An overview of the

EMPLOYMENT IMPLICATIONS OF THE SOUTH AFRICAN POWER SECTOR TRANSITION

July 2018

Based on research undertaken by Meridian Economics

sawindenergy
groups/2977014/profile
@_sawea
admin@sawea.co.za

Briefing note by SAWEA

South African Wind Energy Association

Executive Summary

The employment implications of the South African power sector transition are highly complex, dynamic and politicised. Whilst there are numerous studies and reports which investigate these, a common understanding remains elusive and misunderstandings abound. This briefing paper presents a high-level overview of the status of current information based on a review of existing literature.

The review demonstrates that the misunderstandings is due in part to the use of nonstandard employment metrics and categorisation methodologies, poor and inconsistent disclosure of study parameters, and uncertainty about future energy sector development paths. These aspects can and should be addressed.

However, the briefing also reveals that the comparability of current employment data and analysis is further constrained by: the purpose of the study for which it was gathered or generated; whether the study is of actual or projected employment; what the particular metrics used can and can't reveal about employment; how different employment categorisation methods are used in the study; assumptions around related aspects such as localisation, multipliers and skills; the scale at which the study occurred; assumptions, data, and counterfactuals utilised in modelling; and the degree of independence of the research organisation and the nature of the funding it relies on.

As a result, any discussion that quotes high-level employment figures out of their context is largely meaningless. By cherry picking particular studies' high-level findings, contradictory employment-related arguments can and have been made.

Despite this situation, a few data points can be reported and assertions made around what is known at a high-level:

1. Coal mining drives the employment associated with coal power generation, and absorbs low skilled labour.
2. The loss of up to 35,000 coal mining 'employees' in the Central Basin appears likely due to the planned decommissioning of Eskom's older coal fired power plant over the next twenty years. [1]
3. However, the current threat to jobs at Eskom's older coal stations and affected mines is primarily caused by Eskom's own build programme (Medupi and Kusile) which is stranding the older stations – not by renewable energy. This situation will of course change over time as the energy transition unfolds.
4. As of June 2017, the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) had created 32,532 direct, Full Time Equivalent (FTE) person-years of employment. It is anticipated that 109,444 direct, FTE person-years of employment will result from REIPPPP Bid Rounds 1-4 in both construction and operation (O&M) over their 20-year Power Purchase Agreement time horizon. [2]
5. Internationally it is becoming standardized to report employment in 'person-years'. However, this metric is not yet consistently used across South African studies, and in some cases analysis based on person-years of employment is reported simply as 'jobs' at the high-level. Whilst duration is unspecified in the term 'job', a 'job' (or 'employee') nevertheless implies (not always accurately) a timeframe beyond one year. The use of this term when reporting employment implications of power sector transition can therefore be misleading.
6. There appears to be little agreement on the ratio between direct, indirect and induced potential job figures. In addition, figures for 'gross' jobs appear significantly inflated against those produced by economy wide (or 'net') studies.
7. The net long-term employment impact of particular power generation scenario studies are specific to the particular model, scenario and assumptions used, making it difficult to compare across studies. Some studies assessed suggest that the loss of coal mining jobs will outweigh the jobs created in renewable energy, nuclear or gas, whilst others suggest the opposite.
8. Power mix assumptions [3] can all dwarf the employment implications of the ratio of coal and individual Renewable Energy (RE) technologies within any one power generation scenario.
9. Electricity demand levels is a significant driver for the economy-wide employment implications of the power sector transition; Given the highly plausible causal link between higher electricity prices in recent years and the stagnation of demand this might well suggest that choosing a least cost power sector path will create the most jobs than other options.
10. Employment metrics typically in use do not shed light on whether employment is 'meaningful' or 'decent'.

Future work should aim to standardise the metrics and methodologies used to reduce the current confusion in addition to aiming to fill a number of gaps in the field. Developing transparent and publicly available datasets is another priority.

A combination of responsible use of existing studies with additional work focused on answering carefully articulated and policy-relevant questions will enable and encourage the sensible and productive debate that has thus far eluded us on this critical aspect of South Africa's energy transition.

[1] SA Coal Roadmap: Outlook for the coal value chain: scenarios to 2040 (2013)
[2] Department of Energy consolidated IPP Quarterly report (2017)
[3] For example, around economic growth, technology penetration and learning rates, localisation, skills availability, the trajectory of the coal export price and what happens in relation to investment in natural gas (fracking), nuclear, electric vehicles and coal-to-liquids

Introduction

The South African power sector is undergoing a complex structural transition away from a model of regulated, monopolistic, centralized and coal-based electricity supply. As a highly unequal middle-income country, the employment implications of this transition are politically and socially significant. This briefing paper attempts to better understand the status of current information on employment opportunities associated with this transition and future scenarios for the sector. The paper focuses on utility scale power generation, but also considers embedded generation.

Many studies have and are being conducted which are relevant to understanding the impact of the transition in the power sector on employment **(see Appendix B for an annotated list identified in the course of the research for this briefing paper).** Taken together, these have generated a significant amount of data and information on actual and possible employment implications. However, it is nevertheless very hard to get a good sense of what all these studies are collectively confirming. Individually they are often misleading.

There are a number of reasons for this:

- Various datasets are used by the different studies, without necessarily fully disclosing either their or the study's parameters.
- The inclusion of employment as an indicator in a competitive auction policy instrument (the Renewable Energy Independent Power Producer Procurement Programme, REIPPPP) has greatly decreased data transparency, as employment information become of competitive value (Stands, 2015).
- A plethora of different metrics are used across the studies, making comparison difficult (Caetano, Cunliffe, personal communications).
- Many of the studies are undertaken by those with particular interest in the sector, undermining the independence of their results.
- Those involved in the sector report that these are 'murky waters' (Gibson, personal communication), and that calculating employment implications of a power sector transition is difficult if not impossible (McDaid, 2015; Worthington, 2015), hinting at an inherent complexity to the issue.
- There are multiple pathways and drivers through which employment impacts are realised, and different scales and timeframes at which these occur.

This briefing paper attempts therefore to articulate these complexities, contributing towards a common understanding, aiming to advance the debate and assist planning. It confirms that the value of individual studies can be appreciated as perspectives on a complex whole. It also recommends simplifications where these are useful (such as standardizing metrics), and identifies priorities for future work.[4]

It is accompanied by two Appendices. **Appendix A** comprises a set of questions to assist policymakers and other users of employment studies to understand and draw on findings for planning. **Appendix B** provides an annotated list of the main individual studies considered.

[4] Note that the brief seeks to assist consideration of what is and is not comparable in employment analysis. It does not particularly focus on the adjacent and entangled issues of who the jobs go to, nor the skills and localization debates. These issues may be covered in future briefing papers.

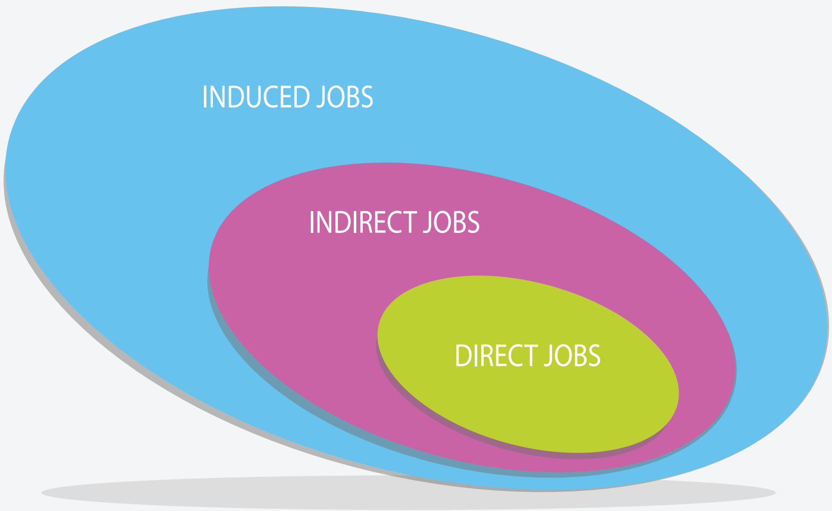
Categorising power sector employment

Three different methodologies are used to categorise the incidence of power sector employment, and these are used variously across the studies. Some studies use only one, others use all three. The categorisations can overlap with each other, and also interact with the scale of the study (see section 5). Their use can contribute towards confusion rather than clarity for the (typical) non-specialist reader. The three categorisation methods are briefly described below.

'Direct', 'indirect' and 'induced'

Power sector jobs are frequently categorized as 'direct', 'indirect' and 'induced'. Whilst the precise distinction between these categories differs from study to study (with one study, the Integrated Energy Plan (IEP) Appendix (DOE, 2016a) including a fourth category, that of 'supplier'), they usually denote the following: [5]

1. **Direct:** people employed by the power generation project itself
2. **Indirect:** people employed by supplying goods and services to the power generation project,
3. **Induced:** those employed to provide goods and services to meet consumption demands of additional directly and indirectly employed workers.



'Figure One: Direct, indirect and induced jobs

Some studies (IEP Appendix (DOE, 2016a); Rutovitz (2010) establish multipliers as a means of estimating indirect and induced jobs.

5 Definitions as per Bacon and Kojima, 2011, although it is not always clear where the boundaries are in the data (Cunliffe, personal communication).

Construction versus operation and maintenance

Power generation jobs are further categorized into those in the construction phase, and those in the operation phase (O&M). Construction jobs are often reported as jobs per MW installed capacity, with O&M jobs being reported as jobs per MWh (DOE, 2016a; Maia et al, 2011).

The categorization methods in 2.1. and 2.2. can be considered together, as in Table 1 below:

Table 1: Typical categorisation of power generation jobs at project, technology or power sector level

	DIRECT	INDIRECT	INDUCED
CONSTRUCTION	A	C	E
OPERATION	B	D	F
SUB-TOTALS	A + B	C + D	E + F
		TOTAL EMPLOYMENT	A + B + C + D + E + F

"Net" and "gross" employment

Most commonly, the term 'gross' refers to jobs created by a particular project, technology or power sector plan, as described by 'Total employment', (a+b+c+d+e+f), in Table 1 above. Critically however, jobs lost by displacement or crowding out of other technologies and their value chains are not considered in a 'gross' jobs study. Therefore 'gross' jobs tend to be an overstatement of the overall employment effects.

'Net' employment, on the other hand, considers both jobs created and lost, i.e. (a+b+c+d+e+f) -(u+v+w+x+y+z), where (u+v+w+x+y+z) represents the direct, indirect and induced employment crowded out. The interactions though are more complex than this simplified equation suggests, requiring the use of sophisticated sector and/ or economy-wide modeling platforms to estimate.

Employment metrics and what they measure

'Employment' can be measured in a number of different ways. One way is as a total number of jobs, or employees and this is typically how employment is reported on. However such a metric is almost meaningless if the duration of these jobs is not also provided. A job could be for a day, a month, a year or more. Internationally and increasingly in South Africa, studies are starting to be formalized around the job year. A job or employment could therefore comprise any number of, or fraction of job years. **The concept of 'Full Time Equivalent' (FTE) is typically used to qualify absolute employment metrics.**

The term job years, however, provides no insight into the relative ability of different power generation technologies to deliver jobs. For this, jobs per MW installed capacity, or jobs per MWh is a more suitable metric.

These metrics in turn do not help to understand the investment required to generate jobs in different technologies or in different power generation sector scenarios. For this, one requires metrics such as jobs per Rand of capital invested. In order to assess the employment contribution relative to society at large, metrics such as jobs per total population are needed.

Metrics can be relative, useful for making comparisons between technologies or scenarios, or they can be absolute.

Further however, the metrics discussed above say nothing about whether the employment created is for those previously unemployed ('new' employment), or in order to address a shift of people from other industries. The metrics also reveal nothing about the skills levels of these jobs. It is important to note that there is no one measure that can capture all the aspects tied up in the concept of 'employment', and strong performance on one metric does not guarantee overall strong performance. When metrics are used without contextualizing findings in terms of what the metric can and cannot provide insight on, the analysis runs the risk of being simplistic and therefore misleading (Stands, 2015).

Meaningful employment

In addition to the problems associated with the metrics discussed above, they have been found to shed insufficient light on the 'decent' and 'meaningful' qualities of employment that South African policy aspires to in its 2011 **'New Growth Path' (Stands, 2015).** The concept of a 'job' is too high level to capture all that is required for a successful development-oriented power sector transition. Aspects that remain hidden include the sustainability of any one particular job, the working conditions, the level of contractual security provided. Questions that remain unanswered include: **Can this job support a family? Does it require relocation? Is there opportunity for learning and progression?**

Work exploring and promoting these aspects has been done by the One Million Climate Jobs campaign, which describes decent jobs as 'jobs that are safe, provide healthy working conditions, and offer social protection, security and fair wages. Decent jobs are jobs that, at the very least, meet the International Labour Organisation's standards of 'decent work' and are in alignment with goals such as meeting the social needs of the majority of the population. In this sense they should be useful jobs' (2011, p9). Accompanying metrics to those discussed above are necessary, and qualitative data is likely to feature highly in furthering understanding.

The issue of "Scale" in different power sector employment studies

Power sector employment studies differ dramatically from each other in terms of the scale of analysis, and then consequently, will differ in terms of the types of research methods employed and the use and positioning of employment categories. It is therefore important that findings from employment studies are considered relative to their scale of analysis. **Five scales of analysis can be identified and are described here and then depicted in Figure 2 below:**

1. **Site or plant scale:** The purpose of this scale of analysis is to explore employment issues at a particular plant. This analysis often includes qualitative data from interviews with employees, plant managers and other stakeholders. It can highlight contextual issues, and explore the specific employment related dynamics of a particular plant.

2. **Technology scale:** The purpose here is typically to compare how one power generation technology fares against another. Issues relevant here include the technological learning curves of each technology, possible ownership structures, the size of the envisaged fleet, whether jobs are temporary (in construction) or permanent (in O&M). This analysis most often uses the 'direct, indirect and induced' job categorisation to organise the research. Studies focused on the REIPPPP largely focus on this scale.

3. **Power sector scale:** The purpose of this analysis is to consider various future power sector development pathways. This is done using sophisticated power generation modelling software which, inter alia, balances electricity supply and demand considering technology costs, learning curves and resource constraints. However power sector analysis cannot assess feedback between the economy and the power sector.

4. **Energy sector scale:** The purpose of this scale of analysis is to consider various forms (or scenarios) of a country's future energy sector, exploring how changes in one energy sub-sector affect other energy sub-sectors. The impact of the power sector transition on coal mining employment, for example, is strongly revealed at this scale.

5. **Economy-wide scale:** The purpose of this scale of analysis is to identify the impact of a particular policy intervention both within the power sector and throughout the economy. Economic modelling shows the net effect on jobs of a particular power generation trajectory, as it can capture jobs lost and gained throughout the system.

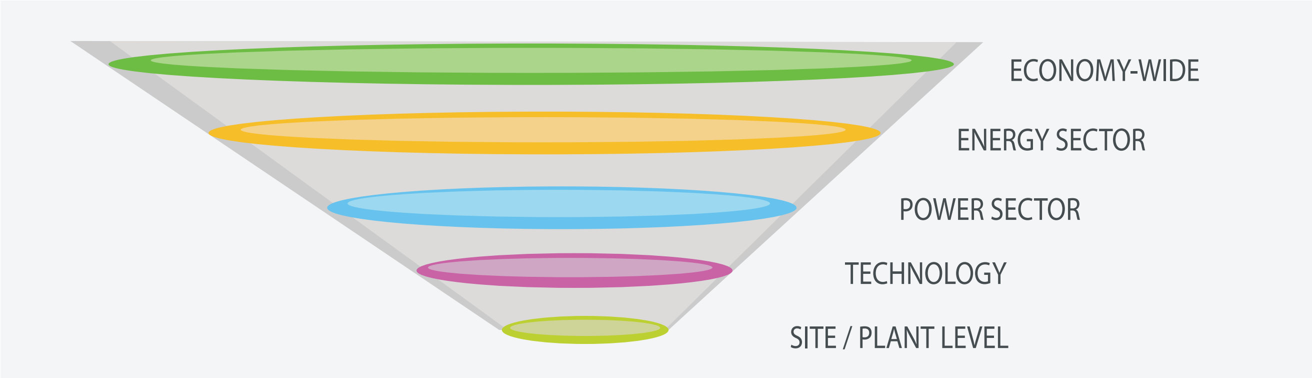


Figure Two: Scales of power sector employment analysis

The categorisation of employment impacts as direct, indirect and induced, is most relevant to the site, the technology and the power sector scales. What is included within these categories may also shift depending on the scale of analysis (for example, coal mining jobs are indirect at the site, technology and power sector scales, but direct at the energy sector scale). When models are used (at the power, energy and economy-wide sectors) these categorisations become less relevant as all categories are explicitly accounted for by the model.

Each scale of analysis provides a particular perspective on the employment implications of the power generation transition and has relative strengths in revealing particular aspects.

The status of knowledge on the employment implications of the South African power sector transition

The paper thus far has shown that employment data is determined by:

- the purpose of the study for which it was gathered or generated
- what the particular metrics used can and can't reveal about employment
- whether the study is of actual or projected employment
- how different employment categories are used in the study
- assumptions around localisation, multipliers, skills etc
- the scale at which the study occurred
- the assumptions, data, and counterfactuals utilised in modelling
- the independence of the research organisation and the nature of the funding it relies on

As a result, any discussion that quotes high-level employment figures out of their context is thus largely meaningless, and by cherry picking particular studies, contradictory employment-related arguments can, and have, been made. **To undertake meaningful comparison requires excavating each and every detail pertaining to each study.** Even then, given how poorly the studies map onto each other (see Figure Three below), it is unclear how much useful information will result. Rather, a different approach is suggested; one that employs a humble, nuanced and exploratory approach in the face of a complex and emotive issue. A more effective approach requires considering carefully what methods are best for addressing particular types of questions. In response to this complexity, a set of questions to assist policymakers and other users of employment studies to understand and contextualise findings is provided in **Appendix A.**

Each scale of analysis provides a particular perspective on the employment implications of the power generation transition and has relative strengths in revealing particular aspects.

Figure Three below maps the main studies identified through the research according to their scalar focus, demonstrating the diversity of the studies and the difficulty of comparing them even across just one dimension of scale.

*Figure Three: mapping of the main studies' **scalar focus*** [6]

STUDY	PLANT	TECHNOLOGY	POWER SECTOR	ENERGY SECTOR	ECONOMY WIDE	REGIONAL
Altieri et al, 2017:						
DOE, 2016 and 2016a: IEP						
ERC, (forthcoming): Coal Transitions						
ERC, CSIR, (forthcoming): COBENEFITS Project						
CSIR, 2017: IRP comments 2017						
IPP-Office, ongoing: REIPPPP data						
CSIR, 2017a: Wind, solar survey						
McDaid, 2016: REIPPPP review						
Stands, 2015: Masters Thesis						
Stands et al (Altgen), 2014: RE&EE Career pathways						
Single technology studies (Gibson, 2017; SABIA, 2016; SAPVIA, 2014. Coal data.)				*coal mining*		

6 Dark grey indicates priority focus; lighter grey indicates additional scales included in the study.

Acknowledging this complex situation, the few data points indicated below nevertheless provide some indication of the status of knowledge of the employment implications of the South African power sector transition within four general themes:

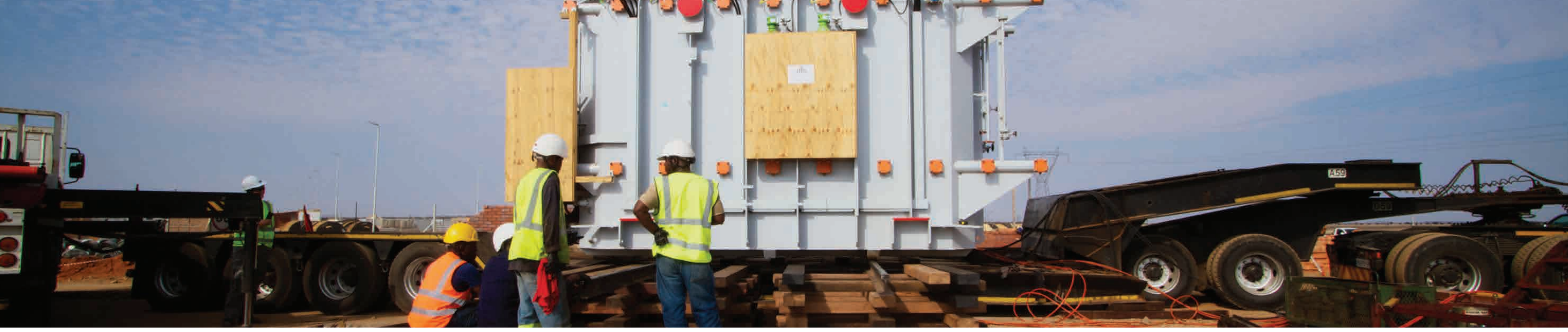
Coal-fired power generation

- There is very little data on coal related employment generally, and coal generated power employment in particular. Indirect coal mining jobs drives the employment potential of coal fired power generation (IEP, 2016; Caetano and Thurlow, 2014).
- Coal mining employs 87,500 people (CoM, 2018), and absorbs more unskilled labour than RE (Caetano and Thurlow, 2014). As an economic activity it has a high potential for job creation (DoE, 2016)
- **Eskom has 7928 employees at its coal fired power fleet as of 2017 (Eskom, 2017).**[7]
- Up to 35,000 coal mining jobs are likely to be lost by 2040 in any scenario due to the planned decommissioning of older power stations on the Central Basin coalfield (SA Coal RoadMap, 2013).
- Up to 55 000 jobs are created in coal mining if the Waterberg coal field is opened up (SA Coal Roadmap).
- Of the studies considered, only the SA Coal Roadmap (now fairly dated) and the 2016 IEP consider an expansion in coal fired power generation (a maximum of 14 MW), creating employment in mining.
- The increase in the labour efficiencies of new build coal-fired power generating plant does not appear to have been taken into account in any of the studies assessed.
- Coal mining job losses are spatially restricted to the Mpumalanga Province, where over half of the population is living in poverty. Here, unemployment rates are second highest in the country, and the occupational profile heavily skewed towards semi-and unskilled occupations (Mpumalanga Economic Growth and Development Path, 2011). Mpumalanga has only one REIPPPP project to date, a Bid Four small biomass plant.
- Currently all coal power related employment studies use the metric 'employees' or 'jobs' as opposed to the more internationally aligned metric, 'person-years' which is predominantly used to report RE employment. This has significance for any employment comparisons made between the two sectors.

The REIPPPP

- As of June 2017, the REIPPPP had created 32,532 direct FTE person-year jobs.
- It is anticipated that 109,444 direct FTE person-year jobs will result from bid windows 1 to 4 over their 20-year PPA lifespans (Eberhard and Naude, 2017).
- McDaid et al (2016) estimate that a further 50,000 FTE person-year indirect and induced jobs will result from REIPPPP Bids 1-4.
- The REIPPPP data is admirably multi-faceted and provides the most nuanced quantitative assessment of employment of all the studies.
- The REIPPPP data reflects the technology mix and MW capacity achieved through the competitive auction process at a particular point in time. This composition of the REIPPPP generation fleet has been determined by a number of criteria relevant to each bid window, including cost, local content etc. Because of this, the REIPPPP employment data is constrained in its ability to reveal aspects such as the employment potential of any one RE technology utilizing economies of scale, or the relative cost of employment creation of different technologies.
- There appears to be little agreement on the ratio between direct, indirect and induced potential job figures for RE at a technology level.
- Technology scale RE studies, including those based on the REIPPPP data, estimate far higher job creation potential for RE than the figures coming from power, energy or economy-wide models, confirming that figures for 'gross' jobs tend to significantly inflate the economy-wide employment implications of RE.
- Studies comparing the job creation potential of individual technologies are heavily context and metric specific.

[7] Information secured by the Centre for Environmental Rights through an application under the Public Access to Information Act.



Technology scale RE

- There appears to be little agreement on the ratio between direct, indirect and induced potential job figures for RE at a technology level.
- Technology scale RE studies, including those based on the REIPPPP data, estimate far higher job creation potential for RE than the figures coming from power, energy or economy-wide models, confirming that figures for 'gross' jobs tend to significantly inflate the economy-wide employment implications of RE.
- Studies comparing the job creation potential of individual technologies are heavily context and metric specific.

Energy, power sector and economy wide scales

- The overall, long term employment impact of particular power generation scenarios can only be known within the context of the particular study presented.
- Some suggest that the loss of coal mining jobs will outweigh the jobs created in RE, nuclear or gas (DoE, 2016; Coal Roadmap, 2013; Caetano and Thurlow, 2014). More recent studies focusing on least cost optimisation models seem to be suggesting a net positive effect (CSIR, 2017).
- Assumptions around economic growth, technology penetration and learning rates, localisation, skills availability, the trajectory of the coal export price and what happens to natural gas (fracking), nuclear, electric vehicles and coal-to-liquids can all dwarf employment implications.
- Structural economic change appears to hold potential to significantly impact employment pathways over the long term, suggesting the importance of considering the demand side of the power sector transition (Altieri et al, 2016; Burton et al, 2016)

Two studies underway are anticipated to add significantly to the knowledge currently available. The Energy Research Centre (UCT) Coal Transitions modelling project runs least cost and decarbonisation scenarios to 2050 with a significantly expanded coal sector. Jobs impacts in coal and RE to 2050 will be included in the model outputs. The COBENEFITS project being undertaken by ERC and CSIR is a similar modelling exercise which will expand the current assumptions for RE **(see Appendix B).** This project will generate a public database of employment figures, which will contribute towards greater transparency and accessibility of employment data in the sector.

Gap analysis

The main drivers of the current confusion and frustration around the employment implications of the South African power sector transition have been argued here as being:

1. a lack of standardization of metrics, employment categorization methods, and power sector plans (counterfactuals); and
2. a lack of appreciation of the inherent complexity of the topic and standardised methodological approaches to address these.

Standardising metrics and employment categorization methods could be relatively easily addressed by the sector. This imperative has been raised locally and internationally. Importantly, standardisation should not be confused with simplification. There is no need to reduce the number of metrics and categories that usefully shed light on different aspects of employment. Updating and confirming an IRP is a political prerogative, and one that is anticipated to be addressed in the second half of this year.

Standardising metrics and employment categorization methods could be relatively easily addressed by the sector. This imperative has been raised locally and internationally. Importantly, standardisation should not be confused with simplification. There is no need to reduce the number of metrics and categories that usefully shed light on different aspects of employment. Updating and confirming an IRP is a political prerogative, and one that is anticipated to be addressed in the second half of this year.

A number of studies raise the issue of complexity. It is inappropriate to attempt to oversimplify this complexity. Instead, continuing to reveal additional aspects of it will contribute to a greater overall understanding.

Specific gaps or areas currently underrepresented include:

- An initiative to provide a frame for transparent disclosure of both employment metrics and categorization methods for employment research;
- An expression of coal power jobs in FTE person-years;
- An independent and methodologically transparent assessment of the particular employment-related strengths of different technologies across multiple dimensions (such as continuity, costs, economies of scale, skills, working conditions etc);
- An investigation into the relative strength of the different key drivers of employment effects, including structural economic change, general economic performance, ownership models, technological drivers, international trends, and regulatory or policy impacts;
- A power, energy or economy-wide investigation into the employment implications of disruptive market events such as sector liberalization, smart-grid technologies and strong uptake of embedded generation and storage;
- Demand side employment opportunities, such as those in energy efficiency technologies such as solar thermal, and how these compare across the multiple dimensions of employment in expanded generation capacity;
- Consideration of the current suite of metrics used to quantify employment, and how these align with an expanded understanding of poverty and inequality and their alleviation;
- Further qualitative investigation of meaningful employment creation dimensions at a plant level, including both where employment will be lost and gained.

Conclusion

A number of South African studies which are relevant to understanding the employment implications of the South African power sector transition have and are being conducted. Taken individually, most provide important insights into pieces of the puzzle. However, given a lack of standardization in the use of both employment metrics and categorization methodologies, together with the inherent complexity of the subject matter, attempts to draw employment data conclusions from these studies as a whole currently tends to lead to confusion.

Nevertheless, some high-level findings of the employment implications of the power sector transition can and have been drawn through this literature review. These include a sense of the limitations of particular findings and clarity on what cannot be concluded at this point. A gap analysis was undertaken identifying a number of priority areas for future research and initiatives. Standardisation of metrics and methodologies, and developing transparent and publically available datasets stand out here.

Investigation of a number of specific content areas currently overlooked would add great value to the knowledge base required for effective planning.

Throughout, care must be taken to maintain and expand both the complexity of the analysis and the number of perspectives from which the issue is viewed and understood. The employment implications of the power sector transition are highly complex and dynamic, validating suitably complex and diverse analysis to enhance useful understanding of these.

Glossary

CGE	Computable General Equilibrium
CSIR	Council for Scientific and Industrial Research
DoE	Department of Energy
ERC	Energy Research Centre
EE	Energy efficiency
FTE	Full Time Equivalent
GHG	Greenhouse gas
IEP	Integrated Energy Plan
ILO	International Labour Organisation
IPP	Independent Power Procurement
IRP	Integrated Resource Plan
O&M	Operations and maintenance
PAIA	Public Access to Information Act
PPA	Power purchase agreement
RE	Renewable Energy
REIPPPP	Renewable Energy Independent Power Plant Procurement Programme
SATMGE	The ERC's South African linked energy and economy model

References

Altieri, K. E., Trollip, H., Caetano, T., Hughes, A., Merven, B., Winkler, H., … Hughes, A. (2016). Achieving development and mitigation objectives through a decarbonization development pathway in South Africa. Climate Policy, Sup 1(August 2017), S78–S91. http://doi.org/10.1080/14693062.2016.1150250

Alternative Information Dissemination Centre (2011). One million climate jobs a just transition to a low carbon economy to combat unemployment and climate change.

Bacon, R. and Kojima, Masami (2011). Issues in estimating the employment generated by energy sector activities. A report to the Sustainable Energy Department of the World Bank.

Burton, J., Caetano, T., Hughes, A., Merven, B., Fadiel, A., & McCall, B. (2016). The impact of stranding power sector assets in South Africa Using a linked model to understand economy- wide implications. Cape Town, South Africa.

CSIR (2017) Comment on 2016 IRP.

CSIR (2017a) Energy research at the CSIR. Jobs impact of solar and wind energy. SATRI Symposium on energy choices and the protection of worker's interests in South Africa. Boksburg, 17 May 2017.

CSIR (2017b) International jobs and economic development (I-JEDI) impact model. Modelling the renewable energy jobs potential of the draft 2016 IRP. CSIR energy centre. Just energy transition roundtable. 28 November 2017. PNtuli.

Chamber of Mines http://www.mineralscouncil.org.za/sa-mining/coal accessed 14 June 2018.

DoE (2015). The State of Renewable Energy in South Africa.

Department of Energy (DoE) (2016) Integrated Energy Plan (IEP)

DOE (2016a) IEP Annexure B: Macroeconomic assumptions.

Eberhard and Naude (2017) The SA Renewable Energy IPP Procurement Programme: Review, lessons learned and proposals to reduce transaction costs.

Eskom (July 2017). Untitled SAP Printout of employment at 15 power stations, obtained by the Centre for Environmental Rights through a PAIA (Public Access to Information Act) process.

Gibson, S. Altgen presentation: South African Job Opportunities in Renewable Energy: 17 May 2017.

Gibson, S. (2017). Assessment of training skills needs for the wind industry in South Africa: Comparing 2012 estimates and compiling new estimates in the light of sector developments. (Funded by GIZ)

IPP Office (2017): The IPPPP. An overview. As at June 2017.

IRENA, 2018

Maia, J., Giordano T., Kelder, N., Bardien, G., Bodibe, M., Du Plooy, P., Jafta, X., Jarvis, D., Kruger-Cloete, E., Kuhn, G., Lepelle, R., Makaulule. L., Mosoma, K., Neoh, S., Netshitomboni, N., Ngozo, T., Swanepoel, J. (2011). Green Jobs: An estimate of the direct employment potential of a greening South African economy Industrial Development Corporation, Development Bank of Southern Africa, Trade and Industrial Policy Strategies.

McDaid L. 2016. Renewable Energy Independent Power Producer Procurement Programme Review 2016: a critique of process of implementation of socio-economic benefits including job creation.

Mining Review Africa (5 April 2018) South African Minister of Energy announces REIPPPP Projects. Accessed https://www.miningreview.com/south-african-minister-energy-announces-reipppp-projects/

Mpumalanga Economic Growth and Development Path (2011).

Polity (28 March, 2018). NUMSA: NUMSA in court to fight IPP roll out. Accessed http://www.polity.org.za/article/numsa-numsa-in-court-to-fight-ipp-roll-out-2018-03-28

Rutovitz, J. 2010. South African Energy Sector Jobs to 2030: How the Energy [R]evolution will create sustainable green jobs. Prepared for Greenpeace Africa by the Institute for Sustainable Futures, University of Technology, Sydney, Australia.

South African Biogas Industry Association (SABIA). (May 2016). Biogas Industry in South Africa: An Assessment of the skills need and estimation of the job potential. By Altgen Consulting.

South African Coal Roadmap: Outlook for the coal value chain: scenarios to 2040. Technical Report (2013).

South African Photovoltaic Industry Association (SAPVIA). Localisation and the Road Beyond REIPPPP 2015 (Phase 1) (December, 2014). (Prepared by Stream Equity, ALTGEN Consulting, Chris Ahlfeldt, Frank Spencer).

Stands, S., (2015). Utility-Scale Renewable Energy Job Creation: An investigation of the South African Renewable Energy Independent Power Producer Procurement Programme (REIPP). Unpublished Masters (MPhil) Thesis. Stellenbosch: Stellenbosch UniversityStands Masters thesis retrieved from http://scholar.sun.ac.za/handle/10019.1/96791

Stands, Moodley and Gibson (November, 2014). Renewable Energy and Energy Efficiency Career pathways (November 2014). AltGen Consulting on behalf of EW SETA, Northern Cape Urben TVET College, PEETS and University of Johannesburg.

Worthington, R. (2015). Challenging the State: Renewable energy opportunities and electricity in South Africa in 2015. A publication of the AIDC.

Personal communications:

Sarah Stands, Independent Consultant. 30 May 2018 Skype conversation

Holle Wlokas, Complex Systems in Transition, Stellenbosch University (23 May 2018, meeting)

Tara Caetano, Energy Research Centre, University of Cape Town (21 May 2018, meeting and email correspondence)

Guy Cunliffe, Energy Research Centre, University of Cape Town (23 May 2018, meeting)

Ntombifuthi Ndluli, CSIR (31 May 2018, telephone call)

Jesse Burton, Energy Research Centre, UCT (24 May 2018 at workshop, and email correspondence)

Alison Hughes, Energy Research Centre, UCT. (email correspondence)

Sean Gibson, Altgen Consulting. (Email correspondence)

(In addition, the author attempted, unsuccessfully, to contact both NUMSA's policy research unit and the AIDC (Million Jobs Campaign) for input.)

APPENDIX A | Questions for considering employment data

SAWEA

Below is an initial list of questions aimed at assisting policymakers, planners and other users of employment studies to better understand and contextualise their findings:

What is the study design?

- What question is the study asking?
- Who is undertaking and / or funding the study? What might they want to show?
- What is the scale of the analysis?
- What is the timeframe?
- Are the scale, metrics, organisation methodologies, counterfactuals and data used appropriate for the question being asked?
- How broad is the study: can it consider future disruptive change in the power sector? Opportunities on the demand side? Structural economic change?

How should the findings be interpreted?

- *Is employment reported as 'jobs' or 'person-years'?*
- *Is employment reported 'net' or 'gross'?*
- *Which dimensions of employment does the study consider, and which can it not comment on?*
  For example: - Impact on electricity price
  - Capital investment requirements
  - Economies of scale for technology / resource
  - Localisation of indirect jobs
  - Sustainability of job (construction vs O&M)
  - Conditions of employment
  - Type of worker (skill level, vulnerability, previous disadvantage etc)
  - Pay and ability of job(s) to sustain a family, community
  - Potential for worker development and progression
  - Ownership potential
  - Spatial implications (where is the job?)
  - Are the jobs new or will workers move from other industries?
  - Does the job displace a job elsewhere (net or gross job)
- *What assumptions have significant bearing on the employment findings?*
  For example: - GDP growth
  - Electricity demand
  - Mechanisation
  - Technology learning
  - Future price of technologies, resources
  - Supply of skills.

Comparability of studies:

- Do the studies focus on the same or similar scales?
- What job categorisation methodologies do the studies use?
- Which technologies or suite of technologies are considered?
- What is the data source of each study and how do these differ in terms of timeframe, structure, detail and focus (i.e. are apples being compared with apples)
- Are the counterfactuals the same?
- How comparable are the assumptions used? (Including macro-economic indicators)?

The research for the SAWEA briefing paper was undertaken in a very short timeframe, aimed at providing a helpful high-level overview rather than a comprehensive and detailed review of individual studies and reports. As has been conveyed in the main body of the paper, the subject matter is extremely detailed, complex and contingent. The reader is advised therefore to take the summaries below as brief guides only. Each study requires a deep read in the context of the discussion in the main report in order to fully appreciate its findings in terms of both contributions and limitations.

The studies were identified according to their focus on employment implications of the power sector transition. Whilst the intention was to identify all core studies in the field, some may have been missed due to the timeframes, and there may well be other relevant studies in other areas which could contribute to the overall picture. These areas include employment in energy efficiency and a reduction in energy intensity – the demand side of the picture; studies on green jobs and the green economy; and a literature critiquing the concept of employment, which interrogates this policy objective, and different ways of interpreting and understanding this.

Studies that re-state previous work directly without adding any new data, analysis or clarity of data / analysis presentation were not considered, neither were studies that have been widely discredited within the industry. The studies are grouped according to their scale of focus, determined by the scale of analysis of the main report.

Economy scale

Most of the analysis undertaken at this scale has been done by the University of Cape Town's Energy Research Centre: Energy Systems, Economics and Policy research group, using a linked energy (E-SAGE) and economy-wide (CGE) model (together called SATMGE). This model is being constantly developed to produce ever-more sophisticated analysis of various aspects of the country's energy sector. A number of modeling runs for various studies have delivered employment indications. Some of the more relevant ERC studies are covered below:

1 Energy Research Centre: Coal transitions project (2016 to September 2018 i.e. ongoing

Description: The Coal Transitions National Report is being developed under an international project funded by the KR Foundation and implemented by a consortium of 8 organisations led by IDDRI and Climate Strategies. This is a transdisciplinary project to link and reinforce policy, research and advocacy efforts on coal transition in different countries. The project aims to fill the gap of international dialogue and learning on coal transition.

Through this project, the ERC team has developed SATMGE's coal sector, including detail on coal sector supply such as cost structures and coal contract information at a station and tied mine level. Data used includes that from previous studies and from fieldwork. The model outputs will provide employment impacts at national, net energy sector and coal mining, per skills level, and at an electricity generating plant level.

The study considers two power sector scenarios to 2050. The first is least cost. The second is a scenario which is constrained to meet the lower range of South Africa's peak plateau and decline GHG emissions trajectory. A sub-scenario is run under this carbon constrained scenario, which forces Sasol's Secunda plant to remain open for the full length of its economic life, to 2040. Energy demand is calculated endogenously. The second scenario optimises for the most cost efficient decarbonisation which is found in the power sector. This application of the model does not consider structural economic change. The study uses coal mine employment data from Quantec (Chamber of Mines).

***Key findings:** Not yet publically available. Information provided by Jesse Burton, Tara Caetano and Guy Cunliffe of the ERC modeling team, via personal communications.*

2 (Burton et al., 2016). The impact of stranding power sector assets in South Africa: Using a linked model to understand economy-wide implications. Paper written for the MAPS Programme

Description: This research uses the SATMGE to explore whether South Africa can meet emission reduction targets without stranding assets, and also what the implications of stranding these assets are. It models a structural change in the economy to stimulate agricultural exports as per Altieri et al (see below).

Model details include: Secunda is allowed to run to the end of its life (2040) (not a least-cost option under carbon constraints). There is some detailing of the coal supply side. The model does not consider potential growth in industry able to switch from coal to natural gas, and corresponding employment implications. Only the impact of higher electricity prices on employment in the rest of the economy is reported. Employment impacts appear to be translated from GDP growth. Although the modeling is capable of providing employment figures (Caetano, personal communication), none are reported in the paper itself.

Key findings: The paper highlights the importance of structural economic change in achieving both decarbonisation and a reduction in unemployment. 'Without (this) structural change, the challenge of growing the economy to address high levels of unemployment and poverty would increase substantially if stringent mitigation targets were required in the electricity sector' (Burton et al., 2016, p. 25).

3 Climate Policy article: Achieving mitigation and development objectives through a decarbonisation development pathway in South Africa. Altieri et al. 2017 (based on a 2015 working paper)

Description: Using a version of the SATMGE, this study considers pathways to achieve employment and decarbonisation (aligned with a 14GT CO2e cumulative target) in South Africa to 2050. By changing the model's assumptions around regional trade, enabling conditions for the growth of the agricultural sector were forced in, as a low carbon, high employment generating sector. A carbon constraint was applied. The IRP 2013 provides the basis of the power sector trajectory. There is a high RE penetration and no new fossil fuel powered generation. Economic structural change is therefore the driver, and significant unemployment reduction and decarbonisation results. There was no detailing of the coal sector.

Key findings: From 2010 to 2050, the model results in the national unemployment rate increasing off a base of 25% in 2010 until it peaks in 2030 at 30%, and then declines rapidly to 12%. The initial increase is a result of the youth bulge joining the workforce. Coal decreases its capacity contribution from 90% to 63% by 2030 in line with the 2013 IRP. Coal is completely eliminated by 2050. There is no new nuclear build.

4 Caetano and Thurlow (2014). The socio-economic implications of renewable energy and low-carbon trajectories in South Africa. In Conference proceedings, Forum for Development and Mitigation (Jooste, Tyler, Coetzee, Boyd, & Boulle, 2014)

Description: This paper uses an economy wide dynamic-recursive CGE model, extended to include a highly disaggregated renewable energy sector, to evaluate the potential implications of a carbon tax and investment in greener energy options for economic growth, emissions, employment and inequality in South Africa to 2050. The IRP 2010 is used to model the power sector trajectory, with coal, nuclear, hydro, PV, CSP, wind, waste, gas and diesel considered for power generation. Employment data (total, and absolute numbers of highly skilled) is based on REIPPPP reporting for bids round 1-3. The data disaggregates between O&M, construction and indirect ('manufacturing').

Key findings: The introduction of renewable energy has a positive impact on direct employment in the electricity sector, although indirect job losses, mostly by low-skilled workers, drown out this effect and lead to a very slight decrease in overall employment. RE is found to be more labour intensive per GWh of electricity in comparison to baseload coal, and also requires a higher proportion of skilled labour. Coal mining has a high labour multiplier, and absorbs low skilled labour. Reporting includes jobs per MW in construction and then GWh for O&M. Economy-wide, direct and indirect jobs are reported on, and a distinction is made between skilled and unskilled workers.

SAWEA

Energy Sector

1 Department of Energy (DoE) (2016) Integrated Energy Plan (IEP)

Description: The DoE uses a scenario planning approach to both project energy demand (taking into account different assumptions around economic development and structure). The impact of key policies such as environmental, energy efficiency, transport and industrial are considered. The planning then determines the optimal mix of energy sources and technologies to meet energy needs in the most cost-effective manner for each of the scenarios, covering wind, solar CSP, solar PV, nuclear, petroleum, gas, coal.Uranium extraction, shale gas extraction, residual underground thermal coal. The associated environmental impacts, socio-economic benefits and macroeconomic impacts are also analysed.

Four scenarios are presented in the IEP: Base Case, Environmental Awareness, Resource Constrained and Green Shoots. The 9.6GW nuclear fleet is included in all scenarios, as are optimistic assumptions around shale gas, although sensitivities are run to test both of these. There is no detail on the nature of the modelling methodology included in the report therefore it is difficult to situate the findings (this study may actually be relevant at the economy wide scale). For example it is unclear whether the intra-energy sector employment interactions are considered. Assumptions around job creation in the electricity sector are drawn from a 2014 McKinsey Analysis and are contained in an Appendix to the IEP which is discussed below. This report focuses on localisation. Multipliers are used to estimate the indirect and induced jobs.

Key findings: Job potential is presented by scenario over the timeframe to 2050. The 'Base Case' scenario presents the greatest job creation potential over the period, with 'Green Shoots' the lowest. 85% jobs are localisable across all scenarios, and there is detail relating to different localisation assumptions. When the nuclear build assumption is relaxed, the resulting scenario performs better at an economy-wide level than the Base Case in terms of jobs. Including an aggressive solar water heater roll out in the scenarios results in equivalent jobs to the Base Case. However, when these sensitivities are only considered for the power sector, the job implications are similar across both of these sensitivities and the Base Case. A scenario excluding shale gas yields the greatest number of jobs in the electricity sector. At a technology level, solar has the highest potential for job creation, followed by nuclear and wind. Natural gas and coal make smaller contributions. Primary energy extraction is found to have the highest potential for job creation and localisation efforts. Further job specific findings are reported in the discussion of the McKinsey study below.

2 DOE (2016b) IEP: Annexure B: Macroeconomic assumptions

Description: The power generation employment figures in the Appendix are based on a study on the potential for localization and job creation by McKinsey, which is the focus of this summary.

A methodology was created for the assessment of job creation across power generation technologies, together with primary energy fuel extraction. They have 4 categories: direct, supplier, indirect and induced. 'Supplier' would generally seem to equate to other studies 'indirect'. In this study the indirect is 'supplier to suppliers'. Direct can also be direct in the mining industry, which is not necessarily aligned with other studies. The technology split is determined from the IRP (date unspecified, assumed 2010 or 2013). The job data appears to have been identified bottom up from power generation project spend on employment. However, it is not clear from the report where this cost data comes from. Direct and supplier jobs are determined from this data and aggregated according to technology. Indirect and induced jobs are determined by technology specific multipliers, again based primarily on spends across industry. A detailed job localization methodology is developed for the study which includes some spatial and regional considerations. The study assumes a minimum of 50,000MW installed capacity of any particular technology in order to compare job and localization implications.

Key findings: Jobs are reported per technology, and divided into construction jobs (per MW installed capacity) and jobs per TWh for operational jobs. The extent of these jobs are heavily dependent on assumptions around localization. Nuclear is reported as providing the greatest number of overall jobs (with aggressive localization assumptions), at 70181 jobs years per GW installed. CSP comes next at 59679, followed by coal at 45682. Shale gas performs the strongest in terms of operational jobs at 409 annual jobs per TWh, followed by solar CSP (251) and then wind (225). When coal and coal mining operational jobs are combined the total comes in at second at 274. Coal power generation has the lowest weighted multiplier, with shale gas the highest, followed by coal mining. Nuclear performs better than all renewables, which are much alike in terms of multipliers. Data is reported 'net' (ie systemic interactions are not considered).

3 SA Coal Roadmap: Outlook for the coal value chain: scenarios to 2040. Technical Report (2013)

Description: This study emphasizes the limitations of the Chamber of Mines coal mining data used for the modeling in the report. In particular: 'The data does not distinguish between employment on opencast and underground mines; No data on employment intensity of beneficiation was found. As such, this is assumed to be included in the employment intensity of coal mining; Data excludes employment in mine construction phases as no data was found; Data is assumed to include contractors; No data on indirect employment could be found; and The models assume that employment intensity does not change over time. The impact of increased mechanisation could reduce employment intensity over time, and hence employment in mining could be over estimated.' (pg 48). In terms of coal fired power generation employment the report found that 'no consistent data sets could be found to provide an indication of employment for operation and maintenance of the coal-fired power station fleet' (pg 49). There has subsequently been updated information for both Chamber of Mines and Eskom data for employment at coal mines and power stations. Employment is reported in terms of 'employees', with the qualifier 'FTE' sporadically applied. The Roadmap uses Maia et al (2011) data for RE. Four scenarios are modeled: 'More of the Same', 'Lags behind', 'At the forefront' and 'low carbon world'.

Key findings of the scenarios: Between 31,000 and 35,000 jobs are lost from 2020 to 2040 in the Central Basin coalmines. Waterberg coal-mines increase employment to between 21000 and 50000 by 2040, or decrease employment. Employment in power stations is not disaggregated to coal, but includes all generation technology types. Generally, operational employment throughout the system is highest for 'low carbon world' and 'at the forefront', with no clear trend for construction employment over the timeframe.

Power Sector

1 COBENEFITS project (ongoing, Report due, August 2018)

Description: This ongoing programme is led by the Institute for Advanced Sustainability Studies (IASS), Potsdam, Germany, and is conducted in close cooperation with the Council for Scientific and Industrial Research (CSIR) as COBENEFITS focal point for South Africa. Four projects sit under this programme, one of which deals with employment and is being undertaken be a collaboration of CSIR (macro-economics group), and the Energy Research Centre. The project will assess future development of employment and skills requirements in SA power sector.

The CSIR are focusing on providing RE jobs, based on their 2016 study (see project description in the RE section below) but augmented with stakeholder interviews. Employment reduced in coal is being considered by ERC. The SATMGE will be used to analyse the data. 4 Scenarios are being used across the four COBENEFITS projects: 1) A scenario based on IRP 2016 shares of different technologies projected forward (to 2030). 2) The CSIR optimistic RE cost scenario to 2050 3) Least cost CSIR scenario. The lower trajectory of the DEA's Peak Plateau and Decline GHG emissions range may also be considered. The study will undertake qualitative research of employment implications at specific mines and power plants, and case studies of international historical experiences (China, UK, Germany, US) to explore what could happen in a coal sector decline. The study will consider skills levels, age profiles, location / spatial, cultural issues in coal employment through a survey of coal companies. Work on the Coal Transitions study discussed above will inform the COBENEFITS study. Embedded generation is not a focus. Structural economic change is not within the ambit of the research. Jobs will be reported annually to 2035, and then in years 2040 and 2050. Some specific mining and power generation project data may be included in order to augment and support the modeling results.

Expected outputs: Employment effects and skills requirements of RE, and losses in the coal sector. The project is anticipated to generate an open publically available database platform intended to support the RE industry.

(Information: sourced from Cunliffe, Burton, Caetano, Nkosi personal communications).

2 CSIR comments on the IRP 2016

Description: TTwo alternative scenarios to the 2016 IRP were run by the CSIR modeling team in order to inform their lengthy comment; a Least Cost Scenario, and a Decarbonisation Scenario, both to 2050. The study is a very detailed depiction of the power sector, including consideration of changes in demand triggered by storage (EV plus batteries). The assumptions around the contribution of newer technologies generally are described as 'conservative', whilst assumptions relating to incumbent technologies are more progressive. The McKinsey IEP study job figures were used for RE and the lower values for the coal industry. The higher value is based on 'CSIR assumption with more jobs in the coal industry' pg 61.

Key findings: The study finds that the CSIR Least Cost Scenario delivers the greatest number of energy sector jobs (between 380 and 392,000 by 2050). The IRP 2016 base case performs least well on 252-295,000. The Decarbonised scenario provides 331,000.

3 **Maia, J., Giordano T., Kelder, N., Bardien, G., Bodibe, M., Du Plooy, P., Jafta, X., Jarvis, D., Kruger-Cloete, E., Kuhn, G., Lepelle, R., Makaulule. L., Mosoma, K., Neoh, S., Netshitomboni, N., Ngozo, T., Swanepoel, J. (2011).** Green Jobs: An estimate of the direct employment potential of a greening South African economy Industrial Development Corporation, Development Bank of Southern Africa, Trade and Industrial Policy Strategies

Description: This pre-REIPPPP study is often cited as a robust analysis relating to renewable energy. It also significantly includes energy efficiency employment opportunities in that it considers 'green' jobs more broadly. The study considers energy generation as one of four areas where green jobs will be generated. It has three timeframes: short term (2011-12), medium term (2013-17) and long term (2018-25). Data is sourced from a wide range of largely international studies, adjusted to local circumstances, the methodology being 'bottom-up' as opposed to a sector or economy level model. Jobs are therefore 'net', not economy-wide. There is a lot of detail in the study on the data and assumptions made. The IRP 2010 is used as a reference case, but the actual build used in the study is constructed by the authors. The study focused on wind, solar, marine and hydro-power. Direct and indirect jobs are reported, but not induced. Construction and O&M jobs are distinguished. There is no consideration of structural change per se. There is a comparison between different technologies.

Key findings: By 2025, 22,280 FTE direct jobs created by wind, solar, marine and hydro power, with an additional 11,278 indirect jobs in manufacturing. For wind power, the manufacturing jobs are 41% of the direct jobs, for CSP, 5%. Relatively PV contributes the lion's share of the jobs at 22,004, with manufacturing jobs as high as 62% of direct jobs.

Technology Scale - Renewable Energy

1 IPP office data

Description: The IPP Office publishes data on the REIPPPP in two forms. The first is the projected number of jobs contained in the individual bidder forms. These are announced at https://ipp-projects.co.za/PressCentre. The second is a retrospective evaluation of how the projects are performing (for example, IPP Office (2017): The IPPPP. An overview. As at June 2017). These can be found at https://www.ipp-projects.co.za/Publications.

The IPP Office holds a detailed database developed from the bidder documentation. However in that this information is of competitive value it is not publically available. Researchers have gained access to this for limited time periods (Stands, personal communication), and find that the IPP-database information allows comparison of technologies, provinces, bid window rounds, differentiating employment along a number of dimensions including according to black citizens, women, local communities, and skills (Stands, 2015). The IPP office reports jobs in job years; 'The equivalent of a full time employment opportunity for one person for one year' (REIPPP Overview, June 2017), although sometimes person-months are also reported. The IPP data tracks citizenship, the number of black SA citizens and local community as job-holders. Data is also collected on numbers of youths, women, people with disabilities and rural communities. Eberhard and Naude (2017) note that employment metrics have changed between the REIPPPP Bid Rounds.

Because the REIPPPP employment data is contractually relevant, it is audited, and as such comes with a high level of accuracy (Gibson, 2017). However, another perspective found that the REIPPPP figures contradict each other, particularly at a provincial vs national level. Only the REIPPPP bid-holder technologies are considered (solar PV and CSP, wind, landfill, hydro, biogas, biomass). Data is publically available to June 2017.

Key findings: The REIPPPP had created 32532 jobs for SA citizens, 29046 in construction and 3486 in operations (REIPPPP, June 2017). This was 64% more than was planned in the construction phase. Construction jobs for black SA citizens and the local community were up to 242% higher than anticipated. (At the time 57 IPPS had completed construction and started commercial operations, with an average operating duration of approximately 26 months. O&M data is therefore limited).

2 Eberhard and Naude (2017) The SA Renewable Energy IPP Procurement Programme: Review, lessons learned and proposals to reduce transaction costs

Description: In reviewing the REIPPPP, the authors have constructed a table of projected jobs for local citizens, by technology and divided into construction and operation. These include all four REIPPPP bid windows, based on the REIPPP data.

Key findings: REIPPPP Bids 1-4 Onshore wind is anticipated to deliver 11355 construction jobs and 32041 operational person years of jobs. Solar PV will deliver 13355 and 33791. CSP: 8400 and 7212. Biomass: 245 and 2187. Land fill gas: 6 and 240. Small Hydro 439 and 173. A total of 109444 jobs, and 17.3 jobs per MW awarded. This study also speaks to some of the implications of the employment metrics used in various bid windows for incentivizing employment.

3 CSIR, 2017: solar and wind energy jobs study 2017

Description: The study was undertaken using the I-JEDI international excel based model adapted for South Africa. This tool estimates the economic output and jobs supporting by the construction and operation of electricity generation plants. Only solar PV and wind were considered, using a scenario based on the IRP 2016 split of technologies project to 2050. The study only considered new jobs in the RE sector, not job losses in other sectors. It uses regional data and considers localization of labour and inputs, sourced from Bloomberg New Energy Finance, directly related to South Africa. A 20 year lifespan of the RE power plants is assumed based on the REIPPPP PPA period. A regional social accounting matrix was used. The results do not consider economies of scale, project economic feasibility or levelised cost of electricity. A gradual increase in local context it assumed.

Outputs are only available in the form of two power point presentations (SATRI symposium on energy choices and the protection of workers interests, 17 May 2017; and International jobs and economic development (I-JEDI) impact model, modeling the renewable energy jobs potential of the draft IRP 2016 for the Just Energy Transition Roundtable. 28 November, 2017). No report was written for this work (Personal communication, Ntombifuthi Ndluli, CSIR). The source data was supplied by Ntombifuthi via email. Findings are reported in job years

Key findings: Construction phase job-years in wind are 470000 (direct), 515000 (indirect) and 523000 (induced) (A total of 1.5million wind construction jobs). O&M Wind jobs are 185000 (direct), 198000 indirect and 383173 (induced) over the period to 2050 (a total of 766,173 wind O&M jobs). It is assumed these are job years. For solar PV, construction job-years range between 20-30000 per annum between 2025 and 2050. O&M jobs range between 500,000 and 800,000 per year over the same period.

4 McDaid L. 2016. Renewable Energy Independent Power Producer Procurement Programme Review 2016: a critique of process of implementation of socio-economic benefits including job creation.

Report for the AIDC, sponsored by the Rosa Luxembourg Foundation

Description: Job numbers are based on Eberhard (2014) and also on REIPPPP publically available documentation, triangulated against site level interviews. The study uses multipliers from the McKinsey study underpinning the DoE's IEP Appendix B, and includes an appendix with some indicative solar PV rooftop numbers. The focus is on REIPPPP technologies. The results distinguish between construction and O&M jobs. Direct jobs are the focus and some indirect job figures are provided.

Key findings: The authors found that construction job figures tended to agree across government and community. The report identifies 'wide agreement that the number of operational jobs as being very few'. Pg 21. The report finds that across bid windows 1-4 there are 43,749 job years of construction jobs, and 55,277 operational jobs. Based on the IEP multipliers, they estimate a further 20,697 indirect sustainable jobs, and then 29,074 induced jobs. Further, using a job calculator against a scenario of 50% RE by 2030, they estimate 281,500 construction job years and 66,100 operational job years per year (1,322,000 over a twenty year operational life), with an additional 1,110,480 indirect jobs in associated industries over twenty years.

5 Stands, S., 2015. Utility-Scale Renewable Energy Job Creation: An investigation of the South African Renewable Energy Independent Power Producer Procurement Programme (REIPP).

Unpublished Masters (MPhil) Thesis. Stellenbosch: Stellenbosch University

Description: This academic research Is based on data from the REIPPPP first 3.5 bid rounds obtained directly from the IPP Office online database (the researcher spent time in the IPP Offices to obtain the data under a Non-Disclosure Agreement. This data was expanded with qualitative data from interviews with stakeholders. The thesis critiques how metrics are currently used within the REIPPPP programme and its contribution to 'meaningful' employment creation. The limitations of individual metrics in their ability to understand this highly complex issue ('meaningful employment') are set out. The work argues for more disaggregated and alternative metrics to be used alongside those currently employed by the REIPPPP programme to fully reveal the 'meaningful employment' aspects of the REIPPPP. The thesis talks about different commitments across the demographics from each technology. Stands concludes that the REIPPPP employment results only begin to reveal quantitative outcomes and trends, but cannot yet conclude if jobs are entirely meaningful. The results are net jobs only, no economy-wide implications were considered. Both Construction and O&M jobs are reported. Direct and indirect jobs are reported with some qualitative indications of induced jobs. The timeframe is the 20 year PPA period of the REIPPPP. The data is disaggregated at a provincial level and reports citizen, black, female, unskilled and local community jobs.

Key findings: Because the study reports across many dimensions of employment, the findings are too many to cover here. A few include: The REIPPP (up to and including Bid Window 3) creates 33,701 person years of employment over the 20 year lifetime of the projects. Relatively, wind contributes the most citizen jobs (93%), then CSP (86%) and then PV (85%).

Continued on next page

Continued from previous page

In absolute terms PV contributed the greatest number of jobs (81,247 in construction and 209,258 in operations), resulting directly from PV achieving the greatest installed capacity for the first three bid rounds. CSP creates far greater number of jobs in construction than operations, whilst PV and Wind generate a greater number of jobs in operation. This is potentially due to the long lead time of CSP construction. Economies of scale are not considered in the bid documentation, potentially skewing employment creation opportunities towards smaller projects. The study's fieldwork found that local communities perceive IPPs to create good employment opportunities, with a reputation for paying a better wage and as being preferable to mining employment. The study concludes that publically available data and the REIPPP documents are insufficient to understand job creation outcomes in the programme. The combination of IPP database information and the researcher's own fieldwork still returned an inconclusive result in terms of the REIPPP's impact on meaningful employment, with further study recommended. The study calls for standardization of key terms including 'direct, indirect, induced, skilled, unskilled, semi-skilled and highly skilled labour', and greater transparency including a central communication platform around employment.

6 **Greenpeace Energy revolution documents (2009-2011): Rutovitz, J. 2010. South African Energy Sector Jobs to 2030: How the Energy [R]evolution will create sustainable green jobs. Prepared for Greenpeace Africa by the Institute for Sustainable Futures, University of Technology, Sydney, Australia; Rutovitz, J with input from Kuno Roth. 2011. More jobs and progress for South Africa: The Advanced Energy [R]evolution scenario and its impact. Prepared for Greenpeace Africa by the Institute for Sustainable Futures, University of Technology, Sydney, Australia.** Available: http://www.greenpeace.org/africa/en/News/news/More-Jobs-and-Progress-for-South-Africa/ Greenpeace. 2011

7 **The Advanced Energy [R]evolution: A sustainable energy outlook for South Africa.** Available: http://bit.ly/ERevolution

Description: The report discusses an alternative energy development scenario for South Africa, one dubbed the Energy [R}evolution Scenario, which has a focus on RE & EE. This scenario led to significantly greater job creation than the reference (or Business as Usual) scenario – almost 30% more jobs in the energy sector in 2020;

8 **AGAMA (2003): Employment benefits of RE in SA.** On behalf of Sustainable Energy and Climate Change Partnership (SECCP), a partnership comprising Earthlife Africa (Johannesburg) and Worldwide Fund for Nature (Denmark)

Description: The study quantifies and characterizes the direct jobs that could be created in South Africa through implementation of wind, solar and bioenergy for both electricity generation and thermal/transport energy services. The study draws comparisons with employment associated with conventional energy sources such as coal, nuclear and natural gas. Also reported is an analysis of the range of skills required in producing and servicing RETs, and health and safety factors. The study also considers the issue of a shift in employment levels in the coal industry and the renewable energy industry.

Coal

1 **Eskom: (2017) response to a PAIA request from the Centre for Environmental Rights**

Description: Key findings: The total number of employees at 15 of its power stations is 7,928 (Information from the Centre for Environmental Rights.)

2 **Chamber of Mines:** 87500 employees http://www.mineralscouncil.org.za/sa-mining/coal accessed 14 June 2018)

NB: No significant data was found for employment associated with power plant decommissioning, coal mine rehabilitation or coal transport.

3 **Gas and Nuclear**

Only the IEP (DOE, 2016) focused particularly on these technologies, but the estimates for employment associated with these fuels are difficult to assess given the unknowns of model parameters. Additional studies for these two technologies were not explored.

SAWEA

Other related work (forthcoming)

1 Tendering sustainable energy transitions (TENTRANS). April 2018 – Sept 2020

Description: The overall objective of the project is to contribute to a transition toward sustainability in the energy sector of emerging economies, including sustainable development of local communities and local industries. The project will analyse the developmental implications of the Renewable Energy Independent Power Producers Procurement Programme (REIPPPP) implemented in South Africa (SA) with a focus on the effects of wind power projects on local industrial development and socio-economic development in local communities. The project will contribute to enhance the research capacity of the younger researchers involved. It will build upon and contribute to significantly advance the literature on sustainability transitions in developing countries through an innovative combination of complementary perspectives on institutional change, global value chains and infant industry development. It will draw on in-depth fieldwork carried out in SA based on qualitative research methods, such as interviews, documents, direct observations and project inventories. Through direct engagement with key policy makers and stakeholders, the project will seek to ensure that local developmental impacts are prioritized and ensured in renewable energy tendering schemes currently being implemented in SA, other countries in Sub-Saharan Africa (SSA) and internationally. The project will contribute to socially inclusive models of implementation by private companies involved in large-scale wind power projects by cooperating with the wind industry associations in Denmark and SA and through direct consultations. Finally, the project serves as a pilot research for a subsequent five year research programme, which will be up-scaled to include solar PV, concentrated solar power (CSP) and hydro-power, and additional countries in SSA, such as Ethiopia, Kenya, Ghana and Malawi.

2 ERC study for SANEDI (forthcoming) (Alison Hughes, personal communication)

Description: This study will consider the potential for electricity demand from industry, using the linked model (SATMGE). The Linked model in general currently uses a very conservative assumption around availability requirements of energy demand (by industry), and this study will explore the implications of relaxing this.

sawindenergy   @_sawea   groups/2977014/profile   admin@sawea.co.za

The research for this paper was undertaken by Emily Tyler and Dr Grové Steyn.

SAWEA

South African Wind Energy Association