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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

Imprint

Commissioned by: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

South African – German Energy Programme (SAGEN)

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Disclaimer

Published in South Africa – November 2017

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Abbreviations and Acronyms

- BWR Bid Window Round
- COD Commercial Operation Date
- DTI Department of Trade and Industry
- DFI Development Finance Institution
- GIZ Deutsche Gesellschaft für Internationale Zusammenarbeit
- GW Gigawatt
- IRP Integrated Resource Plan
- IDC Industrial Development Corporation
- MW Megawatt
- NGP New Growth Path
- OEM Orignal Equipment Manufactures
- REIPPPP Renewable Energy Independent Power Producer Procurement Programme
- RFP Request for Proposal
- SARETEC South African Renewable Energy Technology Centre

1. Executive Summary

In an investigation of job numbers, the South African context is unique in as much as the job numbers for wind farm construction and “operations and maintenance” were committed to upfront in the bidding process. Bid winners were bound by their commitments and reported on them as part of the Implementation Agreement signed with the Department of Energy (DoE), and, in turn, the DoE has verified employment figures at selected facilities to test their veracity. It is for these reasons that we can be certain that the job numbers that emanate from the Independent Power Producers Procurement Programme Office (IPPPP) are nominally accurate and appropriate to South Africa.

However, in any treatise on job creation, there are fundamental issues with the way in which a job is defined. A “job” is a moving target, there is no absolute period for which it lasts, which is why confounding metrics such as “person-months” are introduced into the jobs discourse. Also, there are different types of jobs: a job may be a “direct” job, where a turbine technician is employed on a wind farm, or the definition may include the security guard on the wind farm, as is the case in South Africa where the security guard is committed to under the bidding terms as a job that has been created. In Europe, security is present, but it is often remote, and as such security jobs in Europe would not be counted as “direct” jobs, rather they would be classified as “indirect” or even “induced” jobs, jobs that are not directly in wind, but exist because they are associated with it. Moreover, job creation literature on wind energy separates the various lifecycle stages of a wind farm in various way – some literature will incorporate manufacturing with construction and installation, and others will include wind farm development, and these metrics are then quoted across jurisdictions, yet are not comparable.

Development Jobs

The GLGH study deduced the figure of 0,15 jobs/MW (measured in “person-years” but in this summary, for the sake of clarity referred to as a “job”) of installed capacity, spread over the three years prior to project construction, however, due to the early stages of wind project development in South Africa, a factor for on-the-job training was used which resulted in a final figure of 0,25 jobs/MW until 2017: this equates to a 67% increase in job intensity.

Construction and Installation Jobs

The GLGH figure for construction and installation equates to an assumed 2,45 jobs/MW[1] and is hiked to 6 jobs/MW when including indirect jobs, and the 6 jobs/MW figure is then inflated by another 67% to 10 jobs/MW to compensate for apparent "labour market inefficiencies" which have no cited evidence. AltGen, through its research at the IPPPP Office, reached a figure of 2 jobs/MW, not far off the 2,45 initially proposed by the GLGH. The outcome of the numbers is therefor that the IPPPP Office datasets are actually substantially the same as the initial estimates put forward in the GLGH study. It is the manner in which (1) the statistics are interpreted and (2) assumptions about labour productivity are made, that the misunderstandings arise.

Manufacturing Jobs

The "labour inefficiency" factor that GLGH inserts for manufacturing is 25%, putting the final figure for manufacturing at 5 jobs/MW[2], which is considerably higher than the 1,1 jobs/MW that AltGen deduced in current investigations. The main difference in figures here are from the assumption that "50% of wind tubine capacity would be manufactured in South Africa" and the proposal that this was possible with a strong regulatory framwork, although this is qualified with the rider that an annual installed capacity of 1000MW per annum was an accepted minimum to ensure the development of local manufacturing facilities.

Operations and Maintenance Jobs

These figures from the IPPPP Office show an average of 0,3 jobs/MW installed, where the 2012 GLGH study proposed between 0,8 jobs/MW and 0,5 jobs/MW (reducing over time). The Original Equipment Manufacturers (OEMs) did not take systemic or individual learning into account, and applied the same employment factors that they use in Europe to South Africa.

Turbine Technicians

In the GLGH research, the number of turbine technicians required for operations and maintenance was deduced to be about 40% of the total number of direct jobs in this phase or, around 0,3 turbine technicians/MW. With a predicted installed capacity at the end of 2017 of 2300MW, this should have resulted in 655 technicians. AltGen contacted all of the OEMs in South Africa and the top three second-tier engineering services companies which hold most of the anciliary work, and it is our estimate that

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[1] Assumed because the GLGH research does not make this clear, AltGen has calculated the figure based on GLGH data.

[2] IDC figure is 4,5 jobs/MW.

there are at present around 215 turbine technicians in South Africa (servicing 2021MW). The GLGH figure is three times higher. Further, if GLGH had used the OEMs own more accurate turbine technician factor of 0,2 “technicians per turbine”, at an average turbine size of 2,2MW (the average across all South African projects), then the GLGH study would have predicted an annual need for 45 turbine technicians and not 100[3].

Other unforeseen elements that came into play were that OEMs soon established their own training, and the “Big 3” employed full-time trainers; the largest OEM has its own training centre; further, in South Africa, there is no legislative requirement for Global Wind Organisation (GWO) certifications, which means that some of the OEMs simply do not train their technicians on GWO standards; and lastly, that the last bid window round, BWR 4, has been waiting for financial close for over two years - the pace of the rollout of wind energy has slowed considerably.

After investigating the international and regional markets it is also apparent that wind energy technical vocational training is a “low hanging fruit” that local educational institutions will quickly develop capacity in and there is a very limited (no) market for training of international turbine technicians in South Africa. This, of course, paints a bleak picture for the purpose-built South African Renewable Energy Centre (SARETEC) and its flagship Wind Turbine Technician qualification. What will the demand be for the qualification going forward?

If Bid Window Round 4 (BWR4) proceeds, and all the wind projects achieve financial close, this will mean an additional 1361MW of wind energy being added to the grid. Multiplied by a factor of 0,11 jobs/MW, the “real” South African number, this implies demand for a further 150 turbine technicians[4]. Many of these will be sourced and trained by the OEMs themselves. SARETEC’s cooperation with industry is crucial.

If BWR 4 does not proceed, then limited training may be offered, but candidates need to be very carefully selected, made mindful of the consequences of there being no jobs available, be internationally mobile, and bursary candidates who have jobs should not be taken out of gainful employment to complete the turbine technician qualification.

[3] This figure would exclude the secondary engineering services companies, and only account for technicians directly employed by OEMs. A facility management company would employ much fewer technicians (1 technician per 10 turbines) and they are not necessarily active turbine technicians, often acting as operators.

[4] 0,11 jobs/MW X 1361MW = 149,71 technicians

2. Introduction

AltGen Consulting has been appointed by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) to review the study: *"An Assessment of training and skills needs for the wind industry in South Africa"* conducted by GL Garrad Hassan (GLGH) as commissioned by the GIZ in 2012. The objective of the study was to determine whether the projected wind energy market was substantial enough to motivate for the establishment of a training facility devoted to wind energy skills development.

The macro-economic policy justifications [framework conditions] for the introduction of renewable energy into the South African energy mix are partly to be found in South Africa's commitment to clean energy and green jobs and are discussed in detail in the GLGH report. They include the 2010 Green Economy Accord, which as a part of the New Growth Path (NGP), outlines the countries commitment to the procurement of renewable energy and highlights as one of its objectives creating 300,000 jobs in the green economy by 2020. These jobs are further broken down into 80,000 in manufacturing and 220,000 divided between the construction, operations and maintenance of new "green infrastructure".

But policy is augmented by reality, and the reality is that between October 2007 and February 2008 South Africa experienced regular rolling blackouts, and a national electricity emergency was declared on 24 January 2008. Mines were closed for a week, the national utility, Eskom, imposed power savings on 138 key customers, and large infrastructure projects[5] were put on hold, until the situation could be rectified.

It is against this backdrop that the Department of Energy published the Integrated Resource Plan 2010 – 2030 (IRP 2010-2030) which outlined the energy mix for South Africa for the following 20 years. The IRP 2010 showed significant dedicated support for renewable energy, allocating 3725MW to large scale renewable energy projects by 2016 and 9200MW to wind generation by 2030. The first Request for Proposals (RfP) was issued for Renewable Energy Independent Power Producers (REIPPs) in August of 2011, with preferred bidders being announced in December of the same year, and signatures on the Power Purchase Agreements (PPA's) by the 31st October 2012, a few months after the GLGH report was submitted to the GIZ, in July of 2012.

[5] Such as the Rio Tinto aluminium smelter at Coega.

To date the IRP and its subsequent revisions and updates have facilitated several rounds of bidding for the procurement of renewable energy, and as at the end of 2017 South Africa has 2021MW of onshore wind projects which are fully operational[6].

Thus, 2011 and 2012 were seminal years for renewable energy in South Africa[7], with financial close and PPAs being achieved and construction starting on a government backed renewable energy programme, and it is through this lens that the GLGH study need to be viewed.

The GLGH review analysed various policies pertaining to wind energy and when considering uncertainties relating to the development of the wind industry in South Africa, produced outcomes based on three scenarios – Central, High and Low. In terms of job creation potential, only skilled positions were included in the study and counted as "jobs". These jobs were then broken down into three subgroups; Skilled Workers, Technicians, and Engineers.

The information provided in this AltGen study will give an updated assessment of the GLGH report, reflecting on how the wind energy sector has unfolded since the first RFPs in 2011. Statistics gathered will be analysed and compared to the job creation estimates proposed in the GLGH study – also highlighting differences and possible shortcomings in initial GLGH figures and methodology.

The outputs from the engagement of AltGen by GIZ are a comparison of the GLGH 2012 estimates with actual developments in the wind energy sector in South Africa, a revision of employment and training requirement updates, given the current situation, and estimates of the training demand from the East-African wind energy sector. The detailed activities include a review of the GLGH report, data on wind energy employment since 2012, a comparative review of the GLGH estimates and actual developments, and a recommendation on the training requirements going forward.

3. AltGen

Research such as this cannot be conducted purely as a desktop study as on-site and in-person engagement are important to develop a clear understanding of the number of employees and various organisational structures and organograms through the value chain of the different components of the wind energy industry. Thus, AltGen approached the engagement on several levels, including telephonic discussions, in-

[6] This excludes the Darling and Sere Wind Farms which are not part of the REIPPPP.
[7] This was (coincidentally) also the year of the establishment of AltGen.

person visits to OEMs and engineering services suppliers, and site visits to wind farms and component manufactures, to support the desktop research and data collection process.

Considering that (1) the current focus in South Africa is the operation and maintenance of the facilities, (2) that the developers are in many cases also the IPP's, and (3) that one of the main points of the GIZ brief was to establish the number of wind turbine service technicians that has been and would be required by the wind energy industry, AltGen focussed on more extensive engagement with the downstream component of the value chain comprising orignal equipment manufactures (OEMs), facility managers, owner representatives, balance of plant O&M contractors, lift and blade inspection engineers and technicians, and warranty inspectors, all of which have at minimum an occasional presence on the wind farms. In-person visits were guided by a questionnaire (see appendix 3), which also provided structure for the telephonic conversations.

Data regarding construction, manufacturing, and operations and maintenance commitments made by the IPPs was sourced directly from the Independent Power Producers (IPP) Office as a means of collecting as much primary source data as possible. The focus was specifically bid window rounds (BWR) 1-3 of the REIPPPP as this was the period that was focussed on in the GLGH study, and most of the projects in these bid windows have reached COD and are currently in the operations and maintenance phase. In terms of the veracity of the figures, the numbers were committed to by the IPPs in their Implementation Agreements and verified by the IPP Office and must therefore be assumed to be accurate.

Data on the turbine technicians was sourced from OEMs and secondary engineering services suppliers through interviews, site visits and direct industry engagements, and is probably the most accurate dataset that AltGen has. Manufacturing data is sourced partly from AltGen's interaction with the manufacturers and the balance was sourced online and inferred. Two of the three wind turbine tower manufacturers were not willing to divulge exact figures without a non-disclosure agreement.

There have been several research studies conducted which AltGen was engaged for and that have provided additional insight.

SEPTEMBER 2017: A commission with the South African Wind Energy Program (SAWEP) as funded by the United Nations Development Program (UNDP) titled: *"Status and Analysis of the Wind Energy Training Education Skills and Capacity Development".*

OCTOBER 2017: A project with a large OEM where all supervisors and turbine technicians were engaged with.

MAY 2016 – SEPTEMBER 2017: A project funded by the GIZ entitled: *"Review and Career Development and Professional Progress of 3 groups of SARETEC Wind Energy Technician Training Course graduates"*.

MARCH 2015: A research Master's undertaken by an AltGen consultant, thesis entitled: *"Utility-scale Renewable Energy Job Creation: An investigation of the South African Renewable Energy Independent Power Producer Procurement Programme"*.

Further to this, **AltGen Recruitment**, the sister company to AltGen Consulting, has been recruiting all levels of staff in the wind energy industry in Southern and East Africa since March 2012 and has, in the last five and a half years, placed over 500 resources into renewable energy. Roles have been in construction, development, consulting, project management, and operations and maintenance fields – this has enabled a well-placed and unique insight into corporate resourcing requirements.

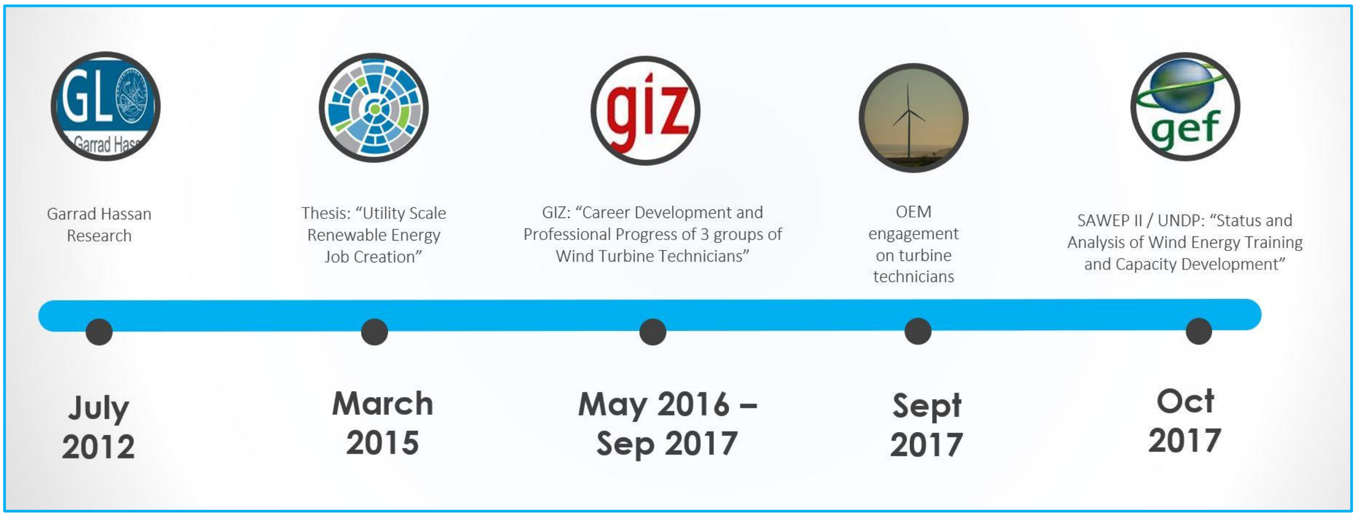


FIGURE 1: TIMELINE OF ALTGEN CONSULTING ENGAGEMENT WITH JOBS RESEARCH IN REIPP

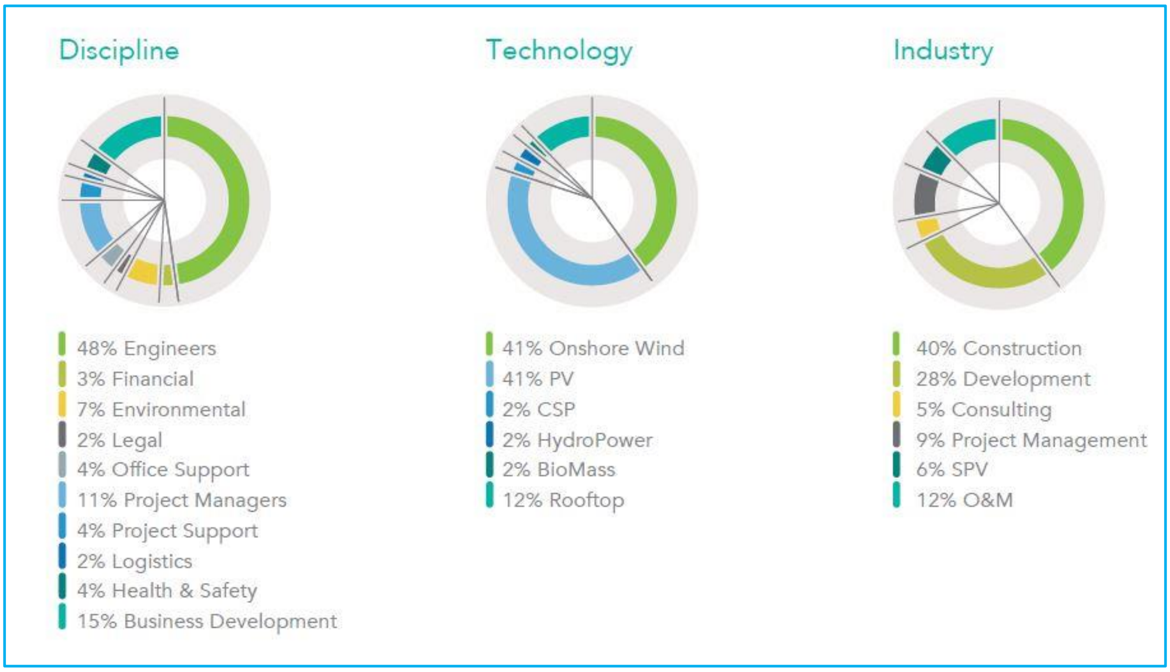


FIGURE 2: SUMMARY OF ALTGEN RECRUITMENT PLACEMENTS

As can be seen from the graphic above, the majority of AltGen's placements (in both solar and wind energy) have been in the construction field, with the second highest number coming from project development. Together, these figures represent a total of 68% of all placements, and operations and maintenance roles account for 12% of placed roles. There is however no correlation between these statistics and the statistics of the GLGH research, they are rather a reflection of need: in an area where skills are scarce, for example in the project and construction management of a large wind farm, there is accentuated competition for skills and employers are willing to pay a fee in order to acquire the required expertise.

AltGen has a branch office located in Nairobi, Kenya, which contributed to the East Africa component of this study.

ALTGEN KENYA ALTGEN RECRUITMENT ALTGEN CONSULTING

4. GLGH use of the IRP 2010 – 2030 & REIPPPP Summary

According to the IRP 2010, 11,4GW of new generating capacity was allocated to renewable energy technologies by 2030, however, this scenario was adjusted following a public consultation process to produce the Policy-Adjusted IRP. The Policy-Adjusted IRP, balancing the most cost-efficient electricity pathway with government objectives including job creation, security of supply and sustainable development, allocated 17,8GW of new capacity to renewables by 2030 of which 8,4GW was allocated specifically to onshore wind.

Going forward, the Policy-Adjusted IRP assumes 400MW of wind energy to be added to the grid until 2023, where it envisioned that a sharp increase in capacity is then rolled-out annually, 800MW in 2024, 1600MW in 2025, 400MW of capacity in 2026, and 1600MW in 2027.

The commencement of the REIPPPP in 2011 sought to give effect to the RE capacity allocations in the IRP 2010 and subsequently formed the justification that GLGH uses as the baseline for the numbers of Wind Turbine Service Technicians (TTs) needed in South Africa: The Policy Adjusted IRP scenario foresaw the introduction of 2400MW of cumulative wind energy by December 2017.

Fast forward to today, and the status of the programme is that, as the Loeriesfontein, Khobab and two Longyuan-Mulilo De Aar wind projects from the third round of bidding (BWR 3) reach commercial operation, the total installed wind capacity in South Africa is 2021MW by December 2017, not far off what the Policy-Adjusted IRP 2010-2030 envisaged.

Considering that wind energy in South Africa to date has been deployed as directed by national policy, it should be stated that the GLGH study is generally sound: the combination of researching international benchmarks, local green jobs research, workshops, questionnaires, and personal calls is the best that can be done - it is in the opaque space were assumptions are made and methodological rigour was of necessity diluted, that the gap between the GLGH study and reality is apparent.

It is in the following three points that much disconnect between the GLGH predicted jobs and real jobs has arisen:

- "The expansion of wind generation in South Africa to 2030. Firm political commitment currently extended only to 2016. Also, delay in increasing or upgrading the capacity of the national transmission system to accommodate wind and other renewables is a significant risk for future projects";
- "The extent to which employment efficiency (jobs per MW) can reach the levels of established wind markets";

- “The extent of local manufacturing of wind turbines and components. Establishment of a local manufacturing industry will depend on a combination of investor confidence in a substantially steady annual market, and strong local content requirements” (GLGH 2012: p3).

While the absolute number of MWs are on par with what the GLGH research modelled for 2017, the pace at which the REIPP is unfolding is going to need to be revised. With low growth in energy demand, competing technologies, and 1361MW of wind energy awaiting financial close for two years now (BWR 4), the timelines for the roll out of REIPP projects are becoming longer, implying that the Policy-Adjusted IRP 2010 - 2030 is no longer an accurate guiding document, and leads to the need for fresh policy certainty[8].

4.1 South African Wind Farm Figures

MWs that are awarded annually, the cumulative total of MWs that have been constructed, and the number of MWs installed annually are illustrated on the following pages, and it can be seen that up until the current point, construction and cumulative installed MWs have been steady. Depending on how this information is interpreted relates to how close the estimates were to actual installation figures.

Since the inception of the REIPP in 2011, South Africa had seen a total awarded MW allocation for Wind Farm projects of 3382,8MW, over a 7 year period, till 2017. This averages out to approximately 483MW of wind projects awarded annually.

[8] At the time of writing, the South African energy mix is at a crossroad. The recently moved previous Minster of Energy announced that 28 renewable energy projects from bid windows 3.5 and 4 were to be contracted in by the end of October 2017. Her replacement has not honoured this commitment, but has himself now committed (8 November 2017) to sign the outstanding power purchase agreements by 20 November 2017. It remains to be seen if these are signed. If yes, there may be a further 1400MW of wind power and 2400MW of renewables coming on line in the coming years.

FIGURE 4: LEAD TIMES FROM RFP TO THE END OF CONSTRUCTION EXTEND FROM 1150 DAYS TO OVER 1900 DAYS.

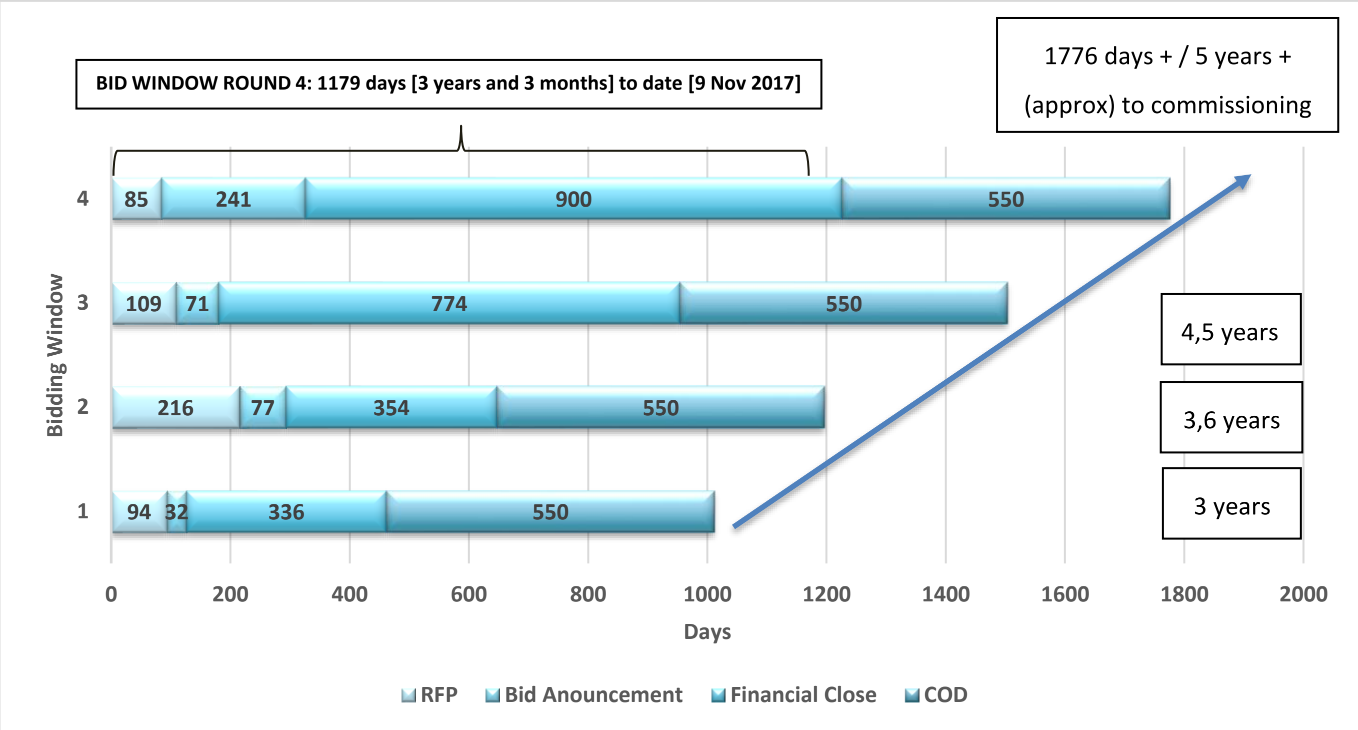
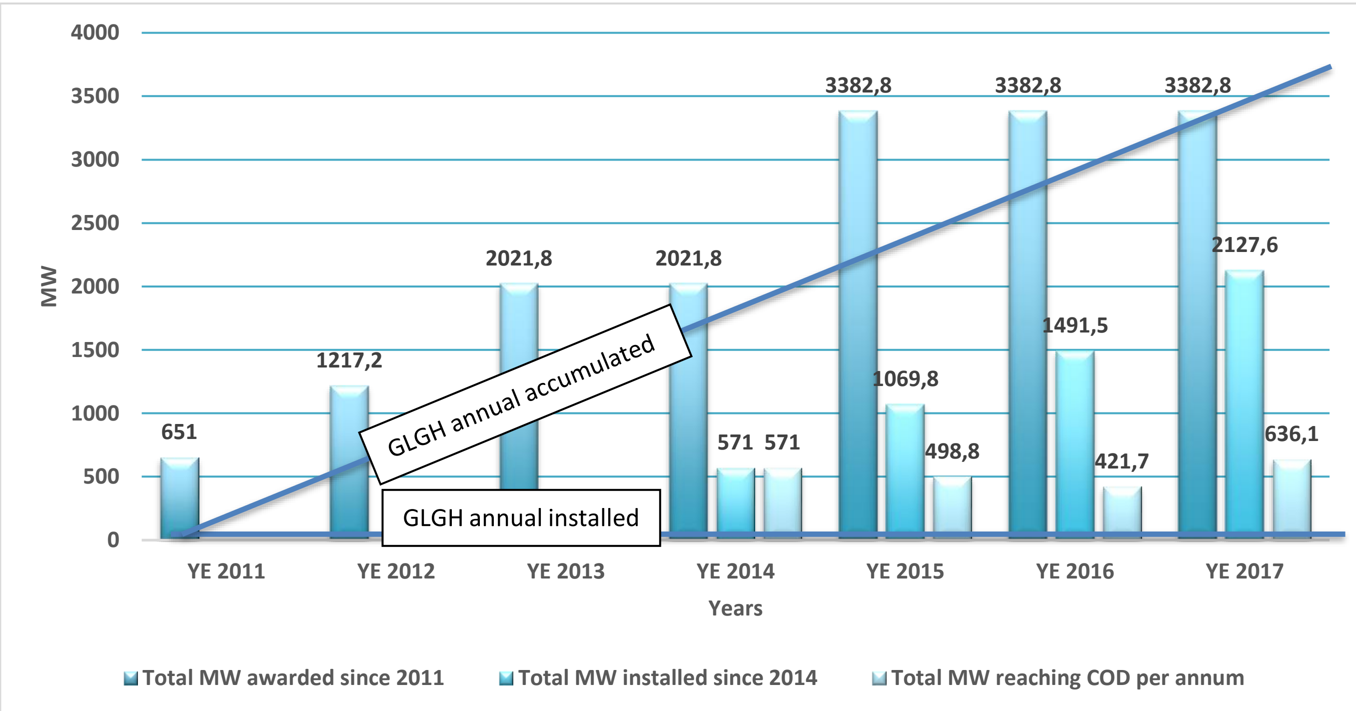


FIGURE 3: WIND MWS AWARDED, CONSTRUCTED AND REACHING COD ANNUALLY

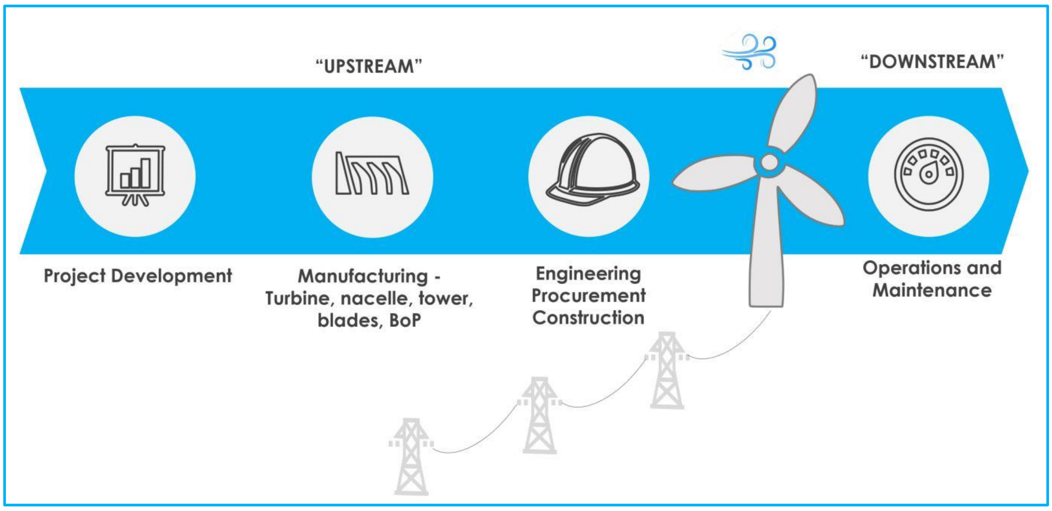


5. GLGH Report: Methodological Review

The GLGH analysis examined several sources to estimate an employment value for each of a number of categories, which included:

- Upstream: Number of jobs per MW **annual installed capacity**
  - covering **short term work** in development, manufacturing construction and installation, and assumed to be required on an annual basis depending on market activity;
- Downstream: Number of jobs per MW total **cumulative installed capacity**
  - covering **long term work** in operations and maintenance and required for all existing operational plant.

FIGURE 5: WIND ENERGY VALUE CHAIN



Broad Terms: Firstly, consider the explicit and implicit scope of the GLGH report: "Assessment of training and skills needs for the wind industry in South Africa". The "wind industry" explicitly states that the research should cover all jobs in the industry, from upstream project development through to downstream operations and maintenance, which is a broad scope. With the implicit mandate of the GLGH research being to underwrite, with research, an investment decision in excess of R 100 million into the South African Renewable Energy Technology Centre (SARETEC), it may be fair to state that the scope of the GLGH report was somewhat broad, and that in attempting to research the entire "wind industry", the focal point of SARETEC was diluted. This should also however be viewed in the context of the fact that there had already been research conducted into the viability of a "South African Wind Energy College" or SAWEC, by the time this report was published.

	YEAR	OUTCOME	O&M JOBS	MANUFACTURING
AGAMA Employment potential of RE in South Africa	2003	36 373 jobs by 2020	22 400 (wind) 2 475 (PV)	N/A
GREENPEACE South African Energy Sector Jobs Report	2010	58 000 by 2020 72 400 by 2030	46 400 by 2020	11 600 by 2020
IDC Green Jobs Report	2011	130 000 by 2025	21 711 by 2025 • WIND: 5 156 jobs / 7 100MW • PV: 13 541 jobs / 4 900MW • CSP: 3 014 jobs / 5 620MW	11 176 by 2025 • WIND: 2 105 • PV: 8 463 • CSP: 608

FIGURE 6: INCONSISTENT SOUTH AFRICAN JOB CREATION NUMBERS

Wind Associations: Further to this, jobs data was sourced primarily from Wind Associations, citing sources such as the European Wind Energy Association (EWEA), the American Wind Energy Association (AWEA), RenewableUK (formerly BWEA), the German Wind Energy Association (BWE) and the Danish Wind Industry Association (DWIA). This information cannot be assumed to be primary source data, rather it is mostly an interpretation of primary data, and it should not be accepted as adequate justification for a meaningful state driven investment into training.

The GLGH report does caveat this with the qualifier that "the numbers are assumed to be accurate" but it remains methodologically better practice to cite primary sources – to drill down into the research to source and reference studies that were conducted in the various geographies and use them to extrapolate accurate first-hand data. To reiterate, the GLGH report recognised the limitations of these sources by stating, "these groups are all pro-renewable industry lobbying associations, and therefore have a vested interest in highlighting the benefits of renewables. Their reported figures should hence be treated with caution, and assumed to represent an optimistic case" (GLGH 2012: p13).

Reference Data: The South African specific studies referenced in the GLGH study were a Council of Scientific & Industrial Research (CSIR) report, an AGAMA Energy paper, and the Industrial Development Corporation (IDC) "Green Jobs" publication, and these were by nature speculative and assumptive since at the time they were published there was no South African wind energy industry. Their outputs were themselves based on research drawn from other countries[9]: primarily from the EWEA study "Wind at Work: Wind Energy and job creation in the EU" (EWEA 2009). The EWEA figures are themselves used by

[9] The AGAMA study was conducted in 2003, and by the admission of one of its authors, not robust enough to be used for the future job creation estimates – in fact when we contacted him ourselves, he implored us not to use it.

AltGen and Stands in her research into jobs creation factors, citing Wiesegart et al. (2011): "The EWEA methodology has been repeatedly tested and used a combination of real data and the EWEA's actual data" (Stands 2015). It does however remain that research figures used by the GLGH study are secondary and not primary research data.

Local Assumptions: The GLGH study attempted to contact various wind stakeholders by using a questionnaire. Responses to this included six of nineteen developers (GLGH Appendix: p75) and three of twelve OEMs / Component Manufacturers. The rest of the responses came from an association, a university, a financial institution, a public organisation, a research organisation, and the utility, Eskom.

The use of the questionnaire to South African stakeholders had mixed results. Local assumptions were incorporated into the research which have since turned out to be incorrect and not contributed to the overall integrity of the research. This was probably best avoided (hindsight being the perfect science).

Methodological Inconsistencies: There are also methodological inconsistencies in the research which will be unpacked on a point by point basis. Jobs research is not well defined and can easily become confusing, what is a job and the difference between direct and indirect jobs for example, with the IPP Office itself not referring to jobs but focussing on the concepts of person-months and person-years as being more relatable measures. The IDC research for example states that the job numbers covered are only direct jobs, and the GLGH research then states that it includes direct and indirect jobs in its numbers citing the IDC direct jobs figures and comparing them to their own figures. This is not comparing "apples with apples" and while it does not necessarily lead to incorrect outputs, it is still not a valid comparison.

Also relevant is the comparison of jobs in a construction period with jobs in an operations and maintenance period, and in applicable countries with the manufacturing period. A sustainable wind energy industry with significant manufacturing capacity such as with Denmark and Germany results in a number of jobs that would be relevant at a moment in time: for example, today, there may be 32 000 people employed in wind energy in Denmark. But in South Africa, for wind farm construction, should the measure of a job be one person employed for 12 months, or should it be one person employed for the period of construction, which is 18 months? If one were to ask the construction worker who has been employed on a wind farm if they have had one job or two, he or she would inevitably say one. But if you were to ask the person who left the wind farm halfway through construction and moved to another job, he or she would say two. Similarly, how many jobs does the average person have in their lifetime? Certainly not one per year, which may make the metric of annual jobs somewhat less relevant.

Labour Productivity: The last point that needs to be mentioned is probably the most important, and that is the use of the concept of "lower labour productivity in South Africa" to increase the job numbers required by varying factor. Nowhere in the GLGH research does it refer to where these factors are sourced from and no research on labour productivity in South Africa is consulted. The IDC Green Jobs study uses the concept, the questionnaires refer to it, and the workshops also made specific references to "lower labour productivity" but in no case is there any empirical evidence given for this, no supporting literature cited, and no reasoning is provided for the quantum of increase.

Thus, in summary:

- The scope of the GLGH report, as prescribed by the GIZ, was perhaps too broad;
- The research used local assumptions, some of which proved incorrect;
- The research figures used by the GLGH study, specifically the South African studies, is problematic;
- Per the following analysis, the GLGH report has methodological inconsistencies and numerous assumptions;
- The definition of a job is not referred to consistently, also when using other research;
- The assumptions about lower about productivity are not verified and are ultimately incorrect.

Instances and examples of each of these criticisms are provided in the sections that follow.

The GLGH research agreed with the conclusions of previous studies relating to skills development (GLGH 2012: p85) that training provision would be needed in three broad classes: skilled workers, technicians and professional engineers, and with a fair degree of confidence in the estimates and a lack of indication to the contrary, the research seemed to indicate that a robust strategy was needed in order to proceed with provision of training, especially since it concluded that:

- (1) Training provision is low-cost in the early stages, i.e. does not require substantial capital investment. Therefore, provided there is a frequent review of needs, training approaches can be adapted where necessary without substantial wasted investment;
- (2) The economic consequences of having insufficient trained staff are greater than the economic consequences of training too many[10].

But there were caveats, prime of which was also the main risk affecting the entire wind industry in South Africa, being: "uncertainty" – this translated to lack of confidence in the long-term wind market and may have had numerous negative consequences including deterring investment, the adoption of short-term solutions, the use of expatriate staff, and negligible local manufacture of components.

[10] This ignores the consequences on the individuals who have been trained: reality is that many trainees would exit stable jobs to do the training.

6. Wind Farm Project Development

GLGH estimated project development jobs based on "own experience of international markets and stakeholder consultations" as follows: a 100MW project may take around three years to develop, with the equivalent of approximately five full-time technically-qualified staff, including consultants. Thus, a requirement of 0,15 "person-years per MW" of installed capacity, spread over the three years prior to project construction, was established. Due to the early stages of wind development in South Africa, a factor for on-the-job training was used resulting in a figure of 0,25 person-years/MW until 2017 (GLGH 2012: p37).

This equates to a 67% increase for on-the-job training or between eight and nine full-time technically-qualified staff for a 100MW project versus the five for mature international markets.

The reality was that some developers did employ "Study Engineers" or augmented the skills base of existing staff[11], with high level wind resource data being sourced from research institutions such as the CSIR and Stellenbosch University, but, for many projects localised wind data was interpreted and manipulated offshore by international resources: consulting firms included GLGH (now DNVGL), Wind Prospect, Windlab, 3E Renewables, Arup, Mott MacDonald and others. Where local staff of consulting firms were used, engineers utilised widely available tools (under licence) and upskilled themselves on wind yield interpretation and turbine placement. By the time the GLGH study was concluded in July 2012, several wind farms had already been approved and a number these used international engineering resources for the design portion of their bid submissions.

However, this externalisation of labour can be counter-balanced by the need to use local resources to work through the permitting aspects of project development including water use, land use, environmental permits, waste management, building plan approvals, civil aviation authority approvals, heritage council consents and many other requirements, which was apparent in the comments that two developers made that are noted in the GLGH study: "Much effort was required on legal and financial tasks" (GLGH 2012:

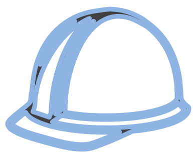
[11] Among them Innowind, Mulilo and G7 Renewables.

p29) and they had already used a greater number of staff than what was predicted in the GLGH Draft Assessment of Needs.

The convoluted procurement process and the newness of the legal and financial mechanisms may have meant that further along in the project development process there were possibly more resources used than in international markets, however, tempting as it may seem, this finding should not be transferred to other wind farm phases and the GLGH finding that “more staff were needed than anticipated is significant” (GLGH 2012: p29) seems to imply that this may have been the case.

A further complication is that South Africa was in the earlier stages of renewable energy project development which may have meant that many more projects being developed than ever had the possibility of seeing it through to preferred bidder status and financial close, in which case there could have been significantly more resources focussed on early stage project development than a mature market would have.

Another factor that needs to be considered is that project development skills are by their nature highly educated, transferrable, mobile and entrepreneurial - todays wind farm is tomorrows desalination plant. As much as there may have been a focus on project development and the legal and financial closing of projects during 2011 and 2012, there is currently, end of 2017, a surplus of developed wind projects in South Africa and limited legal and financial skills focussed on them.



7. Wind Farm Construction

The South African research that GLGH refers to for construction includes the IDC Green Jobs construction figures, yet these are not supported by any reference calculations: they simply appear as an estimate. (GLGH 2012: p20). Sourced from page 37 of the IDC document, as follows: “The following ratios have been used in estimating the employment creation potential associated with wind power: for construction employment, 1,5 jobs/MW capacity; for operations and maintenance, 0,5 jobs/MW capacity; and for manufacturing employment, 4,5 jobs/MW capacity. These add up to a combined total of 6,5 jobs/MW capacity” (IDC 2011: p 37).

Recall that the IDC figures are not referenced, the calculations are not shown, and the GLGH study refers to the IDC figure, specifically for construction, as being an outlier, in which case it should not be used as a reference. The IDC also compensates for "lower labour productivity" in this instance: "the figures have been adjusted upwardly to some extent (authors emphasis) due to lower labour productivity" (IDC 2011: p28). There is no explanation offered as to where the "lower labour productivity" comes from and there is no explanation as to why this quantum is used.

Further, when discussing the EWEA construction, installation and manufacturing (CIM) figures of 15 jobs/MW the GLGH report refers to these as being much higher than the IDC figure of 6 jobs/MW, but does not note that the IDC research is on direct jobs only, and the EWEA CIM research includes indirect employment – the IDC and EWEA results are therefore not usable in the same context, especially when considering that the EWEA 15 jobs/MW include a large research and manufacturing industry that exports turbines globally, and this does not exist in South Africa.

The GLGH Draft Assessment figures which equate to an assumed 2,45 jobs/MW[12] is hiked to 6 jobs/MW when including indirect jobs, citing the following: *"*Note that the totals derived in this section and the previous section, i.e. for the development phase and construction phase, are well below the figure of around 6 jobs/MW derived for the Construction and Installation activity in Section 3. This is because Section 3 considers all direct employment attributable to the wind industry, including subcontractors and suppliers of services and components, and also including a substantial number of non-technical roles in management and other fields such as finance, legal, administrative support, marketing, transport and others" (GLGH 2012: p39). The 6 jobs/MW figure is then inflated by another 67% to 10 jobs/MW to compensate for apparent "labour market inefficiencies" which have no cited supporting research except to say that several stakeholders cited potential "labour market inefficiencies".

[12] Assumed because the GLGH research does not make this clear, we have had to derive the figure from our own calculations of the GLGH data

7.1 AltGen Wind Farm Construction Employment Figures

Due to the majority of jobs within this subset coming directly from the installation of developed projects, only job figures for BWR 1, 2 and 3 were used for comparison. Figures were gathered directly from the IPP office, providing detailed job numbers for installed projects as reported directly by the Engineering, Procurement and Construction (EPC) contractors (Stands 2015).

	BWR 1	BWR 2	BWR 3	Total
Person-Months	21720	21444	31344	74508
Project life Jobs	1810	1787	2612	6209
Annual Jobs (divided by 18-month construction period)	1207	1191	1741	4139
Total Awarded Capacity (MW)	651MW	566MW	804MW	2022MW
Project life Jobs/MW	2,8	3,2	3,2	3,1 project years jobs
Annual Jobs/MW (divided by 18-month construction period)	1,9	2,1	2,2	2

The results from Stands were provided in "person-months" as this is the most accurate metric to use when discussing job numbers, and is the metrics used by the IPP Office from where the figures are sourced. In order to arrive at a 'job' figure, the person-months may be converted to jobs per annum assuming an average wind farm construction period of 18 months according to the following methodology: BWR 1 – 3 IPPs committed to utilising 74508 person-months of labour (Stands 2015: p 58), this number, divided by 12, will give us a figure of 6209 years project lifecycle work, which with an installed capacity of 2022MW results in a job intensity figure of direct project life jobs of 3.1 jobs/MW and annualised job figure of 2/MW.

This means that at a mean point in time during the construction of a wind farm in BWR 3, there would be around 2600 lifecyle jobs present.

Bid Window 3 Job Specifics			
Sector	Person Months	Lifecycle Jobs	Annualised Jobs
Construction	31 343	2 612	1 741
Operations	102 069	8 506	425

(PPIAF, 2014; inputs received from the IPPP office, 2014)

* Note: Job creation potential for Bid Window 3 Projects during operations is calculated following a different methodology than that employed in the previous rounds

FIGURE 7: FIGURES FROM THE DEPARTMENT OF TRADE AND INDUSTRY FOR BWR 3 ARE THE SAME AS THOSE FOR STANDS, S, AND BOTH ARE DRAWN FROM THE IPP OFFICE

The outcome of the above interpretation is that the datasets are actually substantially the same as the initial estimates put forward in the GLGH study. It is (1) the manner in which the statistics are interpreted and used and (2) that assumptions about labour productivity are made that the misunderstandings arise.

- GLGH – 10 Jobs/MW

This figure includes indirect jobs and labour inefficiency. When taking these out, the "apples for apples" comparison results in figures that are much closer to those that were reported by the IPPs to the the IPP Office.

- IDC – 1,5 Jobs/MW

This figure excludes indirect jobs, yet has an (yet unexplained) increase for labour inefficiency. It is substaintially lower than what was reported from the IPP Office and can be discounted.

- ALTGEN – 2 jobs/MW (annual)

What can be deduced from the above? In researching jobs, great care needs to be taken to compare figures.

Points to note here include that:

- The different phases of development are not treated the same across studies, in some instances development is combined with construction, and in other cases construction also includes manufacturing (CIM)[13];
- The definition of a "job" needs to be clear. The generally used default definition is that one year of full time employment equates to one job. The IPP Office, in reporting on construction, reverted to person-months since this is a more direct metric that can take into account varying construction periods but it is, at best, not intelligble and does not make for good quoting;
- The inclusion of indirect jobs into some studies is confusing, since these numbers are by their nature much less specific than direct jobs;
- The addition of a multiplier to compensate for a perceived local issue is not a sound research principle. In this instance, under construction jobs, GLGH first added a number for indirect jobs, and then added 67% to the combined figure to account for labour inefficiency. The 67% assumption is not elaborated on, there is no supporting research cited, and it is clearly refuted when looking at the real numbers that eminate directly from the IPP office.

[13] The key to sound jobs research is to remain consistent.

Even if the assumptions are made explicit in the research, the danger is that the "soundbite headline figures" are taken out of context.

On page 15 of the GLGH report, figures are used which correlate closely to the AltGen figures but they are not cited other than referring back to the GLGH Draft Assessment of Needs - they do not lead to original research. The fact that they are substantially similar (after taking out the indirect jobs and the assumed low labour productivity) seems coincidental.

8. South African Wind Farm Jobs in Manufacturing vs Estimates

The REIPPPP required project developers to commit to specific minimum local content requirements, the agenda being to create conditions for the establishment of local manufacturing of high value components such as wind turbines and blades (Eberhard 2014). To account for these minimum requirements, the GLGH report adds in considerable jobs to cater for local manufacturing with the caveat that: "It was found that the likely annual installation rate is below the level commonly estimated to be necessary for local manufacturing, but strong policy and regulatory requirements can overcome this" (GLGH 2012: p39).

Further to this a report completed by the Department of Trade and Industry (DTI) in 2015 highlighted that OEMs in South Africa have not considered establishing blade manufacturing facilities as they perceive that the market is currently not large enough for a viable blade manufacturing industry[14] (DTI 2015). Similar circumstances prevail with regard to nacelle assembly, the market is too small to justify local assembly[15]. Wind turbine towers are however manufactured locally, with 2 local steel tower manufacturing facilities and a batching plant having been used for the construction of concrete towers. DCD, located in Port Elizabeth, started manufacturing steel wind turbine towers in 2014 and GRI Wind Towers, located in Atlantis, produced its first towers in 2015. DCD was set to produce 110 towers per annum with the intention to increase production to 200 towers per annum when at full capacity (DTI 2015).

[14] There is an independent blade manufacturer that has considered a facility in Atlantis in Cape Town, but this is yet to be committed to.

[15] There was one manufacturer that was assembling a local turbine, Isivunguvungu Wind Energy Converter (I - WEC), but they managed to assemble a single turbine before they closed down, which was soon after the GLGH study was concluded in 2012.

GRI Wind Steel was designed with a manufacturing capacity of 150 three-section wind towers per annum (DTI 2015).

FIGURE 8: DCD WIND TOWERS, PORT ELIZABETH

FIGURE 9: GRI TOWERS, ATLANTIS

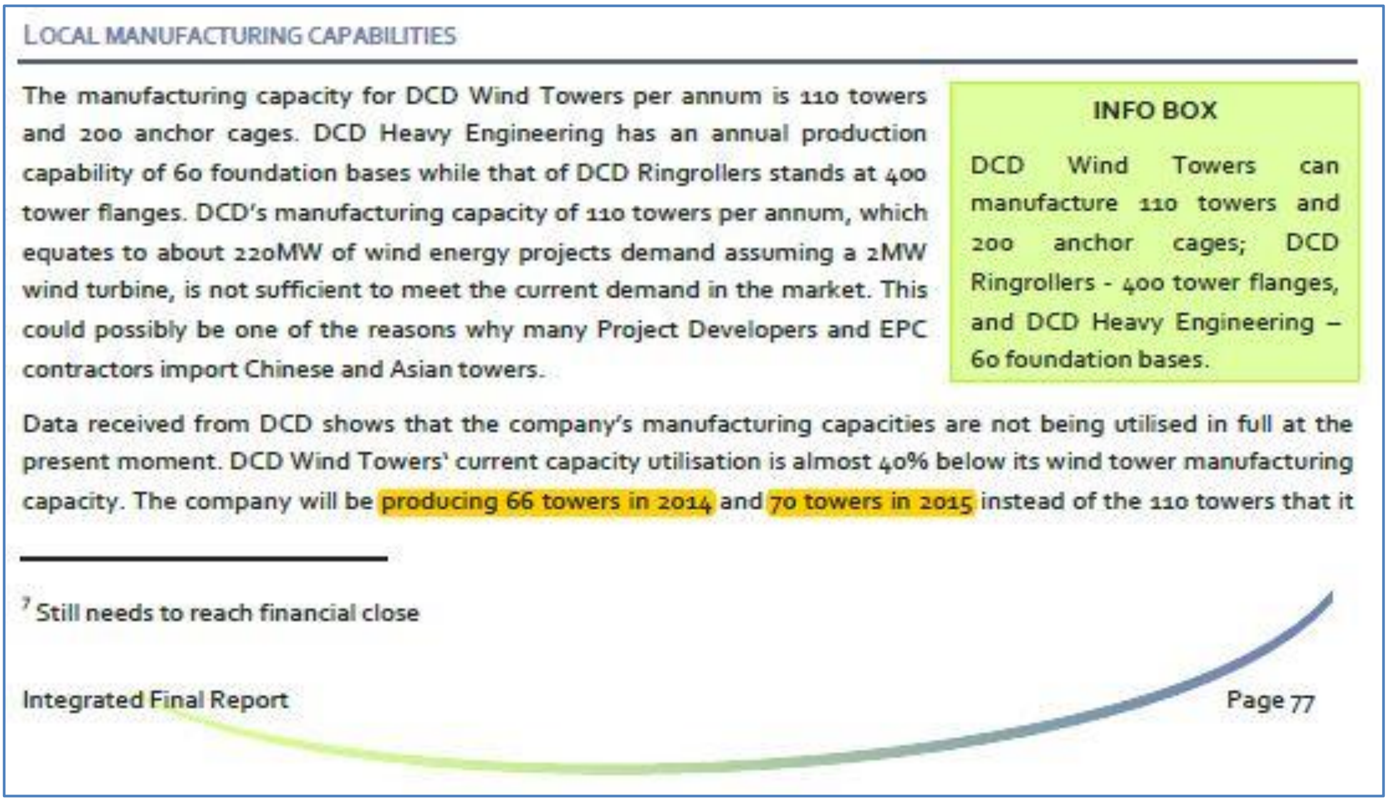
FIGURE 10: ACCIONA CONCRETE TOWERS AT GOUDA WIND FARM

The third manufacturer is the Acciona concrete wind tower mould technology where the wind towers are cast in sections in a batching plant using a proprietary mould and concrete mix. Towers were manufactured for the Acciona owned Gouda Wind Farm but up until BWR 3 this was the only wind farm that Acciona secured and no other wind farms have since made use of the proprietary technology (Gouws 2015a).

8.1 South African Wind Farm Manufacturing Employment Figures

It must be stated at the outset that tower manufacturers would not publically state the number of towers that they have manufactured and numbers have been deduced from online sources and conversations. At full capacity of 200 towers per annum DCD was to employ upward of 600 staff but full capacity has not been achieved and the highest number of towers produced in a calender year was 110. The number of staff employed at the time was around 172.

Acciona produced towers for a single facility, their own Gouda Wind Farm (GWF). GWF has an installed


LOCAL MANUFACTURING CAPABILITIES

The manufacturing capacity for DCD Wind Towers per annum is 110 towers and 200 anchor cages. DCD Heavy Engineering has an annual production capability of 60 foundation bases while that of DCD Ringrollers stands at 400 tower flanges. DCD's manufacturing capacity of 110 towers per annum, which equates to about 220MW of wind energy projects demand assuming a 2MW wind turbine, is not sufficient to meet the current demand in the market. This could possibly be one of the reasons why many Project Developers and EPC contractors import Chinese and Asian towers.

INFO BOX

DCD Wind Towers can manufacture 110 towers and 200 anchor cages; DCD Ringrollers - 400 tower flanges, and DCD Heavy Engineering – 60 foundation bases.

Data received from DCD shows that the company's manufacturing capacities are not being utilised in full at the present moment. DCD Wind Towers' current capacity utilisation is almost 40% below its wind tower manufacturing capacity. The company will be producing 66 towers in 2014 and 70 towers in 2015 instead of the 110 towers that it

[7] Still needs to reach financial close

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FIGURE 11: DCD DETAILS FROM THE DTI (DTI PG 77, 2015)

capacity of 138MW at 3MW per turbine, and 46 X 100m high concrete towers were produced. At the height of production the tower manufacturing facility employed 216 people and production took 10 months (DTI 2015), when annualising this figure[16] it equates to a total of 180 jobs or 1,3 jobs/MW for the year.

DCD has been operational since March 2014 up until mid – 2017, from which time it has been running with short staff and doing minor repair work and working on recalls. Assuming a fully operational period of three years (March 2014 – March 2017) and a production of 246 towers, this equates to around 82

[16] As previously mentioned, when comparing "job intensity" in order to be able to make a direct comparison, jobs may be reduced to person-months, where one person employed for 12 months equates to one job.

towers per annum. Who DCD's customers are and the size of their turbines is not publically available, but when dividing the number of turbines installed in South Africa, 956, by the number of MWs installed, being 2022MW, an average capacity of around 2,2MW per turbine may be assumed.

For DCD, at an assumed average annual production of 82 towers at 2,2MW per tower, it can be inferred that 180MW worth of installed capacity was catered for and, with around 172 employees at maximum, this is 0,96 jobs/MW.

As mentioned above, GRI employed 340 staff at maximum and produced an assumed annual total of somewhere around 150 towers (DTI 2015). The facility was opened in November 2014 and was completing final orders for bid window round 3 at the time of writing. It has thus been operational for around 3 years and in this time has produced somewhere around 450 towers. Using the same average of 2,2MW per turbine, this equates to a per annum equivalent of 330MW and with 340 employees (at maximum) this is 1,03 jobs/MW.

When taking the combined 3 manufacturers, 0,96 + 1,03 + 1,3 a sum of 3,29 jobs/MW reached, and when dividing this number by the 3 manufacturers, the average per annum job intensity of the South African wind energy manufacturing industry is around 1,1 jobs/MW.

Tower Manufacturers	DCD	GRI	Acciona
Staff Employed at Full Capacity (approx.)	172	340	216
Current Employment (approx.)	120	320	0
Date Starting Operation	March 2014	Nov 2014	2014
Years Operational	3	3	0,8
Max # of towers produced in one year (app.)	110	150	N/A
No. of Towers Produced in Total (approx.)	246	450	46
Total MW Equivalent Supplied (approx.)	541MW	990MW	138MW
Jobs / MW (approx.)	0,96 jobs/MW	1,03 jobs/MW	1,3 jobs/MW

The GLGH report reflects that construction, installation and manufacturing (CIM) create as many as 10 jobs/MW, with construction and installation alone accounting for 6 jobs/MW and manufacturing for 4 jobs/MW, in countries such as Germany and Denmark where there is a substantial manufacturing base (GLGH 2012: p24). The "labour inefficiency" factor that GLGH inserts for manufacturing is 25%, putting the final figure for manufacturing at 5 jobs/MW[17], which is considerably higher than the 1,1 jobs/MW which is the case with the current tower manufacturers.

The main difference in figures here are from the assumption that “50% of wind tubine capacity would be manufactured in South Africa” and the proposal that this was possible with a strong regulatory regime, although this is qualified with the rider that an annual installed capacity of 1000MW per annum was an accepted minimum to ensure the development of local manufacturing facilities (GLGH 2012: p 48).

It is noted that the tower manufacturers are not the only local content providers, there are many components that go into a wind farm and a number of them are being sourced locally. The base plates on two of the recent wind farms, cabling, substation components, and much of the electrical equipment is all local, and is not accounted for here. But, with the exception of the base plates, these are not wind farm specific components, and could thus be considered indirect contributors.

	Non-technical and unskilled	Skilled workers	Technicians	Engineers	Total
Split	20%	50%	20%	10%	100%
Jobs/MW installed in any year	1	2.5	1	0.5	5

Table 6.6: Employment for turbine and component manufacture in South Africa

FIGURE 12: TABLE TAKEN FROM GLGH (GLGH 2012: P 48)

9. Wind Farm Operation and Maintenance

The GLGH study sources operations and maintenance figures from the perviously cited 2009 EWEA study Wind at Work, the 2003 Agama Energy report, the IDC Green Jobs study, and the GIZ funded study on Options for the Establishment of SAWEC, (GLGH 2012: p 48) and then hikes the figure by 142% in order to arrive at the figure of 0,8 jobs/MW, as per the below comparison.

[17] IDC figure is 4,5 jobs/MW

WIND FARM	AGAMA	SAWEC	IDC	EWEA	GLGH	AltGen / IPP Office
Operations and Maintenance jobs/MW	1	0,4	0,5	**0,33**	**0,8 – 0,6**	**0,3**

FIGURE 13: JOB INTENSITY FROM THE VARIOUS SOURCES

Jobs per MW in operation	Skilled workers	Technicians	Engineers	Total (technical roles)	Total direct employment
Initial stage (to 2015)	0.05	0.3	0.05	0.4	0.8
2015-2018	0.04	0.25	0.04	0.33	0.7
2019, 2020	0.03	0.22	0.03	0.28	0.6
Post 2020	0.025	0.2	0.025	0.25	0.5

FIGURE 14: GLGH JOB INTENSITY FIGURES

The European figures are drawn from the employment figures across the spectrum of EU countries from various industry associations and from EWEA's own survey conducted in 2007, therefore the 0,33 jobs/MW may be considered an accurate average for Europe.

The AGAMA research for operations and maintenance of wind farms is drawn from the Renewable Energy Policy Project (REPP 2001) which was a US based think tank, as well as from a now defunct Spanish turbine developer which was planning on developing 1000MW of wind energy in the Eastern Cape (in 2001). Besides the fact that these are very dated sources, more than 15 years old, the GLGH study does not note that the AGAMA operations and maintenace figure of 1 job/MW is reduced annually to 2020 (Agama 2003: p54, table 6.1) at which point it is predicted to be 0,5 jobs/MW. The AGAMA study cites this reduction as ostensibly to cater for "learnings" by South African skills and labour.

The IDC "Green Jobs" research is not cited and no calculations are shown, with the net result being 0,5 jobs/MW for operations and maintenance incorporating a factor built in for labour inefficiencies (IDC 2011).

9.1 South African Wind Farm Operations and Maintenance Employment Figures

Operations and maintenance figures were sourced directly from the IPP Office for BWR 1-3 providing AltGen with detailed job numbers for operational plants. This data was initially provided in person-months, converted to jobs over a 20 year operational period and then annualised to represent person-years, as per the table following.

These figures show an average of 0,3 person-year jobs/MW installed for the indivdual BWR's 1-3. As can be seen, the OEMs did not take systemic or individual learning into account, and applied the same employment factors as used in Europe to the South African situation - the figures as committed to by the OEMs in the South African context correlate directly to the European direct jobs average. There were no "on-the-job" learnings and there was no need to factor in "lower labour productivity".

20-year PPA	BWR 1	BWR 2	BWR 3	Total
O&M Person-Months	29532	26856	102072	158460
O&M Jobs for 20 years (29532/12)	2461	2238	8506	13205
O&M Person-Years (2461/20)	123	112	425	660
Total Awarded Capacity (MW)	651	566,2	804,6	2021,8
O&M Person-Months/MW (29532/651)	45,4	47,4	126,9	78,4
O&M Jobs/MW (45,4/12)	3,8	4,0	10,6	6,5
O&M Person-Year Jobs/MW (3,8/20)	0,2	0,2	0,5[18]	0,3

9.2 South African Wind Turbine Service Technician Employment Figures

The number of technicians that GLGH predicted would be required during the operations and maintenance phase was three-quarters of the total number of technical skills required, which they estimated to be half the direct employment roles required. In other words, if the total direct operations and maintenance employment was 0,8 jobs/MW then 0,4 jobs/MW of these would be technical roles, and 0,3 jobs/MW would be wind turbine technicians. With a predicted 500MW per annum, GLGH postulated that by the end of 2017 South Africa would have installed around 2300MW of wind capacity deduced from the central forcast per the graphic below (GLGH 2012: p32) which would equate to a need for approximately 655[19] technicians, with this increasing to around 931 by 2020.

[18] The BWR 3 factor is higher due to more onerous employment commitments being required by the IPP Office. The extra jobs are placed where they are cheapest, in supporting services such as security. It does not mean more technicians have been employed.

[19] 2012-2013, 400MW x 0,3 = 120

2013-2014, 350MW x 0,3 = 105

2017-2018, 400MW x 0,25 = 100

2018-2019, 400MW x 0,22 = 88

This may correlate with the "technician level staff", especially in the operations and maintenance phases, that are referred to by GLGH on page 48 being: "Taking only the Central estimates, it is seen that the major areas of employment are: Technician-level staff, especially in the operation and maintenance phase (total around 1000 by 2020)" (GLGH 2012: p 48).

In order to gather an accurate dataset on the number of wind turbine technicians in South Africa, AltGen contacted all of the OEMs and three of the established engineering services companies directly, the results of which have been tabulated below. As AltGen, we do not claim that these operations and maintenance figures are 100% accurate, but, they are close.

The number of WTST's required differs depending on the type of employer, i.e, OEM's have full responsibility for the plant operations and maintenance and therefore employ more WTSTs per/MW but this varies widely. It also bears noting that in most cases the OEMs do not use the metric jobs/MW in order to measure their own number of employees, referring rather to the number of jobs/turbine as a more accurate measure. This is because turbine sizes vary greatly in South Africa, from 1,5MW to 3MW, yet the number of technicians needed per turbine remains the same. Servicing the gearbox on a 3MW turbine requires the same number of technicians as servicing a gearbox on a 2MW turbine. From the table following, it can be observed that an OEM will employ one WTST for every five turbines in operation reducing to one WTST for every 10 turbines for facility management companies. However, in order to remain consistent, the jobs/MW metric is retained.

2014-2015, 600MW x 0,3 = 180

2015-2016, 600MW x 0,25 = 150

2016-2017, 400MW x 0,25 = 100

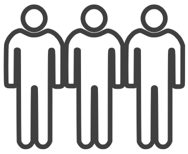
2012-2017 = Total 655 Technicians

2019-2020, 400MW x 0,22 = 88

2012-2020 = Total 931 Technicians

Company Type	MW Portfolio	No. Turbines	No. Technicians	No. TT's/Turbine	No. TT's/MW
OEM 1	522,2	235	45	0,19	0,09
OEM 2	499,1	217	44	0,20	0,09
OEM 3	425,4	157	32	0,20	0,08
OEM 4	244,5	163	33	0,20	0,13
OEM 5	138,6	66	14	0,21	0,10
OEM 6	138	46	10	0,22	0,07
OEM 7	54	18	4	0,22	0,07
	2021MW	902			
Engineering Services 1	363,2	129	13	0,10	0,04
Engineering Services 2	220	100	10	0,10	0,05
Engineering Services 3	5,4	4	2	0,50	0,37
Utility	105,8	46	8	0,17	0,08
			215		0,11

At the time of writing, toward the end of 2017, the total number of turbine technicians in South Africa is around 215. This is much fewer than the 655 turbine technicians that GLGH predicted and also much fewer than predicted by any of the other previously conducted research (Agama, IDC, Greenpeace and SAWEC studies). As the GLGH study states: “These dominant issues (labour efficiency and local content factors) were identified as major uncertainties earlier in this report. We have not been able to find a way to achieve greater certainty on either of these issues, and believe that the best way to proceed is to ensure that the skills and training policies adopted are robust against these uncertainties, until direct experience is gained in South Africa” (GLGH 2012: p 83).



10. Training

Based on the assumed number of engineers and technicians required for the South African wind industry during project development, construction, manufacturing, and operations and maintenance, GLGH provided the training summary that follows. There are a few issues with the summary of training requirements, summarised as follows:

- The website www.windskill.eu seems to have been widely consulted on the possibilities in terms of wind energy courses, but is inaccessible on the internet at this point, which is a concern. No other direct training institutions or organisations seem to have been cited or used as sources. A second reference, www.imwatt.eu is also inaccessible, and it cannot be established why this source was cited.
- There is no summary of 2012 Wind Energy academic courses that were being offered in South Africa or evidence of research being conducted into wind energy training or education, or of engagement with academia in this regard, although this aspect is covered in the questionnaires that were disseminated: Pg. 63, question 3 – "What is the existing training provision? (Identify organisations and capacities i.e. number of training places per year)".

Further, by interviewing the Service Managers and Supervisors of various OEMs it is apparent that all the service technician base line training, which is not turbine specific, is covered by existing legislation. This includes lift inspection technicians, working at heights, working with rotating machinery, first aid in confined spaces, electrical switching as well as other Department of Labour required certifications which combine to allow the legal operation of a wind farm. This theme has been repeated many times and in multiple forums by stakeholders including EWSETA and MerSETA. The final comment on training is that no international training providers were consulted in the research.

Activity/phase	Requirement	Numbers of staff	Duration
Common requirements	Mast & tower climbing	Initially 100/y, increasing to 900/y in 2020	2 d
	Wind industry awareness for policymakers & managers	5 – 10 courses per year	2 d
	Introduction to wind turbine technology	4+ courses per year	1 week
	Introduction to wind farm operation & maintenance	4+ courses per year	1 week
Project development	Wind measurements & energy production assessments	20/y initially	• 2 weeks for initial competence. • 6-12 weeks as part of university or college course
	Project development skills	50/y	2 weeks
Wind farm construction	Turbine installation and commissioning: technician training course	50/y initially, reducing	3 y
	Turbine installation and commissioning: technician conversion course	50/y initially, reducing	3+ months
Operation & maintenance	Turbine service: technician training course	100/y initially, reducing	3 y
	Turbine service: technician conversion course	100/y initially, reducing	3+ months
Wind turbine & component manufacture	No specific additional training provision required		

FIGURE 15: WIND TRAINING REQUIREMENTS IN SOUTH AFRICA (GLGH 2012: P65)

FIGURE 16: TRAINING PROVIDERS

During 2015, Monsson showed intent to open a training facility in South Africa to provide the Global Wind Organisation (GWO) BTT and BST courses: basic safety training and basic technical training. The initial plan was for training on site with a mobile training facility, and then to invest in a training centre for blade inspection and other more technical training requirements. In Romania, Monsson issue around 600 certifications per annum, with many of these being annual or bi-annual renewals of the safety training. The training centre is certified by the GWO.

According to Sebastian Enache, the training manager for Monsson (Conversations and emails in 2015) the "pool" of MWs that Monsson draw from is around 6000MWs, being Romania (4000MWs) and close Eastern European countries (2000MWs). Monsson, similarly to the OEMs, also work on a technician per turbine factor (as opposed to a job/MW factor) of one technician for five turbines, and this translates to a pool of perhaps 600 technicians. In a South African market of somewhere around 215 full time technicians (servicing 1000 turbines), a training school such as this would not be considered viable, and it was for this reason that a centre was never established. Further details of the Monsson long term course are to be found in Appendix 2.

The Danish Wind Power Academy (DWPA) also showed an interest in opening a training facility in South Africa and made several visits to South Africa and conducted training for a number of South African companies, including SARETEC itself. Ultimately the DWPA decided not to open a facility (personal conversation in the DWAP office in Denmark, March 2017).

AID Renewables did go ahead and offer GWO training in South Africa, and opened a modest training facility in Cape Town. AID is now able to offer both the 4 BST and 4 BTT GWO modules and have conducted training on behalf of SARETEC to enable SARETEC to obtain GWO certification for their students.

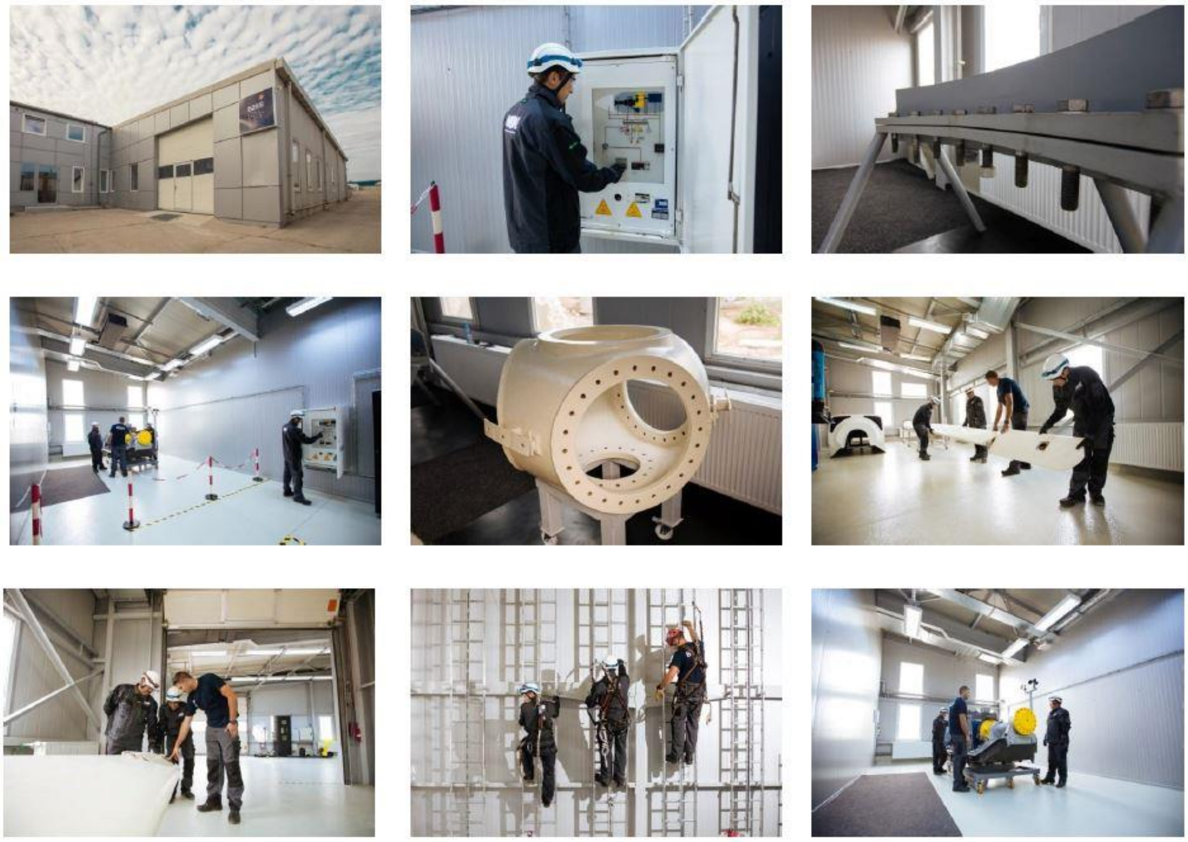


FIGURE 17: MONSSON TRAINING CENTRE, ROMANIA

Vestas, the largest OEM in South Africa, has its full-time trainer and training facility in Port Elizabeth where they conduct GWO BTT training, with Working at Heights generally conducted by High Angle in Cape Town

Siemens, currently the second largest OEM in South Africa, does some of their turbine specific training in Midrand at the Siemens Head Office, and the basic certifications (BSS and BST) are on occasion conducted by AID Renewables.

At this point it is important to note that the secondary engineering services companies[20] present in South Africa do not necessarily require GWO certified staff, which is a consequence of South African IPPs not insisting on GWO certification.

[20] Staff do all possess the South African basic health and safety certification requirements, first aid, working at heights, etc.

Thus, there are headwinds that SARETEC needs to navigate:

- Many fewer technicians being required than was anticipated
- OEMs are able to conduct their own training, and the "Big 3" employ their own full-time trainers;
- The largest OEM has its own training centre;
- There is no legislative requirement for GWO certifications;
- The last bid window round, BWR 4, has been waiting for financial close for over two years and the pace of the rollout of RE has slowed considerably;
- And SARETEC must compete with very well priced training competition in the marketplace.

11. Revised Employment and Training Requirement Updates

In an early 2017 report by Deloitte Consulting, on behalf of Eskom, the outlook in electricity consumption was defined by three primary factors: (1) "expected growth in GDP, (2) the trend in electricity intensity and (3) real electricity process" (Deloitte 2017: p34).

In terms of electricity intensity, Deloitte produced a well-considered projection which couples the increasing electricity price path and the nominal long-term trend of decreasing electricity intensity and when factoring in the decreasing electricity intensity of the economy, the GDP linked electricity consumption growth is halved to a forecast 1% per annum.

There is a factor that the Deloitte study did not consider and that is the growth in embedded generation, rooftop and off-grid solar PV, which, anecdotally, in 2017 seems to be in the region of 200MW installed capacity per. It is likely therefore that electricity sales do not increase at all, and if anything, they are likely to shrink as electricity intensity decreases. Considering that Eskom heavily leveraged its balance sheet to pay for a new build programme, and that the income stream from electricity sales was assumed to continue to increase over the period to 2021, the trend of a reduction in sales will not fit the business plan. This being the case, Eskom will have to rise prices higher than it would otherwise have done, leading to a further reduction in demand, a classic "utility death spiral".

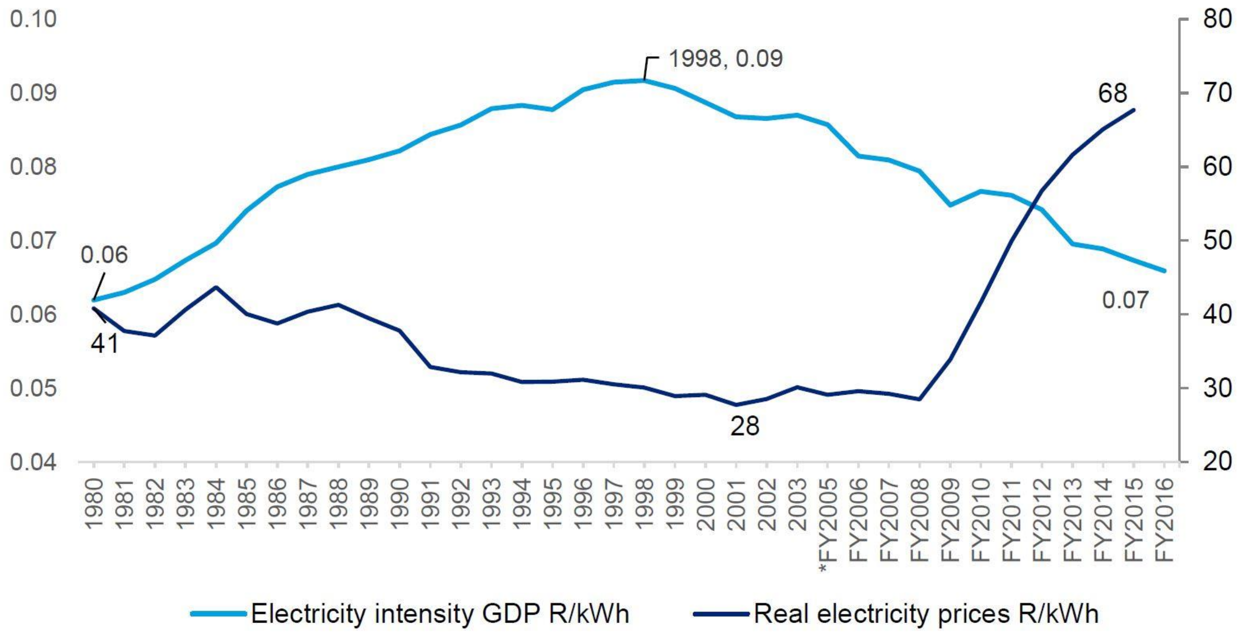


FIGURE 18: DECREASING ELECTRICITY INTENSITY OF SOUTH AFRICA (DELOITTE 2017)

In the interim, the balance of Medupi and Kusile Power Station's, which are not yet online, are scheduled to become operational in the next 5 years: with the 2 power stations providing an additional 9 600MW and with the introduction of 1332MW from Ingula earlier in 2017, the result is that Eskom now has a peak excess capacity of over 5600MW which continues to increase (Eskom 2017).

At this point the spectre of Bid Window Round 4 solar PV and wind projects should be introduced. An additional 2174MW of renewable energy will mean that Eskom may need to start retiring some of its production capacity as the "perfect storm" of a reduction in sales, continued addition of generating capacity, and the introduction of game changing embedded generation, is added to the possibility of cheap and reliable energy storage being made available sooner than later.

What does this mean in terms of training?

Scenario 1: BWR 4 proceeds

If BWR 4 proceeds, and all the projects achieve financial close, this will mean an additional 1361MW of wind energy being added to the grid. Multiplied by the previously determined factor of 0,11 jobs/MW, this implies a demand for a further around 150 turbine technicians[21]. Currently there are 215 turbine technicians in South Africa, of which around 35 are SARETEC graduates: 16,7%. If this success rate is extrapolated out over the next three years, then SARETEC could train a further 23 technicians, but, SARETEC needs to be mindful of how many technicians it introduces into the marketplace and when it does so. If BWR 4 goes ahead, financial close will still have to be achieved prior to NTP being issued (Notice to Proceed) and construction commencing. In a typical 18 months build programme technicians are only utilised toward the end, once the towers are up and the turbines have arrived on site. This would mean that at best the first turbine technicians would be on site toward mid-2019.

With a seven-month training period, five months of training plus two months of internship, this would mean that SARETEC should only start training these technicians in early 2019. Further, as we have seen from BWR 1 - 3, the wind farms do not complete construction at the same time, and a phased training period would be recommended. Two or possibly three tranches, with the first starting in early 2019, a second tranche in mid-2019, and possibly another tranche in 2020. Added to this, there are four wind farms in BWR 4 which are in close proximity to one another, as per the below map centred on the town of Lainsburg. Lainsburg is a deprived community, and recruiting technicians from this municipality would seem to make intuitive sense.

BWR	Technology	Project	Location	MW	Province	Turbines
BWR 4	Wind	Golden Valley	Cookhouse	117	EC	Goldwind
BWR 4	Wind	Oyster Bay	Oyster Bay	140	EC	Vestas
BWR 4	Wind	Roggeveld	Matjies	140	NC	Acciona
BWR 4	Wind	Karusa	Matjies	140	NC	Vestas
BWR 4	Wind	Nxuba	Cookhouse	139	EC	Acciona
BWR 4	Wind	Soetwater	Matjies	139	NC	Vestas
BWR 4	Wind	Kangnas	Springbok	137	NC	Siemens
BWR 4	Wind	Perdekraal	Matjies	108	WC	Siemens
BWR 4	Wind	Excelsior	Swellendam	30	WC	Goldwind
BWR 4	Wind	Wesley-Ciskei	Ciskei	33	EC	Vestas
BWR 4	Wind	Copperton	Copperton	102	NC	Acciona
BWR 4	Wind	Garob	Copperton	136	NC	Acciona

[21] 0,11 jobs/MW X 1361MW = 149,71 technicians

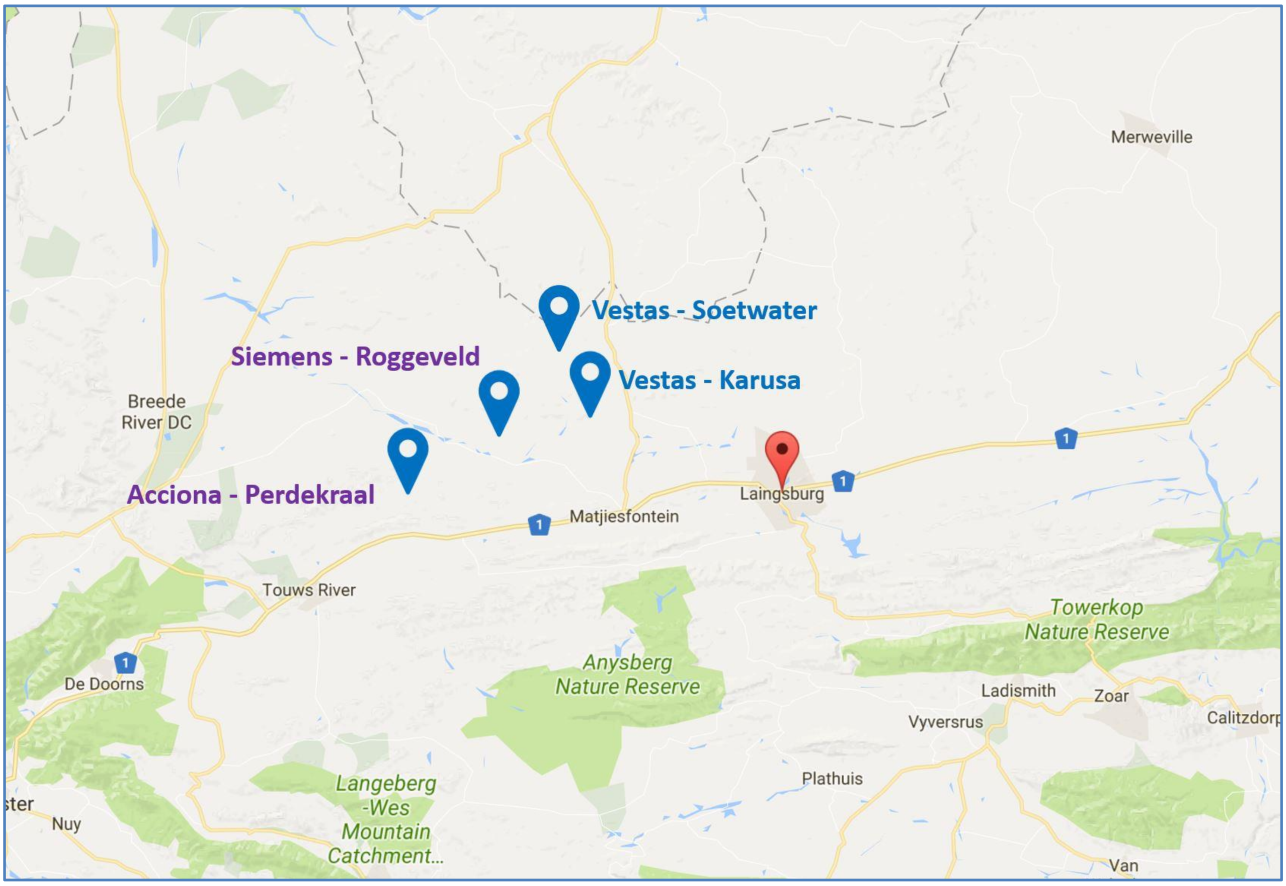


FIGURE 19: LAINSBURG WIND FARMS

Considering that the "Wind Turbine Technician" course that SARETEC offers is an NQF level 7 course (essentially one needs a technical diploma to enter into the course), it may be challenging to recruit appropriately qualified technicians from this community and it may be worth considering structuring a course specifically to cater for the "missing middle": school leavers who do not have a post school qualification and would not be able to enter into the course, but who are capable of becoming technicians and need basic training to augment their skillset.

Scenario 2: BWR 4 does not proceed

Of the last two tranches of SARETEC graduates who qualified as turbine technicians, there are, at the time of writing, still 17 technicians who are unemployed, and for the next while it would be expected that any "structural unemployment" caused by employees leaving the industry could be taken up by these candidates. Further to this, the MW pool will remain static.

In conclusion:

If BWR 4 proceeds, then there will be a two-tiered requirement for more wind turbine technicians. The 7-month formal qualification should be offered, with carefully selected graduates and well considered timing. The second tier of training would be offered to candidates sourced from areas adjacent to the wind farms, and this sourcing and selection would be conducted in close cooperation with the OEMs.

If BWR 4 does not proceed, then limited training may be offered, but candidates need to be very carefully selected, be internationally mobile, and candidates who are currently employed should not be taken out of gainful employment to complete the course unless they pay for the course themselves.

12. East Africa

Ethiopia, according to the countries Growth and Transformation Plan II, aims to procure 5200MW of wind energy by 2020, making this country a particularly important wind energy market. It has 3 operational wind farms (per the below figure) and several more in the planning stages. Development finance is underwriting much of the early stage consultancy work, and the Danish Energy Agency and Ethiopia collaborate on technical assistance for the "Accelerated Wind Power Generation in Ethiopia programme" (AWPGE) (DEA n.d).

FIGURE 20: ETHIOPIA ELECTRIC POWER CORPORATION (DEA N.D).

During a recent meeting between AltGen and the Director of the Ethiopian Ministry of Water, Irrigation and Electricity, it was made clear that Ethiopia does not have any Technical Colleges offering training in electricity or energy provision, and there is therefore a shortage of technicians. But the question was not, "where can we train our technicians?", it was, "how do we start up (our own) training?".

The expansion of wind energy in Kenya has been a stop-start affair with the largest wind farm in Africa, Lake Turkana Wind Park, having completed construction but gird connection being delayed - it seems as if this may only happen two years after the end of construction.

The East African Interconnector project has already been constructed from Addis Ababa through to the Ethiopia-Kenya border and awaiting the linkage to the Kenyan grid and once completed this will open the trading and distribution of flexible power throughout the East African Power Pool and unlock the potential of many of the East African Wind Energy facilities. It does however illustrate how dependent new wind capacity is on the extension of the transmission network by KETRACO, the Kenya Electricity Transmission Company. Besides bureaucratic and grid issues, Kenya currently has an excess of power, with an installed capacity of 2 400MW and a peak requirement of 1 600MW. Excess capacity is one of the reasons that the World Bank gave for withdrawing funding support from the Turkana project[22]. Per the table on the following page, the conclusion is that while there are many wind farms in the development stages, there is a multitude of circumstances that need to dovetail in order for a facility to be awarded a PPA and proceed, and as a consequence of this, the deployment of wind energy in under-developed markets, while inevitable, will be slow.

A July 2017 request for proposals (RFP) from the Kenya Electricity Generating Company (KenGen), the owners and operators of the Ngong Hills Wind Farm, is illustrative of the early stage development of second tier training markets. An excerpt from the proposal follows:

> **37. WIND TURBINES**
> Dis-assembly and assembly of wind turbine parts, Advanced troubleshooting of faults in wind turbines, Wind turbine technology, High pressure hydraulics and pneumatics in wind turbines training., Bearing technology and lubrication course, Safety and rescue operation in wind turbines, Protection relays programming skills, Servers, software and programming Vista V52 turbines.,

This RFP speaks to the fact that KenGen has the 'undergraduate' component of the turbine technician training dealt with, and only need training to "top-up" their expertise on the original equipment manufacturers turbines. On the RFP above, while not yet officially awarded, it seems as if Vestas will be the preferred training service provider. AltGen has also spoken with Geoffrey Ronoh of the Energy Research Centre of Strathmore University in Nairobi on several occasions about conducting short courses on wind energy and these are in the planning stages: https://serc.strathmore.edu/.

[22] DFI funding was then sourced from the African Development Bank.

TABLE 1: PARTIAL LIST OF EAST AFRICAN WIND FARMS

Country	Project	Location	MW	Status
Kenya	Ngong Hills	Kenya Rift Valley	25	Completed
	Lake Turkana Wind Park	Turkana County	365	Completed. Land compensation issues - transmission line delays
	Kinangop Wind Park	Kinangop region	60,8	Cancelled due to land issues, negotiations ongoing
	Meru Wind Farm Project	Meru County	400	On hold due to land disputes
	Kipeto Wind Energy Project	Kajiado County	102	On hold / for sale - due to environmental delays (vultures)
	Limuru Wind Farm	Kiambu County	50	Last active in 2014. PPA seems on hold?
	Kilifi/Vipingo wind farm	Mombasa Cement Vipingo Plant	36	Zoning approved, 2-3 years from contract signature
	Baharini Electra Wind Farm	Lamu-Mpeketoni	90	Land disputes
Rwanda	Ngoma (South East)			Low national demand 76MW, project stalled
	Kanyonza (East)			
Ethiopia	Ashegoda	Makelle region	125	Operational
	Adama I	central Ethiopia	51	Operational
	Adama II	central Ethiopia	153	Operational
	Assela	Ethiopia	100	Bid documentation preparation
	Ayisha	Ethiopia	300	Awaiting Construction
	Debre Birhan	Ethiopia	100	Tender Process underway
	Messobo	Ethiopia	42	Feasibility done
		Ethiopia's Somali regional state	120	pre-construction stage
Tanzania	Makambako	Makambako Township, Iringa	100	
	Singida Wind Power Project	Tanzania	100	Awaiting Construction
Uganda	Njiapanda	Singida	50	Uncertain
	Tororo Wind Farm	Tororo District	20	Financial close
	Kabulasoke, Nkenda, Nkone, Opuyo	Various	50	Prefeasibility

But perhaps most revealing of the OEMs "modus operandi" is the following example: AltGen Kenya was tasked with the full outsourced recruitment of 24 turbine technicians for the Lake Turkana Wind Park (LTWP). The task was a challenging one, compounded by the fact that the technicians had to be from the local area or at least from within the greater provincial boundary. AltGen facilitated the on-boarding and first aid certificates of candidates, before site induction and handing over to the Vestas appointed trainers, and the full recruitment process was concluded successfully and within the prescribed time frame. At no point was an outside training institution utilised for any of the wind farm specific training. In conclusion, there will be no demand for training at SARETEC emanating out of East Africa.

13. Conclusion

As stated in the GLGH study:

"Although there are substantial uncertainties in the quantitative analysis, it is believed that a strategy of providing training as identified here is robust, because it will be relatively easy to modify as understanding of the volumes and requirements improves with time. This assumes regular review, and clear allocation between institutions of responsibility for review" (GLGH 2012: p9).

In the current state of play therefore, while we wait on financial close for BWR 4 wind enegy projects, there is zero new employment. If BWR 4 were to be revived soon, the local content thresholds will remain, and the flexibility of capital will be illustrated as it is mobilised to conform to local content requirements and plants are re-opened and towers are constructed.

13.1 Methodological Critique

This highlights another uncertainty created in the GLGH report, that of the metric used to measure a 'job'. The Department of Energy via the IPP office realised early in the REIPP that the metric with which to measure a job has, by nature, to be bounded, and the international has become that one job equates to, one person, being employed full time, for a defined period. Thus, while the GLGH report continually refers to "jobs" it is appears to be methodologically more correct to refer to "Job-years/MW". Better still, to incorporate the differing construction periods, is to reduce the breakdown to months, thereby arriving at the metric "person-months/MW". However, when conducting a study of this kind, using the better metric of "Job-years/MW" or "person-months/MW" does not result in "easy soundbites" of conveniently digestible information.

Moreover, the OEMs do themselves not use the metric "jobs/MW" or "Job-years/MW", rather using "jobs per turbine". As turbine sizes increase the OEMs are not finding that their number of employees increase proportionally, rather that the number of empoyees is linked to the number of turbines that they are servicing and is very clearly illustrated in the research. Wind farms with 1,5MW turbines and wind farms with 3MW turbines employ the same number of technicians relative to the number of turbines, not the number of MWs. Thus the international trainers standard of using the metric "technicians per turbine" –

it is drawn from the OEMs. For the purposes of the GLGH research, it would have been more relevent and more accurate to use the measurement, “technicians per turbine”.

Further complicating the jobs landscape is the varied use of the concepts of direct jobs and indirect jobs, and on occasion, induced jobs. The research literature that GLGH utilised used these concepts in different ways, and although the GLGH research starts by stating that all of the figures include indirect jobs, it moves fluidly in between the two, and whilst it does not make a mathematical error, it is challenging to dissect and confusing to read.

But methodologically the most important factor that lead to an overstatement of the figures is the use of the concept of “lower labour productivity”. In some cases, the GLGH figures are overstated by as much as 67%, purely based on an assumed “lower labour productivity” that is not underwritten by any quoted research or methodological evidence. It is simply built in, based on anecdotal accounts. This is not unique to the GLGH study, all of the other South African research does this, with GLGH simply continuing the trend, and it is a myth that needs to be debunked.

Industrial Development Corporation: “Green Jobs”:

Pg. 28: “These figures have been accepted as a basis for estimating employment potential, although they have been adjusted upwardly to some extent due to allow for lower labour productivity in South African relative to the respective industrialised countries”.

CSIR: “Investigation into the development of a Wind Energy Industrial Strategy for South Africa”.

Pg. 129: It remains to be seen whether such an analysis will create more jobs bearing in mind South Africa’s lower labour rates when compared to the rest of the world”.

AGAMA: “Employment Potential of Renewable Energy in South Africa”:

Pg. 15: “the data is conservative for the South African economic and labour context”.

Understanding this, as well as having it reaffirmed in face to face meetings where project developers reaffirmed it, how was the GLGH study going to come to any conclusion other than, that South African labour is less productive? Rutowitz in the Greenpeace funded work on the “Energy Revolution” in South Africa was the only jobs research to based labour productivity calculations on anything other than conjecture. This leads to a fundamental methodological error in the GLGH research, since throughout the phases of wind farm development, construction, manufacturing and operations and maintenance, quanta are randomly selected and integrated into the discourse:

Garrad Hassan: “An Assessment of training and skills needs for the wind industry in South Africa”:

Pg. 20: “The IDC analysis also includes some allowance for lower labour productivity in South Africa…. Details of the calculation is not provided”;

Pg. 25: “Unfortunately it has not been proven possible to obtain reliable data for comparable industries, comparing labour efficiency in South Africa with other economies”;

Pg. 29: “Some areas of concern… surrounded the recognized relative inefficiency of the South African labour force”;

Pg. 38: “Several comments on expected lower labour efficiency compared to traditional wind energy markets” and “the increase is due to greater allowances for lower labour efficiency”.

Rutowitz is an excellent resource, and while it is not referenced by the GLGH research, it is notable that it too states the following: Pg. 15: “All factors (for wind) are taken from the European Wind Energy Association (EWEA 2009) and are multiplied by 2,15 for use in the South African context”.

Jobs/MW Comparison	EWEA	% Increase for SA Labour Inefficiency	Garrad Hassan Estimation	AltGen/Actual Figures	Actual vs GLGH
CMP/CI (Jobs/MW)	6	67%	10	2	-80%
Manufacturing (Jobs/MW)	4	25%	5	1,1	-78%
Operations and Maintenance (Jobs/MW)	0,33	142%	0,8	0,3	-63%

FIGURE 21: PERCENTAGE INCREASE FOR LABOUR INEFFICIENCY

13.2 Practical Critique

The practical critique is that practical, real life, implementation is not considered. The GLGH conclusion was that if the South African wind industry were installing at the GLGH predicted 500MW per annum, this would equate to a need of 100 operations and maintenance technicians per annum[23], a figure which seems to have been used as justification for the establishment of a centralised wind energy training facility, however, a combination of the factors make this an incorrect assumption, some of which were within the ambit of research to predict, and some of which are out of the sphere of controllable variables.

The primary uncontrolled variable is how many MWs are procured annually, and thus the sustainability of the industry. GLGH sought to account for this by reducing the number of annual MWs but could not possibly consider that the wind energy industry has now been waiting for 24 months and more for financial close on BWR 4 projects. This of course has a material effect on the training requirements.

In terms of controllable variables, if one considered international norms that catered to the direct training offered by secondary training institutions in the European Union, then a much more elucidating figure would have been derived. It seems, with the benefit of hindsight, obvious to look at other institutions that are similar in origin to SARETEC and compare the size of the wind markets that they cater to and the typical clients that they cater for.

Had this been done, it would have become obvious that the predicted 100 technicians required per annum in a 500MW per annum new wind market would mostly have been trained by the OEMs themselves, as was the case with the 300MW Lake Turkana project. Independent wind energy technician training institutions become more relevant in large and sustainable wind energy markets, where wind parks exit their service agreements and second tier engineering services companies come in to play.

Further, if GLGH had used the OEMs own turbine technician factor of 0,2 turbine technicians per turbine, and an average turbine size of 2,2MW (the average across all South African projects), then the GLGH study would have predicted an annual need for 45 turbine technicians and not 100.

[23] A low estimate of 0,2 technicians/MW*50MW per annum.

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Appendix 1: Summary of South African Projects

BWR	Project	Location	MW	No. of turbines	Province	COD	Status
BWR 1	Dassiesklip	Caledon	27	9	WC	2014	Operational
BWR 1	van Stadens	van Stadens	27	9	WC	2014	Operational
BWR 1	Hopefield	Hopefield	66,6	37	WC	2014	Operational
BWR 1	Nobelsfontein	Nobelsfontein	73,8	41	NC	2014	Operational
BWR 1	Kouga Wind Farm	Kouga	80	32	EC	2015	Operational
BWR 1	Dorper	Dorper	100	40	EC	2014	Operational
BWR 1	Jeffreys Bay	Jeffreys	138	60	EC	2014	Operational
BWR 1	Cookhouse	Cookhouse	138,6	66	EC	2014	Operational
BWR 2	Amakhala Emoyeni	Bedford	134,4	56	EC	2016	Operational
BWR 2	Tsitsikamma Community	Tsitsikamma	94,8	31	EC	2016	Operational
BWR 2	West Coast One	Vredenburg	94	47	WC	2015	Operational
BWR 2	Waainek	Grahamstown	24	8	EC	2016	Operational
BWR 2	Grassridge	Port Elizabeth	60	20	EC	2015	Operational
BWR 2	Chaba	Komga	21	7	EC	2015	Operational
BWR 2	Gouda	Gouda	138	46	WC	2015	Operational
BWR 3	Red Cap / Gibson Bay	Gibson Bay	111	37	EC	2017	Operational
BWR 3	Longyuang Mulilo	De Aar 2	144	96	NC	2017*	Construction
BWR 3	Longyuang Mulilo	De Aar	100,5	67	NC	2017*	Construction
BWR 3	Khobab	Loeriesfontein	140,3	61	NC	2017*	Operational
BWR 3	Noupoort	Noupoort	80,5	35	NC	2016	Operational
BWR 3	Loeriesfontein	Loeriesfontein	140,3	61	NC	2017*	Operational
BWR 3	Nojoli	Bedford	88	44	EC	2016	Operational
Other	Sere	Vredendal	105,8	46	WC	2015	Operational
TOTAL			**2127,6**	**956**			

Appendix 2: Long Term Turbine Technician Course, Monsson

Modul Portfolio Servicetechniker, Langzeitlehrgang
Modul portfolio Service technician, long term course

BZEE

HSE	HEALTH & SAFETY			
Code	**Modul**		**Level**	**Duration**
BZEE-HSE-01	Arbeitssicherheit	Health and Safety regulations	2	8
BZEE-HSE-02	Erste-Hilfe	Emergency first aid for working at height	2	16
BZEE-HSE-05	PSA Grundkurs	Working at heights and rescue training, basics	3	16
BZEE-HSE-07	Arbeiten in engen Räumen	Working in confined spaces	3	8
BZEE-HSE-15	Heben und Anschlagen von Lasten	Lifting and attachment of loads	3	16
BZEE-HSE-16	Brandschutz, Grundtraining	Fire awareness and fire-fighting, basic training	2	4
BZEE-HSE-17	Brandschutz auf Windenergieanlagen	Fire awareness and fire-fighting on wind turbines	3	4
BZEE-HSE-18	Umgang mit Gefahsstoffen	Handling of hazardous materials	2	8
				80
ELT	**WT ELECTRICS**			
BZEE-ELT-01	Grundlagen Elektrotechnik	Principles of electrical engineering	3	40
BZEE-ELT-08	Konfektionieren von Kabeln	Cable finishing	3	8
BZEE-ELT-09	Generatoren und Elektromotoren	Generators and electric motors	4	24
BZEE-ELT-10	Transformatoren	Transformers	4	8
BZEE-ELT-11	Umrichtersysteme	Inverter maintenance and trouble-shooting	4	4
BZEE-ELT-12	Messtechnik	Electrical measurement techniques	3	8
BZEE-ELT-13	Sensortechnik	Sensor installations in wind turbines	4	24
BZEE-ELT-14	Grundlagen Elektronik (Dioden, Gleichrichter)	Wind turbine electronics	3	40
BZEE-ELT-15	Parknetzwerke, Datenfernübertragung, LWL-Technik	Wind farm networks, data transmission, optical fibre technology	4	16
BZEE-ELT-16	Blitzschutz	Lightning protection maintenance	3	8
				180
MEC	**WT MECHANICS**			
BZEE-MEC-01	Werkstoffkunde	Materials engineering	3	16
BZEE-MEC-02	Grundlagen Mechanik	Mechanical sytems and components - basics	3	40
BZEE-MEC-03	Inspektion Lager, Wellen, Getriebe	Inspection of bearings, shafts, gears	3	16
BZEE-MEC-04	Bremssysteme	Brake systems maintenance	3	4
BZEE-MEC-05	Schmierstoffe, Filtertechnik, Ölanalysen	Lubricants functions and deployment	3	8
BZEE-MEC-06	Kraftschrauber (hydraulisch, elektrisch, mechanisch)	Power drive sockets (hydraulic, electric, mechanical)	3	8
BZEE-MEC-07	Windnachführungssysteme (Funktion, Wartung)	Function and maintenance of yaw systems	4	8
BZEE-MEC-08	Beschichtungssysteme und Korrosionsschutz	Coating systems and corrosion protection	2	8
				108

HYD	HYDRAULICS			
BZEE-HYD-01	Grundlagen Hydraulik	Hydraulic principles	3	16
BZEE-HYD-02	Hydraulikaggregate	Assembly and maintenance of hydraulic units	3	24
BZEE-HYD-03	Pumpen und Ventile	Assembly and maintenance of hydraulic pumps and valves	3	24
BZEE-HYD-04	Hydraulikanlagen	Assembly and maintenance of hydraulic systems	3	24
BZEE-HYD-05	Elektrohydraulik	Assembly and maintenance of electro-hydraulic controls	3	24
				112
ROT	ROTORBLADE			
BZEE-ROT-01	GFK-Inspektion	Rotor blade inspection	3	8
BZEE-ROT-02	GFK-Reparatur	Rotor blade repair	3	72
				80
WET	WIND ENERGY TECHNOLOGY			
BZEE-WET-01	Einführung Windkraft	WT technology - systems and components	3	16
BZEE-WET-02	Aerodynamik, WEA	Wind turbine aerodynamics	3	4
BZEE-WET-03	Fundamente Onshore (Gründung, Schäden)	Onshore Foundation Structures	3	4
BZEE-WET-04	Meteorologie, Einsatzplanung	Meteorology, deployment planning	3	4
				28
MAN	OPERATIONS MANAGEMENT			
BZEE-MAN-01	Arbeitsrecht	Labour legislation	3	16
BZEE-MAN-02	BWL-Grundlagen	Basics of business management	3	24
BZEE-MAN-03	Einführung in Qualitätsmanagement	Quality Management processes	3	4
BZEE-MAN-04	Warenwirtschaft	Goods Management	3	8
				52
SUP	SUPPORT			
BZEE-SUP-01	technisches Englisch	Technical English	3	80
BZEE-SUP-02	Teamtraining	Team training	2	16
BZEE-SUP-03	Praktikum	Industry internship	3	240
				336
				976

Appendix 3: Questionnaires

Questionnaire 1

Original Equipment Manufacturers and second tier Engineering Services suppliers

a) How many turbine technicians do you employ?
b) What are the levels of turbine technicians that you have in your organisation? Please could you elaborate on the organisation structure your organisation uses to classify turbine technicians? For example, the various OEMs have differing classification of technicians, this is in order to understand the niche training that can be conducted by an 'independent' trainer in South Africa, it is important to understand how the OEMs structure their own training.
c) Do you have your own dedicated trainer, or do you in-source or out-source this function?
d) How do you choose your turbine technicians?
e) Do you receive unsolicited applications?
f) Do you choose from among current staff?
g) Do you recruit specifically from the local community?
h) If you do recruit locally, does this help you to fulfil your ED requirements?
i) Which courses do you conduct in-house, and which do you outsource?
j) Where does most of your training take place (physical area, e.g. Port Elizabeth, Cape Town?
k) Can you please give me an example of the outsourced training contractors you use?
l) Have your heard of SARETEC?
m) If yes, do you think it is an institution that you would use for turbine technician training?
n) Have you heard of the 7-month Wind Turbine Service Technician course?
o) Have you ever employed a graduate from this course?
p) If yes, please could you give brief elaboration on your overall impression of the 7-month course?
q) Given the choice, which courses do you think SARETEC should offer to the wind energy industry?
r) Any other information you think may be useful for the study, please elaborate?

Questionnaire 2

Independent Power Producers

a) How many employees do you have employed in wind?

b) Of these, how many are technicians, skilled employees, and engineers?

c) Do you ever envisage taking over the Operations and Maintenance of your wind energy facility?

d) If no, would you ever use a 3rd party engineering services provider to manager your facility? And if not, do you envisage your facility being manged by the OEM for the balance of its lifetime?

e) If you do envisage taking over your facility, would you employ your own Wind Turbine Service Technicians?

f) If yes, do you have any idea how you would go about training them?

g) Have your heard of SARETEC?

h) If yes, do you think it is an institution that you would use for turbine technician training?

i) Have you heard of the 7-month Wind Turbine Service Technician course?

j) Given the choice, which courses do you think SARETEC should offer to the wind energy industry?

k) Any other information you think may be useful for the study, please elaborate?