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1. OBJECTIVES

Hydroelectricity provided by small hydroelectric power plants introduce positive impacts, which justify its development, both at large scale (greenhouse effect avoided…) and at local scale (air pollution avoided, balance between offer and supply and needs for adjustment…) Nevertheless, it comprises negative impacts on aquatic environments operation and in the other river uses, on the one hand on the set-up scale, but also on the layout more or less long, for example when the river accommodates large migrating fishes. In practice, these impacts qualified of “local” in opposition to the greenhouse effect avoided, are in the middle of the Environmental Impact Assessment (EIA) studies.

In the study of the local impacts, the question of the aquatic environments is often developed. Indeed these are complex, dynamic and interdependent fields whose components are to be preserved or to be restored to maintain their main role in term of water resources regularisation or of landscape and bio-diversity self purification.

If several guides were written (in France and Europe) to facilitate, on a site, the preparation of an Environmental Impact Assessment study (Water Direction 1989, SHF/ADEME guide, CSP guide…) it is natural to go today beyond the influence zone of this site, to take into account most largely the natural dynamics of a river from its source to its confluence.

The report called “Technical and operational procedures to better integrate SHP plants in environment” published by SHERPA (WP4-August 2007) list, in its introduction, the most outstanding “local” impacts (in the form “Effects induced by the hydroelectric production/awaited impacts/People or system affected by these impacts”)

The table hereafter shows this same list revealing there the main actions to be carried out:
From these actions, corrective and compensatory measurements are replaced which aim to reduce the impacts on the field.

The main objective of this document is to analyse, in practical and representative cases, the economic impact of these measurements on SHP plants (IRR evolution, production cost, etc…)

2. SHORT RECALL OF THE EUROPEAN DIRECTIVES CONTEXT

The table hereafter summarizes the main European directives surrounding the electric output of SHP plants.

<table>
<thead>
<tr>
<th>EUROPEAN DIRECTIVES INTERESTING THE HYDROELECTRICITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>WATER: Directive DCE 2000/60/CE establishing a Community framework in water field</td>
</tr>
<tr>
<td>ENERGY: Directive ENR 2001/87/CE relating to the electricity production produced from renewable energy sources</td>
</tr>
<tr>
<td>FISHING AND SAFE Guarding of the Aquatic Environments: Directive 78/653/CE concerning the quality of fresh waters having need to be improved or protected to be suited to the piscicultural life</td>
</tr>
<tr>
<td>CONSERVATION AND SAFE Guarding of the Natural Environments: Directive 92/43/CE relating to the conservation of the natural habitats and wild fauna and flora</td>
</tr>
</tbody>
</table>

The first two directives, both of them being motivated by an environmental protection approach, air on the one hand, aquatic environments on the other hand, give a new topicality to the question of “the integration” of the SHP plants by recognising its contribution to the fight against the greenhouse effect, to the improvement of the air quality, the adjustment of the supply/demand, and thus to the safety of the electrical supply networks. However it recognises that the hydroelectricity has real impacts on the aquatic environments, and enter also in competition with other uses as the leisures associated with the rivers: fishing-canoe kayak, and must include for this reason to
corrective and compensatory measurements expected in the regulation, in order to reduce these impacts.

They contribute also and indirectly to interest and check which can be the economic impact of these measurements.

3. TOOLS FOR DIALOG WITH THE OTHER USERS OF THE RIVER

From the environmental, economic or technological point of view, a participate decision-making approach improves quality of decisions while facilitating more advantageous choices, with choices, technically wiser and socially more acceptable than those that would emerge from non-participate decision-making processes, as top-down process.

3.1 PARTICIPATION OF HYDROPOWER PLANT AND STAKEHOLDERS IN WATER MANAGEMENT

Besides the increased importance of ecological criteria and hydrological boundaries in water management, a major principle of the European Water Framework Directive (WFD) is the emphasis on public and stakeholder participation in water management.

Several practical questions regarding who should be involved, why, when, and how still remain unanswered but public participation is a way to overcoming the social dilemma in the case of hydropower. The criteria and methodology laid out by the Swiss greenhydro standard developed by EAWAG inform on how to fulfil basic ecological requirements at local scale, so that the river system’s principal ecological functions are preserved. Criteria cover 8 areas: river flows, water quality, fish passage and protection, watershed protection, threatened and endangered species protection, cultural resource protection, recreation, and facilities recommended for removal. The solving of the problems/effects involved at a local level were handled extremely poorly.

Efforts of hydropower plants to participate in good watershed management may be eligible to different labels and benefit from premium prices on the green electricity market.

3.2 GREEN HYDRO AND LABELS

Small Hydropower plant have little externalities compared to other power sources and thus benefit from different tools that contribute to internalising the
externalities\textsuperscript{3} such as taxes, subsidies, green certificates...The certification of environmentally friendly produced electricity depends on independent and credible criteria. This is also the case in regards to “Green Hydropower”.

SHPP may benefit from the different standards (Eugene\textsuperscript{4}, NatureMade, Grüner Strom Label, Ok Power, 100% Energia Verde and Bollino Verde…) and from a premium price. The third case study looks at the effects on the IRR.

Below is an extract of http://www.eugenestandard.org/mdb/publi/10_CLEAN-E%20WP%201%20Report%20labels%20%20final.pdf, p159

“The Bollino Verde - as the 100% Energia Verde label is usually called - was born in 2001 from an idea of Enel Green Power (former detached controlled company of Enel, at present merged back into Enel) and APER (renewable producers organisation) by setting up the official owner of the label, the non-profit foundation Re-energy.

In order to use the 100% Energia Verde label, electricity products have to pay a royalty to the owner of the label depending of the type of product and the nature of the user of the label. Each contract for the users of the label lasts 12 months, no matter the amount supplied, with a top limit of EUR 25,000 payable in royalties by each client.

Two rates (for the royalties) have been created for each kind of consumer: residential consumers pay a flat rate of EUR 25 for a 12 months supply and non-residential consumers pay 0,25 EUR/MWh with a minimum amount of EUR 25 for a 12 months contract.

Non-residential can be integrated into two different categories: customers buying the equivalent of their yearly total electricity demand, and those who pay for a limited amount, covering only partially their electricity bill (respectively utilizzatori totali and utilizzatori parziali). However, no incentive is given to reward a company to choose a full supply, since tariffs are calculated per MWh with a rate independently from the amount bought.

On the production side, electricity suppliers pay 0,05 EUR/MWh in royalties to the owner of the label, with a minimum amount of EUR 100. Producers organisations are billed EUR 2,500, while traders and distributors have a fixed rate of 1 EUR/MWh.

Fees for the cost due to the management of the green labelling, on the other side, refer to yearly rates with a fixed entry rate for each client, with a top limit of 20,000 EUR/y per client.”

The label has been structurally conceived to foster a green electricity market and not its production. The principle identified by Enel and APER aims to develop a market for the present production, yet far to be fully exploited and clearly opposes the introduction of any compulsory measure of additionality.

\textsuperscript{3} To understand the methodologies of evaluating environmental externalities, see in particular, the results of ExternE and NEEDS European projects as well as works on non tangible externalities. The MAXIMA projects and workshop aimed at establishing tools to favour dialogue between industry, NGOs and consumers on estimating and internalising external costs of electricity production.

\textsuperscript{4} For an overview of the ‘Overview of green power labelling schemes’, see European Network for Green Electricity Labeling http://www.greenelectricitynetwork.org/ and the Clean-E study.
3.3 ISO 14001 CERTIFICATION

In France, the hydro suppliers, sensitised with the safeguarding field in which their activity carries on, set up within the GPAE (Groupe des Producteurs Autonomes d’Electricité) a group of “pioneers” decided to engage from 2001 in an experimental step of environmental management: the ISO 14001.

Certification ISO 14001 is a reference frame describing the requirements of an environment management system, with an aim of self-evaluation and then a certification by a third. It is based on the principle of a loop of continuous improvement, which optimises its organisation to improve its environmental performance. The system must comprise a formalisation using procedures and recordings in order to show the effectiveness of its functioning with the thirds.

The construction of these environmental management systems allows to the suppliers to have a dynamic tool. Thus the critical points of environmental impact of the activities of the plant can be controlled by privileging strong engagements, which are:

- The engagement of the directions as regards environmental protection,
- Conformity with the requirements, whether those result from the regulation or other sources,
- Concept of continuous improvement, which induces in a direct way the improvement of the environmental performances of the plant.

The standard is organised in 6 paragraphs:

- General requirements,
- Environmental policy,
- Planning,
- Implementation and operation,
- Control and corrective actions,
- Review of Direction.

4. CORRECTIVE AND COMPENSATORY MEASUREMENTS

The definition of a project thus results also in defining measurements, which aim at reducing its impacts on the field.

Those can take the form of modifications of the investment or the operation of the installation concerned or of measures adopted concerning the zones close to the project.

They can concern the operator, but also other actors, public in particular, possibly on the basis of ad hoc financial payment on behalf of this same operator.
Corrective measurements concern for some of them a lawful obligation. The detailed measurements in the EIA study consist at least with these obligations and require an examination on a case-by-case basis.

However it is noted that one cannot make generally correspond a corrective measurement to an impact. For example, most of measurements improving the biological state of the fields ensure a better living conditions for fishes. In fact, they contribute indirectly with the maintenance of fishing.

The compensatory measurements (which usually succeed to the corrective measurements) are traditionally intended to compensate the residual impacts of the installations. They have vocation to be developed near the sector concerned by the installation.

The majority of corrective and compensatory measurements must be gauged. Moreover the appreciation remains open, for each case, of possible supplementary measures, to estimate in the eyes of environmental benefit consideration, which results from these. They must be optimised during the examination of the project taking into consideration loss of production, which they can sometimes induce.

5. AID DOCUMENTS LIST, EXISTING PROCEDURES AND MAIN ENVIRONMENTAL CORRECTIVE MEASUREMENTS

<table>
<thead>
<tr>
<th>IMPACTS ON THE PHYSICAL ENVIRONMENT</th>
<th>AID DOCUMENTS</th>
<th>EXISTING PROCEDURES</th>
<th>USUAL ENVIRONMENTAL CORRECTIVE MEASUREMENTS</th>
<th>OBSERVATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impacts on surface waters</td>
<td></td>
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<tr>
<td>Impacts on sub-surface waters</td>
<td></td>
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<tr>
<td>Impacts on stability of the grounds</td>
<td></td>
<td></td>
<td>Paneled architectural design for the power station - Filling of the penstock</td>
<td></td>
</tr>
<tr>
<td>Impacts on the landscapes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IMPACTS ON THE BIOLOGICAL ENVIRONMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wetland ecosystems</td>
</tr>
<tr>
<td>Pasturelial Context (CSP) - Water Mass (WFD) - Minimum Biological Reserve (BIOLOG PEC)</td>
</tr>
<tr>
<td>Reserved lakes</td>
</tr>
<tr>
<td>Pass from maintenance or demolition - No fish damage - Turbines - Cleaning - Recovery of the floating bodies and debris - Recycling</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>IMPACTS ON THE HUMAN ENVIRONMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound impacts</td>
</tr>
<tr>
<td>Impact on the infrastructures</td>
</tr>
<tr>
<td>Social-economic impacts</td>
</tr>
<tr>
<td>Impacts on the vicinity</td>
</tr>
<tr>
<td>Sound traps - Buried power stations</td>
</tr>
</tbody>
</table>

6. IMPACT OF THE “GOOD ENVIRONMENTAL PRACTICES” APPLIED TO SHPP - ECONOMIC ANALYSIS OF VARIOUS SCENARIOS

The different case studies, which follow, establish various economical analysis with different scenarios, in order to evaluate potential additional costs of new or refurbished SHP development.
The results were very interesting while they demonstrated in each case the well impact of good environmental practices in developing small hydro.

6.1 CASE STUDIES AND MAIN RULES

Four projects are presented, One in Italy, Two in France and one in Austria.

- RINO hydroplant located in the Adamello Regional Park in the Italian Alps (Lombardy region),
- COMBE SOULOUZE hydroplant located south of France on Ceze river in the Gard Departement (Languedoc Roussillon Region),
- Case of a low waterfall power station located in France (source GPAE),
- Case of a low waterfall power station located in Austria: HPP ST-MARTIN – Thörlbach.

For these four projects, each analysis will be specific and present the various ways in which are taken into account the environmental mitigation activities as well as the results of the economic analyses carried out. The results of these analyses will then be compared.

Briefly let us point out the main rules of the economic analysis of a project.

The economic analysis, which follows, consists, for the various scenarios considered, to establish which is the intrinsic profitability of the project, i.e. apart from any countable or financial consideration. It’s based only on the earnings before interest, taxes, depreciation and amortisation.

In general it takes into account (1) the expenditure related to the works realisation, (2) the maintenance and operating costs.

In each situation, the economic life span of the investment is anticipated starting from the start up of the installation at 30 years and sometimes 20 years.

Each situation will have the following results: (1) the earnings before interest, taxes, depreciation and amortisation (2) the time of return on investments and (3) the internal rate of return (IRR)

Let us recall that the IRR gives the indication of profitability drawn potentially from a project by comparing it to the profitability which would obtain while investing the corresponding funds to the initial investment on n years at an interest rate equal to the IRR.
6.2 RINO HYDROPLANT LOCATED IN THE ADAMELLO REGIONAL PARK IN THE ITALIAN ALPS (LOMBARDY REGION)

A reference case for the integration of new SHP power stations in the environment is the RINO HYDROPLANT (3.7 MW) which is situated in the Adamello Regional Park. The owner of the plant is a textile local firm, Franzoni S.p.A. of Esine (BS).

The project obtained a financial support from the E.U. programme Thermie 1995, which supports the implementation and diffusion of technical innovation in the renewable energies field.

The original project dated back to 1983 (before the creation of the Adamello Regional Park) had been made on the basis of a “classical” concept of the plant, i.e. intake, basin, open channel, high pressure penstock, power station, in order to get the best results from an economic standpoint.

The new project was made in 1996 (after the creation of the Adamello Regional Park) thinking that it was necessary to make the plant compatible with the existing natural and anthropical environment, believing that it was impossible, and expensive too, to solve the environmental problems only in the erection phase.

The transformations brought of 1983 were successively the following ones:

- **Intake structures**: An important variation was the creation in 1996 of a fish pass to be used also to guarantee the reserved flow. The type of this fish pass – weir and pools – was stated together with the technical staff of Lombardia Region,

- **Basin**: To improve its fitting in the landscape, the basin was redesigned to follow the irregular lines of the existing environment. The visible surfaces of the works had to be entirely coated with the local stone reminding the slopes of the river which had been coated with stones after the ruinous flood which in 1987 had hit a great part of North Lombardy.

- **Low-pressure penstock**: The open channel foreseen in the original project was substituted by an underground penstock at low pressure. As we were no more obliged to follow a precise altimetric line, we chose a plot that could avoid a fen area of relevant environmental interest. The new plot follows an existing secondary road and so we didn't have to occupy non-urbanised areas and we had to cut only a few trees.
- **High pressure penstock:** During the design phase in 1996, the staff thought to put all the penstock underground. But apart the very high costs, the result, on the environmental impact, was unattractive. The large earthworks required by the digging in are not advisable on very steep slopes, because of their instability. Moreover the erection phase has usually a great impact on the environment. For safety reasons, because of the high pressure, the penstock should be checkable as easily and as soon as possible. That’s why the staff decided to keep open air the part of the penstock at high pressure and to inter the low pressure one. To attenuate the environmental impact the staff tried also to reduce deforestation and to use materials and colours similar to the natural landscape.

- **Power station and tail race:** The original project from 1983 has been modified on the basis of the indications of the different institutions involved. The layout modification which had the worst consequences on the production was the moving of the power station upstream of Rino di Sonico village with a loss in head of about 60 m. Nevertheless in that way we could return the water to the river upstream of the village giving an answer to the environmental and hygienic needs and also feed a sprinkler irrigation plant. To this aim, an exchange chamber has been realized which allows the conveying of the water from the turbines directly to the river or to the irrigation plant without affecting, in any way, the operation of the hydroelectric plant or of the irrigation one. In the same time, an auxiliary intake already existing, can feed the irrigation plant when the hydroelectric plant is not working. But usually the water used comes from the turbines because it is already desilted.

The economic analysis of the project built in 1983, based on the readjusted investments (6,125,000 €), the operation and maintenance cost (106 725 €/year over the period 1983-2007) and on the energy produced during this period (approximately 14,85 GWh/year) is interesting and provided good ratios (see table Reference situation A)  

It appeared interesting economically to examine the impact of the work undertaken in 1996 (735 000 €, that is to say 12% of the preceding amount) because the environmental effects were immediate, but especially because they led to a loss of energy production because the introduction of a reserved flow (of approximately 1,25 GWh/an), but also, like already stated, of a reduction of the fall of the installation of approximately 60 m (1,60 GWh/an)

With the certified assumption of a time of return of 6 years in the initial investment, of no income in 1996 (year of works) and of an increase of operation/maintenance cost from 1996 to 2 013 of 8% (114 900 €), the economic analysis shows, at the horizon 30 years a very weak variation of the EBB between the two situations, proof if it were necessary that an “ecological” different accompaniment from
6.3 COMBE SOULOUZE HYDROPLANT LOCATED SOUTH OF FRANCE ON CEZE RIVER IN THE GARD DEPARTEMENT (LANGUEDOC ROUSSILLON REGION),

The mill of Combe Soulouze, stated south of France, is a very low waterfall power station having required the rehabilitation of a weir and a mill and the total restoration of the hydraulic and electric equipment. This power station profits from March 2007 of EDF tariff-appendix 1 and an “overestimation for small power station”. However the “quality overestimation” is not applied in winter period.

This project takes place under a broader project of mills rehabilitation in the Gard Department, between the communes of Montclus and Saint-Gervais.

The reference situation A is represented (1) by the installation of a no fish damage turbine (called “Aqualienne”) and (2) by taking into account of a reserved flow equal to 1/10 of the inter annual flow of Cèze river.

The aqualienne is a blade turbine with slow velocities, non destroying the aquatic environments and whose simple design makes it possible to propose some standards (for the moment up to 20 kW and less than 1000 kW) easy to implement, and thus opening the way of an ecological alternative for the hydraulic production.

The alternative B differs from the reference situation A by dividing the flow reserved by 4 (1/40 of the inter annual flow): The modification of the reserved flow, when looking at the end of the lifetime, involves an increase in the net amount of 630,000 € that is to say 56% of the investment cost. The operation is economically interesting with a return period of 14 years and a IRR of 7,2%.

The alternative C presents a traditional solution of equipment by replacing the aqualienne by a low fall turbine and by equipping the weir with a fish pass: This solution, at the end of the lifetime, involves a reduction in the net amount of 514,000 € that is to say 41% of the initial investment cost. The operation, which undergoes a fall of the economic profitability of 3,8% is uninteresting and financially non profitable.

The alternative D is the alternative C to which a system of recovery of floating waste is add to. The increase in the amount of the investment (of approximately 2%) led to a reduction of 2,8% of the net amount at the end of the lifetime (either 2,1% of the investment cost).
What it is interesting to note is the difference of the economic analysis results obtained between situations A (or B) and the situation C. This difference shows (if it is necessary) that technological progress, as regards low fall equipment, while taking part in a better respect of the environmental aspects, can lead to better economic results.

### 6.4 Case of a Low Waterfall Power Station: Costing of the Reduction of the Impacts (Source GPAE)

Case of a low waterfall power station in plain commissioning in 1980 and having required a restoration of the hydraulic and electric equipment (Kaplan turbine).

This power station profits from June 25, 2001 EDF tariff appendix 2, with 2 components (Quality overestimation of 50% not remunerated)

The assumptions taken into account are identical to those exposed to the preceding chapter.

Each situation will have the following results: (1) Cost of the invested kW, (2) the time of return on investments and (3) the internal rate of return (IRR)

The reference situation A is represented by the power station authorising a reserved flow equal to the 1/10 of the inter annual flow of Ceze river, having chutes of defoliation rejecting downstream the products of cleaning, but not having a functional fish pass (not rebuilt).

Doubling the reserved flow in the alternative B involves a reduction in the net amount of 200,000 € that is to say 25% of the investment cost. The operation is economically uninteresting and financially non profitable.

Rebuilding the fish pass of the alternative C has the effect to raise of more than 9% the investment cost without increasing the net amount. The operation undergoes a fall of the economic profitability of 1.7%.

Rebuilding the fish pass and the recovery of floating waste of the alternative D cause to raise of more than 9.6% the investment cost without increasing the net amount. Economic profitability is reduced by half.
These results are presented in the table hereafter:

<table>
<thead>
<tr>
<th>Case of a low waterfall power station located in France (source GPAE)</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference situation A: Low fall turbine (Kaplan type). Reserved flow equal to 1/10 of the inter annual flow of the river.</td>
<td>1,134</td>
<td>1,134</td>
<td>1,239</td>
<td>1,243</td>
</tr>
<tr>
<td>Situation B: Reserved flow increased to 20% of the inter annual flow.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Situation C: Rebuilding of a weir and pool fish pass</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Situation D: “C” with recovery of floating waste</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

| Cost of kW injected (€) | 5,77 | 6,88 | 6,32 | 6,87 |
| Time of return of investments (years) | 9,9% | 5,7% | 8,3% | 4,9% |

6.4 Case of a low waterfall power station located in Austria: HPP ST-MARTIN – THÖRLBACH.

It is the case of a low waterfall power station in plain commissioning in 1980 at Thörlbach (Austria)

The main characteristics of the hydro-plant are presented in the table hereafter:

<table>
<thead>
<tr>
<th>No</th>
<th>Name of the project inter-connected with the national network - Name of the river concerned</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HPP St. Martin - Thörlbach</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Equipped flow $Q$ (m$^3$/s) and fall value $H$ (m)</td>
<td>5m$^3$/s, 7m</td>
</tr>
<tr>
<td>3</td>
<td>Value of the reserved flow maintained in the river ($%$ of $m^3$/s)</td>
<td>0,4 m$^3$/s</td>
</tr>
<tr>
<td>4</td>
<td>Installed capacity ($kW$ - $MW$)</td>
<td>235 kW</td>
</tr>
<tr>
<td>5</td>
<td>Output in average year ($kWh$ - $MWh$)</td>
<td>1.9 GWh/yr</td>
</tr>
<tr>
<td>6</td>
<td>Annual income in average year (in €)</td>
<td>150,000 €</td>
</tr>
<tr>
<td>7</td>
<td>O &amp; M costs (per year – en €)</td>
<td>15,000</td>
</tr>
<tr>
<td>8</td>
<td>Economic life span for Civil Work &amp; for Electromechanical features (in years)</td>
<td>3 years</td>
</tr>
<tr>
<td>9</td>
<td>Investment (in €)</td>
<td>300,000 €</td>
</tr>
</tbody>
</table>

The average kWh tariff cost applied is 0,08 €.
In this project, the list of the corrective measurements brought to the project (total amount 8 900 €) is the following: (1) Automatic measurement of reserved flow (900 €), (2) Structural measures in the diversion reach (5 000 €) and (3) Structural measure in the head race channel (3 000 €).

The compensatory measurements brought to the project (total amount 21 000 €) are (1) The erection of a fish by-pass channel (11 000 €) and (2) the delivery of a reserved flow that is to say a loss of production of 10 000 €/year.

The economic analysis of the 1990 project, based on the investments, the (observed) operation and maintenance costs and on the energy produced during this period is very interesting and provided good ratios (see table Reference situation A).

This project (like the previous project) is a low fall standard project. It is interesting to examine economically the impact of the proposed measures of accompaniment that were carried out at the same time as the project itself. In this case an increase in the investment of approximately 3,7% led to a time of return of investment between six months and one year and at the end of 20 years (2 010) a loss of income from approximately 3%.

<table>
<thead>
<tr>
<th>Case of a low waterfall power station located in Austria: HPP ST-MARTIN – Thörlbach.</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference situation A: 1990 Original project made on the basis of a “classical” concept of the plant</td>
<td>1 940 000</td>
<td>1 880 100</td>
</tr>
<tr>
<td>Situation B: 1990 Project to which the environmental mitigation activities, described above, are applied</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Earnings before interest, taxes, depreciation &amp; amortization (EBE)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time of return of investments (years)</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Internal rate of return (%)</td>
<td>16,3%</td>
<td>15,4%</td>
</tr>
</tbody>
</table>

This brochure has been co-ordinated by Geoffroy du Crest from IED (F) associated to Sara Gollessi from APER (I) Bernhard Pelikan from IWHW (A) and Janusz Steller from EC BREC/CLN (P). We wish to thank ESHA staff for the revision and other SHERPA partners for their contributions.