

Managing Hydropower Assets

ISO 55000 for Performance-Based Maintenance

Hydropower is becoming less price-competitive. As a result, hydropower infrastructures need advanced management tools to make sure that the production assets remain a reliable source of added value for shareholders. The deployment of an asset management model based on the ISO 55000 standards, combined with the performance-based maintenance model, optimize the lifecycle of hydropower infrastructures, whilst ensuring the people and equipment safety.

Nicolas Rouge, Olivier Bernard

The current electricity market is characterized by low prices, not expected to increase any time over the next decade or so. These low prices combined with the current framework conditions are lowering down profit margins for hydropower infrastructures. From now to 2020, the drivers for value creation will not come from the market place nor from the political arena; rather, they will be provided by asset managers representing the owners of hydropower assets. Adding value will require optimizing investment plans and operating costs in order to deliver the required level of performance expected by the owners. This might entail, for example, ensuring that an availability goal is reached, or extending the lifetime of some assets, or investing in critical assets which, if they failed, would have a significant negative impact on the value unlocked.

These are the considerations which have led Alpiq, supported by the firms Oxand, specialized in value unlocking from assets, and Hydro Exploitation SA, in charge of operation and maintenance of some of the hydropower infrastructures managed by Alpiq, to embrace two new tools:

- An asset management system, compliant with ISO 55001 (“Asset Management System”) and enriched with international best practices associated with this standard (in particular: clarification of roles and responsibilities, enhanced processes, performance-indicator tracking, continuous improvement, aligning decisions with a value function for the company)

- An advanced method to manage assets with a Performance-Based Maintenance. This method can be used to optimize the

expenditures required to manage the lifecycle of the infrastructures in order to create as much value as possible without compromising asset sustainability.

Alpiq’s solution aims to optimize the economic and technical performance of assets under management, whilst guaranteeing the people and equipment safety and satisfying the risk-tolerance and decision-making limits set by the Board of Directors.

The purpose of this article is to describe Alpiq’s solution which aims to implement the best practices of the ISO 55000 standard into the company’s management system, as well as the Performance-Based Maintenance tool.

Why the ISO 55000?

Faced with increasingly prevalent cost-cutting programs, asset managers need to be able to “take more risks” and report these propositions to the boards of directors of the power generation companies. Working with the asset operator, the asset manager needs to strengthen its predictive capabilities by integrating advanced knowledge on aging and risks of the assets. The asset manager have to be able to suggest alternative expenditure scenarios where the residual risk level is quantified to facilitate decision making for the asset owners and other stakeholders (other shareholders, energy managers, etc.).

With regards to the ISO 55001 certification, Alpiq’s goals are:

- Speak the same language, and in particular have in mind the defined and shared value function of the organization
- Define the framework to facilitate the implementation of the Performance-Based Maintenance
- Be sure that asset managers access the best practices in order to find the best balance between the performance, risk and the total cost.

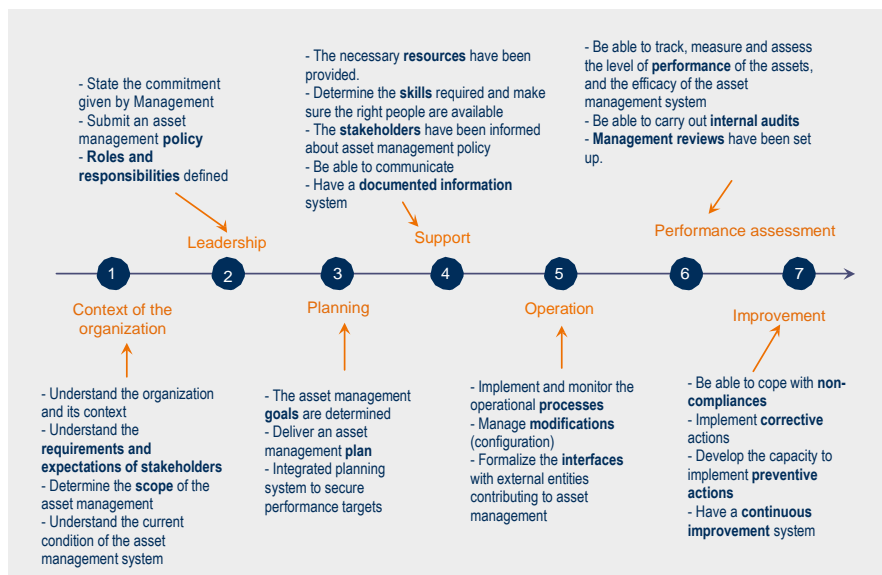


Figure 1 Overview of ISO 55 001 requirements

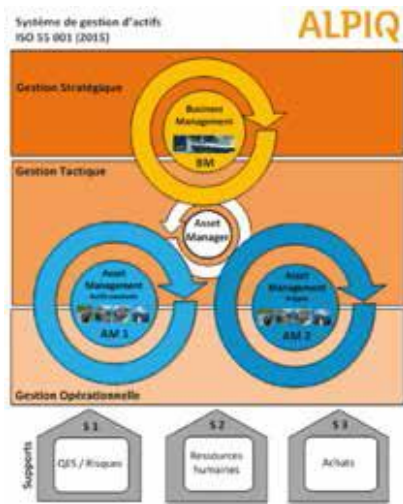


Figure 2 Alpiq Asset Management System

- Set a common asset-management framework to facilitate knowledge and best practices sharing
- Reconcile potentially contradictory goals: minimizing the total cost of the lifecycle of assets whilst minimizing the short-term marginal cost (production cost without amortization).

In 2014, with the help of its existing management system compliant to the principles of PAS 55 British standard [4], the Business Unit Hydro Power Generation of Alpiq Group decided to improve its asset management system and go for the ISO 55001 certification journey [2]. Oxand and Hydro Exploitation SA actively participated in the design and implement of this new management tools. In March 2015, Bureau Veritas have attested that the Alpiq’s management system is complaint with ISO 55’001 requirements. This certification illustrates the best in class Alpiq’s skills, expertise and know-how in hydro power asset management. Alpiq is the first hydropower generation company in Europe and the first utility company in Switzerland to be ISO 55001 certified.

The scope of the ISO 55001 certification achieved by Alpiq covers its asset management activities for the following generation companies: Grande Dixence SA, Cleuson-Dixence, Électricité d’Émossion SA, Electra-Massa SA, Énergie Électrique du Simplon SA, Salanfe SA, les Forces Motrices de Gougtra SA, les Forces Motrices de Hongrin-Léman SA, les Forces Motrices de Martigny-Bourg SA, and the plant owned by Alpiq Suisse SA.

With the support of Oxand and the Swiss Railways (CFF), Alpiq applied its ISO 55001 Management system to the Nant de Drance pumped-torage power plant, managed for Nant de Drance SA partners

(Alpiq, CFF, IWB and FMV).

ISO 55000 standard

The ISO 55000 standard was introduced in 2014 [1], [2], [3] for the purpose of providing an international framework gathering the best practices in industrial asset management. The founding principles of the ISO standard, largely inspired by PAS 55 British standard [4] are the following:

- Assets are a resource to create value for the organization.
- Each organization stakeholder contributes to the creation of value thanks to coherent decisions (line of sight).
- Asset managers deliver strong leadership to ensure that asset management practices are applied by all.
- When taking decisions, the organization has sufficient assurance to deliver the expected value.

An overview of the ISO 55001 requirements is given in figure 1.

The Alpiq asset management system

The Asset Management System set up by Alpiq applied to the various asset systems under contract is described in figure 2. It comprises three business processes: Business Management (BM), Asset Management of existing assets (AM 1) and Asset Management of capital projects (AM 2).

The combined goal of the 3 asset management processes is to support the asset manager and contractors active at the various management levels. To this end, they have a quality process to ensure ongoing improvement and risk control, these being key considerations to making better-informed decisions (S1). They also ensure that all the human resources required to perform the asset management tasks will be on hand (S2) and that external contractors will be efficiently managed (S3).

The asset management system covers three levels of management:

- The purpose of strategic management level is to steer the company, to define the asset management strategy, and, more specifically, the value targets to reach (financial and technical performances) and risk tolerances. The company’s Management Board is responsible for this management and takes decisions based on the asset manager recommendations.
- The purpose of tactical management is to manage the company, optimize the asset management, prepare the asset management plans, i.e., define the means mandatory to reach the required value and performance targets, and to control risk criticality. The asset manager is responsible for this management, acting on proposals made by the operator (Alpiq partners in ‘Électricité d’Émossion SA’ and

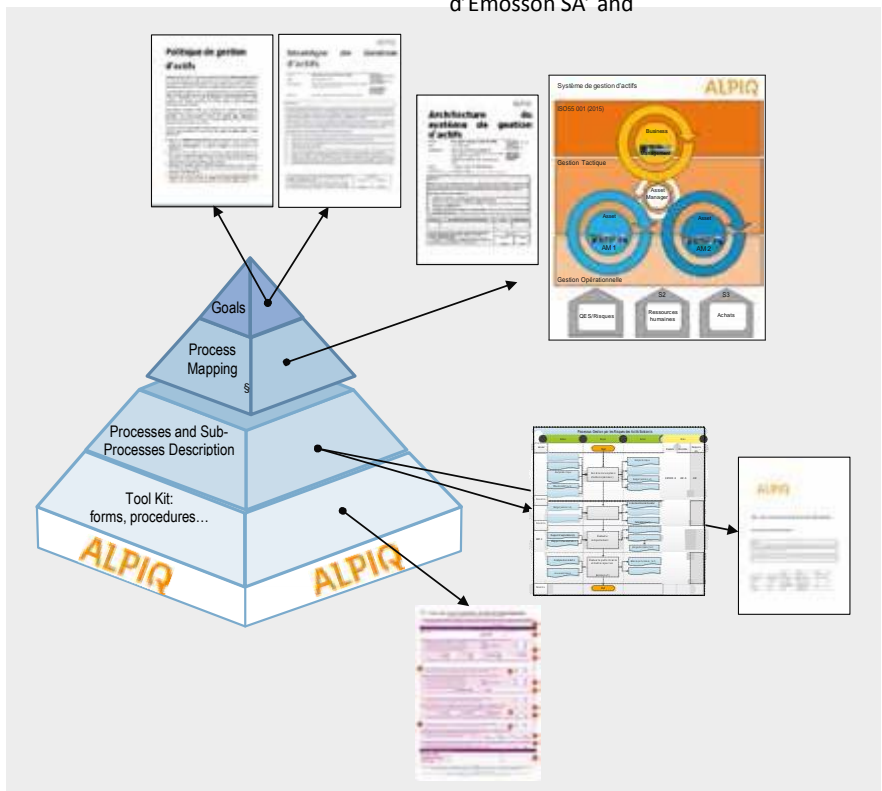


Figure 3 Alpiq Asset Management System Documentation

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Alpiq Hydro Aare AG or by sub-contracting to Hydro Exploitation SA for plants such as Cleuson-Dixence, Grande Dixence SA, Electra-Massa SA, Énergie Électrique du Simplon SA, Salanfe SA, as well as Forces Motrices de Gougrou SA, Forces Motrices de Hongrin-Léman SA and Forces Motrices de Martigny-Bourg SA). The asset manager handles the maintenance plans and prepares the repair and maintenance schedules for the forthcoming 10 years, as well as a maintenance master plan and projects involving significant investments, over the concession period of the assets.

■ The purpose of operational management (routine maintenance, inspection, modifications, new builds) is to operate and maintain the assets on the basis of: the asset management plan of the generation company, performance and value targets (operational and financial performance), and risk tolerances.

Structured documentation has been prepared for the Alpiq asset management system, as shown in **figure 3**.

Asset Management Plan

Prepared for each generation company, the Asset Management Plan, a ISO 55001 required documented information provides all the guidance which the operational stakeholders require in order to prepare an action plan with value unlocking for the shareholders. The main purposes of this Asset Management Plan are:

- present the company, the hydropower infrastructure, the list of assets concerned by the asset management system and the list of current projects on the infrastructure;
- set the value and current performance level of the company;
- define the roles and responsibilities of the various stakeholders (owner, asset manager, operator, energy manager),
- present the value targets (short-term and long-term economic value) and performance targets (level of availability, water collection) expected given the draft budget, taking into account the main risks and opportunities related to the operation of the infrastructure.

Performance targets for future budgets

Performance-Based Maintenance analysis has led to the development of an arbitration methodology involving economic profitability, availability and risks. This tool enables constrained optimization. Thus, Alpiq can maximize the value produced by the assets on

behalf of the company by optimizing maintenance and investment expenditures, and can do so with full knowledge of the impact of these variations on the level of availability and risks for the infrastructure, but without compromising the people and equipment safety. The methodology is based on the following elements:

- a “value” function: optimize the profitability of the infrastructure (e.g., the Net Present Value (NPF) for the infrastructure)
- constraints: unacceptable economic and safety risks, market prices, end of concession requirements
- variables: maintenance expenditure and the associated scheduled downtime, direct and indirect costs in the event of an unforeseen risk occurring.

To apply this model, the asset manager must have defined the following key elements: budget for year ‘y’, maintenance and investment master plan (if possible, up to the end of concession), risk analysis, financial and technical performance indicators. In this regard, the Board of Directors is responsible for setting the short-term and long-term profitability and availability targets.

The asset manager and the operator assess the current condition of each infrastructure component by a scoring

based on the basis of several criteria (normalized method). The purpose of this assessment is to assess the probability of failure. The results are used to adjust the aging curve for each component. The assessment results quantify the impact, on the value function, of inspection, maintenance and rehabilitation actions. This methodology is used to optimize the maintenance plans according to the expected performance and the criticality of the failure risks for each component. Several maintenance scenarios are then simulated, and compared. This in turn yields the optimal scenario, created by optimizing selected technical and economic factors.

The objective and normalized method gives asset managers a solid basis to support decisions regarding maintenance scenarios or equipment-replacement scenarios. The method is structured by using performance indicators.

Armed with these tools as well as the short-term and long-term profitability and availability targets defined by the Board of Directors, the assets manager has sufficient information to prepare a 10 year asset management plan and to provide a long term vision on all expenditure during the remaining time of the concession.

Zusammenfass

Management von Wasserkraftwerken

ISO 55000 im Dienste eines performanceorientierten Unterhalts

Aufgrund der tiefen Strompreise steht die Wasserkraft seit einigen Jahren unter einem enormen Kostendruck. Um sicherzustellen, dass ihre Produktionsanlagen weiterhin zur Versorgung der ganzen Region sowie zum Betriebsergebnis beitragen, hat Alpiq ein Assetmanagementmodell eingeführt, welches den Lebenszyklus seiner Wasserkraftwerke im Hinblick auf Performance, Kostenkontrolle, Rentabilität und Risiko optimiert. Ebenfalls wichtig ist es, die regulatorischen Vorgaben und Umweltanliegen im Zusammenhang mit dem Kraftwerksbetrieb zu erfüllen und keine Kompromisse bzgl. Sicherheit einzugehen.

Unterstützt durch die Firmen Oxand und Hydro Exploitation SA hat das Unternehmen am 30.3.2015 die Zertifizierung nach ISO 55001:2014 für sein Assetmanagementsystem erhalten. Der Artikel beschreibt diesen Ansatz und insbesondere die Methode der risikobasierten Investitionspriorisierung und Performanceoptimierung, die neu als Grundlage für Investitionsentscheidungen herangezogen wird.

Das Assetmanagementsystem von Alpiq umfasst alle drei Ebenen – strategische Planung, taktische Planung und operativer Betrieb. Insbesondere die strategische Planung hat von der risikobasierten Zustandsbeurteilung und der Alterungsvorhersage stark profitiert, indem sie es erlaubt, die Zustands- und Performanceindikatoren für die Zukunft vorherzusagen und in Beziehung zu verschiedenen Investitionsszenarien zu setzen.

Diese Verknüpfung von technischen und wirtschaftlichen Daten hat den Dialog zwischen Betreibern und Ingenieuren, Assetmanagern und dem Verwaltungsrat viel gehaltvoller gemacht. Entscheide können nun szenarienbasiert gefällt werden, und der Zusammenhang zwischen Investitionskosten, längerfristiger wirtschaftlicher Rentabilität wird nachvollziehbar aufgezeigt. Dies sorgt für eine breite Akzeptanz auch schwieriger Entscheide.

Dank dieser Methode konnten alternative Szenarien gegenüber den bisherigen Unterhaltsplänen identifiziert werden, welche gezielt Einsparungen für die nächsten fünf Jahre ermöglichen, und dennoch den Nettobarwert der einzelnen Anlagen bis Konzessionsende um bis zu 15% gegenüber dem bisherigen Wert erhöhten.

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The innovative nature of the methodology developed is two-fold:

- predictive analytics are generated; these are used to identify the possible positive and negative events which could, in the future, have an impact on the value produced by the hydropower assets

- the risks associated with the various scenarios are quantified; this information significantly enhances the quality of the dialog between asset manager and the Board of Directors. It can be used to set the financial performance and technical performance targets, approved in the budget, with respect to the risk tolerance of the company. Thus, the asset manager is capable to inform the Board of Directors about the global risk to not reach availability target in the light of the financial resources allocated to carry out (or not) interventions on the assets.

Conclusions

The Alpiq asset management system, ISO 55001 certified is the first corner stone to manage hydropower infrastructures in the current market conditions where profitability of hydropower plants is under pressure. The system provides processes that are optimized and applied by stakeholders with clear roles and responsibilities.

The Performance-Based Maintenance planning methodology provides an additional tool to be used in close collaboration with technical expertise and with data about the aging of infrastructure components in order to generate predictive analytics regarding the performance and the risks of the assets. As a result, the Alpiq asset managers, as well as the owners of the hydropower assets have better knowledge regarding the positive and negative events which could, in the future, have an influence on the value produced from their infrastructures.

The progressive deployment of these innovative asset management tools on all hydroelectric infrastructures managed by Alpiq has already led to expenditure reductions over the next five years whilst simultaneously increasing the value produced from the infrastructures during the concession. The ratio between the savings achieved and the costs incurred to acquire these advanced tools is in excess of ten for one. For some infrastructures, Alpiq was able to suggest new maintenance scenarios respecting short-term constraints whilst increasing the NPV on asset life cycle by more than 15%.

References

- [1] ISO 55 000:2014, Asset management -- Overview, principles and terminology
- [2] ISO 55 001:2014, Asset management -- Management systems -- Requirements
- [3] ISO 55 002:2014, Asset management -- Management systems -- Guidelines for the implementation of the ISO 55001
- [4] PAS 55, Asset Management -- Part 1: Specification for the optimized management of physical assets

Authors

Nicolas Rouge, EPFZ Graduate, mechanical engineer, MBA, with EOS/ALPIQ since 1992, current Head of Asset Management Support Department, FMHL (including FMHL + project) Asset Manager, and on the board of several hydroelectric sector companies.

Alpiq Suisse SA, 1001 Lausanne
nicolas.rouge@alpiq.com

Olivier Bernard, EPFL graduate, civil engineering PhD, a founder member of the Oxand group, current Technical Director of the Oxand group. Consultant in the energy and major infrastructure sectors.

Groupe Oxand, 1005 Lausanne
olivier.bernard@oxand.com

By courtesy of the Swiss professional Journal "Bulletin"