Turbine Generator Power Plant Reliability for Solar System Improvements

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Abstract

The reliability of power supply by South African coal-fired power plants has become the central focus of many areas of governments' strategic planning. The reason for this is its poor maintenance, unplanned outages, increased generator trips and lack of adequate skills. The impact of the above shortcomings is increased load shedding, insufficient electricity in the country, high cable theft, low production in manufacturing industries and insufficient photovoltaic energy produced in grid-tie system configurations. Thus, this work tends to demonstrate the need for improving the existing coal power plants to increase the amount of solar energy in the national grid. The historical data was collected from plant failures, generator asset management, maintenance strategies and unplanned capability loss factors. This data was analyzed through qualitative and quantitative research methods. The results obtained from the proposed methodology show that inadequate training of employees, skills shortages, unavailability of quality spares, and lack of maintenance are some of the major contributing factors to plant breakdowns and failures. Furthermore, research has revealed that a preventative maintenance strategy is the most recommended strategy to improve generator plant reliability instead of a corrective maintenance strategy that is currently used and found to be ineffective and inappropriate.

Keywords
Electrical Generator Plant, Solar Energy Reliability, Maintenance Strategies and Asset Management

1. Introduction
Compared to many other countries with several power utility companies, the supply of electricity in South Africa is generated and transmitted by a single monopoly state-owned power utility (Khobail et al 2017). However, electricity distribution is shared between several entities. The electrical energy generated by the South African power utility is approximately 90% of the total electricity generated in the country. The remaining 10% of electricity is generated through renewable energy comprising wind, solar and water. Renewable energies such as solar systems are a great energy alternative to coal-fired power plants because they can be used concurrently with coal-fired power plants to reduce the power generated from pollutant raw materials such as coal by maintaining the demand capacity at the requested level. This implementation technique is usually done through a grid-tie system. At present, there are many shortcomings experienced by the South African power utility. These include asset breakdowns, tripping of units, increased generator failures, higher unplanned capability loss factors, and forced outages. Certain sectors of economic importance are highly dependent on reliable electrical power for their productivity and functionality. Major economic sectors like mining industries have been severely affected by the continuing electricity blackouts in South Africa (du Venage 2020).

The importance of electricity supply to the health care system must not be underestimated. Electricity shortages result in patients' health degeneration, extended illness, and death (Ndaguba 2016). Khobail et al. (2016) suggest that electricity generated is the key aspect of the country's economic growth. Electricity is generated, transmitted, and distributed to key sectors of the economy like mining, agricultural, industrial and commercial sectors (Dhillon 2007). Therefore, the effects of unreliable power supply can negatively impact the economy and result in a loss of employment and poverty, even when renewable energy penetration is high. This is because a reference voltage has to be provided to the inverters in a case of a grid-tie solar system to transfer the power produced from the solar to the national grid. Thus, it is insidious to think that the deployment of solar systems is enough to tackle load shedding. In fact, for households' alternative power, a hybrid solar system could be well used. However, for industrial and commercial solar deployment it is necessary to develop a grid-tie system with a reference voltage obtained from a more stable power generation source. The South African power utility has developed strategic plans to improve the reliability of coal plants and other critical areas which include data acquisition and integrity, generator maintenance, condition monitoring, diagnostics, standards, and databases. The maintenance of electrical generators is the key to ensuring steady and reliable electrical output. Using generator monitoring systems is one of the measures implemented to improve power plant reliability and reduce load shedding.

1.1 Objectives

The objective of the research study was to investigate, analyze and review challenges that affect the reliability of the turbine generator plant in a coal-fired power generating plant. The research further investigated factors affecting generator management taking into consideration asset reliability, accessibility, and maintainability. Knowing that the increase in reliability of existing power plants can highly contribute to the penetration of solar systems in the South African environment. The paper assessed the feasibility of current reliability and generator management strategies at coal-fired power generating plants.

The study was designed to achieve the objectives through both qualitative and quantitative research methods.
The main objective of this study was to develop an understanding of reliability, maintainability, and generator plant asset management. The targets were to further investigate the effectiveness of turbine generator maintenance strategies applicable to coalfired power generating plants so as improve the reliability of the generator plant. The specific research objectives were to:

- Investigate the performance of a turbine generator plant in a coal-fired power plant.
- Identify the major causes and effects of turbine generator plant breakdowns and failures.
- Analyze new technology to improve boiler plant reliability.

The study serves as the basic contributor to the development of improved turbine generator maintenance strategies to help increase the availability of power supply in South Africa. Secondly, the study identifies the areas which contribute to poor turbine generator plant performance in an attempt to improve asset management. The third contribution is to suggest new technologies that can be implemented to improve plant reliability. The research findings will be presented to the power station management with the intention to improve the reliability of the turbine generator plant.

2. Literature Review

Turbine generator plant reliability and causes of failures are analyzed through inspections and partial discharge testing (Duarte 2017 Liu 207). According to Barella et al. (2011), the rotor is among the most critical parts and the most severely affected by failures. The failure of a steam turbine generator rotor has high-cost implications during maintenance and repairs (Barella et al. 2011). Generator bearing failure is one of the prominent failures associated with long downtime (Amirat et al. 2012). The generator bearing failure results from the high speed of rotation of the generator shaft and or insufficient lubrication oil in the bearings. It is noted in Figure 2 that generator failures due to bearing failure result in high shaft vibrations.

The steam turbine generator is a rotating shaft engine that converts the energy of high-temperature steam and pressure steam into kinetic energy into mechanical energy that produces electrical energy through alternators (Amirat et al 2012). The superheated steam is produced by a boiler which is then converted into mechanical motion of the shaft through the turbine's blades which drive the generator rotor to produce electricity. The operating principle of the steam turbine generator is that it uses the water heated through coal combustion of a boiler plant. Then superheated steam flows past the spinning blades of the turbine. The potential energy created by the steam is then converted into kinetic energy in the spinning turbine blades, which in turn drives an electrical generator. Figure 1 shows the steam turbine generator breakdown at one of the South African coal-fired power generating plants. The generator breakdown resulted in a class 5 explosion and the loss of 600MW power of electricity generated. The investigation indicated that the explosion was due to boiler over pressurization.

The reliability of the generator is measured as the amount of output power the generator will be able to produce according to its intended design specifications without failures. For a modern electrical system to be effective and ensure reliability it must continuously supply reliable energy (Kolawole et al. 2019). To ensure the smooth running and development of any country it is essential to maintain a reliable and steady power supply (Billinton and Lian 1993).

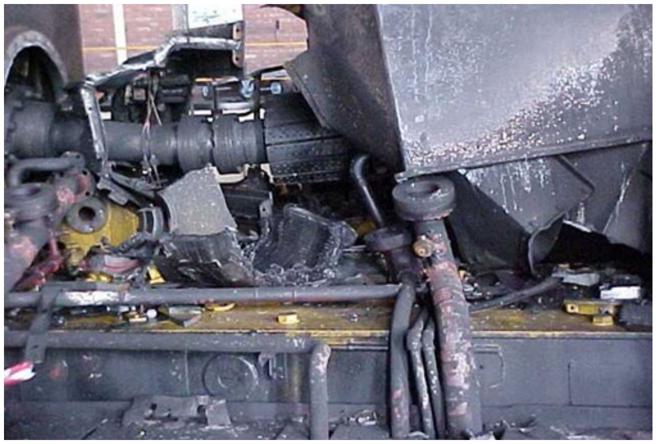

Figure 1. Steam turbine generator plant failure (Power Station Engineering Report)

The reliability of the power-generating plant solely depends on the reliability of its auxiliary plants and other equipment integrated into the plant (Zatsepina et al. 2017). Any power-generating plant aims to ensure continuous power supply to customers and improve the reliability of equipment (Wikstrom et al. 2000). Reliability, accessibility and maintainability (RAM) are used to achieve high reliability, good maintainability and availability (Blaabjerg et al. 2017). RAM plays a significant role in improving plant operation and ensuring the efficiency and effectiveness of equipment. Design for reliability is used during the design phase of equipment or a system that ensures maximum performance to achieve high reliability (Blaabjerg et al. 2017).

In addition, to ensure maximum performance, the power-generating plants must achieve a high degree of design for reliability. Design for reliability increases generator plant production, reduces life-cycle cost and ensures the effective management of assets. Asset management entails the strategic planning, organizing, and maintenance of assets to increase asset performance and reliability to achieve greater organizational competitiveness (Hang and Song 2003). Generator asset management represents measures put in place to ensure that the turbine generator plant is operated within its designed specification. For example, the generator must be operated within certain specifications to be able to produce the desired output power. If the generator specifications are exceeded, the internal rotor and windings are likely to be damaged. Therefore, a system to manage and monitor asset and generator performance needs to be implemented to monitor performance.

Figure 2. Generator monitoring system in power plant.

In Figure 2, a generator condition monitoring system is implemented as a method to internally monitor generator parameters to improve performance and report any deficiencies in the expected generator performance. The generator condition system is also used to predict and plan for preventative maintenance before serious deterioration or breakdowns occur and estimates the machines' performance levels (Sign et al. 2017). In Figure 2, the generator monitoring system is also interconnected to the system control and data acquisition system (SCADA) to monitor specific generator parameters online, including winding temperature and rotor as well as shaft vibration, to store data and to conduct an assessment in the case of a generator trip or failure. A generator condition monitoring system and condition assessment can be used as the basis for the development of preventative maintenance and predictive maintenance.

The types of maintenance strategies to be discussed in this paper are preventative, predictive, corrective and total productive reliability-centered maintenance strategies. Preventative maintenance is based on planned schedules to prevent plant breakdowns and failures. This maintenance measures the actual performance versus the design specification of the plant or equipment and develops scheduled maintenance which comprises outages, refurbishment and planned maintenance of machines, equipment and or components that prevent failures (Sign et al 2017). This type of generator maintenance comprises routine inspections of the rotor, windings, coils, moisture, generator shaft, and turbine blades. A predictive maintenance strategy can be used to predict equipment failures, and plant reliability and collect adequate data or information to implement efficient decisions (Elazab and Elgamal 2017). Predicting turbine generator plant failures and reliability requires accurately collecting data and information using integrated technology. For example, turbine generator historic plant failures can be used as the basis for developing predictive maintenance. Particular South African coal-fired power generating plants have already implemented systems of integrated technology for generator monitoring systems, generator condition assessment, and the use of SAP plant maintenance techniques to ensure effective predictive maintenance.

Corrective maintenance can only be implemented once a failure or breakdown occurs (Ahmed and Salama 2009). Generator corrective maintenance usually takes place once the failure has occurred and or is detected through the generator monitoring system. The generator will then need to be isolated from the rest of the system for maintenance purposes. Corrective maintenance could not be an ideal maintenance strategy for critical plants like generators taking into consideration the non-availability of generator spares and workmanship. For example, if the generator fails due to winding and rotor insulation breakdown, the generator will need to be rewinded which might take a considerable long time and at a high cost. Therefore, corrective maintenance might be ineffective for critical plants like boilers, turbines and generators at any power-generating plants. This type of maintenance system has a high impact on renewable energy installation, particularly for solar plants. Instead, a preventative maintenance strategy takes priority to ensure the planning, organizing and coordination of resources. A reliability-centered maintenance strategy is used to conduct maintenance focusing on the results of generator failures and implementing the most cost-effective plant maintenance program (Schneder et al 2006). Reliability-centered maintenance emphasizes equipment maintenance prioritization, depending on its criticality and reliability. For example, condensate systems and generator hydrogen coolers take priority instead of waterboxes because of their criticality in the generator cooling process.

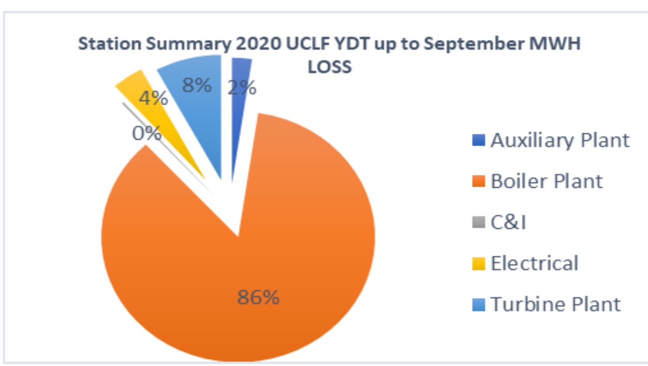

Figure 3. Station Summary UCLF for January 2020 to September 2021

Total productive maintenance (TPM) forms an integrated maintenance technique to improve equipment failures and plant performance while reducing deficiencies by implementing effective measures of plant reliability (Bamber et al 1999). The Japanese developed the TPM process to enhance productive maintenance techniques and standards

(Wakjira and Singh 2012). During the implementation of the TPM processes, maintenance departments can benefit by carrying out inspections and plant assessments. TPM processes suggest the implementation of root cause analysis and failure mode effect analysis to determine the exact causes and the extent of failures. Root cause analysis is used to identify the problem, understand the factors creating the problem, and to which extent the problem affects other equipment to prevent it from reoccurring (Okes 2005). Root cause analysis is also used in turbine generators to measure and identify causes of failures within the generator plant and failure effects. In addition, Ishikawa diagrams, fishbone diagrams and or cause and effect diagrams are analysis methods used to effectively analyze the relationship between the failures and their causes. Root cause analysis, fishbone diagrams, failure mode and effect analysis are some of the failure analysis techniques that are used to analyze and investigate defects. In Figure 3, it is shown that in 2020 the turbine generator plant was the second highest contributor to the power plant unplanned capability loss factor with a total of 8% MWh loss.

3. Methods

The research methodology for the study was using both qualitative and quantitative research techniques. Qualitative research methods are used to collect and gather information from relevant operational personnel. The objective of both qualitative and quantitative research methods is to investigate asset management, reliability management, breakdowns and failures, plant maintenance strategy, performance and systems and technology. The objective of qualitative research methods in this study was to collect data from historical records about asset breakdowns and failures which mostly contribute to plant load losses. The historical data collected comprised unplanned capacity loss factor and MWh loss that was found in the Eskom database, SharePoint, SAP and related reports for both boiler and turbine plants.

4. Data Collection

Turbine generator energy losses are significant and immediate measures must be implemented to restore a generator to operation in cases of failures, unit trips and or breakdowns. Generators are critical electrical power equipment in power plants and no electricity will be generated without their efficient functionality. It is therefore important that energy losses through generators are not to be underestimated and be thoroughly investigated and corrective measures implemented.

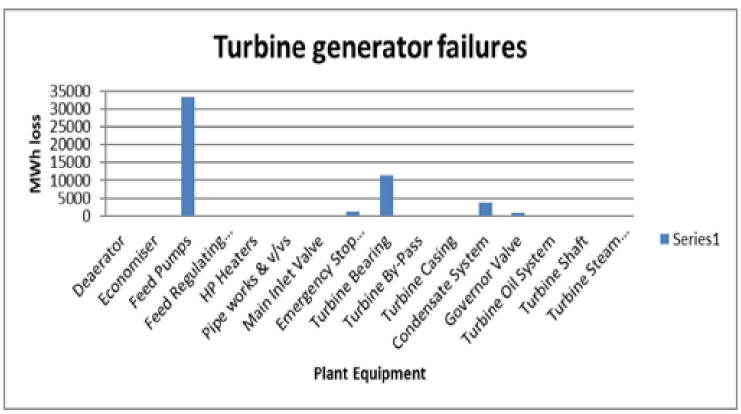

Figure 4. Sample Turbine generator failures Report 2021

In Figure 4, feed pumps and turbine bearing failures are some of the causes of high vibrations of turbine shafts. Bearing failures can result in turbine oil leakages, the poor rotational performance of the shaft as well as hydrogen leakages. Hydrogen in turbine generators is particularly used for cooling the generator windings. Generator windings must be effectively insulated, and heat be properly cooled to prevent insulation breakdown. Safety precautionary measures need to be implemented to prevent hydrogen leakages because hydrogen can lead to explosions when mixed with air. For example, Unit 3 at one of the power stations analyzed in Limpopo, in the north of South Africa, experienced hydrogen leakages during turbine purging that resulted in a turbine generator explosion and severe damage to secondary plants.

Table 1 shows the energy losses of turbine bearings at 11546,32 MWh in the year 2021 which is a 22,65% unplanned capability loss factor. Feedwater pump failures were the highest contributors with 33284,52 MWh in the year 2021, followed by turbine bearings. Governor valves and condensate systems also indicated certain malfunctions that needed maintenance attention. Governor valves are shown to be the lowest contributor to generator failures in the year 2021 with 994 MWh of energy losses. The failure of effective operation of closing and opening emergency stop valves is also a notable contributor to energy losses. Emergency stop valves contributed to 1367 MWh of energy losses in the year 2021. The collection of individual components' contributions helps to develop an effective maintenance schedule. The maintenance priority schedule is then developed based on the criticality of failing equipment. Figure 5 shows the analysis of shaft vibrations and rotor vibrations during generator operation. To examine the vibration a strain gauge-based sensor with high sensitivity and low noise digital telemetry is used. It is noted in Figure 5, that as the generator shaft turns 360 degrees to drive the alternator, it is not rotating as smoothly as expected. There are areas during rotation where a vertical rising line shows that the vibrations are occurring. As indicated before, the vibrations can be created by bearing failures which result in unstable shaft movement and decreased generator output power. Therefore, the maintenance schedule now should focus on implementing measures to ensure and prevent occurrences of vibration by conducting further inspections and preventative maintenance measures.

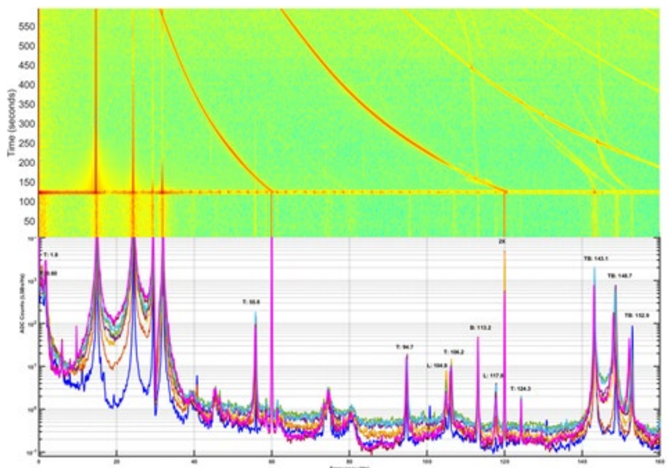

Figure 5. Vibration analysis (EPRI Report).

Generator vibrations should not be underestimated because they can lead to severe damage to the rotor and generator stator. Vibrations can further affect the reliability and power output of the generator. Since generator costs are very high, sophisticated technology for generator monitoring and data acquisition systems must be installed to fully protect generators against any malfunctions and report on deficiencies. In Figure 5, the analysis is obtained through the use of integrated technology which uses sensors and other generator monitoring systems.

5. Results and Discussion

The objective of asset management and maintenance strategies developed and implemented by power utilities is to reduce unplanned outages to always provide a reference voltage for grid-tie solar systems and diminish maintenance costs to optimize profitability. The power utility indicated the need and opportunity to develop strategies to improve the reliability, maintainability, accessibility, and performance of the generator assets by developing maintenance and asset management strategies. The asset performance management (APM) strategy is created and implemented by competent engineers, managers and people who have experience in asset management. The strategy emphasizes the analysis of historical data to assess the performance of an asset and or through means of Computerized Maintenance Management Systems (CMMS). Furthermore, APM indicates the importance of the development of a maintenance execution strategy, age, and economic asset remaining life analysis.

In addition, APM highlights the use of online condition monitoring systems and supervisory control and data acquisition (SCADA) to improve plant performance. The importance of the application of reliability techniques to assess asset failures such as failure mode, effect, and criticality analysis as well as reliability-centered maintenance is suggested to be applied. However, an asset management strategy is not designed and intended for operational maintenance, outage, operational planning and or scheduling. Therefore, this creates a certain gap between the management of assets and the maintenance of assets within the asset management strategy. Asset maintenance is of particular importance and needs to be defined in the asset management strategy because asset maintenance identifies an opportunity to develop maintenance programs. The APM strategy does not mention any asset design for the reliability or quality management systems of assets. The asset risk analysis defined in the asset management strategy does not include an asset risk register. An asset risk register helps to monitor, control, and improve the risks associated with each asset.

The survey using a questionnaire was conducted to collect data to support the data collected from plant breakdowns and failures concerning plant reliability and performance. Surveys were circulated in different departments which are departments of Projects, Maintenance, Outage, Roschon Cabling, and Quality to collect as accurate data as possible to support the results obtained in quantitative analysis.

The total number of targeted employees to participate in the survey study was at least 80 employees which comprise managers, engineers, technologists, technicians and artisans. The total number of employees who responded to the questionnaire was 61 employees from all departments. The survey comprised five open-ended questions designed to request data about load losses that result in unplanned capability loss factors (UCLF), plant breakdowns and failures, asset and maintenance strategies, plant reliability as well as newer and advanced technology to improve plant performance. The survey revealed a very strong link between quantitative and qualitative data analysis. The survey study indicates that people working in a plant need to be empowered in terms of training and skills development. Skills development enables employees to be able to be in line with new technological developments.

5.1 Numerical Results

Table 1 shows the MWh loss comparison between the year 2020 and year 2021 in a coal-fired power generating plant. Then the analysis is made between the years to check whether there was an improvement in plant maintenance and a reduction in plant failures and breakdowns.

Table 1. Station Summary from January to September 2020/2021 (Power Station Report 2020).

Plant Area	2020 January to September		2021 January to September	
	MWh Loss	**%UCLF**	**MWh Loss**	**%UCLF**
Auxiliary Plant	61 732,41	2,33	81732,41	*3,350*
Boiler Plant	2270807,3	85.87	1960567,9	80,36
C&I	7177,47	0,27	6390,32	0,262
Electrical	97 928,75	3.7	83 564,4	3,425
Turbine Gen Plant	206707,97	7,8	307 345, 17	12,6
Total	2 644 353,9	99,9	2 439 600,23	99.99

Table 1 above shows the MWh Loss for the year January to September 2020. The boiler plant incurred 85.87% unplanned capability loss factor (UCFL) and the turbine plant 7.8% for the year 2020. In the year 2021 unplanned capability loss factor for the boiler plant was reduced to 80.36% and the turbine plant increased to 12.6%. The turbine generator plant suffered a 4.8% UCLF and an increase of 307345,17 in energy losses. An increase in energy loss means an increased occurrence of turbine generator failures and breakdowns.
An increase in plant failures and breakdowns is associated with the high costs of plant maintenance. It is therefore crucial that plant breakdowns be minimized to avoid unnecessary expenditures. For example, in 2 hours of load shedding due to a plant breakdown for a 20MW grid-tie solar system, an investor could lose up to US$ 6120 at a rate of US$0.153/kWh.

Thus, analysis of energy losses can help to improve maintenance programs and the development of effective maintenance strategies. For example, the analysis of energy losses in the stator of the generator will reveal the exact causes and effects of stator failure. Once the causes are understood, it can be simple to plan the procurement of required spares, the time it will take for the repairs as well as the correct procedure to be followed for the rotor maintenance. Furthermore, the maintenance planning can determine whether there is a sufficient budget for maintenance and or replacement of the rotor.

In Table 2, the objective of the seal oil system is to take the lubricating oil from the oil tank into the seal under controlled pressure. Oil is then directed through the gap between the stator housing and the shaft so that hydrogen gas (H2) cannot escape from the generator. Hydrogen is a highly flammable gas when mixed with air. Therefore, seal oil prevents hydrogen leakages. Seal oil flow failures are noticed around the turbine generator area. Oil leakages are due to sealing gasket problems. In some cases, during maintenance, the incorrect seal oil gaskets are used due to the non-availability of spares.

Table 2. Generator auxiliary plants energy losses.

System	Losses (MWh)
AVR/Excitation	20 918.07
Brushes / Slip rings	22 943.75
H_2 cooling	**248 964.92**
H2/Seal Oil	**751 458.63**
Rotor	**419 275.03**
Stator	**1 694 404.25**
Stator water	**4 727.75**

5.2 Graphical Results

Figure 6 shows the graphical representation of the energy losses between the year 2020 and year 2021and is based on the data obtained from Table 1. The results show that in the year 2021, the boiler plant energy loss decreased by 5% compared to 2020. However, the unplanned capability loss factor remained at more than 80%. Taking that into consideration, a 5% decrease in boiler plant failures for the year 2021 is very little and an insignificant improvement in plant breakdowns and failures. On the other hand, turbine generator plant UCLF increased by 4.8% resulting in an energy loss of 307 345,17 MWh. Furthermore, the auxiliary plant failures increased by 1.02% and electrical plant failures were reduced by 0.3%. Therefore, in the years 2020 and 2021, there was no significant plant performance improvement.

The challenges of plant failures and breakdowns remained almost the same. In 2021 there was supposed to be at least a notable improvement and reduction in plant failures. This is because the set target of 40% failure reductions for three years cannot be met if such a low improvement is achieved. In addition, plant lessons learned need to be developed for effective maintenance planning, acquiring sufficient equipment spares, training and developing employees, and hiring scarce skills.

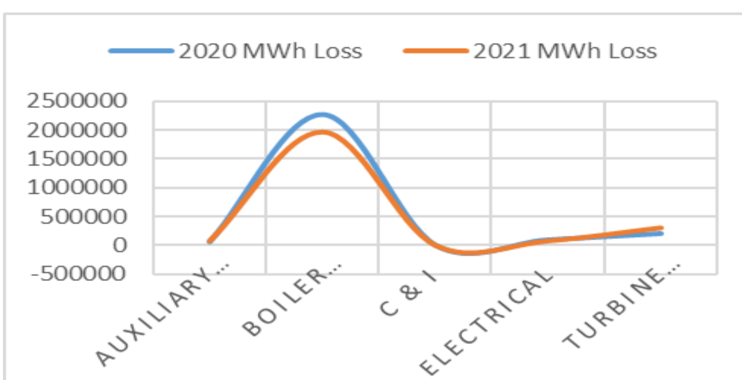

Figure 6. Comparison Graph of MWh Loss in the Years 2020 and 2021.

Figure 7 below shows the results of energy losses within the generator plant. It shows that 53% of energy loss in the generator is found in the stators, the H_2 seal oil system contributes 23% of MWh loss while 13% of breakdowns are rotor losses and hydrogen cooling failures are at 8%. Rotor failures are notable due to the loss of cooling within the stator and generator rotor. The direct effects of insufficient cooling within the rotor results in phase-to-phase internal generator stator winding faults. Furthermore, this can result in winding short circuits leading to generator trips and loss of production

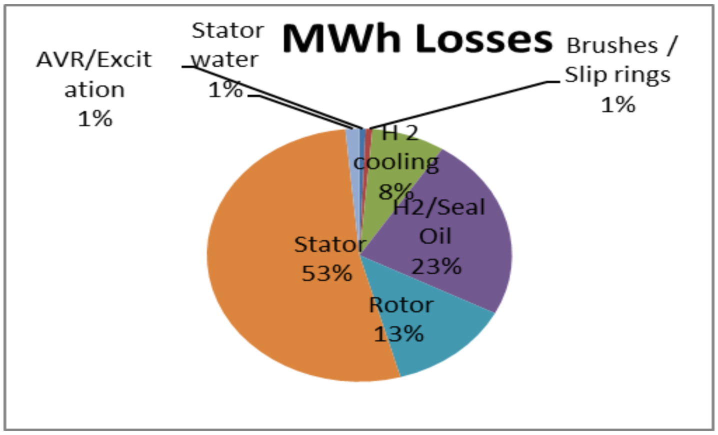

Figure 7. Generator components of energy losses

In Figure 8, the average reliability plant performance of the turbine generator is shown. The result shows that the average availability of the generator plant is calculated by adding the total number of plants available and dividing by the total number which results in an average of 84.6%. The average operational reliability of the generator plant is calculated as the sum of the total number of generator individual plants divided by the total number of generator plants and results in 10.9% and design for reliability has an average of 76.2%. The operational reliability of the generator plant is very low compared to availability and design for reliability. The reasons for this difference are the results of poor generator plant performance. Among other plants that contribute to the operational reliability are feed heating, condensate system as well as turbine centerline. Therefore, strategic maintenance planning should be emphasized in these areas to improve turbine plant performance. Lack of adequate skills, maintenance procedures not followed, delayed outages and unavailability of spares are major hurdles to be overcome. It is of great importance that all plant breakdowns, failures, causes and effects are analyzed and examined to develop effective maintenance planning.

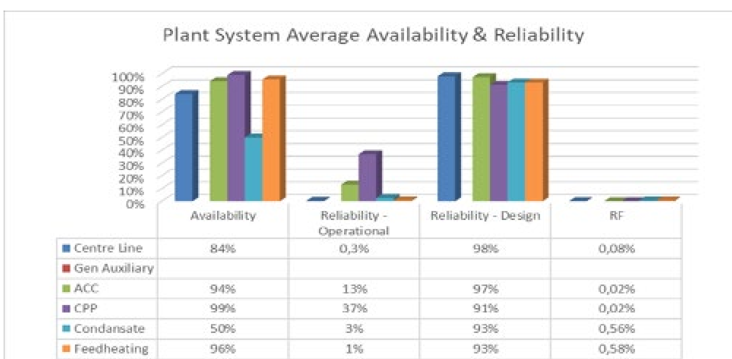

Figure 8. Turbo Generator Average Plant Performance (Eskom Report 2021).

The technology currently installed in the generator plant is old and obsolete. The implementation of new technology is crucial for the improvement of turbine generator plant reliability. For example, online equipment monitoring systems can be very useful to detect failures before they occur for example, sensors to monitor flame quality and stability as well as supervisory control and data acquisition to monitor temperature parameters. There is always room for technological improvement to ensure generator plant reliability. New technology implementation will provide speed, selectivity, reliability, and availability. New technology implemented could help to monitor the generator system performance and provide accurate data for preventative maintenance. Improved technology could offer relief for real-time generator plant performance and plant failures which can be detected even before they create severe damage. Technology-driven organizations have seen increased plant production, ease of maintenance, organized data collection, improved working conditions, and fewer incidents, and accidents. Technology has advanced plant operation beyond reasonable doubt and continues to add value to the generation of electricity.

5.3 Proposed Improvements

Results indicated that plant breakdowns and failures are due to delayed maintenance and outages. Proposed improvements include ensuring outages and maintenance are conducted on a routine basis by competent and skilled workers. Power generating plants are in a crisis of aging infrastructure that can no longer be maintained but must be improved through refurbishment and the installation of new equipment in the plants. Improved maintenance asset management strategies will directly result in improved availability, reliability, and plant utilization. The technology currently installed in the plants is old and obsolete. Improved technology will offer real-time plant performance and plant failures can be detected even before they create serve damage.

6. Conclusion

There is a high demand for reliable electrical supply from the continuously growing population in the world. Many business sectors have declared losses in profits and revenues due to the unavailability of reliable power supply. Several strategies and procedures have been developed by the power utilities in support of maintenance departments and projects to ensure the improvement of plant maintenance and performance. The power utilities are underperforming despite the investment of large amounts of money in maintenance and outage budgets.

From the data collected, results obtained and analyzed in this study it is shown that power utilities have been and are still experiencing a continued high rate of plant breakdowns and failures over the past years. The plant failures comprise boiler, turbine, and generator failures which result in the unavailability and unreliability of electricity supply. Various plant breakdowns and maintenance are due to poor maintenance, delayed maintenance, and outages. In addition, some of the contributing factors to poor plant performance are lack of adequate skills, training, aging infrastructure, and non-availability of quality spares. Asset management strategy and maintenance strategy, particularly corrective maintenance strategy applied to coal power plants are futile, ineffective, and inappropriate strategies that could lead to continued load shedding.

It is recommended to improve maintenance and minimize delays on scheduled outages by conducting regular inspections and preventative maintenance. The aging infrastructure that can no longer be maintained must be refurbished and new equipment with improved technology installed to monitor plant performance. Skills gap analysis must be performed to assess the skills shortages of personnel as well as the level of competency to assist maintenance departments to allocate budgets for the training and development of employees. Doing this will help to have a reference voltage for solar plants compulsory to the national regulator for a grid-tie inverter to produce electricity. Thus, the amount of solar energy produced will help to improve the grid’s stability.

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Biography

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