

# **STRATEGIC ASSET MANAGEMENT IMPLEMENTATION (SAMI) AT NATIONAL GRID, SAUDI ARABIA**

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## **EXECUTIVE SUMMARY**

The electricity sector is changing rapidly... Utilities will face substantial grid operation and grid development challenges such as interconnections between neighboring countries, grid restructuring for decentralized electricity generation and even maintaining their infrastructure in good condition. In the meanwhile, resources, both financial and human, might not grow at the same pace.

Elia Grid International's research shows that utilities will not be able to satisfy growing demands and operation of the existing network using current work patterns; working methodologies will have to be adapted through the implementation of Asset Management principles and more precisely, by integrating risk in decision-making processes. The primary aim of Asset Management is to assure that organizations reach their performance targets, while balancing cost and risk.

Such as other utilities, National Grid Saudi Arabia is facing a number of important challenges, including, but not limited to, an extremely high growth in the demand for power (a 100% increase in installed grid power in a single decade), a large territorial area over which the assets are operated (approx. 2.1 million square KM), an increasing asset replacement need within its network

and a rising number of incidents & failures in the asset fleets across the Kingdom. In addition, National Grid SA is the result of several company mergers; with the inherent challenge lying in the harmonization of best practices across the organization.

This paper outlines how National Grid SA determined that the solution to these challenges could be provided through the implementation of a strong Asset management approach within the company as well as detailing the strategy taken for its implementation.

In order to illustrate the implementation of these Asset Management guidelines, this paper will focus on the approach that was used to deploy Asset Performance and Incident Analysis activities in National Grid SA. As one of the main concerns of the Transmission System Operators (TSO), system reliability is directly affected by these activities. The Asset Performance Analysis process also provides a case to illustrate the strong link between performance, cost and risk.

## **KEYWORDS**

ASSET MANAGEMENT, RISK, LIFECYCLE, CONTINUAL IMPROVEMENT, CHANGE, TRANSFORMATION PROJECT, EFFICIENCY, ASSET PERFORMANCE ANALYSIS, RELIABILITY, FAULT ANALYSIS, GRID AVAILABILITY

## 1. INTRODUCTION

The electricity market is changing rapidly and the challenges for the utility sector are tremendous. One of the main challenges of the Transmission System Operators (TSO) is to comply with higher demand and increased performance, with cost efficiency programs hanging over their balance sheets. Other challenges of TSO worldwide are operating the existing network at its limit, ageing assets and the integration of new technologies.

This is certainly valid for the Saudi Arabian TSO National Grid SA. A widely suggested and proven solution is to develop sustainable Asset Management practices.

In order to apply Asset Management, TSO can follow the commonly accepted guidelines of Asset Management, which are also recommended by international standards (PAS55 or ISO55000). The following section of this paper shall focus upon the application of these standards in a large utility in the GCC region.

All Transmission System Operators do have a strategic layer defining the vision and mission of the company, as well as the company's overall strategy. All utilities also have people working on the field to make sure the operations are performed. Nevertheless, most utilities still lack a tactical layer that connects the Strategy and Operations of the company. This tactical layer in the case of Asset Management is commonly referred to as the Asset Manager.

The activities of the Asset Manager tend to ensure that the prescriptions of the strategic layer are adequately implemented by the operational layer (vertical alignment) and that the activities over the different phases of the asset life cycle are coordinated (horizontal alignment). In other words, the Asset Manager translates the strategy of the company in vocabulary understandable by operational departments to perform their activities, and ensures that the activities of the operational departments are not in contradiction with each other and correctly implemented. The Asset Manager's governance is always guided by an optimization principle between cost, performance and risk.

Other primary roles of the Asset Manager are to enable feedback from the field to guide and adapt the Asset Management Strategies and Objectives based on this

feedback, but also to monitor the performance of the grid and issue recommendations in order to improve it. This mainly consists in analyzing events that impact the performance of the asset system.

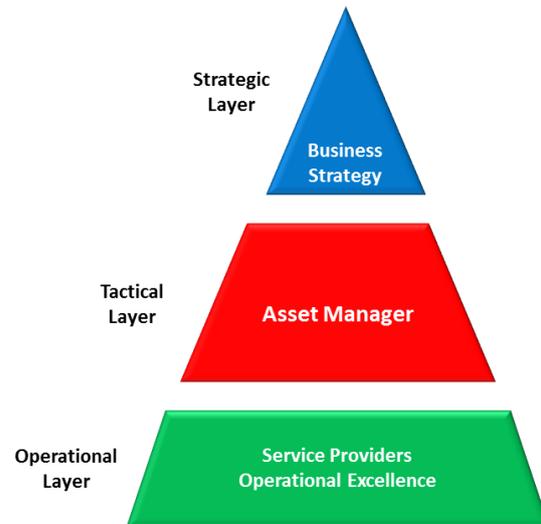


Figure 1: The Asset Manager as tactical layer

The standards mentioned above specifically mention and address Asset Performance and Incident Analyses, for which best practices are developed in this White Paper. Although this topic has been touched upon in previous publications of CIGRE, this paper shows more insight in the real application of these practices in large utilities including obstacles and pitfalls.

## 2. STRATEGIC ASSET MANAGEMENT IMPLEMENTATION (SAMI)

The high ambitions of the Kingdom of Saudi Arabia emphasize and generate a set of constraints that are even more challenging for its transmission system operator, National Grid SA:

- The combination of industrial development, population growth and high energy consumption has forced National Grid SA to double the installed grid power over the past decade;
- The energy transition that the Kingdom of Saudi Arabia has been preparing to sustain its economy requires huge investments in a short period, especially for National Grid SA; and
- The electricity market of Saudi Arabia has been regulated since 2001. In addition to the previously enumerated challenges, the Electricity and

Cogeneration Regulatory Authority (ECRA) rightfully expects increases in quality and savings.

In addition to the previous factors, some existing assets have reached their end of life and the reliability of some assets is decreasing. National Grid SA will face replacement waves in a near future in concert with the ambitious grid development.

In this changing context, the implementation of an efficient Asset Management System could provide National Grid SA with a powerful approach to succeed in facing its challenges, which are:

- An extreme growth in demand for power leading to quick grid development and to assets operated at their limits
- The introduction of renewable and nuclear energies;
- An increasing asset replacement need within the network;
- Internal challenges, such as high diversity, silo-working, missing information, and large territory;
- A strong regulatory framework;
- Safety of its personnel and stakeholders.

During the implementation of Asset Management best practices in the company, a special focus was placed on the following:

- The creation of strong Asset Management governance through the development of an Asset Manager entity (Transmission Asset Management or TAM) with highly experienced people and the creation of transversal governance committees;
- Controlling the key processes by connecting the replacement and investment processes, establishing a risk management system, structuring the continuous improvement process and so on; and
- Formalizing asset information (documents, data and related processes, and information technology (IT) platform) governance.

This project was articulated around three major axes, as described below:

- The creation of a strong Asset Management governance;
- The creation of committees to position the Asset Manager entity in National Grid SA;

- The development and application of appropriate processes.

The last axis of the SAMI project consisted of developing processes to make TAM work as an Asset Manager. This included the Operating Model of TAM and detailed core processes of which some are enumerated here:

- Asset Performance Analysis;
- Continual improvement;
- CAPEX (Capital Expenditures) and OPEX (Operational Expenditures) Management;
- Information management; and
- Risk management.

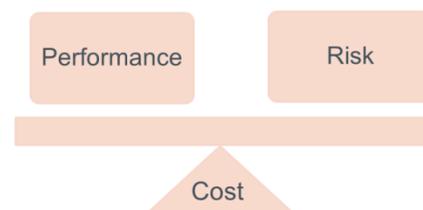


Figure 2: AM - balance cost, risk and performance

The aim of Asset Management activities comes down to optimizing the performance of the organization, while taking into account risk and cost, by acting in a systematic and coordinated way on the phases of the assets' life cycle.

As one of the core processes of Asset Management, Asset Performance Analysis is top-of-mind of TSO. Similarly, one of the main concerns of National Grid SA is to control the incidents affecting the performance of its assets and asset systems. Prior to the SAMI project and due to the aforementioned challenges National Grid SA focused on restoring power, working in silos and not systematically. The development of systematic and coordinated incident analyses will now enable National Grid SA to better identify the root-causes of unplanned outages and take the right decisions to avoid new or similar occurrences of grid disturbance, taking into account the whole asset system and balancing cost, risk and performance.

The following sections allow the reader to get a better insight, through the example of implementing the Asset Performance Analysis (APA) process, of how the implementation of Asset Management principles improve the performance of the overall organization,

taking into account cost and risk. This paper will also focus on the interrelation between APA and other processes of the Asset Management System.

### **3. WORLD CLASS ASSET PERFORMANCE ANALYSIS**

To reach the promised benefits of Asset Performance Analysis, outlined in the next sections, international standards, such as PAS 55 or ISO55000, impose the following requirements with regards to this domain of the asset management system:

- Corrective and preventive actions to improve the asset system performance and condition of individual assets;
- Leading and lagging indicators of the performance of the asset systems;
- Individual analysis of incident: identify root-causes, check the correct response of the system to the incident (protections, circuit breakers, automation,...), suggest corrective and preventive measures to avoid new occurrences of the observed problems and communicate actions to relevant stakeholders;
- Monitoring the effectiveness of the implemented actions;
- Managing data related to asset system performance;
- Continuous improvement.

The Asset Manager's main duties and responsibilities with regards to Asset Performance Analysis (APA) can, based on the above, be decomposed in five (5) major axes:

- Managing assets (e.g. Digital Fault Recorder) and software that provide the data to facilitate the analyses;
- Analyzing the incidents that occurred on the grid and issuing recommendations;
- Analyzing all historical disturbance data to discover trends and issuing recommendations;
- Performing complex studies and measurement campaigns and analyzing rare technical phenomena.
- Providing training to operational staff and collect experience feedback for continuous improvement.

### **4. THE CURRENT SITUATION AT NATIONAL GRID SA**

With over 2500 incidents per year, of which 500 leading to ENS (Energy Not Supplied)<sup>1</sup>, the challenges of National Grid SA are huge. Nevertheless, many activities were already performed at an embryo stage by different business units of National Grid SA.

Similarly to a large number of utilities, Asset and system Performance Analysis at National Grid SA is an activity which is performed by all, but with a relatively clear cut in responsibilities. Due to the visibility and importance of this activity for the executive level, all business units are involved and taking responsibility of a non-coordinated set of activities. Single version of the truth is required.

Although the executive level has clear targets and objectives towards the reliability of the grid, based on the requirements of the regulator, there is room for improvement to translate these performance requirements to the operational activities.

The development of strong governance in processes will have a direct causal effect on the improvement of technical governance or data governance. Data acquisition equipment showed some gaps leading to a set of data with limited quality.

While experts and expertise do exist in National Grid SA, their dissemination, authority and process governance limit the development of Asset and system performance analysis. National Grid SA needs to invest in a better understanding of Incident Analysis by major internal and external stakeholders.

### **5. ASSET MANAGEMENT AND APA AT NATIONAL GRID SA**

The typical Asset Performance Analysis process, which was also implemented in National Grid SA through the SAMI Project, can be decomposed in five (5) consequent steps which are all closely interconnected with the Asset Management System's processes.

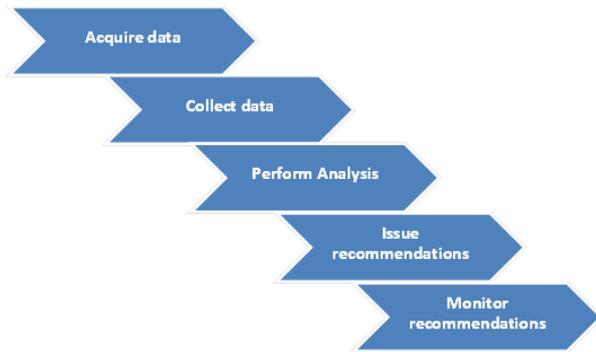


Figure 3: The APA Process

The first two steps relate to the acquisition and collection of incident data. These steps are intimately linked with the Asset Management System's processes to guarantee control over technical governance and asset information. Technical standards, in this case especially for data acquisition equipment, are developed in collaboration with the asset managers and validated by an overarching decisional committee (governance board). Information governance is coordinated by another governance board that is responsible for matters relating to asset information and supporting tools. Data standards, determining which data, their format and e.g. frequency of acquisition are as important as the technical standards of the equipment.

The issuance of recommendations aims at defining corrective and preventive actions to assure incidents or disturbances will not occur again on the grid. By weighing risk, performance and cost, APA provides action plans for the asset manager, service providers and other stakeholders. By developing replacement or disposal plans, the action plans will impact the asset management processes that manage capital expenditures, while other action plans will impact processes that guarantee control over operational expenditures. The Asset Risk Management process treats/manages risks that have already been identified, while this process sources the Asset Risk Management process with new information on existing risks or new risks and their mitigation actions.

The last step of the process consists in monitoring the issued recommendations and therefore ensuring the continuous improvement pursued by the Asset Manager. Communication channels are developed to assure contact with the service providers.

## 6. THE SAMI PROJECT APPROACH

As part of the Strategic Asset Management Implementation (SAMI) Project, National Grid SA has decided to continue the implementation of best-practice Asset Performance Analysis, building on its current strengths and reinforcing its flaws.

The general project approach relied on:

1. Assessing how National Grid SA is performing asset and system performance analysis;
2. identifying major improvement areas towards international standards and Elia Grid International's experience;
3. developing a roadmap to work on the improvement areas identified;
4. initiating the foundational steps of the roadmap to ensure success;
5. calculating and interpreting performance indicators to show the added value of APA, including the definition of recommendations towards concerned stakeholders;
6. performing complex incident analyses to illustrate the ambitions of the implemented activities.

The assessment of current practices was conducted by interviewing all potential stakeholders of the asset and system performance activities, leading to a realistic and concrete understanding of the situation in the Kingdom of Saudi Arabia.

A gap analysis was performed based on the assessment of each step of the Asset Performance Analysis process. The outcomes showed existing activities and improvement areas in a diversity of domains in each step of the process, reaching from governance (e.g. weak roles and responsibilities or lack of processes) to data management, misuse of equipment or technical harmonization of data acquisition equipment. Eight (8) domains were assessed on the maturity level of each step of the Asset Performance Analysis process of National Grid SA.

In collaboration with the main concerned stakeholders of asset performance analysis, the project focused on setting maturity targets for each domain that showed significant improvement areas, as well as actions to reach these targets. The mitigation actions were consequently ranked and placed on a time-line to provide National Grid SA with a decennial roadmap

towards their maturity targets. The roadmap aims at developing incident and asset system performance analysis activities which comply with the international standards and allow National Grid SA to achieve its performance objectives.

The foundational steps of the roadmap were initiated as part of the SAMI project in order to assure the roadmap would be implemented successfully. These foundational steps included a.o. the establishment of a neutral entity with the authority on all asset and system performance activities, in order to cope with the current issue that entities performing the incident analyses today are also those responsible for the human errors causing them. Another role of this entity consists in following the roadmap described above to improve National Grid SA's maturity in performing asset and system performance analysis activities.

The activity of calculating performance indicators, interpreting the results and developing action plans was reinforced during the SAMI Project, while not disturbing the existing reporting processes towards the organizations major stakeholders. This activity nevertheless enabled the Asset Manager to show the added value of the Asset Performance Analysis cell through a better understanding of the root-causes. This cell, in order to keep its neutral position and tactical purpose was located as part of the Asset Manager TAM.

Lastly, and in order to illustrate the ultimate aim of the developed roadmap, the SAMI project has performed several incident analyses. The incidents were chosen by the involved stakeholders, covering different kinds of causes, which had remained unsolved until then. This activity highlighted the presence of skilled expertise disseminated over the different regions of the Kingdom, without coordination or governance.

## **7. INCIDENT ANALYSIS: CASE**

As part of the SAMI project, and as mentioned above, to illustrate the ambition of the asset performance activities and roadmap, National Grid SA has conducted several incident analyses. This section will briefly come back on one of these analyses to show their extent.

The chosen substation had undergone multiple incidents in the past years. The substation was

commissioned in 2011, but incidents occurred repeatedly as from 2014. The same busbar was impacted over 15 times in 3 years.

In all occurrences, the failure led to:

- the unwanted trip of several healthy feeders
- the unwanted trip (by E/F or SGF protection) of the 13.8kV earthing Transformer connected to the affected busbar
- the unwanted trip of the feeding transformer, leading to the complete blackout of the 18.3kV busbar
- long customer interruptions.

Other substations have been reported to undergo similar incidents in the region. The analysis showed that 6 substations in the region had the same design and could potentially be impacted by this analysis.

The results of the analysis highlight:

- Accumulation of undetected "grounding" events causing the appearance of unbalanced currents on several feeders (neutral currents) and leading to a situation where protective systems cannot operate properly anymore and ensure a selective elimination of the faulty grid elements. This situation should never occur as each single event should be addressed effectively as soon as it occurs.
- Sources of non-symmetrical currents have been analyzed and are raising concerns on the topology of the distribution system, including the loads connected to it (active loads, asymmetrical loads and open phase situations).
- Protection schemes applied to the ETR is not adequate and should be improved to allow the early detection of any earthing event. Recommendations are proposed to adapt the ETR scheme and improve relay coordination between ETR protections and feeder protections.
- Switching procedures and reclosing sequences are raising concerns too. These procedures should be improved to avoid confusing grid situations and reduce safety risks in downgraded situations.

While previous analyses of this incident have led to ineffective actions, as the reoccurrence of the incidents prove, the present APA analysis proposed over 43

recommendations to be issued and monitored for implementation, including:

- Procedures and methods of maintenance staff need to be reviewed, e.g. reclosing procedures;
- Technical governance for data acquisition equipment need to be controlled for more harmonization, e.g. DFR configuration;
- Incident analyses are an opportunity to test the whole system, e.g. check similar incidents or assets on the system.

The aforementioned analysis and recommendations have led to a remedial plan to be implemented by the Asset Manager and its service providers.

## **8. BENEFITS FOR NATIONAL GRID SA OF IMPLEMENTING APA**

The main benefits sought after by TSO when implementing world-class asset performance analysis are:

1. Increased availability of the grid
2. Increased reliability of the assets
3. Better knowledge of the assets and systems, allowing to optimize decisions in terms of asset management and grid development
4. Continual improvement of processes, methods, skill management, etc.
5. Improved communication towards internal and external stakeholders (regulator, customers, etc.)

Indirect benefits are a safer place to work for personnel and stakeholders, an optimized utilization of capital and human resources, a better corporate image and increased revenue.

National Grid SA could today already benefit from the implementation of Asset Performance Analysis. Being the “eyes and ears” of the Asset Manager, the entity should enable experience feedback mechanisms to live in the company, while ensuring one single source of the truth. Other benefits are summarized below:

- The authority provided to the APA division will allow it to take rapid decisions as support to field staff during incidents. The direct consequence is a *reduction of the unavailability* of assets and the system.
- The *optimization of capital expenditure* is the second benefit to which APA will contribute.

The analyses performed by APA will enable National Grid SA to make the right decisions, and therefore avoid spending capital uselessly.

- Recommendations from APA, whether they are issued based on historical incident data or on specific incidents, will allow National Grid SA to *avoid future occurrences of similar incidents*. National Grid SA optimizes the system, and not only the performance of single assets.
- Rare phenomena, impacting the performance of the system, will allow National Grid SA to *increase the performance of complete asset fleets and system*.
- The developed governance *streamlines the communication channels* and reporting to the concerned stakeholders.
- Managing *data acquisition equipment* is now under the responsibility of APA, which will aim at *harmonizing* these equipment.
- The centralization of the activities will enable National Grid SA to *be more efficient* in the way its activities are performed.

The added-value to the company will only increase with the implementation of the roadmap.

## **9. FINAL ADVICE**

The energy sector and especially the Transmission System Operators are facing huge challenges, of which one is to guarantee performance levels as required by its stakeholders.

Utilities around the world have endeavored to take on the journey of Asset Management with the aim to install coordinated and systematic activities that will balance cost, performance and risk in alignment with their corporate strategies in order to be prepared to take on those challenges.

Acting upon the performance, while assessing the risk and proposing efficient solutions to avoid further impacts on availability and reliability of the grid, the Asset Performance Analysis activities are core to Asset Management principles. The inputs and outputs of the Asset Performance Analysis process originate and source the Asset Cost Management processes, the Asset Information Management processes and the Asset Risk Management processes as part of the Asset Management System.

Transmission System Operators willing to take on the journey of best practice Asset Performance Analysis shall face obstacles, as many as they are specific to the TSO business, and that are broadly shared by other TSO. These challenges range from the lack of centralized governance, to the dissemination or existence of specific expertise and support from stakeholders. The importance of asset performance data and technical governance has also been highlighted throughout this paper. Likewise success factors are also broadly shared, including the

commitment of the executive level, the recognition of concerned stakeholders, the monitoring of issued recommendations and the development of specific expertise.

If the challenges and actions to be implemented are common to most organizations, the expertise and capabilities to support this transformation is restricted to those actors that have a long term experience in this domain. Experience shows that the gains at the end of the journey outrun the challenges.

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<sup>i</sup> Asset Performance Analysis, National Grid SA