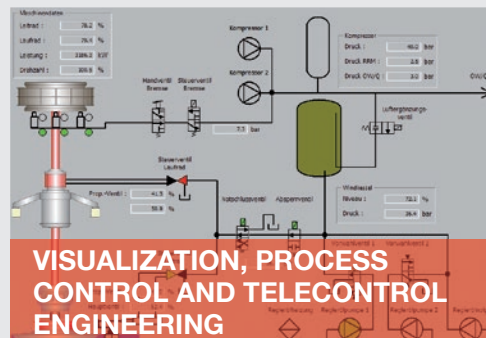


ENERGY AND AUTOMATION TECHNOLOGY FOR HYDROPOWER PLANTS FROM THE CONCEPTUAL DESIGN TO THE POINT OF REALIZATION





OUR EXPERIENCE IS YOUR SAFETY

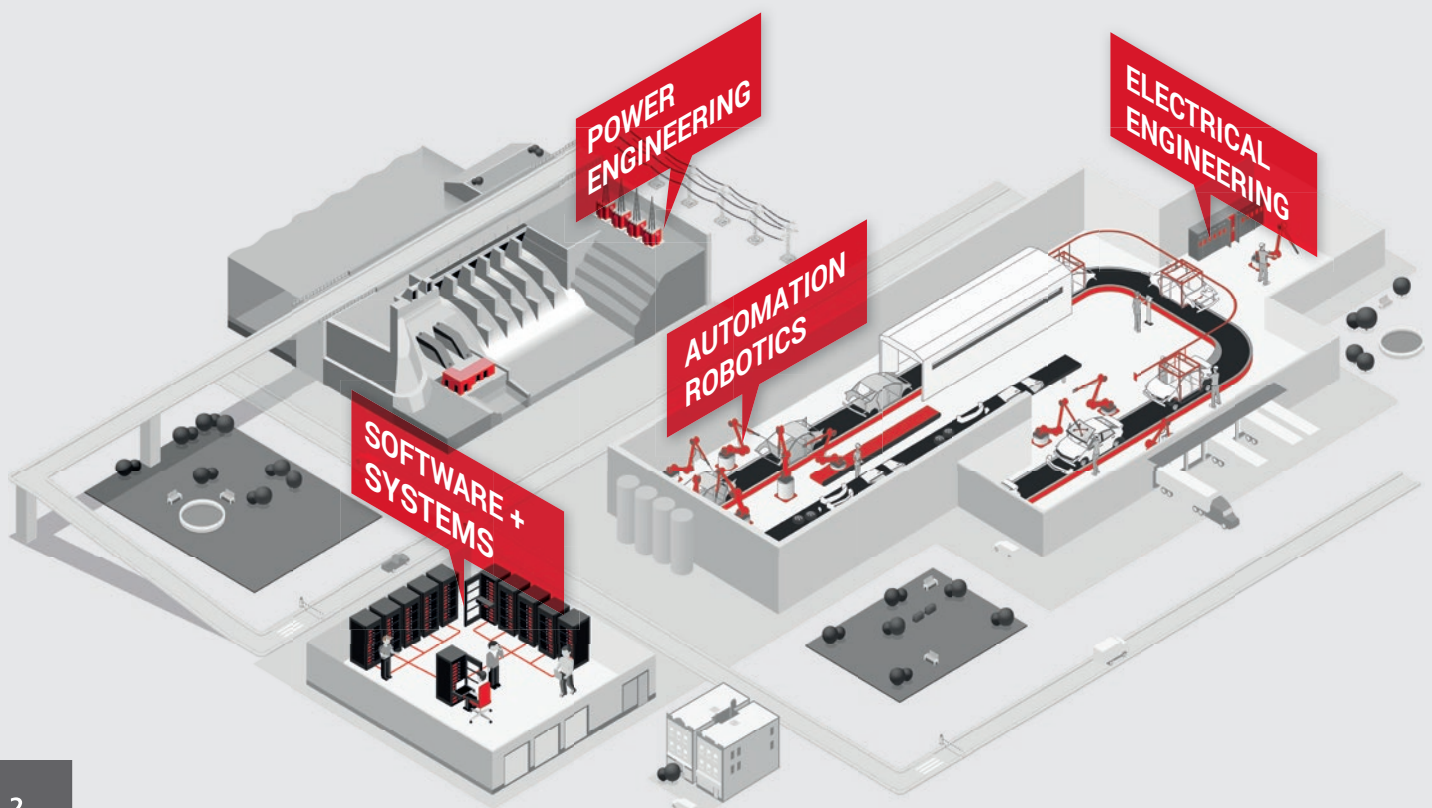
With currently around 1,000 employees, the **F.EE company group** is one of Germany's market leaders in manufacturing and automation technology.

The company is committed to the world's growth markets of the capital goods industry, the energy sector as well as the engineering and services segments. With its four business divisions Electrical Engineering, Automation Robotics, Software + Systems and Power Engineering, the company offers very successfully customised solutions in addition to products and services individually adapted to customer requirements. As a rule, the business divisions operate independently of one another in the market. In addition to the worldwide automobile and supplying industry, small and medium-sized businesses in

a wide range of sectors as well as energy suppliers, municipalities and power plant operators also make up the F.EE customer base.

State-of-the-art technical equipment, expertise, flexibility and many years of know-how are among the strengths of the F.EE company group. Around 30 employees work in the hydropower sector.

Since 2006 F.EE has had an ultra-modern control cabinet manufacturing centre in Neunburg vorm Wald: On an area of 8,500 m², approx. 4,000 linear metres of control cabinets (row cabinets, individual cabinets, control panels, control boxes and terminal boxes) are assembled, wired and tested annually.





HYDROPOWER

– A BUSINESS UNIT OF THE F.EE COMPANY GROUP

FLEXIBLE

We adapt to your circumstances.

INNOVATIVE

We find new solutions for your special requirements.

SUSTAINABLE

Together – for sustainable energy generating plants.

Irrespective the size of the hydropower plant and the type of turbines we realize high energy efficiency with our well-proven control engineering. Using reliable control technology we guarantee high availability. System stability, remote maintenance and fault log are demands we meet by PLC control and user-friendly control panels or PC visualization.

For small hydropower stations F.EE realizes compact systems (circuitry and control technology including compensation and hydraulic). For all other power plants we supply not only control systems but also hydraulic aggregates from a compact solution up to a redundant execution for big facilities. By using high-quality standard components from the field of power plants (Siemens: SIPROTEC, S7, ABB: Unitrol, Syn 5 usw.) a long lasting spare-part availability can be assured.

F.EE sets a high value on quality. The complete control system (electric cabinet, hardware and software) will be thoroughly tested in a simulator before delivery. As far as possible our control concept is based on standardized and pre-installed control lines; this reduces the assembly time enormously.

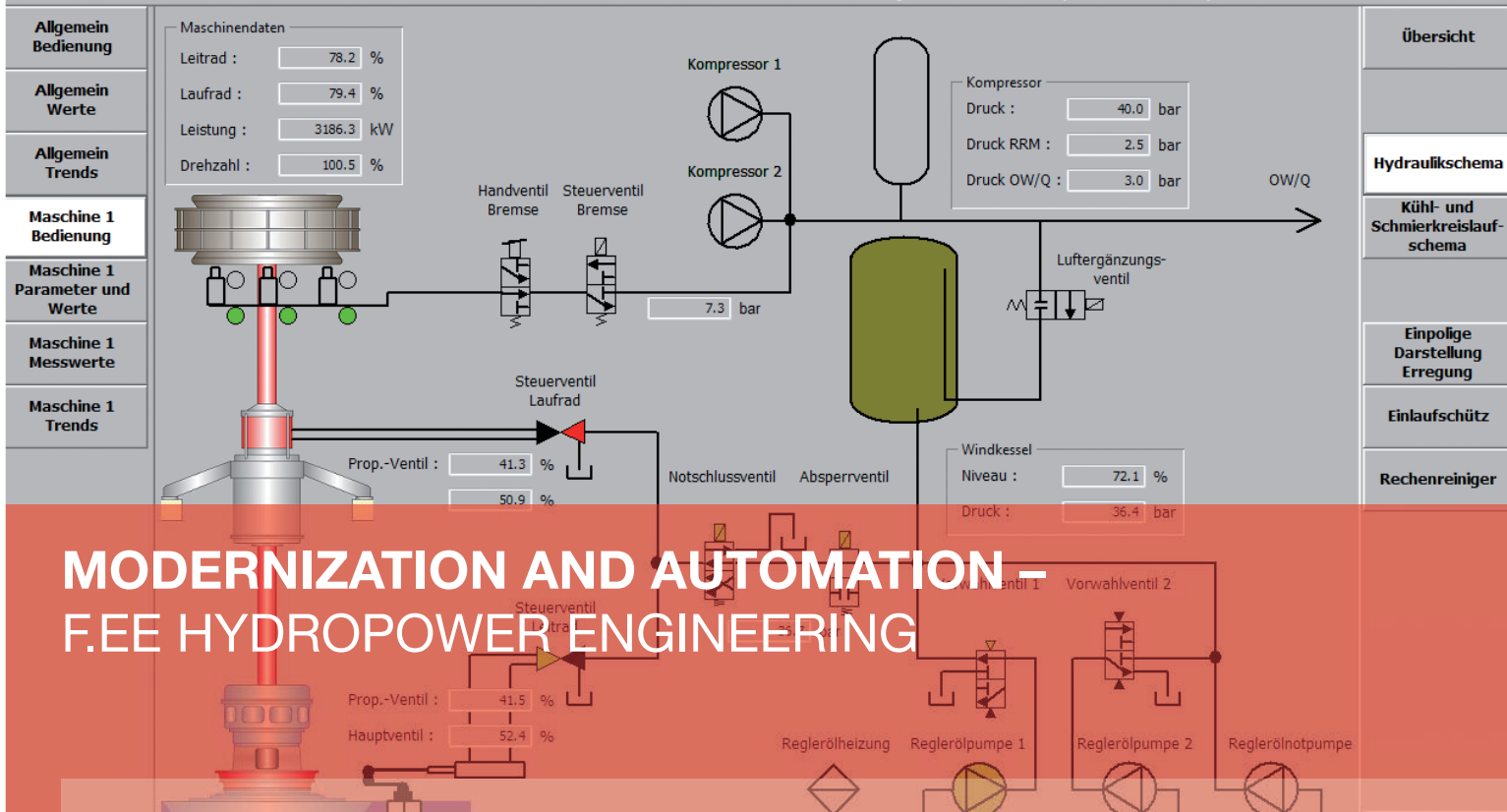


F.EE flexibel – innovativ – nachhaltig
WASSERKRAFT

**1.000 EMPLOYEES –
A TURNOVER OF
175 MILLION EUROS**

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MODERNIZATION AND AUTOMATION – F.EE HYDROPOWER ENGINEERING

Demands on the new hydropower-control technology:

- Personal security and plant protection
- Performance optimization
- System stability, availability
- Longevity and spare-parts supply of the components
- Fulfillment of the statutory requirements WWA (minimum water-level, -water delivery, etc.), EEG
- Recording and archiving of data
- Remote control and monitoring

Availability and system stability:

- Usage of industrial standard components
- Long-lasting availability of spare-parts
- Reversion to the lower automation level

Hydropower turbine control:

- Refitting to a digital turbine control with hydraulic
- Redundant rotational frequency monitoring
- Independent safety activation
- Software control in the machine PLC
- Data logging and triggering of the turbine
- Integration in the machine control possible

Water-Level and OWQ-Control:

- Multi-loop controls and error remote
- Simple and redundant level recording
- Opening and flow rate computation
- Free given value and limit value specification
- Integration for overview and control of all actuators (turbine, RRM, weir flap, bottom outlet, etc.)

Monitoring:

- Generator windings, -bearing (temperature and vibrations)
- Turbine bearing
- Pressure and flow rates, oil temperatures
- Setup of the limit value (warning, danger)
- Mechanical protection
- Electric security

Monitoring and remote control of the hydropower plant:

- Remote control by remote software
- Identical handling as at the electric control cabinet
- VPN-access via Internet (e.g. Internet café)
- Via PC, Notebook
- Via Smartphone while travelling (iPad, iPhone, Android)

F.EE – YOUR RELIABLE PARTNER

BENEFIT FROM MORE THAN 30 YEARS OF EXPERIENCE AND MANY REALIZED PROJECTS.

OUR STRENGTHS

- Planning and Production in Germany
- Components of well-known manufacturers (industrial standard, e.g. Siemens, ABB, Rittal, Phönix, Wago, Janitza)
- Short delivery times because of high standardization
- Long-lasting availability of spare-parts (up to 20 years)
- Customer-focused solutions
- Online-Service (remote control)
 - to support the optimization, error control
 - no long travelling times (cost saving)
- Redundant controls for high availability (e.g. separate PLC for each turbine)
- General contractor
- Capable contact persons
- Advice, Development, Construction, Planning, Mounting, Commissioning
- Certified by ISO 9001:2008 und ISO 14001: 2004
Quality management, environmental and safety management
- 30 years of experience in the field of hydropower technology
 - specialized personnel: e.g. programmers, design engineers, electric control cabinet builders
 - plant-specific solutions by consequent project planning
- Availability of our employees/contact persons for many years



REALIZED PROJECTS – OUR REFERENCES

F.EE – HYDROPOWER realized more than 300 hydropower projects in different sizes until now.

■ Cutomers

Private persons, construction companies, public services and energy suppliers

■ Types of power plants

River power plants, storage power stations and pumped storage hydro power stations

■ Types of turbines

Water wheel, flow through turbines, Francis-/Kaplan-turbines, Pelton-turbines

■ Generators

Synchronous-, non-synchronous-, permanent- or variable-speed generators

■ Spectrum of realization

From 5 kW up to a two-digit MW field

BAYERISCHE ELEKTRIZITÄTSWERKE GMBH | Bayerische Landeskraftwerke GmbH | BETRIEBE DER STADT MÜLHEIM AN DER RUHR | Block-Gruppe Friedrich-Georg | E.ON THÜRINGER ENERGIE AG | E.ON Wasserkraft GmbH | ELEKTRIZITÄTSWERK SCHWANDORF GMBH | Elektrizitätswerk Wörth an der Donau Rupert Heider & Co KG | ENBW KRAFTWERKE AG | Enercon GmbH | ENVIA THERM GMBH | FWA Dienstleistungen | HARZWASSERWERKE GMBH | HGvW Wasserkraftanlagen GmbH & Co. KG | HSI HYDRO ENGINEERING GMBH | Hydro-Energie Roth GmbH | KARL GMBH & CO. KRAFTWERKE KG | Kochendörfer Wasserkraftanlagen Turbinen-Maschinenbau e.K. | KRAFTWERK AM HÖLLENSTEIN AG | Lister und Lennekraftwerke GmbH | RAPPL WASSERKRAFT GMBH & CO. KG | Regionalwerk Toggenburg AG | ROBERT BOSCH GMBH | RWE Power AG | STADTWERKE MÜNCHEN SERVICES GMBH |

PROJEKTE

Stadwerke Passau GmbH | STATKRAFT MARKETS GMBH | Thurkraftwerk AG | Wasserkraftwerke Murg Breitwies Schlechttau GmbH & Co. KG | Wupperverband



BEW – WEIR SYSTEMS AT THE LOWER LECH AND THE UPPER DANUBE

Between 2007 and 2013 F.E.E. renewed the electrical engineering of ten weir systems at the lower Lech and the upper Danube for the Bavarian Electric Works (BEW). In sum, 30 weir fields – each with a sector gate with flip gate.

BEW operates the Upper-Danube-Hydropower-Plants which are owned by Obere-Donau AG and the Lower-Lech-Hydropower-Plants which are owned by Rhein-Main-Donau AG.

These weirs are run by winches – one on each side. A common chain transfers the adjustment to the sector gate and the flip gate. The winches which were formerly run by electric drive shafts are now adjusted by synchronous run control and electronic frequency converter.

The extremely high availability of weir systems is basically achieved by bypass control of the drives as well as ring topology of the network and by star-shaped power supply from both watersides.

Technical data:

Per weir plant three fields with a maximum flow rate of 500 to 700 m³/s (cubic meters per second).

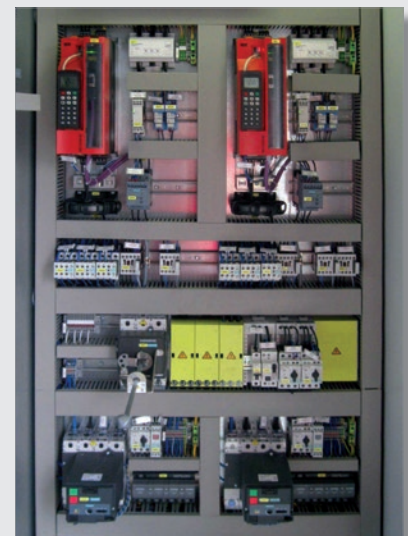


Image 1: weir control



Image 2: winch weir

STATKRAFT MARKETS GMBH – WAHNHAUSEN AND WERRAWERK

Powerplant Wahnhausen lies – same as the watergate – at the Fulda Weir Wahnhausen.

F.EE modernizes the complete automation and electrical engineering at the powerplant Wahnhausen. Especially interesting is the renewal of the power electronics, the control engineering and the static excitation by maintaining the already existing power and tension transformer as well as the high availability of these new static excitation device.

Technical data Wahnhausen:

A 4 megawatts (MW) Kaplan-turbine drives a static excited synchronous three-phase machine by a directly coupled vertical drive shaft.

F.EE provides a new OWQ-control for the Werrawerk near Hannoversch Münden after the reconstruction of the weir plant and establishes the communication to the already existing power plant control. The connection to the existing remote control system is carried out according to IEC 60870-5-104.

Technical Data Werrawerk:

The output of the power plant of 2.6 MW is transferred by three Kaplan-S-Turbines via gear mechanism to three synchronous three-phase machines.

Two new weir fields – each with a hydraulic controlled sector gate with flip gate – are used for pond in case of floods.

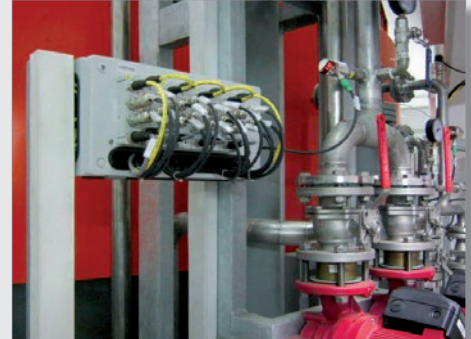


Image 3: Decentralized E/As in the cooling circuits in the HPP Wahnhausen



Image 4: Static excitation in the HPP Wahnhausen

LLK – LISTER AND LENNE POWER PLANTS

Between 1994 and 2013 F.E.E. has modernized and replaced, respectively, the electrical engineering on all 15 hydropower plants of the Lister and Lenne power plants. The 15 hydropower plants have an output of 0.1 up to 16 MW. 4 of which are river power plants, 10 power plants at dammed lakes and 1 pumped storage hydropower station.

The profitability of a pumped storage hydropower station is highly depending on the availability. The revision or manual mode, the local-automatic-mode is independent for each hydroelectric generating set. The subordinated control technology controls the pumped storage run and the output. In case of malfunctions detailed notices will be sent. The servicing levels at the luminous panels, control panels and the visualization are clearly assigned. The static excitation mechanisms projected and produced by F.E.E. are also set up with standard and automation components.

Technical Data HPP Sorpe:

Pumped storage hydropower station 2 x 4 MW Francis-turbine with horizontal shaft and pump / 1 x 200 kW Kaplan-turbine for continuous duty



Image 5: Pumped storage hydropower station Sorpe



Image 6: Machine shop power plant Sorpe

RWE – SAARKETTE AND EIFEL POWER PLANT

In the course of the Sub-Component-Renewal (TKE) F.EE renewed the complete electric engineering as well as the lubrication and control units of the turbines as the general contractor for the RWE Power AG between 2005 and 2011.

Technical data Saar power plant:

7 hydropower plants with an output of 1.4 up to 12 MW, all in all 12 hydroelectric generating sets, all of them are Kaplan bulb turbines, 8 of them are directly coupled Bulb generators and 4 machines with gears.

Between 2009 and 2013 F.EE renewed the complete electric engineering as well as the lubrication and control units as the general contractor for the Eifel power plant.

Technical data Eifel power plant:

5 hydropower plants with an output of 0.7 up to 16 MW, with penstocks of 100, 60, 40, 7 and 5 Meters, all in all 7 hydroelectric generating sets, 5 Francis spiral turbines and 2 Kaplan bulb turbines.



Image 7: Turbine cellar



Image 8: Direct current distribution



Image 9: Central control system hydropower plant Schwammenauel



(By courtesy of Elektrizitätswerke Mittelbaden)

POWER PLANTS WITH SPECIAL FEATURES

F.E.E. develops the control technology for the first four movable plants and the first four plants with permanently charged bulb generators. These plants were mainly realized in Baden-Württemberg and Switzerland. New solutions concerning the monitoring of the sensor system and the triggering of the gears that are used in a hydropower plant are necessary regarding the overtopping of the movable hydropower plant.

Meanwhile, the innovative general concept (patent owner: Hydro-Energie Roth) received several awards, amongst other awards one from the EU as the best environmental project in 2011.

Technical Data Bulb generators:

- Output 300 up to 650 kW
- Kaplan bulb turbines with directly coupled, permanently charged generators (Krebs & Aulich)
- Generator overtopped by works water

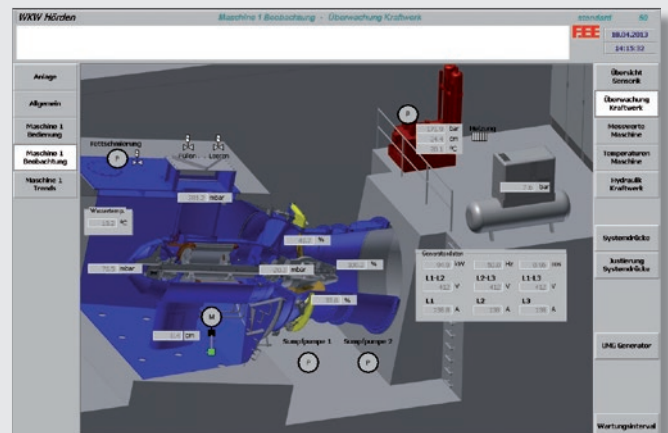
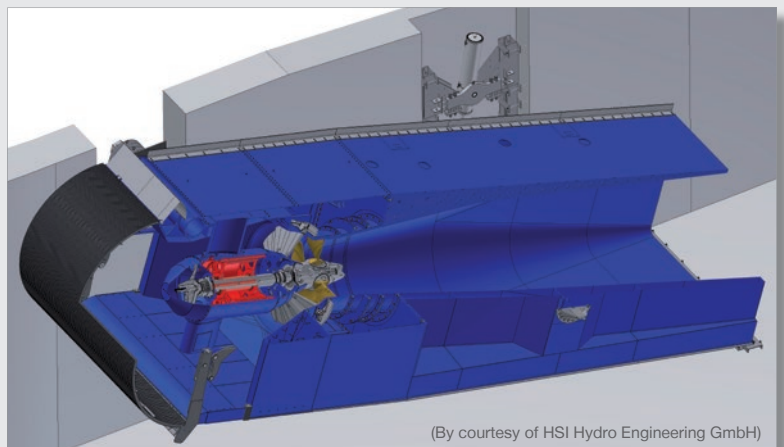


Image 10: Image from B&B-System

Technical data movable hydropower plants:

- Output 50 up to 550 kW
- Kaplan bulb turbines with directly coupled, permanently charged generators (Krebs & Aulich)
- Generator overtopped by works water
- Hydropower plant under- and overtopped



(By courtesy of HSI Hydro Engineering GmbH)

Image 11: Movable hydropower plant (Konzept: Hydro-Energie Roth)

MICRO POWER PLANT

For the last 30 years F.E.E supplied many micro power plants with the necessary economic control systems. According to the individual requirements “miniature hydraulic systems” and lube facilities were integrated in the compact control cabinets at these small plants. The pre-tested complete systems facilitate the installation and commissioning. Hence, a high comfort in monitoring and controlling can also be realized in those micro power plants.

HydroCompactPower 75 kW:

- Modular compact controller for all common types of turbines up to 75 kW
- Innovative operation via web visualization possible (e.g. via tablet PC or smartphone)
- Standard industrial controllers of well-known manufacturers such as ABB, Phoenix, Rittal, Siemens, Wago, guarantee the availability of spare parts for many years.



Image 13: HydroCompactPower 75 kw by F.E.E



Image 12: HPP Germek



Image 14: Integrated compact hydraulic system



INTERNATIONAL HYDROPOWER PLANTS

The main market of F.EE Hydropower is the German-speaking world. However, for the last years the market grew more and more internationally.

Technical data Rukarara II (Rwanda):

- 2 Francis-Spiral turbines with directly coupled synchron generators
- Penstock height of 50.6 m
- Water Catchment in two rivers: Rukarara and Rubyiro
- Installed plant output: 2.4 MW



Image 15: HPP Rukarara II

Technical data Mazimeru:

We delivered the switch and control units for the hydropower plant Mazimeru by order of Kochendörfer Wasserkraftanlagen.

- 2 Pelton-Turbines with directly coupled synchronous generators
- Penstock: 210 m
- Installed plant output: 500 kW



Image 16: HPP Mazimeru

PHILOSOPHY

PROJECT PLANNING

Together we will develop a concept for an efficient use of your hydropower plant. Specially tailored solutions are one of our assets. We will hand on our experience and knowledge to you regarding an effective development.

SERVICE

Our long-time employees will support you regarding all questions in the field of hydropower and are your personal contact. In case of a service being necessary, different communication ways are possible to handle the problem immediately.

INNOVATION

The long-time experience of our employees specialized in the field of hydropower and the special demands of our customers enable F.EE to innovations in details.

ON-TIME DELIVERY

Always a Must for F.EE!

MAN – MACHINE

We do not only offer man-machine interface and archive. F.EE also integrates alerting, remote control, parameterization and diagnostic capabilities in the visualization.



flexible – innovative – sustainable
HYDROPOWER

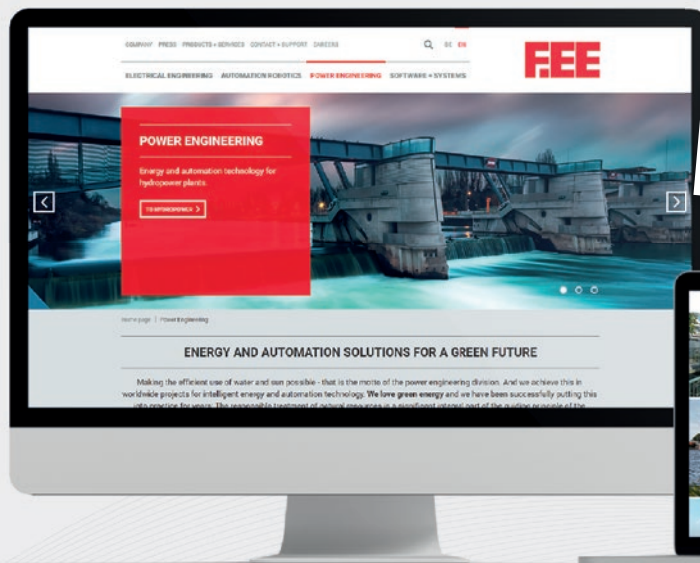
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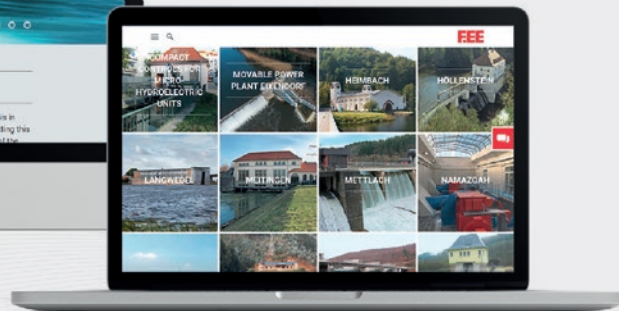
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F.EE Hydropower Technology

In der Seugn 10
D-92431 Neunburg vorm Wald

Phone: +49 9672 506-0
Fax: +49 9672 506-139

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