
A large undertaking

5 December 2016

IWP&DC provides an update on construction work being carried out or recently completed at selected large dam projects across the globe

Large dam construction is currently underway throughout the globe, with a number of projects hitting the headlines – both in a good, and bad, way. Many projects are being lauded for helping to bring much needed power to energy thirsty regions, while others have been shrouded in controversy, particularly with respect to environmental impact studies. Below we take a look at how work is progressing on a number of these dams

Banja dam and hydropower plant, Albania

The Banja hydropower project located on the Devoll River in southern Albania was officially inaugurated at the end of September. Mott MacDonald, in joint venture with Coyne et Bellier of France, acted as owner's engineer on the scheme on behalf of developer Statkraft AS of Norway.

Banja, the first hydropower project to be completed in the Devoll cascade, has a clay core rockfill embankment dam measuring 940m long, 370m wide and 80m high. The reservoir will have a surface of 14km², an area comparable to 2000 football fields. With an installed capacity of 73MW from three Francis turbines, Banja will have an annual production rate of 256GWh.

As owner's engineer, the Mott MacDonald / Coyne et Bellier JV supervised construction of the scheme, provided project, commercial and quality management services and assisted with the delivery of commissioning under a licenced International Federation of Consulting Engineers (FIDIC) contract.

"Additional resources are required to meet the increasing demand of electricity consumption in Albania," explained David Cullen, Mott MacDonald's project director. "The inauguration of Banja is a key first step in the overall delivery of the Devoll hydropower project, which once complete will increase electricity production in the country by 17%, all through renewable, clean energy."

After supplying its first electricity to the grid at the end of August 2016, Banja is expected to be in full commercial operation by the end of October 2016 following testing and commissioning.

The power plant was opened on Friday (23 September) by Albanian Prime Minister Edi Rama and Statkraft CEO Christian Rynning-Tønnesen, together with Albanian Energy Minister Damian Gjijnuri and Norway's Ambassador designate, Per Sjaastad.

"This investment is a great example of the private interest and the public interest meeting at the same point. In this area alone, over 100 km of roads have been built, with some great engineering efficiency. Banja-Gramsh road has 14 bridges and one of the bridges, 520m long, is the second-longest bridge in Albania. Statkraft is an example to be followed by all other companies investing in Albania," Prime Minister Rama said at the opening ceremony.

In his speech, CEO Rynning-Tønnesen praised Albania for developing renewable and climate friendly hydropower, and also underlined the importance of completing the market reforms, deregulation and the creation of a power exchange in the country.

In total, the Devoll-project will have an installed capacity of 256MW, increasing the power generating capacity of Albania by 17%.

The construction of the second plant – the 183MW Moglice hydropower plant – is ongoing, with commercial operation planned in 2018. Even this part of the project reached a major milestone this week, as the river was diverted from the dam site, making it possible to start dam construction.

The total investment of the Devoll project is estimated to approximately EUR 500 million.

Grand Ethiopian Renaissance dam, Ethiopia

The 6000MW Grand Ethiopian Renaissance dam project is being built on the River Abbay (the Blue Nile) and will feature Africa's largest dam - a 1.8km long RCC structure. It was previously named the Millenium scheme. The project will feature 16 x 375MW turbines.

Being built by a team led by Salini Impregilo, the project's dam contains some 10,000,000m³ RCC and includes a 70m rockfill saddle dam. There will be two surface Powerhouses located immediately downstream of the dam at the right and left abutments accordingly, housing the schemes 16 Francis turbines.

In September, Egypt, Sudan and Ethiopia signed final the contracts for the project's technical studies, following a previous agreement made in March 2015 between the three countries to address cooperation, identify mutual gains and address water interests.

French consultancy firms BRL and Artelia have reportedly been contracted to carry out studies on water flow impact on the Nile, with law firm Corbett appointed to overlook the legal affairs of the process.

The project is reportedly around 70% complete.

Bakhtiari dam, Iran

The Bakhtiari Dam is an arch dam currently under construction on the Bakhtiari River within the Zagros Mountains in Iran. At a planned height of 325m it will be the world's tallest dam once completed and hold back the second largest reservoir in Iran after the Karkheh reservoir. The project will include a 1500MW hydropower station, and will also serve to extend the life of the downstream Dez Dam

The main purpose of the dam is hydroelectric power production and it will support a 1,500 MW power station. By trapping sediment, the dam is also expected to extend the life of the Dez Dam 50 km (31 mi) downstream.

Inga 3, DRC

Late July saw plans for the Inga 3 project in the Democratic Republic of Congo hit a major hurdle when it was announced that the World Bank Group has suspended disbursements of funding to the project, due, it says, to the Government of DRC's decision to take the project in a different strategic direction to that originally agreed in 2014.

On March 20, 2014 the World Bank's Board approved a US\$73.1-million grant from its International Development Association (IDA) for the Inga-3 Basse Chute (BC) & Mid-Size Hydropower Development Technical Assistance (TA) Project, consisting of Inga-3 BC development support (US\$47.5 million) and mid-size hydropower development support (US\$25.6 million). At the time of suspension, approximately 6% of total project financing had been disbursed.

The Inga component of the TA project aimed to finance a flexible suite of technical assistance, including strategic advice to the Government,

complementary studies, capacity building, and institutional strengthening. The IDA TA project aimed to support a government-led process for the transparent development of Inga-3 BC as a public private partnership. The World Bank Group is in a continuing dialogue with the Government about the implementation arrangements of the project, with the goal of ensuring that it follows international good practice.

In a statement, the World Bank Group said it remains committed to supporting the DRC in its efforts to provide affordable and reliable energy for its people and to drive sustainable sources of growth for its economy. Beyond the Inga project, it will remain engaged in the electricity sector in DRC by focusing on improving the performance of the State Utility SNEL, rehabilitating mid-size hydropower plants, increasing energy access, and continuing support to regional transmission interconnections.

Inga 3 is the first part of the 40,000MW Grand Inga project on the Congo River. The Inga 3 development would divert about one sixth of the flow of the Congo River into the Bundi Valley. A dam on the Bundi River would create a 15.5km² reservoir. Inga 3 does not include a dam on the Congo River itself.

How the suspension of funds will affect the project still remains to be seen, but we will be keeping a close eye on the situation at IWP&DC

Lower Kaleköy, Turkey

Back in June, Kalehan Genç Enerji Üretim awarded Pöyry the detailed design services assignment for the Lower Kaleköy Hydroelectric Power Plant and Dam in Turkey.

The assignment included the execution of the detail design for the civil engineering of the powerhouse, and structural reviews, including the roller-compacted concrete (RCC) dam, power intake and penstocks, piano-key weir spillway solution, diversion structures with two tunnels and bottom outlet.

The four projects at the Beyhan and Kaleköy cascade are being developed by the same private investors. The installed capacity of the Lower Kaleköy plant will be 500MW with an annual generation of around 1200 GWh. The detail design will be executed jointly with the Consortium partner Temelsu up to end of 2017.

"We are proud to be working on this landmark project. Ranked in the global top 10 of power generation engineering companies, Pöyry has a proven track record of delivering sustainable hydropower solutions around the world and improving client's return on investments," says Ernst Zeller, Pöyry's Regional Director for the Energy Business Group, Austria.

Site C, Canada

July marked the 1st anniversary since construction started on BC Hydro's Site C Clean Energy project in British Columbia, Canada - with significant construction made and the project on track for schedule, scope and budget.

The Site C Clean Energy Project is the third dam and hydroelectric generating station being built on the Peace River in northeast British Columbia. It is also the largest energy infrastructure project currently in the works across Canada. The project will supply 1100MW of capacity, and produce nearly 5100GWh of electricity annually. Work on the project will continue through peak installation periods in 2022 before a scheduled completion in 2024.

"Site C will provide British Columbia with a generational opportunity to secure a reliable source of clean, renewable and affordable electricity for the future," said Premier Christy Clark. "The construction of Site C is also providing economic benefits today — employing more than 1,000 B.C. workers, offering skills

training opportunities for young workers, and providing opportunities for businesses of all sizes.”

“Site C is a key component of our long-term plan to keep rates down by choosing the least expensive generation option available,” said Bill Bennett, Minister of Energy and Mines. “Like our heritage hydro assets, Site C will also maintain B.C.’s commitment to renewable electricity.”

The latest employment statistics for the Site C project show that there were 1547 total workers on the Site C project in May 2016, with 1223 workers from British Columbia (79%) including carpenters, truck drivers, crane operators, safety advisors and officers, general labourers, heavy-equipment operators, mechanics, electricians, worker accommodation lodge operations staff, construction supervisors, environmental workers, engineering consultants and office staff.

In May 2016, there were a total of 107 apprentices working on the project in a range of trades including carpenter apprentices, electricians, plumbers and floor-covering installers.

Site C is also bringing significant opportunities for small, medium and large businesses in the Peace region and throughout the province. To date, over 200 B.C. companies have been involved in Site C construction, either as contractors, subcontractors or suppliers.

Main civil works at the project began in June 2016, with work to include the construction of an earthfill dam, two diversion tunnels and a concrete foundation for the generating station and spillways.

The \$1.75 billion main civil works contract was awarded to Peace River Hydro Partners in December 2015. Its partners include ACCIONA Infrastructure Canada Inc., Petrowest Corporation and Samsung C&T Canada Ltd.

Xe-Pian Xe-Namnoy project, Lao PDR

Xe-Pian Xe-Namnoy Power Company's (PNPC) 410MW Xe Pian Xe Namnoy hydroelectric power project is located in the southern region of Lao People's Democratic Republic (Lao PDR). The project is estimated have an annual energy generation of approximately 1,860GWh.

PNPC is a joint-venture formed in March 2012 by SK Engineering and Construction (SK E&C), Korea Western Power (KOWEPO), Ratchaburi Electricity Generating Holding (RATCH), and Lao Holding State Enterprise (LHSE). SK E&C holds 24% stake in PNPC, LHSE 26%, and RATCH and KOWEPO equally own the remaining share in the project.

The project, which is estimated to cost \$1.02bn, is the first build-operate-transfer (BOT) project to be undertaken by the Korean companies in Laos.

The feasibility study for the hydroelectric project was completed in November 2008. Construction of the project began in February 2013 and commercial operations are expected to begin in 2018.

The Xe Pian Xe Namnoy power project is located on the Bolaven plateau, approximately 550km southeast of the capital Vientiane city of Laos. The project will be developed on a 238ha land leased for a period of 32 years.

The project includes the construction of three dams: Houay Makchan Dam, Xe Pian Dam, and Xe-Namnoy Dam along the Mekong River. It will consist of a large storage reservoir on the Xe Namnoy River, underground tunnels, shaft waterways, and an open-air powerhouse featuring four generator units (three Francis turbines and one Pelton turbine).

The Xe Namnoy reservoir will be 73m-high and 1,600m-long, and will have a capacity to store approximately 1,043 million cubic meters (MCM) of water. Approximately 1,000MCM of water will be collected from Houay Makchan and Xe Pian catchments and stored at the Xe Namnoy reservoir.

The power house, which is located at the base of the valley, will generate power using gravitational force of fall and flowing water from a height of 630m. The water will further flow through the tailrace channel and discharged into the Xe Kong River.

The Xe Pian Xe Namnoy project is the first major power investment in Laos by South Korean sponsors SKE&C and KOWEPO.

The project achieved financial closure in February 2014 and is financed through 70% debt and 30% equity. Debt financing of approximately \$737.5m is provided by a syndicate of Thai financial institutions including Bank of Ayudhya, The Export- Import Bank of Thailand, Krung Thai Bank, and Thanachart Bank.

SK E&C was awarded the engineering, procurement and construction (EPC) contract for the construction of the project, while KOWEPCO was awarded the operations and maintenance contract (O&M) for a period of 27 years. Ratch is responsible for the construction supervision of the project.

Tractebel Engineering was engaged as owner's engineer for the hydropower plant construction. KTB Advisory, Australia and New Zealand Banking Group, and the Export-Import Bank of Korea are the financial advisors for the project.

SK E&C awarded a civil works sub-contract to Right Tunnelling for the construction of high and low-pressure tunnels.

TEAM GROUP prepared the basic design and tender documents, along with the environmental impact assessment for the project. ATT Consultants were engaged for designing the transmission system model, which will enable the transfer of power to Thailand.

AF Consult was engaged to conduct pre-feasibility and feasibility studies, engineering for basic design and tender documents, environmental and social management aspects, and to provide support services for finalising the concession and power purchase agreements.

Lower Subansiri, India

The 2000MW Lower Subansiri hydroelectric power project (LSHEP) is located on Subansiri River, on the border of Arunachal Pradesh and Assam states. The project is being developed by the state-run National Hydro Power Corporation (NHPC).

The construction of Lower Subansiri started in 2005 and was due to be completed in 2010. However, the project has been plagued by delays due to stiff opposition over its potential environmental impact.

In early 2013, the project was more than 50% complete, but the construction works had been stalled from then for an indefinite period because of strong resistance. The LSHEP will be the single largest hydroelectric plant in India when completed.

The Lower Subansiri HEP is designed as a run-of-the river power project on the lower reach of Subansiri River, a tributary of River Brahmaputra. River Subansiri flows from Arunachal Pradesh into Assam where it joins the Brahmaputra.

The project consists of a concrete gravity dam, which will be 116m high from the river bed level and 130m from foundation. The length of the dam will be 284m. The gross storage capacity of the reservoir will be 1.37km³.

The power house will be equipped with eight 250MW Francis turbines located on surface on the left bank of the river. It will also have eight horse shoe shaped head race tunnels (diameter 9.5m and length varying from 608m to 1,168m), eight horse shoe shaped surge tunnels (diameter 9.5m and length varying from 400m to 485m) and eight circular penstocks (diameter varying between 400m and 485m, and length between 7m and 9.5m).

A tail race channel (35m long and 206m wide) will take the water discharged by the turbines back to the river.

The construction contract was awarded by NHPC in December 2003, but the construction did not commence until 2005 because of delays due to land allotment issues.

The diversion of the river was completed in April 2007, after which the excavation works were carried out. The dam was, however, subject to redesign in October 2008.

The construction was further suspended for five months in 2009 because of monsoon season. By November 2011, the dam excavation and associated tunnelling works had made good progress. However, the construction was halted in December 2011 because of protests.

By December 2012, approximately 55% of the project was complete. The excavation of the dam and the power house had been finished, with only the concreting work left. The diversion tunnel of the river was also complete.

In addition, around 60% of the hydro-mechanical equipment and 95% of the electro-mechanical equipment for the project had been supplied by December 2012.

A contract worth INR10.98bn (\$202m) to build the dam and associated structures was awarded in December 2003 to a consortium comprised of Boguchandgesstroy, Soyuzgidrosptsstry and Soma Enterprise.

In January 2004, the Engineering Construction & Contracts (ECC) division of Larsen & Toubro was awarded an INR9.2bn (\$169m) contract for the civil and structural work related to water diversion, tunnelling and the power house.

Alstom (now GE) was contracted to supply the turbine and generator sets of the hydroelectric power plant in April 2005.

Texmaco was awarded a contract worth INR2.96bn (\$54m) in June 2006, for supplying the complete hydro-mechanical package for the power plant.

Resistance to the ongoing hydroelectric project has taken the form of a far-reaching anti-dam movement. It is alleged that the dam is located in a seismic zone but it is significantly under-designed to resist earthquakes. The fluctuation of water level in the river is also feared to affect the ecology in the lower Subansiri region in future.

The project has displaced 38 families, but it is claimed that it will displace many more people residing downstream of the project because of ecological changes endangered by the project. The project is also alleged to affect cultivation and cattle graze in the downstream area.

In December 2012, NHPC set up an independent dam design review panel to facilitate the progress of the project while taking into account the issues advanced against the dam from different quarters.

Since then there has been little news from the dam, but in August, NHPC told local media in India that it hopes the project will be back on track soon. The company said that all the concerns raised by various groups have been

addressed and mitigated, and stated that it has taken into account all safety parameters.

A tribunal hearing on the project was underway as we went to press but we will keep you updated on any news online and in print.

Daivoes dam, Portugal

A consortium led by Ferrovial Agroman and including local company MSF has been selected by Iberdrola to build the Daivoes dam and hydroelectric plant on the Tâmeга river, in northern Portugal.

Expected to cost over EUR 90 million and be completed by 2021 the project includes construction of a 77.5m high and 264m long concrete arch-gravity dam together with a power plant housing two turbines with a total installed capacity of 118MW.

Ferrovial will also build a 388m tunnel to divert the river, and a weir 71m long and 10.5m high, located 2.2km downstream of the dam.

Daivoes is the first of four main contracts to be awarded by Iberdrola as part of the Tâmeга river hydroelectric project and is the second to be executed by Ferrovial Agroman for the utility in Portugal in the last two years, following its involvement in building the penstock for the Gouvaes hydroelectric plant and the inspection galleries in the Alto Tâmeга dam.

Bagatelle Dam, Mauritius

The Bagatelle Dam in Mauritius is expected to be completed in 2017. The project features a 2.5km long dam which has the following features: an earthfill section (clay core and random fill) for the low section of the dam (H < 30 m approx.) located on both banks; a rockfill section with central clay core (H = 47 m approx.) in the central part of the dam; a concrete tower integrating all appurtenant structures such as the intake, the bottom outlet and a morning glory spillway (capacity 450 m³/s) with a gallery under the rockfill dam; and an appropriate cut-off wall with associated grouting works into the foundation.

Artelia Group was involved in the project's inception, expert review and design, and is also responsible for construction supervision. Bauer Spezialtiefbau installed a diaphragm cut-off wall 2.4 km long (56,781 m²) with rock embedment. The soil contains in parts very hard basalt – approximately 20,000 m² slightly to medium weathered basalt had to be penetrated along the complete new dam structure. In the central dam area, up to 28 m deep heavy basalt layers had to be removed to construct the cut-off wall in the required depth. For the project, five duty-cycle cranes of the type MC 64, MC 96 and MC 128 with three trench cutter BC 40 and two grabs were deployed.



Construction work underway on the Grand Ethiopian Renaissance Dam. Image courtesy of Salini



*Banja dam and
hydropower plant,
Albania*



*Artist's impression of
the Site C project in
BC, Canada.*

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