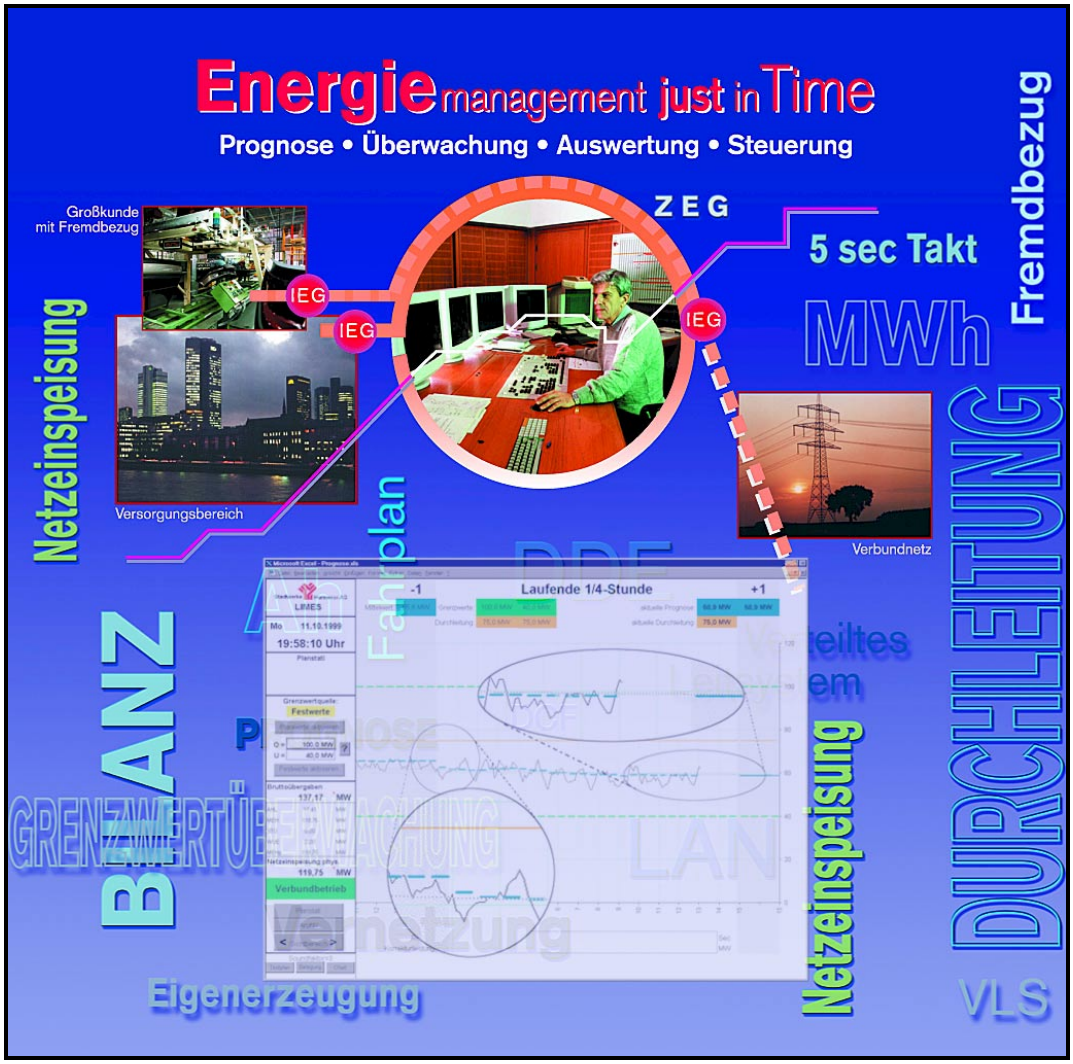
Ingenieurbüro für Echtzeitprogrammierung

LIMES

Energy pulse measurement



Optimal energy management

in the

liberalized power market

Power utilities in the change

Acting economically in the liberalized power market requires the fast reaction to increasingly complex business operations.

Short term commercial transactions by distant energy producers and consumers have increasing influence on the operation of the local grid and of the local power utilities.

The economically efficient steering of the local utilities requires to take the energy flow resulting from commercial transactions into account in addition to the physical operating data.

Correcting the load profile

LIMES supports energy management by considering the energy flow from energy trading in the balance and in the forecast of local operating data.

Energy trading data are summed up from:

- Conveyance profiles
- Load profiles bought and sold
- In-time metering at major customers with external procurement
- Statistical load profiles of private customers with external procurement

Managing the local systems economically depends not only on the knowledge of the local load profile but on the knowledge of the energy trading profile as well. Balancing the local operating data with the load and the trading profile results in clear operating state information and leads to a trustworthy short-time forecast.

Design

LIMES is designed as open and distributed system in addition to an established management system. **LIMES** takes energy pulses as input and calculates a local balance as well as a forecast all 5 seconds. The net operating data are calculated by a balance of measured values and an energy trading profile.

Quintessential points of the system concept are:

- Local preprocessing and balancing of energy pulses
- Distributed, hierarchical balance includes energy traded
- Standard interfaces to operator systems on a LAN
- Forecast of net operating data includes energy traded

Cost-efficiency

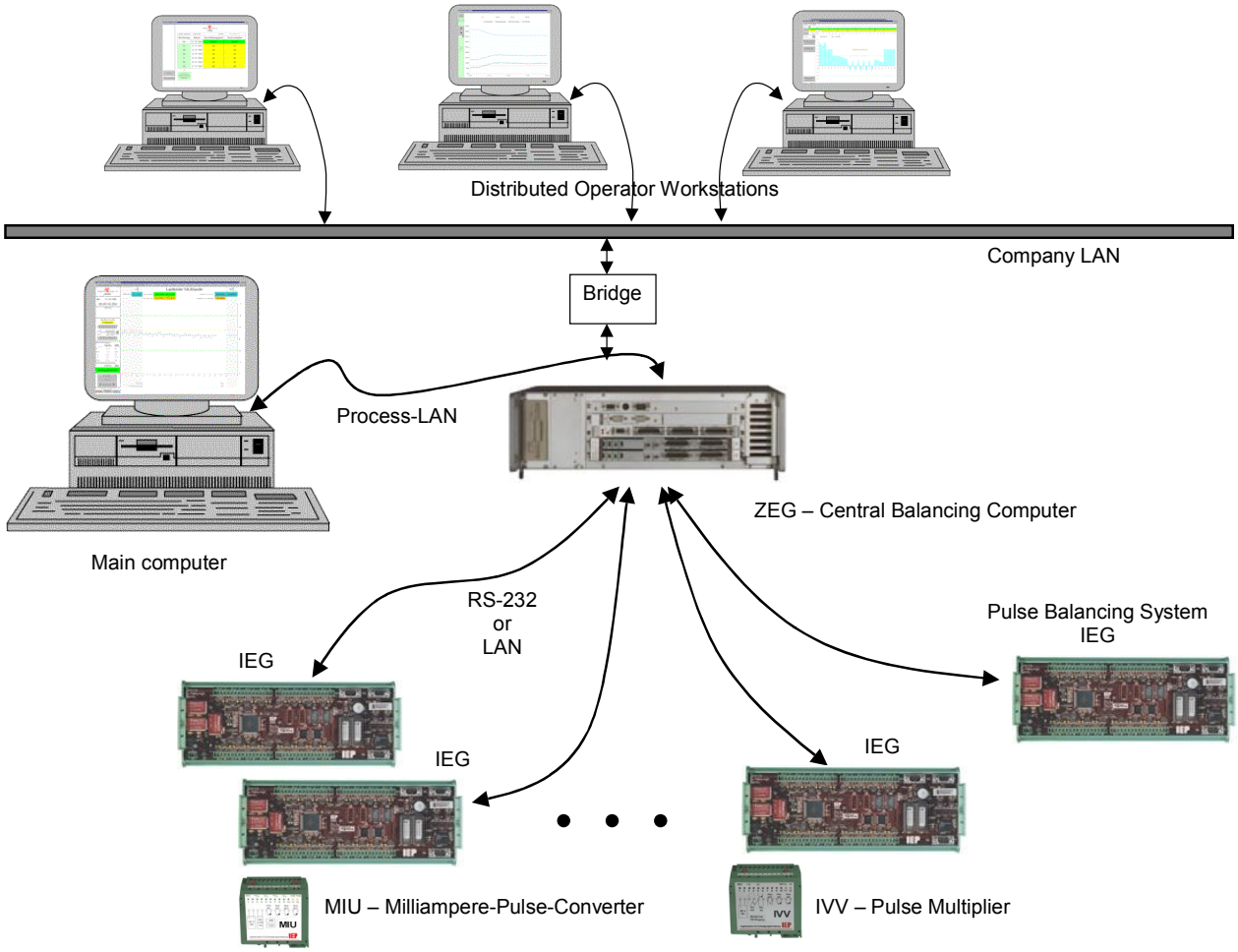
LIMES is conceived with special consideration of the installation and operating expenditure.

Low costs, even at new installations, are coming from:

- Simultaneous use of existing sensors
- Avoidance of costly analog data exchange
- Open interfaces for user-specific interpretation
- Use of commercial standard software for visualization and operating with problem-free adaptability by instructed personnel

System Overview

LIMES is a recording measurement system, which counts energy pulses and calculates a balance and a forecast including traded energy. All measured data as well as all computational results are made accessible on the company LAN by a main computer.



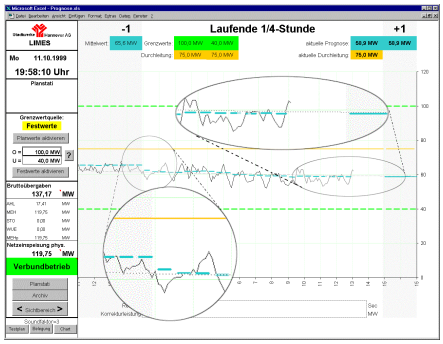
Operator workstations

Standard PCs with a Microsoft Windows NT-type operating system and Microsoft Excel can be used as operator workstations. These are connected to the company LAN and use Network-DDE (Dynamic Data Exchange) to access the **LIMES** main computer

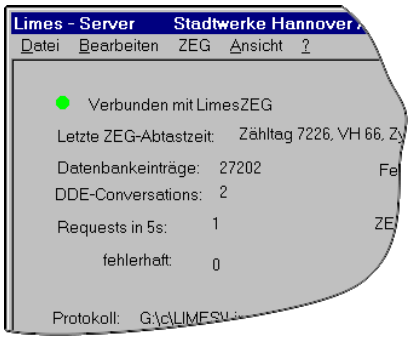
The operator workstations can access the entire **LIMES** database by only communicating with the main computer. The **LIMES** application programs are Microsoft Excel workbooks and can be used on every operator workstation.

Worksheets can be adapted or created by everyone with Excel and Visual Basic knowledge. A password protection guarantees only authorized access.

The main computer acts as a DDE-server which can be used by every DDE-aware application.



Main computer



In **LIMES**, the main computer fulfills the following tasks:

- Central data server for operator workstations
- Presentation of a standard interface to operator workstations
- Priviledged functions for the setting of operating parameters for the ZEG and the IEGs
- Decoupling of operator workstation activities from the time-critical data acquisition and balancing in the ZEG
- In addition, it is the primary operator workstation

The main computer is responsible to supply data to the operator workstations attached. As a DDE-server it provides access to **LIMES** data throughout the network. The main computer updates its database by direct communication with the ZEG.

The direct access to the ZEG-data is restricted – only the main computer has direct access to the ZEG. The time-critical data recording and balancing in the ZEG is protected from disturbances in the LAN and from impairment by operator workstation load.

A standard commercial PC with a Microsoft Windows NT-type operating system and Microsoft Excel can be used as main computer.

ZEG Central Balancing Computer

The ZEG is the central component of the **LIMES** system. Its major tasks are:

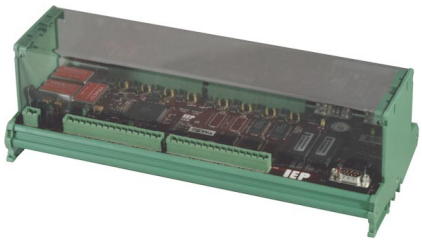
- Collecting the energy balance data prepared by the IEGs with a 5 second cycle-time.
- Providing time synchronisation for the IEGs
- Consolidation and balancing of data, including energy traded
- Administration and updating of the **LIMES** data base
- Maintaining a 7 days archive of the 5-seconds balance data
- Maintaining a 30 days archive of the quarterly balance data
- Forecasting and monitoring of limit values with excess alerts
- Storage and administration of parameters and data models for the IEGs
- Administration and storage of a timetable for limit values
- Logging of selectable balance data to analog data recorders

The ZEG operates independent of the main computer and the operator workstations. All data are continously acquired, computed and archived even without a connection to the main computer. When the main computer connects to the ZEG, it has immediate access to a current database.

High availability and reliability is ensured by the use of a VMEbus-based industrial computer using the realtime operating system RTOS-UH.

For limit value excess alerts and online-logging digital and analog outputs are provided by an InterBus-S fieldbus interface. The I/O-configuration can be specified by the user.

IEG Impulse Collection Equipment



The IEGs acquire energy pulses in a 5 second cycle on site and calculate a local balance. Most important performance data are:

- 16 pulse inputs S0 or WT, upto 1 kHz
- Cascadeable with a second IEG
- Local balance – 32 inputs to 32 balance values
- Parameters and data models administered by the ZEG
- Coupled to the ZEG by RS-232 (modem)
- Time synchronisation of all IEGs in **LIMES**: < 5 ms
- Retention of the time synchronisation also after loss of the ZEG-connection
- Local 30-days archive of quarterly balance data
- Data retention (operating parameters and archives) in case of power supply voltage failure

Each pulse input can be scaled individually. The IEG computes local balance data by a weighted summation of the local inputs. Each input can be assigned to each balance value with an individual weight.

High reliability and accurate timed performance are ensured by the realtime operating system RTOS-UH.

IVV Pulse multiplier

LIMES uses energy pulses provided by the conventional metereing technology as inputs. If no more free pulse outputs are available, IVVs can be used to connect two pulse inputs to one pulse output.

An IVV provides:

- 1 input, alternatively S0 or WT
- 1 output WT
- 2 outputs S0

IVVs can be used upto 1 kHz input pulse frequency.

MIU Milliampere pulse converter

A MIU allows to couple an analog signal to an IEG input. It converts a bipolar input current to a pulse train with a frequency proportional to the current. A MIU has different outputs for each direction of current flow and therefor originates generator pulses as well as consumption pulses.

A MIU offers:

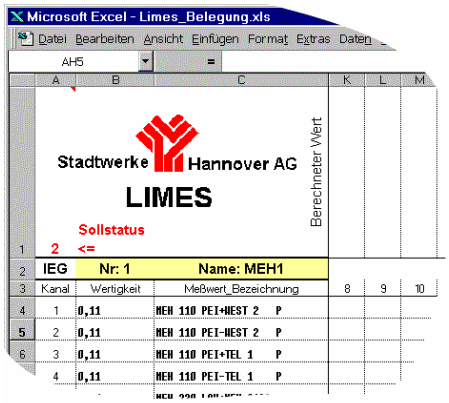
- Current inputs ±20 mA (load 200 Ω)
- 2 S0 outputs generation
- 2 S0 outputs consumption

MIUs can also be used to acquire additional operating data from non-electrical sensors by using an industry-standard measurement range.

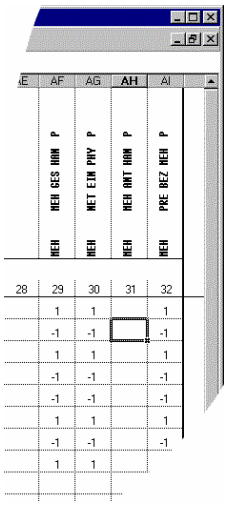
Setting parameters

The operating parameters of **LIMES** are configured in Microsoft Excel worksheets on the main computer. The **LIMES** server reads these worksheets on user request and transfers their content to the ZEG. The ZEG stores the paramters locally and distributes them to the IEGs concerned for further local storage.

IEG balance



Going the direction of process data flow, the configuration starts with the weighting of the pulse inputs of the IEGs. For each IEG, there is a worksheet, in which line by line both a name and an pulse weight is assigned to each input.



An IEG accumulates each input's energy by calculating the weighted pulse count sum during 5 seconds.

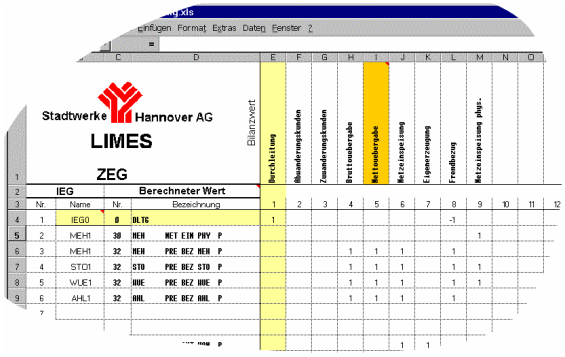
In the columns, the names of balance signals and the weight of their individual addends are defined. Each input can be used as addend for each balance.

An IEG determines the local balance data each 5 seconds. The local balance data are read by the ZEG for further processing.

ZEG balance

The configuration of the ZEG is also done using an Microsoft Excel worksheet. Here, the balance data calculated by the IEGs are available as inputs as well as the load profile resulting from energy trade (shown in light yellow).

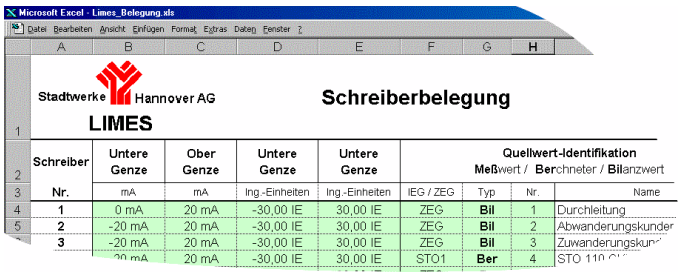
The ZEG's balance data should be chosen to give a good overview over the power utilities technical and economical working condition. The balance data are calculated all 5 seconds using the input data obtained by the IEGs.



Apart from balancing, the ZEG computes a forecast for one of its global balance data. The column used as input to the forecast is shown in dark yellow. Using a balance that includes the load profile resulting from energy trade, a clear economical forecast is computed and can be used for optimal economical and technical steering of the utilities operation.

ZEG logging

The ZEG provides for logging of its input values as well of its balance data on external analog data recorders. Digital and analog outputs are provided with the ZEG's fieldbus interface.



Using a configuration worksheet, the signals to be logged as well as the configuration of the external data recorders can be specified.

The logging is also active when the main computer or the company LAN is not available.

Trading Load profile

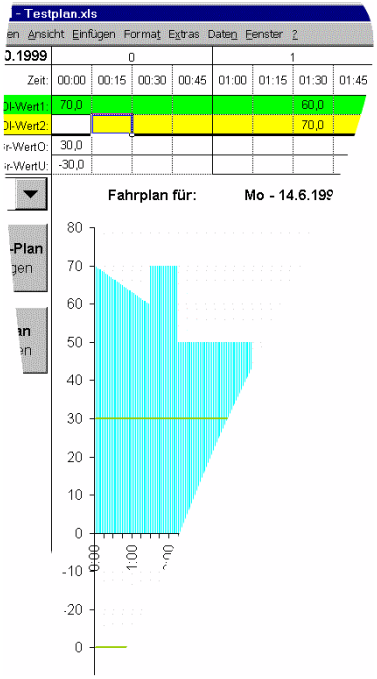
LIMES provides a load profile computed out of energy traded as input to the global balance calculated in the ZEG. This load profiles shows the sum of energy bought and sold and is constructed by a starting and an ending value for each quarter of an hour.

The **LIMES**-ZEG gets the trading load profile as an ASCII-textfile that can be created by customer supplied software, e.g. by exporting the profile from a database. An Excel-Worksheet to prepare and to edit this load profile is provided, supporting the import and export of textfiles as well as the transfer to the ZEG.

Using this load profile as input to the balance calculated by the ZEG allows to adjust the operating data acquired by measurement in order to show additional short term energy-flow explicitly. **LIMES** not only shows the technical operating data but also automatically gives a clear information about the economical operating state. With its converging short-time forecast, **LIMES** even allows for corrective technical actions in case of unexpected energy flow.

The trading load profile can be transferred to the ZEG up to one week in advance. The load profile used by the ZEG can be changed at any time, even in the current quarter of an hour.

The mean power data archived by the ZEG include the average of the trading load profile data valid during each quarter of an hour.



Limit value timetable

Aside from the trading load profile, **LIMES** includes a limit value timetable. The limit value timetable allows to specify a tolerance band, in which the utilities should operate. Deviations from the tolerance band are signaled by digital alarm outputs as well as by visual and acoustical indication on the main computer.

The limit value timetable can be created and transferred to the ZEG by an Excel worksheet. For the operators, a manual override of the timetable's limit values is provided.

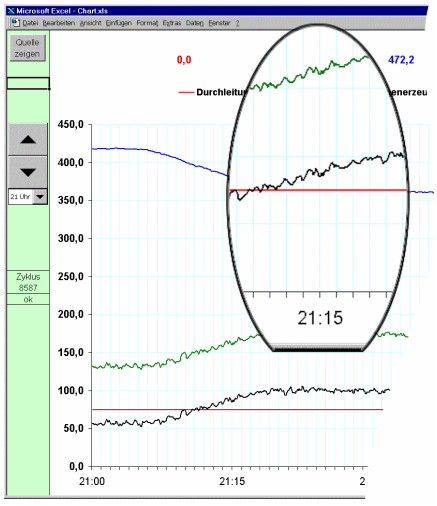
Technical diagnosis

With its short 5 second measurement cycle, **LIMES** is an excellent tool for detailled observation of the utilities operation.

An Excel workbook, Chart.xls, provides the logging of 4 values, freely selectable out of all input- and balance-values. When this worksheet is active, it stores a 24-hour history of the logged values and allows for immediate graphical inspection of anomalies.

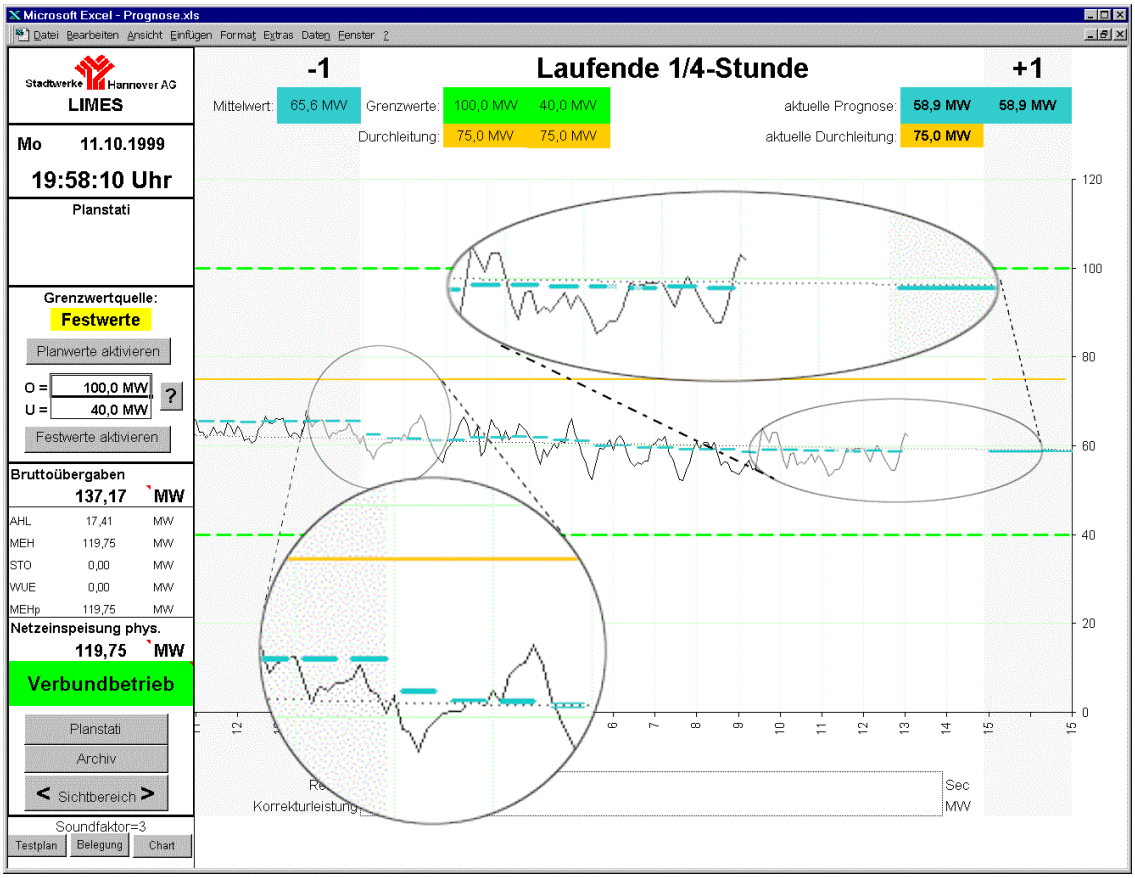
Together with the ZEG's 7-days archive of 5-second-balance data a detailled protocol of the operating state is available.

The logging data can be printed graphically or numerically and are available as textfiles for documentation and further inspection.



Management

The Microsoft Excel main operating worksheet of **LIMES** shows all data necessary to assess the technical and economical operating state of the utilities.



The central traces are showing:

- External procurement as 5-second measurement (black)
- Forecast, actualized all 30 seconds (blue)
- Trading load profile (yellow)
- Limit values, here manually set (green)

When limit value are exceeded (not seen here) special warning symbols are appearing in the diagram.

In particular in the bottom of the screen the power demand necessary for countersteering as well as its gradient are indicated. These data allow for a quantified reaction to problematic changes in the operating state, both by economical (trade on the spot market) and by technical (change of the generator power) countermeasures.

Aside from these diagrams some current operational data of individual subsystems (generators, deliveries etc..) are quantified.