Better understanding, Better examples, Better policies.
Forewords

Topic case studies

Project case studies

Initiative case studies

A collection of 24 case studies examining good-practice examples of specific aspects of hydropower development.

Hydropower projects from around the world that have demonstrated overall good practice in sustainable development.

Examples of broader schemes undertaken in relation to hydropower projects to address commonly problematic development challenges.

“

Hydropower can only deliver to its full potential if developed responsibly and in collaboration with a broad range of stakeholders.”

”
Forewords

Better Hydro: Compendium of Case Studies 2017 is a collaboration between the International Hydropower Association and the World Bank Group.

Welcome to Better Hydro: Compendium of Case Studies 2017, a publication that compiles and highlights examples of sustainability in hydropower, encompassing all aspects of project development from a variety of local and regional contexts around the world.

In a world facing the pressures of population growth, complex water and energy challenges, and a changing climate, the tangible benefits that hydropower can provide to society are possibly greater today than they ever have been. Hydropower can only deliver to its full potential if developed responsibly and in collaboration with a broad range of stakeholders. A much richer dialogue within the hydropower community and advances in technology have enabled rapid progress in key areas; however, many challenges remain. A decade ago, a multi-stakeholder forum began a three-year-long process to address an issue not yet successfully tackled on an international, sector-wide scale: the need for consensus among all parties on how hydropower can be developed in a sustainable manner. The product of this work is the Hydropower Sustainability Assessment Protocol, which has now been applied in all regions of the world, and has become established as the primary tool for measuring and improving sustainability performance in the sector.

By using the protocol, project developers have been able to identify gaps in their practices and processes, and better understand how they can be addressed. This has brought forth some invaluable information for the sector as a whole, but until now this has not been made widely accessible. With the publication of this compendium, we are taking an important step towards sharing these examples.

The case studies you will read on these pages have been written by the accredited assessors who have carried out the project assessments on-site. They cover examples from all stages of project development from early stage through to operation, and encapsulate all facets of sustainability: social, environmental, economic and technical.

“A decade ago, a multi-stakeholder forum began a three-year-long process to address an issue not yet successfully tackled on an international, sector-wide scale.”

This publication has been in the making for many years. I hope it also signifies the beginning of a new journey towards building a sector that is better connected, better informed and better prepared.

I would like to thank everyone who has been involved in the Better Hydro initiative to date, and look forward to expanding our collaboration in taking it to the next stage.

Richard Taylor
Chief Executive,
International Hydropower Association

It is my pleasure to introduce you to Better Hydro: Compendium of Case Studies 2017. This publication brings together practical examples of responsible hydropower development from all over the world, covering a range of sustainability considerations.

The case studies are drawn from projects that applied the Hydropower Sustainability Assessment Protocol, a rigorous, an objective tool that evaluates more than 20 sustainability issues in a standardised way.

“The challenge of energy, food and water security have become more urgent, particularly in developing countries.”

The protocol, which looks at technical, social, environmental and financial issues, was developed through a multi-stakeholder process that included governments, industry, non-governmental organizations, and the multi-lateral development banks. The World Bank has been involved in the development of the protocol from the outset and has participated, as an observer, in the forums that created it. Since it was launched in 2011, the protocol has been implemented in all regions of the world and in many different contexts, making this the perfect time to reflect on what has been learned so far and how we can improve going forward.

The challenge of energy, food and water security have become more urgent, particularly in developing countries.

We are applying this approach in a number of countries around the world. At the World Bank we are firmly committed to the responsible development of hydropower projects, both large and small. When hydropower is done in a socially, financially and environmentally sustainable way, the development outcomes are impressive. I hope you find something in these case studies that inspires you as we work together to reach the more than a billion people in the world who still do not have access to power. Hydropower has a vital role to play in our joint mission to end energy poverty.

William Rex
Global Lead, Hydropower and Dams, World Bank Group

It is the first time that such a broad scope of cases has been compiled into a single manual.”
Better Hydro: an introduction

What follows is a compendium of case studies that, under the aegis of the Better Hydro initiative, casts light on innovative local and regional approaches to the preparation, implementation and operation of selected hydropower projects from across the globe. These can be considered as going beyond basic good practice as defined in the Hydropower Sustainability Assessment Protocol and which demonstrate a clear contribution to sustainable practice in the hydropower sector.

The Hydropower Sustainability Assessment Protocol

The protocol, developed over three years from 2007 to 2010, is a reference framework that enables the development of a full sustainability profile of a hydropower project. Informed by existing international safeguard policies and frameworks such as the Equator Principles, to date 20 official assessments have taken place around the world. Moreover, a much larger number of informal applications have helped foster a greater understanding of sustainability in the sector.

Official assessments are carried out by a team of accredited assessors, experts in the field of sustainability and hydropower, who assess the sustainability performance of a project against over 20 topics. These range from ‘economic and financial viability’ to ‘erosion and sedimentation’ and ‘biodiversity’. Cross-cutting issues such as climate change and financial viability are also addressed in the Protocol.

An assessment can be carried out from early stage development and more specifically through the preparation, implementation and operation stages of particular projects. Each topic is assessed against six criteria: assessment, management, stakeholder engagement, stakeholder support, conformance and compliance, and outcomes. The results are presented in the form of a spider diagram displaying the results clearly and unambiguously with a score from 1 to 5 with 3 being equivalent to basic good practice and 5 being equivalent to proven best practice.

The protocol is governed by a multi-stakeholder body, using a consensus approach. This governing body includes representatives of social and environmental organisations, governments, financial institutions and the hydropower sector. Meeting four times a year to guide the Protocol’s work programme, IHA acts as the management entity for the Protocol’s day-to-day operations, covering tasks such as overseeing training and accreditation, liaising on assessments, and co-ordinating governance activities.

The work to develop this compendium of case studies addresses this last task area. The majority address one of the key topics of the protocol in either the preparation, implementation or operation phases and against which the project scored highly, detailing how the specific project achieved that score and listing the principal policy and practice lessons.

The case studies

The case studies within this compendium have been developed around projects that have undergone a protocol assessment. The majority address one of the key topics of the protocol in either the preparation, implementation or operation phases and against which the project scored highly, detailing how the specific project achieved that score and listing the principal policy and practice lessons.

The case studies have been authored by experienced, accredited assessors with on-site experience that have worked on the project in question or in some cases by the project owners themselves. In order to ensure consistency across the case studies, to better compare and contrast between the different examples of best practice and to enhance the reading experience, the same template has been retained throughout the Compendium.

The case studies

Background to this compendium

Since the first protocol assessments were carried out, there has been discussion within the hydropower community as to how best to record, understand and disseminate the results of what was developed in 2010 through identifying and capturing good examples of successful outcomes of value to be shared within the sector. In order to achieve this and to identify a baseline upon which to describe what constitutes ‘proven best practice’ around the specific protocol topics, the sector identified the need for case studies describing specific examples of how a project scored highly (a 4 or a 5) against the protocol for a specific topic.

To respond to this need, terms of reference were subsequently drawn up by the World Bank’s Hydropower and Dams Global Solutions Group. Better Hydro itself consists of three task areas, these are:

• better information (relating to IHA’s research areas on sector monitoring, on deployment, clean energy systems, greenhouse gas reporting, climate resilience and adaptation, regional development, finance and investment, sediment management and operations, and maintenance),

• better policies relating to preparation facilities, markets and incentives, and

• better examples which showcase highly scoring projects under the Hydropower Sustainability Assessment Protocol and other more general initiatives.

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Each case study contains essential project statistics (i.e. the project developer, the installed capacity of the project, where relevant the stage being assessed as well as the river basin and geographical area) and key policy and practice lessons that are summarised at the beginning of the study and then highlighted within the body of the text. In drawing up the work, emphasis has been placed on identifying and showcasing case studies from developing countries. In addition, a number of more holistic studies have been developed around specific projects that have performed well in all-around sustainability. Finally, a number of studies examine broader initiatives such as multi-purpose schemes, strategic river basin management and capacity building.

You can find out more about the Hydropower Sustainability Assessment Protocol and download full published project assessments at: www.hydrosustainability.org
<table>
<thead>
<tr>
<th>Topic Case Studies</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asset reliability and efficiency: Nam Lik 1-2, Laos</td>
<td>10</td>
</tr>
<tr>
<td>Biodiversity and invasive species: Itaipu, Brazil–Paraguay</td>
<td>12</td>
</tr>
<tr>
<td>Communications and consultation: Romanche-Gavet, France</td>
<td>16</td>
</tr>
<tr>
<td>Cultural heritage: Kabeli-A, Nepal</td>
<td>18</td>
</tr>
<tr>
<td>Demonstrated need and strategic fit: Kabeli-A, Nepal</td>
<td>22</td>
</tr>
<tr>
<td>Downstream flow regimes: Walchensee, Germany</td>
<td>24</td>
</tr>
<tr>
<td>Economic viability: Hvammur, Iceland</td>
<td>26</td>
</tr>
<tr>
<td>Environmental and social issues management: Chaglla, Peru</td>
<td>28</td>
</tr>
<tr>
<td>Erosion and sedimentation: Blanda, Iceland</td>
<td>30</td>
</tr>
<tr>
<td>Financial viability: Murum, Malaysia</td>
<td>32</td>
</tr>
<tr>
<td>Governance: San Francisco, Colombia</td>
<td>34</td>
</tr>
<tr>
<td>Hydrological resource: Jostedal, Norway</td>
<td>36</td>
</tr>
<tr>
<td>Indigenous peoples: Keeyask, Canada</td>
<td>38</td>
</tr>
<tr>
<td>Infrastructure safety: Sogamoso, Colombia</td>
<td>40</td>
</tr>
<tr>
<td>Integrated project management: Trung Son, Vietnam</td>
<td>42</td>
</tr>
<tr>
<td>Labour and working conditions: Santo Antônio, Brazil</td>
<td>44</td>
</tr>
<tr>
<td>Procurement: Sogamoso, Colombia</td>
<td>48</td>
</tr>
<tr>
<td>Project-affected communities: Itaipu, Brazil–Paraguay</td>
<td>50</td>
</tr>
<tr>
<td>Project benefits: Miel I, Colombia</td>
<td>52</td>
</tr>
<tr>
<td>Public health: Mangdechhu, Bhutan</td>
<td>54</td>
</tr>
<tr>
<td>Resettlement: Chaglla, Peru</td>
<td>56</td>
</tr>
<tr>
<td>Waste, noise and air quality: Santo Antônio, Brazil</td>
<td>58</td>
</tr>
<tr>
<td>Water quality: Semla IV, Sweden</td>
<td>62</td>
</tr>
</tbody>
</table>
Rigorous monitoring of equipment performance, together with an effective maintenance routine, has enabled the Nam Lik 1-2 project to exceed the terms of its power purchase agreement and generation target every year since commissioning. This example demonstrates excellent asset reliability and maintenance.

Nam Lik 1-2 is located on the main stream of the Nam Lik river, to the north-west of the capital of Laos, Vientiane. The dam is located in the district of Muang Fueng, and the river flows downstream through the Hin Heup district, where it joins the Nam Xong to form the Nam Ngum. This flows into the Mekong river, downstream of Vientiane. The project has an installed capacity of 100 MW, and is equipped with two 50 MW Francis turbines, which are coupled with 58 MVA transformers, and a 50 MW Francis turbine, and the spillway gates. They also include procedures to follow when monitoring identifies an emerging risk. Each month, NLPC holds a production meeting to review the asset maintenance and safety issues of the previous month, and to plan the following month’s maintenance. The monthly plan allocates tasks and daily activities to individual staff members. NLPC reports to CWE on a monthly basis with a summary of the monitoring results for generation, maintenance and safety.

Asset categorisation enables prioritisation of maintenance

To manage longer-term asset replacement, NLPC classifies equipment into three different categories, according to the required frequency of maintenance and replacement. Category A equipment is the responsibility of the operation group and requires replacement every six to eight years. Category B is also the responsibility of the operation group and requires replacement every three to four years. Category C equipment is the responsibility of the maintenance group and requires replacement annually. NLPC has scheduled the first full overhaul of Category A equipment for 2017, and completed the second category B round in 2016.

Pre-emptive upgrades ensure optimal condition

Engineers measure the exact level of wear and tear to equipment in their routine monitoring, and determine the optimal time for replacement. NLPC replaces most mechanical assets based on the performance of the equipment rather than its predicted lifespan. The company also plans to implement efficiency improvements as new technology develops, rather than through a planned long-term programme of upgrades. There is, however, a long-term programme for electrical assets, requiring replacement and upgrading every seven to eight years, regardless of condition. This is because the engineers believe that technology will improve sufficiently to justify replacement on financial grounds.

Proactive investigation helps identify opportunities for new technology

NLPC’s production team is tasked with investigating areas for improvement in reliability and efficiency, using a number of channels to learn about new technology or research. CWE and CTG send regular updates regarding technological innovations and Chinese regulations on asset performance. The parent companies often send in-house experts to review and advise on emerging issues, such as a review and redesign of the hydrological monitoring system. NLPC employees also have the opportunity to attend CWE and CTG training courses on maintenance.

Each new investment must be justified on financial grounds. Examples of proposed advances and implemented by the production team include improvements to the back-up power system, and an enhanced telecommunications system to facilitate better communication internally and with local authorities during bad weather.

In 2012, routine monitoring highlighted overspeed in one of the turbines. This prompted a complete overhaul of the turbine, which would normally not have occurred until planned maintenance in 2017. When an issue is spotted, this triggers a physical investigation and full technical review by NLPC engineers. Engineers also compile incident reports following unexpected events that affect generation, such as a lightning strike in March 2015 and a grid failure in May 2014. The company is tasked with investigating these issues, identifying opportunities for new technology and investing in improvements.

Case study 1: Topics Better hydro
Case study: Better hydro

Biodiversity and invasive species: Itaipu, Brazil–Paraguay

Policy and practice lessons

- Contributions to habitat protection and ecological restoration can continue many years after project development
- Regional-scale investment, in partnership with experienced agencies, is essential to address regional-scale challenges
- Projects can contribute to scientific research on conservation biology

Key project features

- Project stage: operation
- Developer/operator: Itaipu Binacional
- Capacity: 14,000 MW (20 x 700 MW units)
- Annual generation: 103,098 GWh (units)
- Reservoir area: 1,350 km²
- Head: 118 m
- Purpose: power generation
- Commissioning: 1984–91 (plus additional units in 2006–07)

Itaipu is located in a globally important eco-region, where many species are at risk. This case study demonstrates how a project can make a vital contribution to protecting biodiversity in the surrounding area.

- Itaipu is a bi-national project, located on the border between southern Brazil and eastern Paraguay on the Paraná river, 20 km upstream from the border with Argentina. The project is operated by Itaipu Binacional, which is owned equally by the governments of Brazil and Paraguay.
- Itaipu was built between 1975 and 1982, with the 170 km long reservoir reaching its operating level in 1984. The initial 18 units were commissioned between 1984 and 1991, with a further two added in 2006–07. The Paraná river is one of the largest in the world in terms of length and discharge. Itaipu has generated almost twice as much electricity as any other power plant in the world, providing 79 per cent of Paraguay’s total electricity and 14 per cent of Brazil’s.
- Itaipu is located in the Atlantic forest, a highly biodiverse but critically endangered ecological region. This is a region of global conservation importance, recognised by WWF as one of the Global 200 priority eco-regions.
- The Atlantic Forests consist of tropical and sub-tropical moist broad-leaved forests, located across the south-eastern coast of Brazil, reaching west into Argentina and Paraguay. Isolation from the Amazon Basin by the drier Cerrado region means the forests are home to highly endemic species. The forests originally would have covered an area of 1,234,000 km², although only 7 per cent remains.
- Itaipu is located within the Upper Paraná Atlantic Forest, which is the largest of the 13 eco-regions that make up the Atlantic Forest eco-region. Logging, agricultural expansion, and associated road building threaten this globally important region of biological diversity. Many of the species are facing habitat loss, hunting and the wildlife trade.
- A list of noteworthy species in the region is featured on page 15, although not all of these species occur within Itaipu’s influence zone. Some, like the jaguar (Panthera onca), the harpy eagle (Harpia harpyja), the giant river otter (Pteronura brasiliensis) and the white-tipped pecary (Tayassu pecari), require large expanses of continuous forest, while others have very restricted distributions.
- The Upper Paraná river is recognised by WWF as a Global 200 freshwater eco-region (The Upper Paraná Rivers and Streams). It has remarkably diverse fauna, including over 300 species of fish, a variety of aquatic vertebrates and invertebrates, and a high degree of endemism.
- Protected areas include, to the south-east of the plant, the Iguazú National Park in Argentina, which is contiguous with the Iguazu National Park on the Brazilian side, and the Iha Grande National Park to the north of the reservoir.
- Itaipu’s original development resulted in permanent loss of forests (estimated at 600 km²) due to the creation of the reservoir. It also altered the connectivity of aquatic habitats by creating a barrier to migration as well as flooding a natural barrier, the Salto del Guarani/Siete Quedadas waterfalls.

In Brazil, Itaipu has planted a total of 23.2 million trees since 1979, firstly to establish the protection zone and the Bela Vista and Santa Helena reserves.

- Itaipu initially established protected areas to compensate for the original loss of forest resulting from the reservoir. Since then, the project has established and supported more areas, both for conservation of remaining forest and the re-establishment of forest in previously cropped areas. The area managed by Itaipu now totals 100,732 ha including the reservoir’s protection zones, compared to an estimated loss of 60,000 ha forest, and a reservoir area of 135,000 ha.

In Brazil, Itaipu has:
- established two Itaipu-owned biological refuges, the Bela Vista Biological Reserve (1,908 ha, established in 1984), and the Santa Helena Biological Reserve (1,483 ha), through reforestation programmes;
- contributed to the establishment of an ecological corridor (the Santa Maria Corridor), linking Iguazu National Park with the protection zone around the reservoir, since 2002. It bridges a distance of 12 km between the national park and the protection zone, and consists of a network of parcels of restored forest that are 36 km long and 454 ha in total; and
- planted a total of 23.2 million trees since 1979, firstly to establish the protection zone and establish the Bela Vista and Santa Helena reserves, and more recently through the CultivarDoAgua Bacia programme (read more on page 94).

In Paraguay, Itaipu has:
- established eight Itaipu-owned areas to protect primary and secondary forest, totalling 50,096 ha (bringing the total to 49,855 ha with Bela Vista and Santa Helena). The project also developed five-year management plans for all of these, comprising vision, mission and strategic objectives, and long-, medium- and short-term objectives; and
- launched the Itaipu Preserva programme to reforest a protection zone along the reservoir margin using native species, with a similar protection zone along the left bank.
supported the protection of a total of 230,000 ha of protected areas, including its own, through the Paraguay Biodiversity programme. The area spans from the San Rafael reserve in the south of Paraguay to the Mbaracayú national forest reserve in the north, and includes habitat restoration to establish connectivity between them.

recently established a further protected area, Pozuelo (3,200 ha), on the right margin reservoir bank, in Nueva Esperanza in Canindeyú.

Regional-scale investment, in partnership with experienced agencies, is essential for regional-scale challenges.

Itaipu’s contribution to terrestrial biodiversity conservation in the region is significant, and is widely recognised by partners such as Institute Ocho Mendes de Conservação da Biodiversidade, Fundação Moses Bertoni, Red Paraguaya de Conservación en Terrenos Privados and SEM.

The Itaipu project partners with upstream and downstream hydropower projects to monitor fish migration.

Itaipu’s protected areas and zones are important for linking the Atlantic Forest eco-region with the wetland ecosystems of Iha Grande National Park. The Paraguay Biodiversity Project would be impossible without Itaipu’s involvement, and it also contributes to institutional and legal strengthening in Paraguay and to the country’s Plan 2030 for Sustainable Development.

Itaipu’s investment in biodiversity is considerable. In Brazil, the Biodiversidade Noos Patrimonio (Biodiversity – Our Heritage) programme amounted to USD 1.3 million in 2015; in Paraguay, Biodiversidad Nuestro Patrimonio was USD 1.9 million in 2015. Infrastructure for Protected Areas was USD 3.8 million; Itaipu Preserva was USD 4.8 million in 2015, and conditions for biodiversity under the Paraguay Biodiversity project was USD 4 million, all in 2015. Partnerships are essential for these programmes. In Brazil, the Itaipu project:

was invited to participate and contribute financially to the Santa Maria Corridor by the Brazilian Environmental Agency (IBAMA), in order to create a continuous habitat from Iguazu National Park in the south to Iha Grande National Park in the north.

supported the Ilha Grande National Park by participating in its Consultative Council, financing the building and maintenance of infrastructure such as a headquarters building, and supported Paraná river cleaning campaigns.

partners with upstream and downstream hydropower projects (Porto Primavera and Yacyretá) to monitor fish migration with the use of an internal transponder (tag) system.

partnered with IUCN (International Union for the Conservation of Nature), IBAMA, the State Environment Institute and the State Fauna Conservation Programme on captive breeding.

worked jointly with environmental agencies to take legal action against the illegal extraction of timber and hunting, which has emerged as a risk to the biodiversity value of the protection zone, and

contracts 24-hour policing of biological refuges, the protection zone and reservoir by the Paraná State Security Secretary’s Green Force Environmental Police Battalion and Mato Grosso do Sul (Department of Border Operations) to prevent illegal fishing, hunting and logging.

In Paraguay, Itaipu has provided USD 6 million over three years in co-financing for the Paraguay Biodiversity programme, jointly with SEM (Paraguayan Ministry of Environment), the Ministry of Agriculture, the World Bank financed PRODERS project, and the GEF (Global Environment Facility).

Projects can contribute to scientific research on conservation biology.

The practice of conservation, including habitat protection, ecological restoration and species conservation, is a relatively new concept in all areas of the world. Scientific understanding of ecology, behaviour and genetics is limited, and linking limited scientific knowledge with conservation practice is a challenge. Itaipu is supporting the science of conservation biology through a range of initiatives.

The Bela Vista Reserve is a centre for environmental education and conservation.

The Bela Vista Reserve is a centre for environmental education and conservation, combining the Piracema Canal (a fish passage) and the Ribbona Ribas Lange zoo, a captive breeding area, a veterinary hospital and training centre, tree seedling and medicinal plant production, a pet shop on the reservoir and a monitoring laboratory. It is also important for tourism.

In both Brazil and Paraguay, Itaipu has supported successful captive breeding programmes, for example the harpy eagle (Harpia harpyja) and a deer species (Wazamia gousouleti). In Brazil, Itaipu is establishing a Biodiversity Research Park, currently being built in partnership with the Federal University of Paraná.

In Paraguay, Itaipu’s Wild Animals Research Centre hosts research projects concerning, for example the red-footed tortoise (Chelodina carbonaria), tapir (Tapirus terrestris), red-rumped caciques (Coracius haemorrhous), and the jaguar (Panthera onca). It is home to 32 species of mammals, 24 species of bird and 10 species of reptile, many of which are classified as ‘near threatened’ or ‘vulnerable’ according to their IUCN Red List Category. The centre has successfully bred some of these species (seven mammal and three bird species), including the bush dog (or ‘vireo do mar’, Speothos venaticus).

Itaipu contributes to publications on biodiversity, including books on the fish of Paraguay, and booklets on protected areas and the fauna in the zoo. Itaipu zoos on both banks coordinate their activities with other captive breeding centres, and share information on nutrition and species of mutual interest. Biodiversity conservation is strongly linked to environmental education through the protected areas and zoos on both margins.

Itaipu has also invested considerably in the research and development of a fish migration channel, the Piracema Canal. This is the longest fish pass system in the world, at nearly 40 km. Itaipu monitors fish passage in the Piracema Canal and supports a considerable number of academic studies. These have examined the effectiveness of the canal for fish migration and its ecological implications (with some over the long term, for example a 10-year mark recapture study, spanning a 1,425 km section of the river).

This case study is based on an official assessment of Itaipu using the operation stage tool of the Hydropower Sustainability Assessment Protocol. The assessment was conducted in 2015, with an on-site assessment in August 2015.
The Romanche-Gavet project used a comprehensive mapping process to identify key stakeholders and design tailored plans for how best to engage with them. This case study demonstrates how a constructive consultation and communications approach facilitates good stakeholder relations.

The 94 MW project is located on the right bank towards the middle of the Romanche river, in the tunnel department in the French Alps, in south-eastern France. The project replaces six facilities with a total capacity of 82 MW; built in the early 20th century. Average annual generation will increase by over 30 per cent. The design of the project directly addresses the need to reduce the adverse impacts of hydropower generation in the Romanche valley. Old plants and water transport infrastructure are being removed, conditions for recreation and tourism improved, and some of the decommissioned plants will be repurposed for cultural heritage conservation or economic uses. The valley is a popular route for tourists on their way to the nearby Alpes. EDF is part of the multinational EDF Group which owns, or has holdings in, transmission companies in France and utilities across Europe and internationally. EDF Group is 80 per cent owned by the French state.

Communications and consultation approaches used by the project included:
- using the project offices as a public information centre (the Maison Romanche Energie, MRE), open one morning and one afternoon each week;
- a quarterly newsletter featuring interviews with stakeholders on relevant issues;
- regular public meetings – two per year plus additional meetings on topics of special interest – allowing for exchange of opinions and ideas, and gathering feedback on key issues. Events were attended by up to 1,300 people, equivalent to almost the entire local population;
- open ‘house’ events on topics identified by stakeholders as being particularly important, such as learning about the tunnel-boring machine;
- distribution of invitations and information on all public activities, through leaflets delivered to local households, posters at the town hall and tourist office, and adverts in the press and newsletter;
- around 80 news articles each year;
- dedicated service for visitors to the construction site, provided by a specialist company. By the time of this assessment, 630 people had visited the project and its construction sites; and
- a logbook for complaints, used as a grievance mechanism for stakeholders, noting the question/complaint filed, response and date of closure.

Formal agreements were made between the two main contractors on their respective responsibilities in ongoing communications and consultation. The contractors played an active role in organising public information and open-house events. This approach improved the relevance of communications, timeliness of responses, and ability to respond to emerging communications risks and opportunities.

Separate strategies for stakeholder groups enables tailoring to interests

EDF developed a communication plan in 2011 identifying the project’s approach to internal and external communications and consultation. The company also drew up a stakeholders mapping document. Stakeholders were divided into six groups, each with clear needs: local (department level, municipality and individual community members), internal to EDF; suppliers; elected decision-makers; public authorities; and civil society.

The communications plan was a living document subject to continuous updating. Each year, the company prepared a review of communications activities from the preceding year, and an outlook for the coming year. These reports clearly distinguished specific groups and their respective needs. This included targeting local schools, developing a dedicated website, celebrating the national science day, organising public events, and engaging with the press, contractors, internal EDF stakeholders, and those interested in heritage preservation. Special events showcasing the tunnel-boring machines and the construction site were organised in direct response to stakeholder requests.
Cultural heritage: Kabeli-A, Nepal

Policy and practice lessons

- Local anthropological and heritage expertise is essential for the identification of all impacts
- Involving stakeholders in cultural heritage assessment and planning fosters community support and engagement
- Tailored plans addressing each potential impact are necessary, with mechanisms to respond to unexpected risks

Rivers in Nepal can hold important cultural significance, and the Kabeli-A example demonstrates how a hydropower project can be developed in an area of cultural importance to local communities, working closely with indigenous peoples.

The project is currently under preparation and is set to be located 800 km east of Kathmandu. When complete, Kabeli-A will divert water from the Kabeli River, discharging it 5.6 km downstream, after Kabeli’s confluence with the Tamor river. The Tamor loops around from an east-west to west-east direction, then flows into the Koshi river, crossing the border with India and entering the Ganges. Kabeli-A is set to be a peak-run-of-river plant, using a head of 118 m and a small diversion dam allowing short-term storage. Upon completion, the reservoir will cover an area of just 10 ha, of which 91 ha is the existing river or its flood zone. Its main components are a 14.3 m dam, intake and settling basins, a tunnel over 4 km in length, powerhouse and tailrace. River waters in Nepal can be of significant cultural importance. Hindu ritual practices require water for bathing and funeral rites, and certain fish species are involved in ritual and religious practices. There are a number of heritage sites near the Kabeli-A project that are of importance to the local communities. These include the Panchayam Shivala Temple on the left bank of the Kabeli River, 2 km downstream of the dam site in the stretch with reduced flows; three cremation sites along the reduced flow stretch, Kholakarka, Kabeli and Sinupa; and a rest house, Pabi, near the powerhouse site at Prinae Ghat.

The Kabeli river itself holds significant cultural and spiritual value to local communities, and is regarded as the holiest of rivers by people in the region. Large numbers of worshippers visit the Panchayam Shivala Temple, especially during festivals such as Shiva Ratri and Kada Shiva, when bathing is an important purification ritual.

Hindu pilgrims from the surrounding area come to bathe in the Tamor and Kabeli Rivers on religious holidays. Hindus also perform cremations at the Kholakarka, Kabeli and Sinupa sites. A Mahji community (a Punjabi ethnic group) from a nearby village uses the resthouse for funeral procession and to perform rituals. Among the fish in the river, trout (Schizothorax spp.) and stone carp (Polystigma pseudiochir) are used by the Limbu, Rai and Mahji ethnic groups in rituals.

This case study presents an example of a project to be developed in an area where the river itself is of cultural importance to local communities, sites of local cultural importance could be affected by altered flows, and indigenous peoples are among the affected communities.

The developer of the Kabeli-A project took a comprehensive approach to the assessment of cultural heritage. This took into account intangible practices and rituals, and engaged experts with anthropological knowledge of the area. Affected communities were involved in the assessment and the planning and management measures, resulting in widespread support for the measures. The project developed an array of recommended and suggested measures to mitigate its impacts on sites of cultural significance, as well as associated cultural and religious practices.

Local anthropological and heritage expertise is essential for the identification of all impacts

Kabeli-A engaged senior anthropologists and specialists on the local indigenous peoples as part of its site impact assessment (SIA). The project initially used a screening exercise to map out the cultural and archeological sites likely to be affected. Then, a participatory methodology was used to identify and assess impacts, with rigorous and extensive community consultation. This identified the sites of cultural and religious sensitivity, including the temple, cremation sites, rest house and ritual sites.

It became clear that the temple and cremation sites could be affected by the significantly reduced flow in the Kabeli river at certain times of year. Furthermore, the rest house could be affected by construction activities, and the influx of workers may lead to cultural clashes. The experts were also able to recognise the importance of the trout and stone carp fish species, and found five archeological sites associated with the Limbu ethnic minority in the project area.

Involving stakeholders in cultural heritage assessment and planning fosters community support and engagement

Consultation with local communities during the preparation phase of Kabeli-A was extensive, including:
- 12 formal consultation meetings during the scoping phase of the environmental impact assessment;
- 14 focus group community discussions for the social impact assessment and preparation of a social action plan (SAP); and
- extensive informal household visits and community discussions.

Further rounds of consultation would happen around twice a month. This suggestion was duly incorporated into the social action plan.

Tailored plans addressing each potential impact are necessary, with mechanisms to respond to unexpected risks

Kabeli-A adopted a series of measures addressing the cultural importance of the river:
- at least 10 per cent of mean monthly flow will be released during the driest month to support cultural heritage activities.
- Rivers on religious holidays. Hindus also perform cremations at the Kholakarka, Kabeli and Sinupa sites. A Mahji community (a Punjabi ethnic group) from a nearby village uses the resthouse for funeral processions and to perform rituals. Among the fish in the river, trout (Schizothorax spp.) and stone carp (Polystigma pseudiochir) are used by the Limbu, Rai and Mahji ethnic groups in rituals.
- Rivers in Nepal can hold important cultural significance, and the Kabeli-A example demonstrates how a hydropower project can be developed in an area of cultural importance to local communities, working closely with indigenous peoples.
- Key project features

Project stage: preparation
Developer/operator: Kabeli Energy Ltd., a majority-owned subsidiary of Butwal Power Company (BPC)
Capacity: 38 MW
Annual generation: 206 GWh
Purpose: power generation

Temple by the Kabeli river

Photo: Brent Rydquist
To avoid cultural clashes between construction workers and local communities, Kabeli-A developed management plans for workers' conduct.

Photo: Bernt Rydgren

The project will however monitor and manage aquatic impacts through an Aquatic Ecology Management Plan.

However, both species are also present and common in the Tamor river and upstream of the dam throughout the year. The impact on their availability for ritual is therefore expected to be negligible.

The project will, however, monitor and manage aquatic impacts through an Aquatic Ecology Management Plan. Measures include: restricting fishing among construction workers; restricting illegal and damaging fishing methods; designing and constructing a fish passage; establishing a fish hatchery for targeted red-listed species and planned releases of fingerlings; prohibiting muck disposal into the river; prohibiting aggregate mining in the weed river channel; and prohibiting fishing in certain locations and restricting fishing in others.

Kabeli-A has also developed a series of measures to pick up on any unexpected impacts and emerging risks, both for heritage and others. These measures include: a monitoring and evaluation mechanism; the presence of a team of social experts on-site; a grievance mechanism; monitoring of implementation by an external engineering supervision consultant; and a third-party external monitoring including a panel of experts. A chance-find procedure will be incorporated into the contractor bidding documents, and workers will be trained in the procedures through special training programmes.

Kabeli-A project information centre

Photo: Bernt Rydgren

This case study is based on an official assessment of the Kabeli-A project using the preparation stage tool of the Hydropower Sustainability Assessment Protocol. The process took place in 2014, with an on-site assessment in August–September 2014.
Demonstrated need and strategic fit: Kabeli-A, Nepal

The Kabeli-A hydroelectric project responds to the urgent need for additional power in Nepal without compromising other development priorities. This case study explains how a strong case was made for the project's development.

The project was ranked among the top seven projects in an internationally funded study in the 1990s to screen potential developments in Nepal. The project has a strong fit with identified priorities and needs at a national level. Kabeli-A responds to the urgent need for additional power in the country without compromising any other development priorities. Through the larger Kabeli Transmission Corridor project, it will also address rural electrification in a remote part of the country.

At regional and local level, stakeholders have been given the opportunity to offer their perspectives on project design and options through the feasibility studies and comprehensive environmental and social impact assessments.

The project was considered in the ‘Medium Hydropower Study’ financed by the Canadian International Development Agency in the 1990s. The study assessed a range of proposed options for hydropower projects in Nepal in the range of 10 to 300 MW. The study included an inter-governmental process and significant inter-agency work within the government of Nepal, encompassing planners and policy makers. Subsequent preparation of water and power sector policies and plans were based on this inter-agency cooperation of high-level stakeholders, defining strategic priorities and development needs.

The water and hydropower sectors are closely linked in a planning framework underpinned by the 2002 Water Resources Strategy, the 2005 National Water Plan, the 2003 Irrigation Policy and the 2001 Hydropower Development Policy. Together these documents provide a comprehensive assessment of the needs for both water and energy services at national level. The Water and Energy Commission Secretariat (WECs), established by the government of Nepal in 1975, is made up of representatives from 11 different ministries, with the minister of energy as its chair. The WECs is responsible for overall coordination on water resource development.

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Multi-stakeholder participation in definition of needs provides a sound basis for options assessment

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Case study: Better hydro

Topic case study 6: Downstream flow regimes: Walchensee, Germany

Policy and practice lessons

- The combination of various intakes enables the establishment of a continuous minimum flow regime
- Older plants with minimal or no downstream flow commitments can build stakeholder support by restoring minimum flow
- Extensive studies provide a scientific basis for minimum flow determination
- Nature and innovation combine to minimise downstream flow impacts

Key project features

- Project stage: operation
- Developer/operator: Uniper Kraftwerke GmbH
- Capacity: 124 MW
- Annual generation: 300 GWh
- Active storage: 110 million m³
- Head: 197 m
- Purpose: power generation
- Commissioning: 1924

The Walchensee project has implemented two important mitigation initiatives to address downstream flows, a concept that was unheard of at the time of project construction. This case study demonstrates how downstream flow measures can support local activities and wildlife.

The project is situated on the Isar river, which runs into the Danube in south-eastern Germany, just before it reaches the border with Austria. The station has been generating power for more than 90 years. Commissioned in 1924, Walchensee was recognised as a national monument in 1983. It is a peaking plant, generating power for the electricity grid with four Francis units, as well as single-phase power with four Pelton turbines for Deutsche Bahn, Germany’s national railway. These services inevitably result in variable downstream flows. Water from the upper Isar is diverted into the Walchensee, a natural lake, and discharged into another natural lake, the Kochelsee, taking advantage of a 197 m head between the two. Water flows from Walchensee to Kochelsee via a group of six penstocks, with a total length of 400 m. Walchensee generates 100 GWh per year, approximately 5 per cent of the electricity generated by Uniper’s German hydropower fleet. It is one of Germany’s largest high-pressure storage power stations. As a storage plant with the ability to produce high-value peak power and ancillary grid services, Walchensee is an important power station for Uniper.

Uniper Kraftwerke GmbH operates 109 plants in Germany and has a total capacity of approx. 1,900 MW. The Uniper Group operates 178 plants in Germany and Sweden, with a total capacity of approximately 3,600 MW.

Uniper has completed a project to re-establish flow on the Obernach stream.

The concept of downstream flow releases for environmental and social purposes was unknown when Walchensee was constructed in the 1920s. Growing stakeholder concerns and changing societal demands have led Walchensee to address downstream flows through two important mitigation projects. The project is making the most of the area’s topography and plentiful water supply to maintain peak production while minimising downstream flow impacts. Firstly, the project restored a minimum release on the Isar river, varying this between summer and winter. Secondly, it restored a minimum release on another stream, Obernach, which combined with new fish passages has enabled spawning of the Walchensee population of lake trout.

The combination of various intakes enables the establishment of a continuous minimum flow regime

There was no downstream flow release when the Walchensee project was developed in the 1920s. A weir on the Isar at Krün diverted waters into the Obernach stream for delivery into Walchensee. There are now a total of nine weirs diverting water from further upstream of the Obernach, and from the Rißbach, a tributary of the Isar that joins the river downstream of Krün. Two small power plants utilise some of the head from these diversions. This has enabled a minimum flow release to be established on the Isar at Krün.

Uniper has published a formal commitment to release 4.8 m³/s to the main Isar river course below the Krün weir in summer, and 3.0 m³/s in winter. A higher minimum flow release in summer than winter was chosen in an attempt to mimic pre-regulation variability. Inevitably there are flow impacts on the other streams, including the Obernach, but Uniper has recently mitigated these in partnership with local fishermen.

Older plants with minimal or no downstream flow commitments can build stakeholder support by restoring minimum flow

Uniper has completed a project to re-establish flow on the Obernach stream. This was specifically designed to create spawning areas for the Walchensee population of lake trout. The company cooperated closely with the authorities and the local fishermen’s organisation to assess the situation and design measures to mitigate the impacts of the diversion.

There is a now constant release of 0.5 m³/s at the diversion, and fish can pass freely from the Obernach outlet into the Walchensee, and up to further lakes in the system.

Extensive studies provide a scientific basis for minimum flow determination

The flow regime of the upper Isar has been the subject of extensive analyses, debates and discussions ever since the diversion at Krün. Detailed studies needed to be carried out due to the complexity of the issues, and extensive studies by external experts underpin the agreed minimum flow releases.

Nature and innovation combine to minimise downstream flow impacts

Walchenseekraftwerk is important for high-value peak power and ancillary grid services (including black-start capability). Deutsche Bahn owns the rights to a third of the plant’s generation, and due to the extreme variations in Deutsche Bahn’s power demand, short-term regulation is a fundamental priority. However, this does not lead to significant flow variations downstream of the powerhouse, as Kochelsee acts like a natural re-regulating basin before waters enter the Loisach stream.

Penstocks at Walchensee power plant

Flow regulation has enabled the lake trout population to spawn

Inside the powerhouse

This case study is based on an official assessment of Walchensee using the operation stage tool of the Hydropower Sustainability Assessment Protocol. The assessment was conducted in 2012, with an on-site assessment in March 2012.
Policy and practice lessons

- Detailed, independent economic studies give credibility to master planning
- Integrating economic analysis into broader processes facilitates public involvement
- Strategic basin planning has facilitated the project’s development

Currently under development, the Hvammur project is an example of in-depth economic viability analysis. Much of the information from this process was made public, facilitating public engagement in project development.

The project is being developed by the state-owned Landsvirkjun, which generates 75 per cent of Iceland’s electricity. The Icelandic parliament moved Hvammur from the ‘under consideration’ to ‘appropriate for development’ category in its 2015 Masterplan for Hydro and Geothermal Energy Resources. The proposals for development on the Þjórsá river included a plant at the Urriðafoss waterfall, further downstream, and two alternative proposals upstream, near Núpur mountain. The two alternatives were a single power plant, Núpur Power Plant, with a 36 m head, or two power stations, Hvammur and Holt, with heads of 32 and 18 m. Landsvirkjun has since abandoned the Núpur proposal and intends to build Hvammur, Holt, and Úrðafoss. Hagálón, the intake reservoir for Hvammur, would be formed by a dam over the Þjórsá river, situated above Viðey island, and by dykes along the eastern banks of the river. The powerhouse would be mostly underground, located on the farmlands after which the project takes its name. Two 180 m long pressure pipes would lead from Hagálón to the power station, from which water would re-enter the Þjórsá river below another island, Ómávöxy, via a partly underground, partly open tailrace.

The Icelandic planning agency accepted the proposals, with conditions, in 2003. The minister for the environment then confirmed the planning agency ruling, with further conditions, in 2004. The decision was made on the basis of an environmental impact assessment (EIA) prepared in 2003. Landsvirkjun has placed great emphasis on mitigation measures to minimise negative environmental impacts, especially on fish stocks. However, after more than 10 years had elapsed, the agency was legally obliged to assess the need for a final or complete review of the EIA. The agency concluded that the impact of development on the landscape, its visual impact and implications for tourism and recreation should be reviewed. Work on the review is now underway, following a scoping of issues in 2016. In 2012 Landsvirkjun used the protocol for the first time to assess the preparation stage for Hvammur. The company subsequently commissioned an official assessment of the Blanda Power Plant in September 2013 (see pages 30 and 66).

The results of Landsvirkjun’s cost–benefit ratio calculation, and total capital expenditure were released to the public.

Landsvirkjun was inspired by its experience with the protocol to develop its own Geothermal Sustainability Assessment Protocol. This was recently applied for the first time on the Þeystaréykir project. Between geothermal and hydropower, Iceland’s electricity supply is 100 per cent renewable. Standard cost–benefit analysis (CBA) including socio-environmental costs is not practised as a practical evaluative tool in Iceland. However, all projects that were part of the national master-planning exercise had to list a range within which their capital costs would fall.

Landsvirkjun analysed Hvammur’s economic viability in great detail, including sensitivity analysis for the base, best and worst cases. A calculated cost–benefit ratio along with the total capital expenditure was made public. Most importantly, the economic aspects of the project were considered in detail by an independent expert group, as part of Iceland’s national master planning exercise.

In developing Hvammur, Landsvirkjun is engaged in a methodical and comprehensive planning process for future growth. The company is considering the need for power for energy-intensive industries and encouraging a diversification of users, including through a sea cable to either the UK or mainland Europe.

Detailed, independent economic studies can be integrated into master planning

Landsvirkjun had already estimated the cost of Hvammur in detail, including estimates of the costs of mitigation and compensation for social and environmental impacts. On this basis, the company developed a cost–benefit ratio on this basis, including financing costs. It also calculated an internal rate of return (IRR) and assessed worst- and best-case scenarios, as it does for all projects.

A study commissioned by Landsvirkjun concluded that continued development of Iceland’s renewable energy potential would have a considerable positive impact on the nation’s economy.

Integrating economic analysis into broader processes facilitates public involvement

The results of Landsvirkjun’s cost–benefit ratio calculation and total capital expenditure were released to the public. More broadly, the EIA and the national master planning processes have facilitated public involvement in analysing aspects of project development, including economic issues, in a comprehensive manner. The process has drawn on a diversity of expert opinion, incorporated public opinion and been discussed in parliament. Government at national and municipal levels has been involved and the process is open for public review and opinion.

Strategic basin planning has facilitated the project’s development

Early ideas for hydropower development of the lower Þjórsá river were discussed in the 1950s and 1960s close to and downstream from the Hvammur Farm. However, at the time, none of the projects were considered economically viable, as considerable storage was required to optimise the use of the discharge in the unharmed Þjórsá river, and it was not considered feasible to incorporate storage reservoirs for these projects inundating large farmed areas. Hydropower development in the upper Þjórsá river started in the 1970s when the first plant in the basin, the Búrfell hydropower plant, was commissioned. Later, five more hydropower plants were added upstream from Mount Búrfell as well as three storage reservoirs, all contributing to water regulation and storage.

Today the discharge in the lower Þjórsá river downstream from Mount Búrfell is highly regulated, and the Hvammur hydropower project can be developed with little storage, making the project economically viable. The Hvammur project will be operated as a part of an optimised power production network, which adds to the economic viability of the project.
Topic case study 8: Environmental and social issues management: Chaglla, Peru

Policy and practice lessons

- Methodical reporting procedures ensure systematic mitigation of impacts
- Independent third-party reviews boost performance and innovation
- Engaging with local communities and partners improves pre-project conditions

Key project features

Project stage: implementation
Developer/operator: Empresa de Generación Huallaga S.A. (EGH), a subsidiary of Odebrecht Energia S.A.
Capacity: 456 MW
Annual generation: 2,736 GWh
Reservoir area: 4.74 km²
Height of dam: 202 m

The Chaglla project is an example of thorough environmental and social risk assessment. All impacts of project construction and operation were comprehensively assessed, and there was excellent communication with local communities and environmental consideration.

There are no other hydropower plants on the Huallaga river, although a number of smaller plants are under construction in Huallaga. Environmental management is highly regulated in Peru. An environmental impact assessment (EIA) is required before a concession can be awarded by the Ministry of Energy and Mines (MEM). The EIA and environmental management plan (EMP) must be approved by a directorate within the MEM, with input from the agencies for water resources and protected areas. Another agency, the Agency for Environmental Assessment and Enforcement (DEFA), is responsible for overseeing compliance with the EMP.

The Chaglla project is financed by international institutions, so was also required to comply with international environmental and social performance standards. Socio-environmental issues and risks were assessed in two EAs and an environmental statement, and ongoing assessment of impacts and emerging risks is part of project procedures. The EIA covered associated facilities, such as access roads, quarries and borrow areas. A second, separately approved EIA addressed the transmission line. All impacts during construction and operation were comprehensively assessed.

The implementation of EMPs and project-specific management procedures guided the management of socio-environmental issues. A socio-environmental management system was established and audited internally, and processes were verified by a third party.

The Chaglla project appointed a sustainability team to implement its environmental, social, health and safety management plan.

Stakeholders were able to raise issues through a variety of means, and project-affected communities and regulators found the feedback to be thorough and timely. The project regularly reported back to DEFA on the EIA requirements, and to lenders and their consultants. These measures were successful in avoiding, minimising or compensating for the project’s potential or actual adverse impacts. The project has enhanced pre-project conditions through project-related activities and partnerships, and thanks to Odebrecht’s corporate sustainability programmes.

Methodical reporting procedures ensure systematic mitigation of impacts.

The Chaglla project established clear sustainability procedures and appointed a sustainability team to implement its environmental, social, health and safety management plan (EHS/EMP). The procedures covered management of identification of impacts, inspections and non-conformities, specific issues (waste management, potable water treatment, compensation for land acquisition), and risk and emergency response. For example, a procedure for the socio-environmental management programme described how the project would follow the corporate socio-environmental strategy and commitments. Procedures were regularly reviewed and modified.

Most of the socio-environmental programmes included ongoing monitoring of issues through investigations and analyses. The monitoring programme comprised a range of new risks and opportunities that became evident during implementation.

Monitoring and reporting systems deliver excellent contractor performance

The sustainability team supervised contractor compliance, undertaking periodic inspections and identifying opportunities for improvement. The EPC contractor identified and assessed impacts from each activity in a matrix format, linked to regulatory requirements. It reported on environmental and social management and sustainability indicators on a monthly basis. The regulator, DEFA, carried out annual environmental on-site inspections, and EGH sent DEFA an ‘annual environmental management report’.

Independent third-party reviews promote high performance and innovation

At the time of seeking project finance, the original 2009/2010 EIA and EMP were subject to a gap analysis to ensure compliance with IFC performance standards. The developer prepared additional assessments on fish and ecology, water quality modelling, downstream flow modelling, a resettlement action plan, and analysis of the project’s carbon footprint. The EMP was updated to incorporate the results of the analysis. A number of third-party review processes supported strong performance: lenders’ environmental and socio-environmental reviews; and an expert panel of three external environmental and social specialists with experience in hydropower and international standards.

Engaging with local communities and partners improves pre-project conditions

The project engaged community stakeholders through ongoing meetings with the directly affected population, both general and issue-specific; circulation of a monthly community bulletin; an ‘ethics line’; visits of EGH’s social officers; and community training. A local capacity-building programme entitled ‘Crear’ trained 1,489 people, of which 860 (26 per cent women) worked on the project. A waste management centre was set up to sort, re-use, recycle and dispose of all types of waste, achieving 100 per cent composting of organic wastes; discovering and registering new species; and supporting national parks with the publication of biodiversity books; and facilitating the recognition of, and support for, protection of the highly biodiverse Carish range of forest, a recognised ‘important bird area’.

Posters showing the free community bus service provided by the project

This case study is based on an official assessment of the Chaglla project using the implementation stage tool of the Hydropower Sustainability Assessment Protocol. This was conducted in 2015, with an on-site assessment in June 2015.
Erosion and sedimentation: Blanda, Iceland

Policy and practice lessons

- Catchment-wide research allows in-depth understanding of geomorphology
- Partnerships with habitat restoration experts maximise success in catchment revegetation
- In-river geomorphological changes can also deliver benefits for local communities

Key project features

Project stage: operation
Developer/operator: Landsvirkjun
Capacity: 150 MW (3 x 50 MW units)
Annual generation: 800 GWh
Reservoir area: Blöndulón 56 km² and Gilsárlón 5 km²
Head: 287 m
Purpose: power generation
Commissioning: 1991

The Blanda project carried out one of the largest revegetation and erosion control programmes in Iceland’s history. This case study demonstrates how the project’s efforts to reduce sedimentation and erosion have benefited local communities and biodiversity.

Blandala lies on the fringe of the central highland plateau, with gentle hills and heathland on shallow soils. The climate in the area is dry, cold and windy, with a mean annual precipitation of 400 mm and a mean annual temperature of 0.6 °C.

Blöndulón reservoir is formed by two dams, on the Blanda river and the Kolkukvísl river, and water is diverted through 9,800 m of diversion canals and four lakes to an intake reservoir (Gilsárlón). From Gilsárlón, the water runs through a 1,300 m canal and a 347 m headrace tunnel, before dropping vertically through a 216 m penstock to the underground power station. From the turbines, the water flows through a 1,700 m tailrace tunnel into the Blanda river.

The Blanda river used to be a highly turbid glacial river. It presents an interesting example of a system that has, in the view of affected communities, largely benefited from trapping sediment in an upstream reservoir. River banks have stabilised, primary productivity has increased due to greater light penetration, abundance of aquatic life has increased, and the opportunities for angling have improved.

The project’s development had few adverse environmental and social impacts. One of the most significant impacts, the loss of vegetation and sheep grazing lands to create the reservoir, has been compensated by a large-scale revegetation programme. The area that was inundated was once an area with high-quality soils, the best land for sheep grazing in the region. The absence of vegetative and soil cover is a national environmental problem in Iceland, so the loss of these fertile soils prompted widespread concerns. This resulted in one of the largest revegetation and erosion control programmes in the country’s history. Extensive revegetation efforts have been and are being undertaken to compensate for and extend well beyond the loss of the grazing area.

Watershed-wide research allows in-depth understanding of geomorphology

Landsvirkjun and researchers have studied the geomorphology of the Blanda river system in depth. Any changes to erosion and sedimentation that would positively or negatively affect power generation or other river uses will be identified through a broad array of monitoring initiatives:

- long-term suspended sediment sampling was undertaken at the Langamýri gauge downstream of the power station from 1965 to 2011; this data was used in baseline geomorphology studies and pre-and post-project sediment rating curves;
- samples of suspended and bedload sediments have been taken regularly across the basin;
- glaciological research has been established upstream;
- aerial pictures and site visits of the downstream river reach and the river mouth were used to monitor channel stabilisation; and
- data and studies have either been published or are accessible in the Iceland Meteorological Office database.

Shoreline erosion and sediment accumulation in the Blöndulón reservoir are monitored. For example, a bathymetric survey using echo sounders was conducted in 2012 as part of a Landsvirkjun programme to survey all reservoirs, which will be repeated every five to 10 years.

Partnerships with habitat restoration experts maximise success in catchment revegetation

The revegetation programme compensates for the loss of grazing land and avoided displacing grazing pressure onto soils susceptible to erosion.

Silt or dust storms are typical in Iceland, where much of the landscape is not covered by vegetation due to harsh natural conditions and centuries of overgrazing and wood harvesting. At low water levels and high winds, sediment from the exposed area can be windblown. Sand then settles close to the reservoir, threatening to cover the low vegetation, whilst fine silt is blown further and can be a nuisance.

In partnership with the Icelandic Institute of Natural History, Landsvirkjun has established measures to stabilise areas of land around the reservoir affected by windblown sand. This includes the application of fertiliser to encourage plant growth, and fencing to prevent grazing if dust storms were to become a more regular occurrence; there is an intention to replicate Landsvirkjun’s ongoing monitoring programme from the Kárhúnukar project.

In-river geomorphological changes can also deliver benefits for communities

As a glacial river, the Blanda river was carrying high sediment loads of around 57,000 tonnes per year. Damming the river has substantially reduced sediment load downstream to about 65,000 tonnes per year. However, the erosive capacity of the river is also reduced as spring floods are curtailed. The river has changed from a dynamic braided system with frequently changing channels to a largely static one, and gravel banks in the channel have become vegetated.

The project also had unanticipated benefits for local communities, arising from altered river geomorphology. The effects of the project on erosion and sedimentation are generally seen as positive by the local population. Angling – in particular for salmon – has significantly increased, both because the river provides a better habitat and because of increased visibility. It was also possible to relocate the national road from Blöndúslón to Alkeyur as the river was stabilised and flooding reduced.

This case study is based on an official assessment of Blanda using the operation stage tool of the Hydropower Sustainability Assessment Protocol. The assessment was conducted in 2013, with an on-site assessment in September 2013.

Blanda

ICELAND

The Blanda project power station

Over 500,000 t reduction in sediment load downstream

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This case study is based on an official assessment of Blanda using the operation stage tool of the Hydropower Sustainability Assessment Protocol. The assessment was conducted in 2013, with an on-site assessment in September 2013.
Financial viability: Murum, Malaysia

Policy and practice lessons

- Sophisticated risk analysis and monitoring against key performance indicators played an essential role in cost control
- Board-level oversight of updated analysis ensures financial viability is kept on track

Key project features

Project stage: implementation
Developer/operator: Sarawak Energy Berhad (SEB)
Capacity: 944 MW
Annual generation: 6,000 GWh
Reservoir area: 245 km²
Height of dam: 145 m
Purpose: power generation
Commissioning: 2014–15

The Murum project takes its name from the Murum river, in the uppermost part of the Rajang river basin. The project is located approximately 200 km from Bintulu, in the Malaysian province of Sarawak, on the island of Borneo.

Murum is the second project to be constructed in a plan comprising four hydropower projects on the upper Rajang. This is part of a broader Government of Sarawak strategy, the Sarawak Corridor of Renewable Energy (SCORE), to develop their infrastructure in a timely manner; and higher-than-anticipated costs. The ability of any project to sustain the provision of its wider economic benefits, and its management of social and environmental concerns, depend on financial viability. Cost overruns, especially at the implementation stage, are common. SEB applied its well-developed financial management, analysis and monitoring procedures at corporate and project levels, and financial risks were regularly assessed with respect to the project.

Sophisticated risk analysis and monitoring against key performance indicators played a key role in effective cost control

SEB undertook a full assessment of the Murum project’s financial viability, including an analysis of costs and revenue streams, and the revenue implications of obligations in the power purchase agreement.

The company also carried out a detailed risk analysis, identifying risks such as: financial responsibility for provisional sums in the EPC contract; impoundment date obligations not being met or other sources of delays in impoundment; off-takers’ abilities to develop their infrastructure in a timely manner; and higher-than-anticipated costs.

To keep a regular check on costs, SEB monitored the project’s financial situation on a monthly basis. Updates on costs and project delivery risks were set out in monthly reports. The reports compared project milestones with actual progress, cost overviews, progress analysis and risk management.

The company’s planning and strategy department was responsible for financial optimisation, reporting to the CEO on key performance indicators. This included maintaining the company’s external credit ratings, which was established as a target.

Board-level oversight of updated analysis ensures financial viability is kept on track

SEB applied cost tracking and control measures using systematic processes. Uncertainty around provisional sums in the EPC contract were resolved through board-approved renegotiation and the higher contract price included in financial planning and viability assessments.

A CCE (current cost estimate) process was incorporated into the project execution team’s responsibilities. For example, it was on the basis of the second CCE that the board approved the renegotiation of the EPC contract.

Updated CCEs incorporating firmed-up revenue streams, such as power purchase agreements, were made during implementation. Maintaining the company’s high credit rating was established as an internal target, prompting active management of financial indicators to ensure this was achieved.

Monthly financial data were modelled to understand any implications for project viability, and the analysis was reported to the CEO, together with an assessment of impacts and solutions.

Spend-to-date analyses were included in monthly project reports, and any serious cost overruns were highlighted by the project manager, and escalated to board level. The planning and strategy department runs monthly risk tests for the whole business, including Murum as one of the factors. With this corporate financial backing and with the right systems in place, the project was able to cope with financial issues in a broad range of scenarios.

This case study is based on an assessment of Murum using the implementation stage tool of the Hydropower Sustainability Assessment Protocol. This was conducted in 2012, with an on-site assessment in April 2012, when construction was 66 per cent complete.

The Murum project was commissioned in December 2014. The fourth and final turbine was commissioned in June 2015. Bakun, immediately downstream and the first of the SCORE projects, was commissioned ahead of Murum.

This case study highlights a project financed with a corporate bond, and the measures put in place to ensure the company maintained its credit rating. The construction of Murum was financially viable, taking into account key uncertainties, and using financial contingencies.

The implementation stage tools for the Hydropower Sustainability Assessment Protocol were constructed by the Three Gorges Development Company, Malaysia (TGDCM) under a single contract with SEB. Filling of the reservoir began in July 2013 and the first generator was commissioned in December 2014. The fourth and final turbine was commissioned in June 2015.
The Santo Domingo project is subject to EPM’s comprehensive corporate governance and external management processes. This case study describes how these procedures are implemented to ensure transparency, legality, compliance and quality in project development.

The project is set to be developed on the Santo Domingo river, in the eastern part of the department of Antioquia. It will be situated 97 km from the department’s capital city, Medellín, where the Empresas Públicas de Medellín (EPM) headquarters are located. Antioquia is a hub of hydropower development, where 45 per cent of all planned projects registered with the Colombian Ministry of Energy and Mines can be found. The project area has been one of the worst affected areas in Colombia in terms of violence between armed groups and coca cultivation. The restoration of law and order and the peace process have prompted farmers to return to the area and has resulted in an intensification of agricultural land use.

EPM is Colombia’s largest generating company, with a market share of 22 per cent and an installed capacity of 3,218 MW, most of which comes from 25 hydropower stations. EPM is a public company, owned by the municipality of Medellín. It was founded in 1995 as an independent public institution and later transformed into an industrial and commercial state company. EPM is the parent company of a business group of 56 companies (22 based in Colombia and 34 internationally), in which it has a majority stake and management control through presence on their boards. The EPM group provides electricity, natural gas, water, sanitation, collection, recycling and disposal of waste, and telecommunications services.

As a leading public utility in Colombia, EPM has comprehensive corporate governance and external management processes. These cover key areas such as: occupational health and safety; sustainability; procurement; corporate social responsibility; transparency; ethics and corruption; human rights; stakeholder engagement; grievance mechanisms; risk management; and audits. EPM has a solid understanding of corporate and external governance issues, identifies corporate risks and opportunities through partnerships, and actively manages these parts of its continuous improvements.

The company makes information relating to corporate governance, projects and sustainability available publicly on its website. It also has a number of external initiatives focusing on improving policies within the energy industry and in Colombia, particularly on human rights. EPM also identifies key project-level issues relating to transparency, corporate governance and external management processes. This is done by setting up a corporate governance code for EPM, and ensuring that the code is regularly reviewed and updated.

Governance issues and opportunities for improvement are identified at corporate and project level

Political and public sector governance issues, and corporate governance requirements and issues, are comprehensively assessed across the EPM group. EPM’s integrated risk management system underpins business and project compliance and internal and external auditing processes. EPM has used the results of internal audits to implement between 200 and 300 improvement plans across the company. The system makes it possible to identify and address opportunities for improvement. For example:

- EPM has improved its internal processes to minimise the risk of corruption during land acquisition.
- An ethics line was set up in 2011, available on EPM’s webpage.
- EPM has developed guidelines on human rights to support the development of public policy in Colombia. The company also sent a representative to a UN discussion on human rights in Geneva.
- The company uses a balanced scoreboard as a tool for improvement, including assigned responsibilities.
- The company has improved its response times to community requests, claims and land issues.

EPM has identified project-level issues relating to the Santo Domingo Action Plan, and risks associated with the project moving from the planning to construction phase, and from construction to operation. This was important for ensuring commitments to provide power are met.

Requirements for contractors are set out in the corporate governance model

EPM has a corporate governance model that establishes clear processes to manage corporate, political and public sector issues and risks. The model provides a balance between company growth, investor rights, and stakeholder access to information, transparency and ethics. Practices implemented include:

- A corporate governance model, setting out political risk guidelines for corporate group management;
- A corporate governance code establishing provisions, practices and measures for the municipality of Medellín and EPM to work together, and a code of conduct for EPM;
- A balanced scoreboard reporting process at institutional and group level;
- Assessment of issues and associated risks is undertaken using EPM’s integrated risk management policy and system (GRI). The GRI method, developed for EPM, complies with national and international best practice risk management practices;
- A compliance unit monitors legal and regulatory compliance, and oversees procedures for the control and prevention of money laundering, corruption and financing of terrorism;
- A corporate audit department undertakes internal audits across the business and coordinates external audits;
- A grievance mechanism and official phone line for issues, complaints and anonymous or unidentified claims;
- Transparency is managed through internal audits, the communications policy, and external reviews by Transparency Colombia and Medellin controlling office.

EPM has a code of conduct for suppliers and contractors, requiring them to have policies and standards consistent with the EPM group in the areas of human rights, labour standards (including occupational health and safety), environment, corruption and bribery, and information management and security. All contractors are required to register with EPM prior to working with the company, which includes signing up to its code of conduct. EPM contracts clearly outline the company’s expectations from contractors in terms of meeting corporate policies and legal requirements. Where contractors use subcontractors, they must also be able to demonstrate that their policies and standards are consistent with those of EPM.

Corporate governance procedures are transparent and information is publicly disclosed

EPM’s annual sustainability report is compiled from data collated from across the business. The report is reviewed externally and published on the EPM external website. EPM also publishes important project reports. EPM created a dedicated web page for one of its large projects under construction, giving access to the EIA and EMP, monitoring reports, the public utility declaration, environmental licence, contingency plan, management contract, tender, the EPM’s annual report, and regular project newsletters. EPM reports against sustainability indices from project level up to institutional level. External reviews by Transparency Colombia, Deloitte and Dow Jones Sustainability Index rank EPM highly in its governance practices.
The Jostedal project demonstrates how comprehensive monitoring of hydrological resource and analysis based on climate trends and climate change scenarios provides reliable assessment of medium- and long-term water availability. Jostedal PP is located on the east side of the Jostedalen valley, in western Norway. The Jostedala river runs through the valley, emptying into a fjord, Sognefjord, at the settlement of Gaupe. The project utilises the run-off from a 144 km catchment area, situated at an elevation of 1,200 m. Water is stored in two reservoirs. The main reservoir is Styggevatn, at the northern end of the Jostedala valley. This reservoir can store one and a half years of average inflow. From Styggevatn, an underground penstock carries water down the eastern side of the valley to the power plant, taking in additional water from a further 18 intakes. Kupvatn and Styggevatn, and streams to the west of the valley, are fed by Jostedalsbreen, the largest glacier on the European mainland. Jostedal is a multipurpose project, built to manage damaging summer and autumn floods resulting from glacier melt and rain. Flood protection is a serious concern in the valley, which has experienced two major floods.

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As part of routine medium- to long-term planning, Statkraft uses climate change scenarios in addition to the standard trend analysis tools.

Styggevatn reservoir with dam in the foreground, and the curving Austdalen glacier in the far background.

• Use of climate trends and climate change scenarios provides comprehensive predictions of water availability
• Long-term perspective, including attention to climate change, meets dual purposes of flood control and spill avoidance, with flexibility to adapt to future changes
The Keeyask project was developed by Manitoba Hydro (MH) in partnership with four Cree Nations communities affected by the project. This case study demonstrates best practices in engaging and working with indigenous peoples, respecting culture and livelihoods, achieving consent and providing significant benefits.

The proposed Keeyask hydropower project is located on the lower Nelson river, at Gull Rapids, upstream of Stephens Lake in northern Manitoba. Project construction is projected to take approximately eight and a half years, from June 2014 to November 2022. It was estimated that the first of seven units would begin generating power in November 2019. The reservoir will cover an area of 45 km², and was predicted to expand by 7 to 8 km² over the first 30 years of operation. This would be due to erosion of mineral soil shorelines and peat-land disintegration. The project is designed to operate in either base loaded or peaking modes, using 1 m of water head.

The KCN conducted their own environmental assessments based on the Cree worldview. Communities affected by the project: Tataskweyak Cree Nation and War Lake First Nation (acting as the Cree Nation Partners), York Factory First Nation, and Fox Lake Cree Nation. MH is to own 75 per cent of the partnership equity and the Keeyask Cree Nations had the right to own up to 25 per cent of the partnership.

Keeyask is located in the ancestral land of the four aboriginal partner communities, comprising around 5,500 people, known as the Keeyask Cree Nations (KCNs). Affected aboriginal communities were given the option of becoming investing project partners and receiving revenues. These communities decided to become partners through referendums in each community. The project partnership agreement was signed in 2009 and involved extensive negotiations and inclusive and participatory consultations with directly affected aboriginal communities. The project provided legal and advisory support and capacity-building throughout this process.

Environmental and social studies took a comprehensive approach to considering the views and local knowledge of the affected aboriginal communities. MH also reached agreements with the communities to address the adverse impacts of the project. These agreements address impacts of the project from a community-based perspective, and build on previous agreements to address legacy issues from earlier hydro developments.

The project took a comprehensive approach to incorporating local knowledge
MH provided financial support to the KCNs to participate in the assessment, regulatory licensing and agreements. The process involved establishing a number of processes and committees, such as: a partnership and licensing committee; an assessment coordination team; and a number of working groups involving multilateral stakeholders and representatives of MH and each of the KCNs. These committees and processes gathered the appropriate representation of indigenous peoples, knowledge and cultural sensitivity. Each of the KCNs also conducted their own environmental assessments based on their Cree worldview. These assessments were filed in the licensing process along with the technical regulatory assessment required by the provincial and federal authorities.

Consent was achieved through community benefits including revenue sharing plus continuous engagement and involvement of indigenous peoples in decision-making
The project partnership agreement was developed between 1998 and 2009, and involved extensive negotiations and consultations between MH and KCNs. Engagement included a range of processes, including: working and reference groups, convened for the environmental and social aspects; regular open community meetings; off-reserve meetings; and websites created by the communities and the project. Consultations considered the aboriginal traditional knowledge and cultural practices. All four First Nations approved the partnership agreement and the agreement to address adverse effects through a democratic referendum process. The project partnership agreement was public and legally enforceable, and addresses aspects of project development, potential income opportunities, and training, employment and business opportunities for the KCNs. The project also provides financial support to implement the partnership and maximise anticipated benefits.

Agreements addressed impacts beyond compensation and legacy issues
The partnership agreement provides benefits that go well beyond simply providing mitigation and compensation for adverse effects. For example, the agreement includes a provision for the KCNs to enter into a project-ownership arrangement by investing their own money according to a defined plan. Each KCN is able to choose between two different investment options, with different levels of potential risk and possible reward. One of these options provides a guaranteed minimum return on investment. A KCNs investment option is chosen at the end of construction when final capital costs are known.

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Each KCN signed an adverse effects agreement with MH in 2009. These agreements aimed to avoid, mitigate and replace and compensate project impacts on KCNs with a focus on improving KCN livelihoods and living standards. The adverse effects agreements also provided elements beyond compensation, for strengthening cultural identity, lifestyles, values and aboriginal traditional knowledge and skills. Depending on community, the agreements contained programmes related to resource access, the Cree language, land, environmental stewardship, gravestone restoration, traditional life and knowledge, and oral histories and cultural sustainability. In addition, each of the four KCNs had separate agreements with MH to provide compensation for legacy issues in relation to previous hydropower developments in northern Manitoba.

The project provided support to manage revenues and maximise benefits
The revenue generated through the partnership is to be deposited into individual KCNs’ trusts, and each KCN will decide on how it is invested. This was stated in the partnership agreement. Revenues could be invested in priority activities, such as new infrastructure. The project revenues are to be a sustained source of income that contributes to each KCN’s development. The compensation payments set out in the adverse effects agreement are also deposited into a trust fund, and used for mitigation programmes intended to strengthen the KCNs’ culture and traditional practices.

The project also provided training and work experience in construction activities for KCN members. This would allow them to find other stable jobs in the future. This was facilitated through the ‘Hydro Northern Training and Employment Initiative’, a multi-year training programme designed by MH, affected aboriginal communities and the provincial and federal government to prepare northern aboriginals for employment on hydro and community projects.

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The Sogamoso project was designed and implemented to ensure that people, property and the environment are protected from the consequences of dam failure and other significant infrastructure risks. This case study presents best practices in managing infrastructure and public safety.

The project is situated in north-east Colombia, in the department of Santander. The dam and its reservoir are located in the municipalities of Grün, Betulia, Zapatoca, Los Santos, Lebrija and San Vicente de Chucurí. Sogamoso consists of a 190 m concrete-faced rockfill dam and an underground powerhouse. The mean river discharge at the dam site at the time of the assessment was 471.3 m³/s.

The project requires the construction of 50 km of roads and associated bridges and tunnels, and is located in a region of high seismic activity. There is a population of around 11,000 people exposed to project-related infrastructure risks around the reservoir and below the dam. This population is scattered in small settlements and dispersed along the riverbanks. Sogamoso was designed to deliver both base and peak power. The operating modes will significantly alter flows and water levels downstream of the dam.

Public safety around the site is also being affected by an increase in road traffic during construction.

Key project features

- Project stage: implementation
- Developer/operator: ISAGEN (acquired by Brookfield in 2016)
- Capacity: 120 MW
- Annual generation: 5,056 GWh
- Reservoir area: 69.6 km²
- Height of dam: 190 m
- Purpose: power generation

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The project addressed a range of safety issues set out in regulatory requirements and ISAGEN’s own policies. It identified and assessed potential dam failure scenarios, such as leakage, overtopping, structural instability, earthquakes and logjams. These were incorporated into the project design during preparatory studies.

ISAGEN assessed hydraulic conditions through both mathematical and physical scale models. Each contractor was required to appoint a licensed industrial safety inspector. The project was fitted with instrumentation to monitor the drainage and structural stability at the dam. There was continuous monitoring of hydrological and seismic conditions, and the quality of construction and equipment.

Manual monitoring of the dam was carried out in case of instrumentation errors. ISAGEN staff accompanied the industrial safety inspectors on their rounds to identify opportunities for safety-related improvements. Relevant staff took part in committee meetings every two weeks, focusing on safety risks and opportunities. Any issues that could not be resolved at these meetings were passed on to a construction works committee.

The emergency response plan was put to the test twice in 2011. The effectiveness of the plan was put to the test twice in 2011, when extreme floods threatened to overtop a coffer dam. Overtopping did not happen, but the plan was nevertheless implemented successfully, proving its efficiency and design across all responsible parties.

Infrastructure and public safety issues are assessed and monitored according to a wide range of scenarios.

The Sogamoso project was designed and implemented to ensure that people, property and the environment are protected from the consequences of dam failure and other significant infrastructure risks. This case study presents best practices in managing infrastructure and public safety.

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The Trung Son project demonstrates how regular and detailed monitoring can ensure projects progress according to schedule, and enables early identification of emerging risks.

Trung Son is located on the Ma river, the fifth largest river in Vietnam. The Ma rises in the north-west of the country, running through north-eastern Laos and re-entering Vietnam just upstream of the project site. The power station is located in the province of Thanh Hoa.

Three main contracts were used in the development of the project:
- The main construction works, implemented by a consortium of Samsung (South Korea) and CGCC (Vietnam), with five principal subcontractors, including design of works drawings, drilling and consolidation grouting for the dam foundation, excavation of the emergency spillway, and hydro-mechanical equipment installation, supply of instrumentation and technology transfer;
- Hydro-mechanical equipment, delivered by a Vietnamese consortium, with four subcontractors; and
- Design, supply and installation of the electro-mechanical equipment by a joint venture between HydroChina and Toshiba.

This reduced the risk of violations or shortcomings affecting the project schedule. The Thanh Hoa province Department of Industry and Trade (EXT) and Department of Construction (DC) were responsible for supervising industrial management and quality control respectively.

The DIT carried out biannual inspection trips to the project site to check progress and control quality, reporting to national ministries on a quarterly or annual basis. A team of four from the DC visited the site four times a year for quality control.

Multiple levels of monitoring and review ensure timely construction and correction of early delays

Monitoring of all construction-related issues, including budget and interface issues, was conducted by the supervision consultant, TSHPCo, and the contractor. This ensured that the construction was proceeding according to schedule and within budget. The supervision consultant oversaw the integrated management of the project in cooperation with the main contractor, Samsung/CGCC. This ensured that the works were generally progressing according to schedule and within budget. The main contractor and the supervision consultant worked closely together to identify risks.

The supervision consultant could address anticipated risks before they negatively affect the implementation of the project. The supervision consultant was also in a position to control quality, reporting to national ministries on a quarterly or annual basis. A team of four from the DC visited the site four times a year for quality control.

Independent technical review provides further check on quality of construction

The Trung Son project had a comprehensive construction quality control plan with clear assignments of responsibilities. TSHPCo and the supervision consultant oversaw the integrated management of the project. The main contractor and the supervision consultant worked closely together to identify risks.

The supervision consultant could address anticipated risks before they negatively affect the implementation of the project. The supervision consultant was also in a position to control quality, reporting to national ministries on a quarterly or annual basis. A team of four from the DC visited the site four times a year for quality control.

Implementation plans addressing anticipated risks reduce construction delays

The Trung Son power generation, flood protection, and resettlement project site is on the Ma river in Vietnam. The project was commissioned in 2017 and is located in the province of Thanh Hoa. The project was developed by Son Power Company, a wholly owned subsidiary of the state-owned Vietnam Electricity (EVN). The World Bank provided a loan for a large part of the project cost.

Project management at Trung Son was based on a project operation manual and detailed sub-plans. Monitoring was conducted daily, weekly, monthly, bi-monthly and annually, including a main monthly report with detailed progress charts. The project had a comprehensive construction quality control plan with clear assignments of responsibilities. TSHPCo and the supervision consultant oversaw the integrated management of the project in cooperation with the main contractor, Samsung/CGCC. This ensured that the works were generally progressing according to schedule and within budget. Government authorities also monitored construction progress and quality.

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Key project features

- Project stage: implementation
- Developer/operator: EVN and Trung Son Power Company
- Capacity: 260 MW, with four Francis units
- Annual generation: 1,019 GWh
- Reservoir area: 13 km²
- Height of dam: 84.5 m roller-compacted concrete dam
- Purpose: power generation, flood protection
- Commissioning: 2017

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Multiple levels of monitoring and review ensure timely construction and correction of delays

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Implementation plans addressing anticipated risks reduce construction delays

Monitoring addressed internal and external risks. Numerous risks were identified and addressed, such as problems with the construction power supply, spoil dumps, and late excavations.

Whenever a new risk was identified, measures for its control were set out in a work programme and implementation schedule, setting out short-term targets including monitoring.

Opportunities to speed up progress were taken in some cases, such as during the excavation works. Contractors were also required to monitor external risks, for example meteorological risks.

Independent technical review provides further check on quality of construction

TSHPCo appointed a project technical advisory panel based on terms of reference agreed with the World Bank, which was a continuation of the dam safety review panel used during project preparation. The panel provided external advice and monitoring of issues affecting construction, focusing mainly on safety issues, but also encompassing broader construction management risks and the avoidance of construction interface risks.
Labour and working conditions: Santo Antônio, Brazil

Policy and practice lessons

- Risk-mapping and operational analysis provide a basis for specialised safety procedures
- Unified system facilitates health, safety and environmental management
- Human resources managers provide multiple levels of oversight
- Strict standards applied equally to all contractors and sub-contractors
- Workers’ commission provided regular forum for communications
- Variety of training opportunities fosters employee satisfaction
- Loyalty incentives promote staff retention

The Santo Antônio project required up to 20,700 workers during its construction phase, but faced strong competition for qualified labour in the region. This case study demonstrates how the project provided excellent worker satisfaction and retention.

The Santo Antônio project is located on the Madeira river, 7 km upstream of the city of Porto Velho, the capital of Rondônia state in north-west Brazil. The Madeira river is a major tributary of the Amazon, the world’s largest river in terms of run-off volume. The Santo Antônio project is designed to make maximum use of the water resource potential, with minimal negative impact on the Amazon region. The project required a large number of workers – up to 20,700 in 2011. However, other large hydropower projects being developed in the Amazon region, combined with a construction boom across various sectors, meant fierce competition for qualified labour. The potential consequences of this included higher staff turnover and upward pressure on salaries.

Construction on Santo Antônio began in September 2008, when the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) issued an installation licence. The dam was closed and reservoir filling began in September 2010, following the issue of the operational licence. The first two turbines became operational in 2012, but the plant was only completed only in 2016, following an extension that added additional capacity.

SAE and the consortium members focused intensively on workers’ needs and safety. They put in place systems for continuous monitoring and auditing by external parties. Implementation of safety requirements was delivered through a project-wide health, safety and environmental management system (OSTMAs). The OSTMAs standards applied to everyone, including sub-contractors. Each new contractor was given a risk assessment and constantly followed up and scored on performance.

A specific programme for staff retention included a workers’ commission of representatives and an ombudsman system.

The project’s policy was to focus on quality rather than cost when hiring staff. The workers’ facilities were world-class, offering good, healthy food, excellent and well-staffed medical facilities, air-conditioned lodging and plenty of clean showers and toilet facilities. Workers remarked that the leisure and social facilities were the ‘best’ they had ever experienced.

A specific programme for staff retention was put in place. This included a workers’ commission of representatives and an ombudsman system, through which workers could report grievances.

Risk-mapping and operational analysis provide a basis for specialised safety procedures

SAE initially assessed occupational safety risks on the construction site using a methodical risk-mapping process. This consisted of mapping 10 risks, each of which were evaluated in terms of the dangers involved and the importance of the risk. Combining this with the number of people involved, and the seriousness of potential outcomes, produced a probability–consequence risk rating for each activity. Higher ratings required an additional round of assessment, with an operational analysis conducted by a health, safety and environment team.

This led to the definition of special procedures for specific risks, such as electrical work, work in confined spaces and work at height.
Unified system facilitates health, safety and environmental management

SAE, CCSA and all contractors were required to use a unified system (SSTMA) to manage occupational safety risks. The system is guided by a policy document and described in a fully detailed manual. It covers aspects such as, but not limited to: legal documentation; risk assessment and management; sanitary conditions; preventive health care; personal protective equipment (PPE); accident prevention; work at height; work in confined spaces; work with electricity; safety signage; blasting; emergency procedures; training; safety inspections; and investigations of accidents. Safety themes for the day were discussed at morning meetings, each day.

Human resources managers provide multiple levels of oversight

SAE’s and CSAC’s special purpose human resources and HSE staff monitored the application of systems and the emergence of issues. They analysed trends in accident and turnover rates, and identified opportunities on other projects for demobilised workers.

A range of organisations were involved in auditing personnel and safety practices: government bodies, i.e. the national electrical energy agency (ANEEL); the Ministry of Labour and the regional superintendent for labour; an independent auditor, as part of the SSTMA, every six months; and auditors assessing compliance with the IFC performance standards, appointed by financiers.

Strict standards applied equally to all contractors and subcontractors

SAE’s and CSAC’s safety standards were applied equally to all contractors and subcontractors. Each new potential contractor was subject to a comprehensive risk analysis before contracting. An initial meeting was held once the contract had been signed to conduct detailed analysis and definition of critical risk vectors for which management measures would be necessary. Each employee was given four hours of initial training and a set of performance criteria to be evaluated on a monthly basis. Each contractor knew their employees’ results and areas for improvement. Workers had to show evidence that they had passed the safety training in order to gain access to the project site.

CSAC carried out monthly checks to ensure that contractors were conforming with their contractual obligations, using a system of 0–5 performance scores.

Workers’ commission provided regular forum for communications

There were three main channels through which workers could report any grievances:

• the worker’s immediate supervisor;
• an anonymous ombudman system, giving responses within a maximum of 48 hours; and
• a workers’ commission, i.e. a group of workers’ representatives.

The commission coordinators met three times a week to discuss day-to-day issues, and any issues reported to line managers for immediate action. If this did not yield a satisfactory resolution, the issue would then be escalated to the next level. If still not resolved at that stage, it would then be raised to the CSAC ombudman. The aim was to create good conditions for all workers.

Typical issues raised included workers’ safety; personal health; technical skills; training opportunities, in areas such as: work safety; personal health; technical skills; health and safety courses related to the worker’s function; and technical courses appropriate to the worker’s function. Whenever a worker was promoted, they were offered 45 days of preliminary training, after which the promotion was either approved or rejected. Programmes for leadership were offered at all levels.

There were also special campaigns in areas such as sexual health, combating violence against women, and sexual abuse of minors and adolescents.

Every first Wednesday of the month, members of the workers’ commission met company representatives including the HR department. This approach had a significant positive impact on communications, and on workers’ safety.

Variety of training opportunities fosters employee satisfaction

Workers were offered a number of different training opportunities, in areas such as: work safety; personal health; technical skills; health and safety courses related to the worker’s function; and technical courses appropriate to the worker’s function. Whenever a worker was promoted, they were offered 45 days of preliminary training, after which the promotion was either approved or rejected. Programmes for leadership were offered at all levels.

There were also special campaigns in areas such as sexual health, combating violence against women, and sexual abuse of minors and adolescents.

Loyalty incentives promote staff retention

Stiff competition for qualified workers in Brazil prompted the project to develop a special programme for labour retention.

The programme included benefits linked to a worker’s period of employment, including salary increments after every six months of employment (up to 18 months). The living and recreational facilities provided to workers were also a major factor in employee satisfaction.

The project was careful to support workers in their adaptation to Brazil; and workers’ accommodation to adapt to society; and

Examples of best practice:

• the HR policy included a statement to “hire the best” – cost was considered secondary and candidates were often handpicked;
• the project was involved in a Brazil-wide initiative to improve conditions of work in the construction industry, providing access to experience from other companies and sectors;
• suggestion boxes were placed around the construction sites and workers’ accommodation to identify potential improvements;
• the project had a commitment to avoid rules or defined practices that restrict equal opportunities in terms of race, gender, etc;
• a special programme was established for a group of Haitian refugees to assist with their adaptation to Brazil;
• a special programme enabled prisoners to work on site during the day, in order to assist with their rehabilitation and re-adaptation to society; and
• a professional nutritionist was employed to manage the kitchen and plan meals.

This case study is based on an official assessment of Santo Antônio using the implementation stage tool of the Hydropower Sustainability Assessment Protocol. This was conducted in 2014, with an on-site assessment in April-May 2014.

46 Case study: Topics

Better Hydro

47
**Topic case study 17: Procurement: Sogamoso, Colombia**

**Policy and practice lessons**
- Rigorous processes ensure equitable, efficient, transparent, accountable, ethical and timely procurement
- Incorporated anti-corruption measures in pre-qualification criteria enables screening of suppliers
- Dedicated programmes create opportunities for local suppliers and capacity development

**Construction of Sogamoso involved around 150 companies providing goods and services. This case study demonstrates how well planned and implemented processes can support efficient and effective procurement and boost local employment.**

Sogamoso is located in north-east Colombia, in the department of Santander. The dam and its reservoir are located in the municipalities of Girón, Betulia, Zapataca, Los Santos and San Vicente de Chucurí. The project’s area of influence extends into the lower Sogamoso river area, until it flows into the Magdalena river. Sogamoso’s development required the construction of 30 km of access roads, replacement of some infrastructure located in the reservoir area, and construction of over 60 km of transmission lines and a switchyard. The power plant has three vertical-shaft Francis turbines, each with a capacity of 278.8 MW. The construction required an investment of approximately US$ 2.3 billion, 40 per cent financed by shareholders’ equity and 60 per cent by commercial financing. The plant started operations in December 2014, increasing ISAGEN’s share of total generation to 60 per cent. The project provides 3.8 per cent of annual energy consumption in Colombia.

**Procurement**

**Project features**
- **Project stage:** implementation
- **Developer/operator:** ISAGEN (acquired by Brookfield in 2016)
- **Capacity:** 180 MW
- **Annual generation:** 5,056 GWh
- **Reservoir area:** 69.6 km²
- **Height of dam:** 190 m
- **Purpose:** power generation

**Construction**

Sogamoso involved around 150 companies providing goods and services. Important issues within this topic relate to the implementation of fair and transparent procurement and supplier selection processes, measures to avoid corruption and unethical practices, and procuring quality goods and services that are delivered on time and budget.

Construction of Sogamoso involved around 150 companies providing goods and services, including equipment suppliers, contractors and subcontractors. The major contracts that governed the project included: construction of the main civil works, undertaken by ICT Group; construction of the new Bucaramanga–San Vicente de Chucurí road, undertaken by CONALUVAS, assembly of the electromechanical equipment, undertaken by the Consalfa-Hidrosogamoso Consortium; design and manufacturing of the turbines, undertaken by Andritz Hydro; detailed design and advisory services, provided by INGITEC S.A.; and manufacturing of electromechanical equipment by Mutsumi and Toshiba (generators), Siemens (electrical), Consalfa and ABB (control systems).

**Rigorous processes ensure equitable, efficient, transparent, accountable, ethical and timely procurement**

ISAGEN has a dedicated procurement management unit, responsible for implementing its corporate procurement policy and maintaining and updating methodologies for quality management. ISAGEN’s policy is based on the principles of equality, morality, effectiveness, promptness, fairness, publicity, efficiency, supervision, self-control, corporate responsibility and integrity. Open tenders are published on the ISAGEN website and a national newspaper for a fixed period, and feedback on tender clarifications is given to all bidders. ISAGEN has a supplier relations policy based on the principles of diversity, coherence, collaboration and openness. The company also respects the minimum requirements set out by the International Labour Organisation (IL0).

ISAGEN’s audit team reviewed the project contracts every three months. Owners and engineers prepared a balanced score card for ISAGEN’s management committee on a monthly basis. ISAGEN’s procurement management team monitored the progress and spending within the project contracts every two weeks. This process meant that risks could be identified and adjustments made, such as extending the end dates of contracts or increasing the budget and resources for key milestones.

**Incorporation of anti-corruption measures in pre-qualification criteria enables screening of suppliers**

ISAGEN’s procurement processes include anti-corruption measures and criteria specified in pre-qualification screening. Prior to the start of any contractual relationship, ISAGEN commissions an independent company to undertake screening to ensure companies have not been blacklisted for terrorism, money laundering, human rights violations, or environmental issues. The same company manages a database and registration record of suppliers. ISAGEN used an internal system to prevent money laundering and employed a safety model for IT to ensure information was shared securely with suppliers. Another company carried out a risk assessment for fraud, which prompted ISAGEN to develop a fraud risk management policy.

ISAGEN’s policy is based on the principles of fairness, publicity, efficiency, supervision, self-control, corporate responsibility and integrity. This case study is based on an assessment of Sogamoso using the implementation stage tool of the Hydropower Sustainability Assessment Protocol. The assessment was conducted in 2012, with an on-site assessment in October 2013.

**Key project features**

- **Project stage:** implementation
- **Developer/operator:** ISAGEN (acquired by Brookfield in 2016)
- **Capacity:** 180 MW
- **Annual generation:** 5,056 GWh
- **Reservoir area:** 69.6 km²
- **Height of dam:** 190 m
- **Purpose:** power generation

**Case study: Better hydro**

Construction Under this programme, contractors were contractually obliged to offer opportunities to local suppliers where possible. The programme was included in the environmental and social management plan. ISAGEN established an employment committee to receive and organise applications for unfilled positions, and to maintain direct and timely communications with the employers. This committee was made up of representatives from the project’s area of influence. When contractors were unable to obtain resources or goods locally, they were required to propose alternatives to ISAGEN for approval. The company also developed a programme for supplier capacity development, with the aim of boosting the capacity of local suppliers to enable them to access project contracts. Six suppliers participated in this programme out of the 25 invited.

ISAGEN evaluated contractor performance based on a number of criteria, including: the Sarbanes-Oxley (SOX) into the review process; and an online course for employees on human rights, corruption and fraud risk management. The company implemented a number of other anti-corruption measures, including: inserting clauses into contracts to prevent money laundering and terrorism-related activities; a corporate anti-corruption plan; and a corporate statement of ethical practices. ISAGEN’s ethical phone line was in use for the project, and no corruption issues were reported.

**Dedicated programmes create opportunities for local suppliers and capacity development**

ISAGEN developed a ‘local labour involvement programme’ to prioritise local and regional employment for the project.
Topic case study 18: Project-affected communities: Itaipu, Brazil–Paraguay

Policy and practice lessons

- Ongoing and effective communication processes over 30 years ensure good relations with affected landowners
- Multiple uses of the reservoir benefit local economies in two countries
- The project contributed to better long-term living standards

Itaipu is an example of an operating project developed in the early 1980s that has fulfilled its commitments to economically displaced people, delivered additional benefits to landowners and farmers neighbouring the reservoir area, and promoted new business opportunities in affected municipalities.

Itaipu hydroelectric project is located on the Paraná river, on the border between Brazil and Paraguay. The Paraná river is among the largest in the world, by length and discharge. In 2014, the project provided 79 per cent of Paraguay’s and 14 per cent of Brazil’s energy supply. The Itaipu dam was built between 1975 and 1983. The 170 km reservoir reached its operating level in 1984, and covers an area of 1,350 km² over 16 municipalities in Brazil and five municipalities in Paraguay.

The land cover in the inundated area included fruit trees, timber, crops (e.g., corn, rice, manioc, coffee and soya), cattle farming, and riparian forest. Land acquisition affected landowners, tenants, and occupants in the reservoir area, construction areas and work camp sites, reservoir protection areas and other ancillary facilities. In the long term, the project developed a number of public infrastructure facilities, such as ports, schools and churches, used by affected people.

The ‘Itaipu Binacional Treaty’ and laws promulgated in the 1970s set out the procedures for land acquisition and compensation. In addition, the project prepared a reservoir masterplan in 1982, which is intended to promote recreation, tourism and other uses in the reservoir area.

Ongoing and effective communication processes over 30 years ensure good relations with affected landowners

Affected landowners received fair land compensation based on comprehensive topographic surveys, an inventory of affected land and infrastructure, land and assets valuations, and regional market research. Landowners received compensation for 100 per cent of the land in cases where, for example, only 50 per cent of land was affected, and the remaining land was insufficient for providing a permanent livelihood. Landowners had the opportunity to negotiate and express disagreement with the initial compensation proposal. Valuation prices were higher than market value prices, and Itaipu resolved any land title issues prior to compensation.

Since project development, engagement with affected neighbouring landowners continued around issues such as water use permits and maintenance of land boundaries. In both countries, there is a grievance mechanism in the form of an ombudsman, and a phone line/email for reporting issues. Itaipu provided relevant and prompt feedback to any queries raised.

Multiple uses of the reservoir benefit local economies in two countries

The Reservoir Master Plan identified the need for studies to address regional development and Itaipu identified and implemented opportunities to meet this objective. Itaipu Binacional promoted multiple uses in the reservoir using similar permitting procedures in the two countries. Neighbouring landowners and communities benefited from these activities.

Some uses, such as recreation, ports and aquaculture, require a permit without a fee. Public recreation is the most popular use, followed by ports/boat landings, domestic water supply and aquaculture uses. Aquaculture is promoted and controlled to avoid negative impacts on water quality. Aquaculture areas received significant support, such as training and facilitation from Itaipu.

Fish production reached 140 tonnes in 2014, and around 63 people worked with fish tanks. Fishermen who belonged to local fishing associations were the only group who could use nets on the reservoir.

There were approximately 4,500 active recreational fishermen. Itaipu also supported competitions and other events associated with sport fishing.

Itaipu put a strong focus on tourism. For example, the tourism complex on the Brazilian side generated 100 direct jobs, through a visitor centre, tours, night tours, the biological reserve, zoo and eco-museum. Itaipu had ongoing communications with tourism associations and regular meetings.

Farmers reduced the use of water for cattle watering through the establishment of wells away from the reservoir.

The project also generated significant royalties for affected municipalities, which perform relatively highly in human development indicators (longevity, education and income) and health indicators.

The project contributed to better long-term living standards

Improvement of living standards was not an established practice at the time of project development, but over the long term Itaipu has contributed to improved regional indicators and living standards.

Itaipu monitored the amount of land purchased by landowners compensated for land acquisition. Data indicated that for every hectare that was acquired by the project, an average of 1.6 hectares were purchased with the land compensation payments in the Paraná state of Brazil.

Paraná is one of the most prosperous states in Brazil, and land prices are very high. Wpo Paraná and Canindeyú provinces are also quite prosperous compared to other provinces in Paraguay.

This case study is based on an official assessment of the Itaipu project using the operation stage tool of the Hydropower Sustainability Assessment Protocol and it is focused on issues related to landowners that were economically affected by the project. The assessment was conducted in 2015, with an on-site assessment in August 2015.
The Miel I project has made an important contribution to improving the livelihoods of project-affected communities and to regional development. This case study demonstrates how a project can deliver significant and sustained benefits to the surrounding area.

The project is located in the municipality of Norcasia, on the Miel river. It includes two river diversions: Guarinó on the Guarinó river, operating since 2010, and Manso on the Manso river, in operation since 2013. Hydropower projects in Colombia are legally required to pay 3 per cent of gross sales to any municipalities with jurisdiction over the reservoir area and project catchments. Operating plants are also legally required to pay 3 per cent to regional authorities with jurisdiction over the project area and the catchment, to be invested in catchment protection activities.

There are directly affected communities located in over 50 districts within the municipalities of Norcasia, Victoria, Samaná, and La Dorada. They include communities downstream of the hydropower plant, adjacent to the reservoir, adjacent to the Guarinó and Manso diversions, and downstream of the diversions. Other beneficiaries are more widely distributed across the Caldas and Tolima regions. The population of the beneficiary municipalities is roughly 150,000.

The Miel I project has made some important contributions to regional development, for example by: paying royalties to affected municipalities, establishing a support programme to improve the capacity of municipalities to manage royalties, committing to job creation, and developing investment programmes. The company publishes its commitments to project benefits, monitors royalties paid and reports to the national environmental authority.

The project identified and managed risks through the financial control of co-financing and oversight from committees of community representatives. The project has extended benefits through its expanded environmental management plan (EMP) programme, and through a broad range of voluntary programmes.

Directly affected communities, excluding those downstream, have received royalties amounting to COP 5.7 billion (USD 2.7–3.8 million) from the project. All communities have benefited from job creation. The project appears to have delivered significant and sustained benefits to the area, which has undergone rapid development since the plant’s construction.

Legislative requirements on benefit sharing are complemented by local capacity-building

ISAGEN was aware that local authorities needed to be better prepared to manage royalties, it was important to ensure these were invested transparently, and in priority activities to drive community development. The company implemented a capacity-building programme to maximise the use of royalties generated by the operating plant. By February 2014, the project had generated COP 8.7 billion (approximately USD 440,000) in royalties, benefitting around 150,000 people. Each municipality is notified of all the royalties paid, with the amounts published in bulletins and wallcharts on a monthly basis. The project keeps records of the amounts paid during the first year of operations. Municipalities use the royalties for environmental projects (rural and urban catchment management, reforestation, recovery and ecological rehabilitation, solid waste management, and basic sanitation), and a large proportion is spent on road maintenance. ISAGEN has published a brochure explaining the royalty system and how communities can get involved.

Corporate policies and voluntary initiatives drive regional development through project implementation

All of ISAGEN’s projects must follow a system of corporate responsibility. As a result of ISAGEN’s ‘complementary management policy’ and ‘social management criteria guidelines’, there are numerous voluntary environmental and social programmes that have been implemented to contribute to regional development. ISAGEN contributed more than COP 8.7 billion (USD 4.7 million) to voluntary projects over 2013–14. Voluntary programmes include supporting the Peace Development Programme (PDP), river Integrated Action Plans (PAI) for Miel I, and ISAGEN’s ‘good neighbours’ programme, which supports local districts, mostly in basic water provision and sanitation.

ISAGEN was one of the founding partners of the PDP, established in 1995. The programme works with over 70 community-based organisations in 17 municipalities, spending COP 3–2 billion per year. ISAGEN provides 20–30 per cent of core funding and funding for specific projects. The PAI extends project benefits to downstream communities not eligible for royalties, and partly addresses the impacts of downstream flows.

Other voluntary initiatives supported by the project include:
• the Foundation Ayapó programme to provide training to rural youth, including young victims of armed conflict;
• subsidies for CETEX (the Colombian Institute of educational credits and technical studies abroad) to provide educational credits for people seeking vocational training;
• programmes for agricultural business promotion, rubber production and basin management in Victoria municipality;
• additional support to a regional environmental authority for basin management and to support basic sanitation projects;
• reconstruction of a footbridge over the Tausís river, in response to requests from the local community;
• construction of a cultural house in the community of Norcasia municipalidad;
• construction of a new old people’s home in Norcasia;
• support to the Norcasia youth choir, and rural feeder roads in the Guarinó area.

In Norcasia, the project worked with the local government and regional public authorities to deliver significant projects, such as:• rural feeder roads in the Guarinó area.
• support to the Norcasia youth choir; and
• additional support to a regional programme for agricultural business promotion, rubber production and basin management.

The project has made some important contributions to regional development, for example by: paying royalties to affected municipalities, establishing a support programme to improve the capacity of municipalities to manage royalties, committing to job creation, and developing investment programmes. The company publishes its commitments to project benefits, monitors royalties paid and reports to the national environmental authority.

Key project features

Project stage: operation
Developer/operator: ISAGEN (acquired by Brookfield in 2016)
Capacity: 396 MW
Annual generation: 1,460 GWh (Miel I); 104 GWh (Manso)
Reservoir area: 5.71 km²
Height of dam: 188 m
Purpose: power generation

3% fall in extreme poverty in the project area in 2011

Policy and practice lessons

• Legislative requirements on benefit sharing are complemented by local capacity-building
• Corporate policies and voluntary initiatives drive regional development through project implementation
• Measurable project benefits and programmes are implemented to reduce dependency on project investment
The Mangdechhu project has been successful in improving public health conditions in surrounding districts. This case study demonstrates how comprehensive health management plans and involvement from health authorities and contractors can have a positive impact on healthcare in local communities.

The project is located on the Mangdechhu river in the Trongsa district of central Bhutan. The Mangdechhu river is a major tributary of the Manas river, which is itself a tributary of the Brahmaputra river in India. The project operates as a run-of-river, with a 13.5 km headrace tunnel leading to an underground powerhouse that discharges back into the Mangdechhu river. The project affects three sub-districts within Trongsa: Nubi, Drakten, and Langthel. The project area is very close to Trongsa town, the district capital. Trongsa town is located about 1 km upstream from the dam site and has a population of about 13,000. The town has a government district hospital, while the district capital, Trongsa town, is located about 35 km downstream from the dam site and has a population of about 13,000.

Quality of health services delivered to local communities has improved significantly.

The Mangdechhu project has been successful in improving public health conditions in surrounding districts. This case study demonstrates how comprehensive health management plans and involvement from health authorities and contractors can have a positive impact on healthcare in local communities.

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Resettlement: Chaglla, Peru

Policy and practice lessons

- Comprehensive studies and plans facilitate compliance with international standards
- Continuous two-way engagement mechanisms ensure successful resettlement
- Significant efforts made to restore and improve livelihoods and living standards of resettled communities

Key project features

Project stage: implementation
Developer/operator: Empresa de Generación Huallaga S.A. (EGH), a subsidiary of Odebrecht Energía S.A.
Capacity: 456 MW
Annual generation: 2,736 GWh
Reservoir area: 4.74 km²
Head: 202 m
Purpose: power generation

The Chaglla project required the physical displacement of nine families, and had a direct influence over around 3,000 people. This case study demonstrates how engagement with local people led to successful resettlement.

Chaglla is located on the upper Huallaga river and named after the municipality of Chaglla, in the department of Huánuco, on the eastern slopes of the Peruvian Andes. The project’s area of influence is divided between the districts of San Pablo de Pillao, in the province of Huánuco, and Chaglla, in the province of Paucartambo. About 3,000 people were living in the project’s influence area (including the transmission line) in 2010. This is mostly an area of traditional collective ownership. The department is also one of the least developed in Peru, and has experienced some emigration. Chaglla required the physical displacement of 33 families, most of whom were relocated before the end of 2012. Nine of the 33 families opted for a replacement house. The number of families to be resettled as part of the project was relatively small, and most were relocated within their own community. This reduced the burden on both the relocated families and the host communities. Families were given the choice between a replacement home or cash compensation, and the compensation and transition process was generally well-handled. Post-resettlement assistance was the same as for families who were economically displaced due to land acquisition.

The resettled families who remained in the area were closely monitored, with most reporting improvements in their living standards and livelihoods.

Comprehensive studies and plans facilitated compliance with international standards

An initial environmental impact assessment (EIA) did not address the physical displacement of families. The project is financed by international institutions, so was required to comply with international performance standards on involuntary resettlement. Empresa de Generación Huallaga S.A. (EGH) commissioned a Compensation and Involuntary Resettlement Plan to fulfil those requirements. A number of additional specialist studies were commissioned to better understand the issues affecting local communities. Resettled families were among the 96 families whose land was affected. All were considered ‘priority stakeholders’ and have been closely monitored. The surveys of ‘priority stakeholders’, covering most of the resettled families, were exemplary in their level of detail. These look at a range of indicators that would allow risks and opportunities to be identified, such as income generation. Nine of the 33 physically resettled families moved elsewhere or did not permanently live in the area, and therefore were not monitored. However, their primary residence and occupation were known, and the families were not considered vulnerable or at risk of impoverishment. Monitoring revealed no noticeable impacts on host communities, and social monitoring instruments were regularly updated.

Continuous two-way engagement mechanisms ensure successful resettlement

The resettled families were invited to choose their preferred means of compensation and, where applicable, the locations and designs of replacement homes. In addition to the three rounds of workshops required by the EIA process in Peru, the project delivered additional workshops, and liaison officers performed monthly community visits to address any concerns. Centres for information and citizen services were also available to resettled people and host communities. Feedback to the resettled families was thorough and timely, and no concerns were left unaddressed.

Landowners who were unsatisfied with the valuation of their land or other aspects of the compensation process could access a ‘claims resolution committee’. There have been no evictions or legal cases, very few complaints from the resettled people about the process and outcomes of resettlement, and no complaints from host communities. Surveys conducted among priority stakeholders reveal high levels of satisfaction with living arrangements.

Significant efforts made to restore and improve livelihoods and living standards of resettled communities

The project developed a series of land acquisition plans covering resettlement requirements. Owners could choose between rebuilding a home in a similar style, at least the same size and of better quality, or cash compensation. Only five of the 33 families opted for a replacement house, with 28 preferring cash compensation. Most were resettled within their own plots or their own villages. They were monitored closely and given priority in negotiations and employment opportunities. The lenders accepted the cash compensation option after demonstrating how agricultural income would be maintained.

All families received logistical support with their move, including transport, disassembly or demolition of their existing homes and transport of salvageable parts and, in two cases, temporary rental of homes. The resettlement process was more complex:

- a small community of 15 houses was established at Nuevo Chulla on the left bank, resulting from fraudulent subdivision and sale of parcels;
- seven Agua Nueva landowners remained in the reservoir area after the settlement of compensation, they were treated separately from the resettlement plan.

Their intention was most likely to obtain additional compensation payments or benefit from their position close to construction traffic. EGH resolved the conflict in close cooperation with community leaders. The company paid compensation to move those households away from the reservoir area, even though this was not a requirement.

The nine families that moved out of the project area generally reported using their compensation money to buy additional productive land, build homes, develop small businesses, cover education costs, or purchase property in Tingo María. There were two cases where the resettlement process was more complex:

- seven Agua Nueva landowners remained in the reservoir area after the settlement of compensation, they were treated separately from the resettlement plan.
- their intention was most likely to obtain additional compensation payments or benefit from their position close to construction traffic. EGH resolved the conflict in close cooperation with community leaders. The company paid compensation to move those households away from the reservoir area, even though this was not a requirement.

Specialist studies were commissioned to understand issues affecting local communities

Case study: Topics Better hydro
The Santo Antônio project produced a wide range of solid waste from both the construction site and workers’ camps. This case study demonstrates how regular monitoring, proper treatment facilities and training programmes can improve waste management, including beyond a project’s own impacts.

The project is located on the Madeira river, 7 km upstream of the city of Porto Velho, capital of Rondônia state in north-west Brazil. The Madeira is a major tributary of the Amazon, the world’s biggest river in terms of run-off volume. The project is designed to make maximum use of the water resource potential, with minimal negative impact on the Amazon region.

The dam was closed and reservoir filling began in September 2011, following the issuing of the operational licence by IBAMA. The first two turbines started operations in 2012, but the plant was only completed in 2016, following an extension to add additional installed capacity.

The project produces a wide range of solid waste, from both the construction site and the workers’ camps. The camps are the primary source of domestic wastewater and the concrete and crushing operations also produce industrial wastewater. Vehicles, blasting and crushing are the main sources of noise and air pollution.

Monitoring was adapted according to emerging risks and opportunities during the implementation phase. For example, noise monitoring was increased during blasting, and additional water quality monitoring was established to cover a new treatment process. A dedicated waste treatment area was set up to process solid waste; ponds and treatment facilities were used for wastewater; and vehicles were checked regularly to ensure they complied with noise and air requirements.

The project also provided environmental and waste management education to project-affected communities and project workers, thus contributing to addressing waste management issues beyond its own impacts.

A dedicated centre at the project facilitates waste management

The civil works contractor established a dedicated waste management centre on the project site where solid waste was segregated, classified, quantified and processed.

Monitoring was carried out at the project site across a range of parameters. The civil works contractor, for example, was responsible for:

- recording volumes of solid waste on a monthly basis;
- monitoring effluents from the washing and lubrication ramp’s oil and water separation traps, and outflow from the camp’s wastewater treatment lagoon on a monthly basis;
- monitoring water from the settling ponds of the concrete plant, water from the

Composting of organic waste

Third-party companies were appointed to recycle the materials. This process achieved a recycling rate of 88% per cent of total waste. Organic waste was composted separately, allowing bacteria to break down contaminants, before being combined with other compost.

Material that could not be recycled or composted – approximately 9 per cent of the total amount collected – was disposed of in an on-site sanitary landfill facility.

Comprehensive monitoring facilitates identification of emerging and unforeseen pollution risks

Comprehensive monitoring was carried out at the project site across a range of parameters. The civil works contractor, for example, was responsible for:

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- monitoring effluents from the washing and lubrication ramp’s oil and water separation traps, and outflow from the camp’s wastewater treatment lagoon on a monthly basis;
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88% recycling rate achieved for all project waste
• monitoring air quality on an annual basis, in and around the project site, for particulate matter, carbon monoxide, carbon dioxide, sulphur dioxide, ozone, nitrous oxides, hydrogen sulphide, hydrofluorocarbons and CFCs;
• monitoring ‘black smoke’ from vehicles on the construction on a monthly basis; and
• monitoring noise levels annually in the nearest communities or more frequently when higher noise was expected

Each year, Odebrecht offers awards for employees’ innovation. This led to one of the project’s employees proposing to replace the use of aluminium sulphate in wastewater treatment in favour of a new system using tree bark.

concerns that the activity could disturb local communities; and

river turbidity was monitored when silt from dredging was released.

The project implemented a number of broader environmental monitoring programmes, on issues such as water quality, sediment loads, and macrophytes in the Madeira river.

This enabled SAIE to identify links between the monitoring results for wastewater effluents from site treatment plants and those from broader programmes.

Before work on the project began, the civil works contractor calculated the amount of domestic wastewater the project would generate based on the estimated number of workers on site. An estimate was also made of the volumes of industrial wastewater to be treated, based on an assessment of the amount of concrete to be used; the processing volume of the crushing plant; and use of vehicles.

The civil works contractor also assessed the potential noise impact from equipment, blasting, transport and the crushing plant. The assessment considered how each source could impact the surrounding environment and communities.

During the project preparation stage, potential sources of air pollution were examined, including site vehicles, crushing and blasting.

The civil works contractor trained staff to identify emerging pollution risks by offering a wide range of waste management education courses.

These courses addressed topics such as:
• identification of environmental impacts;
• dealing with oil or chemical product spillage to soil or water;
• solid waste management;
• handling of chemicals;
• incineration of hazardous waste; and
• composting of organic waste and cleaning of grease traps.

Each year, Odebrecht offers awards for employee innovation. As a result, one of the project’s employees came up with a proposal to replace the use of aluminium sulphate in wastewater treatment in favour of a new system using tree bark.

Aluminium sulphate is a toxic reagent which, when discarded, accumulates in the food chain. The replacement of this reagent with the bark of the Veta tree eliminated the impact that the disposal of aluminium sulphate would have caused.

In addition, sludge generated by the project was used as organic fertiliser in a land rehabilitation programme.

Through its environmental education programme, the project offered workshops, lectures and meetings with local communities to improve knowledge on environmental protection.

Programmes for worker and community responsibility improve waste management

The civil works contractor offered staff training on how to manage waste, including disposal of hazardous materials, proper use of pesticides and chemicals, spillage to soil or water, and waste minimisation.

The assessment considered the potential noise impact from equipment, blasting, transport and the crushing plant. The assessment considered how each source could impact the surrounding environment and communities.

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The civil works contractor also assessed the potential noise impact from equipment, blasting, transport and the crushing plant. The assessment considered how each source could impact the surrounding environment and communities.

The assessment was conducted in April–May 2014.

This case study is based on an official assessment of Santo Antônio using the implementation stage tool of the Hydropower Sustainability Assessment Protocol. The assessment was conducted in 2014, with an on-site assessment in April–May 2014.

Water treatment ponds
Water quality issues were assessed during the preparation of the Semla IV project, but what makes this case study particularly interesting is the level of water quality information that was available for the area. This offers lessons for the development of water quality monitoring systems elsewhere.

Water quality in the project area is mixed, with a number of pollution sources unrelated to hydropower. The environmental impact assessment for Semla IV included an assessment of water quality issues. Results showed the project would have no impact on water quality during regular operations, and only temporary minor impact during construction primarily related to turbidity.

The most interesting aspect of this case study, however, is the depth of the water quality information that was available for the area. This offers lessons for the development of water quality monitoring systems elsewhere.

Regional stakeholders join forces to monitor water quality in the catchment area

Regionwide, stakeholders join forces to monitor water quality in the catchment area. This is predominantly forest, but includes some towns, historic and current industrial sites, and agricultural areas. As with many parts of Sweden, the surface waters in the upper catchments are nutrient-poor and therefore have little buffer against acidification, so lakes are limed regularly.

Water quality in the area is generally moderate to good, although the consequences of contamination would be serious. People staying in nearby cabins use drinking water directly from the lakes above Semla, with filtration as the only treatment.

To maintain local water quality, stakeholders in the region formed a water management association, the 'Kolbäcksån Vattenförbund'.

The Kolbäcksån river is also one of the tributaries to Lake Mälaren, Stockholm’s main source of drinking water. To maintain local water quality, stakeholders in the region formed a water management association, the 'Kolbäcksån Vattenförbund' (http://bit.ly/2y5U0QZ). In 2011, the association contracted a private company to continue the water monitoring program, publishing all results online.

National-level systems promote long-term water quality improvement

Sweden has an exceptionally thorough water framework law. The association has a board and holds an annual general meeting at which Uniper is represented. The secretariat is provided by the county administration. The association finances water quality monitoring and other joint efforts, such as flood management studies. Water quality monitoring is comprehensive; the association contracted the Swedish University of Agricultural Sciences (Department of Aquatic Sciences and Assessment) to monitor 11 lakes and 10 watercourses in the basin between 1997 and 2010. The programme comprised physical, chemical and biological parameters, with sampling carried out monthly in the watercourses and twice a year in the lakes.

Online monitoring results provide water quality data, transparently, for all

The results of the water monitoring are accessible to everyone online (http://bit.ly/2y5U0QZ). In 2011, the association contracted a private company to continue the water monitoring programme, publishing all results online.

Regional stakeholders join forces to monitor water quality in the catchment area

Water at Semla IV flows from a 2,200 km² catchment area. This is predominantly forest, but includes some towns, historic and current industrial sites, and agricultural areas. As with many parts of Sweden, the surface waters in the upper catchments are nutrient-poor and therefore have little buffer against acidification, so lakes are limed regularly.

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National-level systems promote long-term water quality improvement

Sweden has an exceptionally thorough system for nationwide, long-term programmes to monitor and respond to problems in water quality. Water management associations across Sweden have joined forces to establish a countrywide water quality monitoring system.

This case study is based on an official assessment of Semla II using the preparation stage tool of the Hydropower Sustainability Assessment Protocol. The assessment was conducted in 2014, with an on-site assessment in November 2014.
Hydropower projects from around the world that have demonstrated overall good practice in sustainable development.

Project case studies

1. Blanda, Iceland 66
2. Kabeli-A, Nepal 70
3. Keeyask, Canada 74
4. Miel I, Colombia 78
5. Romanche-Gavet, France 82
Project case study 1: Blanda, Iceland

Policy and practice lessons

- Certified asset management systems deliver almost 100 per cent reliability and profitability
- Continuous monitoring is used to assess meteorological trends and develop models of glacial ablation
- Community cooperatives facilitate sustained benefits for community members

Key case study features

- Project stage: operation
- Developer/operator: Landsvirkjun
- Capacity: 150 MW (three 50 MW units)
- Annual generation: 800 GWh
- Reservoir area: 56 km² (Blöndulón) and 5 km² (Gilsárlón)
- Head: 287 m
- Purpose: power generation
- Commissioning: 1991

Whilst Blanda is a relatively small project in a sparsely populated, developed context, it sets an example of excellence in technical, financial, environmental and social sustainability.

Located in north-western Iceland, Blanda harnesses the Blanda river as it flows north from Hofsjökull glacier, to meet the sea at the town of Blönduós. It lies on the fringe of the Iceland’s highland plateau, with gentle hills and heathland on shallow soils.

The Blöndulón reservoir is formed by two dams, on the Blanda river and the Kolukvikul river, and water is diverted through 9,800 m of diversion canals and four tunnels to an intake reservoir, Gilsárlón.

From Gilsárlón, water runs through a 1,300 m canal and a 347 m headrace tunnel, before dropping vertically through a 230 m penstock to the underground power station. From the turbines, the water flows through a 1,700 m tailrace tunnel into the Blanda river.

Certified asset management systems deliver almost 100 per cent reliability and profitability

Blanda’s asset maintenance is managed through a management system guided by the new ISO 55001 standard. It uses software that provides good linkages between task scheduling, performance tracking, and higher-level corporate objectives and requirements. Key performance indicators are set regarding system failures, job completion, the balance between monitoring and maintenance attention, and attention to unsafe issues.

The Blanda power station is one of the most reliable in Landsvirkjun’s asset portfolio, with reliability greater than 99.9 per cent outside scheduled outage periods.

Generation scheduling decisions are based on state-of-the-art simulation and optimisation models, integrated across all power stations in the country.

Continuous monitoring is used to assess meteorological trends and develop models of glacial ablation

Blanda is managed with a detailed sense of the availability and reliability of resources, based on long-term historic flows and climate observations and modelling. Landsvirkjun has also undertaken extensive research into future water availability, which is expected to improve due to glacial retreat.

Landsvirkjun carries out extensive hydrological and glacial monitoring, weather and run-off modelling and medium and long-range forecasting of hydrological changes.

Short-term forecasting is made difficult in Iceland by frequent changes between snow and rain around 0°C. Climate change is predicted to significantly increase water resource availability over many decades on glacier-fed rivers in Iceland.

Predicted seasonal changes include: earlier springs and snowmelt; lower flows in early summers but higher flows in late summers due to glacial melt, and more frequent small winter floods. The historical flow series indicates an average inflow into Blöndulón of 41.6 m³/s, but the forecasted average – based on changes already realised up to 2010 – increases to 44.1 m³/s and is expected to increase further.

The meteorological office, Landsvirkjun and the Iceland Glaciological Society are monitoring the mass balance and retreat of Hofsjökull, a 850 km² ice cap that delivers meltwater to several large glacial rivers, including Blanda and Þjórsá. They take snow cores at 30 locations, between elevations of 700 m and 1,800 m during the winter, and record summer mass balance from ablation stakes. The monitoring results feed into seasonal run-off forecasts.

For long-term monitoring, the surface of the ice cap has been mapped with high-resolution airborne lidar, and as part of Nordic cooperation projects, the impacts of climate change on Iceland’s glaciers have been modelled. They are predicted to largely disappear over the next two centuries.

Increased annual inflows and changing seasonality caused by climate change may alter optimal storage and installed capacity values at Blanda, and across Landsvirkjun’s system.

Scenario analyses show that potential energy in the total river flows to Landsvirkjun’s power system is expected to increase by 20 per cent (2.8 TWh) until 2050. This can be mainly attributed to added run-off in glacial rivers, ranging from 27 per cent to 84 per cent for individual rivers.

There may not be the flexibility to adapt to greater variation in flows without additional storage, resulting in a reduced load factor.

Community cooperatives facilitate sustained benefits for community members

When Blanda was developed, Landsvirkjun reached an agreement with farmers who grazed sheep in the lands lost for the reservoir. The agreement was to create new grassland as compensation. Practically, this involved delivering a fixed amount of fertiliser to a compensation area over the project’s lifetime.

The work is being delivered in partnership with the Icelandic Soil Conservation Service and two farmers’ cooperatives, for the west and east banks of the river (further details are provided in the case study on page 30).

Local community members have developed a number of cooperative organisations to manage financial compensation paid by Landsvirkjun.

When Landsvirkjun offered both cooperatives a one-off cash payment to end the fertilisation programme, the west bank cooperative, which had become less reliant on sheep, took the offer and invested the proceeds in a fund to subsidise the community’s energy costs on an ongoing basis.

Local community members have developed a number of cooperative organisations to...
manage financial compensation paid by Landsvirkjun. These include, on the west bank, fencing and roads, angling and grazing. On the east bank, they include fences and roads, angling and a joint cooperative concerning sheep, huts (cabins) and grazing rights. The approach has been so successful that it extends beyond compensation for impacts of the project, to deliver real benefits to communities.

Partnerships provide a practical mechanism for benefit-sharing. Icelandic law requires the payment of property tax to the municipality in which the power station is located. Blanda’s payment increases the local municipality’s annual budget by approximately 15 per cent, and will continue to do so. Since commissioning, Landsvirkjun has also established grant-based partnerships to deliver additional benefits. The company has established the Landsvirkjun Energy Research Fund and the Landsvirkjun Community Fund to distribute grant funding.

Landsvirkjun has developed numerous partnerships with educational institutions, landowners, fishing associations and other stakeholders. Examples of projects supporting Blanda communities are:

- new roads and bridges in the highlands;
- an airstrip to the south of the reservoir;
- a programme, 'Many hands make light work', which employs around 30 young people each summer and provides training in first aid, and health and safety;
- maintenance of a fish ladder to benefit the angling association;
- a fishing lodge for visiting anglers;
- a salmon museum and research centre (the 'Laxa Centre');
- construction of three new huts (cabins) in the highlands for use when collecting sheep, which now generate income for the municipality from tourism;
- additional fencing in the highlands to contain sheep, and stables for sheep and horses in the highlands;
- connection of some farms to fibre optic cable for internet access;
- allowing the meeting rooms at the power station to be used by the community; and
- support for a storyteller to record and distribute an historic story about the area (an Icelandic saga, a good example of intangible heritage).

**Emerging environmental and social risks and opportunities are identified and addressed through partnerships with environmental organisations working in the area, and the project’s strong links with local communities.**

### Landsvirkjun has developed numerous partnerships with educational institutions, landowners, fishing associations and other stakeholders.

**99.99% reliability outside scheduled outage periods makes Blanda one of Landsvirkjun’s most reliable power stations**

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Numerous studies fed into the environmental report and Blanda continues to monitor key issues. Landsvirkjun uses a company-wide ISO 14001 certified environmental management system to address all environmental and social issues, including those at Blanda. Emerging environmental and social risks and opportunities are identified and addressed through partnerships with environmental organisations working in the area, and the project’s strong links with local communities.

### Retroactive environmental assessment at operation stage can promote new, systematic approaches to environmental management

Partnerships are also used to monitor and manage environmental issues. For example, Blanda has partnered with the Icelandic Institute of Freshwater Fisheries on research and consulting services for freshwater fish, and with the Soil Conservation Service of Iceland on its programmes to combat desertification and sand encroachment, and reclamation and restoration of degraded land. Blanda was designed and constructed before legislation requiring environmental and social impact assessments was introduced in Iceland in 1995. However, in response to a stakeholder enquiry, Landsvirkjun commissioned a retrospective assessment of operations in 2004, referred to as the ‘Blanda Environmental Report’. Another study, carried out in 2006 by the University of Akureyri, examined Blanda’s social impact.

### Every job undertaken within the project has its own safety and environmental risk assessment.

In a notable approach, Landsvirkjun makes the reporting of any risks or opportunities an explicit responsibility of all employees. Employees must use a form (part of Landsvirkjun’s quality management system) to describe any environmental, social or labour issue or incident, and the remedial action required. This is processed, analysed and remedial works scheduled, and the manager responsible for the issue must take steps to prevent recurrence.

Every job undertaken within the project has its own safety and environmental risk assessment. This provides a comprehensive overview of the job and is regularly updated. Site inspections have a checklist to identify opportunities for improvement, such as fixing paths or lighting, and reducing waste or noise. The social responsibility department maintains an “ideas bank” where new opportunities are logged.

Landsvirkjun uses an integrated management system that meets the requirements of ISO 9001, and an environmental management system that meets the requirements of ISO 14001. The company is also planning to integrate the requirements of ISO 26000 (guidance on how businesses and organisations can operate in a socially responsible way) into the management system. Blanda was the first Landsvirkjun project to become ISO 9001 certified, and Landsvirkjun has also been certified as a producer of green electricity by the German company TÜV SÜD.

Certified management systems deliver transparency, integrity and accountability

Landsvirkjun applies systematic corporate business structures, policies and practices. This is developed through and reflected in its certification to a comprehensive range of standards: ISO 9001, 14001, 27001, OHSAS 18001, and other external certifications. Policies and procedures apply across all business areas, and are proactively implemented through the quality system processes. Transparency, integrity and accountability are addressed through the adoption of a social responsibility policy and mapping of performance against the UN Global Compact and ISO 26000.

This case study is based on an official assessment of Blanda using the operation stage tool of the Hydropower Sustainability Assessment Protocol. The assessment was conducted in 2013, with an on-site assessment in September 2013.
Purpose:
Annual generation: 206 GWh (KEL), a majority-owned subsidiary of Developer/operator:
Project stage: preparation
Case study: Projects Better hydro

- Iterative siting and design evaluations bring social and technical benefits
- Specialist hydrological methodologies and independent review contributed to improved design and safety
- Specialist studies enhance the validity and completeness of impact assessments

Key case study features

Project stage: preparation
Developer/operator: Kabeli Energy Ltd (KEL), a majority-owned subsidiary of Butwal Power Company (BTC)
Capacity: 38 MW
Annual generation: 206 GWh
Purpose: power generation

A decade of armed insurgencies has made infrastructure development difficult or even impossible in much of Nepal. Kabeli-A is one of the first projects to be developed in a list of options identified prior to this time, and meets proven best practice in a wide range of technical, social and environmental areas.

The project is located approximately 800 km east of Kathmandu, and would be a peaking run-of-river plant. With a small diversion dam, it would use a head of 118 m, and a reservoir covering an area of only 10 ha (of which 9.1 ha is the existing river or its flood zone) would allow for short-term storage.

The main project components are a 14.3 m dam, intake and settling basin, a tunnel over 4 km in length, powerhouse and tailrace. It will divert water from the Kabeli river, discharging it downstream following Kabeli’s confluence with the Tamor river as it loops from an east-west direction to west-east. The Tamor flows into the Koshi river, which crosses the border with India and enters the Ganges.

Kabeli-A would be financed through a mix of loan financing, including from the World Bank (International Development Association), International Finance Corporation (IFC) and commercial banks, and shareholder equity.

Iterative siting and design evaluations bring social and technical benefits

The project design was iteratively improved and optimised. Initially, a sequence of studies through the preceding three decades concerned the identification of project options and their screening and ranking, through the ‘Medium Hydropower Project’ in the mid- to late 1990s.

When Kabeli Energy Limited (KEL) won international competitive tendering to develop the project, it was required to update the feasibility study and environmental impact assessment as a condition of the project development agreement. The focus of the design team has been to prepare as simple a design as possible, in order to reduce potential construction, operation and maintenance problems, whilst avoiding or minimising environmental, social and technical risks.

As would be expected, the updated feasibility study investigated alternative locations for project components such as the dam, powerhouse, access roads, tunnels, construction camps, quarries and spoil disposal sites.

Some of the key issues and innovations were:
- moving the powerhouse site to protect it from flooding,
- moving the intake 500 m upstream, because of engineering constraints, but with the added benefit of increased head
- the addition of a desander, with a so-called ‘serpent sediment sluicing system’ (S4) for flushing the sediments at least hourly, to maintain downstream sediment transport while removing aggressive hard sediment to avoid turbine damage,
- re-alignment of the road to the intake, increasing the distance from 2 km to over 7 km, in response to community requests to route the road through their settlements (the community provided the land for the road free of charge),
- avoidance and mitigation of impacts on cremation sites and a temple located downstream from the intake (more details of which are provided in the topic case study on page 18).

Specialist hydrological methodologies and independent review contributed to improved design and safety

Flows in the Kabeli river were not measured until March 2010, when KEL established a gauging station to develop a rating curve. This required the use of data from elsewhere in the basin, and various methodologies to develop flow duration curves. KEL used hydrological data from four official gauging stations in the Tamor basin, which have been in operation for between 11 and 41 years.

When KEL’s hydrology consultants later increased the design flow even further, based on the standard Nepal Electricity Authority recommendation of using the 40 per cent duration, KEL also used the consultants to assess dam safety risks, reviewed by the owner’s engineer, lenders’ engineer and a panel of experts (PoE). The studies covered most conceivable infrastructure safety issues, and looked at a number of opportunities.

These included increasing the design flood to the 1,000-year flood, expanding the scope of monitoring to cover seepage and uplift, and an assessment of opportunities to use new technologies, which led to a number of automated safety features and extensive

Overview of the powerhouse site at Kabeli-A

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An indigenous and vulnerable community development plan (IVCDP) sets out plans to provide additional development opportunities for vulnerable groups, including indigenous peoples.

An adaptive management approach allows unforeseen risks to be addressed

KEL and its partners developed a range of management plans for different issues and phases. For example, the construction phase IAP addressed issues such as constructing a fish passage, putting in place infrastructure for cremation sites, protecting sacred trees during the construction phase, ensuring slope stability of earth cuts, and maintaining minimum downstream flows.

A catchment management plan, including provision to train local people to improve their management of the forest in the river basin, will seek to reduce sediment load.

Checks were also made to confirm the conclusions of the social impact assessment, particularly the support from local communities, focusing on women, Dalits and indigenous people.

The project assessed numerous opportunities for socio-economic development, including rural electrification, local employment, schools and health centres, as well as the preservation of local traditions and cultural heritage.

A number of ongoing studies will investigate emerging risks and opportunities in more detail as part of an adaptive management approach. These studies include an improved understanding of the aquatic biodiversity and community water uses of the Tamor and Kabeli rivers, a fish hatchery planning study, a catchment area treatment plan and the new cumulative impact assessment (CIA).

Providing benefits in the preparation stage builds confidence among communities

KEL began a social responsibility programme during preparation. Activities included establishing a seedling nursery, a free dental campaign, support to local youth clubs and improving local school facilities. This generated confidence among communities, and created an “entry point” for the project, facilitating genuine participation in the planning of ongoing management plans and benefits sharing.

Kabeli A plans two benefit-sharing mechanisms for the funding of local development, one of which will be generated by the Kabeli A hydropower project (KABHEP).

Firstly, by law royalties will be paid to central government over the 30-year licence period, and 50 per cent will be channelled into the project-affected region. Secondly, KEL will establish a project fund to finance activities in the four affected villages through the construction stage.

Indigenous people will be represented on the implementation structures for the social action plan.

Training and employment schemes will target indigenous people. For example: employment of at least one member from each affected indigenous community household will be guaranteed in project construction and maintenance work; at least one member from each of the affected indigenous community households will be involved in livelihood enhancement activities, such as skills training, for income generation and other livelihood improvement activities; preference will be given to qualified indigenous community individuals in recruitment of community facilitators who will maintain frontline contact with the community in implementing IVCDP activities; supplementary infrastructure facilities will be developed for Majhi households near the powerhouse site, such as latrine construction and drinking water facilities; a small loan assistance programme will be developed, to promote income-earning opportunities for vulnerable indigenous households; and indigenous people’s organisations will be supported to protect and preserve their indigenous cultures, knowledge, oral literature, language and traditions.

Indigenous people will be represented on the implementation structures for the social action plan. KEL will use a range of communication and information dissemination mechanisms to promote awareness of indigenous peoples’ entitlements, including written documents (information sheets and newsletters), FM radio broadcasts through local radio stations, community meetings, focus group discussions, participatory appraisal techniques, household interviews and social-mobilisation techniques.

There are 59 officially recognised indigenous groups in Nepal, known as the Adivasi Janjati, that has its own territory, language, traditional rites and customs, distinct cultural identity, social structure, and history. They are traditionally outside of the Hindu caste system. More than 50 per cent of people in the project area are Adivasi Janjati (for more information please see page 21).

An indigenous and vulnerable community development plan (IVCDP) sets out plans to provide additional development opportunities for vulnerable groups, including indigenous peoples. It comprises a women’s programme (for example, including microcredit; and support for small businesses), a capacity-building programme through a local NGO, loan assistance, and measures to build meaningful participation of vulnerable people. The plans include measures that, based on ethnicity, provide support that is additional to compensation for impacts and wider benefit-sharing measures. It defines actions to maintain and improve the livelihoods of indigenous peoples in the project area, for example through agricultural initiatives, employment, skills and capacity building, drinking water, health and sanitation support.
Keeyask, Canada

Policy and practice lessons

- Partnerships require long-term commitment and formal agreements
- In-depth and broad-ranging public involvement during preparation requires planning
- Public scrutiny and support is facilitated through a stakeholder-focused assessment of the need for the project
- Complex preparation and implementation require a range of procedures for interface and risk management
- Technical detail and indigenous values underpin comprehensive environmental management planning

In an area of Canada where the development of hydropower has a historical legacy of displacing indigenous peoples, the Keeyask project demonstrates best practice of stakeholder involvement in project preparation.

The In-depth and broad ranging public involvement during preparation requires planning

The province of Manitoba in central Canada is developing new sources of renewable generation and a more integrated grid as part of its Clean Energy Strategy initiative, seeking a fossil-free future. A key aim is to import clean energy to neighbouring provinces in Canada, and across the border to the mid-western states of the US.

However, the historical legacy of hydropower for the displacement of indigenous people (First Nations in Canada) is particularly pertinent in the north of the country, where Keeyask will be developed. This case study highlights the preparation of a project through public involvement in the assessment of needs, top-class project management, thoroughness in environmental assessment and a co-owner partnership with indigenous peoples.

Keeyask is the latest in a number of hydropower developments in the Nelson river catchment. The Nelson catchment has been significantly altered in order to generate power, with diversions and the regulation of Lake Winnipeg. Most recently, Manitoba Hydro has brought forward two projects – Wuskwatim and Keeyask. The construction of Wuskwatim was completed in 2012.

Keeyask will be located at Gull Rapids on the lower Nelson river, immediately upstream of Stephens Lake amid boreal forest in northern Manitoba. Its name, “Keeyask”, is the local Cree word for gull. At its widest, the river spans approximately 2.5 km across Gull Rapids, and consists of three large channels.

Three dams (the north, central and south dams) will be constructed across the channels, creating a 93 km² reservoir, approximately half of which is the original river channel. A number of earth-fill dykes will be built on both riverbanks to contain the reservoir, 11.6 km on the north and 11.2 km on the south banks. With a full supply level of 159 m above sea level and a minimum operating level of 158 m, the project will provide either base-load generation or peaking generation drawing down this 1 m of regulation.

Development of Keeyask is a collaborative effort between Manitoba Hydro, Tatakweyak Cree Nation and War Lake First Nation (acting as the Cree Nation Partners), York Factory First Nation, and Fox Lake Cree Nation. These partners have formed the Keeyask Hydropower Limited Partnership (KHLP).

Partnerships require long-term commitment and formal agreements

Manitoba Hydro and the chiefs and councils of the Keeyask Cree Nations engaged in discussions and agreements over more than a decade. They proceeded through agreements-in-principle, and various process agreements. Ultimately, the parties negotiated the Joint Keeyask Development Agreement (JKDA) and various adverse effects agreements in 2009.

The JKDA establishes that Manitoba Hydro will own at least 75 per cent of KHLP equity, and will provide project administrative and management services. The four First Nations, known collectively as the Keeyask Cree Nations (KCNs), together have the right to own up to 25 per cent of the partnership.

The JKDA governs how the project will be developed, as well as setting out agreements on potential income opportunities, training, employment, and business opportunities. It also establishes a number of planning and decision-making bodies, such as the ‘partners’ regulatory and licensing committee’, the ‘monitoring advisory committee’, a dispute resolution mechanism and a number of mediation measures.

In-depth and broad ranging public involvement during preparation requires planning

The JKDA sets out the approach to engagement between the KCNs and Manitoba Hydro within the KHLP, including responsibilities for public announcements by the partners. A further committee, the pre-hearing consultation committee, met every one to two months to review plans for communications prior to hearings. Manitoba Hydro and the Keeyask Cree Nations jointly developed a public involvement programme (PIP) in 2007, specifically for project preparation. Its aim was to guide engagement activities with First Nations and stakeholders beyond the KCN communities. The PIP sets out the purpose and principles of public involvement, target audiences, consultation stages, documenting consultation, methods and schedule.

At a higher level of governance, the provincial and federal governments and each of the KCNs also developed agreements, setting out the principles, objectives and means of consultation between the governments and each community for the Keeyask project.

A key project communication plan was developed for ongoing communications, through preparation and implementation. This sets out the purpose, objectives and means for external and internal communications, and responsibilities for communication within the partnership. It included a ‘public announcement framework’ and a protocol for communications related to the regulatory process. Some of the activities included were: ‘future development’ team offices in each community; regular open community meetings; a KHLP website, phone line and email address; and community liaison officers based at the construction camp.

Public scrutiny and support is facilitated through a public assessment of the need for the project

Manitoba’s provincial government has conducted strategic planning for both the energy and water sectors. It has also developed a clean energy strategy initiative, focused on demand-side management (the highest priority), and renewable, fossil-free power. A ‘power resource plan’ document, which was made public, presented the results of Manitoba Hydro’s evaluation and prioritisation process.

An in-depth process addressing the need for the project became the chosen approach for involving the public and stakeholders in the provincial government’s decisions on whether to allow Keeyask (and earlier Wuskwatim) to proceed. This was called the ‘Need For and Alternatives To’ (NFAT) process. Stakeholders are involved and consulted as well as through other processes such as environmental licensing, and Clean Environment Commission hearings. The NFAT process for Keeyask also addressed all the other potential demand and supply side options, as well as major new transmission within the province and to the USA. The NFAT includes a component described as a ‘multiple-account cost–benefit analysis’ (MACBA). This expands on financial analysis by factoring in costs and benefits accruing to parties, including affected communities, citizens, taxpayers and customers. It looks at the distribution of costs and benefits across the different parties, and incorporates analysis of sensitivity to parameters such as the social discount rate.
Complex preparation and implementation require a range of procedures for interface and risk management

Keeyask has a relatively complex sequence of construction, with confederations on three channels of the river. Preparation of Keeyask also paid close attention to the risks affecting licensing and support for the KLP partnership among Cree Nations.

To organise preparation and construction, Keeyask is managed and was licensed, as three separate projects: Keeyask Generation Project (KGP), Keeyask Infrastructure Project (KIP), and Keeyask Transmission Project (KTP). Several units within Manitoba Hydro are responsible for Keeyask: a pre-construction project team; the transmission planning and design division (TPD); and the Keeyask Project Division.

Manitoba Hydro developed a Keeyask Project Execution Plan (PEP), setting out means, methods, tools and techniques, and assigning responsibilities. It includes descriptions of a Joint Keeyask Development Agreement and adverse effects agreements, licensing, an integrated control plan, and schedule management. It describes work breakdown structures, each of which is given a number in the company’s project and financial management system.

Other measures include a ‘project charter’, project schedules, risk identification, monthly reports to the senior management team, including the top three risks, and change management request forms to identify, manage and approve changes to the schedule.

The pre-construction project team developed a pre-construction risk register and risk registry tables for the preparation of KGP and KIP. A detailed risk register is maintained for project risks.

Effective interfaces between departments, as well as with and between contractors on site, were critical. For example, the pre-construction project team was responsible, via their project champion, for the delivery of licenses and the technical memorandum to the construction team. The strategic direction of the preparation of Keeyask is highly focused on risks related to local community support affecting project licensing. Signed agreements, including the Joint Keeyask Development Agreement and the adverse effects agreements, were instrumental to project relationship with the local peoples, with significant effort to generate local employment and business opportunities.

Manitoba Hydro developed and discussed a paper with each partner to refine roles and responsibilities in the regulatory process. A pre-hearing coordination group was established with lead witnesses from each of the partnering Cree Nations. Interfaces with and between contractors are managed by consideration of the best contracting vehicle, contract stipulations, interface activities identified in schedules, and day-to-day coordination on-site. In addition, detailed construction environmental protection plans (EPPs) were developed for all components, including the generation station, transmission line and access roads. These comprehensively identified risks and measures required to manage them.

Technical detail and indigenous values underpin comprehensive environmental management planning

Environment assessment of Keeyask was conducted over years, resulting in a highly robust assessment. The assessments covered the physical, terrestrial, aquatic and socio-economic environments, as well as cultural issues around resource use and heritage. Risks and opportunities were analysed comprehensively, for example:

• in the case of aquatic biodiversity, macro-invertebrates, phyto- and zooplankton and macrophytes were extensively studied, and the effects of impoundment on their populations were assessed during construction and operation, and overlaid with other influences such as rising temperatures and shorter ice cover periods;

• water quality studies, undertaken over a ten-year period, covered a spatially broad area beyond the hydraulic zone of influence, and integrated the impact of climate change;

• shoreline erosion was mapped for 205 km of the Nelson River likely to be affected by the project, and modelled for the 264 km shoreline of the Keeyask reservoir, using postland-disintegration modelling for northern Manitoba (not undertaken before), and climate change also integrated into the analysis;

• a human health impact assessment, based on Health Canada, WHO and US EPA guidance, peer reviewed by a leading academic, and overseen by a technical working group; this even involved assessing the movement of fish to determine whether those that would have raised mercury levels from the reservoir moved upstream to areas outside the hydraulic zone of influence, and

• an innovative feature of the assessment process was that the Keeyask Cree Nations undertook and disclosed their own parallel assessments. These were based on their own Cree worldview, and used as a basis for their own decisions on compensation and partnership agreements.

A series of plans were developed for project components: environmental protection plans (EPPs); environmental management plans; and environmental monitoring plans. These placed special emphasis on impacts on valued environmental components (VEC), defined on the basis of the technical and indigenous studies.

Examples of communications activities during preparation:

• a comprehensive Public Involvement Program that involved three rounds of consultation throughout the assessment process with partners, other interested or affected communities and organisations, and government agencies;

• the “overview of water and land” (OWL) working groups, and community-level reference groups convened for the Keeyask Cree Nations’ own separate environmental studies;

• referenda on the project within each community (please see page 38);

• websites created by the Cree Nations Partnership, in addition to the KLP website;

• dissemination of a partnership video, “Keeyask: our story”, and regular project newsletters;

• consultation for the transmission line using aboriginal traditional knowledge, and two rounds of open house meetings;

• federal- and provincial-level public consultation by regulatory agencies, including calls for public comment on the assessment, with funding available through a participant assistance programme; and

• a technical advisory committee involving a wide range of agencies, meeting to consult with provincial government.

An innovative feature of the assessment process was that the Keeyask Cree Nations undertook and disclosed their own parallel assessments, based on aboriginal traditional knowledge, as a basis for their own decisions on compensation and partnership agreements.
The Manso diversion structure consists of a 5 m concrete dam on the Manso river and a diversion tunnel from the Manso river to the Santa Bárbara stream, and ultimately, to the Amaní reservoir.

This case study shows how a hydropower project can make significant contributions to addressing issues beyond the impacts caused by the project itself. It also demonstrates the importance of carrying out comprehensive hydrological studies to explore different scenarios, including climate change, and to optimise water use, taking into account environmental, social and financial objectives.

Good understanding of available hydrological resource optimises water use

Colombia has an installed electricity generation capacity of 14,400 MW, 64 per cent of which is in hydropower plants.

There is a high degree of climate variability in Colombia, both temporally and spatially. Rainfall varies considerably and is difficult to predict, due to the rugged topography. Storm cells and flash floods are regular occurrences. The Miel river basin has an area of 1,105 km², and is located across six municipalities in the Caldas department. ISAGEN has a good understanding of the hydrological resource available to Miel I. A hydrological model guides the analysis of data at 40 hydrometric stations, and any issues that could impact on the availability of water due to climate variability are identified at a range of timescales.

Hydrological forecasting reports consider both short and long-term scenarios. Precipitation and flow information is analysed in relation to macroclimatic phenomena, such as El Niño Southern Oscillation (ENSO), North Atlantic Oscillation (NAO), and Madden-Julian Oscillation (MJO) influences. In parallel to ISAGEN’s own modelling, a distributed hydrological model is currently under development. This aims to simulate flows in real time at points of interest in the catchment, and then forecast flows using hydrological and weather data.

The model uses information from a meteorological radar installed by ISAGEN, in partnership with local public agencies, as part of an early warning system. The radar measures reflectivity, which is correlated with precipitation data to enable a more comprehensive alert system than the hydrometric stations alone.

Water diversions increased project generation by almost 30 per cent

The two diversions were built to further maximise the use of available water and power generation potential. The Manso diversion increased generation by 11.3 per cent, and Guarinó by 17 per cent. This was

### Key case study features

- **Project stage:** operation
- **Developer/operator:** ISAGEN (acquired by Brookfield in 2016)
- **Capacity:** 396 MW
- **Annual generation:** 1,460 GWh (Miel I), 308 GWh (Garinó), 104 GWh (Manso)
- **Reservoir area:** 12.8 km²

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**Miel I, Colombia**

**Policy and practice lessons**

- Good understanding of available hydrological resource optimises water use
- Water diversions increased project generation by almost 30 per cent
- Plans contribute to addressing issues beyond the project impacts
- Adaptive processes enable successful management of unexpected environmental and social issues
diversions, based on economic, environmental and social objectives to determine seasonal minimum flow releases (6-7.2 m³/s for Manso and 10.8-17.3 m³/s for Guarinó). The Manso diversion was the first project in Colombia to have its minimum flow release determined using a method developed by the National University in Bogotá in 2008. This method has been approved by the National Environmental Licensing Authority (ANA).

Challenges

Detailed studies were later completed for the Guarinó (2002) and Manso (2006, 2012) diversions, based on economic, environmental and social objectives to determine seasonal minimum flow releases (6-7.2 m³/s for Manso and 10.8-17.3 m³/s for Guarinó). The Manso diversion was the first project in Colombia to have its minimum flow release determined using a method developed by the National University in Bogotá in 2008. This method has been approved by the National Environmental Licensing Authority (ANA).

ISAGEN manages flows down three rivers (Miel, Manso and Guarinó) with the aim of meeting social and environmental objectives. The minimum flow release for Miel (17 m³/s) was determined as part of the project’s environmental impact assessment (EIA), and was one of the first downstream flow releases provided in Colombia. Detailed studies were later completed for the Guarinó (2002) and Manso (2006, 2012) diversions, based on economic, environmental and social objectives to determine seasonal minimum flow releases (6-7.2 m³/s for Manso and 10.8-17.3 m³/s for Guarinó). The Manso diversion was the first project in Colombia to have its minimum flow release determined using a method developed by the National University in Bogotá in 2008. This method has been approved by the National Environmental Licensing Authority (ANA).

Adaptive processes enable successful management of environmental and social issues

Miel I was able to respond to and manage unexpected project impacts using adaptive management processes. Construction of the diversions did not initially require resettlement, but a number of households had to be resettled as a result of unexpected project impacts. These included severe erosion and landslides. The ongoing delivery of ISAGEN’s responsibilities under the Miel I environmental management plan (EMP) programmes provides a management structure for anticipating and responding to environmental and social risks and opportunities.

Since Manso started operations, the project began implementation of an additional programme, ‘Community Care and the Management of Unforeseen Impacts’. The aim of this programme is to ensure timely responses to ongoing damage to property arising from construction or operation. Specific examples of managed risks include:

- negotiations with landowners for the sale of land affected by erosion above the buffer zone around the reservoir; and
- provision of support to farmers on reservoir shores, whose crops were initially affected by increased relative humidity.

Engagement with affected stakeholders has been a key aspect in overcoming unexpected challenges of the project. ISAGEN has set up a range of partnerships with universities, stakeholders and communities to assist with managing environmental and social issues. For example, it has set up partnerships to manage downstream issues, as well as adjusting its operation as required, acquire land and create protected areas; use forest rangers and guides from local communities; provide capacity-building and education within local communities; collaborate with municipalities and other institutions and landowners; create and support conservation zones; and collaborate with NGOs, for example the WWF water stewardship project. This case study is based on an official assessment of the Miel I project using the operation stage tool of the Hydropower Sustainability Assessment Protocol. This was conducted in 2014, with an on-site assessment in June 2014.
Project case study 5: 
Romanche-Gavet, France

Policy and practice lessons

- Increased power generation and restoration can be achieved through ambitious modernisation projects
- Detailed corporate management processes deliver excellence in project management, on time and budget
- Comprehensive environmental management procedures promote contractor compliance
- Local communities benefit from restoration and a range of additional benefits

Key case study features

Project stage: implementation
Developer/operator: EDF (Électricité de France SA)
Construction start date: 2012 (access roads in 2010)
Commissioning date: 2020
Capacity: 94 MW
Annual generation: 560 GWh
Reservoir area: run-of-river project with a reservoir contained within the existing river channel
Purpose: power generation; restoration of the Romanche river through the decommissioning of six old small-scale facilities

The Romanche-Gavet project addresses the need to reduce the adverse impacts of hydropower in the Romanche valley. This case study demonstrates how ambitious modernisation projects can deliver increased power generation and better conditions for recreation and tourism in the surrounding area.

The 94 MW project is located on the right bank of the middle section of the Romanche river, in the southeast department of the French Alps, between Les Évian and Pierre Eybess. It replaces six facilities with a total capacity of 82 MW, built in the early 20th century, and increases average annual generation by over 30 per cent.

The project has relatively limited adverse environmental and social impacts, and has the potential to deliver long-term benefits for the local community. The valley is a route for tourists making their way to the skiing and recreational areas of the nearby Alps.

EDF is part of the multinational EDF Group, which also owns or has holdings in transmission companies in France and utilities across Europe and internationally. EDF Group is 80 per cent owned by the French state.

The group holds two concessions for Romanche-Gavet: one for the construction and operation of the new project, and another for the operation and decommissioning by 2030 of the six existing plants.

EDF managed Romanche-Gavet through a quality-controlled, documented organisational structure. A national-level Directoire was formed, consisting of the deputy director of the Hydropower Generation and Engineering Divisions, the director of the Hydro Engineering Centre within this division, the regional director, a regional project manager, and separate project managers for the construction and decommissioning projects.

Increased power generation and restoration can be achieved through ambitious modernisation projects

The design of Romanche-Gavet directly addresses the need to reduce the adverse impacts of hydropower generation in the Romanche valley, by removing the old plants and water transport infrastructure. This should improve conditions for recreation and tourism, and repurposing some of the decommissioned plants for cultural heritage conservation or economic uses.

The facilities that will be decommissioned are, from upstream to downstream: Livet, Les Vennes, Les Roberts, Roupenoux, Les Clavaux, and Pierre Eybess.

Through removal of five dams, the project will improve the ecological connectivity of the affected stretch of the river. Fish ladders are being installed at both the new Livet intake structure and at the Les Clavaux intake (which will not be decommissioned). The Gavet dam, just below the new project’s tailrace, will not be decommissioned either; therefore, full downstream connectivity to the sea will not be restored at this moment. However, since the priority species of this river stretch – trout and Chabot (bullhead) – do not require access to the sea during their life cycle, the presented solution is acceptable to local stakeholders and legislators.

EDF will be obliged to ensure connectivity though the remaining barriers as part of its commitments under the requirements of the EU Water Framework Directive.

EDF assessed whether it was necessary to vary the minimum flow released downstream of the intake throughout the year.

In addition to improving ecological connectivity, the focus of the project is as much if not more, on restoring aesthetic quality in the valley. The project will remove a range of old and unsightly structures, including intakes, galleries, headrace channels, penstocks, powerhouses, generating units and transmission lines.

EDF assessed whether it was necessary to vary the minimum flow released downstream of the intake throughout the year. Legal requirements call for a minimum downstream release of 10 per cent of annual inflow, which in this case equates to an average of 4 m³/s. However, the law only requires that this target be met as an average over the course of the year.

The local community favoured a constant flow for safe recreational use of the river between the intake and tailrace. Modelling was used to confirm that this would be sufficient from an ecological perspective.

Detailed corporate management processes deliver excellence in project management, on time and budget

The project demonstrates how ambitious modernisation projects can deliver increased power generation and better conditions for recreation and tourism in the surrounding area.
The regional division internally contracted the Hydro Engineering Centre (CIH) to prepare and deliver the project. Within the Directoire, a management team was formed to provide regional-level management. This team consists of the regional director, regional project manager and project managers. EDF used a range of plans to set out organisational requirements jointly for the construction and decommissioning projects, and for risks and interface issues. All documents were quality-controlled and compiled in an internal database, ensuring integrated management of both the construction and decommissioning projects.

Local communities played an active role in assessing issues of importance to them.

Contractors used detailed plans that were reviewed and integrated by the construction project manager. These identified critical interfaces between design and construction, and between construction components. Progress was monitored through monthly management team meetings, and quarterly Directoire meetings monitored risks for implementation. These meetings were an opportunity to review milestones and budgets. Weekly meetings with each contractor were minututed through quality-controlled documents. Three site managers, supported by three additional supervisors, reported to project managers through a quality-controlled reporting structure. Meetings of a “project validation committee” (a technical review committee) and a safety committee from a central level in EDF were held to scrutinise engineering studies.

Comprehensive environmental management procedures promote contractor compliance

EDF assessed and managed a range of environmental issues in a demanding regulatory context. Plans and processes are embedded within a centralised environmental management system, certified to ISO 14001. EDF carried out an initial assessment to examine issues for all phases, including construction of the new project, decommissioning of the old plants, and operation of the new project.

The project’s environmental and social impact assessment addressed the impacts of construction of the intake, new bridge, and powerhouse on surface water, wildlife, flora and the aquatic ecosystem. It also examined the social impacts in terms of economic activities and employment, cultural heritage, property, transport, noise and dust.

The assessment of the impacts of operation included operational impacts on surface water in terms of hydrology, sediment transport, physical chemistry and groundwater, and on terrestrial and aquatic flora and fauna. The long-term social impact of the project was looked at in terms of employment opportunities, tax revenue, impact on infrastructure, property, cultural heritage, tourism, health, education and security.

Environmental management plans were approved by the regulator and established in a prefectoral decree. Plans included:

- an environmental assurance plan (EAP) to manage waste, discharge of pollutants to soil, air and water, noise reduction, integration of the site into its surroundings, compliance with legal and contractual environmental constraints, and preservation of environmentally sensitive areas;
- inclusion of an appendix on environmental requirements in all contracts, and ensuring all contractors’ environmental management plans clearly establish how they will meet their contractual requirements;
- checking contractual requirements on a weekly basis, or more frequently if required, by the EDF site manager using a specific QSSE (quality, security, safety, environment) visit sheet to record findings, lodged in EDF’s central environmental management system, part of the overall electronic project management system;
- EDF environmental officers, with protocols and procedures for responding to an emerging risk of pollution, or a pollution event, which were regularly tested through simulated events.

Two staff members, one on site and one at the Hydro Engineering Centre, oversaw the monitoring of environmental parameters during project implementation. These staff were tasked with analysing and collating the environmental monitoring information.

A comprehensive risk assessment (initially highlighting environmental risks of hydrocarbon and cement discharge to the river, soil pollution from machinery, noise and air pollution) was regularly updated with new risks based on ongoing monitoring.

Each new phase of works required a new “execution procedure”, requiring the contractor to explain to EDF project managers how they would respond to environmental risks. Local communities benefit from restoration and a range of additional benefits

Local communities played an active role in assessing issues of importance to them. They recognised the significant positive impacts the project brings in terms of employment, improved recreational access to the river and conservation of cultural heritage. As a result of community consultation, EDF committed to delivering a range of additional benefits. These include a new domestic water supply system; a permanent bridge in an affected village; the handover of the project office (Maison Romanche Energie) to the local municipality for community use; and permanent noise mitigation measures around a local school.

EDF committed to ensuring that 5 per cent of the project’s workforce (by working time) is sourced from local unskilled workforce. The company implemented this in close cooperation with a local organisation that supports young people aged 16–26. More than 25 per cent of total expenditure at the time of the assessment was on contracts from the southern part of Isère, and more than 50 per cent of hours worked were by employees from this region.

Challenges: decommissioning old plants whilst preserving heritage value

Some of the plants being decommissioned were of cultural heritage value, owing to their role in hydropower and mineral extraction in the industrial era. There was a significant risk that EDF would be required to dismantle and destroy structures to meet its concession requirements (which required decommissioning), despite the genuine heritage value of the plants. The required very careful stakeholder consultation and clarification of EDF’s responsibilities.

The Les Vernes plant was built in 1917 by an entrepreneur who pioneered calcium carbide production and hydropower in the Romanche valley. The building has a neoclassical design, and encompasses a stairway based on the architecture of a nearby château. It also includes the original penstocks and machinery. Les Vernes was classified by the French state in 1994, upon EDF’s request, and the plant and its penstocks are listed by the regional authorities. The Livet plant consisted of two parts: two older buildings built between 1898 and 1902 (Livet 1), and a structure built in 1940 (Livet 2). The second structure is made of concrete and steel, in an industrial design rarely found in the region. The structure is even depicted on a stained-glass window in the local church.

50% of hours worked were by employees from the region.

This case study is based on the findings of an official assessment of the Romanche-Gavet project using the implementation stage tool of the Hydropower’s Sustainability Assessment Protocol. The assessment was carried out during implementation phase of the project, in May to July 2013, with an on-site assessment encompassing a visit to the project site and interviews with stakeholders in June 2013.
Examples of broader schemes undertaken in relation to hydropower projects to address commonly problematic development challenges.
Initiative case study 1: Acreditar training and recruitment programme, Brazil

Policy and practice lessons

- Regional-scale training programmes contribute to regional development
- Local training programmes reduce migrant influx
- Ambitious programmes deliver benefits well beyond the project needs
- Broad programmes support inclusivity of women and young people

Facing strong competition for qualified labour in the region, the Santo Antônio project developed the Acreditar initiative to train local people and develop skills that could be used beyond the needs of the project.

The Santo Antônio hydropower plant is located on the Madeira river, 7 km upstream of the city of Porto Velho, the capital of Rondônia in north-west Brazil. The Madeira is a major tributary of the Amazon, the world’s largest river in terms of run-off volume. The plant has an installed capacity of 3,568 MW.

Santo Antônio was designed to maximise use of water resource potential in the region with minimal negative environmental impact. An important challenge for large infrastructure projects in Brazil at the time of project development was strong competition for qualified labour. The presence of other large hydropower projects in the Amazon region, such as the neighbouring Jirau, contributed to high staff turnover and upward pressure on salaries.

The project workforce peaked in 2011, at 20,700 workers. An extension to the project led to further demand for construction workers. During the implementation stage, the project aimed to hire 70 per cent of workers from the state of Rondônia, in order to address local unemployment and avoid an influx of migrants to the area in search of work. To deliver on this objective, the project developed the ‘Acreditar’ training programme, as well as providing training to local suppliers. Acreditar was a flagship initiative designed to plan for, and supply, sufficient qualified workers for the project. The initiative proved to be financially viable.

Acreditar is an outstanding example of a project taking the opportunity to make a long-lasting impact on the local community and region. Thanks to the initiative, Porto Velho and Rondônia have experienced a notable increase in trained workers and workers with experience on large construction projects. These workers are now qualified to look for well-paid work on similar projects elsewhere.

Regional-scale training programmes contribute to regional development

At the start of project construction in 2008, the EPC contractor evaluated the local supply of labour. They found that Porto Velho and surrounding areas in Rondônia could only provide around 30 to 40 per cent of the project’s labour needs. However, at the time, around 30,000 Porto Velho residents were unemployed. The entire region was experiencing a high level of unemployment. This is because the federal government had promoted an ambitious settlement programme in Rondônia state in previous decades, which had little success in terms of industrial development.

Acreditar began by introducing a series of 15 different training programmes for unemployed people in Porto Velho and the surrounding areas of Rondônia state. However, the project needed to establish a more ambitious target in order to achieve its 70 per cent target.

In response, the project developed two programmes: Acreditar Profesional, and its extension, Acreditar Junior. Acreditar Profesional trained over 45,000 people, including through partnerships with highly regarded technical training institutions, including the National Industrial Apprenticeship Service (SENAI), National Rural Education Service (SENAR), National Comercial Education Service (SEINAC) and the Brazilian Navy.

The training far exceeded the direct hiring and supply needs of the project, and has left a legacy of skills development in the region. It went well beyond more commonly seen programmes, which tend to promote employment in the nearest and most affected communities only, instead taking a regional-level approach.

Ambitious programmes deliver benefits well beyond project needs

Almost 29,000 Acreditar trainees were employed on the Santo Antônio project over the course of its implementation. This figure shows that a significant number – over 16,000 – trainees benefitted from the programme but used their new skills to seek employment elsewhere. This extends well beyond the needs of the project, and was one of the key benefits of the project for the region.

Broad programmes support inclusivity of women and young people

Major construction sites in Brazil employ few women, normally around or below 5 per cent of the total workforce. Acreditar actively sought to address this, through activities to promote equal opportunities, especially in terms of gender.

The project established a commitment to not have any rules or defined practices that would restrict equal opportunities. Courses provided through SENAI included a programme to deliver training to approximately 1,000 women on tasks typically regarded as ‘male’ jobs. The project doubled the employment rate of women compared to national norms, achieving a proportion of 10 per cent of positions taken by women. In addition, the Acreditar Junior programme provided training for teenage children (aged 14–18) years of project workers, with courses offered through SENAI.

Replicable programmes can be readily applied with significant benefits

The approach developed on Santo Antônio has been replicated by the developer on many other hydropower and other projects in 11 countries. These include Chaglla in Peru, and Teles Pires in Brazil. The benefits of the Acreditar initiative extend far beyond Santo Antônio and beyond the hydropower sector. In total, over 100,000 employees have received training through the initiative.

100,000 employees have benefited from the initiative

This case study is based on an official assessment of the Santo Antônio project using the implementation stage tool of the Hydropower Sustainability Assessment Protocol. The assessment was conducted in April and May 2014.
Initiative case study 2:

**Angostura hydropower plant, Chile**

**Policy and practice lessons**
- Continuous engagement with communities and local authorities was key to implementing the project and gaining support
- The integration of energy and tourism was achieved through a partnership approach

**Key project features**

**Angostura is the largest hydropower plant to have entered operation in more than a decade in Chile. Its model was designed to integrate energy and tourism into a single project. This case study demonstrates a successful multi-purpose project that has directly benefitted regional economic development in the Biobío basin area.**

Local communities were involved at an early stage of the project planning process, and mitigating environmental impacts and boosting local economic development were central to the preparation, implementation and operational stages of the project. With an installed capacity of 316 MW, enough to provide power to approximately 400,000 people, the Angostura hydropower station uses the water resources of the Biobío and Huequecura rivers through a reservoir covering an area of 641 hectares. The plant is located 63 km south-east of the city of Los Ángeles, and 18 km upstream from Quilaco and Santa Bárbara, in the Province of Biobío, Biobío Region in Central Chile.

The environmental impact assessment (EIA) was submitted in September 2008 and was approved in November 2009. Construction of the project began in February 2010 with the first earthworks, and ended 48 months later, on schedule.

The Angostura Park is a prime example of a multi-purpose project which both boosts power generation and delivers economic benefits to the entire region. To date, monitoring has shown an abundance of these species. Moreover, in order to identify possible preservation areas for fish fauna, monitoring of the Quilme, Lique, Mininco, Queuco and Quillallo rivers (tributaries of the Huequecura river) is also carried out, given that these have a similar composition.

Regarding the reforestation work associated with the development of the Angostura project, 210 hectares of native forest (with species such as quillay, oak, laurel, guindo santo and naranjillo, among others) have been replanted. In addition, the plant curtain of eucalyptus species such as quillay, oak, laurel, guindo santo and naranjillo, among others have been replanted.

In order to reach an agreement with the 46 families affected by the creation of the reservoir, Colbún implemented an individual resettlement plan, which considered a case-by-case package of compensation, psycho-social support and assistance in the development of vocational projects. A team of 17 people worked exclusively over three years on this programme of support to resettled communities, who are now being provided with ongoing support.

**Continuous engagement with communities and local authorities was key to implementing the project and gaining support.**

Consultation began in October 2007 and lasted nine months. As a result of this process, the project incorporated modifications. For example, the format for negotiating with resettled families changed from a collective format to an individual one. In order to reach an agreement with the 46 families affected by the creation of the reservoir, Colbún implemented an individual resettlement plan, which considered a case-by-case package of compensation, psycho-social support and assistance in the development of vocational projects. A team of 17 people worked exclusively over three years on this programme of support to resettled communities, who are now being provided with ongoing support.

**The site of the Angostura hydropower plant.**
The integration of energy and tourism was achieved through a partnership approach

Angostura Park is a tourism initiative that includes trails, a lookout point, three campites, two free access beaches and a visitors' center. Additionally, there are guided tours to the dam and the turbine hall. To promote the development of tourism in the area, a full marketing plan has been developed, which includes a dedicated website and a Facebook page that now has more than 45,000 followers. These offer information on the tourist project developed around the reservoir and the surrounding area.

In addition to the development of Angostura Park, Colbún has sought to strengthen the area of Quilaco and Santa Bárbara as a new tourist destination in the region, under the name Angostura del Biobío. The basis for promoting this new destination is through a public-private partnership under the aegis of the Angostura Tourism Board. The partnership began operating in January 2011. This body is made up of representatives of the area's neighbourhood associations, local entrepreneurs, representatives of the chambers of commerce, the municipalities of Quilaco and Santa Bárbara, the regional national tourism service and Colbún.

All relevant decisions regarding the park have been made by this board, building a public-private governance for the tourism project.

In 2016, the centre provided training, advice and related services to 2,714 people.

Since it began its operations, the Angostura hydroelectric power station has received the recognition of FEDETUR, Cigrel, AmCham (Chile-US Chamber of Commerce), Capital Goods Corporation (CIC), and has received a Latinocamerica Verde award.

The project supported the opening of an Entrepreneurial Centre to provide training, advice and financing to companies in the vicinity of the plant

In 2012, the Entrepreneur Centre of Santa Bárbara and Quilaco was opened by Colbún in partnership with the NGO Acción Emprendedora. In 2016, the centre provided training, advice and related services to 2,714 people, 688 people attended their seminars and training programmes (workshops), 160 consultancy services were delivered and the centre gave financial support to 72 ventures. Nine of these projects corresponded to tourism development in the power station area. Tourism initiatives have contributed to the development of the region. New offices are being built for the workers of the plant, which will be launched during 2017. Currently, they are under application to be certified as a sustainable building by CES (Certificación Edificio Sustentable), a national accreditation system.

Stakeholder engagement boosts economic development with minimal environmental impact

The Angostura project combines a highly developed environmental management plan with an ambitious plan for economic development through tourism that focuses on the involvement and empowerment of communities in proximity to the plant.

Environmental management measures include the protection of fishstocks in the Biobío and Huequecura rivers and tributaries and large scale reforestation of areas around the reservoir with native trees. In addition, individual resettlement plans offered each family and individual who would be affected by the flooding caused by construction of the dam a bespoke package of financial, vocational and psycho-social support.

At the same time, a unique tourist attraction was developed that includes a visitor centre to the dam, and turbine hall and recreational facilities on and around the reservoir. Angostura Park is managed by a public-private partnership that brings together local neighbourhood associations and chambers of commerce.

In addition to the development of tourist facilities, entrepreneurship in the region has been supported more generally through the opening of an Entrepreneurial Centre.

To date, Angostura has carried out two public reporting presentations, in 2015 and 2016. This is an open exercise in which social, environmental and operational performance is reported to all those living in proximity to the installation.

Results have shown the success of this initiative with more than 160,000 visits to Angostura Park during 2016.
### Initiative case study 3:

**Cultivando Água Boa / Cultivando Agua Buena, Brazil–Paraguay**

**Policy and practice lessons**

- Practical measures to minimise run-off can be taken in partnership with farmers
- A micro-catchment approach allows a large-scale problem to be managed in small parcels
- Catchment management can provide a framework to deliver wider benefits
- Micro-catchment managers and effective communications enhance catchment management programmes

### Key project features

- **Developer/operator:** Itaipu Binacional
- **Associated projects:** Itaipu (14,000 MW)
- **Region/basin:** Parana, south-west Brazil/east Paraguay

**The “Cultivando Água Boa” (“Cultivating Good Water”) programme was set up by the Brazilian part of Itaipu Binacional in 2003. Concerned about siltation of the Itaipu reservoir and the risk of eutrophication due to agricultural run-off, the programme aims to minimise the run-off of silt, fertilisers and pesticides.**

- The Itaipu dam was built between 1975 and 1982, with the 170 km long reservoir reaching its operating level in 1983. The initial 18 units were commissioned between 1984 and 1991, with a further two added in 2006–07. The Paraná River is among the largest in the world in terms of length and discharge. The Itaipu plant has generated almost twice as much electricity as any other power plant in the world. It provides 79 per cent of Paraguay’s total electricity and 14 per cent of Brazil’s total electricity.

- Land on the Brazilian bank of Itaipu’s reservoir. These include physical measures such as: contour bunding; promoting zero-tillage approaches in farming; tree planting on contours and along water courses; constructing rural roads; to meet high erosion prevention standards; and recovery of degraded areas through reforestation.

- Environment improvements, with less agricultural pollution, and better roads and water supplies.

- Building on the success of the programme, the Paraguayan part of Itaipu Binacional has now instigated a similar programme, ‘Cultivando Agua Buena’ (the Spanish equivalent of ‘Cultivating Good Water’).

**Practical measures to minimise run-off can be taken in partnership with farmers**

- **CAB** supports a wide range of measures to manage the quality of water entering the reservoir. These include physical measures such as: contour bunding; promoting zero-tillage approaches in farming; tree planting on contours and along water courses; constructing rural roads; to meet high erosion prevention standards; and recovery of degraded areas through reforestation.

- **Catchment management can provide a framework to deliver wider benefits**

- **Micro-catchment managers and effective communications enhance catchment management programmes**

**The work of the micro-basin managers is supported through a range of CAB-branded communications materials.**

- A noticeable feature is the provision of washing stations, which provide free water to farmers for washing agricultural machinery. This is important for ensuring that soil and other residuals are collected and managed, rather than being washed into watercourses, and ultimately the reservoir. Many of these measures are being taken in partnership with farmers, who can see the benefits of avoiding soil erosion on the productivity of their farms.

- **A micro-catchment approach allows a large-scale problem to be managed in small parcels**

- **CAB** provides a replicable model

Expenditure on CAB in Brazil was over USD 2.35 million, or 13 per cent of its total expenditure on environmental and social programmes in 2015. At USD 2.200 million in 2015, expenditure on the programme in Paraguay is much lower, but is growing. A similar range of measures are underway through agreements of the Department of Reservoir and Protected Areas in Paraguay and the environmental regulator, together with project-affected municipalities. CAB has been replicated in many other areas of Brazil and also in five additional Latin American countries: Argentina, Dominican Republic, Guatemala, Paraguay and Uruguay, as well as in Spain.

The programme was awarded the Water for Life prize by UN Water in early 2015, recognising it as the best water-management programme in the world.
Regional initiative to promote sustainability in hydropower

Policy and practice lessons

- Embedding a sustainability assessment into a wider programme builds stakeholder awareness and buy-in
- A protocol assessment may help attract support of international financial institutions
- Locally focused information sharing supports wider-scale transboundary coordination
- Ongoing training initiatives promote wider informal and formal use of the protocol

Key project features

Partners:
Shardara Reservoir Division of the Ministry of Agriculture, Kazakhstan; Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), CAREC (the Regional Environmental Centre for Central Asia)

Associated projects:
Shardara Multi-Purpose Project (100 MW)

Region/basin:
Aral-Syrdarya Basin (Kazakhstan, Uzbekistan, Tajikistan, Kyrgyzstan)

When the Hydropower Sustainability Assessment Protocol was finalised in November 2010, GIZ’s programme for Transboundary Water Management in Central Asia asked the International Hydropower Association (IHA) to apply it to the Shardara Multi-Purpose Project. The report was delivered in December that year, but the initiative didn’t stop there.

The assessment led to steps to improve transboundary basin management, modernise the Shardara project, and promote sustainability in hydropower across the Central Asian region. After the protocol was finalised in November 2010, the first assessment was carried out in Kazakhstan. It was an assessment of the Shardara Multi-Purpose Project, organised with the support of a GIZ then GTZ programme on transboundary water management in Central Asia.

The Shardara Multi-Purpose Project is located in southern Kazakhstan, near the border with Uzbekistan. The project is one of many reservoirs, weirs, barrages and hydropower plants on the 2,200 km Syrdarya river.

The purpose of the project is irrigation and flood regulation, with power generation as an additional benefit. It was built between 1964 and 1967 and has a 100 MW capacity. JSC Shardashinskaya GES, incorporated in 1998, is the owner and manager of the plant. The company is 100 per cent owned by Samruk Energetik, a power sector subsidiary of the National Welfare Fund Samruk Kazyna.

Embedding a sustainability assessment into a wider programme builds stakeholder awareness and buy-in

The GIZ programme on Transboundary Water Management supports Central Asian states in establishing suitable water management structures. The programme ran from 2009 to 2017, under the German Federal Foreign Office’s Central Asia Water Initiative (the Berlin Process), and with partial co-financing from the European Union. Its objective is to support Central Asian states in jointly developing practical approaches for sustainable regional water management.

Within this programme, the protocol assessment was embedded in a wider evaluation process, involving partners across Kazakhstan and the whole region. The final report, prepared by Dr Helen Locher (a protocol-accredited assessor), was translated into Russian and distributed to all involved institutions from Astana, Shymkent (the provincial capital) and Shardara, in March 2011.

An evaluation meeting was held in late March 2011, and minutes of the meeting were distributed to stakeholders. The national Kazakhstan Committee of Water Resources and Ministry of Environmental Protection delivered official responses in May of that year.

A range of institutions interviewed during the assessment actively participated in the evaluation meeting.

A range of institutions interviewed during the assessment actively participated in the evaluation meeting.

The chairman of the Kazakh Committee of Water Resources recommended the Protocol "be applied to the entire Syrdarya basin".
A protocol assessment may help attract support of international financial institutions

Some of the key findings of the assessment, on the topics of asset reliability and efficiency (O-3) and infrastructure safety (O-6), were that all assets, including generation, reservoir, and irrigation and drainage assets, still require considerable investment for rehabilitation works. Whilst dam safety is closely monitored, and dam and plant rehabilitation works have safety as a strong priority, the need for a new emergency gate at Shardara, and it was also necessary to replace a second dam’s gates and plant gates, and improve irrigation drainage. JSC Shardarinskaya GES has since instigated a rehabilitation project, with loan finance from the European Bank for Reconstruction and Development (EBRD). A ten-year loan of up to EUR 75 million was agreed in 2012, and development (EBRD).

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The conclusions also raised an absence of integration of different institutions

The conclusions also raised an absence of integration of different institutions, such as the Syrdarya Basin Water Organisation and Aral-Syrdarya Council (O-2) topics highlighted that, despite some mechanisms for coordination, such as the Syrdarya Basin Water Organisation and Aral-Syrdarya Council, it was unclear how much lateral exchange of information occurs. This would be a more locally focused grouping within the Aral-Syrdarya Council, as a forum to discuss local issues of reservoir management between Kazakhstan and Uzbekistan.

Locally focused information sharing supports wider-scale transboundary coordination

One of the key recommendations of the assessment was that the chairman of the Committee of Water Resources (the state agency with responsibility for water resources) should establish a Shardara Reservoir Council. This was a more locally focused grouping within the Aral-Syrdarya Council, which could meet to discuss reservoir management issues and share information between agencies. The Shardara Reservoir Council would also provide a forum to address issues raised by stakeholders.

The reservoir at Shardara

The reservoir at Shardara

Conclusions under the communications and consultation (O-1) and governance (O-2) topics highlighted that, despite some mechanisms for coordination, such as the Syrdarya Basin Water Organisation and Aral-Syrdarya Basin Council, it was unclear how much lateral exchange of information occurs. This would be a more locally focused grouping within the Aral-Syrdarya Council, as a forum to discuss local issues of reservoir management between Kazakhstan and Uzbekistan.

Participants at a training event wanted to understand how the protocol complements international lenders’ requirements.

Participants at a training event wanted to understand how the protocol complements international lenders’ requirements. The conclusions also raised an absence of dialogue between Kazakhstan and Uzbekistan operational staff on the Arnasai dam. The dam is located on the southernmost point of the Shardara reservoir, and releases water into Uzbekistan. Transboundary information and negotiation problems (upstream with respect to inflows, and downstream with respect to the Arnasai Dam) were left unresolved, and presented a risk for operations. The Committee of Water Resources acted upon this recommendation, establishing the Shardara Reservoir Council as a forum to discuss local issues of reservoir management between Kazakhstan and Uzbekistan.

Ongoing training initiatives promote wider informal and formal use of the protocol

The chair of the Shardara Reservoir Council participated in a series of training events organized by CAREC in Almaty in 2016. Other participants included representatives from EC IFAS and trainees from across all Central Asian countries.

CAREC approached IHA in 2016 to ask for further training on the protocol and support for awareness raising of the protocol across the region. The resulting initiative comprised:

• a training event to raise awareness among decision-makers;
• The development of a dissemination brochure in Russian;
• an additional ‘train-the-trainer’ event; and
• the development of a scientific paper concerning the initiative (“The Hydropower Sustainability Assessment Protocol – its relevance and suitability for application in Central Asia”).

One of the key questions raised during the training, which is also addressed by the scientific paper, is: ‘Why use the protocol in Central Asia?’

Developers and operators of hydropower projects in the region have to follow detailed regulations and engineering standards for project development. Participants were interested in understanding how the Protocol compared to these standards. Participants also wanted to understand how the Protocol complements international lenders’ requirements.

The scientific paper, prepared in Russian, addressed these questions with the following answers:

• the protocol consists of a comprehensive range of topics, including technical and financial, as well as environmental and social issues;
• the protocol is focused entirely on hydropower (unlike lenders’ requirements, which are general);
• a protocol assessment can be used as a tool for stakeholder engagement;
• a protocol assessment provides a rapid "check" on a project’s sustainability; and
• Following the training events, IHA, CAREC and EC IFAS entered into discussion on the steps needed to promote the protocol further in Central Asia.

Potential actions under discussion are:

• the translation of one or two official assessments of projects in other locations into Russian, or summaries, as examples of assessment reports;
• developing training materials and delivering training courses at a national level, possibly in partnership with universities, targeted at teachers and students;
• providing the protocol brochure and presentations, for example to ministries and working groups, and annual regional meetings of water sector organisations, and development partners;
• disseminating materials in Russian, such as a website, training presentations, case studies, and a video of the process of an official assessment; and
• developing an approach to using the protocol that is appropriate for rehabilitation projects.

Participants at a training event wanted to understand how the protocol complements international lenders’ requirements.
Initiative case study 5: Reventazón, Costa Rica

Policy and practice lessons

- The offset programme was based on environmental and social criteria and designed and implemented with stakeholders.
- The programme protects a free-flowing river and the perpetuity of intact ecosystems.
- A biological corridor was created to safeguard critical jaguar habitats.
- Offset measures address multidisciplinary objectives.

Key project features

Developer/operator: Instituto Costarricense de Electricidad (ICE)
Associated projects: Reventazón (305.5 MW)
Region/basin: Reventazón river, Limón province

The Reventazón Hydroelectric Project (RHP) is one of the first Latin American hydroelectric projects to use a river offset approach. This case study demonstrates how strategic basin planning can help develop the hydropower potential of a river whilst making a significant contribution to biodiversity conservation.

Instituto Costarricense de Electricidad (ICE), Costa Rica’s national power company, developed the Reventazón Hydroelectric Project (RHP) between 2012 and 2016. RHP was built on the Reventazón river in the Limón province, with a 130 m dam and an 8 km long reservoir. The project is the fourth in a cascade of projects on the Reventazón river and is designed to maintain a downstream flow of 40 m³/s. It comprises an additional small powerhouse, with a single 13.3 MW turbine, to utilise the environmental flow release. The project is located in an area of very humid tropical forest.

Reventazón was partially funded by the Inter-American Development Bank (IDB) and as such was required to meet international environmental and social safeguards. Project studies anticipated that, in the absence of environmental management strategies, RHP would make a significant impact on migratory fish species and critical habitats and connectivity.

Studies indicated that the project would affect around 471 species of fauna, of which 34 are at risk of extinction and 58 are under threat. It would also affect 193 species of flora, of which 15 are at risk of extinction, and six are under threat.

The programme had to be implemented in a river stretch with similar ecological conditions and services to the Reventazón river.

ICE designed an offset plan that included protecting the perpetuity of the Parismina river, an intact river that joins the Reventazón river downstream of the dam on the coastal plain.

RHP is one of the first Latin American hydroelectric projects to use the river offset approach. The IDB estimated that the offset would cost USD 2.7 million over 2013–15, and USD 800,000 per subsequent year. This case study is an example of how strategic basin planning can help develop the hydropower potential of a river whilst protecting and avoiding development in other free-flowing rivers in the same basin. It also demonstrates how effective mechanisms can be used to offset environmental impacts.

The offset programme had to be implemented in a river stretch with similar ecological conditions and services to the Reventazón river. The Parismina river and its tributary, Dos Novillos river, were selected for the implementation of the programmes (a total stretch of 105.5 km).

The selection process involved analysing nine river basins discharging into the Caribbean Sea. Three of the nine basins were selected due to their equivalent fluvial ecosystems meeting the following criteria: complex aquatic ecosystems and migratory species with high biodiversity; a continuous flow without barriers; good aquatic and terrestrial habitat conditions; and socio-economic services (e.g. eco-tourism, or sites of cultural heritage importance). Parismina was selected because it receives several tributaries and is key to fish migration. Dos Novillos was selected for offering the best aquatic and riparian habitat conditions, and socio-economic services.

ICE designed an offset plan that included protecting the perpetuity of the Parismina river, an intact river that joins the Reventazón river downstream of the dam on the coastal plain.

The offset programme was based on environmental and social criteria and designed and implemented with stakeholders.

The offset programme was designed to:
- protect a free-flowing river with similar characteristics to the Reventazón river;
- improve water quality and riparian habitats;
- compensate the loss of critical habitat and impacts on terrestrial and aquatic connectivity, especially impacts on big cats and migratory aquatic species; and
- facilitate a possible net gain of critical habitats.

The programme had to be implemented in a river stretch with similar ecological conditions and services to the Reventazón river. About 16 communities had a direct influence on the Parismina and Dos Novillos rivers, with a total population of 6,787 in 2013.

The feasibility study used recognised indicators to measure riparian habitats, hydro-geomorphological conditions and riparian forest quality. The study concluded that the rivers would be suitable for the programme and would enable a net gain of 40 per cent in riparian habitats.

ICE designed the Parismina–Dos Novillos water offset management plan, which included actions to reforest the riverbanks, reduce agrochemical water pollution, promote best agricultural practices, and improve water resource management. The programme engaged local communities, who were involved in capacity-building activities and monitoring.

The programme had to be implemented in a river stretch with similar ecological conditions and services to the Reventazón river.
Contributing to biodiversity conservation in Costa Rica

The programme contributed to meeting the policies and objectives on biodiversity conservation in Costa Rica.

In addition to the protection of the Parismina river, the president of Costa Rica declared that the Savegre and Pacuare rivers would be protected from hydropower development from 2015 for 25 years.

This decision was made as part of a national framework for hydropower development.

The Savegre and Pacuare rivers were selected for their ecological, biological, economic and social importance.

The reservoir location would have a significant impact on one of Costa Rica’s most important biological corridors, the Barbilla-Destierro biological subcorridor.

The powerhouse penstock and surge tower

The reservoir location would have a significant impact on one of Costa Rica’s most important biological corridors.

The programme involves ongoing work between ICE and landowners in the Parismina and Reventazón watersheds to reduce erosion, sedimentation and pesticide run-off.

The effectiveness of protection measures would be verified through a permanent monitoring programme for water quality, biodiversity and key habitats.

A biological corridor was created to safeguard critical jaguar habitats

The reservoir location would have a significant impact on one of Costa Rica’s most important biological corridors, the Barbilla-Destierro biological subcorridor. This corridor plays a key role in the migration of jaguars in the Mesoamerican biological corridor between Nicaragua, Costa Rica and Panama. The Barbilla-Destierro biological corridor was identified as an area of importance for the connectivity of jaguar populations since 1999.

The project performed studies on the effectiveness of the Barbilla-Destierro biological subcorridor management and the role of different stakeholders.

This process contributed to strengthening the corridor’s management structure.

The project implemented habitat restoration measures to preserve the subcorridor’s role in the movement of jaguars and their genetic flow.

Measures included in the offset programme involve riverbank restoration that could create additional jaguar habitats and improve habitat connectivity from Tortuguero National Park on the coast up into the central mountain range.

The offset measures will contribute to meeting a number of environmental and social objectives that will benefit the environment and improve the performance of the project.

The project also included payments to forest owners for environmental services, environmental education, and agroforestry technical support. For example, farmers were able to learn how to raise pigs in enclosures rather than letting them run free. This way, waste produced by the pigs can be converted into fertiliser and gas, and will not affect water quality in the reservoir.

At the same time, the pigs will be less exposed to jaguar predation, reducing the potential for conflicts between farmers and conservationists.

Offset measures address multidisciplinary objectives

The offset measures will contribute to meeting a number of environmental and social objectives that will benefit the environment and improve the performance of the project.

For example, the reforestation of a buffer strip around the reservoir would help to:
- reduce erosion and sedimentation;
- increase the useful life of the reservoir;
- reduce the risk of landslides; and
- create connectivity routes and new habitats for amphibians, reptiles, birds, insects, and mammals.

The project also prepared a reforestation plan using local tree and plant species and local nurseries.

The reservoir location would have a significant impact on one of Costa Rica’s most important biological corridors.
Initiative case study 6: Tulila Hydroelectric Plant, Tanzania

Policy and practice lessons

- Plant supplies energy for load centres in Songea, Mbinga and surrounding rural areas
- Project supports services to local people and charity work
- Local jobs created for operation and maintenance of the power station

Key project features

Developer/operator:
Tulila Hydro-Electric Plant Company Limited (Albert Koch Foundation/ Benedictine Sisters of St Agnes, Chipole)

Associated projects:
Tulila Hydroelectric Plant (5 to 7.5 MW)

Region/basin:
Ruvuma region, Tanzania

The Benedictine Sisters of St Agnes, based in the Ruvuma region of south-west Tanzania, have constructed a small hydroelectric plant on the Ruvuma river in Tulila. It supplies the load centres of Songea and Mbinga and rural areas in the vicinity of the plant, and delivers important benefits to the local community.

In summer 2009 the entrepreneur Albert Koch from Switzerland launched an initiative ‘Hydropower for Africa’ in collaboration with the Benedictine Sisters of Chipole, with his first project: the Tulila hydroelectric plant. To launch his activities, Mr Koch founded the Albert Koch Foundation and Tulila Hydroelectric Plant Ltd, both in Switzerland. Later, the local project company Tulila Hydro-Electric Plant Company Ltd. was founded in Tanzania. All engineering work and support for licensing, financing and insurance for Tulila Hydro-Electric Plant Co. Ltd. was provided by AF-Itesco (formerly Itesco Engineering Ltd.). AF-Itesco carried out the complete technical project, from initial studies to successful commissioning, and allocated two resident engineers over two and a half years for project management and work supervision on the construction site.

The initial studies were carried out in 2010, and construction work began in October 2011. Following commissioning, the commercial operation started in mid-September 2015. All works were completed by end of August 2016.

Technical features

The Tulila HEP is a run-off plant with daily pondage. The damming structure consists of an earth-fill dam, including a concrete part in the middle with intake, overflow section with four weir blocks, a bottom outlet and wing walls. The intake already has three inlet openings, where the inlet next to weir block one is closed (phase two). Inlet one and two lead water through two penstocks and then into the powerhouse. The penstocks have two different diameters for each alignment (DN2300/DN2500). This decision was made to reduce the transport costs because the DN2300 pipe was nested into the DN2500 pipe. The powerhouse was designed for three identically constructed turbine and generator units, each of 2.5 MW. In phase one, only two 2.5 MW units have been installed, due to electricity demand considerations and transmission line capacity of the mini-grid. The third 2.5 MW unit and penstock alignment will be installed when the grid is connected to the Tanzanian national grid.

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The remaining power demand is covered by diesel generators. In order to increase power supply in rural areas, villages along the 85 km transmission line were connected to the mini-grid. Diesel usage has been considerably reduced since the Tulila project came into operation.

Tulila HEP is helping to stabilise the network by supplying the bulk of the load. One 4 MW diesel generator park may now be shut down. The Tulila project and Songea Power Station (operated by Tanesco) are cooperating closely and exchanging experience, as Tulila is currently synchronising onto the regional mini-grid.

**Project supports services to local people and charity work**

The Benedictine Sisters of St Agnes deliver important education, healthcare, nutrition and orphanage services in Chipole Convent and in 45 remote stations. In line with Benedictine tradition, almost all basic daily needs are met by the sisters themselves. All the sisters’ services for the Tulila project were made available with limited own contributions. After repayment of the debt financing, and once proof is established that any general repairs and maintenance works can be carried out by local contractors.

**High demand for medical assistance in the area prompted the sisters to establish a health centre in Tulila.**

The sale of electricity supports the sisters’ services and charity work, and provides a solid and sustainable basis for their activities. The sisters fill an important gap as they offer medical assistance to workers. A skilled nurse was assigned to the Tulila project, and news spread to villages up to 20 km from the project.

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**How was the project financed and insured?**

The total project cost of approximately USD 28.3 million was financed by a bank loan (65 per cent, USD 18.5 million), subordinated loans and equity (32 per cent, USD 9 m) and a Green Generation Performance Grant through REA (3 per cent, USD 0.8 million).

Despite sufficient equity funds, attractive site conditions, low technical risks, high feed-in tariffs and a favourable economy, financing was a challenging aspect of the project. The uncompromising commitment of the main stakeholder and the sisters’ excellent reputation were important factors in convincing creditors and insurers.

Furthermore, the issuance of an export risk policy was a precondition for credit. From the kick-off meeting at the bank, it took 16 months to conclude the credit contract. An export risk insurance covering pre-shipment/supplier loan combined with a buyer credit insurance has been concluded with Swiss Export Risk Insurance (SERV). While technical risks were considered to be quite low, the commercial risks associated with a non-recourse project financing in a Sub-Saharan country was quite a challenge for the financing community.

The existence of a well-designed framework for small hydroelectric power projects in Tanzania was a very positive factor.

The procedure to obtain the required export risk insurance policies took more than six months and was very well supported by SERV. As shown above, overall financing costs (including fees, interest during construction and SERV insurance premium) amounted to USD 5.1 million, which represents approximately 18 per cent of the total project cost.

Another hurdle in connection with the financing was finding an insurance company for technical risks during the construction and operating period, including delay-in-start-up, marine and business interruption insurance. The Tulila hydropower project proved rather small for international insurance companies. Yet, with the strong support of a Swiss insurance broker, this hurdle could be overcome, as a Swiss insurance company was identified and provided the required insurance package.

**Case study: Initiatives**

(Two pages of a Word document with text regarding the Tulila project and its impact on the local community.)