LAHMEYER INTERNATIONAL

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INFORMATION ON THE LAHMEYER INTERNATIONAL GROUP, NO. 49 / JANUARY 2005

BOSNIA-HERCEGOVINA:
400 KV TRANSMISSION LINE

ICELAND: 690 MW HYDROPOWER PLANT
KÁRAHNJÚKAR

YEMEN:
70 MW DIESEL POWER PLANT AL-MANSURA

SUDAN:
BASIC SURVEYING FOR MEROWE DAM PROJECT

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Mujib Dam, Jordan
The Mujib Dam is located near the most ancient road in the world, which has been continuously in use up to now, and which was used in past times by Abraham and Lawrence of Arabia. The Wadi Mujib is also called Jordan's Grand Canyon. It cuts through the Jordanian highlands and, coming from the east, it flows into the Dead Sea, the world's deepest lake.

MASTHEAD

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ALBANIA

The Reform of the Power Sector

Electricity generation by hydropower plants at the river Drin

Since almost one and a half decade, the engineers and consultants of Lahmeyer International realise the technical and economic restructuring of national utilities in several transition economies.

A peculiarity is presented in Albania. Almost 99 % of the electricity generation is provided by domestic hydropower. At the beginning of the nineties, the country exported 20 % of its power generation.

In the nineties our power plant and electrical engineers advised KESH, the Albanian Power Corporation, on the modernisation of the largest hydropower plant (the Drin River cascade), the additional extension with thermal power plants and the construction of a new hydropower plant.

At the end of the nineties the balance supply situation in the Albanian power sector fundamentally changed. The steadily increasing electricity demand (about 10 % per year from 1992) and unfavourable hydrological conditions followed to electricity shortages in the country. At the beginning of this century, the domestic power plants could only cover about 50 % of the national electricity consumption. For financial reasons, but also because the capacities of the transmission system were not sufficient, only one part of the electricity gap could be filled through electricity imports. The population and the economy suffered from massive electricity outages.

Very low tariffs and high technical and non technical losses of 40 to 50 % in total were essential reasons for the high increase in electricity consumption. KESH could not afford the costs of the power imports with own resources. The government felt obligated to pay direct subventions at KESH.

Due to the energy crisis in Albania, the projects for Lahmeyer International in the country also changed. In 2002 our engineers and economists participated in a sectoral study. They recommended, among others:

- to slow down the high increase of the electricity consumption,
- to reduce the technical and non technical losses of service through the improvement of the network capacities and administrative measures,
- to bring step-by-step the electricity tariffs for all consumption groups, under consideration of financial and social aspects, in a cost-covering level,
- to prepare the organisation of the power industry in Albania not only for the commercialisation and privatisation but also for the integration into the UCTE[1] zone and the Southeast European Electrical System.

Based on this study, the Government of Albania worked out a strategy for the modernisation of the energy sector. In 2004, the first measures for the unbundling of the three functions (generation, transmission and distribution) were introduced at KESH.

For further support, KESH has engaged in November 2004 Lahmeyer International with another project financed by the World Bank. The objective of the project is to state and compare the different options for:

- the organisation of the Albanian electricity generation units,
- the organisation of the Albanian electricity distribution divisions,
- the privatisation of the generation and distribution functions,
- the introduction of competition.

The project shall be finished in July 2005.

It is the start for the successful privatisation of KESH that should be finished, according to the plans of the Albanian government, in the year 2007.

Hans-Joachim Kießling,
Rosa Tarragó

[1] UCTE – Union for the Coordination of Transmission in Europe

YEMEN

70 MW Diesel Power Plant Al-Mansura

The Public Electricity Corporation (PEC), the Yemeni state-owned utility under the Ministry of Electricity, operates approx. 50 thermal power plants, out of which three are conventional oil-fired steam turbine power plants. All other plants are diesel engine driven plants, 40 of them operated in isolated grids.

The steam turbines in Ras Kanastib at Al-Hodeidah, in Al-Mukha and in Al-Hiswa at Aden have a total capacity of 450 MW. The diesel power plants in the network compound have a combined capacity in excess of 200 MW, while the diesel power plants operating in isolated grids have a capacity of 235 MW. However, the contribution of the grid connected diesel plants to the power generation is considerably lower. Numerous plants – even of higher capacities – generate intermittent only due to outages and maintenance, resulting in an overall availability of around 60 %. The Ministry of Electricity estimates the demand on new power plants until 2020 at 1,650 MW.

The future location of the 70 MW diesel power plant Al-Mansura near Aden

The 70 MW Diesel Power Plant Al-Mansura is being built on the south coast of the country in Aden. It will comprise seven medium speed diesel generator sets of similar type incl. auxiliary equipment, waste heat recovery steam system, electrical plant installation with 33 kV GIS switch gear, instrumentation and control systems, water treatment as well as interim fuel storage capacities, in addition to the pipeline connection. The plant is designed to operate initially on heavy fuel oil as the main fuel and light fuel oil as backup, and to be convertible to dual fuel / natural gas operation in the future.

The project is financed by a loan from the Saudi Fund for Development and by funds from the Yemen Government. Lahmeyer International was selected among ten short-listed consulting firms under Quality- and Cost-Based Selection (QCBS) to provide the consulting services for this project.

Aden site inspection in Mai 2004

The consulting services during the implementation period of 18 months comprise the project management, design review and approval, witness of factory tests, supervision of construction including commissioning, testing and handing over, as well as assistance to the client during the 12 months defects liability period.

Harald Neff

KINGDOM OF SAUDI ARABIA

2400 MW Combined Cycle Power and Sea Water Desalination Plant in Jubail

In July 2004, Lahmeyer International, leading an advisory consortium, has been commissioned by the Power & Water Utility Company for Jubail and Yanbu (Marafiq) as Owner's Engineer for the so called Independent Water & Power Project (IWPP) in Jubail, being one of the first and biggest privately funded projects in Saudi Arabia.

The dual-purpose installation shall provide power and desalinated water to the customers in Jubail City at the Saudi Arabian East Coast, one of the most important industrial areas in Saudi Arabia. The IWPP comprises a 2400 MW power station and a sea water desalination plant of 300,000 m^3 per day.

Bid submission from international pre-qualified developers is expected in February 2005.

Dr. Uwe Dammel

PAKISTAN

Feasibility Study for Fauji Korangi CCPP

The site for the future Combined Cycle Power Plant Fauji Korangi nearby the city of Karachi

Fauji Foundation has been declared as pre-qualified by Private Power Infrastructure Board (PPIB), Government of Pakistan and intends to setting up a 150 MW dual-fired combined cycle power plant (CCPP) at Korangi nearby Karachi under an IPP scheme.

The consortium Lahmeyer International GmbH (LI) – National Engineering Services Pakistan (Pvt.) Limited (NESPAK) has been awarded to undertake a feasibility study for this new CCPP. LI is consortium leader.

Fauji Foundation is Pakistan's largest welfare cum industrial organization and a fully self-supported private sector entity. Its welfare operations are financed through its industrial and commercial projects. It has 9 million beneficiaries and has welfare operation in education, health and vocational training areas. It spends 80 % of its earnings on welfare.

The PPIB is the contract point to private sector investors concerning establishing Independent Power Producer (IPP) projects and related infrastructure in Pakistan, including the negotiation of the Implementation Agreement (IA). PPIB also provides support to the power purchaser and fuel supplier while negotiating the Power Purchase Agreement (PPA), Fuel Supply Agreement (FSA) / Gas Supply Agreement (GSA), other related agreements, and liaison with the concerned local and international agencies for facilitating and expediting progress of private sector power projects.

The LI-NESPAK consortium will provide the following services:

- Review of existing pre-feasibility study report
- Data collection of the selected site
- Review of basic project parameters and conditions
- Determination of general plant requirements
- Transportation study
- Identification of optimized technical plant concept/configuration
- Preparation of plant conceptual design and implementation concept
- Environmental impact assessment (EIA)
- Review of existing project agreements
- Estimation of project cost and financing plan
- Financial analysis and tariff calculations
- Risk analysis
- Identification of required permits and approvals
- Preparation of feasibility study report

The successful co-operation between LI and NESPAK has been proven in several former projects.

Bernhard Paulus,
Michael Dürr

BOSNIA-HERCEGOVINA

400 kV Transmission Line

Prior to the Balkan War, the entire installed power generation capacity in Bosnia-Hercegovina was 13 Gigawatt (GW), while the maximum demand was 11 GW. 40 % of the generation was by hydropower stations, and 60 % by thermal power stations. During the war, 56 % of the installations were damaged or rendered unusable.

The transmission network comprised a total length of 5,400 km, and the local distribution networks 92,000 km. The transmission backbone consisted of a 400 kV network with 8 substations, which was interconnected with the transmission systems of Croatia, Montenegro and Serbia. 60 % of the interconnections were also damaged during the war. The energy supply is now being reconstructed in three steps:

- Power I, Emergency Programme for Energy Supply
- Power II, Rehabilitation of Energy Supply

These two steps have already been completed.

In June 2002, Lahmeyer International (LI) was contracted by the World Bank, to provide consultancy services for the third step (Power III). This project is being financed by a credit from the World Bank, and comprises the rehabilitation of the damaged 110/220 and 400 kV transmission network, and rehabilitation of the hydropower station Rama.

For these works, LI establishes the technical specifications and bidding documents for an international competitive bidding (ICB). The local power utilities Elektroprivreda Bosne i Hercegovine (EP-BiH), Elektroprivreda Hrvatske Zadjednice Herceg-Bosne (EP-HZHB) and Elektroprivreda Republike Srpske (EP-RS) are being assisted during the bidding stage, in bid evaluation and during contract negotiations, as well as the future construction supervision.

The services of LI for eleven transmission lines with different designs cover the following:

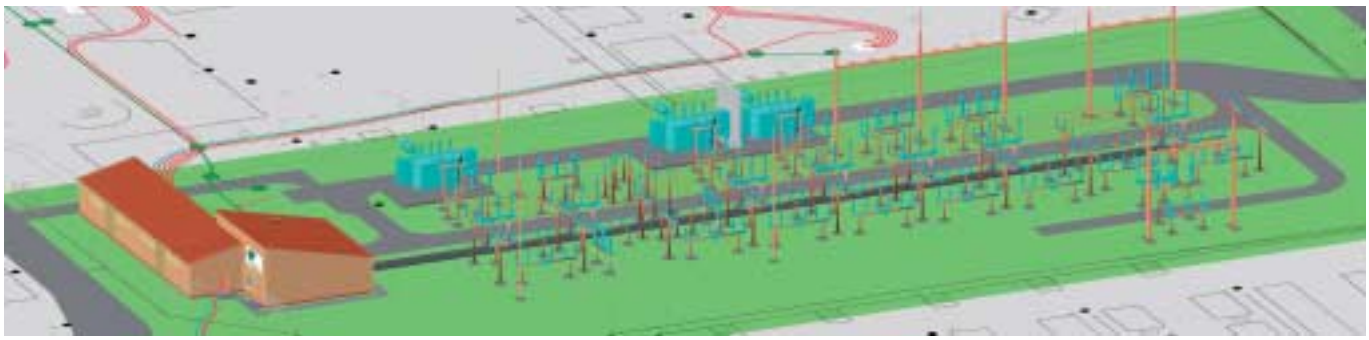
- reconstruction and repair of war damages,
- landmine clearing in the transmission routes, the access roads, and clarification of rights of way,
- reconstruction of existing towers, and erection of new towers (including foundations),
- removal and replacement of damaged conductors including all components like insulator strings and fittings,
- installation of new optical cables for the damaged 400 kV transmission network, and
- the clearing of tower locations.

When the works will be completed by the end of April 2005, a comprehensive supply of power will be secured for Bosnia-Hercegovina and its metropolis Sarajevo, Mostar and Banja Luka as well as the interconnection with the UCTE Grid.

Joachim Lezim

GERMANY

New 110/15 kV Substation Dessau-Alten



Model of the new 110/15 kV Substation Dessau-Alten, anticipated to be in service in 2006

In spring 2004, Dessauer Stromversorgung GmbH (DSV) entrusted Lahmeyer International (LI) with the design, engineering, tendering and site supervision of the 110/15 kV Substation Dessau-Alten.

The scope of services contains amongst others the design for a 110 kV air insulated switchgear (AIS), one 15 kV SF_6 gas insulated switchgear (GIS), double busbar type which will be situated in a separate switchgear building, electrical protection and control systems, remote control implementation to the existing SCADA systems and interconnection to the load control centre of the Dessauer Stromversorgung (DSV).

The main components of the substation are as follows:

- Implementation of four 110 kV transmission lines
- 110 kV AIS outdoor switchyard, nine bays
- 15 kV SF_6 insulated indoor switchgear, 31 feeders
- 110/15 kV transformers, 2 x 40 MVA
- 110/15 kV transformer, 1 x 31,5 MVA
- Arc-suppression coil
- Auxiliary systems
- Electrical protection and control systems
- Remote substation control system
- Switchgear control building

The new installations will be erected and installed on the existing premises, close to the old outdoor switchyard.

The project execution will be carried out mainly by the LI office in Dresden, Germany. Up to now the following services were performed:

- Conceptual design
- Preparation of EU-wide tender documents
- Tender evaluation
- Support during tender negotiations

LI has entrusted a local engineering office in Dresden for the civil design works.

The following services will be performed by LI during the project execution:

- Design approval of contractors design
- Site supervision, including time scheduling and cost controlling
- Supervision of commissioning activities
- Performing of acceptance tests
- Review and approval of the "as-built" documentation

Special emphasis has to be paid to the co-ordination of the commissioning activities. Outages of the power supply must be avoided under all circumstances during the switch-over and interconnection activities from the existing switchyard to the new switchyard. This task requires a close and duly co-ordination of all parties concerned, since the Substation Dessau-Alten is the central grid station between Dessau city and the nation-wide power supplier.

Klaus-Uwe Huhnke

GEORGIA

SCADA/EMS and Communication Systems for High-voltage Transmission Grid

Lahmeyer International (LI) was assigned by Georgian State Electrosystem (GSE) in June 2004 with the preparation of tender documents for SCADA/EMS systems and communication installations for the transmission grid of GSE with 500 kV, 220 kV and 110 kV substations as well as the connection of metering installations for monitoring of energy exchange between GSE and its partners.

LI will also participate in contracting with suppliers, in project management and controlling, in quality assurance of deliveries, the supervision of installations and implementation of the systems as well as the acceptance tests. The tender documents will be completed after reviewing and adaptation of the preliminary design studies.

The project serves in continuation of the commercialisation of GSE within the framework of an extensive reform programme of Georgia's energy sector. The objective is the unbundling of generation, transmission and distribution in order to develop a liberalised energy market. Financing is shared by the World Bank and other international organisations.

The network control system will implement SCADA functions for supervision and control of 39 substations and power plants as well as energy management functions and network application modules.

In addition to new radio links and new own fibre optic cable links, existing transmission capacities on fibre optic systems of other providers will also be used for communication.

Walter Buckow,
Dr. Siegmar Leutloff

IRAN

30 MW Wind Park in Manjil

Lahmeyer International together with the Iranian engineering company Moshanir was assigned to develop a technical and a financial feasibility study for 30 MW wind park located next to Manjil in the province of Gilan. The Japanese government is supporting this project with a US Dollar 60 mill. credit.

Manjil is situated about 220 km north-east of Teheran and 80 km south of the Caspian Sea in the province of Gilan. The wind conditions are characterized by average wind speeds of about 6 m/sec (at 40 m measuring height above ground) in winter and by superb wind conditions especially in summer. The strong north-wind in the months from May to September with an average wind speed of 14 m/sec (at 40 m above ground) and more can be explained with the local climatic and geographic circumstances. Through the different distribution of temperature of the Caspian Sea and the landmasses south of the Caspian Sea, a formation of sea breeze especially in those months which have powerful solar radiation is observed. The long drawn-out valley in north-south direction and the sudden contraction near the city Manjil, additionally leads to a jet-effect with exceptionally high wind speeds.

During the last years, two wind parks were constructed in Manjil which presently will be extended. Already in 1995 a 10.1 MW park with 300 kW and 500 kW turbines was installed with support of the Global Environment Facility (GEF). In

Factory for the production of wind energy plants in Teheran

an additional wind park near the reservoir of Manjil, further turbines of an Iranian manufacturer were installed.

With the goal to achieve the added value for industrial parts in the country itself, the Iran initiated various activities with regard to the wind industry.

Under the umbrella of an Iranian corporate group a company is focussed on the production of wind energy plants.

The company has signed a contract with the international market leader regarding technical co-operation and technology transfer with a budget of Euro 25 mill. In close co-operation of the partners, a 660 kW wind energy plant will be produced.

Bert Hagenkort

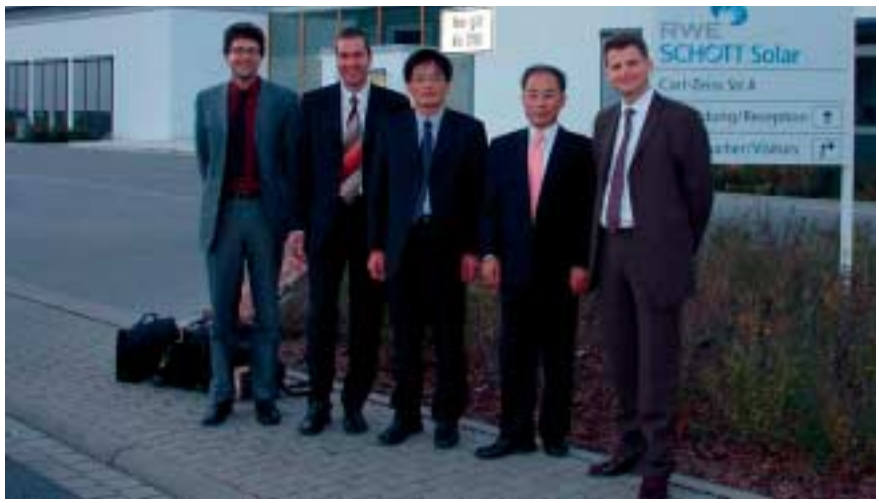
KOREA

Consulting Services for Business Development in the Photovoltaic Industry

In the Republic of Korea a renewable energy law similar to the one implemented in Germany was enacted in 2004. The goal was set to increase the renewable energy share in primary energy consumption to 5 % by 2011, which requires an expansion of the renewable energy generating capacity by 20 % per year. This will be achieved mainly through the utilisation of photovoltaic (PV), wind and biomass energy systems – technologies which are supported by the law.

In Korea, at the moment, photovoltaic systems with a total power of 2 MW are installed each year. Thus the market is small compared to Germany, where about 250 MW of PV systems are installed every year. Nevertheless, it is expected that due to favourable feed-in tariffs for photovoltaic generated electricity, set by the Korean Renewable Energy Law and other financial benefits, the volume of PV system installations per year will rapidly increase in Korea to about 40 MW by 2006.

In October 2004 the Korean company Dongbu contracted with Lahmeyer International for advisory services with regard to their photovoltaic systems business development in Korea. Dongbu is a large Korean Group with business activities primarily in manufacturing and chemical production. Lahmeyer International conducted a study for Dongbu of the European PV market as well as of European PV companies. Lahmeyer International further facilitated contacts to possible business partners for the Dongbu Group.



Dr. Jeong, Dr. Yeo and representatives of RWE Schott Solar in Alzenau, Germany

In Germany the Renewable Energy Law has significantly stimulated the PV market volume, which grew over the last few years at a rate of 30-40 % annually. In this strongly expanding market sector prices are decreasing by more than 5 % per year, and various new companies have been established successfully with different strategies: There are highly vertically integrated companies with manufacturing activities at almost every step of the value chain from silicon production to the complete installation of a PV plant. Other companies are specialised, e.g. in the production of solar cells or in system integration. Both strategies have permitted high growth rates in relation to the world market, which currently has a volume of Euro six billion.

After intensive co-operation, successful meetings and a study tour of projects and manufacturers, our Korean client has the chance to decide on the attractive options for co-operation with several European PV industry companies.

Furthermore, the delegation from Dongbu acquired information relevant and helpful for their business planning, strategy development and joint ventures.

Werner Klaus

ICELAND

690 MW Kárahnjúkar Hydroelectric Power Plant

Raise Boring Machine for pressure shaft excavation

Iceland's largest hydroelectric power plant with a total capacity of 690 MW is currently under construction in the north-eastern part of the country, built by the national Icelandic Power Company Landsvirkjun. The generated power will be exclusively used for aluminium production for which a new aluminium smelting factory is concurrently under construction in the nearby seaport, Reyđarfjörđur.

The future Hálslón reservoir, with a capacity of 2100 million m^3, will be created by a 193 m-high concrete-faced rockfill dam supported by two saddle dams. From the power intake the water will be transferred via a 40 km-long headrace tunnel to two 415 m-high steel-lined pressure shafts feeding six Francis turbines with a capacity of 115 MW each. The electro-mechanical installations will be accommodated in two caverns, which are accessible via a tunnel approx. 1 km long. The generated electric power will be transmitted via a cable tunnel approx. 1 km long to an open-air sub-station, from where it is transferred to the final consumer by a new high-voltage overhead transmission line, also currently under construction. After passing the turbines the water will be discharged into the Jökulsá i Fljótsdal River via a tailrace tunnel approx. 1.3 km long and an open-air channel.

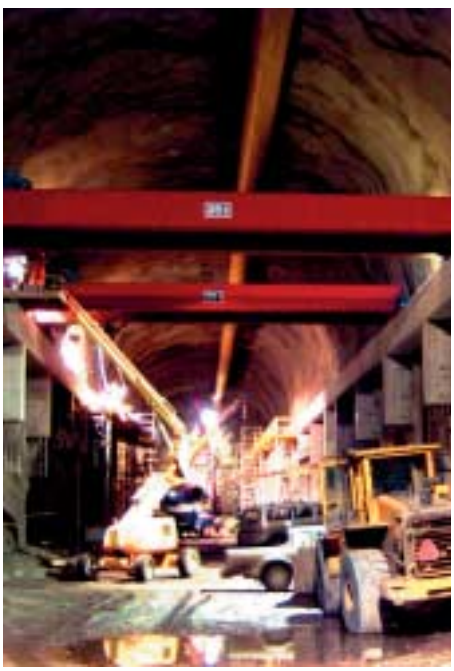
In August 2003 the contract for construction supervision on behalf of the Owner for lot KAR-15 was awarded to the joint venture with Lahmeyer International as leading firm, in co-operation with the Icelandic partners Hönnun, Almenna, VSO and Rafhönnun. Lot KAR-15 powerhouse area comprises all structures from the top of the pressure shafts to the water discharge into the river. The Contractor, Fosskraft, which is a joint venture of Germany's Hochtief, as sponsor, and three Icelandic partners, is carrying out the construction works.

The physical conditions prevailing in this area, only about 300 km to the south of the Arctic Circle, demand immense efforts and untiring engagement from the people involved. The equipment is subject to considerable wear and tear. Regardless of partly adverse weather conditions, the progress of works achieved up to now in lot KAR-15 is enormous. Underground works commenced in October 2003 with the access tunnels to the caverns. All excavation works for the underground structures, with the exception of the raise bored pressure shafts, are being carried out by the Drill & Blast Method. All excavation works will be completed by December 2004. Works at certain sections are currently six to eight months ahead of schedule.

The excellent progress achieved can be attributed to the high portion and standard of mechanised work and to the fact that, to the maximum extent possible, various phases of the work were carried out in parallel. Spray robots, provided with multiple booms, were used for applying shotcrete, generally reinforced with steel fibres. The excavation of the two 415 m-long pressure shafts was carried out by a Raise Boring Machine and was completed in five months, i.e. in two and a half months per shaft.

The first electric power generation is scheduled for April 2007. The use of these hydropower resources for the production of aluminium is considered a valuable contribution to Iceland's economic development and the improvement of its infrastructure.

Rolf-Günter Köhn,
Gunnar Gudmundsson



Status of powerhouse hall in September 2004

BURKINA FASO

Celebration on the Occasion of „Availability of Water from the Ziga Reservoir“ in Ouagadougou

On 10th July 2004 celebrations took place at great expense and in the presence of the State President of Burkina Faso to mark the most significant phase of the Ziga Project: For the first time water from the Ziga reservoir was available in the capital.

A glance at the history of this project shows why this symbolic event was met with so much enthusiasm by the local media and the population.

In 1984 Lahmeyer International (LI) carried out the first studies for water supply for Ouagadougou financed by Kreditanstalt für Wiederaufbau. Nevertheless, LI could execute the final design of the main lot between 1994 and 1996 and project implementation began in 1998.

The main cause of the delay was the funding at that time of 107 billion CFA Francs (163 million Euro) by 12 different international development banks with various credit conditions. In Burkina Faso this is still a record amount for a project.

The water deficiency in the capital is chronic, with recurring emergencies at the end of each dry season. There has been no important improvement in the water supply system concerning water quantities over the last 20 years, which makes the urgency of the situation particularly clear.

Everybody is happy about the water from the Ziga reservoir

On the day of the celebration, 10,000 people gathered at the main pump station. This area was reserved for invited guests and was decked out with a large fountain, stands and tents.

The ceremony was celebrated with music, traditional and modern dance performances, speeches and awards to firms who had contributed to the success of the project, some of which – including LI – are still involved.

The highlight of the celebrations was the opening by State President Blaise Compaoré of the shut-off valve of the distribution line, causing a 10-metre-high fountain.

State President Blaise Compaoré, at the opening of the Ziga distribution line

The water from the Ziga reservoir is still not available to the majority of the consumers. It will take a further two to three years before all the planned new pump stations, water towers, distribution pipes and house connections have been built. LI is responsible for site supervision and technical assistance on the project and will be involved in the region for some time to come.

Harald Hechler

Technical Data of the Ziga Project

Catchment area of the Ziga dam	20,800 km²
Storage capacity	200 million m³
Flood relief	2,400 m³/s
Distribution pipeline DN 1000	43 km length
Water treatment plant and pumping station	4 500 m³/h
Water towers	8 x 2000 m³
Main distribution network	54 km DN 300 to DN 900
Distribution network	103 km DN 100 to DN 300
New house connections	50,000
Estimated project costs 2004	230 million Euro

GERMANY

Preliminary Design for the New Pumped Storage Plant Waldeck I

The pumped storage plant Waldeck I, owned by E.ON Wasserkraft GmbH, has been operational since 1932 and is situated downstream of the Edertal dam on the Eder river near Kassel, Germany. The four conventional generating sets, with a head of 297 m and a total installed capacity of 140 MW, are out-of-date and, after 70 years of continuous operation, in need of substantial repair or even replacement. At present it is anticipated that a new shaft-type powerhouse, equipped with a single 70 MW pump turbine unit, will be added to the existing structure. Furthermore two of the old turbines of the conventional sets are to be refurbished to provide short-term reserve capacity.

As basis for the investment decision of E.ON Wasserkraft GmbH, Lahmeyer International executed the preliminary design between May and August 2004 for a new shaft powerhouse with 70 MW, alternatively 50 and 90 MW installed capacity as well as for the necessary rehabilitation works at the upper reservoir and on the old turbines.

Powerhouse and penstocks of the existing pumped storage plant Waldeck I

The location for the new shaft powerhouse was chosen adjacent to the existing powerhouse. As a consequence of a straight extension and connection to the existing penstocks, this location leads to minimised hydraulic losses, allows - as a result of a perpendicular arrangement of the new pressure tunnel and the draft tube/shaft - for a compact and thus cost-effective layout of the shaft powerhouse, has a number of operational advantages resulting from the unchanged accessibility of the existing structures, and provides enhanced flexibility in the arrangement of the draft tube/shaft and the outlet structure.

The shaft powerhouse has a diameter of 17 m and a depth of 35 m to provide the required suction head for the new 70 MW pump turbine of –25 m. In addition, major parts of the existing switchyard, the lower reservoir and - after a necessary rehabilitation - also the upper reservoir continue to be used for the new pumped storage plant Waldeck I.

The design provided contains a technically sound and excellently executable concept, which makes best use of the existing components so as to contribute to an economic implementation. Provided that a prompt decision for construction is made, it may be possible to commence the new plant's commercial operation in spring 2009.

Dr. Volker Spork

Powerhouse with electro-mechanical equipment from 1932

JORDAN

Mujib Dam

Mujib Dam with full reservoir

The Mujib Dam built for irrigation purposes is located some 100 km south of Amman on Wadi Mujib. The owner is the Jordan Valley Authority. The maximum height of the dam is 67 m and the crest length is 764 m – of which the central 466 m are made of roller compacted concrete (RCC). The flood release is effected by an ungated spillway across the RCC dam. Construction started in January 1999 and was completed in December 2003. The inauguration by King Abdullah II took place on Easter, April 12, 2004.

The construction contracts had already been signed when Lahmeyer International came into the project. After reviewing the tender design some design changes were introduced. These included:

- change of RCC with high to one with low cementitious content,
- omitting the concrete slab in the stilling basin, i.e. rock excavation only,
- introduction of clay core rockfill dams at both abutments in order to bridge a weak and soft mudstone layer surfacing above the valley floor,
- curving the dam axis at the left abutment in order to improve foundation conditions.

A total of 660,590 m^3 RCC and each 26,000 m^3 facing mix and bedding mix were placed. For the rockfill dams 1.3 mil. m^3 were used. The possible maximum flood (PMF) is 5840 m^3/s and results in a specific discharge of 19.5 $m^3/s/m$ over the dam.

The design adjustments were caused by the geological and geotechnical site conditions which were only revealed in detail after the construction started. It was also required to optimise the RCC mix design to take account of the available aggregates, the climatic conditions and the load conditions to be applied.

Because of the ongoing construction contract the design adjustments had to be done under extreme time pressure. Everyone working in the construction field can imagine that such a situation results in some contractual difficulties.

The trivial insight that adequate geotechnical and material investigations are imperative for the successful execution of a dam project was once again confirmed.

Bernhard Stabel

Mujib Dam with partial impounding

MOZAMBIQUE

Strategic Sanitation Plans for Seven Municipalities

Lahmeyer International, in cooperation with German and local partners, prepared Strategic Sanitation Plans covering storm water drainage, wastewater and waste management and institutional development for the municipalities of Maputo, Matola, Beira, Dondo, Nampula, Pemba and Quelimane in Mozambique.

Since the end of the civil war in 1991 strong efforts have been mobilised to rehabilitate urban infrastructure at a minimal level. The development policies of the Government have concentrated since the end of the nineties on the elaboration of medium and long-term perspectives for the efficient upgrading of infrastructure and the improvement of service quality considering the extremely limited financial and human resources.

The Project is part of the First National Water Development Project (1998-2003), implemented by the Government with support of the World Bank and other bi and multilateral partners. During the first years of the Project, activities concentrated on water resources management and improvements to the water supply. In October 2002 the National Directorate of Water, Ministry of Public Works and Housing, commissioned a Joint Venture of German consulting firms with Lahmeyer International as lead firm, to establish the complex and demanding master planning.

The Strategic Sanitation Plans for the most important cities of Mozambique, with a present population of more than 3 million, approximately 50 % of the urban population of the country in 2003, consider a planning horizon of 15 years up to 2017 and cover the following infrastructure sectors:

- Storm water drainage
- Wastewater management and excreta disposal
- Collection and disposal of municipal waste
- Disposal of hazardous and health care wastes

The work programme was implemented in three project phases and comprised the following main components:

- Data collection and situation analysis of all sectors in all municipalities, considering existing planning documents and ongoing projects e.g. for water supply
- Analysis of urban development plans, present and planned land use, population projections
- Immediate measures
- Socio-economic assessments
- Discussion of development concepts / options, comparison of alternatives, preliminary designs for all main components as part of feasibility studies
- Assessment of the potentials for service improvements and reorganisation of the responsible municipal departments, options for private sector participation
- Cost estimates and budget planning for the implementation phases of 2, 5 and 8 years
- Financial analyses, options for cost recovery and tariff systems

Personnel of the National Directorate of Water was continuously and intensively involved in the planning process. The municipalities were represented by multi-disciplinary working groups chaired by the mayors.

For the planning horizon the Strategic Sanitation Plans defined, structured and estimated costs for more than 200 subsequent projects (around 80 planning and general support projects and approx. 120 rehabilitation and expansion projects), which are summarised in sector budget plans for each municipality.

Preliminary design for the rehabilitation and expansion of storm water drainage in the centre of Nampula

The implementation costs are estimated at more than USD 250 million; preference was given only to the most cost effective solutions. For storm water drainage cost estimates cover the primary system components. In 2 municipalities sewerage systems shall be rehabilitated and extended to a total capacity of 500,000 population equivalents.

After completion of the services in August 2004 the Client is to prepare the implementation of Phase 1 and 2, with a duration of 2 and 5 years, respectively.

Rolf Koch

Preliminary design of the main components of the proposed sewerage in the centre of Maputo

SUDAN

Basic Surveying for Merowe Dam Project

GPS measurement in one of the 200 new control points

At the fourth cataract of the Nile River during the next seven years the Merowe Dam is under construction. This is considered to be a key project for the economical and social development of North Sudan.

Since 2000 Lahmeyer International (LI) is commissioned by the Merowe Dam Project Implementation Unit (MDPIU) of the Ministry of Irrigation and Water Resources, Khartoum, to carry out extensive surveying works within the frame of the Merowe Dam Project. By mid 2003 LI was instructed to carry out the basic surveying for the planning and the construction execution of the project.

The basic surveying comprises the installation of a long-range control network and the bathymetric survey of the Nile River. The new control point network was supposed to provide a planimetric and altimetric accuracy at centimetre level which was in view of the local circumstances a very challenging stipulation.

Consisting of 200 new control points the network stretches from Abu Hamed downstream to Dongola over a length of 600 km along the river Nile. Pillars made of concrete with a 3-D-Mark on top were especially produced for the marking of the control points. Due to the high demand in accuracy different surveying methods were applied for the determination of the coordinates: The static DGPS method for the determination of the planimetric coordinates and precise levelling for the determination of the elevations.

During the 42 days of the DGPS campaign 1.3 GB of raw data were gained for the calculation of 1044 baselines. The precise levelling was carried out by means of digital levelling instruments. In inhospitable terrain with temperatures of almost 50° Celsius a distance of approx. 2000 km had to be covered by walking.

The evaluation of the surveying data showed that the demanded accuracy was not only kept but even exceeded. With the completed control network the Merowe Dam Project dispose of a very homogenous, precise and permanent marked surveying network which suites in all respects for the future demands and tasks.

The bathymetric survey of the river Nile totally consisted of 312 cross sections at intervals of about 2 km. The average length of one section amounts to approx. 1 km. In the future reservoir area the section width ranges between 2 and 10 km. Three different methods were applied for the cross section surveys. With GPS supported echo sounding measurements the depths of the riverbed were defined, RTK GPS observations provided data for islands and riverbanks and in addition an existing terrain model was used for the reservoir area.

The field work was a challenge for team and equipment due to the many cataracts and the numerous outcropping and hidden rocks within the Nile itself and required an extraordinary logistical effort. The measurements were carried out during the flooding season in order

Location of project area

to survey the fourth cataract at the highest water level. But even then many passages could only be navigated with great difficulties.

In contrast to this the riverbanks were surveyed during the low water season in order to obtain an overlap between echo sounding measurements and RTK GPS measurements.

With the completion of the raw data processing and production of cross and longitudinal sections, detailed and comprehensive information about the Nile River topography between Abu Hamed and Dongola is now available for the first time.

Leonhard Weimper

Overcoming the fourth cataract

CROATIA

Modernization of Railway Corridor Vc

To improve the European transportation corridors, the railway corridor Vc running north-south through Croatian territory will be rehabilitated and modernized.

The line sections in question were originally developed for a maximum speed of 160 km/h. The line extends southwards over some 123 km from northeast of Beli Manastir through Osijek and Slavonski Samac to Metkovic and the port of Ploce on the Adriatic Coast.

The total cost for the modernization of the railway infrastructure facilities will be Euro 96.62 million. A portion of the costs are being financed by a loan of Euro 40 million from the European Investment Bank to the Republic of Croatia. On July 26th 2002, Lahmeyer International (LI) has been commissioned as Consultant together with German and Croatian partners by the Croatian Railways for track works, station buildings, tunnels, bridges as well as signaling, telecommunications and catenary.

The main services to be provided by LI and its partners cover the review of existing preliminary and detailed designs, assistance in compiling the relevant tender documents and in the tender evaluation process, the construction supervision and issue of reports.

Chart showing the Croatian Railway Networks with Corridor Vc from the Hungarian border to the border of Bosnia and Hercegovina; from the border of Bosnia and Hercegovina to the Adriatic Coast

The construction works include the line overhaul and diversion of a part of the line, reconstruction or refurbishment of bridges, tunnels and stations. For electrical works, power and telecommunications:

- Reconstruction of electric power supply facilities,
- electrification of the line from Beli Manastir to Strizivojna/ Vrpolje,
- new catenary on the sections Strizivojna/Vrpolje – Slavonski Samac and Metkovic – Ploce,
- the reconstruction or improvements to the low voltage network for stations incl. lighting,
- the installation of Auto-Stop equipments, securing of level crossings to improve traffic safety,
- installation of Railway Automatic Telephone network and exchange,
- installation of fibre optic cables along the whole length of the line,
- the establishment of a remote control of train traffic system and the installation of GSM-R and UHF networks in the main stations.

The project started in June 2002. Construction works in the southern section were completed in June 2004. Start of construction works in the northern section are scheduled for the middle of 2005. Completion of the project is scheduled for the end of 2006.

Dieter Krüger

GREECE

Stavros Depot of Athens Metro

The Stavros Depot is located at the end of Metro Line 3, in the direction of Athens International Airport. The Depot had to be completed before the Olympic Games in Athens in 2004 to improve efficiency of the public transport system between the airport and the city. In 2002, Lahmeyer International was awarded the detailed final structural and electro-mechanical design by Themeliodomi S.A.

Stavros Depot during construction

The Stavros Depot has an area of 27.000 m² and is for the maintenance and repair of the rolling stock of Line 3. Furthermore, the future rapid rail connection to Athens International Airport will be linked with the Metro at Stavros.

The metro maintenance building is 130 m by 90 m wide having 13 tracks. The roof of the building will also serve as the ground floor for an 8-storey high car park which will accommodate some 2,400 cars. The car park will have direct access to the Attiki Odos highway and the nearby bus transfer station.

The track level of Stavros is located some 8 m below ground level, supported by retaining walls up to 12 m high, and about 800 m long. The retaining walls are partly constructed as twin walls, with an access ramp in between. At the far end, there is a cut-and-cover tunnel which widens like a trumpet for the entry of the trains into the depot.

An underground rainwater catch basin, capacity of 4,500 m³, was planned as a temporary buffer in case of heavy rainfall. To gain time, this basin was built after the depot building. Due to restricted space a top-down method to construction was used. Diaphragm walls were used as perimeter walls and bored piles as columns. The roof slab was poured directly on the ground, and the excavation was through an open area in one corner of the roof slab.

Dr. Gertraud Lappas

VENEZUELA
Metro Los Teques

Caracas, the capital of Venezuela, has a population of over 4.5 million, and is the economic centre of the country. The explosive growth of the population is attributed to migration of the rural population from the poorer areas to the city.

This rural exodus requires that the infrastructure of the city and the region has to be continuously developed. To date there is still a lack of an efficient public transport system in the region.

Because of the difference in altitude, the climate in the suburb of Los Teques is milder than that in Caracas, which is why people prefer to live in Los Teques and commute to their work in Caracas.

The only direct link is the "Panamericana", which is one of the most used roads in Venezuela. With the construction of the Metro Los Teques, the daily congestion of this link road will be avoided or at least reduced.

The Metro Los Teques is 9.5 km long and runs through a topographically difficult area in the narrow, winding Rio San Pedro valley, which is also characterized by highly erosive surface conditions. Several river training measures were necessary to protect respective valley sections where heavy landslides can occur in the rainy season.

Terminal Los Teques during construction

The Metro climbs the mountainous track in less than ten minutes at a speed of 80 km/h. At the terminal station the track of the Metro Los Teques will be connected to the Line 2 of Metro Caracas, which runs into the centre of the city of Caracas.

In 2003, Lahmeyer International formed a consortium with a local partner and another international consulting firm to perform studies to establish the design criteria and specify in broad terms the rolling stock, the power supply and the tunnel ventilation system, giving priority to the operational safety and security. One critical aspect was the compatibility of the existing infrastructure with Metro Caracas.

In the next project phase these studies will be the basis for the tender documents and for tendering of all electro-mechanical equipment for Metro Los Teques.

Max Läuchli

GREECE

SYGROU - FIX Transfer Station in Athens

The Athens Metro has been in operation since 2000 and is continuously being extended. Transfer stations are necessary to allow passengers to change from private car, bus or tram to the Metro.

The first of these transfer stations "Sygrou - Fix" is located close to the centre of Athens between two busy roads. Construction was completed before the Olympic Games in August 2004, allowing traffic diversions to be removed. In 2002 the Greek contractor AEGEK-EKTER-METON awarded Lahmeyer International the design works for the excavation support and the final structural, architectural and electro-mechanical works.

The transfer station Sygrou-Fix is located close to the centre of Athens between two busy roads.

The station comprises an underground car park with 6 parking levels. Shops occupy part of the first parking level. On the ground level there is a bus stop with space for 4 articulated busses. An external corridor for pedestrians from level -1 to level -2 allows direct access to the Metro Station. A tram stop is located on the opposite side of one of the roads.

The car park accomodates 650 cars having an area of 5100 m^3 and a volume of 110,000 m^3. A 5-storey building is planned to be built on top of the car park.

Initially, Lahmeyer International suggested the Top-Down Method, to minimize interference with the neighbouring Metro station and tunnel. However, for reasons of construction time and to protect possible archeological findings, the cut and cover method was decided upon, using reinforced concrete piles with ground anchors.

During excavation, one side of the Metro station was completely exposed, which resulted in unsymmetrical loads due to soil and water pressure from only one side. Therefore, re-calculations of the stability of the Metro station were necessary.

Detailed calculation of the uplift pressure showed that before construction of the planned 5-storey building, the safety against uplift was insufficient. Permanent soil anchors were not permitted to be used. The thickness of the slabs in two thirds of the area was increased from 0.30 m to 0.42 m to improve stability of the structure. The reinforced concrete piles of the retaining wall of the excavation pit were integrated into the structure as additional weight, where possible. This was achieved by constructing corbels on the external walls below the cap beams, which connect the piles.

The main part of the statical calculation was done using a three-dimensional finite element model. This model comprised beam and column elements, which are combined with plane elements representing slabs, walls and ramps. The foundation slabs and the external walls were assumed to be elastically bedded on the surrounding soil.

The following load cases were considered in the analysis:

- Dead loads of the car park and of the 5-storey building
- Earth pressure due to dead and live loads from each side (effective after failure of the anchors)
- Water pressure, inclusive uplift
- Live loads inside and on top of the car park
- Live loads of 5-storey building
- Earthquake earth pressure
- Earthquake loads of the underground structure and of the 5-storey building

A non-linear analysis was carried out. For all possible load combinations (before and after failure of the ground anchors, maximum or minimum ground water level, with or without earthquake) the required reinforcement for each structural member was calculated separately. Envelopes of the required reinforcement were used for detailed engineering drawings.

Dr. Gertraud Lappas

GERMANY

Modernization of the Auxiliary Klingenberg Dam

The Klingenberg dam in the Wilder Weisseritz Valley was constructed in the years 1908–1914 according to plans prepared by the Royal Hydraulic Engineering Administration of Saxony, to secure flood protection and also improve management of low water flows in the lower reaches as well as the drinking water supply for Dresden.

The auxiliary dam at the root of the Klingenberg dam was commissioned in 1954 in order to improve the water quality. The auxiliary dam was badly damaged by the extremely high floods of August 2002 and has been provisionally repaired in the meantime.

In order to carry out the planned full-scale reconstruction of the main dam, the reservoir must be completely emptied. During this time the release of raw water will be from the auxiliary dam reservoir, which will be enlarged.

The Dams Administration of the Free State of Saxony commissioned Hydroprojekt in December 2003 to modernize the auxiliary dam including the construction of a replacement inflow gauging station.

The modernization measures will include the construction of a homogeneous dam on the same site which will be 4 metres higher than the existing one. This will increase the operating volume from 70,000 to 240,000 m³. The new dam construction will have a height of approx. 12 metres and the length of its crest will be around 144 metres. The dam volume will be approx. 25,000 m³.

The existing auxiliary Klingenberg dam and flood relief spillway

The spillway – because of its ground plan named duck's bill – has a height of 10 metres. The fixed spillway edge is a good 45 metres long. In addition, a vertical slide gate (4 x 2) for controlling the flood protection capacity will be fitted on the front face. During normal operation the gate is open. It will be closed when necessary to prevent the body of raw water in the main dam being affected by the inflow of disturbed sediment. Two bottom outlets, each with a nominal diameter of DN 800, will be integrated into the front face of the flood relief spillway.

Additionally, to improve the water quality and management, the cross-connection to the auxiliary dam will be converted into a low overfall, the inlet section and the downward gradient step at the old Beerwalde gauging station will be converted river bottom slide and an oil barrier also installed. Further, the Beerwalde gauging station will be

The proposed site of the new gauging station for the measuring of water levels and water quality parameters

renaturized, the replacement inflow gauging station constructed, a floatsam barrier erected and improvement of forest roads carried out.

The existing inlet gauging station will be filled in the future and therefore no longer usable.

For the management of the dam it is important that low and mean flows are measured with a high degree of accuracy. In the same way, flood discharges up to 50 m^3/s are to be recorded. As with the existing gauging station, besides water levels, water quality parameters will be measured also in the future.

Parallel recording of measuring data of the new and old levels will be necessary for at least one year in order to take into account the displacement at the site.

The planning documents for the new gauging station are presently in the hands of the authorities for approval. Construction is expected to begin in early 2005.

Jörg Jahn
Hydroprojekt
Ingenieurgesellschaft mbH

GERMANY

New Development of the 'Berliner Platz' in the City of Gießen

The Municipal Council of the City of Gießen intends to bring together all its Municipal employees, who are currently based in different buildings spread over the city, under one roof, in the new development of the Berliner Platz (Berlin place), in the centre of the city. The existing building ensemble currently accommodates 200 employees and a police station. These buildings are no longer suitable to provide up to date, both, community and local government services.

The site will be big enough to accommodate the Municipality as well as commercial and/or private developments.

To find a company or group of companies that will develop an integrated concept for both, the municipal administration and the commercial sector remains one of the leading goals.

The total project is split into the following sub-projects:

- Architectural competition,
- Master plan development,
- Removal of the present users
- Demolition and soil remediation,
- Tendering and investors' competition,
- Design and construction,
- Procurement of architects / consultants.

Due to the complexity, a tough co-ordination of the various subprojects is required to manage and monitor the project successfully.

Berliner Platz

Further tasks to be achieved:

- Definition of project tasks,
- Establishment of an internet based communication,
- Project manual including project specifications, job description, documentation structure,
- Scrutinising architectural and engineering design.

In respect to the various subprojects, involved parties and interfaces, the establishment of a sound project structure and project organisation is the key factor for a successful execution of the project.

The technical project management is carried out by Lahmeyer Rhein-Main, while the legal project management by the law firm FPS, Fritze Paul Seelig, Frankfurt a.M., Germany.

The reason for establishing a Public Private Partnership (PPP) model is not limited to find the best innovations comprising design, construction, operation and maintenance, but also to find the best financial investments for the project.

The current running architectural competition will close at the end of January 2005. The purpose of this competition is to identify the best concept regarding design, investment costs and operating costs and to select an architect to carry out the detailed planning work.

All the design proposals submitted for the competition will be exhibited for a period of 3 weeks.

We look forward to the selected design which will henceforth be intensified in the following stages.

Thomas Börner
Lahmeyer Rhein-Main

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