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# Power Engineering | Smart Grid | Micro Grid

## Training systems on the generation, distribution and management of electrical energy:

- Power engineering training system, distribution training system
- Energy generation training system, renewable energy generation training system
- Transformer training system, high-voltage transmission lines training system, protective systems training system
- Energy management training system, smart grid training systems

The Lucas-Nülle training systems have been designed in anticipation of the newest developments:

- Smart measuring instruments provided with various communication interfaces (e.g. LAN, RS485, USB) and control elements
- SCADA Power Engineering Lab software for the intelligent control and evaluation of "smart grids" using Soft PLC
- SCADA software designed for educational purposes
- Permits investigation of dynamically alternating loads and power generation inside the laboratory
- Intelligent energy management
- Modular integration of renewable energies into a smart grid using protective engineering
- Wind power plant with doubly-fed asynchronous generator (DFIG) and synchronisation to the grid
- Interactive multimedia training course

## "Smart Grids" - Intelligent power supply networks



### **"Smart Grids" - Intelligent power supply networks**

In the future, new technology will better equip power grids for the demands of tomorrow. More flexible grid management should make the increasing proportion of renewable energy sources compatible with conventional infrastructures associated with power stations. The variety and number of these decentralised power plants require a revision in how we manage power grids – so-called intelligent networks or "smart grids":

- Improved coordination of energy requirements and energy generation, e.g. via intelligent switching of loads depending on the energy available
- Using modern IT technology, like the internet, sensors, control systems and wireless transmission devices
- "Smart metering" – digital current meters measure electricity consumption where customers are connected to the grid
- Shifting household consumption away from peak load periods
- Starting flexible applications such as washing machines outside peak load periods, at the initiation of a utility provider

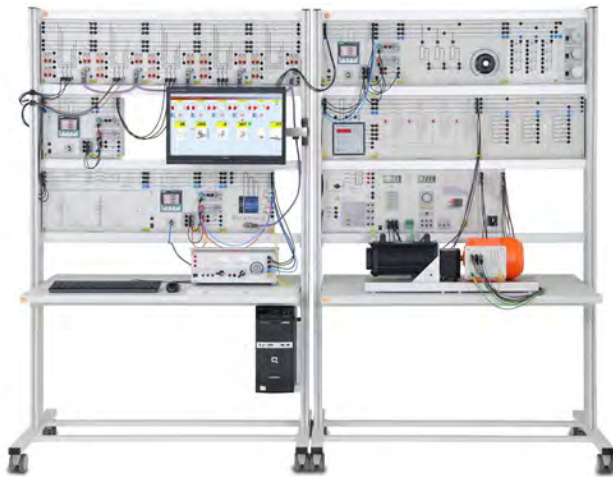
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- Interactive multimedia training course

### **Training system on the generation, transmission, distribution, protection and management of electrical energy:**

- Energy management, smart grid training system
- Energy generation, regenerative energy generation
- High-voltage transmission lines, protective systems

## ESG 1 Smart Grid Trainer



### **ESG 1 Smart Grid Trainer**

## ESG 1.1 Three-phase double busbar system

### **ESG 1.1 Three-phase double busbar system**

### Training contents:



### Training contents:

- Basic circuits of a three-pole, double busbar system
- Three-phase, double busbar system with load
- Busbar changeover without interruption of the branch
- Preparation of algorithms for various switching operations
- Busbar coupling

### Investigations on Three-phase Transmission Lines

#### Training contents:

- Voltage increases on open-circuit lines
- Voltage drop as a function of line length
- Voltage drop as a function of  $\cos\phi$
- Capacitive and inductive power losses on a line as a function of  $U$  and  $I$
- Phase shift on a line

### Overcurrent time protection for lines

#### Training contents:

- Designing and parameterising overcurrent time protection
- Determining the reset ratio in the case of single-, double- and triple-pole short circuit
- Determining a relay's shortest release time
- Checking a circuit breaker's release behaviour in the event of a failure

### Equipment set comprising the following:

| Pos. | Product name                                                | Bestell-Nr. | Anz. |
|------|-------------------------------------------------------------|-------------|------|
| 1    | Double busbar unit, three-phase, incoming / outgoing feeder | CO3301-5R   | 4    |
| 2    | Double busbar unit, three-phase, coupler panel              | CO3301-5S   | 1    |
| 3    | Transmission line model 150km/300km (93.2miles/186.4miles)  | CO3301-3A   | 1    |
| 4    | Time Overcurrent Relay                                      | CO3301-4J   | 1    |
| 5    | Ohmic load 3x 560 Ohm                                       | CO3301-3H   | 1    |

#### Power supply:

| Pos. | Product name                                            | Bestell-Nr. | Anz. |
|------|---------------------------------------------------------|-------------|------|
| 6    | Adjustable 3-phase power supply, 0-450V/2A              | CO3301-3Z   | 1    |
| 7    | Power switch module                                     | CO3301-5P   | 2    |
| 8    | Multiple socket outlet, 6 fold, with illuminated switch | ST8010-4J   | 2    |

#### Measuring instruments:

| Pos. | Product name                                                  | Bestell-Nr. | Anz. |
|------|---------------------------------------------------------------|-------------|------|
| 9    | Three-phase power quality meter, display and long-term memory | CO5127-1S   | 2    |

#### Media:

| Pos. | Product name                                                                     | Bestell-Nr. | Anz. |
|------|----------------------------------------------------------------------------------|-------------|------|
| 10   | Interactive Lab Assistant: Smart Grid                                            | SO2800-3Z   | 1    |
| 11   | Interactive Lab Assistant: Bus bar systems                                       | SO2800-9N   | 1    |
| 12   | Interactive Lab Assistant: High-voltage transmission lines                       | SO2800-3L   | 1    |
| 13   | Interactive Lab Assistant: Protective systems for high-voltage transmission line | SO2800-6L   | 1    |

#### Software:

| Pos. | Product name                                            | Bestell-Nr. | Anz. |
|------|---------------------------------------------------------|-------------|------|
| 14   | Software SCADA for Power Engineering, designer software | SO4001-3F   | 1    |

#### Accessories:

| Pos. | Product name                                                                                                | Bestell-Nr. | Anz. |
|------|-------------------------------------------------------------------------------------------------------------|-------------|------|
| 15   | Patch cable Cat5E 1x 1 m yellow, 2x 2 m yellow                                                              | LM9057      | 2    |
| 16   | USB 2.0 Ethernet adapter, 10/100                                                                            | LM8257      | 1    |
| 17   | 5-Port Ethernet Switch                                                                                      | LM9988      | 1    |
| 18   | Safety connecting plug 4mm with tap (2x), black, 1000V/32A CAT II                                           | SO5126-3R   | 50   |
| 19   | Safety connecting plug 4mm with tap (2x), blue, 1000V/32A CAT II                                            | SO5126-3V   | 5    |
| 20   | Safety connecting plug 4mm with tap (2x), gr/ye, 1000V/32A CAT II                                           | SO5126-3W   | 10   |
| 21   | Set of safety measurement cables, 4mm (31 leads)                                                            | SO5148-1L   | 2    |
| 22   | Safety measurement cable (4mm), 25cm/10", black, 600 V, CAT III ' 1000 V, CAT II / 32A                      | SO5126-8B   | 6    |
| 23   | Interface converter USB/RS485                                                                               | LM9025      | 1    |
| 24   | Mobile aluminum experiment stand, 3 levels, power strip with 6 sockets, 49"x28"x79" WxDxH (1250x700x1995mm) | ST7200-4C   | 1    |

Additionally recommended:

| Pos. | Product name                                                        | Bestell-Nr. | Anz. |
|------|---------------------------------------------------------------------|-------------|------|
| 25   | Display for Smart Grid equipment                                    | CO3301-7B   | 1    |
| 26   | Monitor holder for flat screen monitor of weight up to 15kg / 33lbs | ST8010-4T   | 1    |
| 27   | Keyboard adapter for flat screen monitor holders                    | ST8010-4G   | 1    |
| 28   | Protection cover for three-level experiment trolleys                | ST8010-9Y   | 1    |