LAHMEYER INTERNATIONAL

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Switzerland:
Overall Rehabilitation of Hydroelectric Power Plants

Cyprus:
Extension of Power Plant and Optimised Operation

Mali:
Rural Electrification

Kosovo:
Water Supply and Sewerage in Prishtina

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Garri 4 Power Plant in Sudan

Garri 4 power plant with a total capacity of 2 x 50 MW is fired with sponge coke – a waste product from the neighbouring refinery. The circulating fluidised bed boiler (CFB) is an excellent economical and ecological technology to use sponge coke as a fuel. The plant consists of two CFB’s burning sponge coke at a temperature of about 930 degree Celsius. The produced steam actuates the steam turbine generators for electric power generation. The electric power will be transferred into the electric grid via a 220 kV substation. The Garri 4 power plant is scheduled to be in operation in 2009.

Masthead

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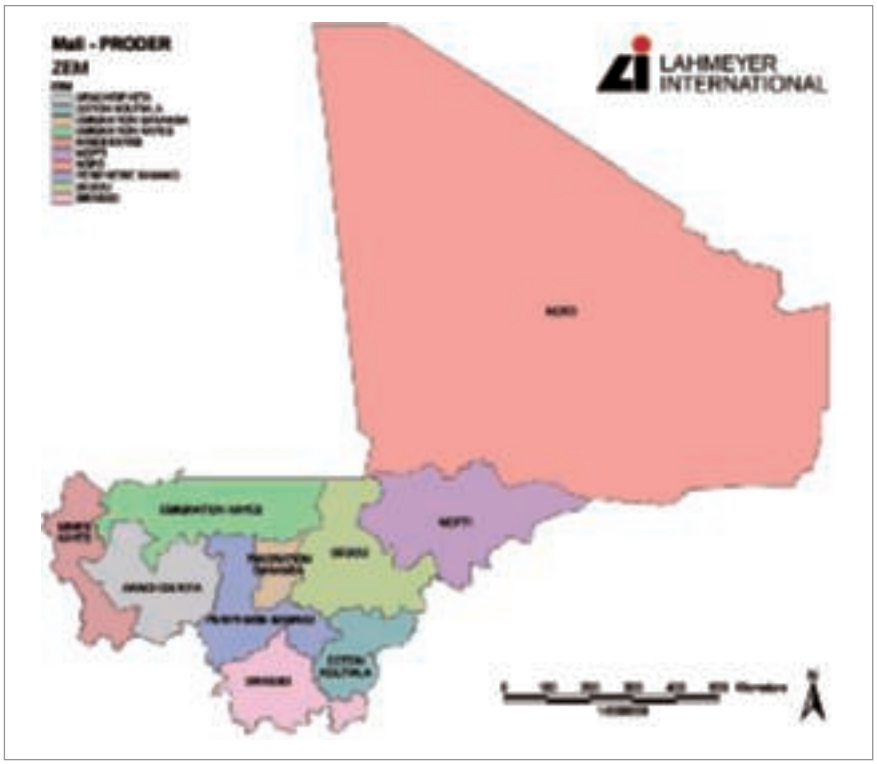
MALI

Rural Electrification in Mali



The master plan devides the country into 10 zones. In each zone one or several concessions for rural electrification shall be awarded to private investors.

Mali is one of the poorest countries in the world. The country's underdeveloped electricity supply infrastructure shows this clearly. Only about 15 % of the population has access to electricity which is, however, mainly restricted to the capital city, Bamako, and a few Malian cities of significant size. 80 % of the Malians live in small villages situated in the rural regions of the country where the electrification rate amounts to only 2–3 %.

The Government recognized the nationwide electricity supply of Mali as an important element for the country's economic development and for poverty reduction. Since the Government does not have the necessary funding it strongly relies on private investors. Yet, the latter must be given financial aid, too, in order to make profitable the investments into the electricity supply of regions with poor infrastructure where potential clients have a meagre income.

Therefore, in addition to the Malian utility EDM (Energie du Mali), the AMADER institute (Agence Malienne pour le Développement de l'Energie Domestique et de l'Electrification Rurale) was created under the supervision of the responsible Ministry. Its task is the implementation of new concepts for the development of regional electricity networks in Mali's spacious rural regions.

The AMADER, with the assistance of the World Bank, already set up numerous programs for rural electricity supply concepts based on privately operated sub-networks or isolated networks. This resulted in over 100 privately operated local electricity supply networks. However, these projects were not subject to a comprehensive strategy with the aim to achieve full coverage electricity supply.

In this context, Lahmeyer International recently conceived a master plan for the rural electrification of Mali, which was ordered by the Malian Ministry for Energy and Infrastructure and financed by the African Development Bank. According to the master plan the country has been divided into 10 zones. In each zone one or several concessions shall be awarded to private investors.

Today, in the frame of another project which was financed by the KfW, the first concessions got off the ground for two of the zones. Therefore, in the first phase of the project, a study was worked out in order to determine the technical and commercial conditions of such a concession with the AMADER and to inform potential investors accordingly. Hence, for example the geographic position of the eligible villages were recorded by a geo-

Village in Mali.

graphic information system (GIS), maps of the villages drafted, the local institutions and commercial activities listed, and the pecuniary circumstances of the inhabitants and their savings potential as regards candles and oil lamps identified. The final objective was to calculate the potential buying power and willingness to pay for electrical power. A list with villages was drafted which should be electrified in the context of a first priority program, and the technical parameters for three different options were determined:

- Next to existing medium voltage lines of EDM: realisation of a medium voltage network for one or a number of villages, supply to the end users via pole-mounted transformers, low voltage lines with integrated street lighting and connections of the subscribers. The network will be fed by the EDM power grid. The concessionaire will become EDM's client.
- Away from existing transmission lines with relatively dense population: instead of obtaining power from EDM's medium-voltage power grid the concessionaire will install own diesel generators ranging from 25 to 250 kW at a maximum.
- Sparse population: in this case no electricity supply networks will be constructed but the individual households will be supplied by battery backed PV installations with a capacity of 50 – 150 Wp.

The second phase of the project started with the tendering of the concessions for the two regions of Mopti and Ségou. The tender documents included a model for a business plan in the form of an Excel spreadsheet. By entering the investment and consequential cost, credit terms, number and type of subscriber's connections, as well as the subscriber tariff to be agreed upon with AMADER, the financial model permits to calculate the project yield and the investor's necessary equity capital.

Lahmeyer International provided significant assistance to the selection process of the candidates for the two concessions by the above described and other activities. In August 2009 the project was completed after the successful contract negotiations between AMADER and the new concessionaire, an Indian-Malian consortium.

Stefan Bollé

Mauritania

Extension of the 20 MW Diesel Power Plant in Nouadhibou

Concrete works at the fuel farm.

Machine hall extension.

In the LI aktuell edition No. 51 dated February 2006 the rehabilitation and extension project of SOMELEC's 20 MW diesel power plant in Nouadhibou, Mauritania, has already been reported. After finalisation of the concept study for the rehabilitation and extension of the plant (end of 2005) LI prepared by mid 2006 the tender documents. The rehabilitation and extension of the plant were tendered in two separate lots. The tender documents could be purchased by interested bidders in September 2006. In November 2006 SOMELEC received two bids for the extension and one for the rehabilitation lot. Due to budget constraints the client decided to pursue only the plant extension. The essential rehabilitation works (diesel gensets) were awarded by SOMELEC in several separate maintenance contracts outside the project.

Both bids for the extension were evaluated. Two clarification rounds were undertaken to complete and to clarify the bidder's offers in line

with the tender document requirements. One bid could not be further considered since it remained substantially non-compliant with the tender documents. This situation made the contract negotiations held with the remaining bidder in October 2007 difficult. The negotiations were successful and the signed contract became effective after the signature by the Mauritanian Prime Minister.

The contract term for the implementation of two 11 MW heavy fuel oil operated medium speed (500 rpm) four stroke diesel generator sets including auxiliary systems, an entirely new fuel storage and supply system and ancillary works is 21 months.

Detailed Engineering will be presumably completed with some months delay by September 2009. The civil works started in October 2008, but lie behind schedule due to material and personal shortage at site. The anticipated project completion delay will be four to five months.

Both 15 MVA medium voltage step-up transformers, the alternators and the diesel engines already underwent successfully the respective factory acceptance tests and were released for shipment.

After their commissioning beginning of 2010, both diesel generator sets will cover the entire electric load from Nouadhibou. Only three out of four existing diesel units from 1978 are operational with reduced capacity. These units, which have each clocked more than 120,000 operation hours, are taking the electric load from Nouadhibou only under severe technical problems until the new units are operational. Thereafter, these units will be used as reserve and only operate partially when the new units are in maintenance.

It is planned to replace in the future the existing diesel units one by one according to the growing electric power demand of Nouadhibou.

Samuel Karres

The Hashemite Kingdom of Jordan

Concept- and Feasibility Study for Jordan Energy and Mining Limited

Jordan Energy and Mining Ltd. (JEML) has signed a Memorandum of Understanding (MOU) providing the right to develop the Al Lajjun Oil Shale Project in the Hashemite Kingdom of Jordan. JEML is a company that specialises in the mining and processing of oil shale in the Hashemite Kingdom of Jordan. JEML is based in the United Kingdom. The Project mainly consists of:

- an oil shale mine,
- a retorting and oil upgrading plant, and
- a power plant.

Lahmeyer International GmbH (LI) was engaged by JEML as a Specialist Consultant to undertake in the first phase a concept study and subsequently a bankable feasibility study for the implementation of the power plant of the Project.

The Project will be located about 120 km south of Amman and 15 km to the east of Karak in an arid desert region towards the centre of Jordan. The power plant shall supply energy to the Project plants as well as to the 132 kV Jordanian national grid.

The concept study for the implementation of the Al Lajjun power integration and generation facility was conducted by LI in the year 2007. The technical and financial feasibility of an oil shale fuelled Circulating Fluidised Bed Combustion (CFBC) boiler based power project with a net capacity between 100 MW and 300 MW electrical net

Oil shale and overburden.

output was also evaluated. The concept study includes:

- the identification of technical alternatives,
- the proposal of the most adequate technical concept,
- a financial evaluation with estimates of capital costs and operational costs, and
- the provision of views on the general suitability of CFBC boilers for burning oil shale.

The concept study further highlights areas for which a deeper insight is advisable, and where detailed studies are recommended to be performed in a subsequent step.

In a later phase, JEML retained LI again in the year 2008 for the preparation of the feasibility study for the same Project. Depending on the possible available fuel types, two power plant options have now been taken into account in the feasibility study. Accordingly, the two power plant options considered differ in the technology used. Option 1 considers a steam power plant with CFBC boiler, based on the results of the concept study, and Option 2 considers a gas turbine power plant in either simple cycle or combined cycle operation.

A combined cycle power plant (CCPP) was identified as the most suitable power plant technology for the Project. The main fuel is a purified high hydrogen-content gas (sweetened gas), a by-product from the oil shale retorting plant with a relatively low heating value. Natural gas from the Jordanian gas grid will be used as startup fuel and backup fuel.

Taking into account the specific Project parameters, particularly the available fuel, a conceptual design for a 70 MW CCPP has been elaborated. The base case consists of one heavy-duty gas turbine, one supplementary fired heat recovery steam generator and one steam turbine.

LI's services for the feasibility study mainly comprised:

- the identification of the optimised technical power plant concept,
- the review of the basic project parameters and conditions,
- the power plant conceptual design and the implementation study,
- the specification of the grid study,
- the estimate of capital costs and operational costs,
- a financial model and tariff calculations, and
- the preparation of a tentative project implementation plan.

Michael Duerr

Thailand

Privately Financed Power Plant Rojana

Rojana Power Company Limited ("Rojana Power") is a Power Producer operating under the Small Power Producers Regulation of Thailand. The Combined Cycle Power Plant is located at the Rojana Industrial Park ("Park") in Ayutthaya Province, approximately 75 km north of Bangkok.

The co-operation between Rojana Power and Lahmeyer International GmbH ("LI") started in 1997.

Phase	Capacity	COD
1	122 MW (2 Gas Turbines + 2 HRSG + 1 Steam Turbine)	1999
2	43 MW (1 Gas Turbine + 1 HSRG)	2003
3	43 MW (1 Gas Turbine + 1 HSRG)	2006
4	60 MW (1 Gas Turbine + 1 HSRG + 1 Steam Turbine)	2009

Rojana Industrial Park Ayutthaya.

One part of the guaranteed power output of the Plant is transmitted to the Electric Generating Authority of Thailand ("EGAT") under the EGAT Power Purchase Agreement dated 19 December 1997. The remaining capacity is utilised to supply power to adjacent off takers ("Industrial Users") located in the Park. In addition process steam is taken from the HRSGs and delivered to Industrial Users in the Park.

LI acts for Rojana as Owner's Engineer since the first installation for the power supply to the Park. The tasks of LI were to review and verify the EPC contract, the design study and the Testing criteria.

Furthermore, LI supervised the site erection, the plant commissioning and the testing activities on site.

One challenge in the various phases was to incorporate additional steam production into the existing system and to utilise it partially in the existing steam turbine.

The extension Project Phase 4 was completed successfully in February 2009 and increases the plant capacity for reliable supply of the complete Park with power and steam.

Adil Errouzi

Rojana Phase 3+4

SUDAN

Garri 4 – Sponge Coke Fired Power Plant 2 x 50 MW

NEC/LI Co-operation

In a time of political and economic isolation the Sudan national energy industry developed continuously according to planning.

New investments on the power plant sector were expedited and the power distribution grid was developed. Lahmeyer International (LI) contributes substantially to this success.

The co-operation of the National Electricity Corporation (NEC) with Lahmeyer International (LI) started in 1978 with the building of diesel power plant Burri in Khartoum, and continued more than 31 years with the successful implementation of many projects. Currently other investments are in the planning stage which will be realized during the next years. From this long co-operation a close and friendly relation has developed which includes all hierarchy levels in both organizations. Unrestricted mutual confidence has become the basic presupposition for our good and successful co-operation.

View of Garri 4 with coal transportation.

Preparations of the project

The power plant Garri 4 is an important milestone for the Sudanese energy industry, because it introduces the changeover from oil-fired to carbon-fired boilers. With the power plant Garri 4 the first circulating fluidised bed boilers on the African continent were established. “Sponge Coke” a waste product from the neighbouring refinery is burned.

After preliminary investigations and studies LI has elaborated the Tender Specification Documents for this project. The EPC contract was assigned to the China National Machinery & Equipment Import & Export Corp. (CMEC) in December, 2004.

The design was carried out from 2006 till the beginning of 2008 by

CMEC and was approved by LI. During this period 27 design meetings have taken place altogether in Sudan, China and Germany.

Implementation and Commissioning

The site activities started in February 2007. The contractors fulfilment of his obligations have had to be strictly monitored and controlled. The scheduled time of construction could not be kept due to problems of planning and delivering of the suppliers.

The power plant consists of two circulating fluidised bed boilers with a capacity of 240 t/h steam with a pressure of 9.81 MPa and a temperature of 540 °C each.

Each steam turbine generator produces with a steam flow of 219.5 t/h and fresh steam parameters of 8.83 MPa and 535 °C in each case a nominal output of 50 MWel.

The whole plant is automatically controlled and supervised by a modern and proved control system of the type OC 4000. This system allows the direct presetting of the power per unit from the load dispatch centre in Khartoum.

Taking into account the customers demands for the high voltage connection the establishment of the outgoing power supply was a big challenge. Two 220 kV bus bars were linked to the neighbour power plant Garri 2 by a 740 m terminal tower arrangement with 39 supports and one bus bar sectionaliser.

These works were additionally complicated because the 220 kV grid of NEC was in operation during the entire works on site in order to serve the power output for Garri 1 and 2. Likewise the protection concept had to be adapted for the existing and the new bus bar protection before energisation.

View of the turbine hall behind the substation.

The Garri 4 power plant could only be sufficiently served via this high voltage connection.

The commissioning of both power plant blocks could begin therefore only after the energisation of one of the two 220 kV transformers.

Subsequently the main components were tested successfully like boiler feed water pumps, cooling water pumps, ID fan, primary and secondary air fans.

In July 2009 the first block was connected to the national high-voltage grid for the first time.

The Garri 4 power plant is technologically considered as a challenge for the Sudanese personnel. Based on the multiplicity of the complex subsystems this project requires a much higher level of education and a deeper process understanding with the local engineers and technicians than with the power plants pursued up to now in Sudan.

At present NEC prepares their selves with a team of approximately 120 engineers and technicians for the future operation and maintenance tasks.

Hence the Garri 4 power plant represents a considerable experience for NEC with special importance for the design, the implementation and the operation of other coal-fired power plants.

Werner Hils,
Burkhard Hofrichter

Bulgaria

Photovoltaic Market Study

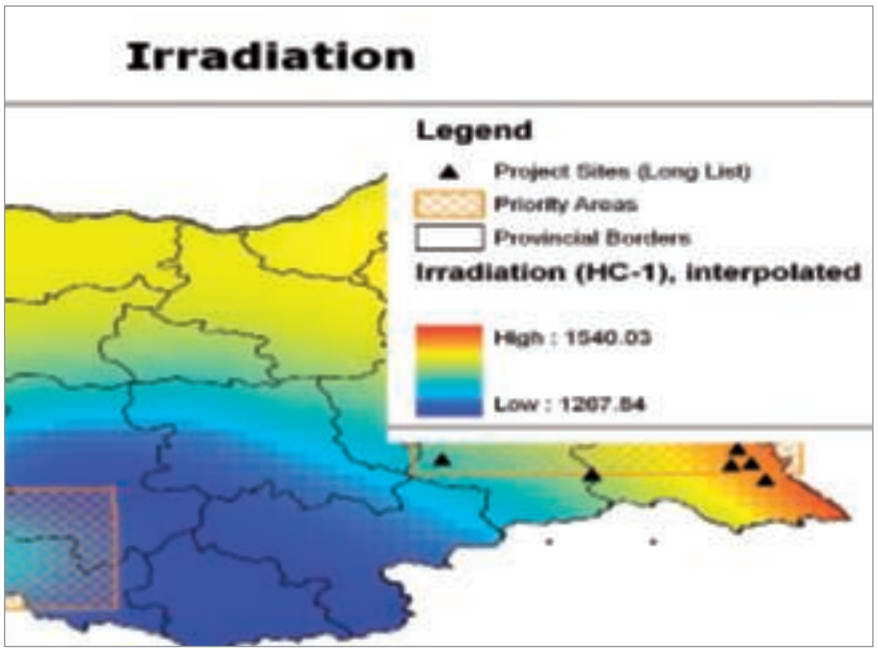
A common procedure for the identification of potential PV projects is a plot by plot approach focused on land availability, i.e. through site visits or offers from land owners or agents. Although practical and proven, this approach does not guarantee the optimal resource allocation and can be extremely time-consuming especially for large scale plants. It is limited to only few criteria and possibly

leaves out more suitable and lucrative options since they are simply unknown. Other determining factors are the solar irradiation, available feed-in capacity of the power grid, fragmentation of land ownership, acceptance by local authorities and community.

These factors were considered when LI conducted a selection process of priority regions and sites for a large scale entry into a new PV market for a European energy group. The aim of the underlying study was the creation of a multi megawatt portfolio based on a comprehensive analysis covering technical, economic but also political issues on national as well as local level.

To achieve the above mentioned objective, a combination of top-down assessment as well as bottom-up analysis was applied. The top-down elements include the countrywide assessment of solar resources, as well as the consideration of technical and legal restrictions. By means of an iterative approach this was combined with bottom-up investigation to include practical experience, e.g. from interviews with project developers and other market players and extensive assessment of pre-developed sites. Thus the previously selected countrywide data could be verified and complemented.

In a first step of narrowing down the potential regions for PV projects a countrywide assessment of solar resources based on three solar resource data sets was conducted. By this means selected solar priority regions more than 60 % of the Bulgarian territory could be excluded as less suitable for further investigation. For the remaining area more criteria were applied to further narrow down the eligible area. On the one hand there are restrictions which are obstacles for the development of PV power plants. These can be physical restrictions such as swamp lands and slope, or legal restrictions, for example military zones and protected areas. On the other hand there are supporting indicators such as land cover indicating for example low land prices or high unemployment rate indicating probable local support. The existing infrastructure or the lack of it (especially of the power network and roads) could similarly restrict or support the PV development. Based on this information the area of priority region could be substantially narrowed down and locations identified where on-site investigations were promising.



Calculated relative difference between two different solar irradiation data sets.

Finally two priority regions were recommended. Within these regions priority sites were identified carrying out a ranking of sites through a special criteria catalogue. Along this selection process ten most suitable sites out of more than 24 visited locations were determined. From this 'long list' five sites with a variety of region, project developer and status of project were highlighted. One most suitable site was recommended for fast implementation and good profitability.

Parallel to the countrywide resource assessment and selection process the policy and market towards renewable energy sources in general and PV in particular were analysed whether they actually provide suitable conditions for long term investments. This also included the analysis of the legal framework for large scale PV power plants contributing a step by step plan of the complete permitting procedures with respective time requirements as well a flow diagram to show the interrelation of the multilayer legal process.

Process and criteria for selection of priority regions.

The market entry study concluded with a financial analysis of all short-listed sites providing key financial figures such as internal rate of return and payback period. Previously rated and estimated attributes were incorporated in the analysis as far as they could be monetized. The analysis also considered additional revenues due to the potential qualification as Joint Implementation project under the Kyoto Protocol. The presentation of the short and long-listed sites were accompanied by short term recommendations for their implementation and long term recommendations for the overall market entry.

Karsten Schmitt, David Lecoufle, Holger Zebner

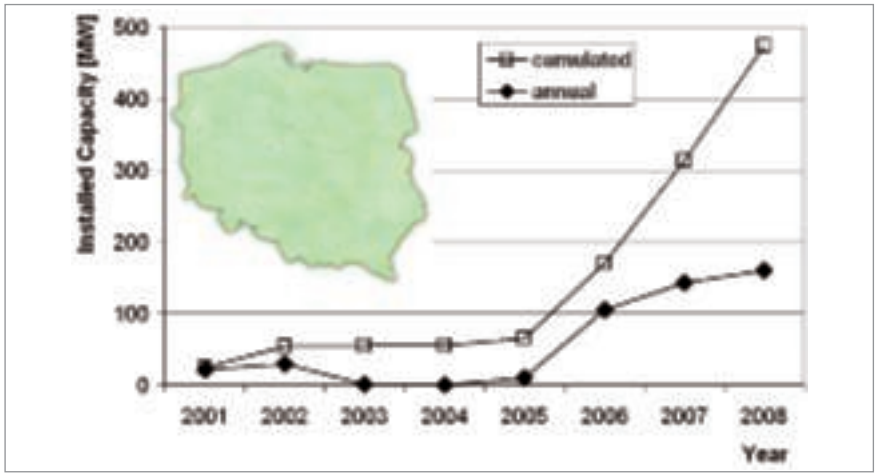
Sample location for large scale PV plant in eastern Bulgaria.

Poland

50 MW Wind Farm in Tychowo

Lahmeyer International GmbH was appointed by the Banco Millennium and European Bank for Reconstruction and Development (EBRD) as Technical Advisor to implement the 50 MW wind farm in Tychowo. This wind farm, an investment of renewable energy investor RP Global, is one of the largest ones in Poland so far.

Tychowo wind farm is the first construction project of LI's Wind Energy Department in the promising wind energy market in Poland. The installed capacity in 2008 in Poland amounted to approximately 470 MW. The generated electricity out of wind increased between 2004 and 2008 by more than 500 %, representing approximately 0.5 % of Poland's electric energy consumption. Before the financial crisis began to inhibit the actual economical growth, the Polish government estimated 2000 MW to be installed by 2010 to achieve 2 % to 3 % share of electricity generation out of in the domestic energy consumption. To reach this goal, about 750 MW need to be installed annually.



Development of wind energy capacity in Poland.

LI's activities for this project began in 2008 with the elaboration of a due diligence study. Since the autumn of 2008 the financial crisis and the uncertainty of markets postponed the credit agreement negotiations. Finally, the financial closing, in which LI also participated as Technical Advisor, was concluded in May 2009. In this month LI entered the task of construction monitoring.

The wind farm of Tychowo is located in the north-western part of Poland, approximately in 20 km distance to the Baltic Sea coast. The project consists of 20 turbines N90 2.5 MW type of Nordex. The balance of plant (BoP) work was assigned to several Polish civil, electrical and telecommunication companies. In order to connect the wind farm to the national grid, a construction of a 30/110 kV substation as well as a 10 km overhead line were necessary. The works are being executed without delay and the start of the commercial operation is foreseen by the end of 2009.

Within the scope of the advisory services to the financing Banks, Lahmeyer International is responsi-

Tychowo wind farm in Poland.

ble, among others, for monitoring the overall construction process and the relevant part of the project budget, inspecting the site on a regular basis as well as reporting and consulting on project implementation.

Due to the successful settlement of the Tychowo project, Lahmeyer International was appointed to execute comparable work in connection with three further Polish wind projects of the Portuguese developer Martifer. Our activities for these projects will start in the autumn of 2009 with due diligence services and will be followed later by construction and operation monitoring. The client in that case is a bank consortium of Société Générale, Banco Esprito Santo and European Bank for Reconstruction and Development.

Ewa Zimmermann

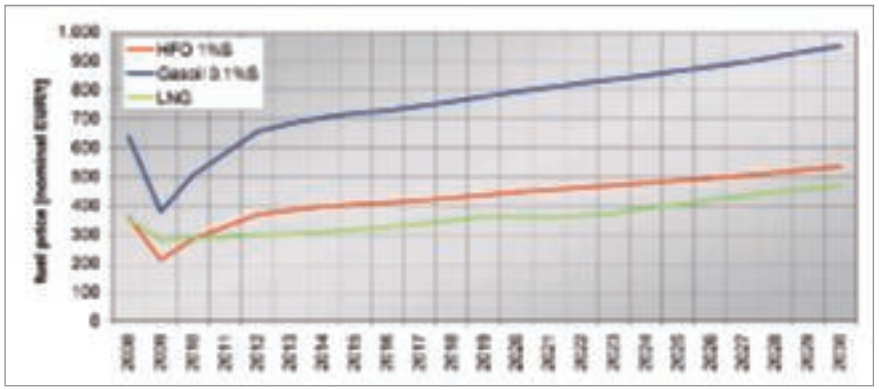
Cyprus

Strategic Power Plant Expansion and Optimised Operation (of Power Plants)

Due to not existing own primary resources, the Cypriot electricity sector entirely depends on the import of fossil fuels. Although potentials for renewable energies (especially biomass, wind power and solar radiation) are remarkable, they have only been used to a minor degree up to today.

According to an estimate of the Ministry of Trade, Industry and Tourism (comparison: projected net generation approx. 5,500 GWh/a) renewable energies will contribute only 8 GWh to the total energy supply in 2009 with an installed total generation capacity of 3 MW.

The Cypriot energy supplier, the Electricity Authority of Cyprus (EAC), faces the challenge to harmonise expansion and rehabilitation of its power plant facilities in a cost optimised way obeying the energy and environmental objectives of the EU.



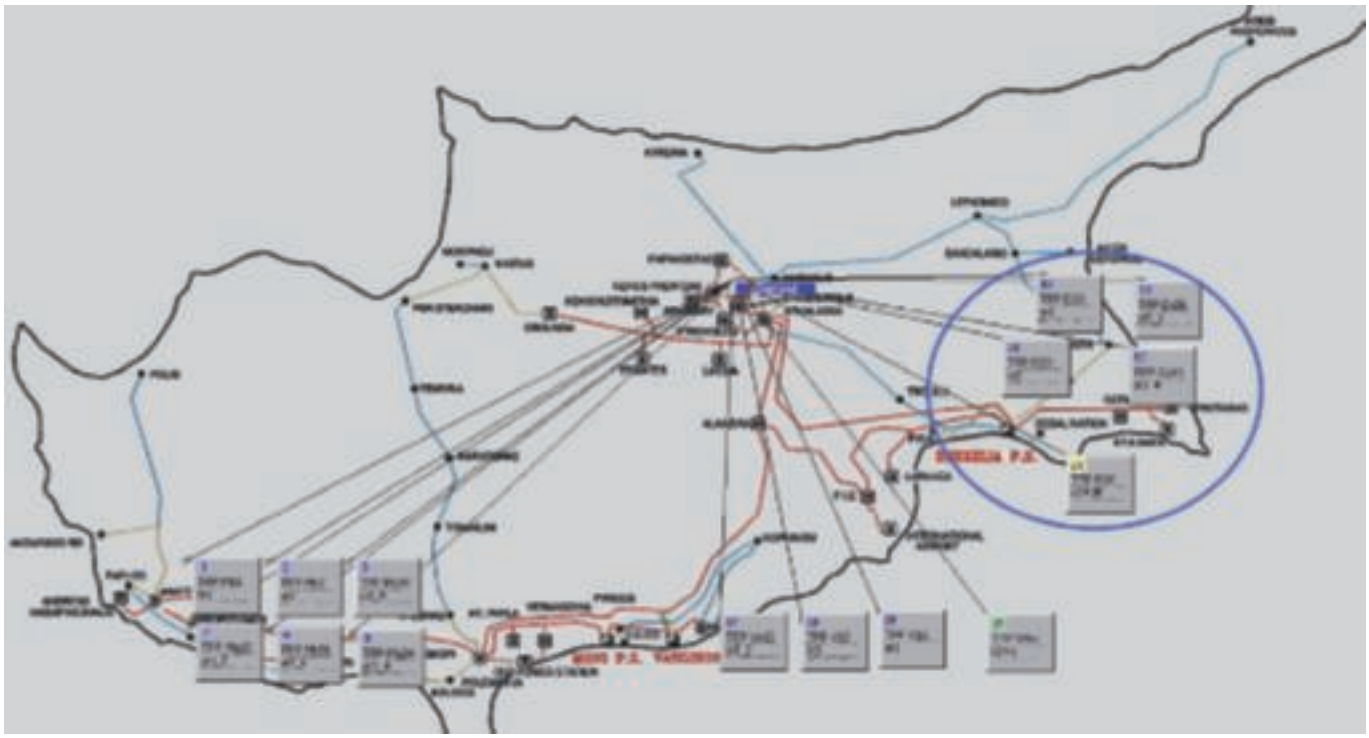
Forecasted price development of heavy fuel oil, gasoil and liquefied natural gas in EUR/t.

In May 2009, Lahmeyer International (LI) has been awarded the contract for the elaboration of this expansion plan.

Within the Energy Division this project is carried out by the Department Economics & Energy Efficiency.

In cooperation with other departments the following work packages have been defined:

- the analysis of fuel price development in the Mediterranean and the projection of future trends;
- the demand forecast of electricity as well as load characteristics of important consumer segments;
- the evaluation of appropriate power supply candidates in respect to technical and eco-



Simulation of the Electricity Generation System of the EAC – User Interface sxPLAN.

nomic as well as regulatory and environmental aspects;
- the simulation of the energy supply system for the period 2009–2030 and the elaboration of the optimal expansion strategy.

In the context of medium and long term planning for the strategic development of the conventional thermal power plants, the following options have been regarded within the techno-economic assessment:

- the fuel switch of employed primary energy resources (oil & gas);
- the replacement of old boiler installations by more efficient combined cycle gas turbines for the supply of base and mid-load;
- the application of power and heat cogeneration systems for energy supply for covering the heat demand for the envisaged regasification of liquefied natural gas (LNG);
- the application of flexible generation facilities in order to ensure peak power supply and the availability of reserve capacities.

The Cypriot objective for the electricity generation from Renewable Energy Sources (RES) aims at a rapid increase within the next years. Already for 2015 a share of 6 % of the annual net electricity generation is projected to be served by RES. This demand is mainly satisfied by means of wind energy contributing approximately 70 % as well as solar energy (CSP) with approximately 20 %.

For an efficient and cost-optimised electricity generation the characteristics of the transmission system as well as the effects of fluctuating electricity feed-in on the future power plant dispatch have to be taken into account particularly.

LI's in-house planning software sxPLAN combines elements of long term power system expansion planning with the short term operation planning. On this basis conventional thermal generation and generation by means of RES can be analysed and optimised.

Dr. Alexis Bonneschky,
Achim Schreider

OMAN

Potential Restructuring of DPC – Dhofar Power Company SAOC

On March 17, 2001 the Government of the Sultanate of Oman signed a Concession Agreement for the Dhofar Region with the Dhofar Power Company S.A.O.G (DPC) to privatise the Salalah Power System, transferring the ownership of existing assets.

DPC, before starting the Commercial Operation, and as part of the Project under the Concession Agreement, constructed a New Power Station comprising six (6) new Gas Turbines, Transmission

and Interconnection Facilities, a 132 kV Transmission Line and three (3) new Gas Insulated Substations (GIS). Additionally, DPC carried out extensions and enhancements to the existing T&D system.

On 1st of May, 2003 DPC successfully achieved the Commercial Operation Date (COD) and since then holds the responsibility for the operation, maintenance, planning and development of the Salalah Power System, according to Good Utility Practices and compliance with Customer Service and Supply Standards (CSSS) for a period of twenty years.

The service area of DPC is the Dhofar region in the South of Oman, approximately 1000 kilometres away from the capital Muscat.

The Concession Agreement binds DPC contractually to the Oman Power and Water Procurement Company SAOC, organism that became responsible for managing this agreement.

The Oman Power and Water Procurement Company SAOC ("the OPWP") is responsible for procuring new capacity and output in the Sultanate of Oman, in accordance with the requirements of the regulation and privatization of the electricity and related water sector ("the Sector Law") promulgated by Royal Decree 78/2004 and the OPWP license.

DPC as an integrated utility, having Generation, Transmission, Distribution and Collection obligations under a Concession Agreement, currently is being perceived as an exception to the specific practice in the North of Oman and the international practice in general.

The Concession Agreement therefore has been conceived to be outside the purview of the Sector Law and therefore any regulation.

On October 20, 2006 Oman Technical Partners Limited (OTPL), Malatan LLC and Muscat Overseas LLC, the major shareholders of DPC, entered into a Memorandum of Understanding (MOU) with OPWP, which sets the principles based on which the parties will be working together in good faith to review the feasibility of, and if necessary, effect the restructuring of DPC in terms mutually acceptable not only to the parties of the MOU but also to the other shareholders of DPC and the DPC lenders.

The proposed process envisages structuring DPC, an integrated utility, in such a way that its transmission, distribution and generation businesses will be operated and regulated in line with international practice.

The intention of the Parties is to attain the proposed new structure in the best possible time. The key milestones of this restructuring process are described in the MOU and based on the principles issued by the Authority for Electricity Regulation, Oman ("the Authority"), which is responsible for the regulation of the electricity and related water sector in the Sultanate of Oman.

In order to realize the restructuring of DPC in the most efficient manner, ERNST & YOUNG, with Lahmeyer International GmbH as a subcontractor, has been assigned to implement this process.

The objective of the contracted advisory services is the implementation of the MOU in lines of the framework and principles contained in the paper issued by the Authority on July 30, 2006 ('the Framework'), as per the intent underlying the MOU and equitably for all the stakeholders related to the MOU.

The principle activities to be performed under this assignment, for which LI has been contracted from February 2008 onwards, are:

- Direction of the project, and
- Technical Advisory services concerning:
  - Financial model audit (vertically integrated company)
  - Electricity demand forecast
  - Estimation of generation capacity, as well as OPEX & CAPEX during the next five years
  - Definition of battery limits between generation, transmission, distribution & supply
  - Opening balance sheets for generation, transmission, distribution and supply
  - Pro-forma statements for the separated businesses
  - Positional organization structure with required functions and job descriptions for the unbundled companies
  - Articles of incorporation and agreements (PPA, bulk supply agreement, connection & wheeling agreement, license agreements)
  - Options for restructuring
  - Valuation methodology
  - Valuation of T&D businesses
  - Formal restructuring plan
  - Tariff models for the new companies
  - Submission of business cases to lenders

Dr. Horst Finck

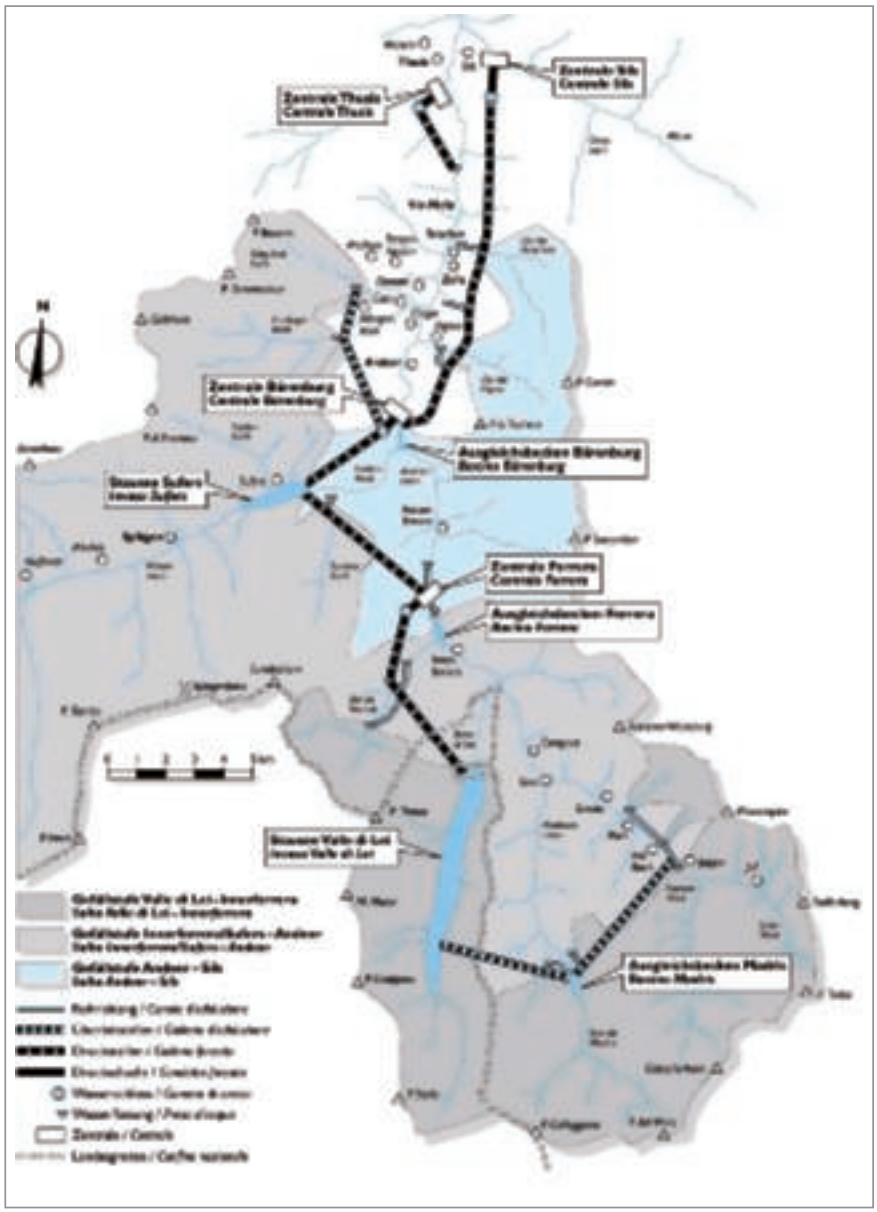
SWITZERLAND

Overall Rehabilitation of Water Power Plants of KHR

The Kraftwerke HinterRhein AG (KHR), Thusis, operates a group of three hydropower plants in the Swiss Alps, consisting of the Ferrera, Bärenburg and Sils plants with a total installed capacity of approximately 650 MW. The head between 1931 m a.s.l. in Valle di Lei and 667 m a.s.l. in Sils is exploited to produce electrical power (see picture: General Layout).

Water reaches the Preda catch basin through a system of intakes and tunnels. From this basin, water is conveyed to the Valle di Lei reservoir, which is, with its capacity of about 200 million m³, the core piece of the KHR plants. Almost the entire reservoir, except the dam itself, is located in Italy.

Water impounded in the Valle di Lei reservoir is used for electricity production by the three horizontal turbines in the cavern powerhouse of the Ferrera plant (max. head 524 m, total discharge 45 m³/s, total installed capacity 180 MW) and is then conveyed to the Sufers reservoir. The generators/motors are also used for the storage pumps (max. 16 m³/s), which can pump the water impounded in the Ferrera compensating reservoir to the Valle di Lei reservoir. Water can also be pumped from the Sufers reservoir to the Ferrera compensating reservoir or to the storage pumps by two vertically arranged feeder pumps.



General Layout of KHR Plants.

The Sufers reservoir balances the inflow fluctuations from the 194 km² catchment area. Water impounded in the Sufers reservoir is processed in the Bärenburg power plant through four vertical Francis turbines (max. head 321 m, flow rate of 80 m³/s total, installed capacity 220 MW) and then transferred to the Bärenburg compensating reservoir.

The four vertical Francis turbines of the Sils power plant (max. head 413 m, total discharge 70 m³/s, total installed capacity 245 MW) form the last step of this cascade of power plants. Moreover, two one-phase units installed in the Sils power plant produce electricity with a frequency of 16 ⅔ Hz exclusively for the “Rhätische Bahn” railway.

In addition to the three main power plants, KHR also operates the Thusis power plant. This plant makes use of the riparian discharge and residual flow remaining in the Hinterrhein river, which is processed by two horizontal Francis turbines (max. head 100 m, total installed capacity 6 MW). All the electricity produced is fed into the valley’s network.

Most of the KHR power plants have now been in operation for more than 40 years. Accordingly, the power plant equipment and all facilities show a pressing need for refurbishment and rehabilitation. Therefore it was decided that a comprehensive engineering plan needs to be prepared for the complete rehabilitation of the plant equipment and the plant structures, including an estimate of the investment needed. This overall rehabilitation of the power plants will optimize and guarantee the reliability, availability and operational flexibility of the power plants and will preserve the substance of the plants.

In October 2007, KHR awarded the Consortium Lahmeyer International GmbH and Ingenieurbüro

Maggia AG the consultancy services for the overall rehabilitation of all elements of the plants. These are made up of the following two phases:

Part A, "Preliminary Design Study", consists of the following:

- Overall management
- Condition assessment and determination of remaining service life
- Scheduling of the overall rehabilitation
- Preparation of the overall rehabilitation concept, including:
  - Optimization, minimization of shut-down time of the plants, respectively.
  - Determination of the shortest possible overall rehabilitation period
  - Preparation of proposals and variants as well as identification and determination of the detailed rehabilitation requirements for all equipment
  - Identification of potential for improvements in efficiency
  - Standardized technical solutions for all plants
  - Optimize follow-up costs for operation and maintenance
  - Preparation of an automation concept
  - Increase of the degree of automation
  - Inspection and assessment of concrete quality, especially regarding concrete strength, surface condition, carbonization and swelling of concrete
  - Planning, coordination and assessment of the required concrete core drilling campaign
- Cost estimate of overall rehabilitation
- Risk analysis

Part B, "Tendering/Construction Supervision" (originally a contractual option):

- Preparation of tender documents
- Client support during contract award
- Construction and erection supervision
- Acceptance tests
- Supervision of commissioning
- Organization of construction site
- Risk analysis

The decision to carry out the refurbishment and rehabilitation was made at the end of 2008. The Consortium was awarded Part B of the services in January 2009. Completion of this very complex rehabilitation project is scheduled for the year 2016.

Dr. Vladimir Zorc

Sudan

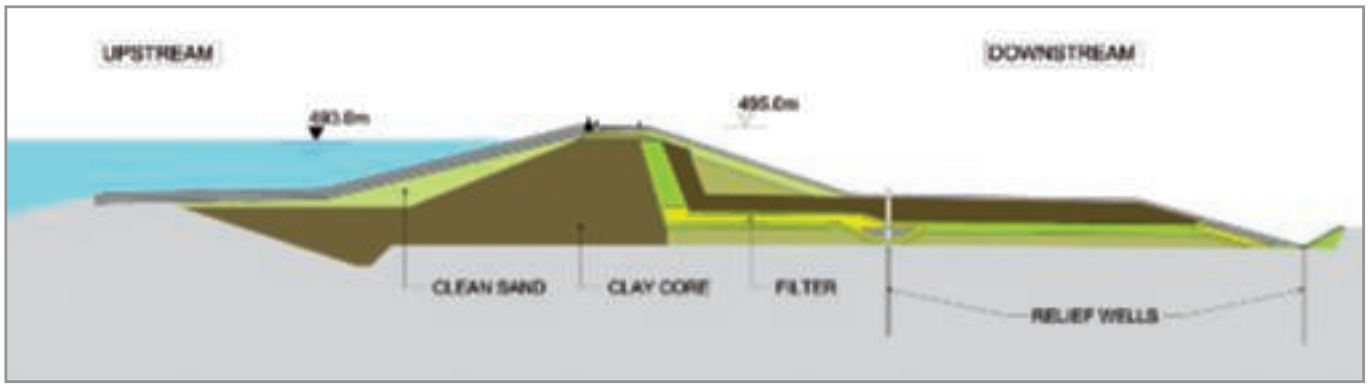
Heightening of the Roseires Dam

Downstream view of the Roseires Dam.

The Roseires Dam located at the "Damazin Rapids" on the upper Blue Nile in the Southeast of the Sudan was completed in the middle of the 1960s. The dam is situated 520 km south-east of the capital Khartoum and about 150 km from the Ethiopian border. Until now the main purpose of this dam is the storage of irrigation water, which is needed for about 1.25 million hectares of irrigated land. In addition, the operation of the 280 MW hydropower plant produced almost half of the electricity generated in the Sudan during the last 30 years.

The accumulation of sediment from the Blue Nile during the last 40 years has reduced the capacity of the reservoir by some 25 %. The Dams Implementation Unit (DIU), which is also our client for the Merowe Dam Project, decided in 2006 to heighten this dam by 10 m and thereby increase its capacity from 2.5 billion m^3 to 7.3 billion m^3. The length of the embankments will also increase from their present 15 km to a total of 24 km, which will require the filling and compacting of 18.5 million m^3 of earth materials.

The construction contract, with a value of about 400 million US dollar, was awarded to the Chinese consortium CCMD at the beginning



Embankment dam cross section with pressure relief wells.

of 2008. Similar to the Merowe Dam Project, the majority of the cost of this project is being financed by development banks from the Arabic world. The construction design and the site supervision will be carried out by SMEC and Lahmeyer International (LI), whereby LI will be responsible for the embankment dams. LI will employ an average of 5 embankment dam experts in the Sudan for the quality control on the site during the planned construction period of 4 years.

The main challenge is less the heightening itself but rather the proper design and supervision of the complex foundation conditions. The embankment dams in most areas are founded on the so-called "Black Cotton Clay", which is a highly plastic clay which swells and shrinks greatly due to seasonal wetting and drying, leading to pronounced shear plains.

Additionally, high storage water levels in the reservoir during the dry seasons have produced increased artesian water pressures under the watertight clay layers located in the foundations of the dam. This reduces the structural stability to a minimum during the construction phases. The planned pressure relief wells, which will be arranged systematically downstream of the dam, as well as the large areas of filter blankets, will control the uplift in the dam foundations.

According to the construction time schedule, the heightening of the embankment dams will be completed by the year 2012.

Egon Failer,
Thomas Ehrhardt

Pakistan

Keyal Khwar Hydro-Electric Power Project

In March 2006, Pakistan's Water and Power Development Authority (WAPDA) commissioned Lahmeyer International to lead a joint venture of consultants studying the feasibility of constructing a high head hydropower scheme on the Keyal Khwar (river) in the country's North West Frontier Province.

The Keyal Khwar commission was another link in Lahmeyer's long association with the development of Pakistan's power generation and transmission systems and it complemented the ongoing construction supervision of the three neighbouring high head schemes – Allai Khwar, Duber Khwar and Khan Khwar.

The project is located in the deeply incised Keyal valley – a side valley of the Indus River with access from the Karakoram Highway. The Keyal Khwar drains a catchment that rises to elevations above 5,000 m asl. The river has cut deeply into the parent rock leaving a steep alpine-like topography and huge vertical walls of rock.

The permanent population of the Keyal valley (some 12,000 persons) all belong to a single clan – the Keyal clan which is unique to the Keyal valley. This clan is a community of interrelated men, women and children with the same origins, the same language and close family ties. The clan people still live by very traditional rules and customs based on a strong belief in individual independence, respect for elders and neighbours, consensus and community work. During the two year study period, the Lahmeyer's engineers and environmental scientists interacted closely with many of the clan members. Several of our staff became well

Keyal Khwar valley access road below dam site.

known faces during drilling and surveying work.

As well as geological and topographic site investigations, our services also covered assessing the impact of the proposed project on the lives of the valley inhabitants – men and women alike. Local custom dictates that all major decisions are made by the senior male members of the clan families, but Lahmeyer's strong relationships with the clan successfully brought local women into the process.

The hydropower project itself will be a high head scheme that will supply Pakistan's national grid with base load during the high flow summer season and peak load during the low flow winter season. The project exploits a head difference between the Keyal Khwar and the Indus River of over 700 m. A 37 m high concrete gravity dam will create a reservoir in the Keyal valley sufficient to assure 24 hour base generation during the summer season and four hours generation during the evening peak in winter. The underground waterways will comprise a desander, a 7 km long headrace tunnel, an inclined surge tunnel, a 600 m deep pressure shaft and a short tailrace tunnel. Two Pelton turbine-generator units, each of 61 MW installed capacity, will be housed in an underground cavern located deep in the right valley flank of the Indus River. A 132 kV double circuit transmission line will connect the Keyal Khwar switchyard to the National Grid at the switchyard of the Duber Khwar hydropower project.

The hydropower scheme brings significant impacts to the Keyal Valley but also great benefits to the surrounding region. It exploits a renewable energy source. It will not deplete Pakistan's reserves of natural resources, it will not increase the nation's dependence on imported fossil fuels and its operation will not produce harmful gases. Indeed the hydropower scheme will be credited with displacing the emission of just over 200,000 tonnes of CO_2 per year that would otherwise be released into the environment by a thermal power plant.

Construction of the scheme, which will take some four years, is scheduled to commence in 2011 and will provide employment and career opportunities for several hundred local people. The improved valley access road will greatly improve the transport link between the Upper Keyal Valley and the Karakoram Highway. This in turn will stimulate local trade and greatly improve the quality of life of the clan communities in the Keyal valley.

Dr. Robert Walker

Keyal Khwar valley at the proposed dam site.

INDIA

Modernization and Upgrading of Six Hydropower Plants

The Uttarakhand Jal Vidyut Nigam Ltd. (UJVNL) is one of the largest hydropower generating companies in India with an annual generation of about 3,500 GWh, which could be increased to well above 4,000 GWh by modernisation and upgrading of existing plants.

After some twenty and more years of continuous duty the six hydropower plants Chibro, Khodri, Dhakrani, Dhalipur, Kulhal and Tiloth approach a stage where rehabilitation of structures and equipment becomes necessary to restore operational reliability and to adjust the plants to the current state-of-the-art.

In order to illustrate the size of the six power plants, the main data are herewith given as follows:

- *Chibro HEPP:* Installed capacity 4 x 60 MW at 110 m head
- *Khodri HEPP:* Installed capacity 4 x 30 MW at 57.9 m head
- *Dhakrani HEPP:* Installed capacity 3 x 11.25 MW at 19.8 m head
- *Dhalipur HEPP:* Installed capacity 3 x 17 MW at 30.5 m head
- *Kulhal HEPP:* Installed capacity 3 x 10 MW at 18 m head
- *Tiloth HEPP:* Installed capacity 3 x 30 MW at 147.5 m head

Within the framework of a study financed by Kreditanstalt für Wiederaufbau (KfW), Lahmeyer International GmbH was awarded the consultancy services for modernization and upgrading (M&U) of the six power plants. The objectives of this M&U study are essentially to:

- conceive the most cost effective modernisation and upgrading concept for the six plants,
- secure an efficient operation of the power stations for the next 25 years,
- achieve or exceed the former design capacity and energy production,
- investigate the potential of uprating of the plants in view of intended peak power production,
- optimize the conjunctive operation of the five plants in cascade on the Tons/Yamuna rivers (Chibro, Khodri, Dhakrani, Dhalipur and Kulhal), and, ultimately, to
- enable the remote control of the plants.

Chibro HEPP (240 MW), damaged runner, view from downstream.

Chibro HEPP (240 MW), Ichari Dam, view from upstream.

In order to reach these objectives the study was separated into three self-contained project phases, comprising the following activities:

<u>Phase I – Inception Study:</u>
- Plant audit
- Proposals for testing of plant and equipment

<u>Phase II – Feasibility Study:</u>
- Tests and additional surveys
- Studies on hydrology, sedimentation, geology, power generation, and socio-economic & environmental impact
- Clean development mechanism
- Power sector study
- Development of M&U options
- Economic and financial analyses
- O&M training course I

<u>Phase III – Tender Documents:</u>
- Technical specifications and tender design
- Construction schedule
- Cost estimate and cash flow
- O&M training course II

The study's holistic approach makes extraordinary demands on all persons involved in the project and requires interdisciplinary cerebration at the highest level, because – apart from the modernisation proper of the structures and electromechanical equipment – also the conjunctive operation of the hydropower plants in the system has to be optimized regarding the provision of strongly needed peak load energy.

Phase II of the study is presently being completed. Completion of the study is expected for the beginning of 2010.

Gonzalo de la Fuente

SUDAN

Irrigation Projects

Lahmeyer's involvement in Sudanese irrigation dates back to the early 1990s, when investigations, designs and tender documents for a 3000 ha extension were prepared for the Sennar Sugar Company.

In 2003, work started on the 400,000 ha Merowe Irrigation Project, located in the Nile Valley approximately 400 km north of Khartoum, between the 3rd and 4th Cataracts downstream of the Merowe dam. Following full coverage of the area by ortho-photo maps at a scale of 1:20,000 under a separate Lahmeyer contract, a prioritisation process at pre-feasibility level was based on technical, agricultural and economic criteria for a set of various gravity supply and pump alternatives. Feasibility studies concentrated on the planning of the conveyance, distribution and on-farm irrigation system.

Further tasks included geotechnical and semi-detailed soil surveys of an extended project area of 1.7 mio. ha. Studies covered the feasibility of improving sustainable agricultural production through irrigation, as well as livestock and agro-industrial production and the need for support in marketing, mechanisation services, input supply, and extension services.

Subsequent tender designs and documents for construction of the irrigation and drainage infrastructure, comprising a mixture of traditional and commercial systems, were prepared in 2005/06 for 380,000 ha of agricultural land, based on new 1:5,000 scale ortho-photo mapping.

The project envisages the construction of over 4,000 km of canals and 9,000 associated structures. It includes two fully concrete-lined major conveyors on both banks supplied from the Merowe Dam. The project also includes a 1,460 m-long aqueduct across the Nile, as well as eight pump stations.

In 2009 construction of cross-drainage culverts under the future left bank canal commenced under LI supervision. The main project was tendered mid 2009.

Since 2007, studies and designs have been in progress for the Kenana and Rahad II Irrigation Projects to the north of Roseires Dam on both banks of the Blue Nile beyond Wad Medani, which would be made partially possible through the raising of the dam (work in which Lahmeyer is also currently involved). The resulting increase in live storage would be sufficient for dry season irrigation of some 400,000 ha. More than 1 mio. ha of irrigable soils (mainly Vertisols) are commandable from the Roseires Dam, within a study area of some 15,000 sq. km, equivalent to about half the size of Belgium.

Water distribution at the lowest level.

Studies included options for combinations of command areas with water supplied by gravity feed from Roseires dam or by pumping from the Blue and White Niles. 24 options (12 gravity feed and 12 pumped options) were evaluated and presented in the Kenana and Roseires-Dinder-Rahad II Development Plans. The pumped options were found to be less viable than gravity supply options.

Tender designs are in process for the irrigation of this area, which includes two major canals. Part of the project would depend for its functionality upon the construction of additional storage in the river catchment or within the irrigation area. Project development is envisaged in three stages over a period of minimum 15 years.

Environmental and social studies of significant scope are being carried out in parallel with the development planning and design. These include screening and scoping, preparation of an Environmental and Social Impact Assessment (ESIA), Environmental Management Plans (EMP), and Settlement Plans (SP) for settling within the irrigation

Cross-drainage culvert under construction.

schemes inhabitants of the area that will be inundated by the raising of the Roseires dam.

The ESIA comprises collection of baseline data, assessment of project impacts and preparation of outline mitigation and monitoring measures with a strong focus in the areas of population/social economy, public health and flora and fauna habitats. Public consultation and participation plans are also being prepared to take account of the interests of legitimate stakeholders. The work is complex, and includes studies of existing rainfed agriculture as well as continued utilisation of the area by nomadic herdsmen.

In order to undertake these works, Lahmeyer has occupied a four-storey office building in Khartoum near the international airport since the end of 2004. The office has over 60 workplaces and is equipped with a modern Local Area Network (LAN), allowing the computers in the system to share data and applications for efficient production of reports, documents and drawings. An integrated team of national, together with international specialists from various countries work together in Khartoum and in the field under Lahmeyer's leadership.

The Dams Implementation Unit of the Government of Sudan, with whom Lahmeyer enjoys a long-standing relationship, is the client and implementing agency for the works on the Kenana and Rahad II and the Merowe Irrigation Projects.

Michael Chegwin

Kosovo
Municipal Water Supply and Sewerage

The KfW-financed project "Municipal Water Supply and Sewerage (Prishtina, Kosovo VII)" is divided into three different phases and aims at the rehabilitation of the present water supply and waste water disposal systems on a long-term basis, thus also improving the living conditions in the city of Prishtina and preserving the natural resources. The project executing agency is the Regional Water Company Prishtina (RWCP).

The Overall Project

In August 2009, Lahmeyer International was awarded the works of Phase I as Consulting Engineer in a Joint Venture with Hidroing-DK (Kosovo) with a total duration of 46 months. Phases II and III are scheduled to be completed in the years 2020 and 2030, respectively.

As far as water supply is concerned, the short-term objective (Phase I) consists in improving the population's supply with quality water from presently 12 hrs/day to 22 hrs/day and simultaneously increasing the urban population's supply rate by reducing significantly the technical losses as well as the high specific consumption. The required water production will be clearly reduced by the envisaged technical and administrative measures and water availability will thus be stabilized, especially regarding the Batllava dam. In the medium-term (Phase II) a further reduction of the technical water losses will be achieved by implementing measures such as restructuring and rehabilitating the distribution network; moreover, a further decrease of the specific consumption to make it reach Western European level will be carried out, aiming at a continuous water supply with regard to quantity and quality. The supply system will be extended in the long-term perspective (Phase III) and the status quo reached will be maintained by reinvestments especially in installations (pumping stations) and the water treatment plant as well as by the replacement of network's parts on the basis of routine leak detection.

Confluence point of the sewer main collector.

As for waste water disposal, the short-term objective consists in minimizing the population's health risks by cleaning of the main water collectors and thus reducing the

risks of partial flooding during high intensity rainstorms. The medium-term objective consists in implementing further rehabilitation measures in the sewerage system and increasing the urban population's connection rate to at least 85 %. A further objective is to preserve the existing water resources by constructing sewer lines and small sewerage treatment plants in the respective areas. In the long-term, the collected waste water will be treated according to European standards.

The Project Phase I

The tasks of LI during Phase I encompass the detailed design of the investment measures and the elaboration of the tender documents including contact negotiations, construction supervision until end of the defect notification period and the complete institutional strengthening. These tasks can be described as follows:

1. Improvement of the water supply by a significant reduction of technical losses from presently 46 % to 30 % and safeguarding the water supply from the place of production to the city by rehabilitation of the main transport pipelines and replacement of the distribution networks in the oldest urban district of Tophane, as well as renovation of house connections and construction of a clear water reservoir at WTP Badvoc;
2. Improvement of the drinking water quality by replacement of the filter medium within the WTP Badvoc;
3. Significant reduction of water misuse by installation of 20,000 water meters and complementary accompanying measures regarding invoicing and public relations;
4. Safe sewerage disposal in residential areas by cleaning of the existing two main sewer collectors (see photo);
5. Supplying of the employer with equipment and material for proper calibration and maintenance of the water meters;
6. Rehabilitation of a booster pumping station to be able to abandon water supply of part of the population with tank trucks;
7. Advising the employer regarding public relations, improved billing and accounting and implementation of a Management Information System in order to reduce administrative losses;
8. Elaboration of a development scheme for the protection of the water resources (Batlava and Badvoc dams) including calculation of the groundwater's pollution load and elaboration of a list of measures (action plan);
9. Elaboration of a Long Term Investment Plan in order to guarantee feasible water supply and sewerage disposal on a long-term basis (Phases II and III).

After completion of Project Phase I, approximately 410,000 inhabitants will be connected to the water supply network, which corresponds to a connection rate of approx. 95 %, compared to the present connection rate of 80 %.

Reinhard Vogt

ETHIOPIA

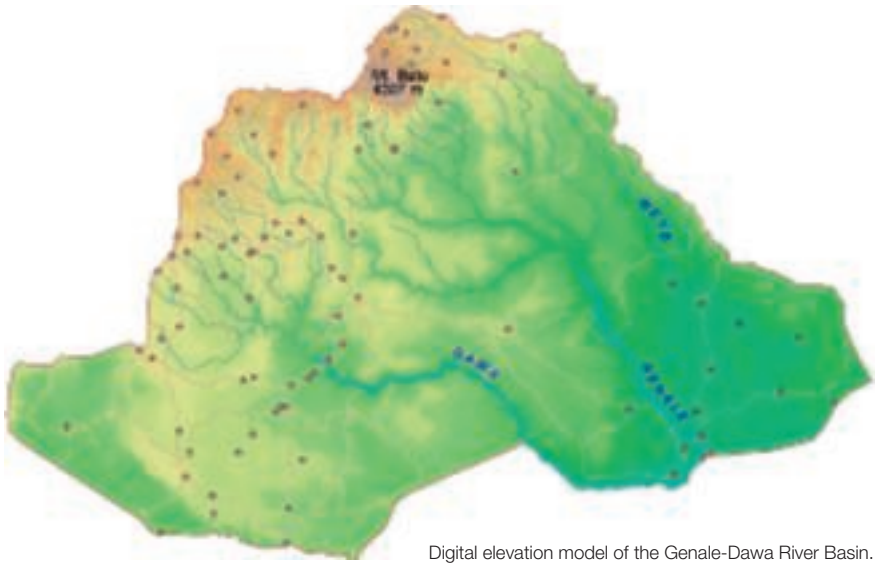
Application of Geographic Information Systems (GIS) for Integrated River Basin Development

GIS is now considered a standard tool for integrated river basin development. Lahmeyer International can look back at a long tradition of using these technologies.

Ethiopia is often referred to as the "water tower" of Eastern Africa. The summer monsoon rains in the Ethiopian Highlands feed no less than 12 rivers basins, from which the water is carried to the riparian countries of many East African rivers. The Nile alone receives 80 % of its water from Ethiopia.

The Ethiopian Government has been engaged in the systematic development of the country's major river basins to harness the underutilised water resources for more than 25 years. While priority is given to the development of hydropower, irri-

Ethiopia's 12 major river basins. Water rich basins contrast with arid and dry basins.



Digital elevation model of the Genale-Dawa River Basin.

gation and water supply, master plans have been prepared with the aim of developing all resources of a river basin in an integrated and optimal manner.

The Ministry of Water Resources is in charge of river basin development and commissioned Lahmeyer International to prepare an Integrated Master Plan for the Genale-Dawa River Basin between 2003 and 2008. The study was financed by the African Development Bank and required the application of a Geographic Information System (GIS) capable of storage, analysis and visualisation of a vast array of data and information from multiple sectors.

The Genale-Dawa River Basin is located in the southern part of Ethiopia. With an area of 173,000 km² it is the country's third largest river basin and almost half the size of Germany. Major rivers descend from the afro-alpine plateau of the Bale Mountains over 4,000 m to the arid bush- and grasslands bordering Kenya and Somalia. They merge at the border with Somalia, from where the Juba River conveys their waters to the Indian Ocean near Kismayo.

With a population of 4.5 million, the area is very sparsely populated and, except for a few cities, little developed. The economy is characterised by rainfed agriculture in the temperate highlands, extensive animal husbandry in the savannah midlands and pastoralism in the arid and hot lowlands. Gold and minerals are mined at a few locations.

The GIS was set up in several steps over the full duration of the project. The hardware comprises a geo-data server, four workstations, together with laser and large-format printers in a networked environment. ESRI's ArcGIS was used as the core software product.

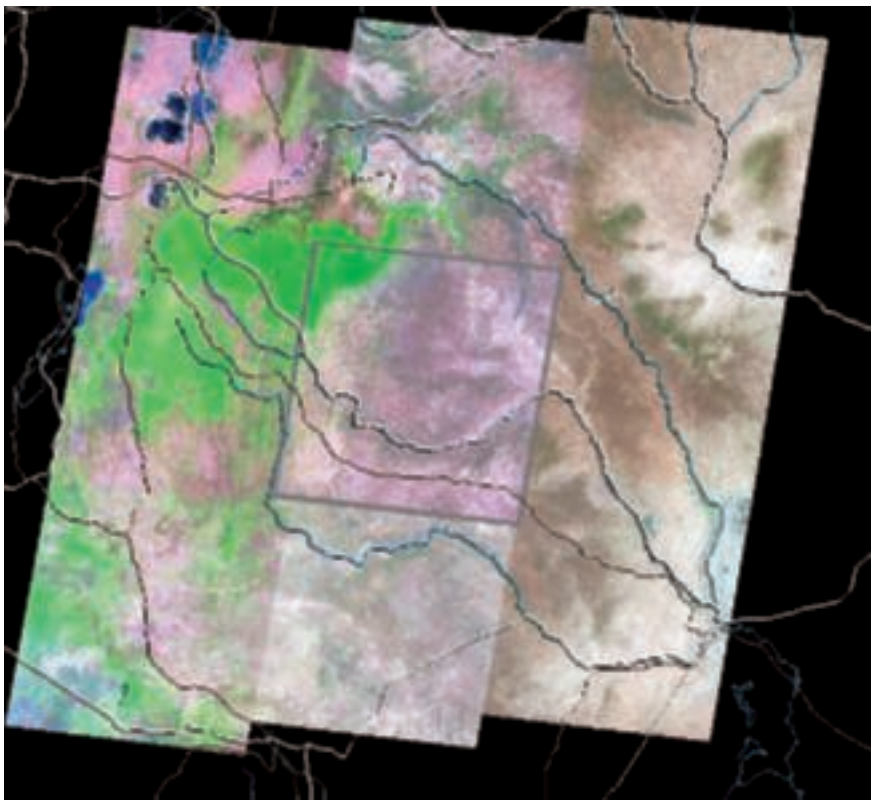
Today, the geodatabase contains more than 250 layers from almost every physical, political and economics domain. A digital topographic map was produced for the whole basin. To support thematic mapping and hydrological and terrain analyses, a basin-wide mosaic of Landsat satellite images and a digital elevation model utilising data from the Shuttle Radar Topography Mission (SRTM) were created. Considerable effort was invested in the collection of data through field surveys or digital conversion from available sources.

A core application of the GIS was the creation of a hydrological river basin model to simulate water use and allocation over a period of 50 years (using the Danish Hydraulic Institute's MIKE BASIN software). The simulations have shown that the master plan, even if fully implemented, would not cause any severe regional or transnational conflicts over water use.

The final master plan has 3,600 pages and contains an album with 1:250,000 scale maps for geology, hydrogeology, soils and land use. Ninety thematic maps at a scale of 1:2 million complement the report.

At the end of the study, the GIS and all data, models and maps were handed over to the client. The Ministry of Water Resources is now responsible for its continuation and integration with GIS data from other river basins.

Klaus Köhnlein



Satellite image mosaic.

GERMANY

Felderhalde Tunnel in Isny, Allgäu

The Felderhalde Tunnel and the 4 km long Isny city by-pass road were completed in July 2009 after a construction period of four years.

The Felderhalde Tunnel, with a total length of 760 m and a construction cost of around 19 million Euros, is the central structure of the new Isny city by-pass road B12. From the total tunnel length of 760 m, 550 m were excavated by conventional drill and blast methods and 210 m were constructed using the cut & cover method.

East portal.

Construction pit at the west portal.

The tunnel and its operational equipment were built according to the new German National Design Guideline for Road Tunnels (RABT 2006). The ventilation is provided longitudinally along the length of the tunnel. The operation building and the settling pond are situated at the west portal.

The federal road B12 is a part of the Euro Route E61 and the most important west-east connection in the Allgäu region. Until the completion of the by-pass road it ran through the centre of the city of Isny. To reduce the disturbance of the citizens of this recreational city, Lahmeyer International was in 1988 awarded the planning contract by the Tuebingen Regional Council. Lahmeyer International was involved in the realization of these works for over 15 years, including the supervision of geotechnical investigations, the preparation of an expertise on the technical aspects of the tunnel works, the design of the tunnel construction and the tunnel equipment, the preparation of noise and air quality reports and the completion of the tender documents for the tunnel in the year 2006.

This project highlights Lahmeyer's International holistic approach to complex tunnel engineering tasks that enables us to cooperate successfully with public – sector clients.

Roland Albert

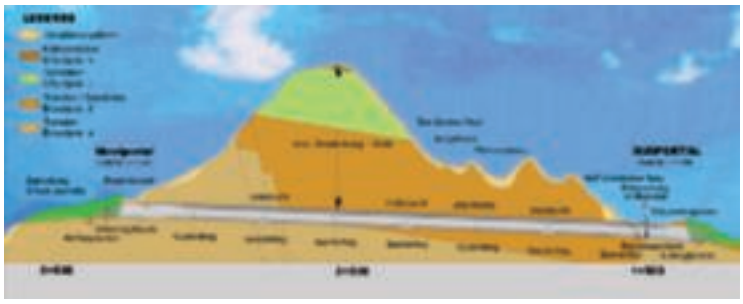
GERMANY

Scheibengipfel Road Tunnel near Reutlingen

"The City of Reutlingen will finally get the long awaited bypass, including the Scheibengipfel Tunnel. Financing through the German second economic stimulus package is secured and the ground-breaking ceremony can be held".

This good news for the City of Reutlingen was announced in February 2009 by the German Federal Ministry of Transport. After nearly 15 years of planning, construction of the 1,910 m long road tunnel will finally commence in 2010.

The bypass on the east side of Reutlingen is expected to relieve congestion in the inner city and to further improve the inter-regional traffic network. The core part of the 3.0 km long by-pass is the 1,910 m long Scheibengipfel Tunnel, 1,620 m of which will be constructed by underground tunnelling, while the remaining 290 m will be constructed using the cut-and-cover method. It is a two-lane tunnel with bi-directional traffic. The cross section is 9.50 m wide and 4.50 m high.



Longitudinal Profile Scheibengipfel Tunnel.

In 1994 Lahmeyer International was contracted with the final design of the tunnel. Our services included a geotechnical interpretive report and studies for the mitigation of noise and vibration. However, the project was put on hold due to right-of-way issues and the resulting legal proceedings.

The tunnel ventilation system was amended completely following the new release of the German National Design Guideline for Road Tunnels in 2006 (RABT 2006). In the course of this amendment, the ventilation system was changed to a longitudinal system with a dedicated ventilation duct in the tunnel

ceiling and a separate emergency ventilation system.

Lahmeyer International was commissioned in the middle of 2007 to prepare tender documents and supervise a supplementary geotechnical investigation program, including an update of the existing geotechnical interpretive report. These activities were completed by the end of 2008.

Lahmeyer International was awarded the tender design of the civil works in May 2009 on the basis of the amended final design. A separate contract for the completion of the final design of the E&M tunnel systems was also awarded to Lahmeyer International. The tender design of the civil works has to be completed by mid of December 2009, in order to enable construction to start in 2010. The opening of the completed by-pass to road traffic is scheduled for 2016. The cost estimate for the tunnel construction is 65 million €.

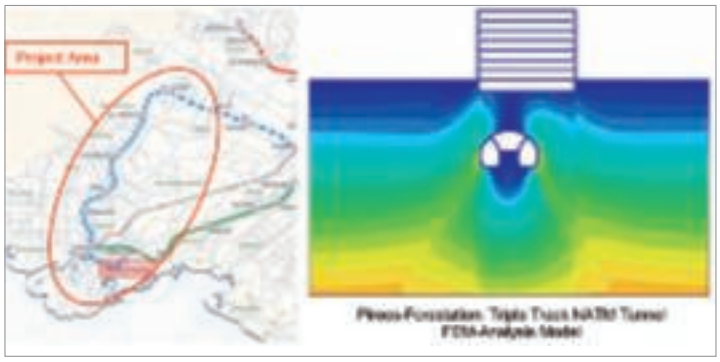
Special features of the tunnelling works include the provision of heavy fore poling with grouted anchors at the tunnel portals, as well as passing the tunnel under ten residential buildings. The civil works are partly to be constructed in a protected recreational area under strict environmental protection regulations.

This project continues the long history of successful cooperation of projects in the region by Lahmeyer International and demonstrates our capabilities for the benefits of the client to perform complex tunnel engineering tasks.

Roland Albert,
Adalbert Gering

Greece

Metro Athens, Pireos Turning Device



Triple-track NATM Tunnel, FEM Analysis.

Attiko Metro S.A. successfully completed the route extensions that were necessary for the 2004 summer Olympic Games and is currently planning a systematic extension of its Metro network in order to provide public transport for most of the municipalities in the Attica region.

Line 3 extension, from the station of Haidari to the City of Pireos, has top priority for the Ministry of Environment, Planning and Public Works. This extension will have a total length of 8.2 km, with six new stations interconnected by double-track tunnel sections with a total length of 7.3 km. It will serve both the western suburbs of the Attica basin and the City of Pireos. Funding will come from the Greek Government and from the EU Cohesion Fund.

The original alignment of the line extension within the City of Pireos had to be re-designed. The original alignment beyond the station “Dimotiko Theatro” was both unacceptable to the public and a construction challenge and thus non economical. The construction of Evangelistria station in particular, with up to 40 m deep construction pits in an archeologically sensitive area, as well as construction of the triple-track tunnel under existing residential buildings in soft marine sediments, was deemed to involve unacceptable costs and risks. The variant finally chosen is more economical and produces fewer disturbances to the public during construction.

In February 2008, Lahmeyer International was assigned with the preparation of the design and tender documents of the turning device (turnaround) area. This station is connected to the new “Dimotiko Theatro” end station. This section consists of a double-track and a triple-track tunnel section, each approximately 220 m in length, as well as two shafts up to 35 m deep for ventilation and TBM dismantling. All structures are located in a densely built-up area, with the tunnels passing under seven-storey buildings. This new design will be included in the existing tender documents of the second phase of the tender procedure for the extension of Line 3.

The services awarded to Lahmeyer International include geotechnical exploration, laboratory tests, geotechnical evaluation report, collection of existing utility network data, alignment of the turning device area, structural design of the TBM, NATM and transition tunnels, including 2 shafts, noise and vibration study, modification of the existing Environmental Impact Study, preliminary E&M design of the lighting, power distribution and earthing for the “Dimotiko Theatro” station and finally the tunnel ventilation study.

It is anticipated that end of 2009 the nominated contractor will start with the construction work. In 2014 the Line 3 extension is scheduled to go into operation.

This project is yet another example, where Lahmeyer International contributes successfully to the goal of sustainable mobility in urban areas, especially in the Athens Metropolitan Region.

Adalbert Gering

GERMANY

Reconditioning of "Kraftwerkstreppe Mittlerer Isar-Kanal", Reach 2 to 5

Surface sheeting and underwater concrete finisher. (Source: Hydroprojekt / Bau und Plan.)

Since its completion the "Mittlerer Isar Kanal" (MIK) operates without an appreciate break since 1929. It is now operated by E.ON Wasserkraft GmbH, Landshut.

Hydroprojekt Ingenieurgesellschaft mbH, Munich obtained the order to recondition all watercontacted buildings such as side walls, side slopes, base and powerplants in association with Bau+Plan GmbH, Munich.

The channel runs from his extraction building – the weir in Oberföhring near München – to Moosburg (sketchmap) over a length of about 54 km. The maximum discharge is 150 m³/s. Five powerplants produce rotating current for the regional and national supply as well as alternating current to supply the German railways. The total head is about 88 m. The construction of the channel changes several times from dam to trench and reverse. Though the MIK has to be shut off to allow the reconditioning works the surrounding net of artificial and natural waters have to be charged to sustain the usual flow and to allow the further operating of thermal power plants which need cooling water from the MIK.

To enable this the reach 1 has to be transformed in a backward current supported by four pump stations with a discharge of 10 m³/s same as a siphon with a possible discharge of 15 m³/s. This "backward current handling" enables the reaches 2 to 5 to be emptied or to be lowered.

Reach 3 with a length of 6 km can be emptied. It is getting a new sealing made of concrete for the base and the slopes by using a slope finisher with an operating speed of 300 m/d.

The lowered reach 2 is getting a new sealing sheeting made of 2 mm PEHD (slopes) and underwater concrete (base) which is placed by a new developed underwater finisher.

The reaches 4a and 5 are to be reconditioned during the next years. It is intended to recondition these reaches while the MIK and his power plants are in use. Therefore the reconditioning will be executed mainly under water. The realisation of a so far new method allows to do the works without a groundwater lowering.

At the same time to the now running construction works the dam crest lanes and about 40 siphons and the watertouched concrete of the Power plants are to be reconditioned by replacement, joint sealing and concrete injection.

The planning team of Hydroprojekt Ingenieurgesellschaft mbH and Bau+Plan GmbH coordinates all external designers, additional engineering experts and construction firms since 2005.

The execution of the construction works of reach 2 and 3 started in May, 2009. Working under a tight progress chart, the MIK will restart operation in November 2009. The total amount of the activities is about 46 million Euro.

Roland Wach,
Hydroprojekt Ingenieurgesellschaft mbH

GERMANY/AUSTRIA

Sediment Management in the Inn River

The river Inn at the border between Austria and Germany has a variable flow regime characterized by a wide range of discharges and a high sediment transport capacity.

The long-term average of suspended sediment load of the river Inn at Wasserburg (Inn km 158.7) amounts to about 2.5 million m³/year.

The reservoirs of the barrages constructed on the river since the end of the 1st World War are silted with fine sediments (fine sands). The reservoirs are in a dynamic state of

morphological equilibrium which is mainly influenced by the strong flow fluctuations. At high flows the deposited sediments are mobilized and large quantities of fine sand are transported into the downstream reservoirs.

Since more than 10 years Hydroprojekt (HPI) develops and applies numerical sediment transport models to study different kinds of problems in the reservoirs of the barrages Nußdorf, Rosenheim, Feldkirchen and Wasserburg operated by the E.ON hydropower Company (EWK). These models are specially designed to compute the transport of suspended sediment in backwater river reaches and they take account of important influence factors like the flow resistance due to bed forms.

The reservoirs of the Austrian barrages Kirchbichl and Langkampfen are flushed every year in order to remove the deposited sediments and restore the necessary bed elevations for complying with the prescribed maximum water surface elevations and freeboards. The reservoir of the downstream barrage Oberaudorf/Ebbs will also be flushed regularly in the future. Due to the flushing large amounts of fine sediments are mobilized and transported into the reservoirs of the next barrages Nußdorf, Rosenheim and Feldkirchen situated downstream. The sediments could be trapped in these reservoirs and cause undesirable aggradation of the river bed.

In order to investigate the sediment transport behaviour in the chain of barrages and develop adequate solutions for management of the sediments a team of experts of the waterpower companies TIWAG, GWK and EKW, of the water authorities of Germany and Austria and of two engineering consulting companies was established in December 2007. In the course of different meetings the expert team developed an investigation program which was mainly carried out by the two consulting companies. The studies were undertaken applying mainly numerical transport models. HPI was responsible for the studies of four of the five reservoirs in the chain of barrages considered from Langkampfen to Feldkirchen.

Downstream view of the barrage Langkampfen.

Three different solution approaches were considered in the investigations:

- allow the development of a morphological equilibrium situation with aggradation in all reservoirs and stable river bed conditions,
- regular dredging of the sand deposits in the reservoirs,
- sediment management in all reservoirs with the aim of transporting the suspended sediment through the chain of barrages.

All three companies operating the barrages were in favour of the sediment management approach. The model studies proved that it is possible to transport large amounts of fine sand mobilized by flushing in the upper reservoirs through the entire chain of barrages, provided that the flushing procedure is well planned and coordinated. Under these conditions it is also possible to guarantee a safe flow of the design discharge in the lower reservoirs as well as a temporally storage of large amounts of upstream sediments in these reservoirs without reduction of the flood safety conditions.

The results of the work undertaken by the expert team were submitted to the German-Austrian transborder river commission in July 2009.

Dr. Roberto Kohane,
Hydroprojekt Ingenieurgesellschaft mbH

Germany

Company Foundation: Consultancy in Sustainable Building

Sustainable construction has become very fashionable. Building owners, investors and occupants have recognised the added value of such structures.

Sustainable buildings are more easily marketed, generate higher revenues and hold their value better. The occupants stay satisfied longer due to the better social and functional qualities of such buildings.

Owners and investors who are engaged at an early stage with the multi-disciplinary overview of the complete life cycle of a building secure themselves advantages in sustainable design. This is a speciality of Lahmeyer Rhein Main GmbH: together with Professor Dr. Carl-Alexander Graubner, who was significantly involved in the development of the “Deutsche

Gütesiegel Nachhaltiges Bauen" (German Sustainable Building Certificate), and Koenig and Heunisch Design Office, we have founded LCEE Life Cycle Engineering Experts GmbH. This is a consultancy which specialises in the functional, environmental and economic optimisation of sustainable buildings.

This consultancy specialises in the following areas:

- consultancy services regarding to optimisation of sustainable buildings,
- certification of the sustainability of buildings according to "Deutsches Gütesiegel Nachhaltiges Bauen" and according to the US American LEED® and the British BREEAM,
- analysis of sustainability at early planning stages (Pre-Check),
- evaluation of life cycle costs for the construction and operation process of buildings,
- life cycle analysis according to DIN EN ISO 14040 and 14044,
- certificate of valuation of sustainability.

Large projects in the Rhein-Main area, such as the new construction of the "Deutsche Börse" or the "MainTor" are already part of the references of LCEE.

LCEE
LIFE CYCLE ENGINEERING EXPERTS GMBH

To get in touch with LCEE Life Cycle Engineering Experts GmbH, please visit www.lcee.de or contact Lahmeyer Rhein-Main GmbH.

Charlotte Baumann-Lotz,
Lahmeyer Rhein-Main GmbH

RUSSIA

Lahmeyer International Russland

On February 02, 2009 "OOO Lahmeyer International Russland" has started operation in their offices in 23, Novoslobodskaya St., Moscow.

Over the period of the last 8 years LI had maintained a representative office in Moscow which was now converted into a fully operative local company. Despite the current economic downturn, the ongoing changes and new developments in the Russian power sector have set the requirements for additional well qualified engineering consultants with international reputation. With our representative office we have achieved to communicate our good international reputation in the power market to the Russian clients, so the new company has a good platform to start its business upon. Our local expertise in Russia is based on a team of experienced power engineering specialists who had been working together over the last three years and have joined efforts with representative office colleagues. Our staff currently consists of eight people supplemented by three to five part-time employees on project basis and supported by the full expertise of the mother company. The team is led by Mr. Viktor Istomin, appointed as Director General, a power plant engineering specialist with 40 years of professional experience.

The present projects focus on technologies and energy economics in respect of new thermal, mainly combined-cycle and coal-fired (CFB) power plants. It is envisaged that services for renewable energies will be added to the portfolio on a medium term basis.

We hope not without reason that demand in consulting will grow in Russia and LI will actively participate in this process.

The present clients of "OOO Lahmeyer International Russland" are TNK-BP Management, Gasprombank, several wholesale (OGC) and territorial generating companies (TGC).

In March 2009 the company signed the first contract with JSC "TNK-BP Management" for preparation of a pre-feasibility study for a gas fired power plant with up to 600 MW capacity in Eastern Siberia. Some new potential contract awards are in advanced stage, particularly with TGC-2 and the non-commercial company "Market Council". It is also intended to bid as Owner's Engineer in partnership with Russian companies in some appropriate cases.

Viktor Istomin,
OOO Lahmeyer International Russland

The team of Lahmeyer International Russland.

LAHMEYER INTERNATIONAL

Lahmeyer International GmbH
Friedberger Str. 173
61118 Bad Vilbel
Germany

Tel.: +49 (61 01) 55-0
Fax: +49 (61 01) 55-22 22
E-mail: info@lahmeyer.de
Internet: www.lahmeyer.de