extraction technique, The Guardian, 6 October 2016; Esmarie Swanepoel, Queensland bans underground coal gasification over environmental risks, 18 April 2016.

comparison, government's climate policy gives South Africa a greenhouse gas 'budget' of between 15 and 23 Gt. Below, we argue that the budget is, optimistically, 10-12 Gt.

Externality costs

The costs of pollution are considered for the first time. The IEP says: "Externality costs are included in the modelling of the energy system and represent the damage costs caused by pollutants, more specifically CO_2, NO_x, SO_x and particulate matter." It gives examples of negative impacts including "the effect of carbon emissions on the climate; deterioration of health and mortality due to fires and inhalation of poisonous fumes from the combustion of harmful fuels; waste handling of spent nuclear fuels; and disaster management in the event of leaks or spills" [119].

However, nuclear waste and impacts from mining uranium are not costed. Only the air emissions from "power stations, refineries, vehicles, mining, shale gas and gas" shown in Table 3 are considered [67]. Water use is costed – correcting for the effective subsidy to the power system – but not water pollution. The destruction and contamination of land is not included.

Table 3: Externality costs (Rand/kg)

Carbon dioxide	0.27
Sulphur dioxide	7.60
Nitrous oxide	4.50
Mercury	41,484.00
Particulate matter	11.30
Particulates in transport sector	280.70

In the case of CO2, however, the "externality cost … is calculated based on the carbon tax rate advocated in [Treasury's] proposed Carbon Tax Policy" [69]. This is well below the externality cost (R270/tonne) in the table. Treasury's proposal is for a R120/tonne carbon tax followed by a 10% annual increase. The tax is softened by 'tax free threshold' for the first five years plus allowance for trade exposure and permitted offsets. This adds up to between 70% and 85% according to sector. Eskom and Sasol are major beneficiaries of these loopholes.

The IEP interprets this as giving a range between R48 and 120/t for the years 2015-2019 but does not tell us who will be charged at what price. From 2020, the externality cost is raised to R120/t. This carbon tax rate applies to all scenarios except 'environmental awareness' which gets the full R270/t indicated in the table.

The effect is striking: Externality costs in EA are around 175% of the costs in the other scenarios. The IEP comments: "While the Environmental Awareness Scenario indicates high externality costs, it has low volumes of emissions but allocates higher value to the environment as reflected in the higher carbon dioxide penalty cost of R270/t which results in

the high internalised cost" [120]. This high cost is mostly from existing coal plant and will therefore be reduced as plants are closed down.

Four points are pertinent here. First, we welcome this first accounting of environmental costs. The IEP shows steep declines in pollutant emissions (SO_x, $N0_x$, PM and Hg) in all scenarios and particularly in EA. Second, monetised values do not really equate to real environmental destruction or people's loss of health or life. In particular, the costs of climate change will finally be incalculable. Third, the benefits of reduced pollution are external to the energy system and the IEP gives no account of them. So costs are not balanced by benefits. Fourth, the additional costs will be imposed as taxes or fees. In the case of the carbon tax, Treasury says the money will be 'recycled' through the economy so that there is little or no overall cost to the economy. It argued that the "tax affects mainly capital and energy-intensive sectors" which primarily benefit the rich.[6] Hence, the tax and recycling could be managed to moderate inequality.

Carbon emissions

National climate policy defines a peak, plateau and decline (PPD) trajectory for greenhouse gas (GHG) emissions. The PPD has upper and lower limits to give a rather wide target range. The IEP assumes that the power sector is allocated 45% of PPD emissions throughout the period. It shows modelled CO_2 emissions from the Base Case, Green Shoots and Resource Constrained scenarios falling within that range while Environmental Awareness comes in below the lower limit – as shown in Figure 3.

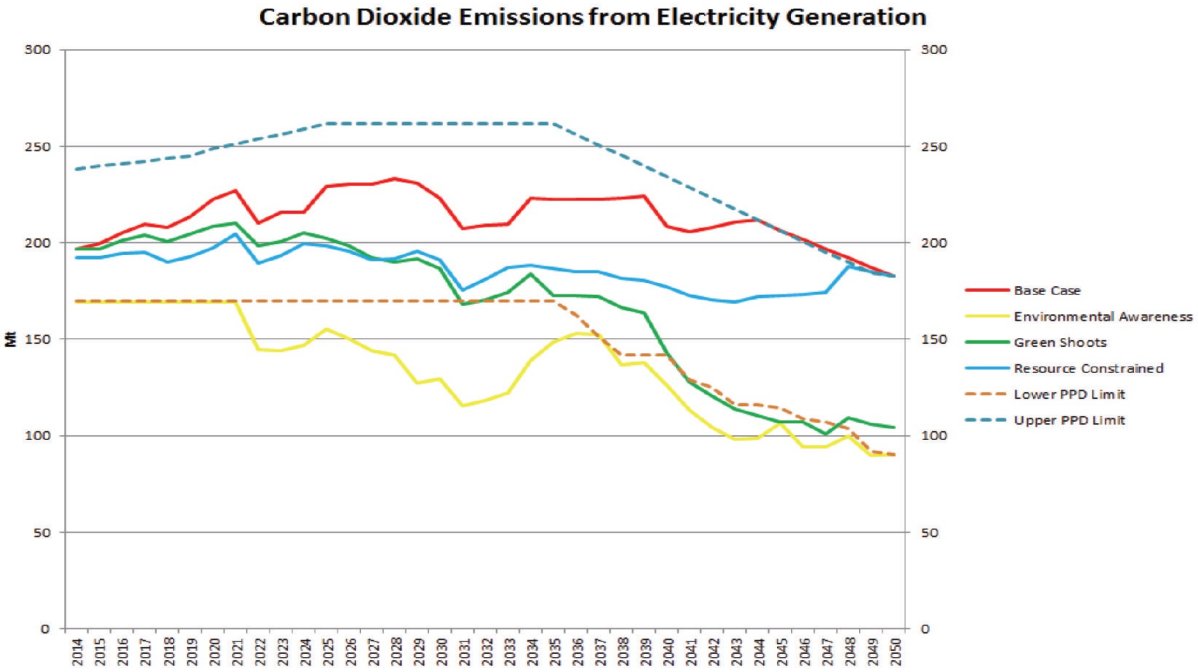

Figure 3: [IEP 128. Fig.0-17]

[6] Treasury 2013, Carbon Tax Policy Paper, para.158.

Several problems are immediately apparent. First, the PPD trajectory is for all GHGs whereas the IEP's is for CO_2 only and so ignores substantial nitrous oxide emissions. It also ignores associated coal mine emissions from spontaneous combustion and venting methane.

Second, Eskom actual CO_2 emissions in 2013/14 were 233 million tonnes (Mt).[7] Fig 3 shows 2014 emissions at less than 200 Mt and, in EA, at about 165 Mt. Clearly the model is under-counting and needs to be recalibrated against historical data. It also needs updating with the latest real data so that all scenarios start with the same emissions figure.

The IEP's fig. 0-18, showing emissions from liquid fuel production repeats these problems. CO_2 emissions start at 50 Mt in 2014 except for EA where emissions start at zero. Sasol alone reported 59 Mt CO_2 and 70 Mt GHG emissions in 2014.[8] Crude oil refinery emissions would add another 3 or 4 Mt CO_2.

The IEP fig. 0-19 shows total energy CO_2 emissions from energy supply and end use starting at about 360 Mt CO_2 in 2014. The DEA's latest GHG inventory gives energy emissions in 2012 as 417 Mt CO_2 and 424 Mt for all GHGs.[9]

Finally, it must be noted that the PPD trajectory is wholly inadequate.[10] The PPD upper limit adds up to a 2010-50 greenhouse gas budget of 23 billion tonnes (Gt) and the lower limit to 15 Gt. The upper limit, assuming a proportionate mitigation effort from other countries, will make for a 4˚C rise in global temperatures by the end of this century – and it won't stop there. This contradicts South Africa's commitment to 2˚C and support for a tighter 1.5˚C target.

For only a half (50%) chance of coming in under 1.5˚C, the global emissions budget from 2011 onwards is down to 600 billion tonnes of carbon dioxide (Gt CO_2) – 400 Gt from 2016. The same budget gives a two-in-three (66%) chance of coming in under 2˚C.[11] This budget is being consumed at the rate of over 35 Gt CO_2 per year. For all greenhouse gases, the budget from 2011 is about 900 Gt CO_2e and this is being consumed at about 50 Gt per year. At present rates, the budget will be consumed before 2030.

If this were divided on a per capita basis, it would give South Africa 6.3 Gt CO_2e. Allowing an overly generous margin to take account of 'common but differentiated responsibility', we think this leaves South Africa with a carbon budget of between 10 and 12 Gt from 2011 to 2050 and almost nothing thereafter for a fifty-fifty chance of exceeding 1.5˚C. This is between 5 and 3 Gt less than the PPD lower limit 2010-50 budget of 15 Gt.

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[7] Eskom Integrated Report 2014.
[8] Sasol Sustainable Development Report 2014.
[9] DEA 2016, GHG national inventory report 2000-2012 (Draft).
[10] And was judged as such by Climate Action Tracker at http://climateactiontracker.org/countries/southafrica.html visited 2 October 2015.
[11] IPCC AR5, WG3, Summary for policy makers, Table SPM1, p.13. We take the lower end of the range for RCP2.6 for two reasons: first, to allow for climate feedbacks and second, because the IPCC relies on the untested assumption that large scale "negative emissions" can be achieved in the second half of the century.

For practical purposes then, the only credible response is a crash programme to shift from fossil fuels to renewables. This would also give the best results for water use and quality which is essential for climate change adaptation.

Jobs

If IEP under-counts emissions, it produces exaggerated forecasts for jobs. Overall most jobs are in construction rather than operations. Hence, a big nuclear build programme makes for big employment. The IEP does not mention the destabilising effects of mega construction projects which create boom-bust local economies.

The most exaggerated job claims are for shale gas. IEP fig.0-37 shows operating jobs at new gas-to-liquids plants rising steeply through the 20s and 30s to produce over 90,000 jobs in 2040. This compares with Sasol's total workforce of 33,000. Fig.0-38 tops this with shale gas extraction jobs arriving at over 1.4 million in 2040. The Scientific Assessment of Shale gas in the Karoo comes to a rather more sober conclusion:

> The 'Big Gas' scenario would be associated with approximately 2,575 direct operational jobs in drilling, trucking and power generation with residents of the study area probably able to fill 15% to 35% [390 to 900] of these positions, increasing over time as training proceeds. It should not be assumed that indirect and induced impacts in terms of jobs in the study area would reach the same level as direct impacts.[12]

The Assessment's 'Small Gas' scenario produces only 420 jobs of which 60 to 145 are local. Moreover, a similar number of jobs in tourism could be lost because of the heavy truck traffic and associated noise and dust.

Just transition

The draft National Adaptation Strategy (NAS) says it "recognises that the climate change challenge requires a paradigm shift in South Africa's sustainable development agenda" [23]. We agree – although we note the implication that South Africa's sustainable development agenda is short on sustainability. As reflected by the NDP, the National Determines Contributions and the NAS itself, economic growth remains the central organising principle of economy and all related policy. Never-ending growth, however, is not compatible with serious mitigation or adaptation.[13] To address climate change and meet the needs of people, there must be a radical redefinition of what is meant by development and who defines it.

[12] Shale Gas Development in the Central Karoo: A Scientific Assessment of the Positive and Negative Consequences, Summary for Policy Makers (SPM), 2016, p33 and table on p.34.
[13] Anderson, K. and A. Bows, 2008. *Reframing the climate change challenge in light of post-2000 emission trends*, Philosophical Transactions of the Royal Society. doi:10.1098/rsta.2008.0138, Published online.

We believe that the central organising principle of economy should be sustainable development founded on economic, social and environmental justice. This means a commitment to growing human solidarity and equality as well as a relationship to the environment which enhances rather than degrades the functioning of eco-systems both for their intrinsic value and for the eco 'services' they provide. The Constitutional justification of such a redefinition is found in the Environment Right. This does not imply that economy and production are unimportant, but that the economy must serve people rather than people serving the economy. This would create the basis for a just transition.

Responding to climate change needs a lot of work. Amongst others, thousands of jobs are needed in an expanded public transport system and in making a zero waste economy with high levels of recycling and the use of wet waste and sewage for biogas production. There is a high job potential in RE provided that an adequate and steady project pipeline creates the demand for local manufacture. Mines can never be fully rehabilitated but rehabilitation is necessary to limit the damage to land and water as far as is possible. Coal mining regions are littered with abandoned mines. On present trends, we can anticipate that the regions themselves will be abandoned as toxic wastelands. A just transition requires a programme for rehabilitating not just individual mines but the coal mining regions as a whole. This is a process that would employ thousands of mineworkers.

In our view, a just transition relates to the people as a whole and not only to those who have jobs. It is essentially about how people will live and is given particular relevance in the present context of high unemployment and the vulnerabilities that go with it. It is also concerned with relations between men and women. The specific vulnerabilities of women are most often the result of their subordination with patriarchal relations.

A more equal society must be part of a just transition. It is essential for mitigation and adaptation. The economy created by capital, energy and carbon intensive development is grossly unequal and has resulted in over 35% unemployment while 57% of the people live in poverty.[14] A sustainable society that caters for everyone can only be founded on democratic economic relations. That requires confronting the power of corporate capital and initiating a major shift in economic priorities. Without this, climate response strategies are likely to entrench inequality and will ultimately prove counter-productive.

[14] Stats SA visited 30 July 2015: http://www.statssa.gov.za/?page_id=739&id=1

IRP

The IRP is the plan for electricity for 2016 to 2050.[15] What the DoE has published for comment is a 'Base Case'. This is not derived from the IEP Base Case or any of the IEP scenarios although it is based on a demand trajectory somewhat similar to 'Green Shoots'. The DoE has invited comment on the assumptions used in the Base Case following which it will (presumably) amend it as well as 'testing' variations on those assumptions (e.g. a lower demand trajectory, different technology cost assumptions, tighter emissions constraints).

The IRP base case is critical because it creates the basis for constructing and judging all subsequent scenarios. The base case makes assumptions in relation to a limited number of elements:

- The demand forecast: how fast demand will rise (or fall) based mainly on GDP growth.
- Other economic parameters: Discount rate, exchange rate, cost of unserved energy and fuel costs.
- Technology options and costs: what technologies are available to generate power and how much will each cost to build and operate. Some technologies cost a lot to build but are cheap to run while others are cheap to build but expensive to run. So planners use the 'levelised costs of electricity' (LCOE) to calculate expected costs over the lifetime of each type of plant. New technologies which are expected to get cheaper and assumptions about how fast this will happen are included under the heading of 'technology learning'.
- The operation and lifetime of the present fleet: additional capacity is needed only when demand exceeds generation capacity. As power stations get older, they tend to get less reliable – particularly if maintenance has been neglected. IRP 2010 assumed that Eskom's plant would be 86% available – where 100% is running all the time at full power. In fact, availability dropped to less than 70% as Eskom prioritised 'keeping the lights on' over maintenance. Eskom says availability has now been restored to 79%. In the end, old power stations must be closed down. Decommissioning dates for the whole fleet are therefore also factored in.
- Greenhouse gas (GHG) emissions: South Africa has committed to a 'peak, plateau and decline' (PPD) trajectory for GHG emissions.

The Base Case – against reality

As noted in the general introduction above, the November presentation of the IRP met with controversy – not to say disbelief – because it inflated the known costs of renewables while depressing the costs of coal and nuclear and put an arbitrary limit on how much renewable energy can be added each year. Costs are included in the 'planning assumptions and input parameters'. The limit on renewables is not included in that section but tacked on in the final

[15] All references are to IRP Update, Assumptions, Base ase and observations, Revision 1, November 2016.

section that presents the results of the Base Case modelling. It does not justify the limitation but says:

> A number of Government policy positions imposed in the IRP 2010-30 are maintained, inter alia, the annual build constraints for new capacity for Wind (1600 MW) and PV (1000 MW) and emissions constraints. This means at any given year the optimisation model is not able to build more the stipulated quantum of wind and PV. [24]

There is, however, no such policy position in the IRP 2010. That document decides four 'policy issues': 1. Forcing nuclear into the model which would otherwise meet the "capacity requirement" without it; 2. Supporting the "policy requirement for continuing a coal programme" by not imposing tighter emission limits; 3. Not limiting imports of coal fired power but including the carbon emissions in South Africa's domestic count; 4. Not reducing demand by increasing the requirement for Energy Efficiency Demand-Side Management (EEDSM). The combined effect of these decisions squeezed the requirement for renewables but there was no "annual build constraint".

At the November hearings, DoE officials then argued that renewables were forced into the IRP 2010 as they were otherwise too expensive at the time. This is also wrong. While the cost of renewable in 2010/11 was high, the IRP 2010 model included them because the 'learning curve' showed rapid cost reductions. In fact, in five 'bid windows' (the fifth is called window '4 expedited') managed by the IPP office, wind and solar PV prices started higher than assumed but fell much faster and are now well below the prices assumed in the IRP 2010 model. Curiously, however, the IRP 2016 Base Case assumes higher renewable prices than the IRP 2010 did.[16]

DoE and Eskom have also suggested that the annual limit is necessary because the grid would not cope with more. We note that international experience does not support this view. More importantly, Eskom already has a large budget to overhaul the grid, so the question is what is it spending it on: a flexible 'smart' grid compatible with renewables or an inflexible 'dumb' grid designed to limit renewables in the interests of maintaining big base load? We note further that grid stability can be maintained, and energy stored, by using some of the generators at decommissioned coal plants as fly-wheels.

Either way, the grid has to change as was made clear in the 2013 'IRP update' [Appendix E]. Generating capacity on the Highveld will decline as old power stations are decommissioned and the IRP 2016 Base Case shows a very large nuclear build of 20 GW between 2037 and 2050. These plants would be on the west and south coasts and would force the total reorientation of the grid. So why is nuclear not constrained in the same way that wind and PV are?

[16] For details, see CSIR Energy Centre, Comments on IRP 2016 Draft, 7 December 2016.

Dispersed and decentralised renewables will not have a straightforward impact on grid costs. PV in particular can be located where it is consumed. In the words of the 2013 'IRP update', "distributed generation … can reduce integration costs in terms of less new infrastructure (both distribution and transmission) and lower system losses" [95]. In short, it needs a smaller and cheaper grid. On the other hand, the smart grid needs big information and must be able to switch power flows from where the sun is not shining to where it is. That increases the cost but also increases the number of jobs.

Costs

Whether smart of dumb, however, grid costs will be a minor fraction of new generation costs. Big base load projects are notoriously over time and over budget. In 2007, Medupi and Kusile were estimated to cost R70 bn and R80 bn respectively but are now estimated at R195 bn and R225 bn – and still rising.[17] This has fed into a five-fold escalation of tariffs. Both plants are also several years late.

The IRP 2016 now puts the 'overnight' costs (without interest on capital) of nuclear at R55,260 per KW [16]. That makes government's 9.6 GW nuclear fleet R530 bn before interest. We can take this as equivalent to the 2007 estimates for Medupi and Kusile. And since nuclear will come with a big import bill and the IRP uses a dated R/$ exchange rate of 11.55, the escalation has already started. Further, as energy analyst Chris Yelland notes, the IRP assumes a 60 year life for nuclear stations but does not include the costs of a mid-term refurbishment, end-of-life decommissioning costs or long term storage of nuclear waste.[18]

The IRP figure is based on a secret DoE document. Yelland made his own calculations and estimated overnight costs for the 9.6 nuclear fleet at R776 bn at a R/$ rate of 14.00. With interest but no other cost escalation, that will go to R1 trillion and more. Yelland estimates a levelised cost of R1.30 to R1.52. The CSIR Energy Centre gives a lowest cost estimate of R1.17 based on the lowest overnight cost estimates from Rosatom, the Russian nuclear corporation. There is no likelihood that real costs will be in line with this estimate. They are much more likely to be at or over the top of the range given by Yelland.

Table 4 compares the 'levelised costs' used by the IRP and CSIR. It shows the IRP's consistent bias against renewables and in favour of coal and nuclear. Whereas the CSIR shows that a system based on renewables supplemented by gas or storage is the least cost option, the DoE gives no costing for the IRP Base Case.

Table 4: Levelised costs IRP v CSIR (Apr 2016 Rands)

[17] Chris Yelland, Eskom's white elephants – Medupi and Kusile – dampen electricity price outlook, BizNews.com, 6 July, 2016;
[18] Chris Yelland, Analysis: The Draft IRP2016 – lightweight, superficial and downright dangerous…, EE Publishers, 30 November 2016; Yelland crunches the numbers – Cost of electricity from new-nuclear build in SA, BizNews.com, 1 August, 2016.

Technology	Tech type	IRP	CSIR
Wind	Renewables	0.87	0.62
Solar PV		1.00	0.62
Coal PF/Eskom	Base load	0.93	1.05-1.16
Coal FBC/IPP		0.96	1.03
Nuclear		1.04	1.17
Gas CCGT	Mid merit	1.27	1.24
Gas OCGT	Peaking		2.40
Diesel OCGT		3.23	3.10

Sources: DOE IRP presentation 22 November 2016 [14]; CSIR Energy Centre Windaba presentation 3 November 2016 [12].

IRP figures are adjusted for 8% inflation (from January 2015 to April 2016).

CSIR figures include 'owner development costs' and the costs of grid connection. IRP figures do not.

CSIR nuclear cost is based on the lowest overnight cost estimate from Rosatom.

Costs do not include externalities.

Squeezing municipalities

The costs of rooftop PV are already at or below municipal retail tariffs. They will soon be below wholesale tariffs and the difference will increase with a nuclear build. Local PV and other micro generation technologies may then be a) accepted as part of the national and/or municipal resource, or b) forced off-grid.

If a), it may increase system (grid and storage) costs but will save on procuring generators. If b), the middle classes and commerce and industry go off-grid and leave municipalities and the poor with a slum grid & more poor people cut off.

Which will it be?

We think a) is self-evidently preferable but must be accompanied by programmes to support the development of locally owned and democratically controlled RE mini-grids in poor areas. Bringing RE to the people would be an essential element in addressing domestic air emissions, producing considerable 'co-benefits' for people's health and for the health system.

Externality costs

IRP includes a section on externality costs and gives the same values for pollutants (SOx, NOx, PM and Hg) as the IEP does. However, it seems that these externalities are not in fact included in the Base Case. The IRP gives no externality value for CO_2 and gives no reason for this exclusion. Nuclear externalities are not considered. They include radioactive pollution from mines and mine dumps, from fuel fabrication and from nuclear waste handling and disposal. In addition, while there are no carbon emissions at the point of nuclear power generation, these associated activities are energy and carbon intensive as are construction, mid-term refurbishment and final decommissioning.

Eskom's historical neglect of pollution control, and its more recent resistance to complying with emission standards, shows a determined indifference to people's lives and wellbeing. A health impact assessment using epidemiological data shows that emissions from Eskom's existing coal fleet results in 2,239 attributable deaths per year as well as a heavy burden of illness. The monetised costs of death and disease add up to around SAR33 billion ($2.4 bn) per year. This does not include the impact of the coal mines that supply Eskom. The study emphasises that "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" [17]. In other words, poor people are made to carry a large part of the bill for Eskom's externalised costs. The study was commissioned by groundWork and we attach it as an annexure (Health impacts of coal fired power plants in South Africa, Dr Mike Holland, 31 March 2017) to this comment.

In 2015, the DEA allowed Eskom to postpone compliance with minimum emission standards. According to Eskom, "Compliance with the 2020 Minimum Emission Standards requires the installation of fabric filter plants and low NOx burners at most coal-fired power stations, and flue gas desulphurisation (FGD) at all coal-fired power stations." This indicates FGD retrofits at all 13 existing coal plants. It then says the DEA's postponement decision requires it to implement emissions reduction programmes at nine plants by 2025 [Eskom AR 2016: 64].

The IRP schedules only six plants for air quality retrofits before 2025 and only for particulates and NO_x [15]. This is considerably less than necessary to comply with minimum emission standards. Assuming that Eskom intends meeting those standards, all plants that are not shut down will get a lot more expensive.

We are nevertheless pleased to note that a baghouse filter was installed at Grootvlei unit 3 in 2016 and "emissions performance … improved significantly" [Eskom AR 2016: 63].

Eskom also complains that "capex required to implement the 2020 Minimum Emissions Standards is significant, and would require an estimated additional 10% increase in the electricity price" [37]. As with externalities, these costs are not evident in the IRP Base Case either for existing or future coal plants.

GHGs

The PPD gives a very wide range of permissible GHG emissions between the upper and lower limits as shown in Table 5. The final column gives cumulative emissions (the implied carbon budget) for the full period from 2010 to 2050. It is based on South Africa's 2009 'Copenhagen offer' which implied peak emissions of 505 Mt in 2025. In 2011, the numbers were manipulated to create the PPD range and increase the 2025 peak to 614 Mt. If other

countries act proportionately, the upper range implies a global temperature rise of well over 4˚C by 2100 and 2˚C by about 2036.[19]

Table 5: PPD 2010 to 2050, Mt CO_2e

	2010	2015	2020	2025	2035	2040	2045	2050	Total 2010-50
Upper	547	562	583	614	614	552	490	428	23,050
Mid	473	480	491	506	506	444	382	320	19,560
Lower	398	398	398	398	398	336	274	212	14,830

Source: DEA DEROS explanatory note 1.

The PPD upper peak in 2025 is 614 Mt. This is 160 Mt above the 2025 emission figure of 453 Mt given for 'Required by Science' (RBS) in the Long Term Mitigation Scenarios. RBS purported to give an emissions trajectory to avoid 'dangerous' climate change taking account of the 'common but differentiated responsibilities' of northern and southern countries. However, it assumed a 2˚C target rather than 1.5˚C and did not take account of climate feedbacks. So this figure is itself much too high.

The Base Case allows power generation emissions of 7,857 Mt for the period 2020-2050. Adding the extra ten years from 2010-20 brings that up to around 10,400 Mt. Assuming that power generation is allowed 45% of emissions for the full PPD period, this puts emissions at the upper limit – on track for 4˚C by 2100 and more thereafter. However, reductions from electricity generation are easier than in other sectors.[20] Hence, the proportion of emissions attributed to the power sector should diminish sharply over time.

In its presentation on 22 November, the DoE included two 'sample scenarios':

1. Base Case + Carbon Budget + Annual Constraint on RE; and
2. Base Case + Carbon Budget + No Annual Constraint on RE.

Energy Minister Tina Joemat-Pettersson has already indicated that government favours the first of these. By comparison with the Base Case, it shows "increased renewables, no new capacity from coal, and nuclear coming online around 2026". Thus, nuclear is needed earlier than in the Base Case (2037) and there is more of it – 25,820 MW against 20,385 MW. She continues, "This is a most likely scenario given that renewable energy cannot be unconstrained. This is because there are network constraints that will limit the extent to which renewable energy can be connected to the electricity distribution grid."[21] As argued above, this reason is specious. Its intention is to use the carbon budget to open the way for nuclear – which also requires a grid make-over.

[19] Michael E. Mann, *Earth Will Cross the Climate Danger Threshold by 2036*, Scientific American, 18 March 2014; *How Close Are We to 'Dangerous' Planetary Warming?* Huffington Post, 23 December 2015.
[20] IPCC 2014, AR5, WG3. SPM p.23.
[21] Tina Joemat-Pettersson, Planning for power in SA, Independent on Line, 30 November 2016.

Without the constraint on renewables in the second sample scenario, very little nuclear and no coal is needed. This RE scenario is somewhat similar to one developed by the CSIR Energy Centre. Using the same model and demand forecast as DoE, the CSIR shows that all new capacity can be supplied by renewables supplemented by gas or storage and no new nuclear or coal is needed. Moreover, this is the 'least cost' option: by the end of the period, it costs R90 bn a year less than the Base Case.[22]

The DoE says both the sample scenarios are 'DEA lower carbon budget'. It shows the first (nuclear) scenario producing 5.03 Gt CO_2 emissions between 2020 and 2050. For the full PPD period, we must add about 2.28 Gt for 2010-20. So that makes 7.31 Gt. Assuming this is 45% of total national emissions, that implies 16.24 Gt for the period – 1.4 Gt above the DEA lower limit. The DoE's second (renewables) scenario comes in a little higher at 5.09 Gt for 2020-50 – implying 7.37 Gt for the full PPD period and national emissions of 16.37 Gt.

The difference, however, is created because the nuclear scenario uses more RE before the first nuclear plant comes online in 2026. For the six years from 2020 to 2025 in the nuclear scenario, 11,380 MW of RE is built and emissions add up to 1.29 Gt. In the renewables scenario, only 8,430 MW renewables are built in these years and emissions are 1.59 Gt. Hence, it appears that if the same amount of RE was built in these years, the renewables 2020-50 budget would have come in at 4.79 Gt. That's 7.07 Gt for the full PPD period which implies national emissions of 15.71 Gt. The CSIR's least cost (renewables + gas) scenario does better with about 6.43 Gt emissions for the full PPD period, implying 14.28 Gt national emissions.

This is still not good enough. If we assume:

1. A national GHG budget of 10 to 12Gt for 2010-50;
2. The power sector gets 45% (4.5 to 5.4 Gt) of that; and
3. Emissions reductions start now so that only 2 Gt is emitted from 2010-19:

Then there is only 2.5 to 3.4 Gt left for 2020-50. We think something in this range is not merely possible, in part because demand will come in lower than the IRP forecast as discussed below, but absolutely necessary. And, since mitigating climate change is not optional, we propose that 3.4 Gt is the ceiling for the Base Case and all other scenarios.

Hence, we conclude that all new coal developments must stop now, the Department of Mineral Resources should lead a major programme to rehabilitate land and catchments ruined by coal mining, and the DoE should initiate a crash programme to shift energy generation to renewables. To facilitate this, we believe that:

- a nationally owned systems operator should be created separate from Eskom;
- Eskom should remain in national ownership and should be allowed – indeed, instructed – to see its future in renewable energy generation;
- Municipal renewable generation capacity should be developed;

[22] Carol Paton, Experts' advice ignored to force nuclear option, Business Day, 8 December 2016.

- Local community owned renewable systems with mini-grids should be developed with municipal and national support.

Demand

As noted above, the Base Case electricity demand trajectory is similar to the IEP 'Green Shoots' scenario. It is one of four trajectories developed by a team from the CSIR. The other three forecasts are based on historical data of electricity consumption for each sector – agriculture, domestic, commerce, industry, mining and transport – and are named for 'low', 'moderate' and 'high (same sectors)' GDP growth. In these forecasts, 'same sectors' indicates that there is no structural change in the economy. None of the forecasts contemplate a shift from petroleum to electric transport.

The Base Case uses the fourth forecast: 'High (less energy intensive)'. As implied, it assumes that less electricity is used to produce more goods and services. Both 'high' forecasts have the GDP growth rate rising to 4.5% in 2019, then levelling off to 2027 and gradually declining thereafter. The 'less intensive' forecast shows higher household use but much lower use in manufacturing and mining. Overall, energy demand rises at about the same rate as in the 'moderate' growth forecast and it more than doubles from about 230 terawatt hours (TWh) to over 500 TWh in 2050.

Although GDP growth is slightly lower than in the IEP's 'Green Shoots', it is still far from plausible. Even the EIUG, the embodiment of 'same sectors', comments: "… the initial 2.6% year on year growth assumption is optimistic, translating to a GDP growth of close to 5% … Overbuilding, leading to overcapacity will result in severe price increases, stifling further growth and triggering a negative spiral …". They conclude that the completion of Medupi, Kusile and Ingula will already result in overcapacity and "there is no need for an urgent investment decision for further base load in the near term".[23]

Indeed, with just one unit from Medupi in commercial operation, the system is already in surplus. On Eskom's account, demand is down 1% on last year, plant availability has improved from 70 to 77% and it has 5,600 MW surplus operating capacity over peak demand. Put another way, demand is down 5% on 2012 and Eskom has total installed capacity of 45,000 MW against peak summer demand of just 30,000 MW. This is a massive 50% 'spinning margin' against an industry norm of around 15%. Thus Eskom can allow for breakdowns of 14% of its fleet and for planned maintenance on another 12% and still have an operating reserve. With the completion of Medupi and Kusile, scheduled for 2022, Eskom's installed capacity will be 54,000 MW.[24]

Eskom has therefore called on energy intensive users to ramp up investments and soak up this surplus capacity. Its demand side management target (i.e. programmes to reduce demand) has all but vanished. And it is acting to derail the REIPPPP by refusing to sign power purchase

[23] EIUG high level comment on the IRP Base Case, 7 December, 2016.
[24] Matshela Koko (acting CEO), Quarterly System Status Briefing, 24 January 2017.

agreements which are legally required. In short, believing that the crisis is now over, it has reverted to type. The DoE has apparently also reverted to type and is patently taking the lead from Eskom. As well as beating the big base load drum, the IRP's demand side management is insignificant.

In the midst of loadshedding in 2009, groundWork predicted as much: "As with Eskom, government's record suggests that getting a return on its infrastructure investments will trump conservation as soon as an expanded power supply is secured and irrespective of any rhetorical devotion to climate mitigation."[25]

Decomissioning

The IRP [15] shows decommissioning starting in 2020 with the first units closing at Hendrina and Camden followed by Arnot (2021), Komati (2024), Grootvlei (2025) and Kriel (2026). The rest of the existing plants start closing in 2030 and all are closed by 2050 except Medupi and Kusile. The IEP [Annexure A: 16] is not consistent with the IRP and delays decommissioning by two or three years in each case.

Given the current oversupply, the older, dirtier and more costly plants should be closed now, particularly where new mines or heavy trucking are needed. At Grootvlei, for example, a new mine would have a life span of around ten years before the plant finally closes but will permanently ruin the water table. Coal is trucked in at several plants and the number increases as the big tied mines are mined out. Many small short-lived mines are being opened to replace this supply, with increased combined impacts. This expanding destruction is not necessary.

As noted above, generators in decommissioned but well maintained plant can be used as flywheels for energy storage and grid stability in a grid powered by renewables. In combination with pumped-storage and hydro, this means that South Africa already has considerable storage potential which the IRP should assess.

Eskom says, "Retrofit installations require outages of 120 to 150 days per unit, which will only be available once the operating reserve margin is adequate" [AR 2016: 23]. The present surplus should thus enable early implementation of the programme where plants are not closed instead.

Conclusion

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

[25] groundWork, The World Bank and Eskom: Banking on Climate Destruction! Written by David Hallowes, December 2009, p.20.

heavy duty pollution. It is unsustainable economically and is socially and environmentally catastrophic. It is now collapsing. The IEP and IRP show that the DoE is remains tied to this model.

The electric power system was made by building big base-load to supply 'cheap and abundant' power to energy intensive industries. IRP 2010 was the creation of the combined interests of the minerals energy complex and was confidently expected to reproduce the system. But Eskom's prices have escalated to pay for the expansion even as the global economy – and commodity markets in particular – stutter on the edge of depression. The effective subsidy to big users, with the exception of South32's aluminium smelters, has been eroded and the rest of the country is in no mood to restore it. Demand for power has collapsed and the big energy users themselves do not anticipate its recovery.[26] This is but one sign of the minerals energy complex breaking up. IRP 2016 is in the same mould as IRP 2010 but now appears to be created only in the marooned interest of Eskom and those who hope to profit from the wreck.

As anticipated by the critics of the big new coal plants, Medupi and Kusile are beset by escalating costs and successive delays. The cost of funding them is exposed to rising interest rates and currency depreciation. Both Eskom and the government's credit rating have been downgraded. The massive import bill also contributes to pressure on the currency and becomes more significant in a period of economic fragility. The choice of a nuclear fleet beyond Kusile would compound this vulnerability and provide a short cut to national bankruptcy.

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 – coal to Richards Bay, iron ore to Saldanha Bay and a new heavy haul line proposed for chrome ore to Coega. 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.

Throughout the 20th century – outside of war – big oil corporations had to deal with the problem that there was too much and they tried both to restrict the supply and to prod demand. The age of plenty is now over: the production of 'easy oil' is in decline and is increasingly substituted by 'non-conventional oil' – tar sands, coal-to-liquids, shale oil and gas, and ultra-deep sea oil. This has brought on 'peak poison'. The production of oil was always dirty and bloody, particularly in the 3rd World, but the production of 'non-con' oil is ever dirtier and ever more expensive. And the price is ever more volatile.

Sasol's profits from coal-to-liquids were buoyed up by the high price of oil and the effect of regulated import parity pricing. When the oil price collapsed in 2014-2016, Sasol's bottom line was saved by the simultaneous collapse in the rand – which meant it got more rands for

[26] EIUG high level comment on the IRP Base Case, 7 December, 2016.

its overseas dollar earnings. But Sasol's production scarcely moderates South Africa vulnerability to peak oil and volatile oil prices. Imported crude oil provides 70% of fuel for transport and is the country's largest import item. The IEP sees oil imports being substituted by refined fuel imports to meet escalating demand which is apparently impervious to price. That supply must meet forecast demand is an assumption of energy planning from the age of plenty and will not hold in the post-peak world. The DoE evidently expects to be saved by a fantasy shale gas boom. It avoids the real challenges of the energy future.

The divorce from reality is particularly evident in respect of climate change. The IEP/IRP are plans for a world that plays the numbers but does not seriously address people's needs and climate change. As noted, South Africa is currently producing its 'fair share' towards global warming of 2˚C by about 2036 – just twenty years away. Whatever coal fired stations have not been shuttered because of the sheer folly of burning more coal, will then be inoperable in the extremes of heat, drought and flood and abandoned. Meanwhile, the mines that feed them are ruining the water resource.

A world that is seriously addressing people's needs and climate change is a world which changes the economic and associated energy system. We propose that energy planning be made compatible with this world. Alternatively, it must anticipate catastrophic climate change. The IEP/IRP 2016 does neither.

In sum, if SA wants to 1) supply the energy needs of its people, 2) avoid catastrophic climate change, 3) clean up air pollution to let people breathe, 4) conserve water and prevent the further destruction of whole watersheds, and 5) avoid bankrupting itself, it is imperative to focus national resources on developing renewables under democratic control while shutting down coal plants.

End:

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