Call for tender
Smart wind farm controller

Tender:

Project “Smart Wind Farm Controller” (SWFC): Optimisation of the level of efficiency for wind farms of different sizes.

Subject of the invitation to submit an offer:

Objective of the whole project is the development of an active controller for an entire wind farm (WF) consisting of several Wind Turbines Generator (WTG) to optimize the efficiency of the WF (e.g. to include wake or boost effects). Depending on external parameters (e.g. topology, farm layout, wind environment and WTG status), the maximum WF efficiency has always to be achieved automatically. The SWFC shall work with a variety of WTG control systems. Interventions into the WTG controllers have to be minimal. The function and impact of the SWFC shall be demonstrated based on provided historical WF and WTG data.

The project is divided into three subprojects / lots:

- Lot 1: Collection and processing of Windfarm and WTG specific data. Development of a mathematical model to find correlations between the data and to optimize the wind farm efficiency. A proof of the optimisation potential based on the simulation data shall be given based in developed performance indicators.
- Lot 2: Development and implementation of a communication and control box as an edge component which reads parameters of a given WTG, communicates with the SWFC and transmits the parameters / adjustments of the SWFC to the WTG.
- Lot 3: Implementation of the algorithm for the SWFC (based on the results from lot 1).

Client

Our client is a pioneer in the wind energy market and one of the leading German WF developers. The core business ranges from planning and construction of wind and solar farms and its operational management in Germany and several foreign markets.

Background and situation

A simple example illustrates the background and the situation: A WF consists of various WTGs which, usually follow an “isolated” operational management. Each WTG locally collects its data (e.g. wind direction, wind force) and independently manages itself (e.g. in the form of wind direction tracking). This management regime is based only on locally known variables (e.g. wind direction).

Following this example, all turbines in a WF would turn into the wind independently. Under the aspect of a global optimum it could e.g. may make more sense, to only turn the first row of wind-facing WTGs into the wind at an angle other than the individual optimum, in order to allow higher wind pressure and a higher wind volume to pass through for the following WTGs. The global optimum might not be reached when only local optimisation is performed on every WTG.

General technical requirements

- The WTGs must continue to function autonomously in order to compensate for a failure of the SWFC. As an emergency or fallback level, the local WTG-internal control system must continue to guarantee isolated operation (as without the SWFC)
- All factors influencing WF efficiency have to be identified. A system of key indicators has to be developed with individual key figures and their dependencies.
- In addition to performance data, the SWFC must also consider the operating states of all WTGs in the WF to determine the optimum efficiency.
- The SWFC must be defined in such a way that the additional yield vs. the additional wear will be optimized.
- Regulatory requirements must always be considered.
- The edge component for the WTG must be designed in a general way so that it can communicate with WTG specific communication interfaces
- Safety mechanisms shall be implemented to avoid load overshoot and faulty control.
- CE-conformity or the corresponding certification of the parking controller is to be strived for.

Control system, operational management

The control technology of a WTG is digital. This means that the control logic within a WTG is typically implemented on a computer (PC system) available in the WTG. Changes to the control characteristics only require a change within the software parameterisation. The control system usually fulfils the following tasks:

- Ensuring fully automatic operation (isolated operation) incl. wind direction tracking, power control and speed control, monitoring of loads and vibration behaviour,
- Ensuring operational safety,
- Production data acquisition and communication to central SCADA system

The control parameters of all WTGs are combined in a control room and monitored as part of the operational management. Maintenance and service measures are planned and carried out in coordination with personnel management, means of transport, availability of tools and similar.

Lots and service packages

Lot 1

The SWFC will be implemented on the basis of a uniform, universal, manufacturer-independent system of key performance indicators.

The different tasks in this lot are:

- develop a system of key performance indicators describing global attributes of the WF
    - timing: real time, short term, long term
    - area: technical, operational, business
- the indicators have to be described by fact sheets, which, in addition to general information, contain requirements about data collection, data processing and data presentation, if necessary.
- identify and assess relevant WTG and WF parameters which build the basis of the calculation of the above defined KPI
- determine the interrelation between WTG specific and WF specific parameters
- develop a mathematical function to calculate WF yield and WF efficiency form the above data

- develop mathematical functions to optimise WF yield and WF efficiency
- develop an algorithm to optimize WF efficiency (short term, long term)

The mathematical model and the optimization function must be well documented, extendable and applicable to existing wind farms as well as to new farms. The client will provide appropriate input here.

expected competences of the contractor

- Development of mathematical models and cause-effect relationships, AI models
- Mathematical optimization and mapping, linear and non-linear optimization
- Implementation of mathematical functions as programmes (MATLAB, Mathematica)
- Simulation and handling of large test data
- Industry knowledge wind energy, wind farm management

Lot 2: Edge Component / "IoT Box"

In a WTG, manufacturer-specific components of control technology are installed. This control technology controls the individual WTG on the basis of locally measured parameters. The operating data of the WTG are typically transmitted via a SCADA system to the central control room. The control room is used for operational control and management.

The task of this lot is the construction of a communication and control box which works as an edge component on the WTG.

- The box communicates with the WTG (e.g. via the SCADA interface) and with the SWFC, reads the parameters of the WTG and accepts control measures of the SWFC and readjusts the WTG accordingly.
- The box should only communicate via standardized interfaces.

expected competences of the contractor

- IoT, Embedded Systems, Hardware
- Experience in hardware design and hardware-related programming
- Knowledge and experience in communication with SCADA systems
- Technical experience and knowledge in the area of field communication (protocols and formats at SCADA level, network and Internet protocols and connectivity)

Lot 3:

Lot 3 deals with the software implementation of the SWFC. In later operation it collects the data from the IoT box from lot 2 and performs the calculations from LOT1 (generate the indicators and control commands) to optimize WF efficiency. The software must be scalable and implemented based on a modern software stack. License costs have to be avoided as far as possible. The software solution should be based on a container solution both on-premise and in the cloud (e.g. Azure IaaS). The AI procedure and the entire software system must be executable using data of existing wind farms, i.e. on the basis of real time data via corresponding interfaces (residual APIs or message queuing) as well as on the basis of simulation data. Suitable AI procedures will be selected together with the client. Hosting of the software system will be handed over to a third partner who already takes care of the client's existing software systems. A software maintenance and support contract, including terms and conditions and rough SLA parameters should be attached to the offer as a draft.

In a first phase the SWFC will control a digital twin of the WF. In a second phase the SWFC will be applied to a real WF based on its real time data. Step three is the successive simulation of the SWFC with real time data from all wind farms of the client and in step 4 the SWFC will be rolled out into productive mode controlling all WFs.

expected competences of the contractor

- General software development skills with modern solutions and tools, cloud experience etc.
- AI / Data Science experience and knowledge: Neural Networks, Machine Learning, Algorithms
- AI procedures, AI frameworks and implementation experience from linear optimizers to intelligent agents e.g. in Python
- Basic knowledge about the wind industry / wind farms
- The willingness to take over software maintenance and, if necessary, future development, must be offered by the contractor without restriction. The client wants a long-term cooperation.

Description of the tendering procedure

Tendering will be done in form of an open competitive tendering process. There are no restrictions on who can submit a tender. Interested parties may apply alone or as a consortium together with other companies. Interested company can apply for one or more lots. The stages are

Stage one:

- After the signature of a non-disclosure agreement, interested parties can ask questions based on the information in this document.
- embeteco will collect the questions, discuss them with the client and provide answers to the interested parties. All questions and all answers will be made available to all interested parties.
- After all questions have been clarified an application has to be submitted in form of a document and a presentation by the interested party to embeteco.
- The application should address the information from this document and suggest solutions to the different tasks.
- The application should contain the following information:
    - Presentation of experiences, competencies and skills of the interested party in the requested areas, with references and contact persons of former customers.
    - Presentation of the technical approach and project management methods
        - Lot1: suggested data and key performance indicators
        - Lot3: system architecture, hardware
        - Lot3: software stack, programming languages
    - Elaborated rough concept for coping with the requirements and tasks.
    - Estimation of the expected budget, including the estimated time required and daily rates (all-inclusive).

Stage two

- Selected parties will then present their application to embeteco and the client following an interview / discussion.
- Once all the interviews are completed, one or more applicants will be selected to go into the contract negotiation with the client

Schedule

- Date of publication of this invitation to tender:	24.07.2020
- Contact to embeteco and Submission of questions until:	14.08.2020
- Communication of the answers to all participants:	21.08.2020
- Submission of the application documents:	15.09.2020
- Invitation to present the offer:	01.10.2020
- Contract negotiations will take place up to and including:	30.10.2020

The email-Address for all communication is swfc_tender@embeteco.de