Organizational strategies in the hydropower industry

Benchmarking of six major hydropower companies

E-CUBE STRATEGY CONSULTANTS

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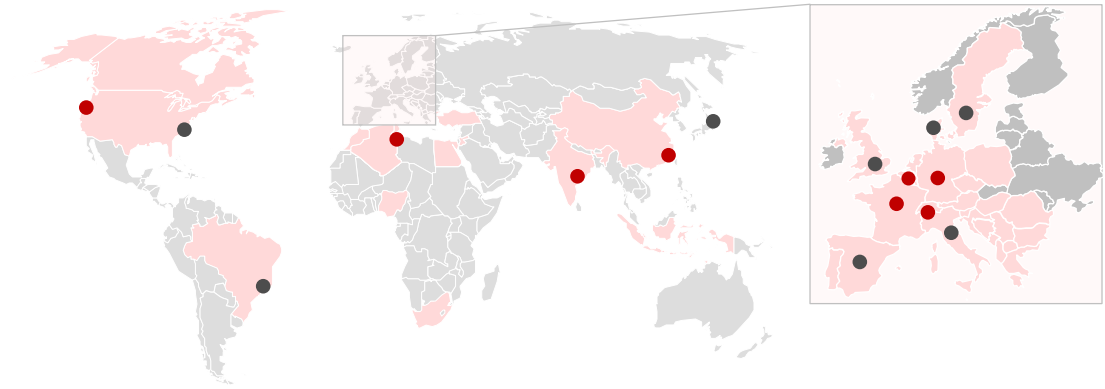

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Organizational strategies in the hydropower industry

Executive Summary

This study provides key insights from a benchmarking exercise conducted by E-CUBE Strategy Consultants with six hydropower producers in Europe (5 companies) and North America (1 company). All of those companies are leaders in their home markets, with capacities between 3 and 50 GW for a total production between 5 and 200 TWh. They are well implanted as major historical actors and some of them develop their activities internationally.

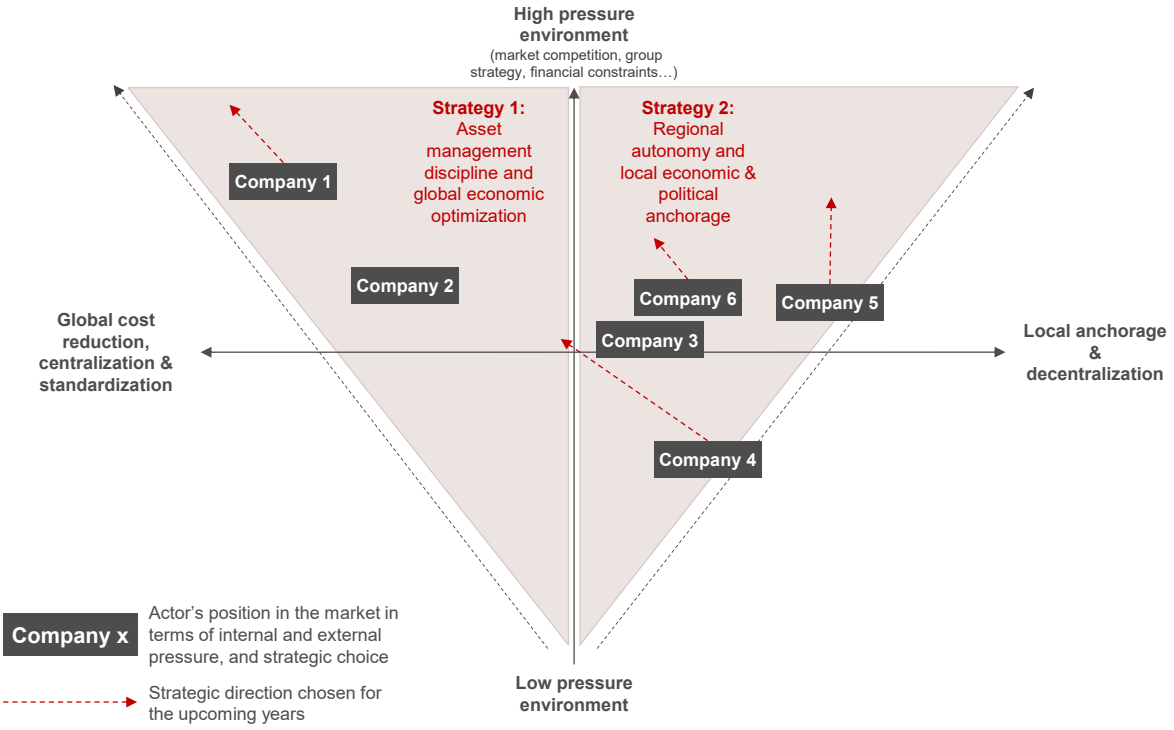
Interviews and organization work were performed with the Executive Boards and Asset Management teams within those companies. Through a thorough analysis of their internal and external environments, their organization chart and processes, as well as their major strategical focus for the future (three companies out of five are in a process of re-organization), a global vision of their organizational and strategic positioning was acquired.

In a context characterized by increasing competition and pressure on costs, two major organizational strategies have clearly emerged as two different answers given to the challenges ahead (*see Figure 1*):

- **"Asset management discipline and global economic optimization" (Strategy 1)**, characterized by a focus on global cost reductions and asset optimization, a centralized organization and highly standardized processes – Company 1 and 2 in the benchmark follow this strategy;
- **"Regional autonomy and local anchorage" (Strategy 2)**, characterized by a focus on local economic and political anchorage and a decentralized organization with major autonomy given to regional entities – Company 3, 4 and 6 follow this strategy to a certain extent, while Company 5 is its most emblematic example.

Given the current market situation and companies' performances, both organizational strategies are legitimate; significant benefits can be derived from each of them, but they also include major drawbacks that need to be tackled. Nevertheless, our analysis suggests that a third way is possible, a best of breed of these two strategies that would allow to be "local" while securing a good performance on asset optimization.

FIGURE 1 - STRATEGIC POSITIONING OF THE SIX BENCHMARKED HYDROPOWER COMPANIES IN EUROPE AND NORTH AMERICA



Introduction

Developed and commercialized since the 1870s, hydropower is the most mature and cost -effective renewable power generation technology and is meant to play a major role in the energy transition. In Europe and North America, the hydropower market has been shaped by a small number of large national industrial companies: mostly public monopolies or private actors operating through concession contracts. Due to the characteristics of the activity (capital intensive, long lead-times for development and construction, public status of rivers) hydropower producers were intended to remain on the local scene for a long time: most concessions were granted for 70 to 90 years or had no time limit.

Many changes have occurred in the hydropower market since the establishment of those first players. In particular, the EU's will to liberalize the electricity market has intensified competition and put an end to the near-monopoly situations. Many concessions and authorization contracts will be coming to an end in Europe in the next 10 to 30 years; significant redistributions could therefore occur in the short term and historical companies will have to compete with others, including international ones. Additionally, electricity market prices follow a persistent downward trend while ageing historical hydropower plants need major investment for refurbishment and rehabilitation, putting pressure on companies' cost structures. In reaction, historical hydropower actors have positioned differently in the market, different "philosophies" leading to different organizational choices.

The benchmarking exercise conducted by E-CUBE Strategy Consultants with six major companies — five located in Europe and one in North America — provides a good overview of the variety of answers given to those challenges.

Those six companies are leaders and key historical actors in their home markets, and most of them also develop their activities internationally. They all have a total capacity between 3 and 50 GW. Their production is between 5 and 200 TWh, and total workforce between 100 and 1,400 FTE. The in-depth analysis of their environment and organization allowed to acquire a global vision of the market's main organizational and strategic options.

One of the key insights from the benchmark is the existence of two major organizational strategies in the market:

The first one places emphasis on the **"Asset management discipline and global economic optimization" (Strategy 1)**, while the second one focuses on regional autonomy and **"Local anchorage" (Strategy 2)**.

The main strategic choices, organizational structures and challenges of those two strategies are summarized in *Figure 2*.

The six producers involved in the exercise all adopted one of those two strategies in a more or less "extreme" way: some remain moderate in their choices while others seem to follow one direction with determination (Companies 1 and 2 for Strategy 1, and 5 for Strategy 2). Moreover, four of them are currently in a process of re-organization, whether it is to reinforce their strategy or on the contrary to moderate it and adopt a more "middle way" position – *see Figure 1*. Those six actors therefore provide a concrete illustration of the market's more general tendencies (*see all the Company profiles in appendix*).

The benchmarking exercise does not highlight one better strategy: all scenarios imply important strengths and challenges; a best of breed of the two strategies still needs to be designed.

FIGURE 2 – SUMMARY OF STRATEGY 1 AND STRATEGY 2' MAIN CHARACTERISTICS

	Strategy 1: "Asset management discipline and global economic optimization"	**Strategy 2:** "Local anchorage"
Strategic positioning and main "business driver"	▪ Economic performance and financial optimization	▪ Anchorage in the local environment (local economy and politics)
"Highest" evidence of success of the strategy	▪ ISO 55 001 certification on asset management	▪ Being recognized as a key local economic actor and intermediary to public actors
Organization centralized/decentralized	▪ Centralized	▪ Decentralized (strong regional autonomy)
Main competencies developed	▪ Development of highly sophisticated Asset Management processes	▪ Development of competencies on the whole hydropower value chain ▪ Development of non-hydropower activities
Role and importance of asset management	▪ Major	▪ Secondary
Asset Management processes	▪ Centralized and standardized, ▪ Risk based maintenance	▪ Decentralized, collaborative, not standardized ▪ Periodic and systematic maintenance
Main risks	▪ Duplicating expertise (complex interfaces) ▪ Losing core competencies	▪ Duplicating teams ▪ Losing competitiveness along the value chain
Main challenges in a competing environment	▪ Remain connected to territories and adaptable to local specificities	▪ Avoid "uberization" by more efficient competitors

Strategy 1: « Asset management discipline and global economic optimization »

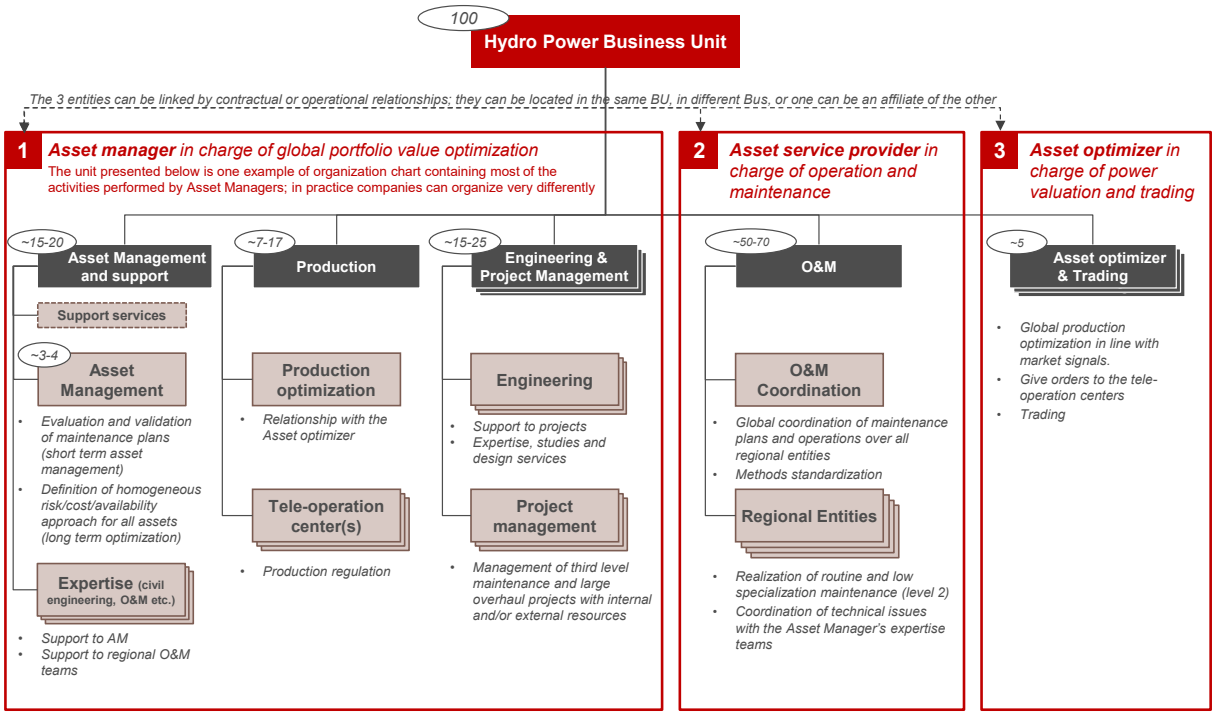
Strategic positioning and main "business drivers"

This organizational strategy values economic performance on hydropower assets. Driven by an increasing pressure on costs, notably due to low market prices but also in some cases to important investment needs (for ageing infrastructures), this organization tries to rationalize and reduce costs in order to maintain the asset portfolio value. Economic performance is also seen as a decisive advantage to renew ending concessions.

To reach a maximum degree of rationalization of both CAPEX and OPEX expenses, companies seek global asset optimization through strong asset management processes. The most "advanced" in this strategy would typically have (or be eligible to) an ISO 55 001 certification on asset management.

FIGURE 3 – TYPICAL ORGANIZATION DESIGNED FOR "ASSET MANAGEMENT DISCIPLINE AND GLOBAL ECONOMIC OPTIMIZATION" [1)]

With ETP on an Index Basis with 100 = total workforce in the Hydro Power BU



Legend:

100 Workforce in Full-Time Equivalent, with Index Basis 100 = total workforce in the Hydropower BU

1) This is a generic chart representing the major components of an archetypal organization; number and names of entities, as well as hierarchy links can vary from one company to another.

Main organizational characteristics

The typical organization chart of companies driven by economic performance include the following characteristics (*see Figure 3*):

The organization is structured around three pillars:

- The asset manager, in charge of global portfolio value optimization - *Figure 3* 1
- The asset service provider in charge of operation and maintenance - *Figure 3* 2
- The asset optimizer in charge of power valuation and trading - *Figure 3* 3

Those three pillars are translated into three separate entities, globally independent from one another, and sometimes governed by contractual relationships with internal invoicing flows. The asset manager leads the company's efforts to evolve from a fully preventive maintenance strategy towards more optimization between maintenance costs, availability and risks.

The organization is globally centralized: the workforce in regional entities is limited, mostly composed of technical staff performing routine and low specialization maintenance, and of a few experts and operations' coordinators. The Asset Manager centralizes all the maintenance

planning and budget decision-making power.

Major developed competencies

In this "old industry", implanting such a model represents a significant change: the organization and processes must be largely reviewed. Those changes are sometimes endorsed by an ISO 55 001 certification. This norm on asset management, applicable to all industries, can be a real driver of change in the hydropower sector. Obtaining it can also bring a significant competitive advantage in tenders for concessions as it provides an objective indicator of the company's good economic performance on its assets.

A key stage of process changes towards economic performance would be achieving global asset optimization. This requires a detailed condition monitoring of the plant and dam's components (Typically more than 30 types of components, not to mention sub-components – *see example of condition monitoring tools in Figure 4)*, detailed risk analysis (several per components, each defined by safety, outage and corrective maintenance costs consequences) and an analysis of the impacts of the resulting risk matrix on maintenance actions (- *see example of a risk matrix in Figure 5)*. Most advanced players are considering the impact on routine maintenance actions (e.g. frequency of visual controls, oiling, etc.) on this risk matrix. To date, no benchmarked company reached this level on all its hydropower assets. The key steps of a risk-based maintenance process are summarized in *Figure 6*.

This asset management processing is initiated in the company by the asset manager; yet it has a strong impact on the asset service provider (in charge of O&M) which encompasses most of the needed expertise, data and levers. It requires a homogeneous CMMS, a renewed mobilization of expertise notably on risk analysis (e.g. structured operational feedbacks, ageing curves, etc.), condition monitoring, best-of-class operational excellence and an overall capacity to differentiate maintenance strategies between assets.

It also affects the asset optimizer (trader) as it requires long term visibility (up to 10 years) on specific market dynamics (peak and off-peak energy values, capacity market values, ancillary services values) in order to link it with maintenance investments resulting in different asset capabilities or availability. Short term optimization with the operator (e.g. maintenance outage positioning) is necessary as well.

FIGURE 4 – ILLUSTRATION OF A CONDITION MONITORING TOOL: CARTOGRAPHY OF ALL DAMS AD PLANTS COMPONENTS AND EVALUATION OF THEIR CONDITION

CARTOGRAPHY OF ALL COMPONENTS (IN PLANT, PUMPING STATIONS, RESERVOIRS ETC.)

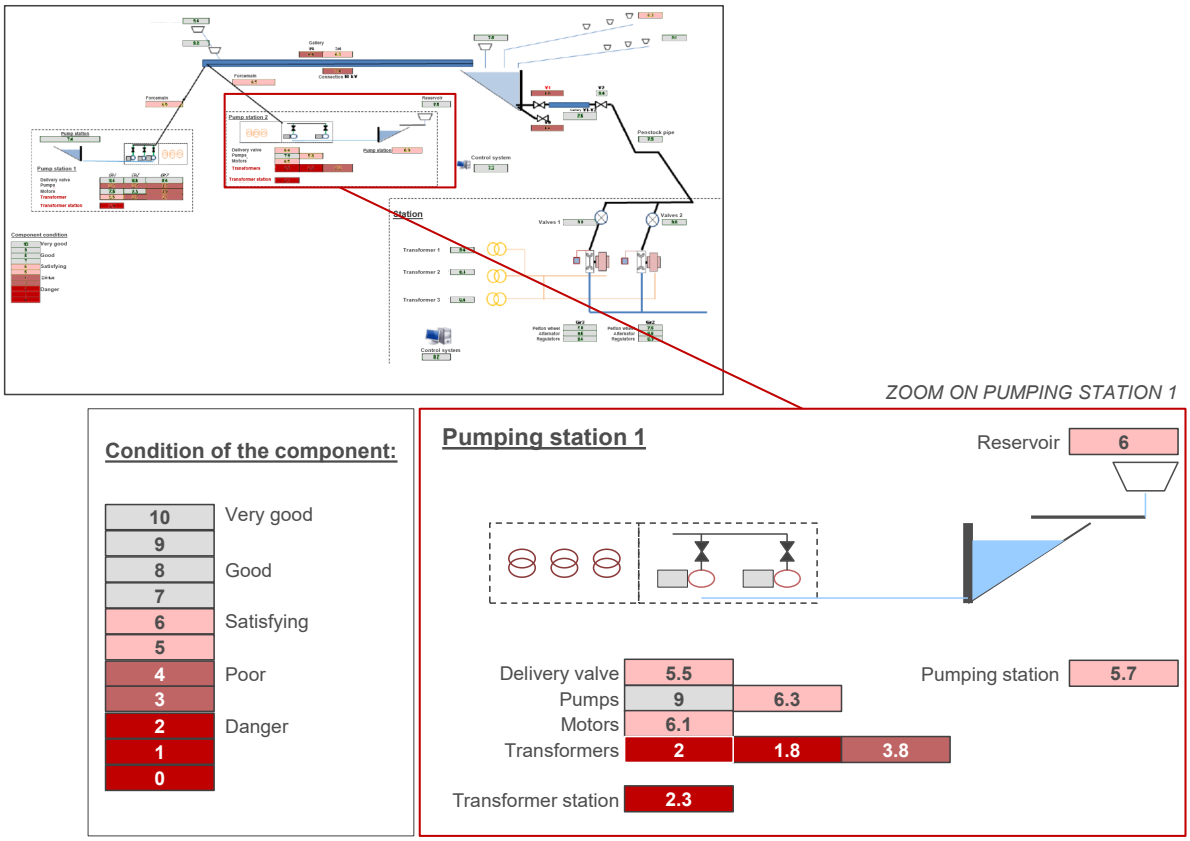


FIGURE 5 – ILLUSTRATION OF A RISK MATRIX ON RISKS ASSOCIATED WITH COMPONENTS OF A PELTON TURBINE

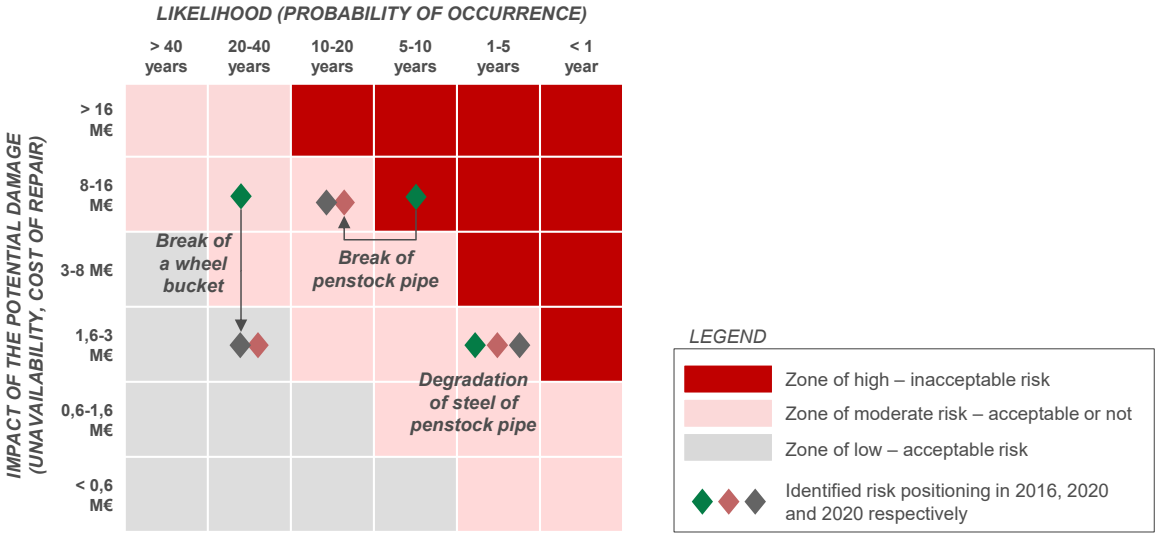
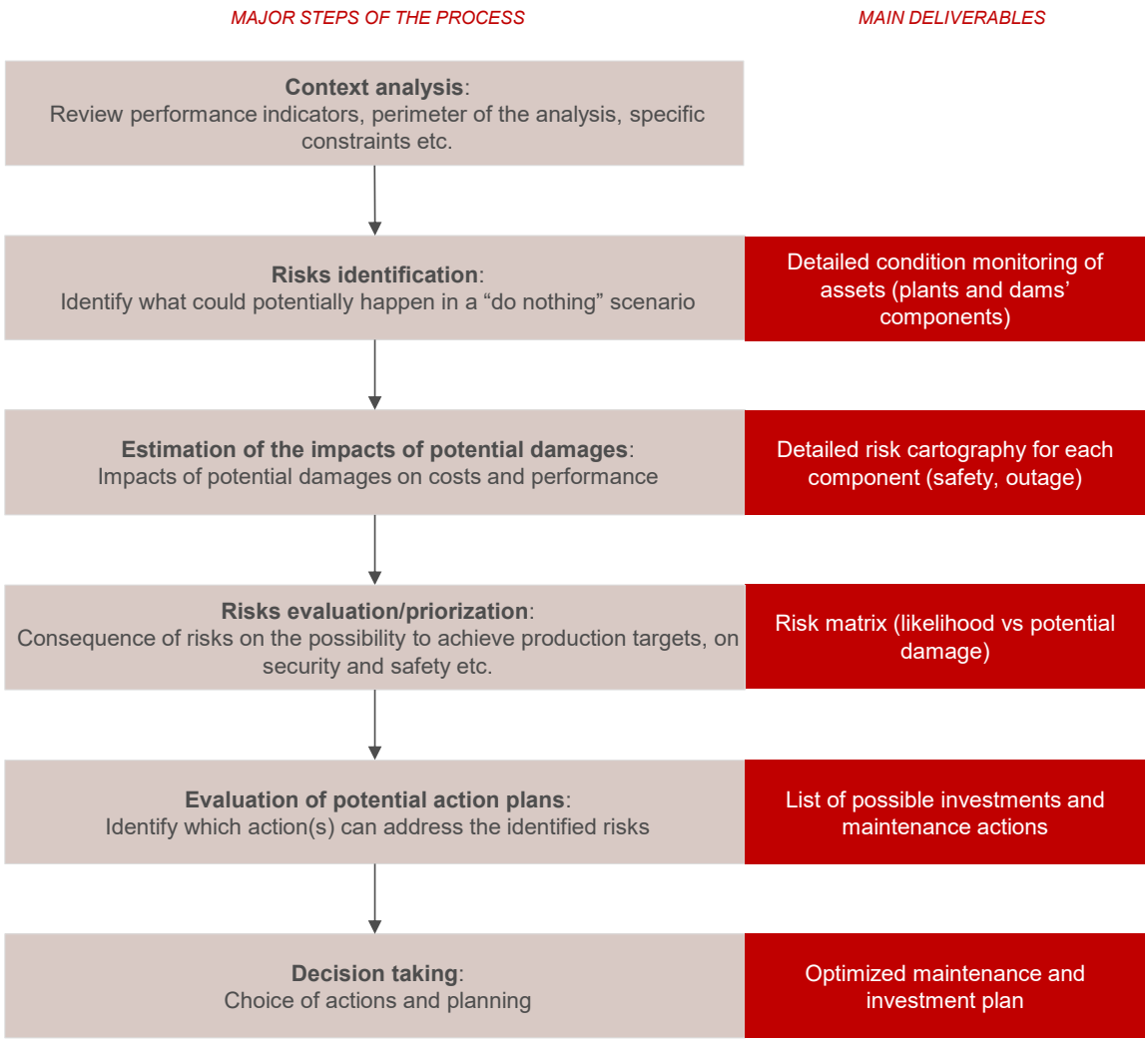


FIGURE 6 – MAJOR STEPS OF A RISK-BASED MAINTENANCE PROCESS



Main risks and challenges

The transition to such a model is complex and requires an alignment between strategical, tactical and operational goals in an industry with an important inertia.

But beyond that, companies focused on the economic performance of their assets need to cope with several challenges. Firstly, they must avoid duplicating expertise in the three different "pillars" of their organization, and avoid "on-line losses" due to complex interfaces. Secondly, they need to maintain competences and skills while optimizing costs; in particular they must be careful about not being too dependent on outsourcing and external actors on core competencies. Finally, they must continue to value their "local anchorage", remain connected to territories and adaptable to local specificities as far as possible. Indeed, being an actor of the local economy and an influential intermediary in the local political scene are valuable assets for a hydropower company, especially in a context of concessions' renewal and international competition.

Strategy 2: « Local Anchorage »

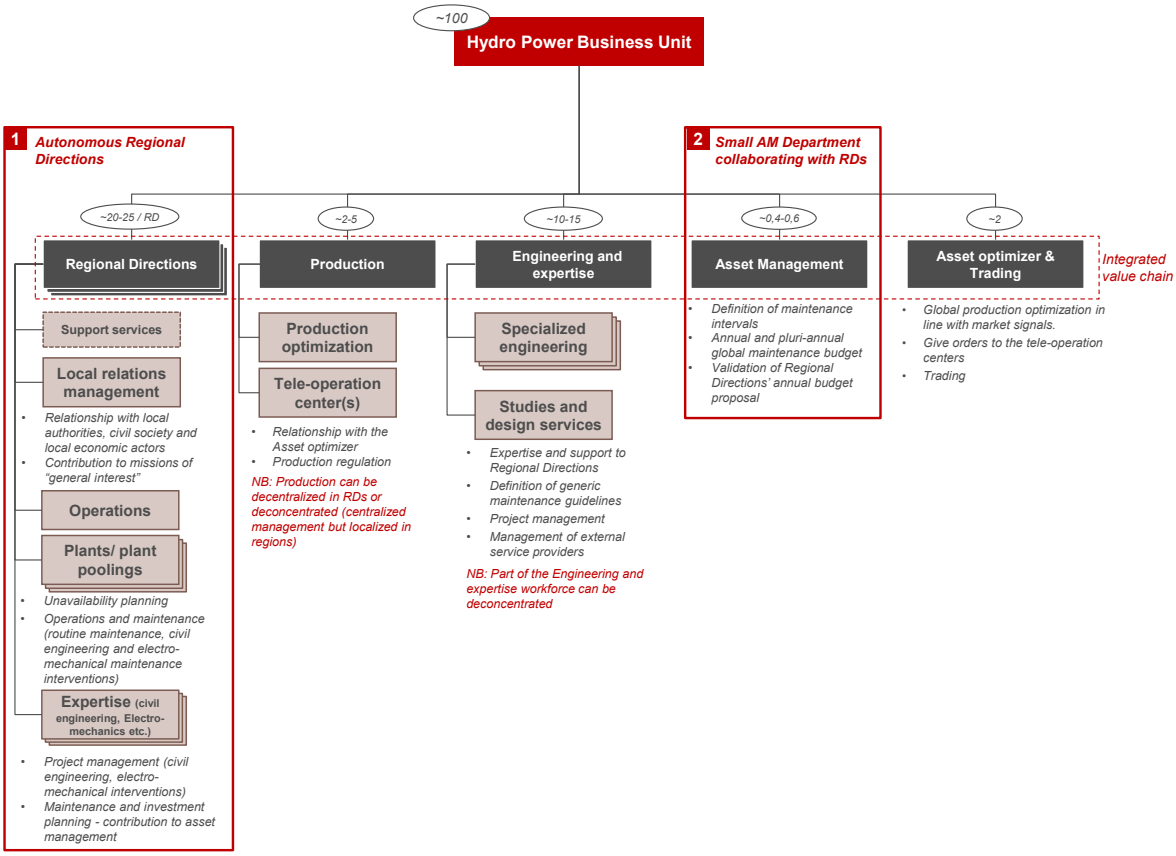
Strategic positioning and main "business drivers"

This organizational strategy is driven by the idea that the hydropower industry is in essence closely connected to territories; it is dedicated to promoting the local anchorage of the company. Its main goal is therefore to be recognized in its areas of operation as a key local economic actor and a major intermediary for public entities.

This strategy is a key lever to reinforce concessions renewal negotiation positions and lobbying capabilities; it also facilitates synergies between hydropower and the local economy (environment, irrigation, navigation, etc.)

FIGURE 7 – TYPICAL ORGANIZATION DESIGNED FOR "LOCAL ANCHORAGE" 1)

With ETP on an Index Basis with 100 = total workforce in the Hydro Power BU



Legend:

(100) Workforce in Full-Time Equivalent, with Index Basis 100 = total workforce in the Hydropower BU

1) This is a generic chart representing the major components of an archetypal organization; number and names of entities, as well as hierarchy links can vary from one company to another.

Main organizational characteristics

The organization is characterized by its strong decentralization. The local or regional entities are largely autonomous in both strategy and means, in order to remain respected and valuable counterparts for local authorities - *Figure 7* 1 This autonomy is twofold:

- Local or regional entities have a large degree of autonomy and an important workforce to manage the hydropower activity. They usually cope with a large perimeter of activities and responsibilities, including in expertise and project management; they perform all routine maintenance but also a large share of specialized maintenance. The total workforce is therefore important, to adapt to those needs. Moreover, those entities are largely autonomous regarding budget management and maintenance plans.
- Apart from core hydropower activities, regional or local entities also have a large degree of responsibility and autonomy on other activities focused on developing the company's local anchorage. Indeed, they are the best intermediary for public local actors for any issue concerning river management (navigation, dams etc.). Through employment and relationships with local contractors they can become major players of the economic scene as well.

As a consequence of regional autonomy, companies following the "local anchorage" strategy usually do not have a strong Asset Management entity at the top of the hierarchy. Asset management is more a collaborative process between the company's central head office and each local entity; if a central Asset Management Direction exists, it is not very prescriptive and plays an overall role of coordination and advice (as shown by the position of this Department within the organization chart, often at the same hierarchical level as Regional Directions) – *Figure 7* 2

Major developed competencies

In companies following the "local anchorage" strategy to an "extreme" point, several tens of millions of euros can be invested yearly in the launch of non-economic programs on a large scale. The goal of those programs is to reinforce the company's influence and anchorage in its local environment. Investments include a certain number of actions "around rivers and hydropower" (small hydropower stations, fish passes etc.), but can also answer to more general territory and land-use development issues – *Figure 8*.

As a consequence, players following this strategy generally expand the reach of their activities far beyond hydropower, including wind power and photovoltaic development, or prospective businesses like electric or hydrogen vehicles.

A key success factor is that those activities remain relatively close to standard hydropower operations: same point of contact with local authorities; shared engineering skills; shared O&M teams. Yet, specific competencies in those various activities must be developed by all regional and central departments. This model generally exhibits an upstream / downstream integration resulting in a stimulated cooperation between operations and trading activities, and an undeniable agility on short term arbitrages.

FIGURE 8 - EXAMPLE OF A "LOCAL ANCHORAGE DEVELOPMENT" INVESTMENT PLAN

- *Duration: 5 years*
- *Total Budget: ~150 M€ (30 to 45 M€ invested in each area described below)*
- *Selection of actions through concertation between the company, political and economic local actors and civil society representatives.*
- *Main areas of activities and example of actions:*

  - Energy and sustainable mobility: construction of small hydropower plants, development of a network of charging stations for electric vehicles.

  - Biodiversity and water resources: construction of fish passes on the river, support to environmental associations, investment in research and partnerships for agricultural innovations.

  - Tourism and economic development: construction of bicycle paths and recreational centers, support to cultural initiatives, organization of touristic visits of hydropower installations.

  - River transportation: development of harbors and navigation services

Main risks and challenges

Companies endorsing such strategical choices encounter several challenges. Firstly, standardization of maintenance processes and monitoring is complicated by regional autonomy and there is a risk of duplicating teams between central and regional entities. Secondly, the choice to keep all "in-house" competencies makes it more difficult to remain a leader on each activity of the value chain; a lot of effort and organization is necessary to remain competitive and adapt to fast moving environments in the core business (hydropower) as well as in new activities (meteorological and hydraulic forecasting, new renewable energies etc.) Finally, companies focused on local anchorage can lose their capacity to remain in contact with external markets, and to compete on the international scene.

More generally, the "local anchorage" strategy does not facilitate economic performance (as it requires to converge towards a global optimum, as opposed to several local optimums). Global economic performance must nevertheless remain a goal for those companies. Indeed, it is essential in a context of downward market prices and concession renewals. Moreover, non-performant companies take the risk of losing their position through an "uberization" phenomenon (when a more competitive and dynamic actor suddenly overthrows the historical actor that has not made the effort to adapt to its new environment).

Appendix — Results of the benchmark

Company 1

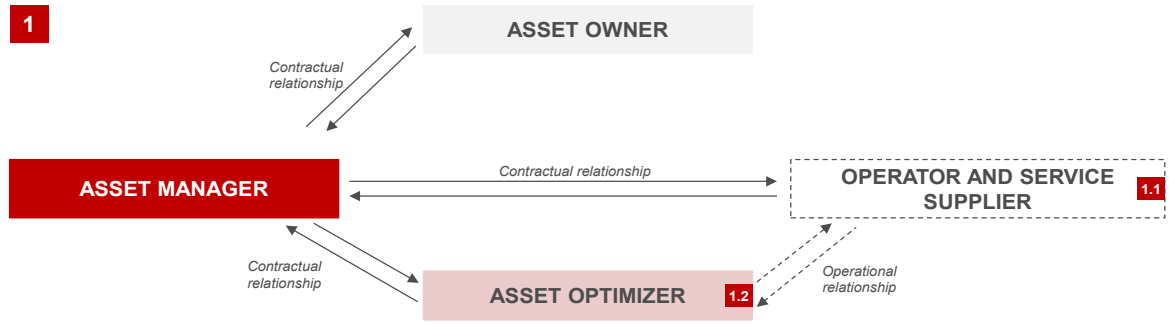
Context and company profile

Company 1 is an electricity and energy services provider (energy production, trading and sales) with installed power plant capacity over 3 GW.

Hydropower production is organized within a Hydropower unit composed of ~100 collaborators. Its perimeter covers 20 to 50 plants for an annual production of ~5 to 10 TWh. Company 1 has an affiliate specifically in charge of operating and maintaining hydropower plants (owned by different companies) in the country. This affiliate operates 20 to 50 plants with ~500-1,000 collaborators.

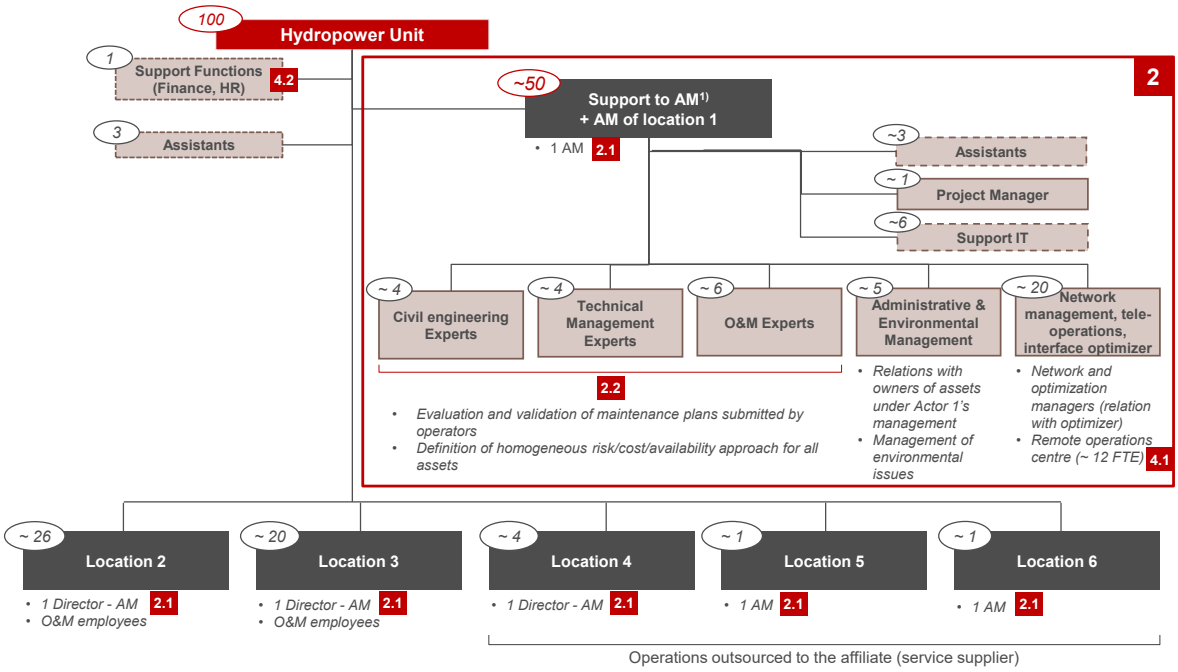
Company 1's assets are under concession contracts (mostly awarded for a duration of 50 to 80 years), and some of the major ones will expire within the next 20 to 30 years. Company 1's strategy is partly influenced by the necessity to obtain the renewal of its major concessions and the opportunity to acquire new concessions in its country or internationally.

ORGANISATION OF RELATIONSHIPS BETWEEN THE ASSET MANAGER, OPERATOR AND ASSET OPTIMIZER



ORGANIZATION CHART OF COMPANY 1

With ETP on an Index Basis with 100 = total workforce in the Hydro Power BU



Legend:

(100) Workforce in Full-Time Equivalent, with Index Basis 100 = total workforce in the Hydropower BU

1) Asset Management (AM)

Organization and processes

Amongst the 5 benchmarked companies, **Company 1 is the one that has the most focused its strategy on financial optimization and cost efficiency**. Organizational choices and processes illustrate this choice.

1 Company 1 has chosen to demerge business lines: O&M is outsourced to its affiliate for most of its assets – **1.1** while asset optimizer, trading and sales are centralized in another Department dedicated to Commerce and Trading – **1.2** . Asset Management therefore remains the only core business of the Hydropower unit. This organization is focused on optimization and competitiveness. Each entity has a specific objective: operational cost optimization for the service supplier, asset valuation on the market for the asset optimizer, global portfolio value for the asset manager. The latter has a leading position which creates a strong drive towards economical optimization.

This organizational choice creates three challenges: firstly, interface between stakeholders are complex, even more complicated by a misalignment between the long term vision of the asset manager, and a shorter term vision of the operator; secondly, there is a need for "controllers" within the "Support to AM" unit (~13 FTE[1)] - on an index basis 100), creating risks of duplicating certain functions and of blurring perimeters of responsibilities; finally, the global optimum may not be the sum of three specific optimums (cost reduction impact on HR core competencies and skills; maintenance impact on long term market valuation opportunities).

2 A whole unit of ~50 collaborators (on an index basis 100)– which represents nearly half of the unit's workforce – is dedicated to "Support to Asset Management". Additionally, 6 asset managers are specifically in charge of each group of assets (Location 1 to 6) – **2.1** . Support to Asset Management includes a team of experts (~14 FTE - on an index basis 100) in charge of evaluating and validating the maintenance plans submitted by operators (including the affiliate), and of defining a homogeneous risk/cost/availability approach for all assets **2.2**

3 Beyond the number of dedicated resources, Company 1 has reached high quality AM processes in all its activities (planning, operations, performance evaluation etc.) It has been a forerunner in the development of a "risk-based maintenance strategy", aiming at prioritizing maintenance resources toward assets that carry the most risk and highest consequence of failure. Following the principles of the British norm BSI-PAS55 as early as 2007-2008, Company 1 was one of the first European power companies to obtain the ISO 55001 certification on Asset Management. Those processes have allowed continuous cost reduction (for both OPEX and CAPEX) and a better alignment of decisions with assets owners.

4 Following a cost-reduction goal, both Company 1 and its affiliate look for resources optimization. The tele-operations Centre allows remote operation of plants with only 12 FTE (on an index basis 100) - **4.1** Support functions are limited and mutualized - **4.2** The affiliate's operational staff is also mutualized amongst several plants.

5 Company 1 has identified two main areas of progress for the upcoming years: developing more flexibility of operational staff, and reinforcing data acquisition and analysis (through tools such as CMMS) to improve Condition Monitoring. Its affiliate, in parallel, aims at developing conditioned-based maintenance (introducing a differentiation in maintenance plans based on a risk and obsolescence analysis of structures. **Company 1's position is therefore to keep and reinforce its initial strategy of global economic optimization.**

6 With this strategy in favor of AM and cost optimization Company 1 is positioning its offer as a particularly efficient and competitive one for concessions' renewal. However, centralization, business separation and resource optimization also have the consequence of disconnecting the company from its "local environment"; this lack of local anchorage could be costly in the concessions' renewal process. Indeed, at the end of concession contracts the public owner can exercise a right of return and decide to renew the concession (with the previous company, or a new one), to operate the plant by itself or a mix of the two solutions above. Lobbying power and recognition as a major local actor can therefore be a major asset in the process.

1) All FTE numbers in this study are given on an Index Basis 100 = total workforce of the Hydro Power Business Unit

Company 2

Context and company profile

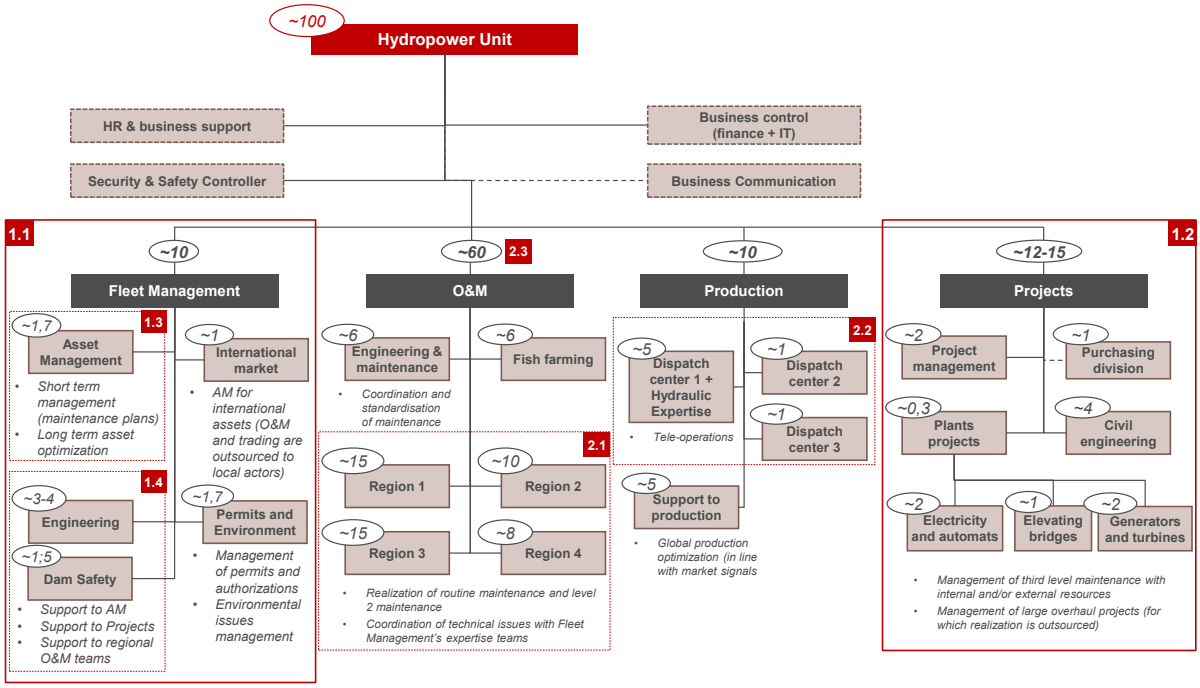
Company 2 is a public company, operating hydropower assets under concession contracts which were mostly granted in the 1980s and have no time limits.

Some environmental obligations were added to contracts at the end of the 1990s (such as the construction of fish passes) to comply with new legal requirements. Concessionaires can also be in charge of bridges and fisheries' maintenance.

Hydropower generation activity is located within a dedicated Business Unit (BU). It accounts for ~500-1,000 employees and manages more than 50 power plants, as well as other assets for a total capacity over 3 GW nationally and internationally. Annual production is over 30 TWh, and all of it is sold to deregulated commodity market.

ORGANIZATION CHART OF COMPANY 2

With ETP on an Index Basis with 100 = total workforce in the Hydro Power BU



Legend:

(100) Workforce in Full-Time Equivalent, with Index Basis 100 = total workforce in the Hydropower BU

Organization and processes

1 Company 2 has made a clear strategic choice towards cost (and profit) optimization. This has led to the separation of the O&M and expertise functions at the end of the 90's (with the creation of an affiliate O&M company offering its services to Company 2 and other hydropower producers) to optimize each activity separately. The O&M part was insourced again several years later.

One result of this move was the centralization of all expertise resources, which has led to the later creation of the asset management function. In the new organization, most expertise resources are located in the Fleet Management Department– 1.1 and the Project Department – 1.2 . The latter, organized by expertise, centralizes all project management activities: third level maintenance and big overhaul projects (~12-15 FTE on an index basis 100).

Company 2 has organized its Hydropower Unit in a way that clearly shows the importance of asset management: it is located in a dedicated department, which is one of the core pillars of the organization. Indeed, the Fleet Management department represents ~10 FTE on an index basis 100 (10% of the BU's total workforce), including ~1.7 FTE in the Asset Management unit, with full time asset managers (half in charge of short term issues, particularly maintenance coordination, and half in charge of the longer term vision) – 1.3

Two expertise units (respectively ~3 FTE for engineering and ~1.5 FTE for Dam Safety - on an index basis 100) 1.4 are also centralized in this department in support of asset management (those units can support O&M and Projects departments as well)

Company 2's main strategic objectives for the upcoming years are directed towards more cost optimization; reinforcing Asset Management processes is therefore identified as a priority. Indeed, the asset management function was created recently in 2008-2009 and is still under development. The company is now studying the opportunity to get the ISO 55001 certification, which requires, among other conditions, to develop conditional maintenance. At the same time, two years after the re-integration of the O&M function (due to lack of competitive market dynamics), the company is pursuing harmonization of maintenance intervention processes between regions and better collaboration between O&M and AM.

2 Rationalization of resources is part of Company 2's strategy. In the O&M department, the workforce is mutualized and works through regional pooling; coordination is ensured by a regional office – 2.1 . Tele-operations being generalized in the company (through three dispatch centers of 1 to 5 FTE -on an index basis 100- in the Production department), most plants work without employees 2.2 The O&M department now works with ~60 FTE (on an index basis 100) which is nearly half of the number of collaborators at the end of the 1990s (including some expertise resources that are now centralized) – 2.3

Given its rationalization logic to limit internal resources, Company 2 makes use of outsourcing in engineering, project management (projects >1M€ are outsourced) and maintenance. Outsourcing represents an annual cost of ~10M€. Beyond cost, this situation could put core competencies' durability at risk.

3 Within Company 2's Group, two different BUs are in charge of power trading (the "Market" Unit) and of asset management and operations (the "Hydropower" Unit). This might not be totally efficient on an asset value point of view (market value tends to be prioritized over assets value by the optimizer). The three dispatch centers in the Production division receive directly orders from the trading center.

Company 3

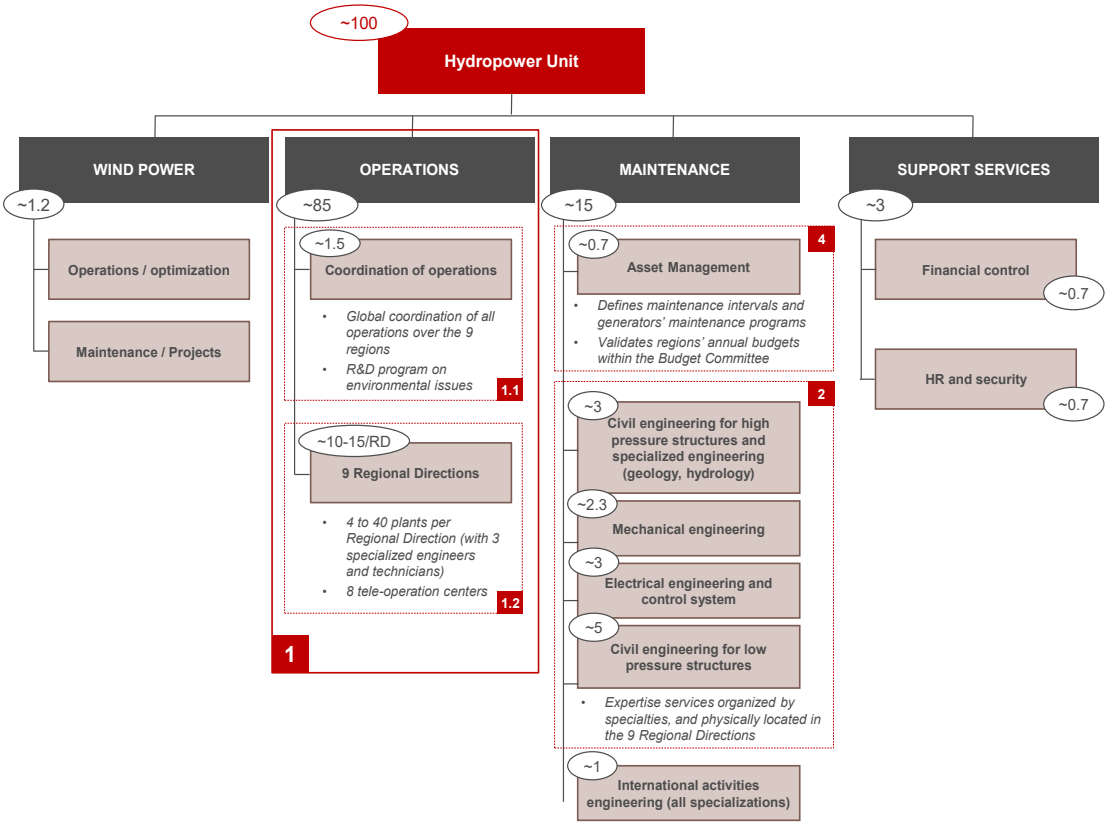
Context and company profile

Company 3 is an international hydropower producer. In its home country, it operates assets under licenses granted for an average duration of 25 to 75 years, and no competitive procedure for new concessions or concession renewals is provided in the national legislation, which provides for environmental obligations to hydropower operators, but no other investment obligations.

With over 1,000 collaborators, Company 3 manages more than 50 plants for a total installed capacity over 3 GW and an annual production of 10-30 TWh. A wind power unit (~1.2 FTE) was added in 2014, but remained very independent from other units.

ORGANIZATION CHART OF COMPANY 3

With ETP on an Index Basis with 100 = total workforce in the Hydro Power BU



Legend:
(100) Workforce in Full-Time Equivalent, with Index Basis 100 = total workforce in the Hydropower BU

Organization and processes

Amongst the two strategic "paths" followed by hydropower actors, **Company 3 has made the choice to rely more on regional autonomy and "in-house" competencies**. Its organization chart and processes reflect this choice.

1 Company 3 Operations' BU has an important workforce of ~85 FTE (on an index basis 100), most of which are located within the nine Regional Directions (only ~ 1.5 FTE are in a centralized unit called "coordination of operations", in charge of optimizing production at a global level by coordinating regional O&M actions **1.1**

The Regional Directions – **1.2** – have important means: each of them has three dedicated engineers for routine maintenance (one for civil engineering, one for mechanics and one for electricity and control systems), and teams of technicians. The company has eight tele-operation centers located in regions (nearly one per region). Regions receive operations' instructions directly from another affiliate of the Group in

charge of energy trading).

2 The Maintenance BU has substantial expertise resources which are centrally managed but physically located in regions: four engineering services of 2 to 5 engineers organized by specialties (on an index basis 100). Employees of each service are distributed amongst the regions, and intervene in support of regional teams.

3 Beyond the organization chart, some processes also illustrate the important regional autonomy in Company 3. Firstly, resource pooling for maintenance staff is not a rule of the company: the decision to mutualize or not is left to the appreciation of each region. Secondly, regions are relatively autonomous regarding budget and maintenance planning: they define maintenance plans themselves with few instructions from the Asset Management unit (which limits its role to defining maintenance intervals and arbitrating purchases over 30,000€), and they submit their own budget proposals to a Budget Committee. Finally, project management for projects up to 25 M€ is decentralized in the regions.

4 In alignment with the "local autonomy" strategy, a centralized Asset Management function exists but remains secondary in the organization. Asset management is not a core department in itself but is located within the Maintenance department with <1 FTE (on an index basis 100). This unit has restricted responsibilities and action perimeter: it defines maintenance intervals and generators' maintenance programs, and participates (along with the Operations and Financial control Directors) to the Budget Committee in charge of validating annual budgets proposed by regions.

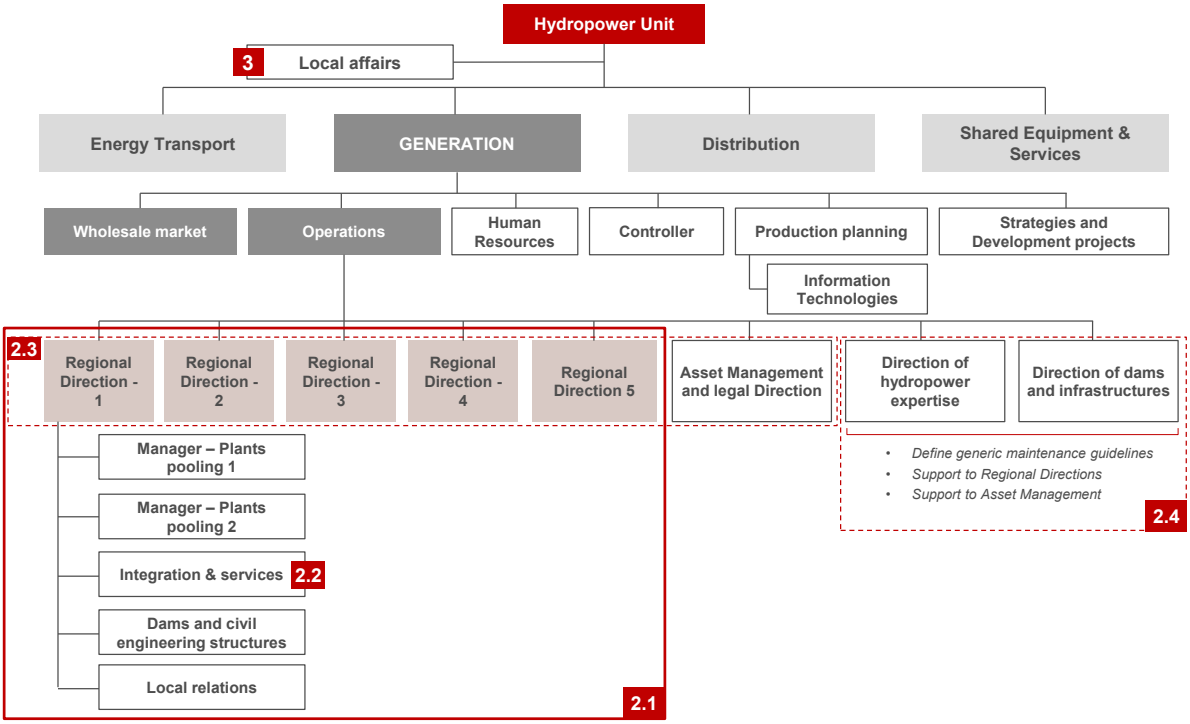
Conditional maintenance processes and tools are not implemented in the company and the ISO 55001 certification is not studied. Time intervals between interventions is the main criteria taken into account to optimize maintenance plans (new rules are defined based on an empirical approach).

Company 4

Context and company profile

Company 4's installed capacity is over 10 GW, for an annual production over 30 TWh. It manages more than 50 plants, and its portfolio is still in development.

As a State-owned utility, Company 4's mission is defined by law. The Generation division has the obligation to deliver a certain amount of production to the domestic market at a fixed price; the company also exports energy to neighboring territories at market prices.



Organization and processes

The company is divided into four main operational divisions. The Generation division operates all on-grid hydropower plants.

1 **One of the main characteristics of Company 4's organization is the scope of responsibilities and autonomy given to regional offices**. This situation can be explained by several factors, among which are the size of the territory covered and distance between plants. Yet, in a context of increasing financial pressure (important amounts of investments will be necessary in the upcoming years for refurbishment and rehabilitation of aging infrastructure, and to meet expansion targets), the company is reinforcing centralized and standardized asset management decision processes.

2 The company's operating organization is based on five large regions with important financial and human resources, and relative autonomy in O&M - 2.1 .

In terms of investment plans, regions have the decision-making power, but large capital investment projects must be approved by the VP, Division president, CEO or Board depending on the project value. Each of them negotiates its own maintenance budget annually with the VP in charge of Operations.

"Integration & Services" units within each Region – 2.2 – are in charge of annual technical evaluation of their installations; those evaluations are then centralized and used by the Asset Management division to evaluate the state of the production fleet globally.

When projects of > 2M€ are initiated, a Project

Charter must be completed. The corporate expertise directions must be consulted during this process in order to ensure that the best technical decisions are made. Asset management is therefore a collaborative process between Regions and the corporate directions, with a final decision left to the management of the Region. The location of the corporate expertise directions at the same level as Regional Directions illustrates this situation – 2.3 .

In terms of maintenance processes: two centralized expertise departments (one focused on civil engineering and security, and the other on mechanics, electricity and control systems) – positioned at the same hierarchical level as the regions – are in charge of defining guidelines for annual maintenance processes - 2.4 .

Environmental processes, including for pollution control equipment, fall under the asset management direction. But regions then have the responsibility of declining those guidelines into proper actions according to each installation's specificity.

3 One of the company's obligations as a state -owned utility is to dedicate time and resources to relations with local populations. This mission is ensured by regional staff and reinforces the company's local anchorage. To deal with increasing needs for standardized and homogeneous practices, the creation of a central department has been decided: most regional staff working in this sector are now attached to this department.

Company 5

Context and company profile

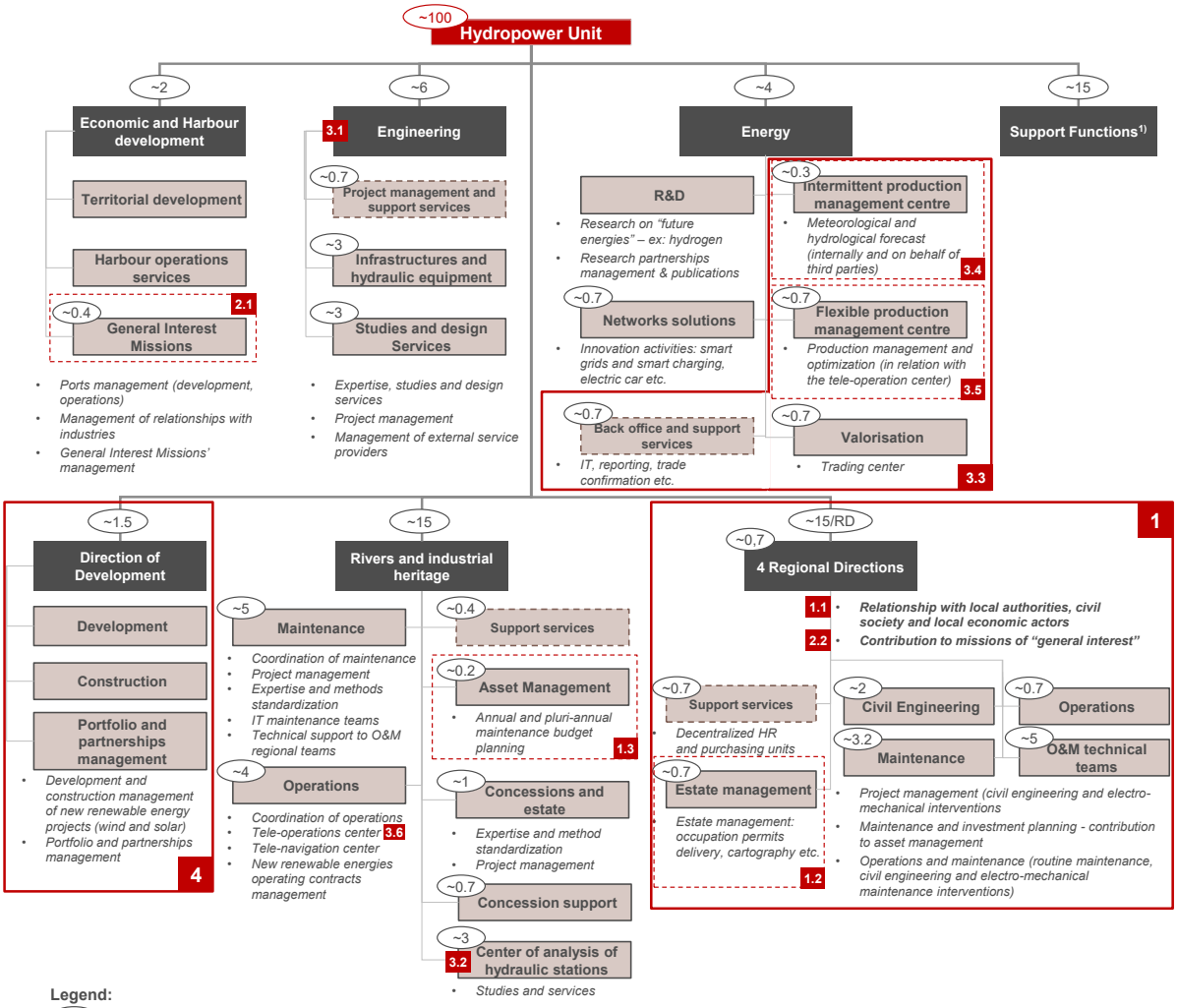
Company 5 operates over 50 plants and dams for a total capacity over 3 GW, with over 1,000 collaborators. The average annual production is 10-30 TWh.

Its plants are under concession contracts that were granted for an average duration of 50 to 75 years, many of which will expire in the next 10 to 20 years. Competition conditions are still uncertain in the country, with a moving legal framework.

Company 5 also operates wind and solar assets (wind farms – ~350 to 400 MW, and solar farms – ~25 to 50 MWp). In addition to power generation activities, Company 5 is in charge of projects of public interest in the field of river transportation and harbor management.

ORGANIZATION CHART OF COMPANY 5

With ETP on an Index Basis with 100 = total workforce in the Hydro Power BU



Legend:

(100) Workforce in Full-Time Equivalent, with Index Basis 100 = total workforce in the Hydropower BU

1) HR, IT, Risks, Legal, Communication, Financial services, Infrastructure and Logistic, Middle Office…

Organization and processes

Amongst all hydropower actors, Company 5 has developed a very specific strategy focused on territories and local anchorage, but also based on an integrated model keeping strong in-house competencies. Indeed, the company has its own development model, based on the idea of redistributing to local territories the wealth produced by the river. Following this idea, the company calls itself a "territory developer and planner". Many of its strategic and organizational characteristics are designed to address the needs of territories.

1 Company 5 is decentralized: Regional Directions (RD) being the center of the development model, close to the field and to local actors, they benefit from a large perimeter of responsibilities and an important degree of autonomy. They also have an important workforce >15 FTE/RD on average (on an index basis 100); the four RDs therefore represent 60% of the company's total workforce.

The size of the workforce is also explained by the fact that RDs are in charge of a larger perimeter of activities than in most hydropower companies. Regional Directors hold the operator's liability (and are therefore responsible for production and availability of installations, security and safety), and the perimeter of "classic" hydropower activities is particularly large: O&M, project management, expertise services, as well as a high degree of autonomy concerning local asset management, maintenance and investment budget and planning. In addition to those activities, RDs have several other responsibilities:

- They are the company's main intermediaries for local economic and political actors, and their local representatives (this mission is specified in the RDs' organization notes) **1.1** The Directors and assistant Directors (one focused on industrial issues and the other on local public relations), as well as managers in charge of each RD's unit (Civil Engineering, Land Management, Operations etc.), share the various responsibilities of external representation of the company.
- RDs also have specific Estate Management units in charge of managing the public domain (granted under the concession contract) and the company's own patrimony – **1.2** . Employees in this unit are in charge of keeping a cartography of the domain up to date, valorizing the domain, granting occupation permits and authorizations, and representing the company in all land management issues. This activity, specific to Company 5 (due to the concession contract), contributes to its regional strength.
- RDs play an important role in "general interest missions" which are at the heart of the development model (detailed below in paragraph 2).

In alignment with this "local autonomy" strategy, the asset management function is secondary in the organization. Only 3 employees (on an index basis 100) are fully dedicated to this activity within an Asset Management unit, in charge of defining pluri-annual maintenance plans, validating RD's planning and budget proposals and coordinating projects – **1.3** . Conditioned based maintenance is not yet developed within the company.

2 Company 5's concessionaire obligations include some missions of public interest such as harbor management and valorization of the public domain, irrigation and navigation. But the development model goes much beyond those obligations. Since 2004, nearly 300 M€ were dedicated to over 500 actions within the framework of general interest missions. Those actions cover various topics including energy, mobility, biodiversity or economic and tourism development. In the next 5 years, the company is committed to dedicating ~160 M€ for those activities.

Within the organization, a specific team of ~0.4 FTE (on an index basis 100) is fully dedicated to the coordination of those missions within the Economic and Harbor Development Direction - **2.1** But the integrated model implies that all Directions get involved in general interest missions. RDs especially have the specific role of contributing to them; the Director and associate Director in charge of sustainable development manage the relationships with local external actors involved (companies, citizens, local authorities). All of RDs' units dedicate resources to contribute to those transversal activities – **2.2**

All other Directions also contribute to general interest missions by dedicating specific competencies and time. The Direction of Engineering, for example, designs small hydropower plants or fish passes while the Direction of Energy's Networks Solutions unit gets involved in the electric vehicles' projects. The whole organization is structured to address territories' needs.

3 The development model is an integrated one, based on the choice of keeping all competencies of the value chain in-house: studies and design, development, construction, O&M, trading etc. The company is willing to maintain core competencies in all those activities. Expertise and engineering — centralized in the Direction

of Engineering - 3.1 and the Center of Analysis of Hydraulic Station - 3.2 are particularly important; the Direction of Engineering has external business activities (including internationally) additionally to its internal contribution, representing 30% of its total activities. Company 5 also considers important to keep O&M activities in-house.

Unlike many hydropower companies, Company 5 has chosen to keep a close link between energy production, optimization and trading (trading activities are located within several units of the Direction of Energy – 3.3). Sophisticated meteorological and hydrological forecasting competencies (in the Intermittent Production Management Center – 3.4) allow to maximize energy production both on a market value point of view and for maintenance operations. The Flexible Production Management Center — 3.5 – in charge of production optimization is located within the Direction of Energy, but is in direct contact with the tele-operations center (Operations unit – 3.6): they are geographically located side by side and permanently interacting. This proximity between trading and operations is seen as one of the key strengths of the organization. Energy management and optimization is a core competency of Company 5, which has the capacity to offer its services in this sector to external actors.

4 The development of new renewable energies (mostly wind and solar farms) and involvement in "research on future energies" is another core element of the company's model (the company committed to invest 160 M€ per year for development outside from the concession perimeter). If some other hydropower actors develop and operate wind and solar assets, most of them keep those activities completely separated from hydropower. Company 5 on the contrary, in line with its strategy of integration, does not keep such strict separation. Although one Direction is specifically in charge of new renewable energies (the Direction of Development), the company looks for synergies with other "historical" competencies (engineering, IT tools, RDs' local anchorage etc.) to develop in those new activities.

Company 6

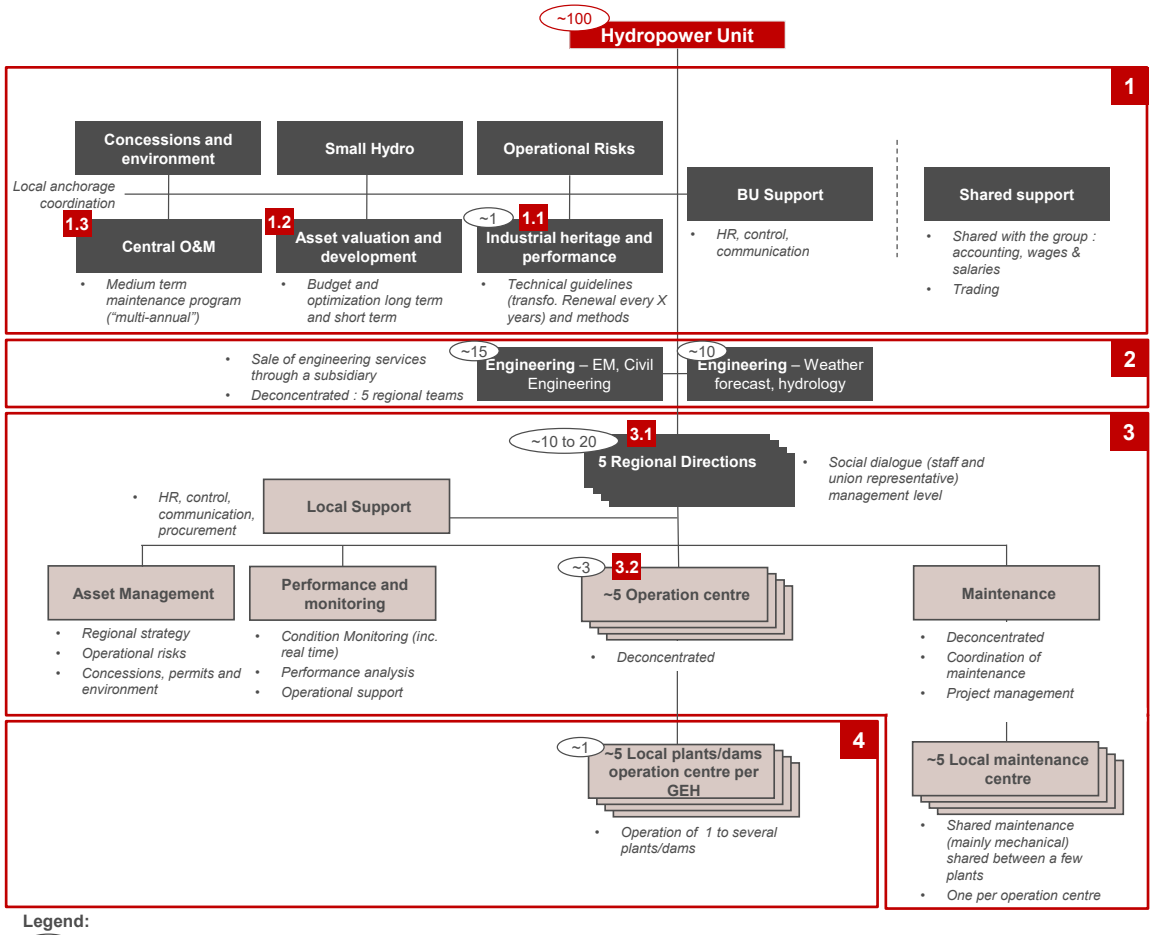
Context and company profile

Company 6 hydropower business unit operates hundreds of small and large plants and dams for a total capacity of more than 10 GW. Its fleet consists of run-of-river (with river navigation management), dams and pumped-storage. With over 1,000 collaborators it manages a total production >30 TWh. Its plants are under concession contracts, many of which will expire in the next 10 to 20 years. Competition conditions are still uncertain.

Beside this business unit dedicated to hydropower, the group operates a large fleet of conventional assets.

ORGANIZATION CHART OF COMPANY 6

With ETP on an Index Basis with 100 = total workforce in the Hydro Power BU



Legend:
(100) Workforce in Full-Time Equivalent, with Index Basis 100 = total workforce in the Hydropower BU

Organization and processes

The business unit is organized on four levels :

- National (all plants) - **1 & 2**
- Regional - **3.1**
- 3.2 infra-regional (~10 plants or more) - **3.2**
- plants (~2 plants or more) - **4**

Company 6 organization is both decentralized (operational teams, asset management) and deconcentrated (engineering teams have a central reporting line while being spread geographically).

1 The national levels focus on global asset management and economic optimization for the fleet. An expert team builds the technical framework (e.g. transformers' renewal every X years) for ~10 categories of equipment - **1.1** . The asset and valuation team applies a financial approach for long term budgeting, integrating concession constraints - **1.2** . The O&M team programs the medium term maintenance ("multi-

annual") - 1.3 . Finally the asset valuation team sets the short term (one year) budgets. The national level also provides some supports (HR, control, communication, etc.) while several supports or services are shared with the group (accounting, wages and salaries, and also trading).

2 Engineering teams (electro-mechanical, civil engineering, hydrology, weather forecasts, …) are mostly centralised but spread grographically to match regional directions (deconcentrated model). They are in charge of large maintenance or development projects. They also have a limited share of activity sold to external customers through a subsidiary. These engineering teams are operated as services providers for the five regional directions.

3 Five regional directions regroup most of the workforce - 3.1 ; they are in charge of operations and maintenance and are responsible for production, availability of installations, security and safety. They are relatively autonomous with local asset management, "project ownership" (only very large and transverse projects are managed centrally) and social dialogue with staff and union representatives responsibilities. These directions are budget driven. However, company 6 is considering the opportunity to consolidate an analytical PnL for each regional directions (with an EBITDA target corrected for hydro-climatic variability as well as safety and security requirments).

Each regional direction is divided into about five infra-regional operation centers and five infra-regional maintenance centers - 3.2 . The PnL management is also considered for these infra-regional units (operation centre). The short term maintenance program is designed by these infra-regional units.

4 Finally front-line operations are organized around local centers, each for one to several plants/dams. These teams are sized according to on-call duty or flood management requirements. Most of the plants and river-navigation sites are manned.

About the authors
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