Monitoring System

REMOTE MONITORING

Single ENERCON wind energy converters or wind parks are equipped with a remote monitoring and control system. This is located in the vicinity of the control cabinet or in the interconnecting station in the case of single machines or in the interconnecting station in wind parks. Remote monitoring is carried out by a standard PC. ENERCON Service has a central remote monitoring system which retrieves the data from the single wind energy converters and wind parks and which enables the converter's parameters to be changed from a distance and which also receives fault messages and warnings from the machines.

Please note that single converters and wind parks can be operated without the remote monitoring system. The remote monitoring system is not part of the converter's control system.

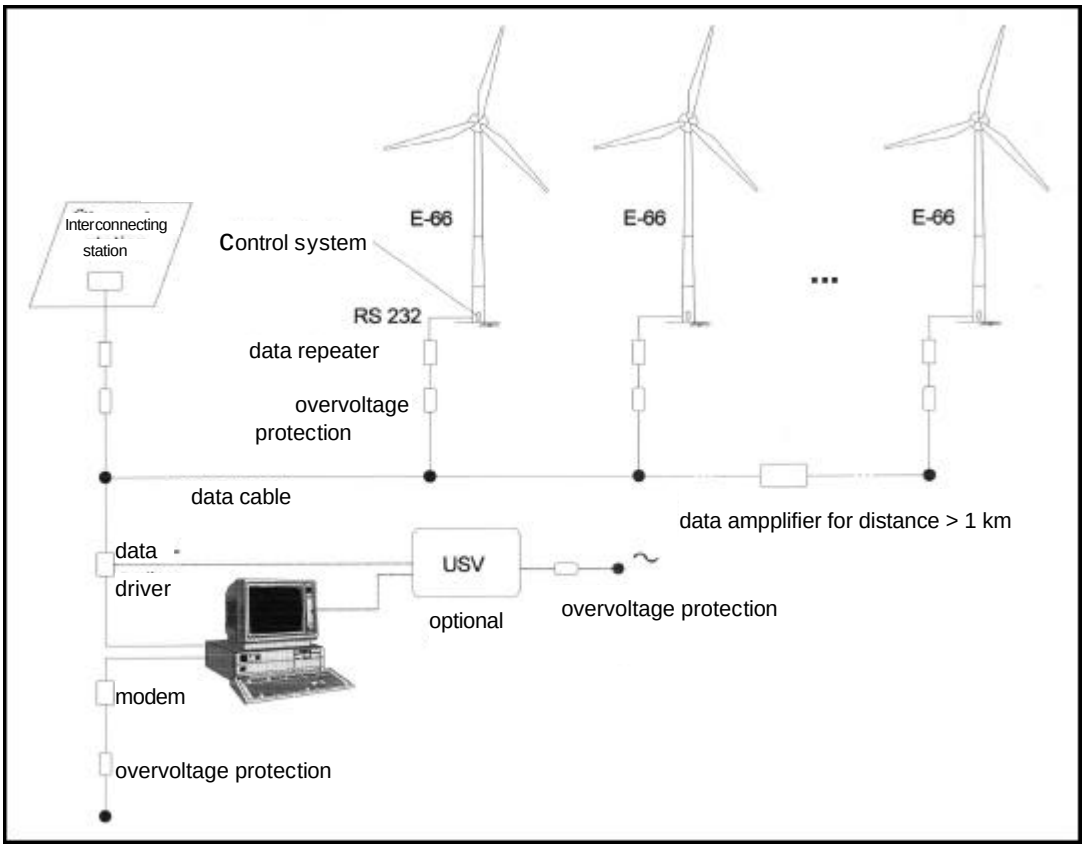

Figure 1: Remote monitoring system for wind parks

In a wind park, the converter's data is transferred using a null modem connection to a PC (park computer) which by means of the wind park software captures the data of the single wind energy converters. In wind parks communication cables are installed through which the single converters are connected to the remote monitoring system. The PC is equipped with a modem for the telephone network so it can communicate with other equipment.

Up-to-date operating data is relayed from the remote monitoring system at the wind energy converter or wind park over the telephone or radio telephone network via a modem to the central remote monitoring system. In addition, (central) remote monitoring and control systems can be installed on the operator's and relevant utility's site.

Hereinafter the term "wind park" is used synonymously with wind energy converter and wind park. A complete description of the remote monitoring system is available with the wind energy converter monitoring software description.

Scope of system

ENERCON supplies as standard a remote monitoring system with every wind energy converter and a pager for the operator. The remote monitoring system currently comprises[1] the following components:

- Computer: Current standard PC
- Monitor, black & white
- Telecommunication cable between each wind energy converter and the remote monitoring system (to be provided by the operator)
- Modem, Hayes-compatible
- Interface: ENERCON
- ENERCON remote monitoring software for wind parks incl. 1 licence

The equipment delivered may clearly exceed this standard and is dependent on the current technical standard.

The wind park is connected to the central remote monitoring system by telephone (modem). The telephone connection is to be arranged by the operator. Mobile telephone installations (GSM or C-network) may also be used.

Optional additional equipment

The computer may be equipped with uninterrupted power supply (UPS) for remote monitoring as an option.

A central monitoring system may also be set up for the operator as standard which enables all data about the converters to be called up. In which case, the system currently[1] comprises the following components:

- Computer: Current standard PC
- Operating system Windows 95/98
- Colour monitor (low radiation)
- Modem, Hayes-compatible
- Keyboard, mouse, mouse mat
- ENERCON remote monitoring software for central monitoring system (incl. three licences). The operator's own computer may also be used with licences providing the hardware requirements are satisfied.

[1] The exact configuration of the computer for remote monitoring continuously changes according to the current state of the art of PCs.

The system is delivered complete. The equipment delivered may clearly exceed this standard and is dependent on the current technical standard.

Additional monitoring systems

In addition to individual wind energy converters, a wind measuring mast, the interconnecting station and optional performance or power monitoring systems and controls can be connected to the remote monitoring system.

Monitoring options

Remote monitoring enables the production and statistical assessment of much of the data which arises during the operation of the wind energy converters such as wind speed, converter speed, power and work. This data can be statistically evaluated for different periods. In general, the data is saved in binary format. It is also possible to convert this to dBASE IV format so that individual criteria can be evaluated, e.g. using a spreadsheet. The evaluation of online data enables continuous observation of individual converters and, in particular, constant comparison of different converters in the park.

Wind energy converter

The data reproduced in the following table is calculated and produced as standard. The calculation intervals are therefore constant (online), by the minute, every four hours, daily, monthly and yearly.

Value	Unit	Calculations
Wind speed	m/s	Average, peak[1]
Speed	r/min	Average, peak
Output	kW	Average, peak
Phase angle	φ	Pre-set, adjusted value
Operating hours	h	Accumulated
Energy yield	kWh	Accumulated
Nacelle alignment	°	Average, main direction
Primary status, secondary status	-	Availability

[1] Peak values are actual values which have not been produced from a calculation.

The data can also be shown as a graph. The following figures are examples of the form in which the data in the remote monitoring system in the wind park may be displayed to the operator and in the central remote monitoring system. The output pictures are standardised and are the same for the E-30, E-32/33, E-40 and E-66 and E-66 / 18.70 converter variants. Machine type E-40 is used in this illustrative example.

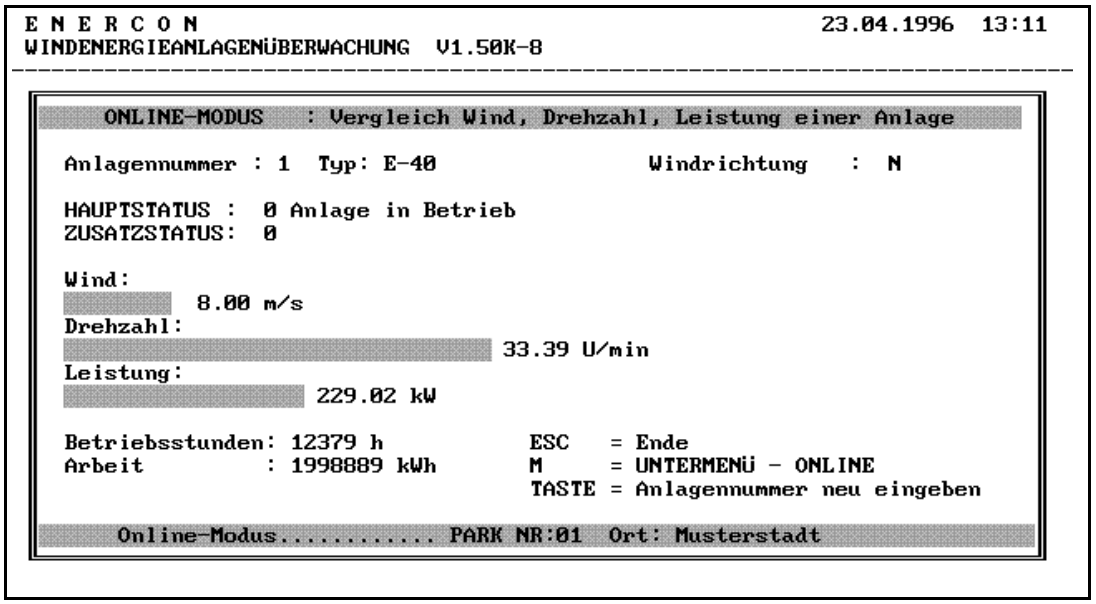

Figure 22: Online comparison of wind, speed and output of a converter

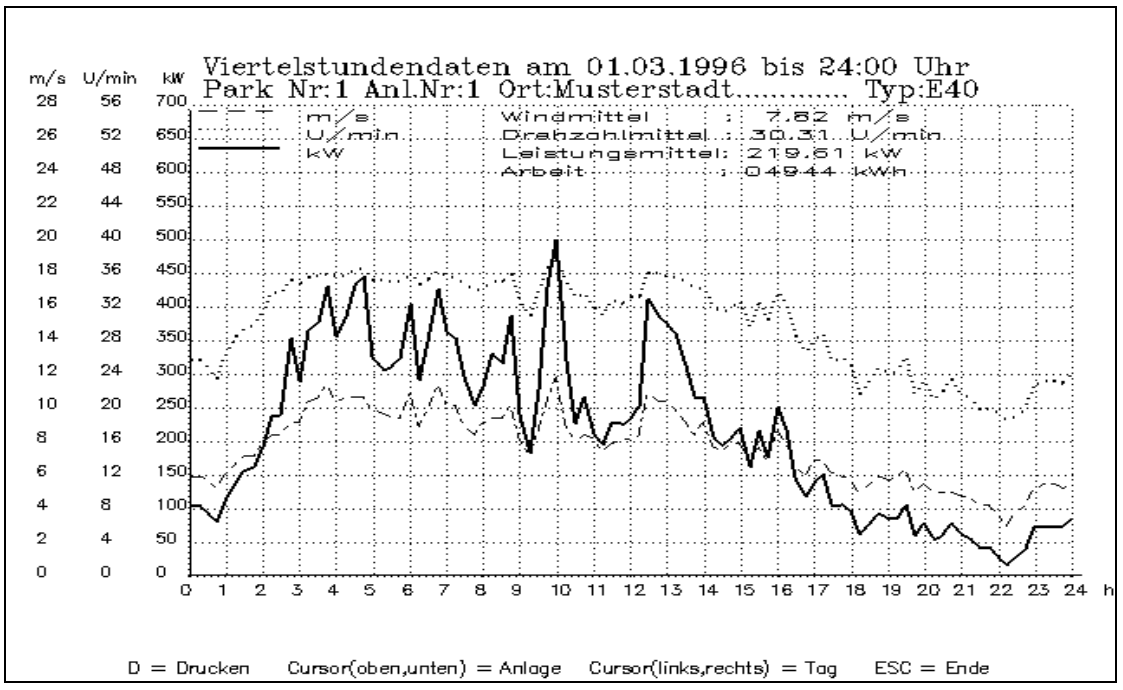

Figure 33: Graphical evaluation of 15-minute data in one day

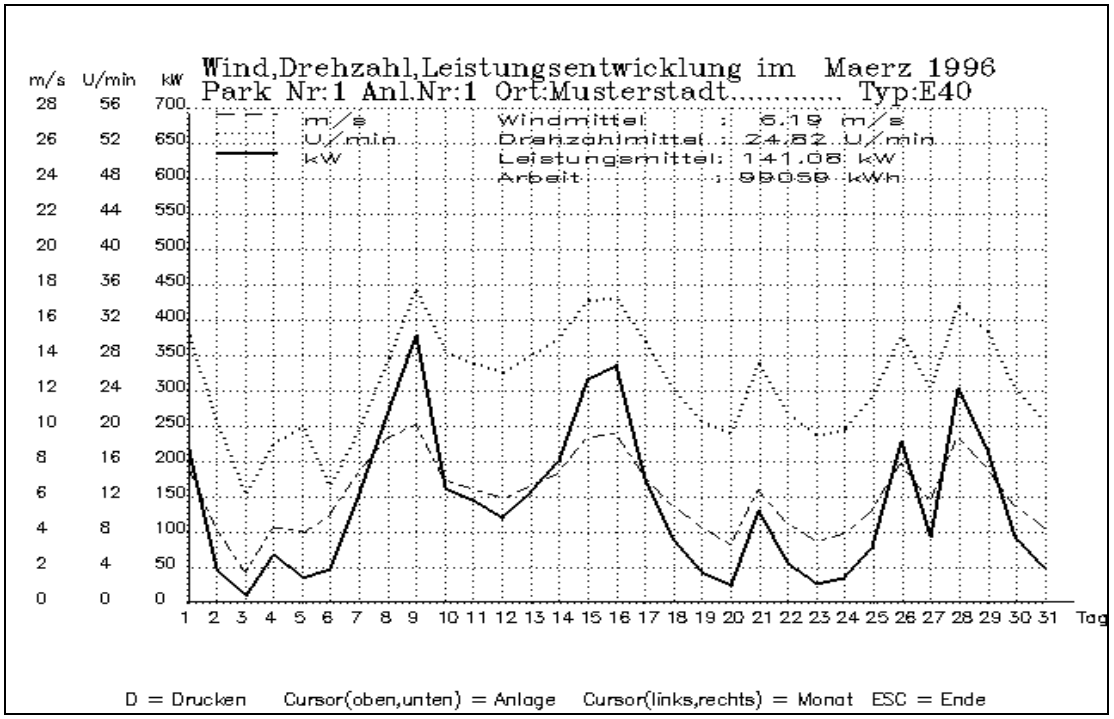

Figure 44: Graphical evaluation of data in one month

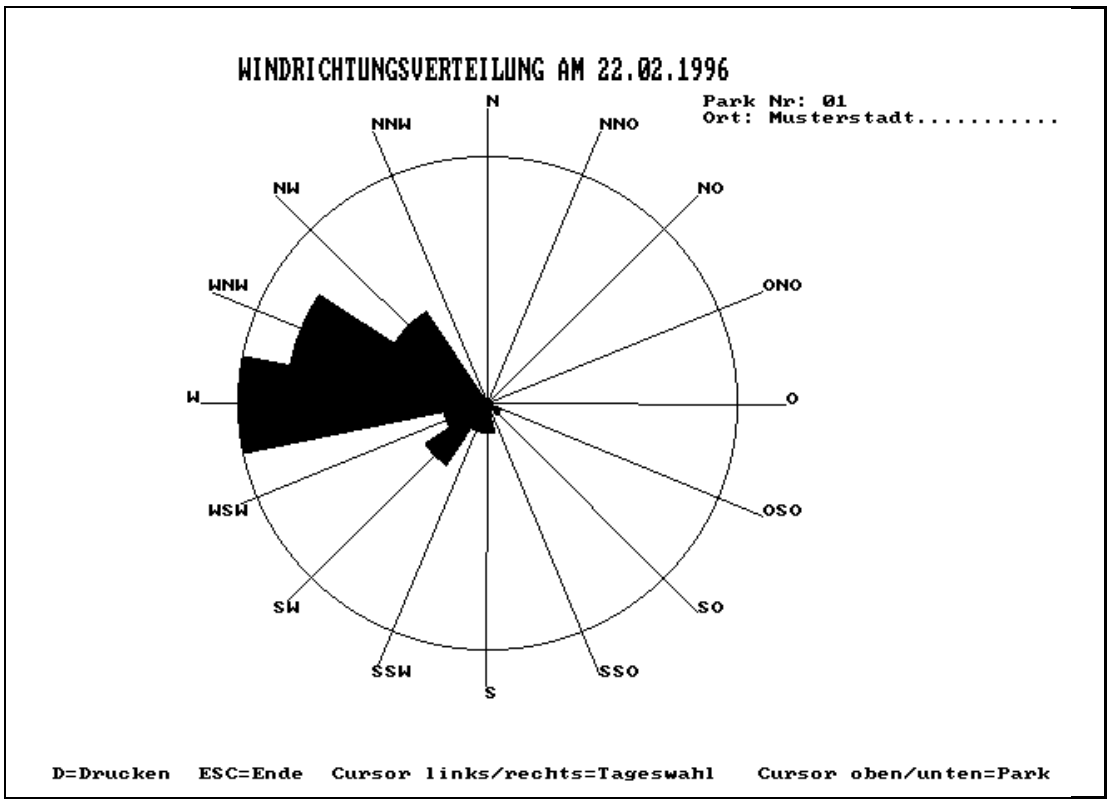

Figure 55: Wind direction distribution over one day

Wind parks

In wind parks single machines can be compared with each other or specific converters selected for comparison. The following figures illustrate the form the data can be represented in.

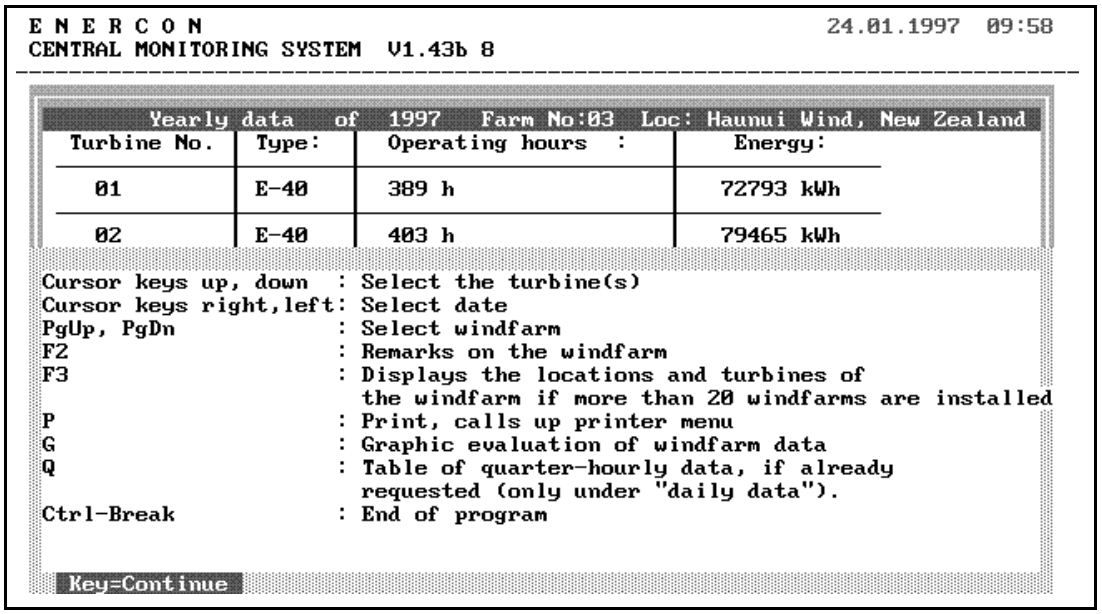

Figure 66: Tabular comparison of time in operation, energy yield

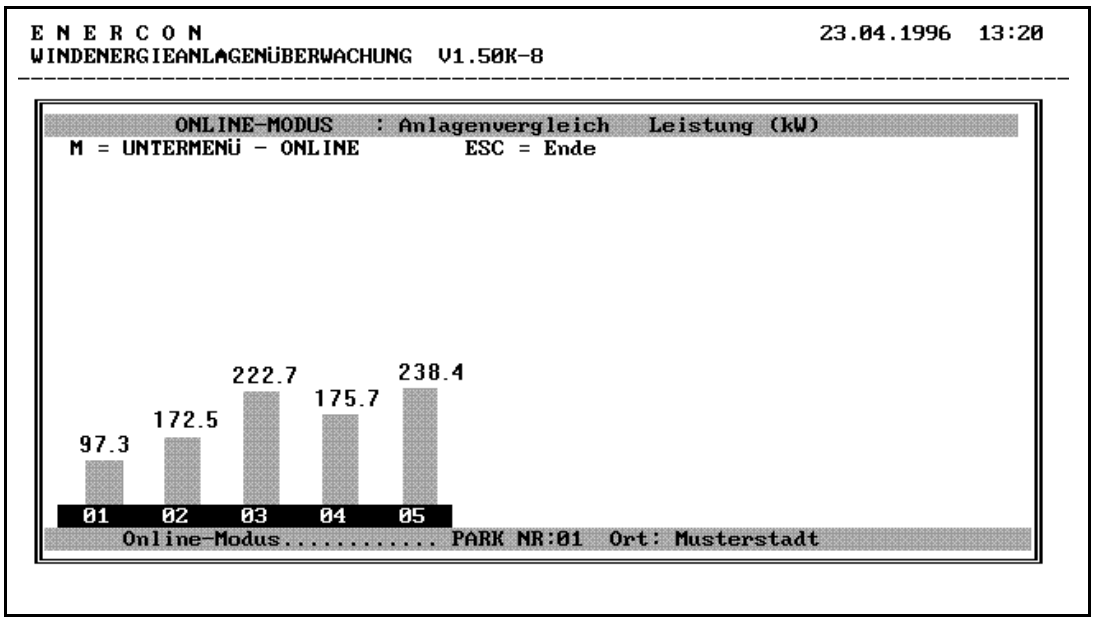

Figure 77: On-line output comparison

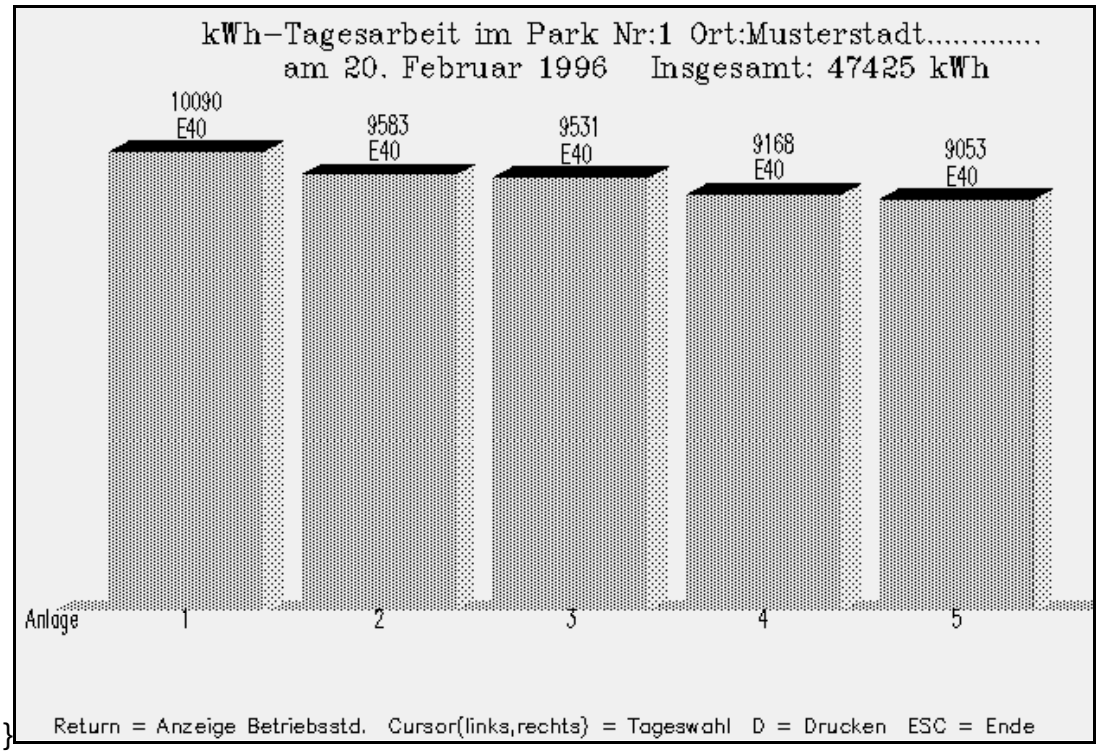

Figure 88: Converter comparison, daily energy yield

Interconnecting station (optional)

If the interconnecting station is monitored as part of an output/power rule, the following data can be issued and calculated.

Value	Unit	Calculations
Primary status, secondary status	-	Availability
Energy yield	kWh	Accumulated
Active power	kW	Average, peak
Reactive power	kVA	Average, peak
Power L1:	kV	Average, peak
Power L2:	kV	Average, peak
Power L3:	kV	Average, peak

Meteorological measuring stations

If an additional measuring station (measuring mast) is to be installed and monitored, the data reproduced in the table below can be recorded. The calculation intervals are therefore constant (online), by the minute, every ten minutes, daily, weekly, monthly and yearly.

Value	Unit	Calculations
Wind	m/s	Average, peak
Wind direction	°	Average, peak
Air temperature	°C	Average, peak
Air pressure	hPa	Average, peak
Humidity	%	Average, peak
Primary status, secondary status	-	Availability

System messages

The system messages are divided into several areas according to the type of event in question.

Status messages

Depending on the operating status (e.g. in operation or fault X), each wind energy converter is allocated a two-figure status message. For a precise description, a primary status (e.g. EMERGENCY OFF activated) and a secondary status ("nacelle") are given. The operating status is therefore always shown as a unique number combination (in this example 10: 2). A complete, up-to-date list of status messages is available from ENERCON and can be found in the appendix to these operating instructions.

Faults

In the event of a fault in the wind energy converter, the remote monitoring system can automatically inform the operator and Service provided the relevant settings are in place. If a fault occurs in a converter in a wind park, a message is relayed immediately to the service centre via the modem.

The wind farm software must be connected to the telephone network. The relevant telephone connection number must be known and the software for the central program must be started. If a fault message fails, the software tries every 15 minutes to start a new fault message until it is successfully relayed (six hours maximum).

A fault message is created for the following faults:

1. The converter has shut down (due to a fault which can only be rectified by Service or the operator);
2. Several status changes within a specific period which do not lead to the complete shutdown of the plant;
3. Transmission failure between converter and park computer;
4. Converter does not respond;
5. Simulation of a fault message on the park computer;
6. No output despite wind of > 4 m/s.

Faults 2-6 are alarm messages. The messages under points 2, 3 and 4 are not safety-relevant warnings and do not activate the pager or fax.

Fault messages

The following data is relayed to and stored on the remote monitoring system in the form of fault messages.

- Park identification;
- Converter number;
- Time of the fault message;
- Nature of the fault (error);
- Status message (primary status, secondary status);
- Last 15 minute data set (mean wind speed; work; mean / maximum output; mean / maximum speed);
- Last 15 minute data (time; primary status, secondary status; mean, current wind speed; work; mean / maximum output; mean / maximum speed).

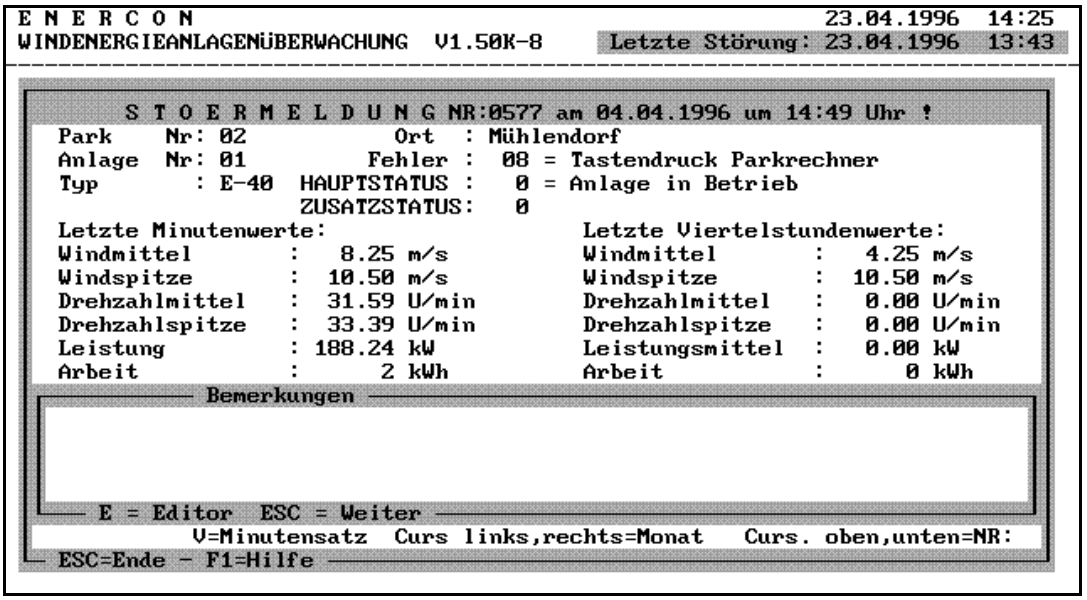

Figure 99: Fault message

In the event of a fault, the last 15 minutes set of data relayed every minute is automatically displayed. Otherwise, the old data is overwritten by the new data (ring memory).

Relay options

The data and status messages created by the wind energy converter can be sent by fax, telephone (modem), SMS or various pager systems. As soon as a converter shuts down as the result of a fault, several fault messages can be sent to up to ten recipients.

Fault message on the remote monitoring system (office computer)

In the event of fault messages, the above-mentioned data is sent to Service's central remote monitoring system via the remote monitoring system in the wind park. Provided the operator has a remote monitoring system, the fault messages will be sent to him.

Fault message by fax

All fault messages relayed to a PC can also be sent by fax.

Fault message on SMS or a pager

The software offers connection to Deutsche Telekom Citycall. The Citycall number is dialled immediately after the fault message is received from the central computer or from the wind park computer. Citycall can also be optionally activated or send a numeric fault message, i.e. relay a code, without transferring data.

Control system

The following parameters can be controlled from the central remote monitoring computer:

- Starting or stopping the wind park;
- Maximum output of single wind energy converters or wind park (in the case of the latter there must be a power / voltage control system for the interconnecting station installed);
- Power gradient (change in output over time) for the switch-on and shutdown processes of the wind park or the single converter.

Additional functions

If an automatic data request has not been successful (e.g. due to a poor telephone connection), the missing data from the day in question can be manually requested at a later time and then included in the data processing. A connection report (report on the modem connections) can also be generated.

Connection report

The connection report records the park number, date, time, connection type and data transfer process each time a connection is tried. Only failed attempts are recorded using the automatic data request. These are marked in colour in the report. The last 120 messages are shown in the connection report.

Further request for erroneous data

The remote monitoring software can automatically make a further request for missing data. The software attempts to request the missing data a maximum of three times per park. If the automatic further request for data fails or data is not requested automatically for a long time, the missing data may also be subsequently requested manually.