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Brandenburg University Enters Renewable Energy Education & Research with a Flexible Hybrid RE System

Case Study

BTU Cottbus expands teaching and research into renewable energy for Electrical and Mechanical Engineering Programs.

Client Profile: The KWT Department - Chair of Power Plant Technology

KWT CHAIR OF POWER PLANT TECHNOLOGY

b-tu Brandenburg University of Technology Cottbus

Brandenburg University of Technology Cottbus (BTU Cottbus, Germany)

University Link: www.tu-cottbus.de

Chair of Power Plant Technology

Department Link: www.kwt-cottbus.de

Client Profile: The KWT-Department - Chair of Power Plant Technology

The Chair of Power Plant Technology is directly linked to the Faculties of Mechanical, Electrical and Industrial Engineering. The focus of the Chair is on teaching and research in the area of energy conversion, including:

- Increasing Efficiency of Conventional Power Plants - component and process level
- Technology Development of Components for the next lignite-fired Power Plant Generation with Pressurized Steam Fluidized Bed Drying and the Combustion process with pure Oxygen (Oxyfuel process)
- Modeling of complex power plants and power plant components, stationary and transient behavior, thermal design and optimization of power engineering processes
- Energy storage concepts in the context of conventional, flexible power plants and the use of surplus energy from PV and wind turbines
- Hybrid power plants for decentralized use with storage of surplus energy from renewable energy sources
- Storage technologies including electrolyzers and catalyst systems.

A primary goal of the Chair of Power Plant Technology is to contribute towards creating a safe and environmentally sound energy supply for the future.

Client Request: Expand Power Generation Education & Research into Renewable Energy Systems

BTU Cottbus approached Heliocentris with the goal of expanding their Power Generation Programs to include extensive teaching and research in the area of Renewable Energies. The Chair of Power Plant Technology saw great demand for the integration of renewable energy systems into their programs and set a primary focus on power generation and the optimization of grid-tied renewable energy systems. They wanted to couple their extensive knowledge of traditional energy systems based on coal and biomass, with renewable energy systems to create better and more efficient energy systems. This was to be achieved by providing students hands-on experience with a complex renewable energy laboratory.

The university realized the need for a project partner that could deliver a high quality custom renewable energy system for both teaching and research at all levels of study. BTU Cottbus selected Heliocentris as a project partner because they had confidence we could meet the following requirements:

- Advanced expertise with various types of renewable energy technologies
- Experience developing industrial grade systems that are applied for teaching, training and research
- Specific expertise with hydrogen, fuel cells and energy management

Field components (outdoor)

- Photovoltaic systems (stationary and tracking)
- Solar thermal plant
- Small wind turbines (rotor-DELA)
- Weather Station

Laboratory components (indoor)

- H_2 system with electrolyser and fuel cell
- Energy storage and electrical load
- Measurement and control module with visualization on PC
- Fuel cell / electrolyser for teaching
- Model wind turbine

The Heliocentris Solution

Heliocentris developed a customized technical solution based on the main components of our New Energy Power Supply (NEPS). The standard NEPS platform was appropriate for this custom system as it allowed us to meet BTU Cottbus expectations of having both an industrial and didactic platform.

The NEPS is a real-world hybrid renewable energy system with 4 kW peak output achieved by combining PV and Wind power. The system is integrated with batteries, hydrogen storage, fuel cells and a smart energy management platform for training and research. Energy from the renewable energy inputs can be used to supply the island grid or fed to grid. This allows universities and research institutes to investigate the inputs under the restriction of an island grid system and a grid tied system.

When energy is not being consumed by loads connected to the system, it will store excess energy in two ways: short-term storage in batteries or long-term storage through hydrogen production. If there is an energy shortfall, the system converts the stored hydrogen into electricity by the use of the 1.2 kW fuel cell system. In order to ensure the system operates with maximum efficiency the smart energy management platform allows for optimal system design.

For research purposes, the web-based user software collects data from over 60 data measuring points and allows for logging and exporting of data. Long-term scenario analysis on energy generation, storage and management can be conducted.

In addition to the modified NEPS system, BTU Cottbus also uses hands-on training equipment from Heliocentris:

- Instructor
- Professional
- Dr FuelCell Model Car
- Dr FuelCell Science Kit

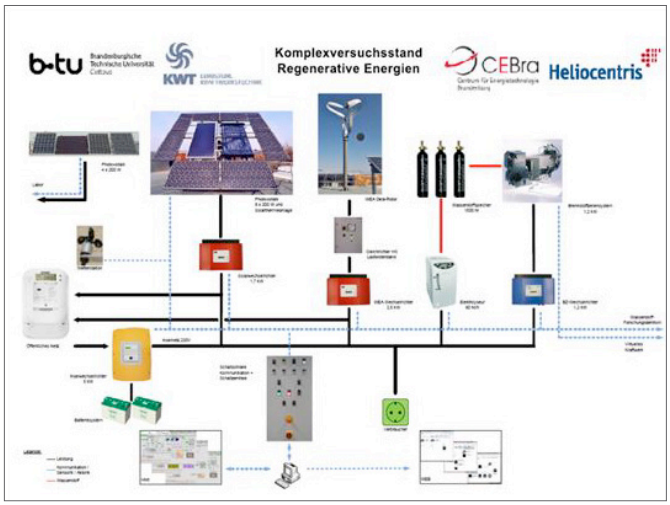
Client Involvement

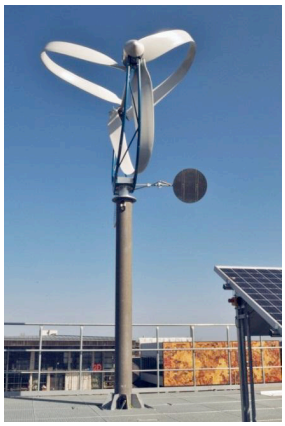
On a project such as this, the client is involved in the entire process, from the initiation of the system design, to final installation, training and commissioning.

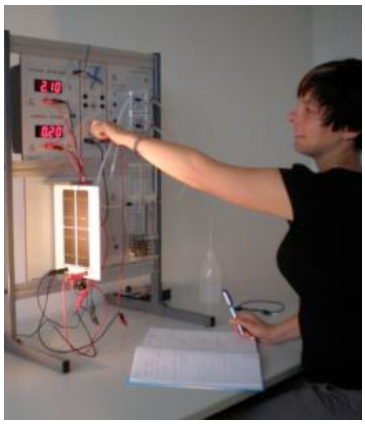
Important to this project was clearly defining the customization pieces to the NEPS system, such as individual workstations, fixed and tracked solar, prototype wind generator and solar thermal.

Technology Used

The key to the technology used in this solution was the mix of various types of renewable energy combined with hybrid energy storage and grid connection. The combination of the technologies, such as, Wind and PV or Hydrogen and Batteries allows BTU Cottbus to test the system under various conditions, with different system components and at various times of the year.







Customization Notes

BTU Cottbus had an interest in customizing the system to meet their goals of studying various types of solar panels, various mounting technologies (fixed vs tracked), solar thermal systems and a custom wind turbine design. Customized systems are:

- *Solar*
  - Multiple Panel Types
  - 2 Mounting Systems – Fixed & Tracked
  - Integrated Software for analysis & comparison
  - Separate PV Tracker, environmental data collector and measurement box
- *Solar Thermal Test Station*
  - Various solar collectors in a closed system – including valves and pumps
- *Wind Turbine*
  - designed of DETHLOFF & LANGE GMBH, Neubukow, Germany
- *Multiple Workstations*
  - Wind, PV, Fuel Cell
- *Grid-Tied*
  - Smart Meter Connection to the electrical grid

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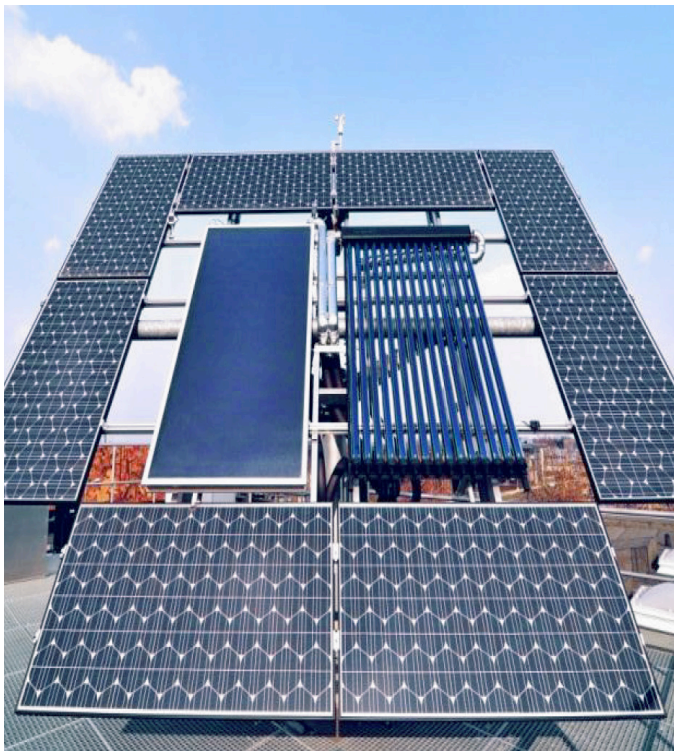
Benefits of the solution

- **Turnkey System**
  - Includes all relevant renewable energy technologies in one industrial grade energy system
- **Educational & Industrial**
  - A key advantage of the system is the unique combination of both educational and research components based on an industrial system
  - Students at all levels can utilize the system - undergraduate to post graduate
- **System Analysis & Component Comparison**
  - System allows for in-depth component evaluation and comparison between systems – ie. Comparing solar panel types or Fixed vs Tracked
  - Workstations – separate workstations for various technology systems
- **Web Integration**
  - The system is connected to the intranet for displaying information about the system and monitoring data
- **Professional Support & Management**
  - Project Management – From design, development, install and post-sale support
- **Capacity Building**
  - During installation and upon completion, university staff and students will be trained to operate, manage and use the system



Program Details & System Usage

The KWT Lab uses the standard training products, combined with the customized NEPS system for use in different program disciplines. The flexibility of the systems allows for teaching and research that ranges from scientific fundamentals to system level engineering principals and advanced level research of renewable energy systems. For example, the NEPS will be used in post graduate studies by PhD candidates, as well as with senior level students from electrical and mechanical engineering programs. Here is sample overview of system usage at each level:

» Undergraduate Level:

- Basics of renewable energy with a focus on hydrogen and fuel cell technology for electrical & mechanical engineers
- Fundamentals of renewable energy systems for business students
- Didactic Approach:
  - Each year more than 4 classes from different departments use the various training systems and lab set-ups
  - Approximately 20 students in groups of 3 students
  - During the hands-on lab sessions, students spend 6 hours in the lab

» Masters/Post-Graduate Level:

- At this level students focus on advanced understanding & research. For example:
  - Renewable Energy Technology & Systems
  - System Design & Energy Management
  - Integrated Energy Systems
- Electrical & Mechanical Engineers split the laboratory into 4 work spaces for their practical work – Wind/PV/Solarthermal/Fuel Cell/ Energy Management. 2 students can work at the same time at these stations.
- Research and lab activities are used for completion of their final Thesis.

» PhD./Research Level:

- Plans moving forward include having PhD candidates optimize the system, perform new development work and work on integration of latest renewable energy technology.

Research Focus

Research with the system varies greatly from student to student, level to level and discipline to discipline. Recently published papers have focussed on items such as the “grid integration of renewable energies and hydrogen research at BTU Cottbus”. Primary areas of research for the institute include:

- » Grid Integration of Renewable Energies
- » Energy Storage through Hydrogen – Electrolysis, Storage & Conversion
- » Flexible Power Systems with Integrated PV & Wind Power
- » Thermo-photovoltaic Systems
- » Technology & Energy Chain of Hybrid Energy Systems
- » Future Energy Systems

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Final Thoughts

As a result of this system, the Chair of Power Plant Technology at BTU Cottbus has been able to expand their level of power generation knowledge to include a solid foundation in renewable energy system technology. BTU Cottbus is now able to use this system to analyze, compare and combine traditional energy systems with renewable energy technology. BTU Cottbus is able to use this system to analyse, compare and combine traditional energy systems with renewable energy technology.

A noticeable side benefit to having a system of this configuration installed has been the interest received in the system and the reputation of the BTU Cottbus. Already an established and well respected university, the addition of renewable energy studies has added to the universities esteem in the form of press articles, community and corporate interest and most importantly interest from the educational community. Students want to train and research at the facility and other Universities visit for workshops and continuing education.

While the programs are still in their infancy, the message is clear; there are significant benefits to having a system of this kind at the University. Currently the University is looking into ways to expand on the system with new technology, programs and courses.

"The NEPS System gives us the flexibility we require for research focussed on different areas of the system: PV (Fixed & Tracked), Wind, Energy Storage (Hydrogen & Batteries), Fuel Cells, Energy Management, Grid Tied & System Efficiency. We also were able to have the system customized to allow for various system workstations, the integration of a solar thermal system and testing of a wind turbine, developed by a third party company."

Dr. Herbert Ristau, *Head of the Lab*

„Our ability to give students hands-on experience with real-world renewable energy systems has significantly increased the value of our program."

Steffen Löffler, *Tutor*

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