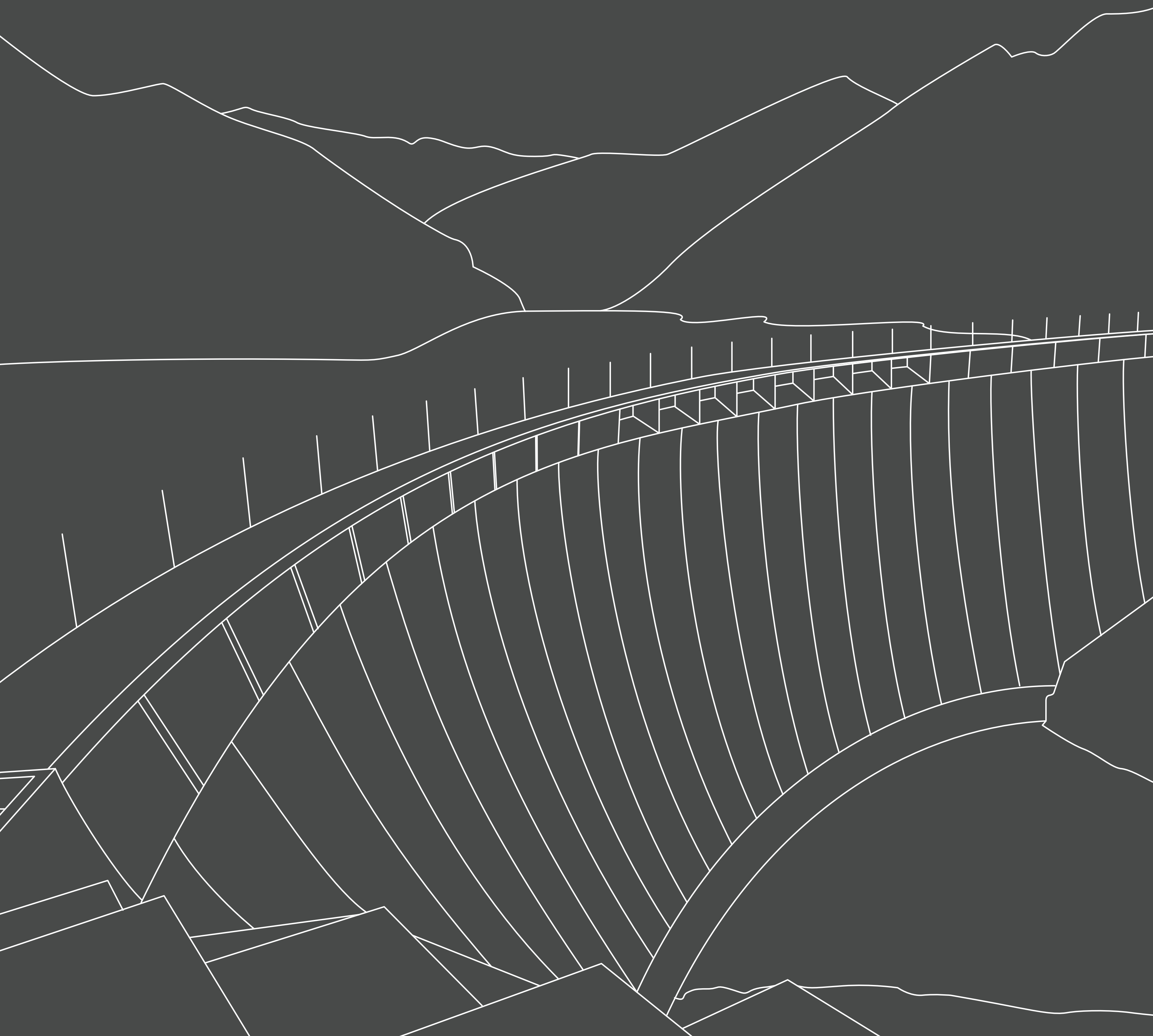
WATER IS LIFE

Water infrastructure for the future: dams, hydroelectric plants and hydraulic works

salini impregilo



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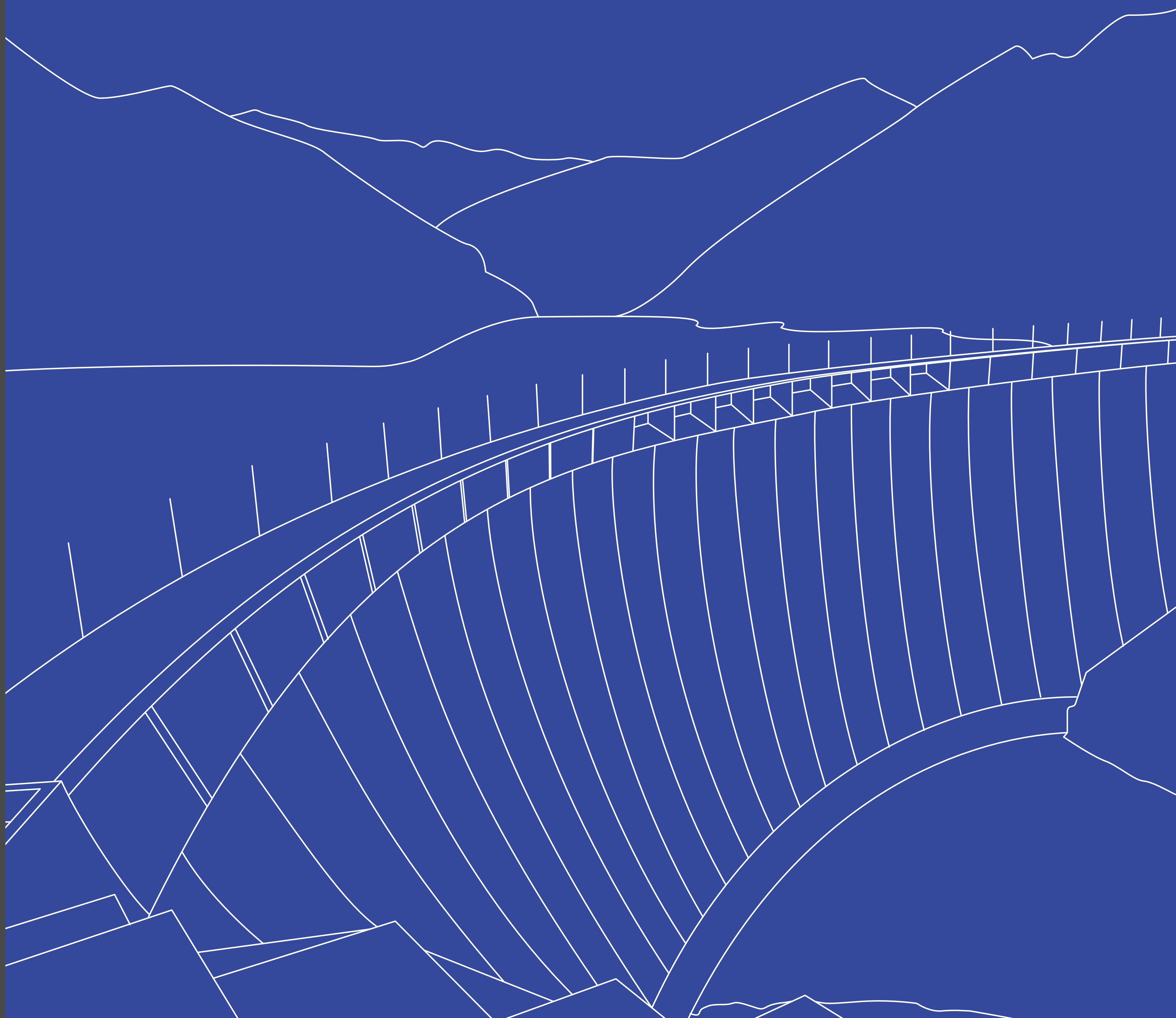

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salini impregilo

WATER IS LIFE

Water infrastructure for the future:
dams, hydroelectric plants and hydraulic works

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OUR VISION

We firmly believe that large infrastructure projects contribute to the creation of a better world for current and future generations.

OUR MISSION

We undertake daily to help build a better world, bringing together beauty, functionality and quality, continuing the engineering legacy of ancient Rome and the great works of the Renaissance, from which we draw inspiration.

Val di Lei Dam, **Switzerland**

1

A GLOBAL LEADER IN COMPLEX LARGE-SCALE INFRASTRUCTURE

Salini Impregilo is an international player in the complex large-scale infrastructure industry.

The Group has over **110 years** of experience in projects that range from dams to hydroelectric plants and ports, motorways and bridges, metros and railways and underground excavations for hydraulic tunnels for aqueducts and drainage systems, hospitals and civil and industrial buildings and airports.

With over **35,000** employees, revenues of **€6.5 billion**, the Group operates in over **50 countries** and has been acknowledged as a global leader in the water sector since 2013 in the Top 10 of the Transportation sector and in the Top 10 of the US market (Engineering News-Record/ENR).

Salini Impregilo is inspired by the principles of sustainable development and uses technological and organisational innovation combined with its extraordinary human and professional resources to develop increasingly advanced construction solutions that support clients to create economic and social well-being.

The geographical diversification of our works has enabled us to develop a great capacity at managing heterogeneous conditions while respecting local culture. The diverse climate conditions have allowed us to consolidate the necessary organizational skills required to work worldwide: from Northern Europe's cold climates to Italy's mild climates, as well as in dry, tropical and equatorial climates in the Middle Eastern, African and Central American countries.

Our projects aims at contributing to the attainment of the UN's Sustainable Development Goals (SDG). They also aim at **supporting clients to develop territorial potential**, while promoting access to renewable resources, like water and hydroelectric energy. They also facilitate people and vehicles in their movements, across long distances (through road and railway projects) and in large cities (through sustainable collective mobility systems), as well as urban mobility within large cities (through sustainable collective mobility systems, like metros).

Next page
Lake Mead Intake Hydraulic Tunnel, **USA**

2 SALINI IMPREGILO: WORLD LEADER IN THE WATER SECTOR

Hydraulic engineering works have always represented a distinctive characteristic of the Group, **acknowledged since 2013 as world leader** in infrastructure projects in the water segment by Engineering News-Record (ENR).

Salini Impregilo, in over 110 years of experience in five different continents has gained a vast amount of experience in the construction of all types of infrastructure in the water segment and hydraulic engineering, particularly:

- **Dams and hydroelectric plants**, dams for water control and for irrigation purposes
- **Water resource management systems** and combined sewer overflow projects
- **Ports and maritime projects**
- Water **desalination, wastewater treatment and purification** plants

Hydroelectric energy is considered to be the greatest source of electrical energy among the renewable ones and, in 2017, it represents 16% of the electricity produced globally, besides producing energy with minor costs compared to other sources. Great amounts of water are first used to produce energy through turbines and generators, then released to take their natural course and for eventual further uses.

The International Energy Agency (IEA) expects that the installed hydroelectric capacity will continue to grow reaching 2,000 GW by 2050, which will avoid releasing 3 billion tonnes of CO_2 each year due to fossil fuel usage.

Salini Impregilo contributed to build **260 dams and hydroelectric plants** (1960-2017) for a total installed capacity of **45,000 MW of clean low cost energy**. Among these are some of the largest dams to date in the world. Currently under construction is the Rogun Dam in Tajikistan, destined to be the tallest dam in the world and the Grand Ethiopian Renaissance Dam, the largest in Africa.

Salini Impregilo is at the forefront, not only in building dams and hydroelectric projects, but also in complex **hydraulic engineering projects** like the hydraulic tunnel at Lake Mead, a complex structure for collecting and transporting waters of one of largest artificial lakes of the United States to provide water to Las Vegas.

Salini Impregilo is also increasing its presence in the CSO sector (**Combined Sewer Overflow**), to support clients for reducing pollution risks caused by **discharging urban and industrial waste** into rivers and water sources. United Nations Water estimates that 80% of the world's water discharge does not go through adequate treatment before it is re-introduced into the environment and into cities.
This results in the main cause of water pollution, which is followed by industrial and agricultural chemical waste. Many countries are taking increased action to face this issue, as water pollution will become, together with climate change, the main reason for water shortage in the near future. The Anacostia River Project in Washington is one of the works built by Salini Impregilo in this sector and an example of this. The Group, in the US, is also currently involved in two projects in this city and also the Cleveland Dugway Storage Tunnel project.

It also is active in other subsectors of the water area, like **ports and naval projects**, having acquired great experience in Africa (Libya's Port of Homs and Nigeria's Port of Apapa) and in Europe (Port of Costanza), both to build new ports and to modernize and renovate existing ports. Among these, the expansion of the New Panama Canal, which is considered the most important engineering projects of the 21st century.

The Group with Fisia Italimpianti, a company specialized in **desalination and water treatment** plants, has been, for more than 40 years now, consolidating its experience in the Middle East and in North Africa, in countries like the United Arab Emirates, Qatar, Kuwait, Saudi Arabia, Bahrain and Morocco.

Emosson Hydroelectric Plant, **Switzerland**

Next page
Osborne Dam, **Zimbabwe**

Track Record

1,600 t/hour
concrete aggregates: Panama

1,900 t/hour
aggregates for RCC: GERDP

670 m^3/hour
concrete: Ertan

970 m^3/hour
RCC: GERDP

(Data as at 30/11/2017)

2.1 Technical Aspects

The Group, thanks to its experience and technical skills acquired in more than 110 years of activity, can meet and solve any technical and geological difficulty, and work in extreme environmental and climate conditions, like during the construction of the **Karahnjukar plant within the Icelandic glaciers** or the **James Bay project in Northern Canada.** The methods used represented, in many cases, unique solutions, used for the first time in the world for this specific sector.

These solutions, especially for river deviation purposes, were studied using sophisticated **mathematical modelling techniques. Physical models** to reproduce the hydraulic phenomena inside a lab were also used at times. Specific issues related to foundations and the control of filtration waters were solved using specialist techniques like diaphragm walls, jet-grouting curtains, draining shafts, the injection of waterproofing and consolidating materials.

Construction timings and deadlines have always been met. Salini Impregilo has therefore developed a capacity of designing and managing **plants** to produce aggregates and **high-capacity** concrete. Complex plant systems, implemented with humidity and temperature control systems capable of producing great quantities of concrete, were designed and implemented, due to the large volumes of materials, in order to treat and to be able to move in often difficult environmental situations, and to the fact that each material had different characteristics.

In Panama, where the Group built one of the most important engineering feats in the world, the Third Set of Locks of the new Panama Canal, plants capable of **producing 3300 t/hour of concrete aggregates and 1240 m^3/hour of concrete were designed and installed.**

The characteristics of the structures required by our clients and the existing environmental conditions also asked for the installation of complex cooling and/or heating plants to control the concrete's temperature during packaging and seasoning, like for the **Ulu Jelai dam in Malaysia,** due to the region's tropical climate.

Concrete laying and distribution technology is particularly developed, adapting it to the specific characteristics of each project: tower cranes, oscillating tower and radial mobile tower blondins, special belts, etc.

The Group is **leader in constructing earthfill and rockfill dams.** It has a significant capacity at building large complex projects and has experience at solving issues connected to managing large machinery fleets required to produce the quantities requested by contract.

In the tunneling sector it has built innovative and globally unique works, like **Lake Mead's Tunnel (Intake 3)**, a project that won the 2016 "Tunneling Achievement award of the year" of US magazine Tunnel Business Magazine, having previously won the NCE Tunnelling & Underground Space Award" as "Global Tunnelling Project of the Year".

The excavation of the connecting tunnel set an important tunneling record: the TBM used to excavate 4.6 km of the tunnel is the only specially created prototype in the world of its kind. It is designed to resist pressure conditions that have never been experienced before in tunnelling history, excavating at a pressure of 15 bars, which is double the previous world record.

2.2 Added Value

The large infrastructure projects carried out by Salini Impregilo create value for our clients who rely on our technical and organizational skills and experience to build the work required in the given time, according to the given budget, while also listening to third-party needs. All completed works aim at supporting clients to develop high quality, reliable and resistant infrastructure and at increasing territorial accessibility and economic potential.

THE LARGE INFRASTRUCTURE PROJECTS CARRIED OUT BY SALINI IMPREGILO CREATE VALUE FOR OUR CLIENTS

However great value is also generated locally within these territories in terms of personnel **professional growth** opportunities. Each new project is a training field for the local workforce, which in many cases, upon completion of the works, can then continue to work with us on other projects in the world.

Based on merit, staff frequently have the chance to continue to work in other sites or in other countries (in **Iceland's Karahnjukar** site more than 30 different nationalities were employed by us; a great number of these people came from other projects), within a **development and career path.**

The engagement of local personnel in its worksites has always been one of our Group's top priorities. Most of the managers, labour workforce and the majority of worksite staff are hired locally. These people have the chance of acquiring great skills during the time-frame that it takes to complete the project.

In **Ethiopia**, where the Group is involved in building the country's most important hydroelectric projects and multipurpose projects, and is present since 1957, 97% of the workforce is employed locally.

Salini Impregilo is also very committed to complying with the required DBE (**Disadvantaged Business Enterprise**) objectives. The involvement of companies representing social minorities or led by women is also promoted to support the local authorities' actions at avoiding work discrimination.

Significant examples are Namibia's **Neckartal** Dam and the New **Panama** Canal, where the employed **female workforce** respectively reached 16% and 15%.

2.3 Social and Environmental Challenges

All projects built by the Group globally abide by **standards** defined by **international funding institutions** (e.g. World Bank), like IFC Performance Standards, Equator Principles, and the World Commission's requisites for Dams.

All Salini Impregilo projects align their **HSE Management System** with the Parent's, certified according to the **ISO 14001** and **OHSAS 18001** standards, and compliant with local HSE regulations.

ALL PROJECTS GLOBALLY ABIDE BY STANDARDS DEFINED BY INTERNATIONAL FUNDING INSTITUTIONS

The Group pays particular attention at planning and implementing an effective management system, including acquiring client-made risk analyses for assessment purposes and identifying environmental aspects, but also at following up on safeguarding measures and the correct implementation to use.

With regard to **safety** in the workplace, great attention is placed on jobs and tasks that are carried out at a certain height range, e.g. on formworks, platforms, planks, steel reinforcements, and when using heavy lorries and lifting machines, or managing plants that include rotating parts in movement. We wish to reduce risks to a minimum.

As to the **environment**, having already acquired all client assessments, all environmental aspects connected to the activities we carry out, and our processes and project plants, are always detected by expert personnel. Control measures are also determined for everyone. Particular attention is placed on waste management, on the use of land for backfilling and restoration purposes, on the amount of dust created when aggregates and vehicles move, on correctly managing wastewater, which is regularly monitored and treated before being introduced again into the environment.

PARTICULAR ATTENTION IS PLACED ON WASTE MANAGEMENT

Salini Impregilo is constantly committed at establishing good relations with **local communities**, wherever it works, according to client-developed plans. A significant example is represented by the programme created in **Malaysia**, for the Ulu Jelai hydroelectric project, which is located in an area with 12 villages with local communities. All integration activities that were agreed upon with the client included regular meetings concerning various topics, with the aim of understanding the community's needs and of always finding the most appropriate solutions. Road conditions, other transport infrastructure, and employment rate were all improved.

2.4 Our Values

Solidity

We build infrastructures that last in time and promote sustainable development for current and future generations.

Excellence

We believe in competence and skill, in work that is well done and capable of exceeding client's expectations.

Transparency

We promote an ethical, open and transparent conduct with all our stakeholders.

Respect

We respect people, diversity and the environment.

2.5 Our People

In an ever more complex and competitive world, human capital is a key factor in maintaining leadership: it is the key element to the success of Salini Impregilo. The Group believes in the competence and skills of its people as a key asset to fulfil business goals.

In every corner of the world, behind every major infrastructure project, there lies the hard work and creativity of the Group's **35,000 people** from more than **100 nationalities.** Highly skilled professional men and women, together share a common objective: to build infrastructures that improve the quality of life of people living in the communities.

HUMAN CAPITAL IS A KEY FACTOR IN MAINTAINING LEADERSHIP

The Group is guided by a value-based culture and endeavors to maintain an innovative, high quality, and ethical environment that is essential to employees' development. It encourages innovation and creativity to pursue employee-generated ideas that help all work better and more efficiently.

It is through its people that the Group builds value.

3 THE MAIN ICONIC PROJECTS

Dams

260 dams and hydroelectric projects in 5 continents, for an installed capacity greater than 45,000 MW of clean low cost energy, which contributed to the sustainable development of entire nations.

Hydraulic works

Building excellence in water channelling and management projects and in Combined Sewer Overflow projects. Record breaking projects, like the Lake Mead Tunnel.

Ports and marine projects

More than 80 years of experience and works built globally, among which the New Panama Canal, which allows Post-Panamax ships to sail through it, therefore changing world trade forever.

Water resource management

Total desalination production achieved is more than 4,400,000 m^3/day (1,000 MIGD) mostly delivered in the Middle East.

3.1 Dams

Dams and hydroelectric plants, dams to control water and for irrigation purposes

The dams and large hydroelectric plants built by Salini Impregilo during its many years of activity supported its clients in creating economic development. The amount of energy produced in the plants that have been built by the Group is more than 50% of the total produced hydroelectric energy.

THE DAMS AND LARGE HYDROELECTRIC PLANTS BUILT BY SALINI IMPREGILO SUPPORTED ITS CLIENTS IN CREATING ECONOMIC DEVELOPMENT

The Zambesi, Paranà, Nile, Indo and Yellow rivers are amongst the largest rivers in the world. Their water has been channelled and collected thanks to the large engineering works that have been built by the Group.

The Group, in its 110 years of activity, built:

- concrete dams (both arch and gravity ones), like **Kariba on the Zambesi River**. It forms the largest artificial basin in the world in terms of water volume. **Ertan, in China,** on the other hand is amongst the tallest concrete dams ever to be built, measuring 240 m in height;
- RCC dams: the tallest in the world is **Gibe III, located in Ethiopia**. It reaches **250 metres** in height;
- earth and rock dams, both zoned and homogeneous, among which the first European dam and the tallest of this kind in the northern regions: **Iceland's Karahnjukar**;
- mixed structure dams, partly in concrete and partly in earth, like **Keban, in Turkey**, which measures 207 m in height.

Just during 2017, the Group has been involved in the building of 10 hydroelectric projects in 9 countries in 4 continents. Once completed they will offer an installed capacity of approximately **18,000 MW** and an electrical production of **55,000 GWh per year**: this is the amount of energy needed to satisfy the energy demand of 68 million people.

These projects will contribute to reducing CO_2 gas emissions for over 16 million tonnes per year, which equals the emissions of 3.5 million cars.[1]

1 The data is an internal estimate based on the project's documentation.

WATER
DAMS

Africa
America
Asia
Europe
Oceania

Client
Hidroeléctrica Piedra del Aguila S.A.

ARGENTINA

Piedra del Aguila Hydroelectric Plant

Project description

The hydroelectric plant is situated between the Neuquén and Rio Negro provinces, where the Limay River flows. It is approximately 25 km away from Piedra del Aguila, 250 km from Neuquén and 1,200 km from Buenos Aires.

The project included building **a concrete gravity dam** with a maximum height of 165 m. Its crest length measures 820 m with a 9 m width. The dam includes inspection galleries at height intervals of 30 m.

The powerhouse is located at the foot of the dam, and is equipped with **four 350 MW Francis turbo generators**, utilising a 111 m head. It is 162 m long, 68 m wide and 64 m high.

Diversion works, consisting of a canal and a control structure with a flow capacity of 4,800 m^3/s, is regulated by four sluice gates, 6 m high and 9 m wide. Intake works in the dam body, with six openings regulated by sluice gates 10 m high and 7.40 m wide are included.

Four steel penstocks with a cross section of 64 m^2 and a length of 88 m, in the dam body are also present.

There is spillway, regulated by four radial gates, 21 m high and 17 m wide, located on the left side of the dam, together with a 98 m long tailrace channel and 250 m chute terminating in a flip bucket energy dissipater.

Main Technical Data

Earth excavation	1,904,000 m^3
Rock excavation	2,590,000 m^3
Underground excavation	113,600 m^3
Embankments (cofferdams)	683,000 m^3
Concrete volume	3,518,600 m^3

ARGENTINA/ PARAGUAY

Yacyretà Hydroelectric Project

Client
EBY, Entidad Binacional Yacyretá

Project description

The main works of this bi-national project are located on the Paranà River, the second largest river of Latin America and one of the largest in the world, approximately 80 km downhill from the cities of Encarnación and Posadas, on the Argentinian-Paraguayan border.

This dam measures **nearly 70 km in length, being the world's longest dam.** Its construction continued through different phases for more than a decade, meeting highly difficult engineering issues: these were determined by the river's huge dimensions and flow capacity, but also by the need to implement complex operations to safeguard the natural environment and local populations.

The dam begins on the Argentinian side of the Paranà. It then passes through the river's navigable stretch (Brazo Principal), downhill from the Apipé rapids. It stretches for 18.7 km on Yacyretà island. After crossing the Aña-Cuá stretch, it extends along the Paraguayan bank, parallel to the river, to the town of San Cosme y Damián.

The dam's reservoir has a surface area of 1,600 km², and a total volume of water of 21 billion m³. The powerhouse currently houses 20 Kaplan turbines for a **total installed capacity of 3,200 MW.** It provides approximately **60% of Argentina's hydroelectric energy**, approximately 22% of the national energy demand.

The main concrete structure is 270 m long and 27 m wide, enabling vessels with a maximum draft of 3.65 m to clear the river level difference of 23.60 m.

The project contributed to creating new jobs in the nearby area, for a total of 12,000 people involved in the works. In time, it has become one of the main tourist sites of the area.

Next page
Yacyretà Hydroelectric Project,
Argentina/ Paraguay

Main Technical Data

Total length	63.7 km
Total volume of the basin	21,000,000,000 m³
Installed capacity	3,200 MW
Earth excavation	32,175,000 m³
Rock excavation	4,375,000 m³
Embankments and fills	65,436,000 m³
Total concrete volume	3,599,000 m³


DISCOVER EXCLUSIVE CONTENT

Client
Société d'Energie de la Baie James Montreal

CANADA

James Bay Hydroelectric Project on the La Grande River

Project description

The project comprised **a series of large scale interventions.** Among these, the deviation of the Eastmein and Opinaca Rivers which were both directed into the La Grande River. Dams and plants were built on its course.

Two works were built by Salini Impregilo: building the dam named LG2 (from 1974 to 1978) and the QA8 dam, an integral part of the hydroelectric plant called LG4 (1979-1982).

The LG2 Dam is the project's main structure: a rockfill embankment with a crest length of nearly 3 km and a height of 160 m. It required the placement of 25,000,000 m^3 of materials. The dam forms **one of the largest artificial basins in the world**, with an area of 2,830 km^2 and a volume capacity that equals 62,000 million m^3 of water.

The inner impermeable core, which represents 20% of the embankment's total volume, consists of compacted glacial moraine treated with grizzly and partly dried in large rotary kilns to reduce the moisture to the optimum required percentage. To form the reservoir, four other small dams enclosing as many side saddles were built.

The spillway channel, located at the northern end of the main dam, is 2,896 m long, 122 m wide, and descends in tiers. This channel has a total discharge capacity of 15,300 m^3/sec and is equipped with eight gates measuring 12 m wide and 20 m high.

Canada, with China and Brazil, is currently one of the largest producers of hydroelectric energy in the world (exporting 30% of its produce). **The James Bay system is the Country's largest hydroelectric complex. It can generate, combined, 16,021 MW,** producing **83 billion kWh of yearly electricity**, approximately half of the quantity consumed by Québec.

Main Technical Data

Height	160 m
Volume	25,000,000 m^3
Spillway lenght	2,896 m
Spillway width	122 m
Discharge capacity	15,200 m^3/sec
Required combined excavation	2,500,000 m^3
Spillway excavation	7,800,000 m^3

CHINA

Ertan Hydroelectric Plant

Client
EHDC, Ertan Hydroelectric Development Corporation

Project description

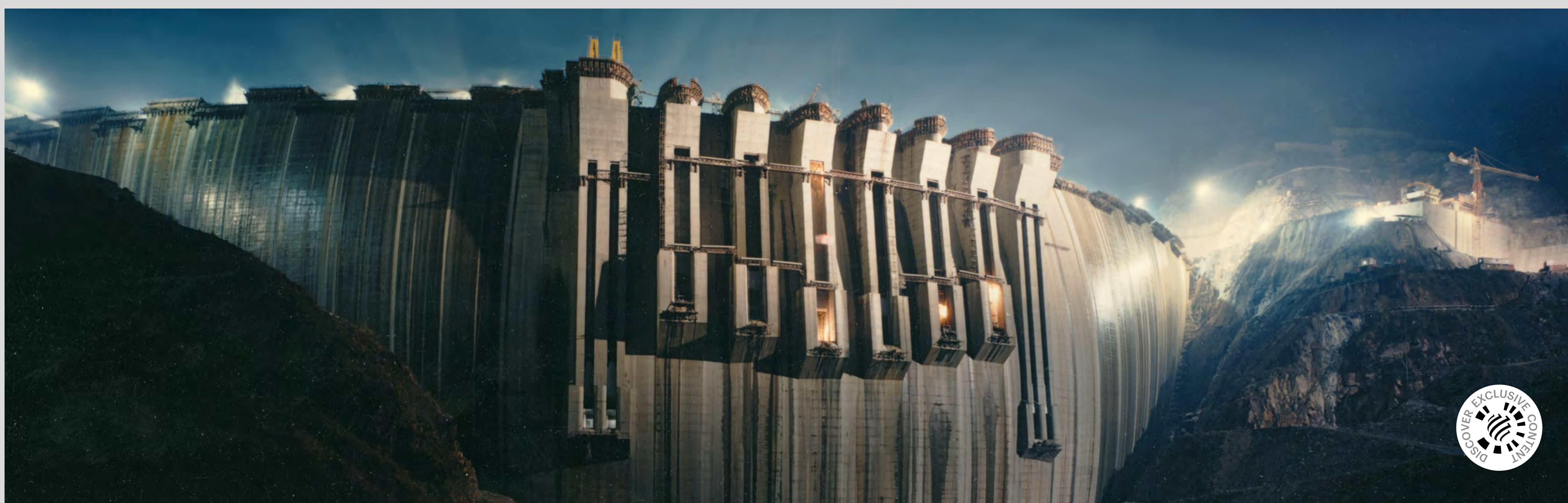
Ertan, when works began in 1991, was one of the three highest parabolic arched dams in the world, allowing the installation of a **powerhouse with a 3,300 MW and capable of generating 17 GWh/year.**

The hydroelectric power plant is located on the lower stretch of the Yalong River, a Yangtzé affluent, about 745 km from Chengdu, capital of Sichuan province, and about 2,000 km from Beijing.

The dam reaches a maximum height of 240 m, a length of 775 m. The average dam width is 11 m at the crest and 56 m at the foundations. The weir's huge dimensions required a worksite that was just as large and construction rythms that were tremendously pressing: **the nearly 5 million m³ of concrete that form the dam were laid in approximately three years,** with records reaching 230,000 m³ per month.

Main Technical Data

Height	240 m
Length	775 m
Crest width	11 m
Foundation width	56 m



WATER
DAMS

Africa
America
Asia
Europe
Oceania

CHINA

Xiaolangdi Multipurpose Project

Client
Ministry for Water Resources – Yellow River Water and Hydroelectric Power Development

Project description

The Xiaolangdi dam is located on the Yellow River, in the Henan Province. It mainly consists in **one of the largest zoned earth and rockfill dams.**

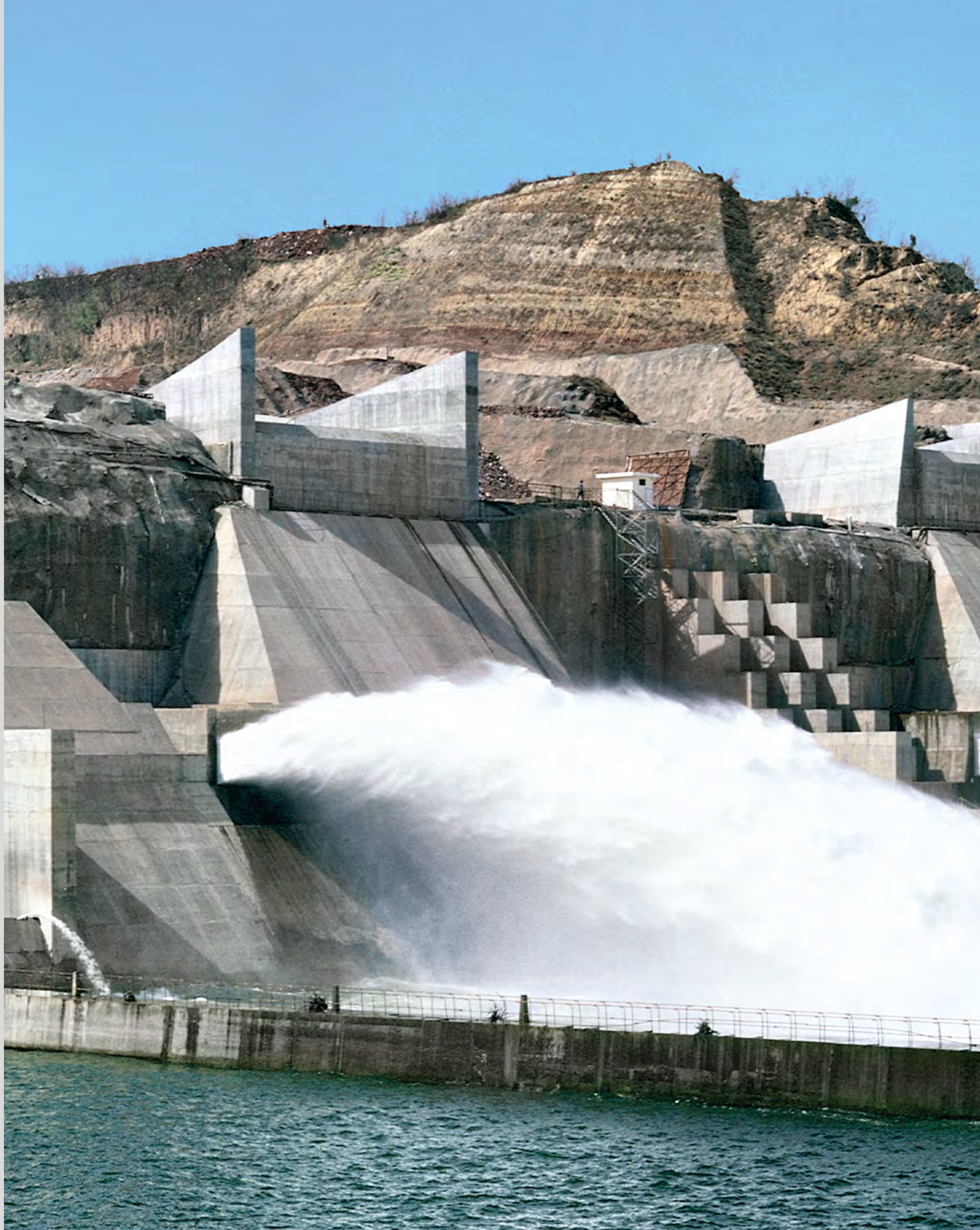
The earth and rock embankment represents the dam's main structure. It aims at stabilizing the quantity of water that passes at the low end of the river, while also controlling material sedimentation and blocking the passage of ice slabs during the winter season. Besides restraining the river's course, it also allows procuring water for domestic, industrial and agricultural purposes, and to **produce 1,800 MW of energy**.

The main dam was completed in November 2000, **13 months before** the date set by the contract. The entire project was completed the following year.

Its construction also included works connected to intake systems, tunnels (deviation, adduction, etc.), to the spillway and return systems. To this day, the dam generates **5.1 billion kWh/year** of electricity. It offers a spectacular show when its locks are opened during the seasonal floods that inflate the Yellow River.

Main Technical Data

Height	154 m
Length	1,667 m
Volume	50,600,000 m³



Client
I.S.A. – Interconexión Eléctrica S.A. Bogotà

COLOMBIA

Chivor Hydroelectric Project

Project description

The Chivor hydroelectric plant is located 160 kilometres northeast of the capital Bogotà, in a deep gorge on the Batà River, renowned for the extraction of emeralds. For this reason the dam was named "emeralds' dam" by the Colombians.

The project comprises: **a rock-fill dam 237 m high** measured from foundation's level, with an impervious clay core. The dam has a total embankment volume of over 11 million cubic metres, with a crest length of 300 m and a maximum width of 820 m at the base.
It includes a concrete spillway with a discharge capacity of 10,600 m^3/sec. About 2,300,000 m^3 of rocks were excavated and 52,500 m^3 of concrete placed for the spillway works to build it.

When completed, **in 1982, Chivor was the third highest dam of its kind in the world.**

An open-air powerhouse is located on the right bank of Lengupà River. During the first phase of the project, from 1970 to 1975, four vertical axis generators of 125 MW each were installed. During the second phase, from May 1976 to 1982, the powerhouse's capacity was doubled with the installation of another four sets, for a **total installed capacity of 1,000 MW** and an **average yearly production of 3.48 billion Kwh**.

As noted by its general lay-out, the Chivor dam is characterized by **the extremely steep and narrow gorge in which it is located.** The dam forms a reservoir basin 22 km long with a total storage capacity of about 800 million m^3 of water.

Main Technical Data

Dam height	237 m
Open-cut excavation	4,400,000 m^3 (first phase), 60,000 m^3 (second phase)
Underground excavation	543,000 m^3 (first phase), 270,000 m^3 (second phase)
Dam embankment	11,100,000 m^3 (first phase)
Concrete	143,500 m^3 (first phase)

COLOMBIA

El Quimbo Hydroelectric Project

Client
EMGESA ESP S.A.

Project description

The El Quimbo powerhouse, located in the District of Huila on the Magdalena River, will have an **installed capacity of 400 megawatts** with **average yearly estimated energy production of 2,216 GWh**, using two vertical axis turbines and a tank with a storage volume of 1,824 hm^3.

The project includes building a main dam in loose materials, with a concrete surface (cfrd), which measures 150 m in height and 635 m in length, with the spillway located on the left side of the dam body, controlled by four sluices and with a “trampoline” drainage channel for energy dissipation. There are also plans for a secondary dam 66 m high and 410 m long.

The hydroelectric project was completed within the time frame set by the contract. More than 2,300 people worked at it, also building four tunnels, each measuring 10 m in diameter and 400 m in length; 5 million m^3 of excavations; 13 million m^3 of fillings and 250,000 m^3 concrete works. The plant’s construction used the most advanced environmental safeguarding solutions to re-qualify an area that is highly developed agriculturally.

Main Technical Data

Open excavations	2,915,071 m^3
Underground excavation	459,609 m^3
Spriz beton	12,619 m^3
Concrete	207,200 m^3
Steel reinforcement	15,198,321 ton
Anchorage	407,628 t-m
Dam embankments	11,239,567 m^3

COLOMBIA

Sogamoso Hydroelectric Project

Client
Isagen S.A. E.S.P.

Project description

The project is located on the Sogamoso River approximately 40 km from the town of Bucaramanga in the north-west of Colombia. The work is part of a project that wishes to make the most of the country's most important reservoir, Rio Magdalena, of which the Sogomoso River is an affluent.

The work involved building a dam that is 190 m high and 300 m long, an underground powerhouse which houses three turbines with a **total installed power of 820 MW**, two diversion tunnels approximately 870 metres long, and the construction of the access roads and tunnels system to the underground powerhouse.

The plant is the fourth in the Country. It was inaugurated in January 2015. It provides 10% of the annual national energy demand, and plays an important part in terms of average annual energy generation.

The plant, besides contributing to the region's energy security and developing tourism, also provides a real opportunity for the communities of the Santander department.

It was built in 5 years thanks to approximately 7,000 workers.

ACCOLADES: In 2015, the project received a recognition from the President of Colombia, from the Minister of Transport and from the President of Colombia's Engineering Society.

Next page
Sogamoso Hydroelectric Project,
Colombia

FOCUS ON LOCAL COMMUNITIES

The Group, in agreement with the client, created a social management plan in the building site based on a close dialogue with more than 1,000 local stakeholders. This process detected 7 priority intervention areas: creation of job opportunities for locals population, use of local suppliers, personnel training activities, welfare initiatives for employees, safeguard of the archaeological heritage during construction, constantly informing the local community and participation in developing social initiatives.

These engagement activities allowed to design and implement specific initiatives with specific objectives and KPIs, useful to monitor our performance over time.

Dialogue mainly involved workers, subcontractors and local communities. Monthly meetings (with workers) and periodic ones (with subcontractors and local communities) followed.

The project represented a virtuous example of collaboration with local communities near the project site. The social management plan became a decisive element to build a relationship based on communication and trust between the client, the contractor and local stakeholders.

Main Technical Data

Height	190 m
Crest length	300 m
Volume	8,900,000 m^3
Open excavations	6,290,000 m^3
Underground excavations	900,000 m^3


DISCOVER EXCLUSIVE CONTENT

WATER
DAMS

Africa
America
Asia
Europe
Oceania

ETHIOPIA

Gibe III Hydroelectric Project

Client
EEP,
Ethiopian Electric Power

Project description

The Gibe III hydroelectric plant is located approximately 450 Km South-West of the capital Addis Ababa, on the Omo river. The works consist of the design and construction of the **the world's highest RCC dam** (at the time of construction) and an open-air power plant with 10 Francis turbines with a **total installed power of 1,870 MW** and an expected energy output of **6,500 GWh per year**.

The project was built in very challenging situations, both in design and construction terms. This construction complexity arose from the project's actual dimensions, from the terrain's geo-morphological conditions, along with the extremely hot climate conditions.

One of the greatest challenges in building this work, was the need to lay a very large amount of RCC within the dam's body, to meet the strictly demanding requirements of the "Fast Track" work plan. The Group, during the first year, laid more than 1 million m^3 of RCC in the dam's body. In the following 24 months, more than 5 million m^3 of the 6.1 necessary were laid: that is more than 140,000 m^3 per month, with a maximum of 250,809 m^3 during August 2013. Between December 11 and 12, 2014, 18,519 m^3 of concrete were laid in just 24 hours, breaking **the new world record of the amount of RCC laid in one day.**

The project is the natural completion of the largest integrated complex on the Gilgel Gibe River, with the previous and independent hydroelectric plants of Gibe I (completed and functioning since 2004) and Gibe II (functioning since 2010).

The first plant increased Ethiopia's electrical production by a third. With Gibe II, the objective set by the government to make electricity available to one million new users was met: 20% of its population could use electricity.

The Gibe III plant further increases Ethiopia's available energy. It also allows the implementation of integrated grids with the participation of bordering countries.

Next page
Gibe III Hydroelectric Project,
Ethiopia

FOCUS ON LOCAL COMMUNITIES

1) *20,000 people, during the various phases, worked on the project. The majority of these were Ethiopian together with professionals from other 32 countries. Gibe III was designed and built while keeping in mind and mitigating the impact on local communities, while enhancing the benefits. The reservoir, for example, allowed fishing to develop as an activity, therefore diversifying the local economy and the population's food regime. The plant also aims at regulating water flow: it releases much more water to the population downstream, compared to the amount that used to arrive before, during the dry season. It also eliminates floods, which used to violently hit the areas of the valley during the rain season.*

2) *In 2012, the first school for children of different nationalities that live within the worksite was inaugurated. The Nicholas Mini School was acknowledged by the Italian Ministry of Education. Its training courses are accepted both in Italy and EU Countries.*

Main Technical Data

Height	250 m
Annual Energy Production	6,500 GWh
RCC	6,200,000 m^3
Excavation	4,000,000 m^3


DISCOVER EXCLUSIVE CONTENT

ETHIOPIA

Gilgel Gibe II Hydroelectric Project

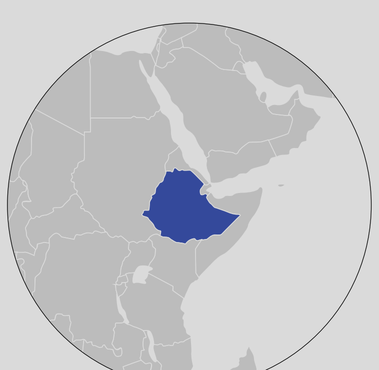
Client
EEP,
Ethiopian Electric Power

Project description

The Gilgel Gibe II plant is the second of the three plants of the Gibe-Omo system. It is located some 250 km south-west of Addis Ababa and 80 Km north-east of Jima. The project was commissioned by Ethiopian Electric Power as an extension of the Gilgel Gibe I project, part of a larger project aimed at changing the Country into a great energy producer.

The hydroelectric plant uses the same reservoir formed by the previous dam. It can reach a **yearly production of 1,650 GWh**. This work comprises a 26 km long hydraulic tunnel, which **during construction was Africa's longest one**. It was almost entirely excavated using a Tunnel Boring Machine (TBM). It also includes a 50 m high gravity dam and an open powerhouse that houses 4 Pelton turbines offering **an installed capacity of 420 MW**.

Ethiopia's power grew by 80% when the plant was made to function. It reached the objective set by its government: to bring electric energy to a million new users, allowing, in 2010, 20% of its population to be able to use electricity.



Main Technical Data

Dam height	50 m
Crest length	140 m
Intake tunnel	26 km
Installed capacity	420 MW
Yearly electrical production	1,650 Gwh

ETHIOPIA

Grand Ethiopian Renaissance Dam Project GERDP

Client
EEP,
Ethiopian Electric Power

Project description

GERD will be Africa's largest dam. The project is located approximately 700 km from the capital Addis Ababa, in the region of Benishangul - Gumaz, along the Blue Nile. It comprises a main dam, an ancillary dam, and two hydroelectric powerhouses located on the two banks of the river. The main dam is made of RCC, with a volume tow times larger than the largest dam of this type built to this day or undergoing construction. The ancillary dam is of the CFRD type (Concrete Face Rockfill Dam – a rock dam with a concrete covered upstream face).

Once these two hydroelectric plants start to function, **the plant will provide Ethiopia with 6,000 MW** and an expected yearly production of 15,000 Gwh, triplicating the energy that is currently used and allowing exportation to nearby countries.

Construction related needs required the use of innovative solutions that mark a significant progress of the RCC technique, especially with regard to mixtures.

The exceptional dimensions of this project required consistent work as to ancillary works: camps and personnel services built near the worksite created a small village of 11,000 people, connected to the rest of the Country thanks to specially built roads (that extend for 120 km) and to 240 km long transmission lines.

85% of the energy currently produced in Ethiopia comes from hydroelectric plants. This result was possible thanks to the large investments made and completed works. Ethiopia aims at becoming carbon neutral by 2025.

Next page
Grand Ethiopian
Renaissance Dam Project
GERDP,
Ethiopia

FOCUS ON LOCAL COMMUNITIES

Salini Impregilo set up a main hospital and four satellite clinics, which provide 24/7 medical assistance to foreign and local workers, and to all the people who live in the neighbouring villages. Over the last few years, approximately 32,000 people received free healthcare thanks to the structures present in the GERD site, which performed 5,400 operations in 2012, a figure that rose to exceed 11,100 in 2015.

For local communities, the works represent a growth possibility under many aspects: from energy production to employment increase, and the project's contribution to local and national economy, helping to modernize Ethiopia's productive sector and improve its inhabitants' life quality.

FOCUS ON PEOPLE

The project created jobs for approximately 16,000 Ethiopians, contributing to reducing the Country's unemployment rate.

Great attention, just as for any other Group project, is placed on developing workers' capacities and skills. It is done through a 4-phase training programme: identifying needs; designing training processes; process implementation; monitoring and assessing its effectiveness.

Main Technical Data

Height	155 m
Length	1,800 m
Volume RCC	10,400,000 m³
Excavation	3,500,000 m³
Installed capacity	6,000 MW
Production capacity	15,000 GWh/year


DISCOVER EXCLUSIVE CONTENT

WATER
DAMS

Africa
America
Asia
Europe
Oceania

Client
EEP,
Ethiopian Electric Power

ETHIOPIA

Koysha Hydroelectric Project

Project description

The Koysha hydroelectric project, which is located in the Country's south eastern area will be the fourth plant of a system of dams on the Omo River, following the Gilgel Gibe I, Gilgel Gibe II and the hydroelectric project, Gibe III. The Koysha plany will guarantee an installed power of **2,160 MW and an annual production capacity of 6,460 GWh.**

The project includes a 170 metre high RCC dam; it is 1 km long at crest, with a total volume of 7.02 million m^3, intake works taking to an open powerhouse with 8 Francis Turbines, each offering 270 MW, a concrete spillway positioned on the left bank of the valley, and two culverts to divert the river flow during the construction of the dam on the right side. The basin's volume will measure 6,000 m^3. Other permanent works include a bridge on the Omo river and structures for the Client.

This project, with GIBE III and GERD (Grand Ethiopian Renaissance Dam) on the Blue Nile will allow Ethiopia to lead Africa's energy production.

Koysha is an EPC (Engineering, Procurement, Construction) project, which greatly focuses on the environment. It complies with Ethiopian laws and contractual terms, with EHS Guidelines of the International Finance Corporation (IFC) of the World Bank Group, and with Environmental and Social Standards, Equator Principles and with requirements set by the World Commission on Dams.

FOCUS ON SOCIAL AND ENVIRONMENTAL ASPECTS

Main Technical Data

Dam	
height	170 m
crest length	1 km
Excavation	5,900,000 m^3
RCC	7,020,000 m^3
Excavation to deviate the river	2,500,000 m^3
CVC for diversion culverts	210,000 m^3
Excavation for Power House	2,000,000 m^3
CVC for Power House	469,000 m^3
Excavation for Independent Spillway	6,300,000 m^3
CVC for Spillway	275,000 m^3

WATER
DAMS

Africa
America
Asia
Europe
Oceania

Client
Municipality of Addis Ababa

ETHIOPIA

Legadadi Dam

Project description

Ethiopia's great demographic growth in the 60s and the need to start economic modernizing and development processes made it necessary to create distribution systems for the large water resources of Ethiopia's mountains, for the capital's growing population.

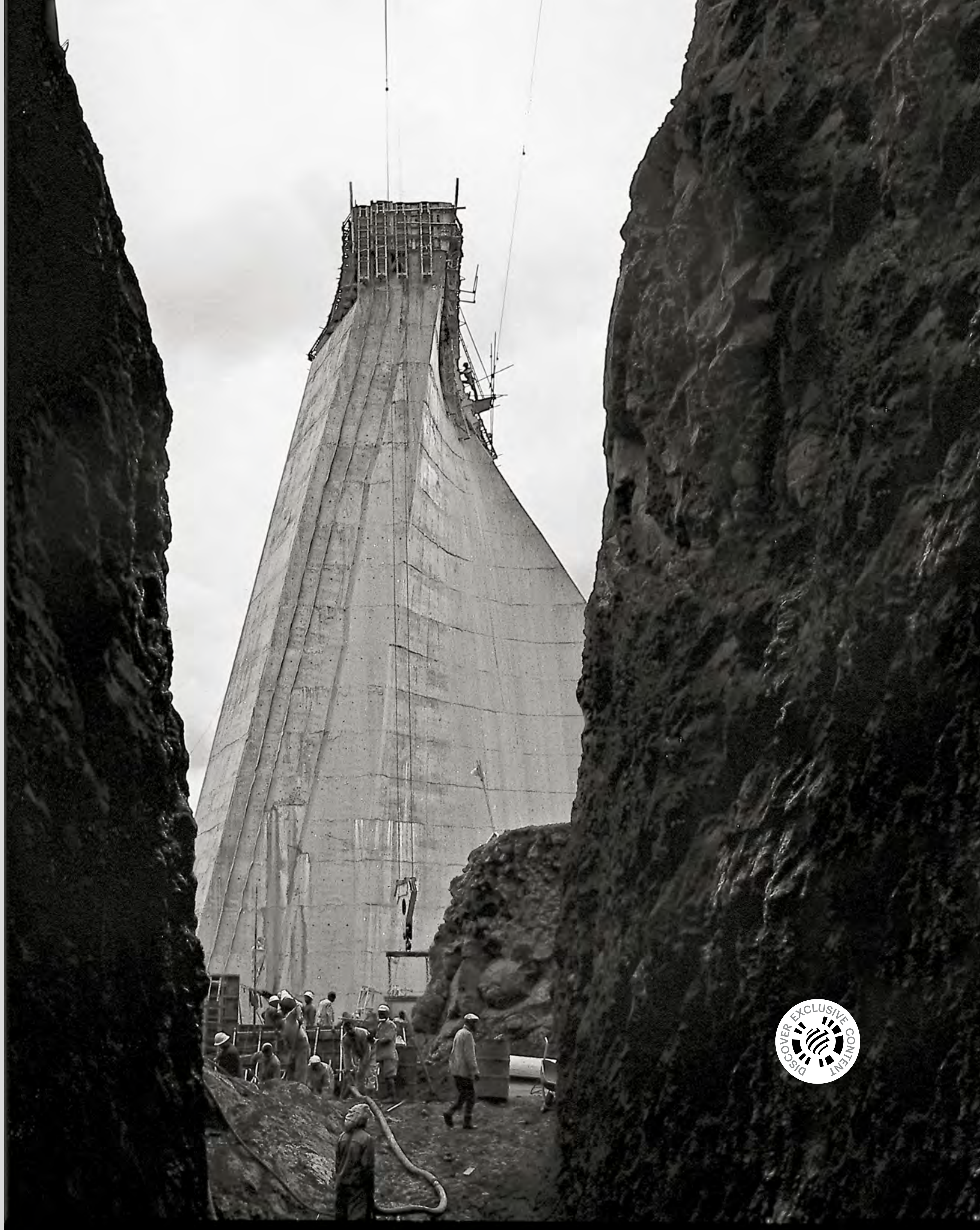
The project included building a weir made of a **main concrete dam** and by **a rockfill embankment upstream**, a rare solution for those times.

The waters of the Legadadi reservoir are made drinkable through a prechlorination, sedimentation, filtration and chloration plant, and are channelled towards the city through an aqueduct with a 30 km long iron pipeline.

The artificial basin can hold 40,000,000 m^3 of water while the water treatment plant can treat 50,000 m^3 of water each day.
The Legadadi plant provides 70% of Addis Ababa's water, therefore ensuring its urban and demographic development.

Main Technical Data

Artificial reservoir capacity	40,000,000 m^3
Daily drinking water provided	50,000 m^3



WATER
DAMS

Africa
America
Asia
Europe
Oceania

Client
JSC Nenskra Hydro Consortium

GEORGIA

Nenskra Hydroelectric Project

Project description

The project comprises The Nenskra hydroelectric project will have an **installed power equal to 280 MW** and will guarantee the energy supply needed during the winter season while maximizing the export capacity during the summer season.

The project comprises a dam, a pressure tunnel, a surge tank, a penstock and a powerhouse. Additionally, a transfer tunnel will carry the water from the Nakra river to the new Nenskra dam reservoir, to improve the project's performance. An asphalt faced rockfill dam (AFRD) has been selected considering the site conditions in the Nenskra river basin. The peculiarity of the structure is the 65 m deep Cut-Off wall to be realized throughout the alluvial deposit on the river bed.

The other main structures of the dam are:

— the Bottom Outlet structure (tunnel with gate shaft)
— the Spillway Structure (tunnel with lateral over flow structure and unlined plunge pool)

The project is capable of providing on average total energy generation of 1,219 GWh/y, 259.2 GWh of guaranteed supply in the winter months and maximizes export benefits in the summer months. The power will be distributed through a 220 kV transmission line to Akhari-Jvari substation.

FOCUS ON SOCIAL AND ENVIRONMENTAL ASPECTS

The project complies with very strict environmental and social requisites. The executive methods are drawn-up according to environmental and social policies of financers, besides operating according to criteria established by the World Bank (IFC), the World Health Organization (WHO) and International Labour Organization (ILO).

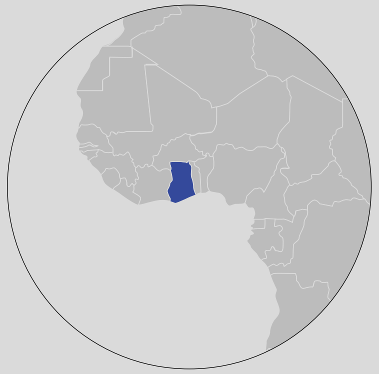
Main Technical Data

Intake weir on the River Nakra	
height	9 m
length	50 m
Nakra Transfer Tunnel	
length	14.4 km
diameter	3.5 km
Asphalt-faced rockfill dam	
height	130 m
crest length	820 m (Storage: 183 million m^3)
Headrace tunnel (Intake ~ Surge shaft)	
length	15.6 km
diameter	4.5 m (excavated with TBM)
surface powerhouse	280 MW (4x70 MW) with no. 4 Pelton turbines
net head	679 m
rated discharge	12 m^3/unit, total 48 m^3/sec
Surge Shaft	
depth	184 m
excavated diameter	14 m
final internal diameter	12 m
calculated maximum water level in the surge tank	1481.00 masl (sudden simple closure)
minimum water level	1389.00 masl (sudden simple closure)

GHANA

Akosombo Hydroelectric Plant

Client
Volta River Authority on behalf of the Government of Ghana



Project description

Akosombo is a dam on the Volta River in the southeastern region of Ghana, where it is responsible for the largest artificial body of water in the world: Lake Volta. The plant consists of **a main concrete faced rockfil dam**, a secondary dam, intakes, a power station on the right bank and two spillways on the left.

The main dam is a rockfill dam with a clay core: its crest length is about 700 m and its maximum height is 134 m.

The project's construction, began in 1961. It had to meet the challenge of excavating **extremely hard ground** (the quartzite that was dug up was then used to build the dam). It also faced difficulties posed by one of the largest African rivers overflowing.

The project led to the creation of Lake Volta, **one of the largest artificial basins in the world for its volume and the largest for its extension**: its surface area is 8,500 km^2, occupying 3.6% of Ghana's territory.

The dam was completed five years later, **one month ahead of schedule** despite the massive flooding that interrupted work for more than three months in 1963, one of the most delicate phases of the project.

Akosombo has been described as the largest and most ambitious project built in Ghana since its independence in 1957. It represented economic progress for the country. It was also multi-purpose: in addition to generating electricity for the industry and the energy demand of urban and rural families, among the main objectives of this project, it enabled large-scale irrigation, it modernized agriculture, developed factories and industries, and created tourism.

Main Technical Data

Height	134 m
Crest length	700 m
Main dam volume	8,400,000 m^3
Artificial storage capacity	144,000,000,000 m^3

WATER
DAMS

Africa
America
Asia
Europe
Oceania

Client
ENELGUI

GUINEA

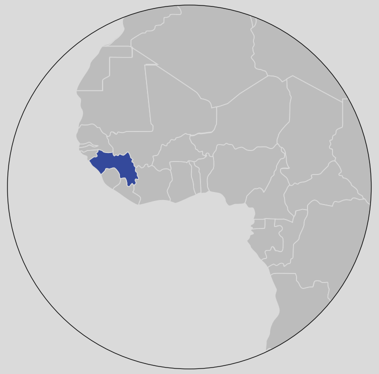
Garafiri Dam

Project description

Unlike other African states, there are no large rivers within Guinea's national borders, although the particular climate conditions in the equatorial area of the continent's Atlantic coast do cause heavy rainfall.

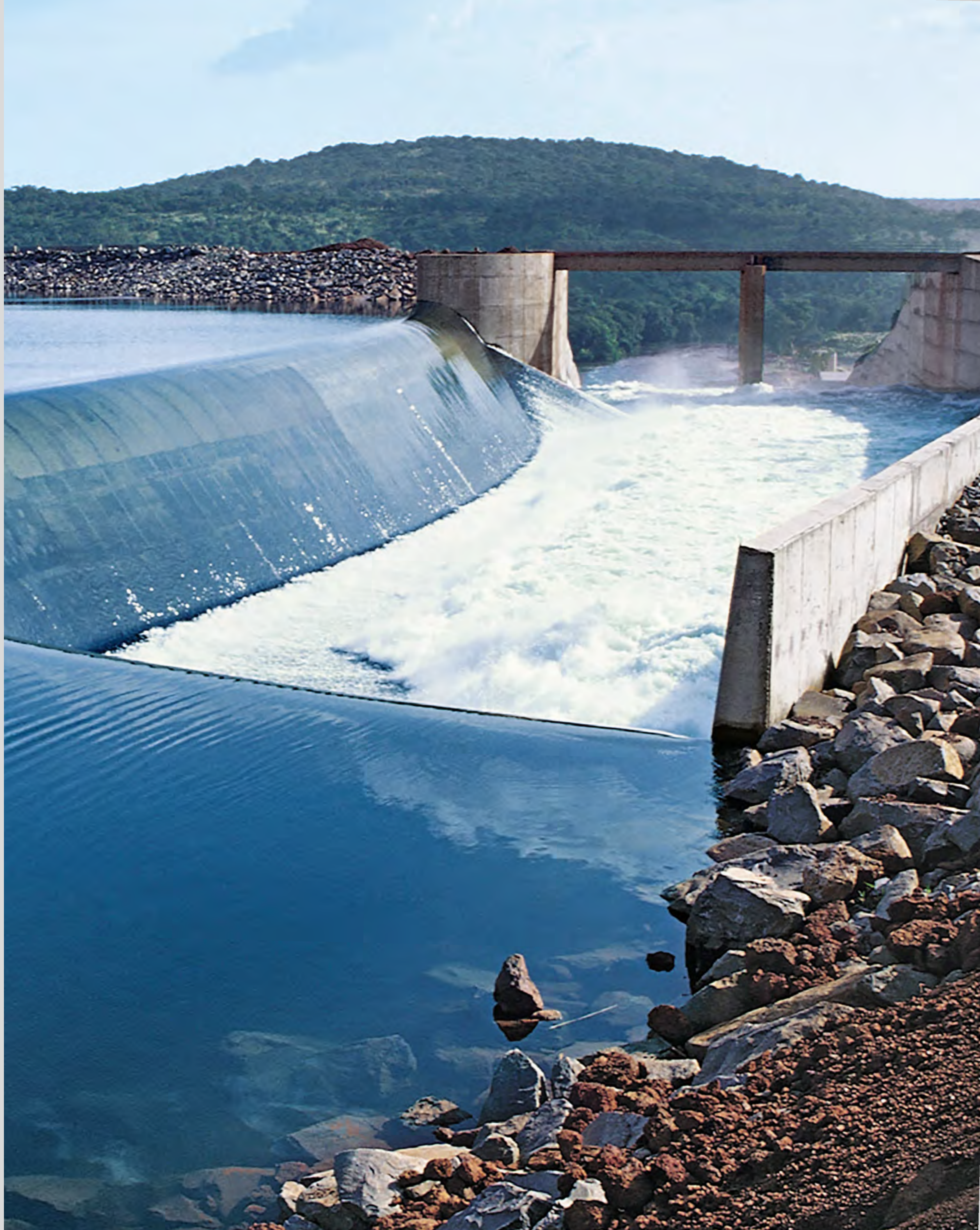
Though plans to build a dam on the Konkouré River date to the mid-1980s, its construction did not begin until the following decade, thanks to a diversified pool of investors made of the local government, French and Canadian development agencies, the European Bank for Investment, and a number of Arab funds (in particular the Arab Bank for African Development and Saudi and Kuwaiti funds).

The work were carried out from 1996 to 1999, and led to completing a zoned earthfill dam and an electricity station connected downstream by penstocks to the one in Kaléta. The installation of three new **75 W** turbines allowed to increase the local energy output, offering new prospects for the social and economic development of the Kindia and Mamou regions.



Main Technical Data

Artificial storage capacity	1,600,000,000 m^3
Crest length	725 m



WATER
DAMS

Africa
America
Asia
Europe
Oceania

ICELAND

Karahnjukar Hydroelectric Plant

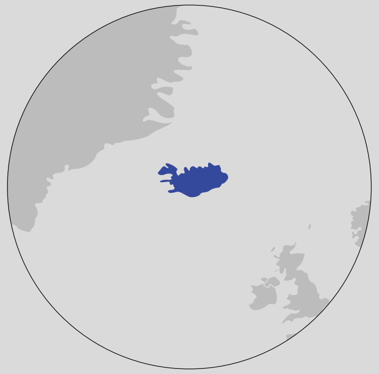
Client
LANDSVIRKJUN – National Power Company of Iceland

Project description

Iceland is the country with the highest renewable energy quotas in the world (as much as 99%), with a huge quota generated by hydroelectric sources (80% of the available electricity).

The project for the exploitation of the water resources in the area near Mount Karahnjukar covers the north-eastern plateaus of Iceland, some 300 km from Reykjavik, Iceland's capital, and less than 200 km from the Arctic Circle. Its implementation was made possible thanks to the collaboration between the Icelandic government and the aluminum multinational Alcoa: after being approved by a popular referendum, the project started in 2003.

The work includes a concrete-faced rockfill dam measuring 193 m in height, making it **the tallest in the Nordic regions and the first European one of the rockfill type**. The glacial waters from the Jökulsá a Dal river are collected into the reservoir of Halslòn, and diverted to an underground power station with an headrace tunnel almost 40 km long that took three Tunnel-Boring Machines to excavate.



Main Technical Data

Height	193 m
Crest length	730 m
Dam rockfill embankment	8,900,000 m^3

INDIA

Nathpa Jhakri Hydroelectric Project

Client
Satluj Jal Vidyut Nigam Ltd. formally known as Nathpa Jhakri Power Corporation Ltd. (NJPC)

Project description

The Nathpa Jhakri project, located in the mountainous area of the state of Himachal Pradesh, about 160 km from the city of Shimla, uses the waters of the upper reaches of the Satluj River for hydroelectric purposes. It is part of the program aimed at enhancing the already considerable hydroelectric power production of the northern Indian state (reckoned to be 20,000 MW for five hydrographic basins).

The facility includes a 67.50-m-high **concrete gravity dam**, which diverts 400 m^3/s of water through four underground sand traps discharging into a headrace tunnel (HRT) that is 27.3 km long, at the end of which a surge tank was built. In addition to the surge tank, the tunnel is linked to three penstocks feeding into six 250 MW generator units located underground in the power plant, which will exploit a drop of about 292 m.

In addition to having to overcome the problems related to carrying out work in a zone devoid of infrastructure and modern services, the construction of the head-race tunnel also meant dealing with the difficulties in crossing the **Himalayan range** for almost 30 km: the excavation was carried out in the presence of highly complex geological configurations, while encountering substantial high temperature water inflows that made the working environment very difficult.

Main Technical Data

Underground excavations	1,300,000 m^3
Underground concrete	318,000 m^3
Shoring	10,000 t
Centering	4,000 t
Reinforcing iron	12,000 t
Surge tank depth	296 m
Variable excavation diameter	24.5-10 m

Client
Plan Organization of the Government of Iran

IRAN

Dez Hydroelectric Plant

Project description

The Dez River hydroelectric plant is on the Dez River in the Khuzestan region. The project is designed and built to regulate the flooding of the river in order to use the water for hydroelectric and irrigation purposes.

The power plant and all its accessory structures are built underground, along with the surface outlets on the left bank, the intake structures on the right bank, and the penstocks.

The concrete dam, with a thin double curve arch, has a maximum height of 203.50 m, a crest length of 240 m, and a thickness of 21 m at the base and 4.50 m on the crest.

Three 2.74-m-diameter ducts are built in the body of the dam to provide water for irrigation purposes.

There are two surface outlets on the left bank, each controlled by two large sector gates; they consist of two upper horizontal tunnels which empty through shafts into two lower, circular-cross-section tunnels having a diameter of 14 m and 12.60 m, respectively, which are about 400 m long. The power plant, together with its underground accessory structures, is located on the right bank and is 76 m long, 18 m wide, and 36 m high. The plant is designed for the installation of **four 65 MW turbine-alternator units**.

Next page
Dez Hydroelectric Plant,
Iran

The intake structures on the right bank consist of two 10-m-diameter tunnels. The 4-m-diameter penstocks depart from the first tunnel and feed into the four units installed in the power plant. The second tunnel is used to feed the planned future expansion of the plant.

Filling of the basin started in fall 1962 and, in just a few months, the lake reached its maximum volume of 3.350 billion cubic meters. Production of electrical power started immediately after.

Main Technical Data

Dam foundation excavation	400,000 m^3
Other surface excavation	240,000 m^3
Underground excavations	500,000 m^3
Concrete volume of dam	465,000 m^3
Underground concrete volume	140,000 m^3


DISCOVER EXCLUSIVE CONTENT

Client
Gruppo Edison

ITALY

Morasco Dam

Project description

The Morasco Dam is the most important dam in the Val Formazza area (Piedmont) and its construction represented **a significant milestone in the evolution of handling and distributing concrete.**

The **dam has a large concrete wall** and is 50 metres tall and extends over 600 metres, with a bend radius of 556 metres. It created a reservoir with 19.38 million m³ of water that reaches 50 metres in depth. By means of a five-kilometres tunnel, Morasco, together with the Toggia Dam, feeds the Ponte hydroelectric plant, built between 1929 and 1932.

The altitude (more than 1,800 metres) did not allow the workforce to work for more than four months a year. A well-developed construction site was necessary to allow work to **concentrate works during the summer months.** Access roads were built and a workers' village rose near the small village of Morasco. Complex systems of cranes and cable cars were used to connect the building site to Ponte, the final point that could be reached by truck.

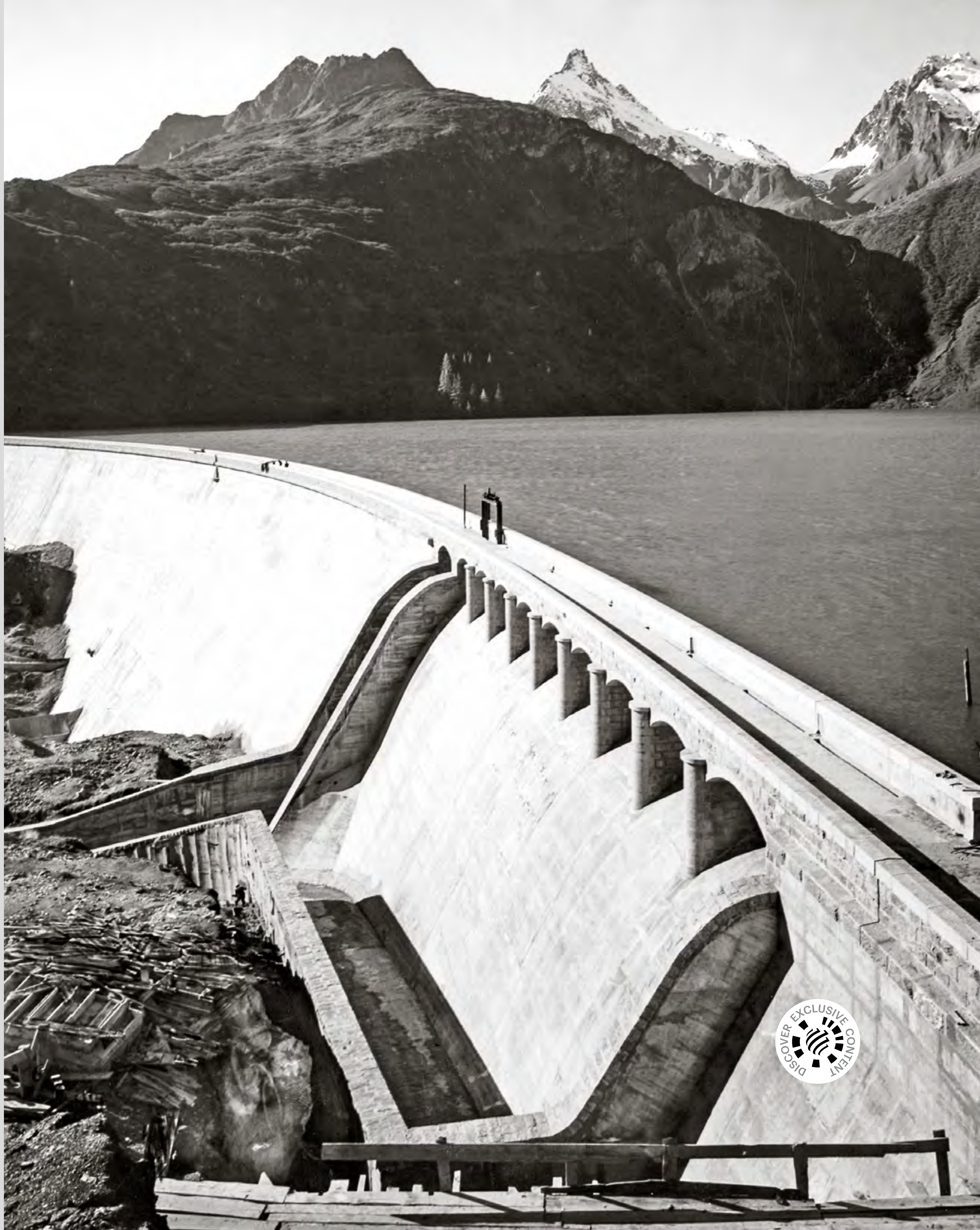
Cement (1,300 tonnes) was carried to Ponte by truck, and then by cable car up to the silos. Concrete transportation and laying were carried out with different systems for the two parts of the dam.

Works ended in 1940, involving **1,200 people**.

In 1957, the plant was expanded with the inauguration of the hydroelectric power plant with the same name, entirely underground and fed by the Sabbione Dam (with a capacity of 26 million m³), built after the Second World War, the **first artificial lake in terms of capacity in Piedmont and the second in all of the Alps.**

Main Technical Data

Reservoir volume	19,380,000 m³
Discharge capacity	269 m³/sec
Excavation	58,000 m³ (earthfill); 61,000 m³ (rockfill)
Bend radius	556 m



WATER
DAMS

Africa
America
Asia
Europe
Oceania

Client
Ministry of Water & Irrigation, Jordan Valley Authority

JORDAN

Karameh Dam

Project description

The water of the Jordan River and its tributaries have always meant life for the populations living in the area lying between the regions' two great lakes: Lake Tiberias and the Dead Sea. Swollen by the rains only in the months between May and October, the chance to exploit the river for irrigation is thus limited by the uncertainty of the climate.

A better exploitation of the water resources of the Jordan River is a necessary consequence of the demographic growth and the new opportunities for development resulting from domestic stability.

Following a contract awarded by the Jordan Valley Authority, in 1994 works started on the dam situated some ten kilometers north of the city of Karameh.

The dam consists of a barrier approximately 45 m high that collects the waters of the Jordan River. Situated in an area that is potentially subject to **strong tectonic movement**, the dam, mostly built with excavation materials coming from the foundations, is **very thick** (10 meters at the crest) and features elevated flexibility in case of extreme stress.

The dam's functioning allowed the region's inhabitants to increase the amount of water for inhabitants to 130 liters per day, and to cultivate some **50,000 hectares of land**, creating many new small farming businesses.

Main Technical Data

Maximum height	44.5 m
Dam length	2,050 m
Dam volume	11,500,000 m^3
Reservoir capacity	55,000,000 m^3
Pipework	10,000 m
Daily water supply	2,400 m^3

WATER
DAMS

Africa
America
Asia
Europe
Oceania

Client
Lesotho Highlands Development Authority

LESOTHO

Katse Dam

Project description

Katse Dam, 185 m high and with a total volume of 2.32 million m³, is **one of the ten largest barriers in the world among the double-curvature arch dams**. Its reservoir has a capacity of 1,950 million m³ of water. The dam has a crest length of 710 m and a width of 60 m at the base and 9 m at the crest.

The spillway is built into the dam crest and can release up to 6,250 m³/s. The river diversion was achieved with two tunnels, 643 m and 598 m long respectively, with a diameter of 7.5 m, and a rollcrete cofferdam 35 m high, 240 m long, with a volume of 90,000 m³.

The 2.5 million m³ of aggregates, taken from a nearby quarry, were transported from the primary and secondary crushing plants to the tertiary crushing plant on a continuous 2.4 km conveyor belt, which crossed the valley and passed through a 1.4 km tunnel built ad hoc. All materials were delivered to the Katse dam site on the 150 km access road, via a mountain pass, at an altitude of 3,090 m.

In addition to the benefits stemming from the exploitation of the energy produced and the water supply made available, the production of the dam allowed for the construction of access roads to the central plateaus, created a real communication network, and opened up a mountainous region of great beauty, until then practically inaccessible. Moreover, a special government fund fueled by the royalties accruing from the sale of water supports the local population by financing projects like the construction of hospitals, first aid centers and schools with plans for the development of domestic breeding, reforestation, and professional training courses.

ACCOLADES: Completed after six years' work, Katse Dam received the SAICE National Award from the South African Institution of Civil Engineering "for the most outstanding civil engineering achievement in technical excellence for 1997".

Main Technical Data

Dam height	185 m
Earth excavation	700,000 m³
Rock excavation	1,400,000 m³
Underground excavation	135,000 m³
Rollcrete	90,000 m³
Concrete	2,500,000 m³
Underground concrete	47,000 m³
Dam grouting	5,000 m³

MALAYSIA

Ulu Jelai Hydroelectric Plant

Client
TNB, Tenaga Nasional Berhad

Project description

Works to build the Ulu Jelai hydroelectric project and the Susu dam, included in the project, began in 2011. They include building the weir, channelling works and the underground hydroelectric plant.

The Ulu Jelai plant is part of a programme that was promoted by the Client to develop hydroelectric energy in five sites, so that Malaysia can increase its hydroelectric capacity from its current 1,900 MW to more than 3,000 MW by 2020. The dam is built with the **RCC** technique, and uses advanced technological solutions like those for the underground excavation to stabilize the ground (in particularly difficult geological conditions due to abundant clay deposits) and the installation of the bridge crane that is needed in the plant, which had to be transported along a tunnel whose dimensions were particularly limited.

ACCOLADES: In January 2016, the project was mentioned as a best case in the hydro sector according to "International Water Power and Dam Construction".

Next page
Ulu Jelai
Hydroelectric Plant,
Malaysia

FOCUS ON THE ENVIRONMENT

The project, located in a tropical area subject to intense rain, with approximately 4,000 mm of annual rain water, will reduce CO_2 emissions by 250.387 tons per year. It will be used instead of conventional fossil fuel generators with hydroelectric energy during peak periods.

The greatest challenge in environmental terms was to mitigate and contain continuous soil erosion phenomena by using drainage systems, control barriers, soil consolidation systems, protection systems and fibromat (biodegradable sheets). All control measures were identified during a complete risk assessment analysis of every project phase.

Solutions to optimize the project's environmental impact were developed, both during the construction phase and subsequently. For example, an underground power plant was built eliminating all landscape impacts and all soil damage.

Energy production efficiency also greatly improved. According to a UN report, Ulu Jelai generates a great quantity of energy with a reservoir with limited dimensions.

Main Technical Data

Height	85 m
Length	512.50 m
Volume RCC	750,000 m^3


DISCOVER EXCLUSIVE CONTENT

MEXICO

Zimapan Hydroelectric Plant

Client
CFE - Comisiòn Federal de Electricidad

Project description

The plant takes its name from Zimapan, a nearby village. It is located in a mountainous area in the west of the State of Hidalgo, about 150 km north of Mexico City. It dams the Moctezuma river, using its water to generate hydro-power.

The project comprises a **double curve thin arched concrete dam**, which measures 203 m in height and is 130 m at crest. Its volume amounts to approximately 250,000 m³. The project also included underground works. The underground steel-lined penstock, is 1,060 m long, with an internal diameter 3.50 m, and with 2.10 m internal diameter bifurcations. A 604 m section of this tunnel has an inclination of 60°.

The transformer cavern, is concrete lined. It measures 70 m in length, 22 m in width and is 38 m high. It houses **two 146 MW Pelton turbines**. Works were completed a month before the established contractual deadline.

Main Technical Data

Underground excavation	865,532 m³
Underground concrete	222,000 m³
Gunite	48,000 m³
Drilling for grouting	396,000 m

WATER
DAMS

Africa
America
Asia
Europe
Oceania

Client
Ministry of Agriculture, Water and Forestry

NAMIBIA

Neckartal Dam

Project description

Located in the Karas region along the Fish River in the south of the country, the project is the first phase of the Neckartal Irrigation Scheme.

Made in **RCC**, around 80 metres high, 518 metres long and with a volume of 850,000 cubic metres, the Neckartal dam will harness water from the Fish River to produce energy and create a reservoir with a capacity of 857 million cubic metres, which will **irrigate 5,000 hectares** of land for the agricultural development of the area.

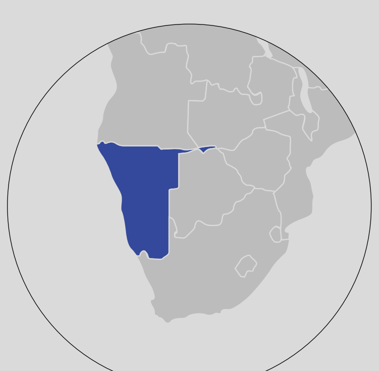
A crossing will be built 13 km downstream from the dam, 360 metres long and 9 metres high, as well as a pumping station with corresponding intake structures. The water will flow through an 8.7 km steel pipe with a diameter of 1100 mm to reach a reservoir with a capacity of 90,000 cubic metres, also part of the project.

FOCUS ON PEOPLE

The project has already made an impact on the region: it has created hundreds of jobs for local inhabitants. 760 people work at the project. Of these, 67% are from Karas and only 8% are foreigners. Also considering subcontractors, the overall number of people working at the project reaches 1,500. A significant figure for a region where unemployment rates, according to the Namibia Statistics Agency, for people of a working age reaches 32%.

Main Technical Data

Open excavations	approximately 700,000 m^3
Concrete (including RCC)	approximately 1,075,000 m^3
Embankments	approximately 250,000 m^3
Steel reinforcement	approximately 7,000 ton
Formworks	approximately 115,000 m^2



WATER
DAMS

Africa
America
Asia
Europe
Oceania

Client
Sokoto Rima Basin Development Authority

NIGERIA

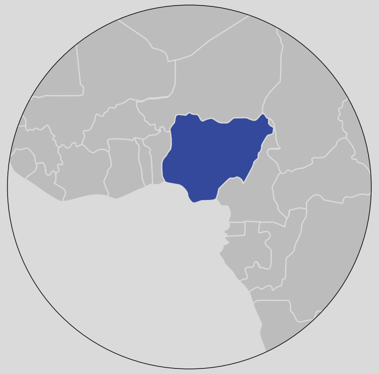
Bakolori Dam

Project description

The project is located in the Sub-Saharan area of the Sokoto State, in the north-western region of the Country. It spreads over a 400 km^2 area and includes the Bakolori Dam on the Sokoto River and every necessary structure for a 35,000 hectares area in need of irrigation.

Bakolori Dam is 5.5 km long. It comprises a central concrete nucleus and two earth wings. It contains **450 million m^3 of water for irrigation purposes**.

The structures built include a water supply canal that is 15 km long. It allows the passage of 30 m^2 of water per second. There are also 4,400 concrete structures to deviate the water's course.



Main Technical Data

Reservoir	
volume	450,000,000 m^3
maximum area of the lake	8,000 ha
Dam - concrete section	
crest length	356 m
maximum height	48 m
Dam - earthfill section	
crest length	5,135 m
maximum height	19 m

PAKISTAN

Tarbela Hydroelectric Plant

Client
WAPDA, West Pakistan Water and Power Development Authority

Project description

The project is located in North – West Pakistan, where the Indus, which rises in Tibet, leaves the mountainous region and enters the plain. This immense plain stretches over 1000 km to the shores of the Indian Ocean, and drains a surface of almost one million square kilometers.

The scheme is designed for the production of electric energy and for the supply of **water for irrigation** and creates a reservoir with a working storage capacity of 11,000 million cubic meters.

Works include building **Tarbela's system of dams**, an open-air powerhouse and the tunnels required by the main plant.

The size of the project was of a scale that had never before been experienced by the Group: the length of the main dam at its **crest was almost 3 km**, and the construction site required a constant presence of complex and diversified machinery.

Throughout the project, as many as **45,000 workers**, from 26 different countries, worked at Tarbela; this also meant building a closeknit network of dwellings and auxiliary services.

In the early 1980s, the Tarbela consortium was also commissioned to enhance the plant's hydroelectric capacity by building a new power station. Born as a project to supplying water for irrigation at the start of the twenty-first century, the plant has been generating over 23% of the hydroelectric output of the West Pakistan Water and Power Development Authority.

Next page
Tarbela Hydroelectric Plant,
Pakistan

Main Technical Data

Main dam height	148 m
Main dam length	2,740 m
Main dam volume	121,000,000 m³
Auxiliary dams height	105 m and 67 m
Auxiliary dams length	710 m and 293 m
Total Auxiliary dams volume	15,500,000 m³
Concrete	800,000 m³
Excavation	39,000,000 m³
Installed capacity	700 MW
Reservoir	approximately 11,000,000,000 m³

PERU

Mantaro Hydroelectric Project

Client
Corporación de Energía Eléctrica del Mantaro, Lima, Peru

Project description

The plant, located **2,700 meters above sea level**, consists of a **concrete dam**, a sizeable desilting structure upstream of the intake, a long power tunnel which cuts across a wide bend in the river, a surge shaft with expansion chamber, a valve chamber, three steel penstocks on the surface and an open air type powerhouse.

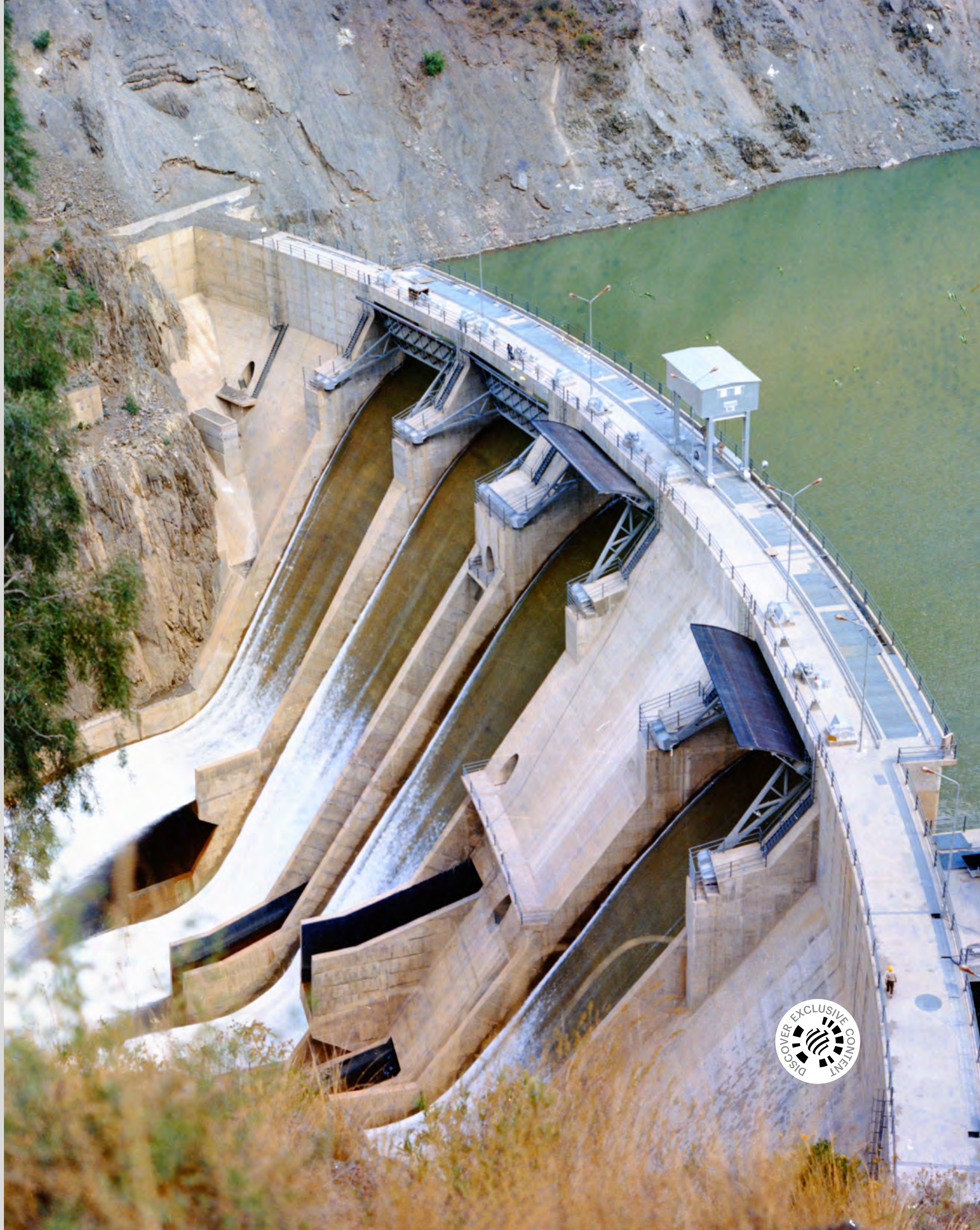
The fact that the work had to be done in a remote area of the Andean plateau meant overcoming some highly complex logistical difficulties: the main building site (Kichuas) was some 400 km away, and could only be reached via inaccessible mountain roads. In order to reach the furthest worksites, a modern road network had to be built, in some cases overcoming mountain passes at over 4,000 meters in altitude.

The dam's technical features (the hydroelectric power station was **the country's largest until 2012**) involved some major challenges: the headrace tunnel (almost 20 km) was excavated in very difficult geological conditions, and particular techniques had to be used to control the high velocity of the water during river diversion and to **build the weir in such a narrow gorge.**

In 1979, the plant was enlarged with the construction of the **hydroelectric power station** of "Restitución". Inaugurated in 1984, the new power station added **216 MW power** to the original plant, reaching a **total of 1,008 MW.**

Main Technical Data

Dam height	237 m
Crest length	200 m



WATER
DAMS

Africa
America
Asia
Europe
Oceania

Client
Eskom Enterprises

SOUTH AFRICA

Ingula Hydroelectric Project

Project description

The project, approximately 350 km south-east of Johannesburg, on the border of KwaZulu-Natal and Free State, involves the construction of a power generation and pumping plant with a **total installed capacity of 1,332 MW**, to produce electricity at peak times and re-use the water, pumping it into the upstream reservoir at times of low demand. It will be possible to **recycle more than 80% of the water used**, therefore building a more convenient model to collect great quantities of hydroelectric energy.

It is the fourth of its kind to be built in South Africa, but it is the biggest in terms of generating capacity.

Specifically, the project involves underground civil works to build the adduction and return tunnels, balancing shafts, penstocks, halls for the power station and transformers, access tunnels to the various structures and the upstream and downstream intake structures.

ACCOLADES: In 2013, for the project, Eskom awarded the Group its "Best Principal Contractor" title, for its environmental management. Due to its excellent performance, it received many recognitions for how it has dealt with occupational safety matters.

Next page
Ingula Hydroelectric Project,
South Africa

FOCUS ON THE ENVIRONMENT

The project idea and construction techniques used drew inspiration from sustainability principles. Great attention was paid to safeguard the environment surrounding the structure. The plant will be a virtuous producer of renewable energy created by recycling the water used by the same plant.

Main Technical Data

Open excavation	1,265,000 m³
Underground excavation	1,110,000 m³
Concrete	345,000 m³
Steel for concrete	21,975 ton
Sprayed concrete	58,000 m³
Steel penstocks	14,730 ton

SWITZERLAND

Val di Lei Dam

Client
Kraftwerke Hinterrhein A.G. – K.R.R. – Thusis

Project description

The Val di Lei Dam is located in Switzerland in the municipality of Ferrera (Farera), in the Canton of Grisons. Its artificial reservoir is fed by one of the affluents of the Rhine, which lies inside the Italian territory.

The **dam** is **a double-curvature arch-gravity dam** and has a crest lenght of 690 m, the biggest in the world at the time of its construction. It is 141 m high and creates a reservoir of 197,000,000 m^3 of water.

The materials needed for the works, including 12,000 tonnes of cement per day, were transported from the valley to the construction site using a cable car system capable of covering a distance of 14 km.

The Val di Lei dam is part of the Hinterrhein hydroelectric complex (Alto Reno Posteriore), **an integrated system producing 1,325,000,000 kWh of energy per year**, through a group of three power stations.

Works started on 1957 and finished just three years later, far ahead of schedule.

Main Technical Data

Crest length	690 m
Height	141 m
Reservoir volume	197,000,000 m^3
Concrete	220,000 ton

WATER
DAMS

Africa
America
Asia
Europe
Oceania

TAJIKISTAN

Rogun Hydroelectric Project

Client
OJSC "Rogun HPP" Open Joint-Stock Company

Project description

The **Rogun Hydropower Project** is divided into nos. 4 Contract Lots comprising the entire work, from the dam to the hydroelectric plant.

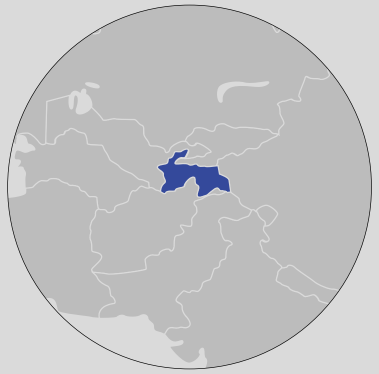
The project consists of the construction of a **335-metre-high** rockfill dam, **the tallest in the world**, on the Vakhsh River. The dam will be located in Pamir, one of Central Asia's main mountain ranges.

1st July 2016 Salini Impregilo signs the Contract for **Lot 2** and a framework agreement for others 3 Lots.

Once completed, the plant will have **6 turbines of 600 MW** each with a total installed capacity of **3,600 MW (the equivalent of three nuclear power plants).**

The most significant impact of the new dam will be to make Tajikistan a point of reference for the energy sector in the region, **doubling energy production in the country** and strongly contributing to the **reduction of power shortages suffered during the winter months.**

Main Technical Data



Outdoor excavation	2.6 M m^3
Underground excavation	0.1 M m^3
Concrete works	0.5 M m^3
Dam embankment	74.0 M m^3

WATER
DAMS

Africa
America
Asia
Europe
Oceania

UGANDA

Bujagali Hydropower Plant

Client
BUJAGALI ENERGY LTD (BEL), JV between Industrial Promotion Services Kenya and Sithe Global U.S.A.

Project description

The hydroelectric plant is located on the top portion of the Victoria Nile, some ten kilometres downhill from the sources of the great African river, can be seen as a symbol of a fruitful dialogue between different "technical" and "organizational cultures".

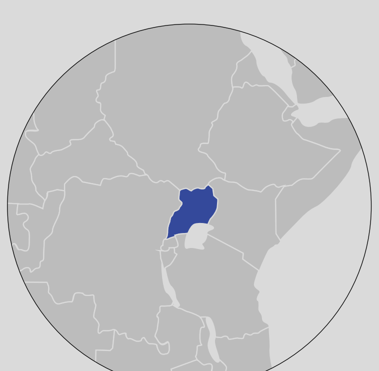
The building of Bujagali Dam was in fact made possible thanks to the **first project experience in a public-private partnership in the hydroelectric sector in Africa.**

The project was awarded by Bujagali Energy Ltd with a turnkey contract (EPC: Engineering, Procurement and Construction), and saw the participation of 4,000 Ugandan workers alongside 250 people of 50 different nationalities. The main structures of the project include an open air powerhouse accommodating five Kaplan turbines of 51 MW each, a gravity dam 900 m long, two spillways, a siphon spillway and three sections of the dam in rockfill with a clay core. It took exactly five years to complete, from June 2007 until June 2012, and was handed over to the client during August of the following year.

With **a power output of 250 MW, the plant is capable of independently covering half the energy needs of Uganda**, offering the country concrete growth possibilities with a reduced environmental impact.

ACCOLADES: In 2012 Bujagali was recognized as a Clean Development Mechanism Project within the scope of the United Nations Framework Convention on Climate Change. Furthermore, thanks to the integrated management of Corporate Governance, the project received various international awards both in 2012 and 2013 including the prestigious Uganda Responsible Investor URI Award.

In 2013, Salini Impregilo was appointed the "Best Responsible Investor of the Year" title for its commitment in Corporate Social Responsibility, environmental safeguard, quality of the activities carried out, creation of local occupation, and systems for preventing corruption.



Next page
Bujagali Hydropower Plant,
Uganda

FOCUS ON LOCAL COMMUNITIES

Salini Impregilo, after having delivered the plant to the Client continued to keep solid relations with its stakeholders and the NGO that work in the Country. These relations gave way to an innovative project to help oncological patients and Salini Impregilo united with "Oncology for Africa", a non-profit organisation that develops health prevention, treatment and training programmes. The Group, through this partnership, built the Nsambya Hospital in Kampala, the Country's capital.

The "Family House for Uganda" project aims at providing real support to oncological patients with economic difficulties, who thanks to this structure can stay here for free during the chemotherapy and/or radio therapy cycles. This structure can house up to 24 patients, on rotation, covering the entire treatment period. It mainly houses people who arrive from rural areas from all over the country.

FOCUS ON HSE

The project was built by fully respecting strict environmental and social requirements, including EHS Guidelines of the International Finance Corporation (IFC) of the World Bank Group.

Main Technical Data

Dam volume	662,000 m^3
Excavation	1,104,000 m^3
Reinforced concrete	322,000 m^3
Drilling/Grouting	19,500 m^2
Jet-Grouting	6,100 m^2

Rockfill Dam On The Nile River

Height	33 m
Crest length	860 m
Measured dam volume	623,000 m^3
Excavation works	1,256,000 m^3
Landfill	623,000 m^3
Total excavation works	1,879,000 m^3
Reinforced cement	305,700 m^3

VENEZUELA

Tocoma Dam

Client
Corporación Venezolana de Guayana (C.V.G.), Electrificación del Caroní C.A. (EDELCA)

Project description

The project, located in the south-eastern region of the Bolivarian Republic of Venezuela, on the Caroní River, a tributary of the Orinoco River, is an integral part of the Lower Caroní Hydroelectric Project.

On the Caroni River hydroelectric plants have been built in series to take advantage of the drainage basin of the region and generate clean energy. The Tocoma plant is the fourth on the Caroni River; it is, however, the first in which, in order to optimize casting times, climbing formworks were used to build the project's large concrete structures.

The machine hall is designed to generate **2,160 MW** through the installation of 10 Kaplan turbines. The volume of the machine hall is 1,060,917 m^3, in concrete, distributed over a length of 360 m. The spillway structure has a **discharge capacity of 28,000 m^3/s** through 9 radial gates, and is composed of 207,500 m^3 of concrete over a length of 175.86 m.

The Manuel Piar (Tocoma) hydroelectric plant consists of three main intake structures. The main one is in concrete with a maximum height of 82 m and a length of 583.86 m (Powerhouse and Spillway); the left dam is built from rock fill with a concrete face, a fill volume of 2,748,238 m^3, and a length of 3.8 km; the right dam is composed of an embankment with a core of impermeable material (clay) and filling material (rock), with a total volume of 7,093,671 m^3 and a length of 1,835 m.

Next page
Tocoma Dam,
Venezuela

FOCUS ON LOCAL COMMUNITIES

A training programme aimed at teaching sustainable agricultural techniques has been created as a consequence of the results shown by a study on the needs of local communities, carried out through surveys and interviews.
The initiative involved more than 50 people in 6 months in theoretical training and practical sessions. They were able to learn breeding, reclamation, biodiversity protection and conservation of natural resources techniques.
The aim of the project was to train this first group of people so that these could then train other local resources.

Main Technical Data

Excavation	9,412,000 m^3
Earth moving	14,670,231 m^3
Concrete	1,605,795 m^3
Metalwork	4,320 ton

ZAMBIA/ ZIMBABWE

Kariba Hydroelectric Plant

Client
Federal Power Board of Rhodesia and Nyasaland

Project description

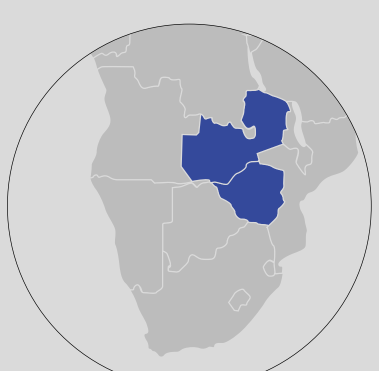
The Central African Federation (CAF), which within a Commonwealth unites the countries that will one day become Zimbabwe, Malawi and Zambia, ordered the construction of a large dam on the Zambesi River at the beginning of the 50s.

Works on the Kariba Dam began at the beginning of 1956. The project was completed six months before the contractual deadline.

The Kariba plant consists of a **double-arch concrete dam**, which is 620 m long and 128 m high, with spillway and underground works comprising penstocks, a powerhouse, a transformer hall, surge chambers, tailrace tunnels and service shafts.

The artificial lake is 300 km long and 30 km wide at its widest point. It occupies an area 4 times and a half greater than the largest artificial existing basin at that time. The underground powerhouse houses six turbines, each with a power generating capacity of 100,000 kW.

A small village rose on the hills surrounding the Kariba gouge, at approximately 150 m above sea level. All public services were guaranteed to make the lives of the people of the community of this new village easier: transport, amusement parks and swimming pools. A road network was rapidly created to serve the building site and to guarantee road connections with the main Salisbury-Lusaka existing axis.



Next page
Kariba Hydroelectric Plant, **Zambia/Zimbabwe**

A total of **10,000 people** took part in the Kariba's plant construction, including workers, technicians, and executives. Approximately 5,000 locals worked in the Kariba building site, directed by Italian experts, who left a great technical and managerial know how, as heritage, on the territory.

The dam, once in function, tripled the country's energy availability and allowed to regulate the river, impeding floods.

The project's direct beneficiaries were the **extraction industries of Zambia and Zimbabwe** and their employees. The dam to this very day still provides 84% of the whole available water volume of the artificial lake to produce electricity.

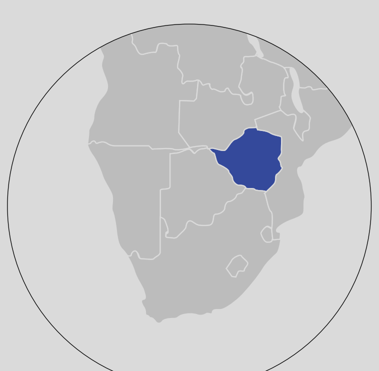
Main Technical Data

Height	128 m
Length	620 m
Artificial storage capacity	185,000,000,000 m^3
Concrete	1,125,000 m^3

ZIMBABWE

Tokwe Mukosi Dam

Client
Ministry of Environment, Water & Climate – Harare-Zimbabwe



Project description

The dam, rising 90 m above its foundation, is the tallest in the country and it creates the **largest artificial lake in Zimbabwe. It has a capacity of 1.8 billion cubic meters** and the artificial basin is over 40 km in length. The dam, which will be mainly used for irrigation purposes, will irrigate approximately 25,000 hectares of farmland, in the downstream areas, contributing to agricultural development and to the agro-food industry in one of the poorest areas of the country.

The project involved the construction of a **Concrete Face Rockfill Dam (CFRD)**. The intake structure comprises a 35-m tower fitted with grilles that directs the water to a 6 m diameter concrete lined tunnel excavated along the left abutment (350 m long) equipped with a regulating tower and two service gates. The water is released into the riverbed throughout two 2 m diameter steel pipelines. There are two morning glory spillways, near the left and right abutments, with a concrete lined outlet tunnel, 6 m in diameter and about 200 m long. Salini Impregilo introduced a dedicated Plunge Pool with the aim to increase and guarantee the safety and stability of the dam toe.

The ancillary works envisaged are an 8 km, access road and an earthfill cofferdam, 20 m tall and 133 m long. Finally, there are five saddle dams on the upstream right bank of the main dam, with a clay core and a total volume of more than 1,120,000 m^3.

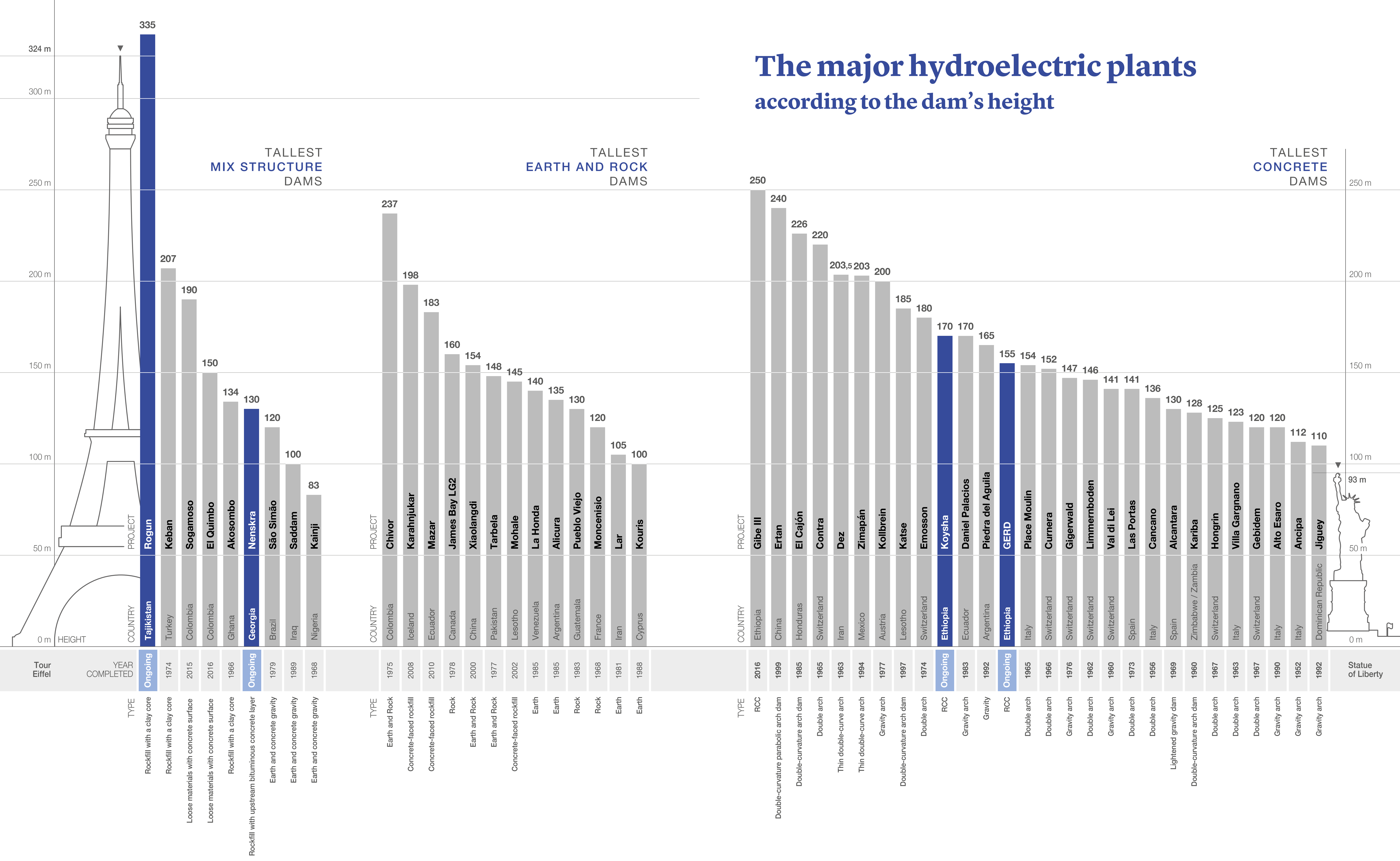
The “Taking Over Certificate” was officially received on the 16^{th} December 2016, 3.5 months ahead of the contractual deadline.

Next page
Tokwe Mukosi Dam,
Zimbabwe

Main Technical Data

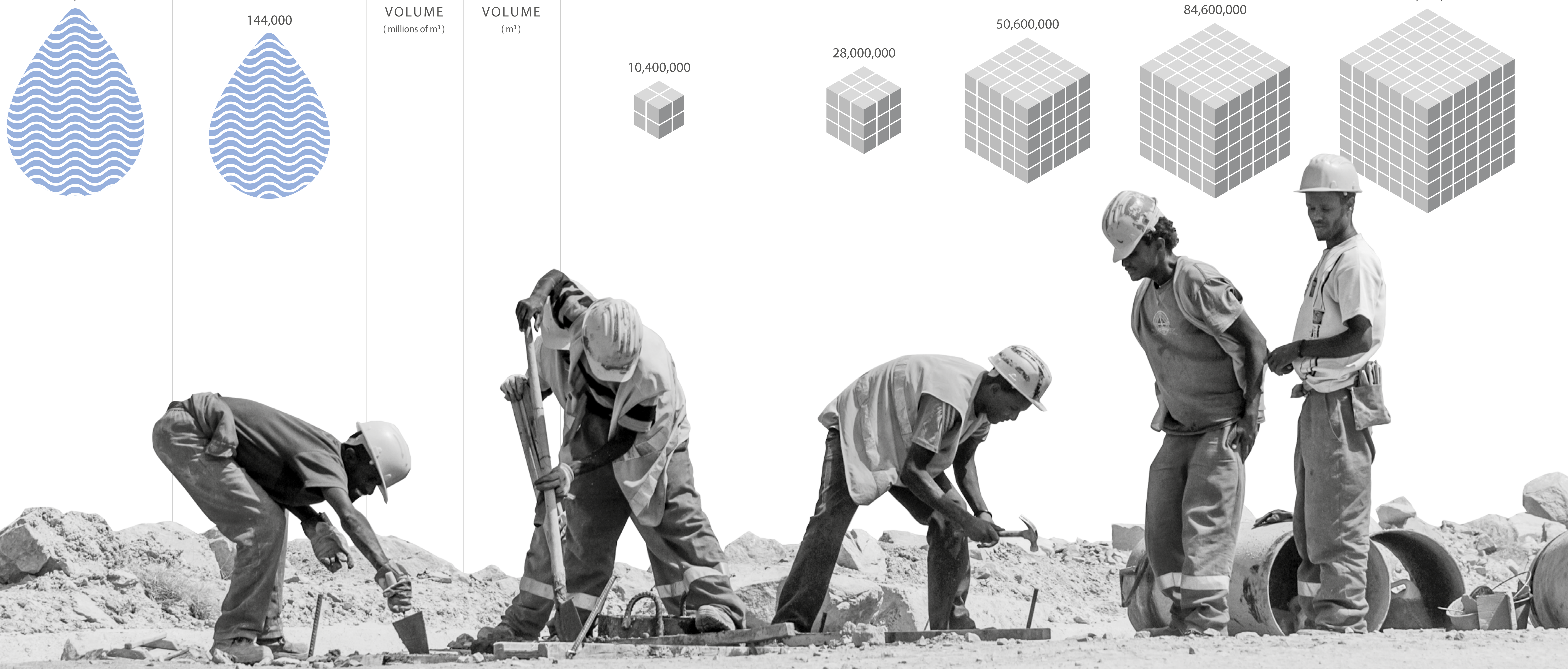
Main dam excavation	1,390,505 m^3
Saddle dam excavation	663,300 m^3
Main dam backfill	2,927,624 m^3
Saddle dam backfill	1,120,000 m^3
Concrete	95,000 m^3
Iron	4,500 ton
Waterproofing layer	8,542 m

The major hydroelectric plants
according to the dam's height



The largest hydroelectric plants
according to reservoir or to dam volume

PROJECT	Kariba	Akosombo	GERD	Al Whada (M'Jarra)	Xiaolangdi	Yacyretà	Tarbela
COUNTRY	Zambia / Zimbabwe	Ghana	Ethiopia	Morocco	China	Argentina / Paraguay	Pakistan
YEAR COMPLETED	1960	1966	Ongoing	1998	2000	1998	1977
TYPE	Concrete arch	Earth and Rock	RCC	Earth and Rock	Earth and Rock	Earth and concrete gravity	Earth and Rock
◄ RESERVOIR VOLUME (millions of m^3)	185,000	144,000					
DAM VOLUME (m^3) ►			10,400,000	28,000,000	50,600,000	84,600,000	121,000,000



Anacostia River Tunnel,
Washington D.C,
USA

3.2 Hydraulic works

Salini Impregilo is active in this field, where it builds infrastructure that collects, channels and treats waste water from large urban centres, improving the quality of the water in receptive water bodies (usually rivers or seas), reducing pollution and making water resources available for new uses, like irrigation.

The Group, during its many years of activity has been involved in many projects of this kind, from the Us, to Latin America and the Middle East. In Washington D.C., for example, there's the recently completed **Anacostia River Tunnel Project**. It aims at reducing wastewater in the US capital's rivers. The project is part of the ambitious "Clean Rivers Project" which was launched by the Water and Sewer Authority (DC Water) of the District of Columbia. Once completed, the volume of wastewater in rivers will be reduced by 96%: it will pass from 4.8 billion litres in 2008 to 185 million litres.

In Portland and Cleveland, the Group has also built similar projects. Here, the **Dugway Storage Tunnel** includes building a tunnel that will allow to collect 214 million litres of rainwater.

One of the deepest hydraulic tunnels in the world, the **Deep Sewer Tunnel**, was built in Abu Dhabi. It is part of the STEP project, which aims at solving the issue of channelling and treating wastewater.

In Qatar, the first underground tunnel, **Abu Hamour** has been recently completed. In 2017, it won the **Best Global Project Award** from Engineering News Record magazine, which every year also publishes the best international construction companies rankings.

Lake Mead Intake Tunnel is among the most important hydraulic projects built by the Group. It is a complex water intake and distribution system that connects Las Vegas to one of the largest artificial lakes in the US. The project won the 2016 “Tunneling Achievement award of the year” from TBM (Tunnel Business Magazine). It had previously also won, in 2015, the “NCE Tunnelling & Underground Space Award” as “Global Tunnelling Project of the Year”.

WATER
HYDRAULIC WORKS

Africa
America
Asia
Europe
Oceania

Client
AySA (Agua y Saneamientos Argentinos S.A.)

ARGENTINA

Riachuelo Environmental Restoration Project

Project description

The project includes wastewater catchment in the Riachuelo treatment plant. This is made possible thanks to a 40 m deep shaft. Treated waters are subsequently channelled, using a tunnel that measures 11 km in length and 3.8 in diameter, towards a diffuser system built on the riverbed of Rio de la Plata.

The tunnel is positioned 40 m under the riverbed. **Among the longest, of its kind, in the world**, it is used as a canal for the water that has been treated in the plant and that, thanks to its variable diameter, between 1.7 and 3.8 m flows into a river at a speed of 2 m/s.

The last 1.5 km are equipped with a diffuser system made of 34 RISERs that take the treated water to the river bed.

The initiative is socially and environmentally important and is part of a **larger programme, funded by the World Bank**, of the sustainable development of the **Matanza-Riachuelo catchment basin**, which aims at environmentally restoring the Riachuelo river and the territories it crosses, considered among the most polluted in the world.

Main Technical Data

Area cleaning	112,500 m^3
Earth moving	550,000 m^3
Concrete	100,000 m^3

WATER
HYDRAULIC WORKS

Africa
America
Asia
Europe
Oceania

Client
Publiacqua SpA

ITALY

San Colombano, Florence

Project description

Sewage treatment
- Coarse screening 20 mm and fine screening at 3 mm
- Aerated Degritting with grease removal (number 6 chambers each for 540 m^3)
- Primary Clarification (number 3 circular basins , 59 m diameter)
- Biological selector
- Anoxic/Denitrification basins (number 3 basins each of 24,000 m^3)
- Aerated/Nitrification basins (number 3 basins each of 8,000 m^3)
- Secondary Clarification (number 9 circular basins 55 m diameter)
- Disinfection

Sludge treatment
- Thickening by centrifuges
- Two stage Anaerobic Digestion (number 6 digesters 4,500 m^3 each)
- Sludge dewatering by centrifuges

The waste water treatment plant is located on the left bank of the river Arno and it is part of a large environmental project interesting an area around Florence of 200 hectares and serving eight municipalities.

Main Technical Data

Process	Activated Sludge
Capacity	600,000 Inhabitants Equivalent
Design dry weather flow	237,600 m^3/d (80 MGD)
Design wet weather flow	529,632 m^3/d (370 MGD)
Daily BOD5	36,000 kg/d
Daily COD	75,000 kg/d

QATAR

Abu Hamour Hydraulic project

Client
ASHGHAL
Public Works Authority

Project description

The project involves the construction of a **main water collection tunnel 9.5 km long** and with an excavation diameter of 4.5 metres, as well as the construction of 21 access shafts of various diameters and with depths ranging from 15 to 30 metres.

The excavation of the tunnel will involve the use of two Tunnel Boring Machines (TBM). The works are almost totally at groundwater level, therefore at highly unpredictable hydrogeological conditions, with water discharges during excavation works.

ACCOLADES: In 2017, the project won the "Global Best Project" award for the "Water/Wastewater" category, which was assigned by ENR, the prestigious US magazine.

Next page
Abu Hamour Hydraulic project,
Qatar

Main Technical Data

Main tunnel	9,359 m
Branches with microtunnelling and pipe jacking	937 m
Main shafts	18
Secondary shafts for microtunnelling inspection	6
Underground tunnel excavation	150,000 m^3
Microtunnelling excavation	2,360 m^3
Main and secondary shaft excavation	45,770 m^3
Miscellaneous excavation	6,500 m^3
Prefabricated segments	50,435
Concrete	55,045 m^3
Steel reinforcement	7,500 t

WATER
HYDRAULIC WORKS

Africa
America
Asia
Europe
Oceania

Client
ISKI, Istanbul Water and Sewerage Administration

TURKEY

Atakoy, Istanbul

Project description

The Ataköy water treatment plant is located in the south-western part of Istanbul city, near to Atatürk International Airport. The scope of work includes the revamping of the existing plant that came in service in 2010 and the construction of a new WWTP having capacity 240.000 m^3/d plus an MBR section sized for 20.0000 m^3/d. Total area for new construction is of 100.000 m^2. The contract is of EPC (Engineering, Procurement, Construction) type, and it is relevant to turn-key supply including civil works for a duration of works of 730 days.

Sewage treatment
- Rock trap
- Coarse screening 50 mm, fine screening at 10 mm and perforated screen 6 mm
- Aerated Degritting with grease removal
- Primary Clarification
- Bio P biological selector
- Anoxic/Denitrification basins
- Aerated/Nitrification basins
- Secondary Clarification
- Disinfection

Sludge treatment
- Thickening by flotation/thickener
- Anaerobic Digestion
- Sludge dewatering by centrifuges
- Sludge thermal drying with fluidified bed

Odour Control, MBR Plant
- Capacity: 20,000 m^3/d
- Coarse screen 2 mm
- Drum screening at 1 mm
- Anoxic/Denitrification basins
- Aerated/Nitrification basins
- UF membranes 20 l/h m^2 flux
- Disinfection

Main Technical Data

Process	Activated Sludge
Capacity	1,000,000 inhabitants equivalent

UNITED ARAB EMIRATES

Abu Dhabi Deep Sewer Tunnel

Client
Abu Dhabi Sewerage Services Company (ADSSC);
Abu Dhabi Water & Electricity Authority (ADWEA)

Project description

The project involved the construction of approximately two-thirds of the Strategic Tunnel Enhancement Programme (STEP), **a hydraulic tunnel around 40 km** in length capable of collecting the wastewater of the island and of the portion of the city situated on the mainland and then directing it to the treatment plant located in Al Wathba.

25 km of tunnels with excavation diameters of approximately 7 m and 10 access shafts, 40 to 80 m deep, were built.

The excavation had to come to terms with **particularly difficult geological conditions** (ground containing chalk, limestone, sandstone, siltstone and argillite with strong risks of subsidence) and the project required particularly stringent criteria with regard to the durability of the work. As many as **five TBM** EPBs (Tunnel Boring Machines - Earth Pressure Balance) were used **simultaneously**, a technology never used before in the Emirate.

The upgrading of the sewer system to meet the demands of future generations is one of the largest and most ambitious projects in the world for improving waste water infrastructure: **the Strategic Tunnel Enhancement Programme allows the treatment of an average wastewater flow of 800,000 m^3 per day.**

Next page
Abu Dhabi Deep Sewer Tunnel,
United Arab Emirates

The project brings long-term significant improvements for Abu Dhabi, which today is capable of managing wastewater more efficiently and more safely. 34 old pumping stations will be removed thanks to the new system that uses gravity, reconverting the areas and improving the quality of the life of its inhabitants. Moreover, waters channelled by STEP, after they have been treated will be reused for irrigation within the city's green areas, contributing to lowering urban temperatures and, consequently, the energy consumption of the climate plants. FAO estimates that the urban green areas will reduce temperatures from 2 to 8°C and energy consumption connected to air-conditioning plants by 30%.

Main Technical Data

Underground excavations	891,000 m^3
Concrete	310,000 m^3
Steel reinforcement	6,165 tons
Prefabricated blocks	18,452
HDPE membrane	413,350 m^2

WATER
HYDRAULIC WORKS

Africa
America
Asia
Europe
Oceania

Client
Northeast Ohio Regional Sewer District

USA

Cleveland Dugway Storage Tunnel

Project description

The project, which will allow collecting more than 214 million litres of rainwater to send it to the Easterly Sewage Treatment Plant, is part of a broader plan for **the collection, storage and treatment of these waters**, with the objective of reducing the level of environmental pollution in **Lake Erie**.

The Dugway Storage Tunnel **is 4.5 km long, with a diameter of 8 metres**. It will cross the Eastern area of Cleveland. When the tunnel's concrete lining is completed its internal diameter will be reduced to 7.3 meters. The contract envisages the construction of 6 shafts of varying diameters and depths, connections between the tunnel and the shafts and a series of concrete structures for the collection and transporting of wastewater and rainwater.

Main Technical Data

Tunnel length	4.5 km
Tunnel diameter	8 m

USA

Lake Mead Intake Hydraulic Tunnel

Client
SNWA, Southern Nevada Water Authority, Las Vegas, Nevada, USA

Project description

The project involved the construction of **a complex system for collecting and transporting Lake Mead's waters** by building a deeper third intake, a complex intake and channelling underground work in addition to the original two but inoperable lateral conduits.

Lake Mead is the largest artificial lake in the US. It is composed of the renowned Hoover dam on the Colorado river. It has been providing electricity to Nevada and to the nearby States for more than seventy years, supplying water to the city of Las Vegas, located at 30 km.

The project is composed of a concrete and steel intake work, measuring 29 m and weighing 1,250 tons, positioned on the lake-bed at approximately 100 m below the surface of the lake through a complex launch structure and a 200 m access shaft connected to the water purification and distribution plants and grids. The excavation of the connecting tunnel set an important record in tunneling history: the TBM used for excavating 4.6 km of the tunnel is the only specially created prototype in the world of its kind, designed to resist **pressure conditions that have never been experienced before in tunneling history**, excavating at a maximum pressure of 15 bars, double the previous world record.

Its functioning ensures 4,500,000 m^3 of water to the urban area of Las Vegas for drinking and domestic purposes. It guarantees water supply even in case of extreme drought that lower Lake Mead's water level even more.

Next page
Lake Mead Intake
Hydraulic Tunnel,
USA

ACCOLADES: In September 2016, Tunnel Business Magazine (TBM), one of the industry's leading magazines, assigned the "TBM Tunneling Achievement award of the year" to the project, as it acknowledged it as a milestone for future mechanized excavation projects carried out at extreme pressure levels.

In 2015, at the end of the works, the project received the "Global Tunneling Project of the Year" award within the NCE Tunneling & Underground Space Award.

The project also won the (Engineering Excellence Award) of the American Society of Civil Engineers (ASCE) for the State of Nevada placing itself in the top 6 list of the "Outstanding Civil Engineering Achievement Award".

Main Technical Data

Length	4.6 km
Excavation diameter	7.22 m
Underground excavations	30,000 m^3
Depth	185 m
Internal diameter	9.15 m

USA

Portland West Side CSO project

Client
City of Portland - BES - Bureau of Environmental Services

Project description

The project involved the construction of a **new main sewage collection and storage system** in the western part of the city: this included a 5.5-km tunnel (excavated using 2 TBM hydroshield Herrenknecht, never used before in the USA), a pumping station and five service shafts around 40 m deep.

In 1990, the City of Portland's Bureau of Environmental Services began a twenty-year plan aimed at improving the city's sewage system, with a view to the ever-growing environmental sensibility. The work concerned the sewage system close to the Willamette River and involved the restructuring and the extension of existing infrastructure, with particular attention to a system capable of eliminating the risk of untreated wastewater overflow in the event of pipeline overflow caused by heavy rainfall (Combined Sewer Overflow, CSO). The elaborate and complex network of minor underground collection systems to connect the tunnel to the existing sewers required the construction of a series of secondary channels, that is, a network of micro-tunnels. A Herrenknecht micro-tunnel TBM with diameter ranging from 2.25 m to 2.75 m was used to excavate the secondary tunnels and lay the concrete pipelines. The overall length of the pipelines was over 3,400 m.

In relation to the technical difficulties expected because of the features of the soils, the client opted for a "cost plus fee" contract, thereby selecting the Contractor solely on the basis of the methodological techniques offered for the execution of the works.

The plan to enhance Portland's sewer system, referred to as **one of the country's greatest engineering projects** by the American Society of Civil Engineers, reduces the flow of wastewater into the Willamette River by around 94% and almost completely eliminates flows into the Columbia Slough.

Main Technical Data

Underground excavation (main tunnel and micro-tunnels)	132,200 m^3
Pre-cast segments for tunnel lining	20,700 m^3
Shaft excavation	95,000 m^3
Jet Grouting	17,600 m^3
Slurry walls	18,600 m^2
Pump station concrete	25,000 m^3

USA

Anacostia River Tunnel Washington D.C.

Client
District of Columbia Water and Sewer Authority (DC WASA)

Project description

The Anacostia River Tunnel project, **part of the Clean Rivers** project of the DC Water Authority, involves building a 3.8 km hydraulic tunnel which will mainly be developed under the Anacostia River, a tributary of the Potomac River in Washington D.C. The tunnel will transport sewage and rainwater separately to prevent pollution of the rivers during floods (combined sewer overflows - CSOs) that frequently occur during periods of heavy rainfall.

The tunnel is excavated with an EPB Tunnel Boring Machine (TBM) with a **7.9 m excavation diameter**. The contract envisages the construction of 6 shafts for water catchment that are 30 m deep various concrete connecting works with existing infrastructure.

The tunnel runs along the Anacostia River for a total length of 3,800 meters, mostly in clay soils and **at an average depth of about 30 meters**. When crossing the Anacostia River, the TBM will excavate in sandy soils under a hydraulic head of up to 3.5 bar. The tunnel is lined with 6+1 fibre reinforced precast concrete segments, which constitute a concrete ring designed for a minimum bend radius of 220 metres and with a final inner diameter of 7 metres. The earth pressure balance (EPB) TBM supplied by Herrenknecht has been set for working at pressures of up to 4 bar in mixed soils of clay and sand under pressure.

When excavating the tunnel with the TBM, two of the shafts will serve as the main site for the material supply and excavated material spoils. For this purpose, the two shafts are each served by a gantry crane, with a capacity of 50 and 30 tonnes, respectively, and connected by a 100-m long service tunnel. Grouting injections will improve the ground underneath foundations and underground utilities, to protect the existing infrastructure. This procedure will be partly carried out ahead of TBM excavations, and partly following excavations, as compensation grouting.

The shafts are constructed with excavation techniques using bentonite drilling mud for the installation of reinforced concrete diaphragms. A dewatering system is installed when the diaphragms are completed. This consists of a series of shafts with small diameters and equipped with pumps capable of reducing the hydraulic pressure of the groundwater, allowing shaft excavations in well-drained conditions.

Once excavation works with the TBM have been completed, the shafts are lined with concrete by means of 5 circular formworks, the diameter of which varying according to the shaft that is being lined. Other concrete structures include: diversion chambers, which connect the existing structure with the new tunnel; odor control units i.e. ventilation and gas control chambers; an overflow structure; and other hydraulic structures inside the shaft. Finally, the shafts and the maintenance chambers are equipped with electromechanical equipment and put into service.

Main Technical Data

Shafts which vary in diameter from 9 to 22 m and are approximately 30 m deep	6
Soft ground tunnel with a minimum internal diameter of 7 metres, which is approximately 3,800 metres long, and entirely lined in prefabricated segments	1
Diversion Chambers	4
Connections between the shafts and the main tunnel	3
Odour Control Units	5

Next page
Anacostia River Tunnel
Washington D.C.,
USA


salini
impregilo

WATER
HYDRAULIC WORKS

Africa
America
Asia
Europe
Oceania

USA

Northeast Boundary Tunnel (NEBT) Washington D.C.

Client
District of Columbia Water and Sewer Authority (DC Water)

Project description

This work is the biggest component of DC Water's "Clean Rivers Project", in Washington D.C. The tunnel will run 15 to 48 m underground and will measure 8,220 m in length, Kennedy Stadium to the intersection between Rhode Island Avenue NW and 6th Street NW. It will cut the existing areas, which are frequently flooded, at Rhode Island Avenue NW.

The project includes a large and deep sewer tunnel that will increase the capacity of the District's sewer system, significantly mitigating the frequency, magnitude and duration of sewer flooding and improving the water quality of the Anacostia River.

In times of flooding, the tunnel will receive flows from the sewer system captured by diversion facilities and convey them to DC Water's Blue Plains Advanced Wastewater Treatment Plant.

The NEBT project also includes the construction of ventilation control facilities, stormwater inlets, and green infrastructure. Once it is connected to the other Clean Rivers Project tunnels, the NEBT will **reduce combined sewer overflows to the Anacostia River by 98 percent** and the chance of flooding in the areas it serves from about 50 percent to 7 percent in any given year.

WATER
HYDRAULIC WORKS

Africa
America
Asia
Europe
Oceania

USA

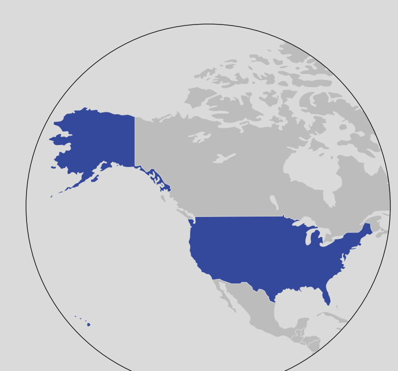
Three Rivers Protection & Overflow Reduction Tunnel (3RPORT) Fort Wayne

Client
U.S. Enviromental Protection Agency

Project description

The Three Rivers Protection & Overflow Reduction Tunnel (3RPORT) is a combined sewer overflow (CSO) tunnel project located in Fort Wayne, Indiana.

It includes a deep rock tunnel, drop shafts and consolidation sewers to convey CSO from eight locations along the St. Mary and Maumee Rivers. Once completed, the tunnelling system will reduce CSO in rivers by 90%.



Expansion of the Panama Canal Third Set of Locks, **Panama**

3.3 Ports and marine projects

Salini Impregilo has many decades of experience in building new ports. Its activities include modernizing and renovating existing ones, at building dry docks, wharfs and piers for tankships, outer dams and quays, but also at building safeguarding and reinforcement works for sea-coastal areas.

The Group's first steps in the naval works sector were made in 1931, with a series of renovating works for the Lisbon and Leixoes ports in Portugal, followed by projects all over the world.

In over 80 years, many works have been built, among which the ports of Homs and Marsa el Brega in Libya, of Mohammedia in Morocco, of Mogadishu and Bosaso in Somalia, of Comodoro Rivadavia in Argentina, the completion and restoration of the outer dams of the port of Constantza in Romania, the reconstruction of the port of Beira in Mozambique and many ports in Italy such as the Gioia Tauro, Porto Torres and Vado Ligure ports.

The Third Set of Locks project to expand the Panama Canal, a flagship project is one of the most important and greatest civil engineering feats of the century, is part of this tradition of building large infrastructure in the world.

Client
Government of Socialist People's Libyan Arab Jamahiriya

LIBYA

Port of Homs

Project description

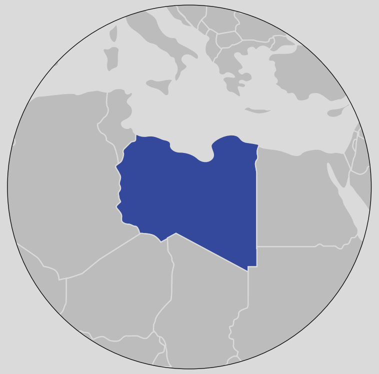
The port is located at a few kilometres from the city of Homs, 120 km East of Tripoli. It features **a main wharf that is 3 km long and a 2 km secondary breakwater wharf.**

Works included building a wharf inside the port's basin, which is "t" shaped and is 1.3 km long, and quays for ships to lay alongside, with a total development of approximately 6 km and a variable depth that goes from 3 to 13 m. The quays were built with large prefabricated concrete blocks, with a variable weight of 120 to 360 tonnes, which were positioned using special pontoons and placed upon a main rockfill stratum, and completed by a concrete superstructure laid onsite.

The first phase of the port built in 1984 was followed by construction activity for important additional works completed in 1987.

Additional works comprised building approximately 6,000 m of concrete pipings, a complete naval assistance system, sea signals, a 175,000 m^3 rockfill dam to regulate the flow of the Wadi Al Fani torrent, and the completion of the "Shiplift" plant with its 2,700 tonnes.

Main Technical Data



Concrete	850,000 m^3
Dredging and backflows	5,500,000 m^3
Hard rock dredging	100,000 m^3
Stone materials	6,500,000 m^3

Client
Direction des Ports de Casablanca et Mohammedia

MOROCCO

Port of Mohammedia

Project description

The oil port of Mohammedia was built by the Moroccan government to reduce naval leasing costs and the stopover time of the oil tankers.

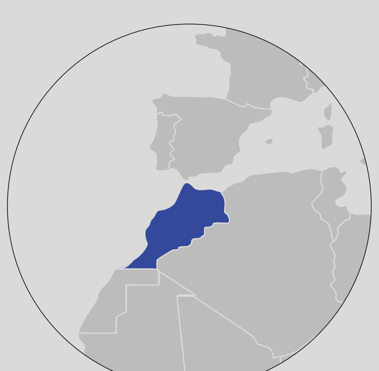
The breakwater structure is 2.7 km long. It extends over the seabed that gradually reaches a depth of 27 m, which becomes 31 m during the rising tide. The dam's nucleus and filters are made of crude ore and rock from a quarry, positioned up to -5 m using two semi-mobile hopper barges with a 600 m^3 bottom opening.

The crowning is made of a reinforced concrete guard wall with a growing top height from 12.5 m to 15.5 m above sea level, and of a thick reinforced-concrete slab with growing width and thickness as depth increases.

Due to the strength of the waves on the top portion of the dam, this has been protected using 22 m^3 cubes with specific gravity amounting to 3.14 t/m^3.

A transversal wharf, exclusively made of rock from a quarry has been connected to the main dam. A 246,000 m^2 embankment was built near it.

Main Technical Data



Quarry exploitation, crude ore transport and laying	4,737,000 m^3
Material supply and laying for the embankment	1,794,000 m^3
Quarry exploitation and rock transport (reef)	730,000 m^3
Precast concrete	504,000 m^3
Concrete works	151,000 m^3

Client
Nigerian Ports Authority, Lagos

NIGERIA

Port of Apapa Lagos

Project description

The project consists of an extension and other **improvements to the pier of Apapa (Port of Lagos, Nigeria)** to increase the annual traffic of goods from 15 million tons to 23 million tonnes.

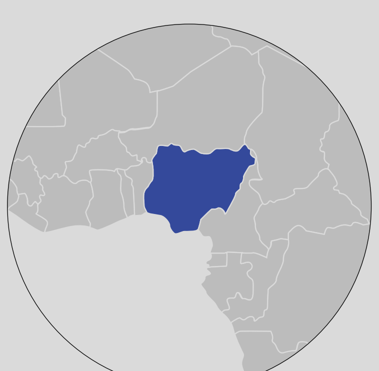
The extension was partially funded by the **World Bank**. It included the addition of 943 m long moorings that were added to the existing ones used for high-sea ships, increasing the length of the main quay (that at the time was 1.5 km long), and the construction of ancillary works and equipment, four transit sheds, two warehouses and the completion of other two being built, depots and cranes.

A stone pit was installed 100 km from Apapa, to adequately satisfy the needed amount of rockfill and crushed stone (280,000 m^3). The materials were then moved to where they were to be used with special trains with specifically-made wagons, which passed daily. One of the key operations of the building site was the unloading and distribution of the inert materials to the various processing sectors, among which the concrete mixing one.

130,000 m^3 of concrete of which 70,000 m^3 to prefabricate the blocks making up the quay wall, with an average daily production of 37 blocks weighing some 20 tonnes were needed.

This complex of works was further increased in June 1965 with the addition of a fifth quay to the four set by the initial contract. The Group, given the results of the construction methods used, working a total of 9 million hours, fulfilled its duty by also completing the ancillary works by the same date of the end of the first contract.

The project had an overall positive impact in economic terms and with regard to the national development plan, having solved the previous issues connected to the traffic of goods being imported and exported in and out of the Country. Today, Lagos is one of the main ports of Western Africa, with a total area of 120 hectares.



Main Technical Data

Concrete	130,000 m^3
Quay wall height	11.8 m

WATER
PORTS AND NAVAL PROJECTS

Africa
America
Asia
Europe
Oceania

PANAMA

Expansion of the Panama Canal Third Set of Locks

Client
ACP, Autoridad del Canal de Panamá

Project description

The Expansion of the Panama Canal, defined as **the most important engineering feats of the 21st century**, involved: creating a new set of locks for the Canal, currently allowing the transit of larger ships, increasing trade traffic in response to the development and continued expansion of the shipping transport market.

The construction of the Third Set of Locks for the canal will larger ships known as Post Panamax with a capacity of up to 12,600 TEUs, a length of 366 metres, a width of 49 metres, to sail along the Canal. Previous Panamax ships have a capacity of 5,000 TEUs.

Specifically, the project involved the construction of **two sets of triple step locks**: one triple step lock on the Atlantic shore and one on the Pacific shore.

Each of the three chambers which make up each lock is 55 metres wide, 427 metres long and 23-33 metres deep, and they are equipped with horizontally sliding sluice systems which can overcome the existing difference in level of approximately 27 metres between the oceans and Lake Gatun.

The efficient and safe operation of the locks is regulated and guaranteed by 8 sliding gates for the Atlantic side and the same number for the Pacific. These horizontal sliding gates are 33 m high, 10 metres wide and 58 metres long, weighing from 2,500 to 4,000 tonnes each.

Next page
Expansion of the Panama Canal Third Set of Locks, **Panama**

Each gate has auxiliary basins (Water Saving Basins) that **save 60% of water per transit**, enabling transit through the Canal using only approximately 200 million litres of water, instead of 500 million litres of water used by the previous Canal. The system allows reutilization of the water from Gatùn Lake, reducing the waste of water into the Oceans.

The project required a colossal effort with **30,000 workers** in the worksite (a peak of 11,500): 290,000 tonnes of reinforced steel, 5 million m^3 of concrete and 74 million m^3 excavated.

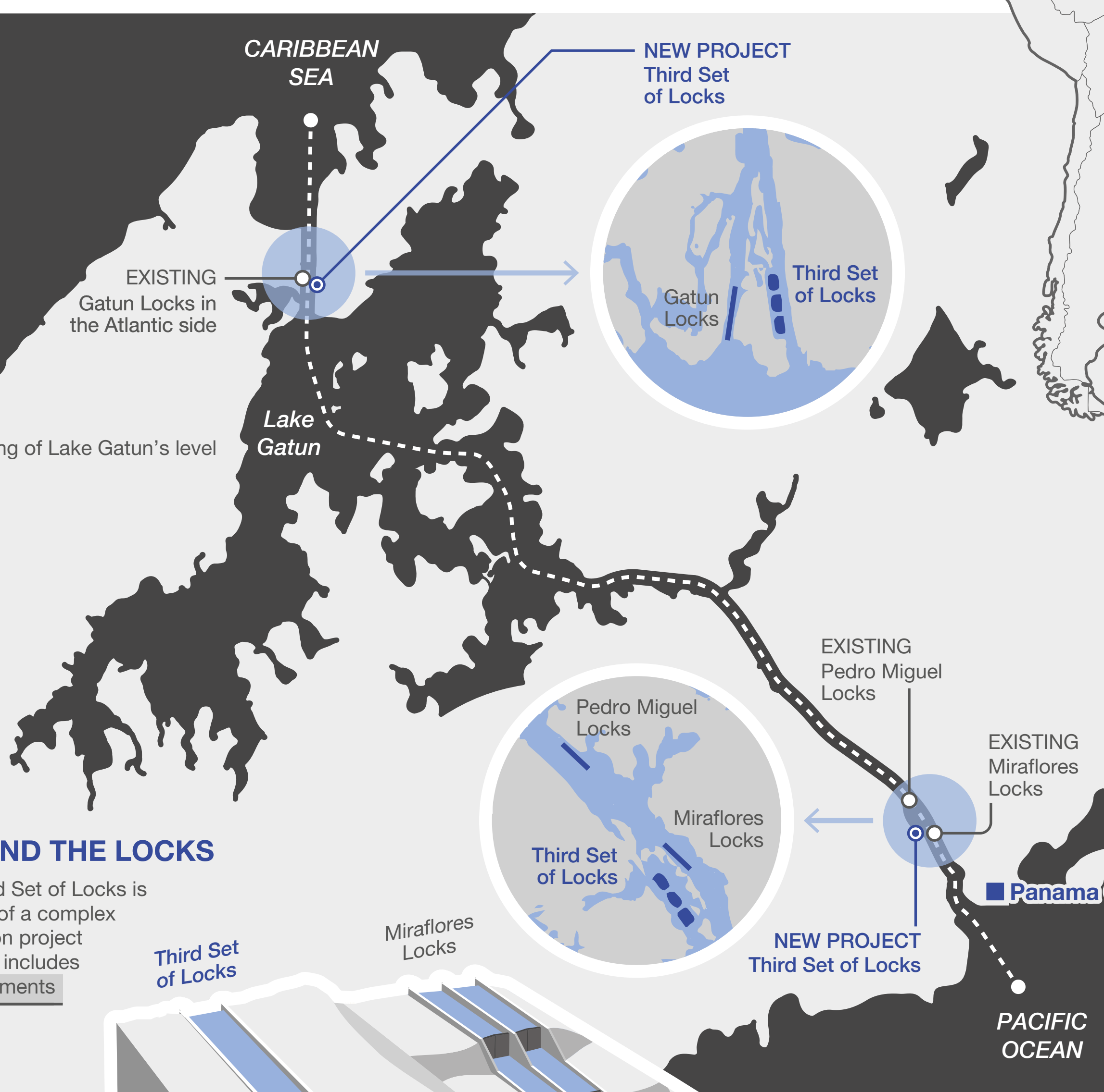
The functioning of the new set of locks of the Panama Canal has really revolutionized sea trade. **The approximately 12 thousand ships that currently cross it each year, will be connected to 1,700 ports of 150 countries and to 144 maritime routes.**

Works on the Canal have always kept economic, social and environmental sustainability as a priority.

Main Technical Data

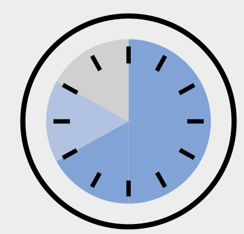
Steel	290,000 tons
Concrete	5,000,000 m^3
Excavation	74,000,000 m^3

Panama Canal Expansion



CANAL LENGTH

83 km (unchanged)



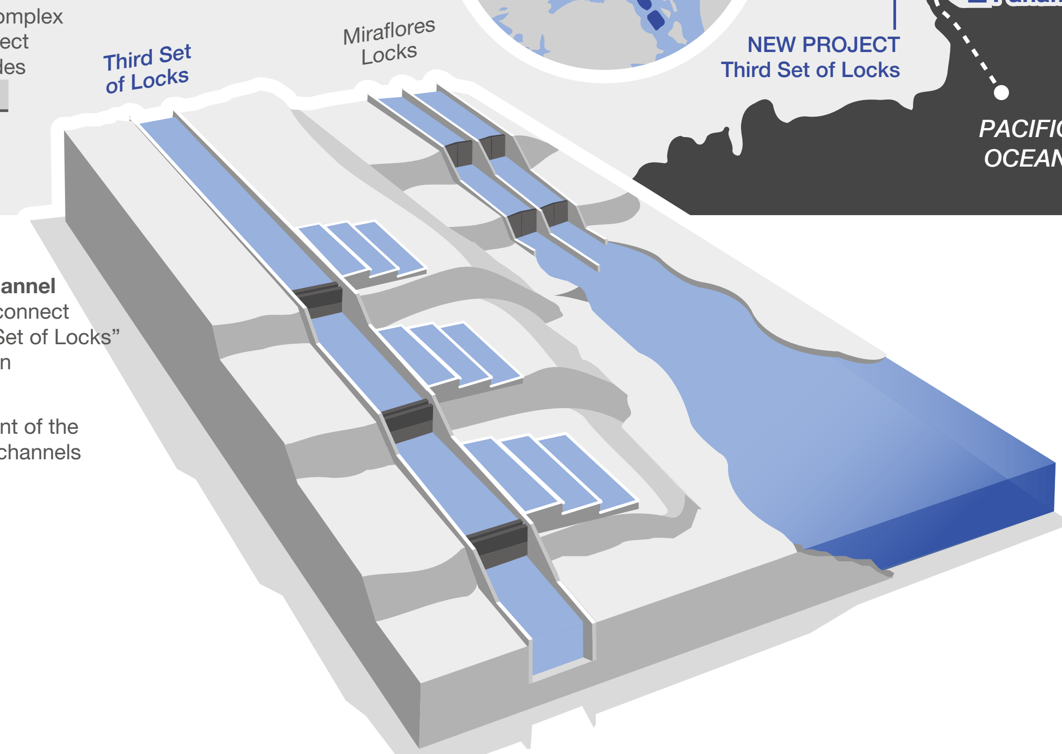
AVERAGE CROSSING TIMING

8-10 hours

BEYOND THE LOCKS

The Third Set of Locks is the key of a complex expansion project that also includes other elements

- Raising of Lake Gatun's level
- **Pacific Access Channel** to directly connect the "Third Set of Locks" to the ocean
- Improvement of the navigation channels



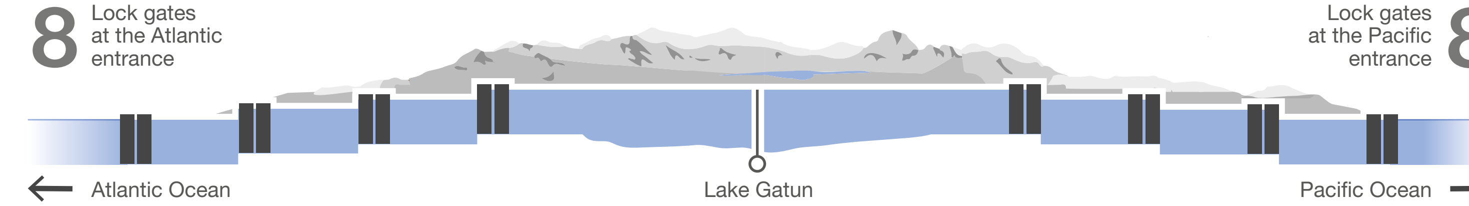
DISCOVER EXCLUSIVE CONTENT

THE LOCK GATES THAT SPEAK ITALIAN

The sixteen lock gates, entirely built in Italy, in San Giorgio di Logaro (Udine) are one of the project's key features

8 Lock gates at the Atlantic entrance

8 Lock gates at the Pacific entrance



The project's numbers

The "Third set of locks" is the largest construction project to be realised at a global level.
Awarded to four European construction companies, grouped in the Grupo Unidos por el Canal (GUPC), of which Salini Impregilo S.p.A. is a part, the infrastructure will once again change the planet's boundaries making the world's shipping trade safer

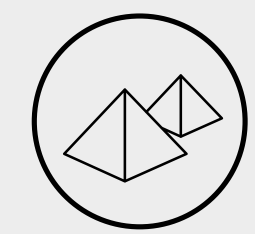
EXCAVATED MATERIAL

74 million cubic metres

equalling 1/4 of the volume of the Great Wall of China

CONCRETE

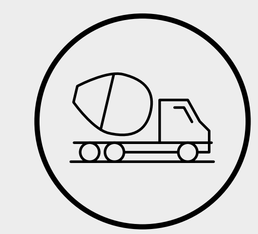
5 million cubic metres



equalling the volume of 2 Great Pyramids of Giza

CEMENT

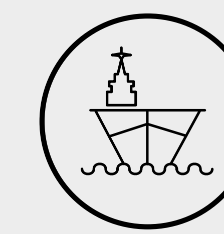
1.6 million tons



equalling the weight of 40,000 concrete mixers

STEEL

292 thousand tons



equalling the weight of 3 Nimitz aircraft carriers

REUSING WATER

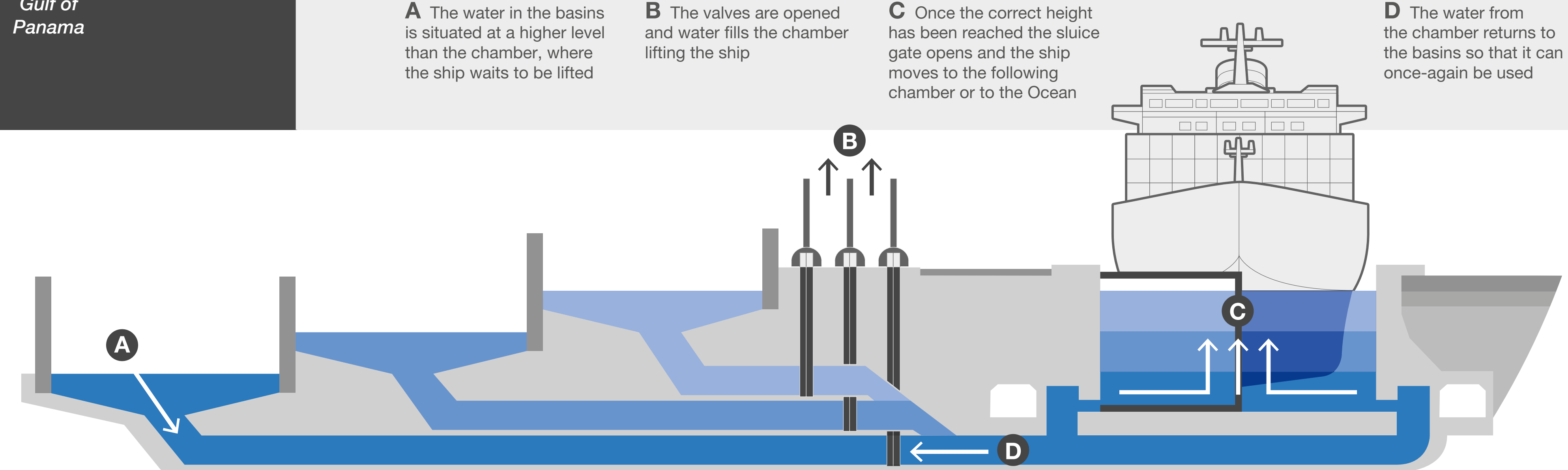
Since the design phase particular attention has been placed, on how to reduce Lake Gatun's water consumption during the transit phases.
The Water Saving Basins system makes it possible through additional basins to partially collect and reuse Lake Gatun's water

A The water in the basins is situated at a higher level than the chamber, where the ship waits to be lifted

B The valves are opened and water fills the chamber lifting the ship

C Once the correct height has been reached the sluice gate opens and the ship moves to the following chamber or to the Ocean

D The water from the chamber returns to the basins so that it can once-again be used



WATER
PORTS AND NAVAL PROJECTS

Africa
America
Asia
Europe
Oceania

Client
Constantza Port Administration

ROMANIA

Port of Constantza

Project description

Works involved completing and renovating the southern and northern breakwaters of the Port of Constantza.

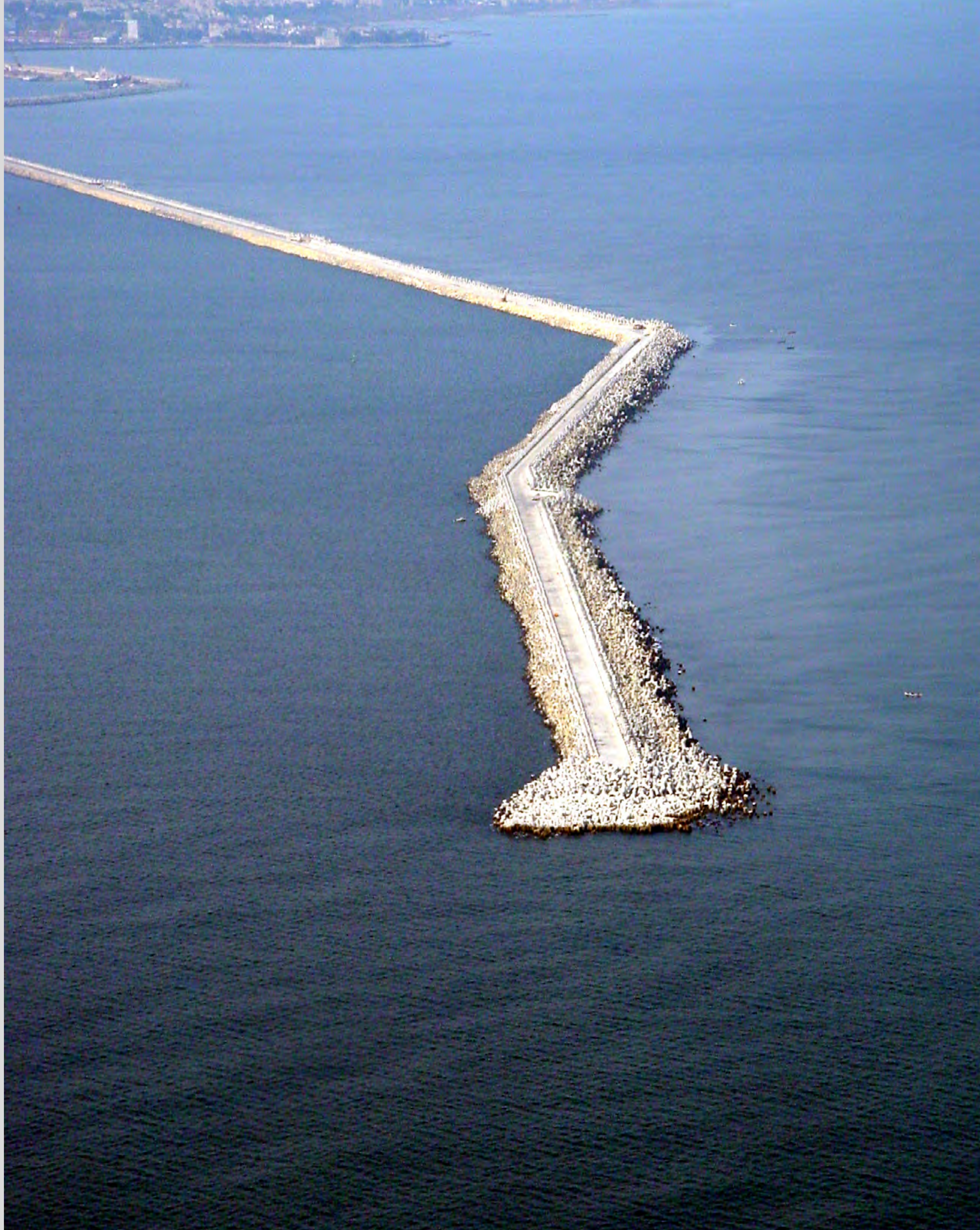
Repair operations consisted mainly of constructing the core using sorted quarry stone, of berms at the foot of breakwaters, with selected quarry material and 15 tonnes of Antifer cubes; of armour protective layers made of selected quarry material, of 7 tonnes of quarry blocks and 4.5 t and 25 t of “Stabylopod” units.

The total length of the two breakwaters is **12.8 km**. The northern breakwater is 7.3 km long while the southern one measures 5.5 km.

The rock material on the existing quays was removed with excavators, some installed on crane barges, transported by dumper trucks to a spoil area, then graded and stockpiled for future use.

Main Technical Data

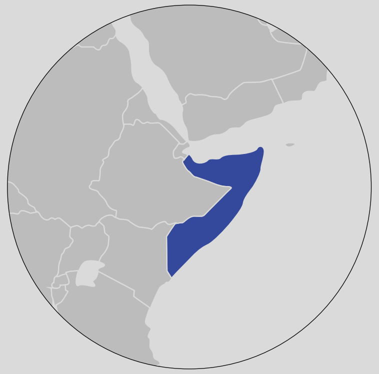
Quarry materials	670,000 m^3
Geotextiles	27,000 m^3
Antifer cubes (15 t)	16,230
Stabylopod units (4,5 t)	17,560
Stabilopod units (25 t)	20,040
Concrete	50,000 m^3



WATER
PORTS AND NAVAL PROJECTS

Africa
America
Asia
Europe
Oceania

Client
Ministry of Public Works – Mogadishu



SOMALIA

Port of Mogadishu

Project description

At Ras Sif, in an area that is heavily conditioned by the South-West monsoon, the works to build the port comprising a **930-m breakwater**, made of a protected rock material, towards the sea, by a series of natural reefs and by a double stratum of concrete tetrapods.

Two quays were built in deep waters. Each measured respectively 165 m and 525 m. A special 80-m long boarding wharf was also built. Underwater excavation and draining of 180,000 m^3 of material (of which 40,000 m^3 of rock) was also carried out.

9,000 concrete tetrapods and 1,000 prefabricated blocks of 100 tonnes were also built as specialized works.

Main Technical Data

Excavation, transport and rock	1,200,000 m^3
Excavation and sand transport from a borrow pit, at sea and on soil, to form the embankments	1,200,000 m^3
Underwater demolition and draining	180,000 m^3
Concrete volume	145,000 m^3

Jebel Ali M Station Dubai,
UAE

3.4 Water resource management

Fisia Italimpianti S.p.A., part of **Salini Impregilo Group**, is a worldwide leader in the sustainable design and execution of water treatment and desalination plants, with a production of about **6,000,000 m³/day** of treated water (1,332 MIGD).

The company, with over 90 years of experience worldwide, is one of the most competitive global contractors, offering advanced solutions in:

- **Water Desalination**
- **Water Treatment**
- **Sustainable Waste Management**
- **Water Desalination through Renewable Sources**

The company has contributed, in its years of activity, to creating new desalination technological standards by using innovative solutions. It has, in particular, built units of **MSF process plants (Multi Stage Flash) that are increasingly bigger**. This has brought benefits, both in economic and environmental terms, and better effectiveness. It has designed, built and put into function the largest MSF units in the world. Among these, **Jebel Ali M in the United Arab Emirates**. It has 8 units, each offering 17.5 MIGD and is at the forefront, when it comes to building desalination plants that function through reverse osmosis through membranes (RO).

The Group, among the Reverse Osmosis (RO) plants, is currently designing and building the **Shuaibah** desalination plant, in **Saudi Arabia**, capable of producing 250,000 m³/d and of providing drinking water to more than 1 million people in the cities of Mecca, Jeddah and Taif as well as Salalah in Oman with a capacity of 113.650 m³/day that will supply drinking water to the city.

Total desalination production achieved is more than 4,400,000 m³/day (1,000 MIGD) mostly delivered in the Middle East.

With Fisia Italimpianti, the Group is also active in **treating primitive water and wastewater.**

It can provide municipal wastewater plants, potable water treatment plants, remineralization and industrial water treatment plants, using the sector's state-of-the-art technologies.

Among the various purification plants built during the last 40 years in Europe, the Middle East, Africa and America, Nigeria's Sokoto and Santo Domingo's Barrera de Salinad plants, which can produce respectively 110,000 m³ and 350,000 m³ of drinking water each day, are worth of mention.

Among the works built in the wastewater treatment sector, Florence's San Colombano plant (whose capacity covers 600,000 inhabitants) and Turkey's Atakoy plant (with activated sludge), which will be able to treat up to 400,000 m³/day of wastewater in Instanbul.

Ras Abu Fontas,
QATAR

WATER
WATER RESOURCE MANAGEMENT

Africa
America
Asia
Europe
Oceania

Client
Dhofar Desalination Company SAOC

OMAN

Salalah Independent Water Project

Project description

Located in the Salalah area on the western Oman, the plant will be a RO seawater desalination plant for the production of 25 MIGD (113,500 MC / G) of drinking water.

Salalah Independent Water Project is the first plant that Fisia Italimpianti realizes in Oman.

The works include seawater intake, brine outfall and the new RO plant.

The plant is particularly innovative for the use of the technology of the DAFT (Dissolved Air Flotation) as pre-treatment and the technology of the Gravity Limestone Contactors as permeated post-treatment.

Main Technical Data

Process	Reverse Osmosis
Capacity	113,500 m^3/d (25 MIGD)
Unit	5 RO trains
Recovery	43%
Membrane type	Spiral wound
Pre-treatment	DAF, Gravity and Dual Media filters
Post-treatment	CO_2 and lime water injection

WATER
WATER RESOURCE MANAGEMENT

Africa
America
Asia
Europe
Oceania

Client
QEWC – Qatar Electricy and Water Company

QATAR

Ras Abu Fontas A1-B2 projects, Doha

Project description

Located in Ras Abu Fontas, at 10 km south of Doha, the Ras Abu Fontas (RAF) complex comprises powerhouses and desalination plants named A, A1, B, B1, B2, etc. These plants were built over 30 years knowing that the most recent powerhouse would provide vapour to the desalination units of each plant. Every desalination plant in the complex is a Multi Stage Flash (MSF) one.

The Group designed the B2 and A1 plants, also making them function. The first of these, can produce **30 MIGD** of water using two MSF units. The A1 project included the installation of three heat recovery boilers at the end of the three existing turbines. Also, three desalination units offering an overall capacity of **45 MIGD**. One of the greatest challenges was the long distance (2 km) between the source of the vapour and the identified position for the MSF units.

Building sections B2 and A1 guaranteed greater operational flexibility to the plant, reduced costs and environmental impact, optimizing energy, vapor and water production in the entire complex, and reducing the total quantity of fuel for the powerhouses.

Main Technical Data (A1 + B2)

Process	Multi Stage Flash
Capacity	340,000 m^3/d (75 MIGD)
Units	5 X 15 MIGD
Perf. ratio	9
Distilled Quality	50 microSiemens/cm
Top brine temperature	110° C

SAUDI ARABIA

Shuaibah 3 Expansion II, Shuaibah

Client
Shuaibah Two Water Development Project Company

Project description

Located in the Shuaibah area on the western coast of Saudi Arabia, the plant will use reverse osmosis technology to deliver up to 250,000 cubic metres of water per day, supplying potable water to more than one million residents in the cities of Mecca, Jeddah and Taif.

The plant represents the return of Fisia in the construction of large-scale desalination and reverse osmosis plants, today the most prevalent technology in this sector.

The works include seawater intake, brine outfall and the new RO plant, located within the existing industrial area.

Main Technical Data

Process	Reverse Osmosis
Capacity	250,000 m^3/d (55 MIGD)
Unit	10 RO trains Double pass
Recovery	40%
Membrane type	Spiral wound
Pre-treatment	Dual Media filters
Post-treatment	CO_2 and lime water injection

UNITED ARAB EMIRATES

Jebel Ali M Station, Dubai

Client
DEWA, Dubai Electricity & Water Authority

Main Technical Data

Process	Multi Stage Flash
Capacity	636,400 m^3/d (140 MIGD)
Unit	8 X 17.5 MIGD
Perf. ratio	9
Distillate Quality	25 microSiemens/cm
Top Brine Temperature	112°C

Project description

Jebel Ali M is an icon among the desalination sector: the project was the largest desalination plant in the UAE at the time of its completion.

It has a capacity of **140 million** gallons of water per day. The eight desalination units are among the largest in the world, each one producing **17.5 MIGD** (80,000 m^3 / day) of water. SW feeds the plant from the Gulf via complex and huge intake works, capable to provide the enormous SW flows necessary.

Jebel Ali M was nominated in 2014 for the **“Year Desalination Plant”** by the Global Water Awards, which rewards the most important achievements in the International Desalination Industry.

4 THE LEGACY

"SALINI IMPREGILO WAS FOUNDED IN 1906, THE RESULT OF A DREAM OF A GROUP OF SMALL BUILDERS, WITH ITS HEADQUARTERS IN ITALY, AND WITH A GRAND VISION: TO GROW BY BUILDING INFRASTRUCTURE THAT WOULD LAST OVER TIME, SYMBOLIZING PROGRESS FOR GENERATIONS TO COME, AND IMPACTING THE DEVELOPMENT AND HISTORY OF MAN."

Pietro Salini, CEO, Salini Impregilo

Salini Impregilo's story begins in Italy in 1906, with a great vision: to grow through the construction of large-scale infrastructure that would endure over time, symbols of progress for future generations.

It is a story of Italian "genius" and continue effort to grow. A story of many families and entrepreneurs who united to bring together the values symbolized by professional excellence and ethics. The Group's early years ran parallel with those of Italy, building infrastructure that accompanied the growth of our country. In the 1950s, the Group subsequently expanded into Europe and soon reached Africa, Asia and Oceania.

The excellence is narrated through epic works, including: the Abu Simbel temples (Egypt), Africa's dams (from Kariba to Ethiopia's hydroelectric plants), the metro systems of Paris, San Francisco, Copenhagen and Riyadh (which are redesigning sustainable mobility in some of the world's most densely-populated cities), Italy's "Autostrada del Sole" and its high-speed railway, that has facilitated the economic and social integration between the north and south of the country.

The Group has undergone a profound transformation: from its origins, as an Italian company of the first years of the 20^{th} century to today's global group.

This is the dream of many different generations of builders and companies, realized through a series of reorganizations and corporate transformation processes which, cumulatively, have come to define the Group in the modern era. More than a century of impossible challenges that have resulted in tangible solutions which drive forward the frontiers of technical and engineering excellence.

Over a century of history

The value of a Group lies also
in its history and origins

Mignano Dam
ITALY
1926

Viaduct of Recco
ITALY
1946

Akosombo Hydroelectric Plant
GHANA
1961

Katse Dam
LESOTHO
1991

Portland West Side CSO Tunnel Project
U.S.
2006

Tocoma Hydroelectric Plant
VENEZUELA
2007

Bumbuna Hydroelectric Project
SIERRA LEONE
2009

Mazar Hydroelectric Plant
ECUADOR
2011

Bujagali Hydropower Plant
UGANDA
2013

Sogamoso Hydroelectric Project
COLOMBIA
2015

1906 Girola and Lodigiani create their respective companies

1929 "Impresit" - Imprese italiane all'estero - is born

1936 Pietro Salini starts up his own activity

1956 Impresit, Girola, Lodigiani and Torno work together to build Kariba Dam

1959 Cogefar Costruzioni Generali Farsura S.p.A is established

1960 Impregilo S.p.A. (Imprresit - Girola - Lodigiani) is created

1982 100% of the American company S.A. Healy is bought

1989 Cogefar Impresit S.p.A is born from the merger between Cogefar S.p.A. and Impresit S.p.A.

1994 Impregilo S.p.A. is born from the merger among Cogefar Impresit, Girola, Lodigiani and Impresit Girola Lodigiani

1998 Impregilo S.p.A. acquires Fisia S.p.A. on 14th July

2009 Salini Costruttori purchases Todini S.p.A.

2014 Gruppo Salini Impregilo is born from the merger between the two companies

2016 Salini Impregilo acquires 100% of Lane Industries

1906 – 1910 – 1920 – 1930 – 1940 – 1950 – 1960 – 1970 – 1980 – 1990 – 2001 – 2002 – 2003 – 2004 – 2005 – 2006 – 2007 – 2008 – 2009 – 2010 – 2011 – 2012 – 2013 – 2014 – 2015 – 2016 – 2017 – 2018

1911
Simplon Railway Line
ITALY

1936
Morasco Dam
ITALY

1957
Val di Lei Dam
SWITZERLAND

1982
James Bay Project La Grande River Dam and Plant
CANADA

2002
Nathpa Jhakri Hydroelectric Project
INDIA

2008
Churchill Hospital Oxford
U.K.

2010
Beles Multipurpose Project
ETHIOPIA

2012
Ras al Khor Interchange
UAE

2014
Abu Dhabi Deep Sewer Tunnel
UAE

2016
New Panama Canal Expansion
PANAMA

Salini Impregilo S.p.A.
www.salini-impregilo.com
www.webuildvalue.com

Project coordination
Salini Impregilo Corporate Identity and Communication

Credits
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