Power and Energy Management

with Energy Control Modules

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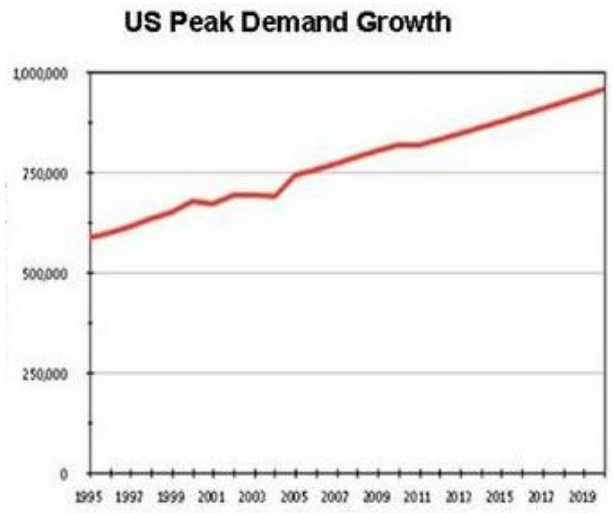
Energy Consumption

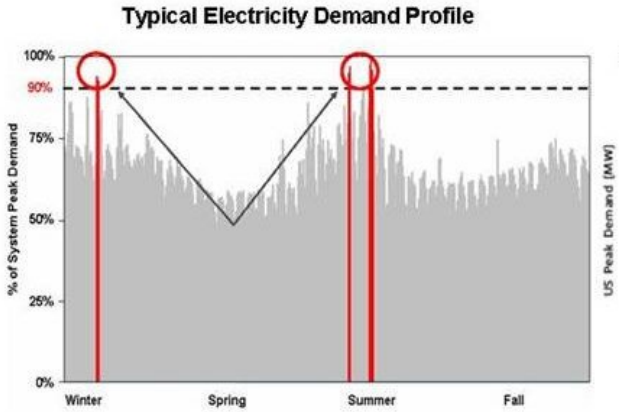
- In average yearly energy consumption increase is higher compared to new investments into electric grids → grid congestion
- Heavily loaded grids → big losses proportional to I^2
- Information technologies → require stable and high available electric distribution
- Energy cost is constantly increasing → energy conservation is trend



Companies: GE, Siemens, LonWorks, ZigBee Alliance, ... Google

Fluctuations of Energy Distribution

- Increase of temporary peak demands → grid congestions, increase losses, require new energy sources, → lead to brown-outs, black-outs
- Alternative sources (solar, wind) → require immediate grid response and availability
- Fluctuations of generators, consumers and grids → require distributed real-time architecture for monitoring and control to maintain stability



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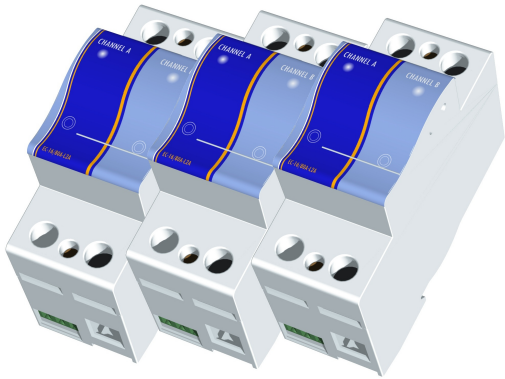
Efficient Solution for Energy Conservation



Conserve

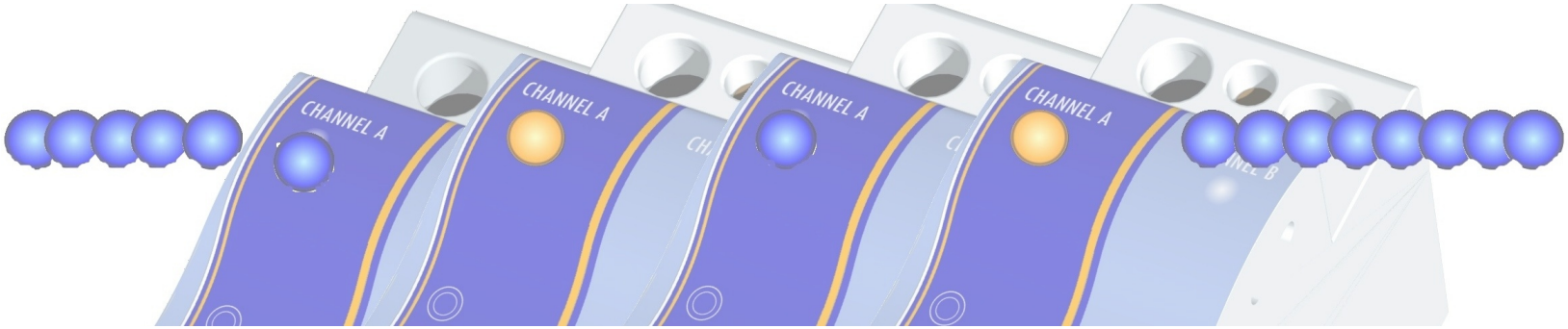
- Conservation based on subscriber power decrease.
- Conservation based on energy consumption decrease.
- Conservation based on detection and elimination of standby power.
- Conservation based on hopping to lower energy classes.

Conservation based on subscriber power decrease

- Typical subscriber power is over 5 kW in Slovenia.
- Requires high grid availability and greater transformers.
- Higher subscriber powers cause greater peak power demands and cause higher power losses in distribution grid.

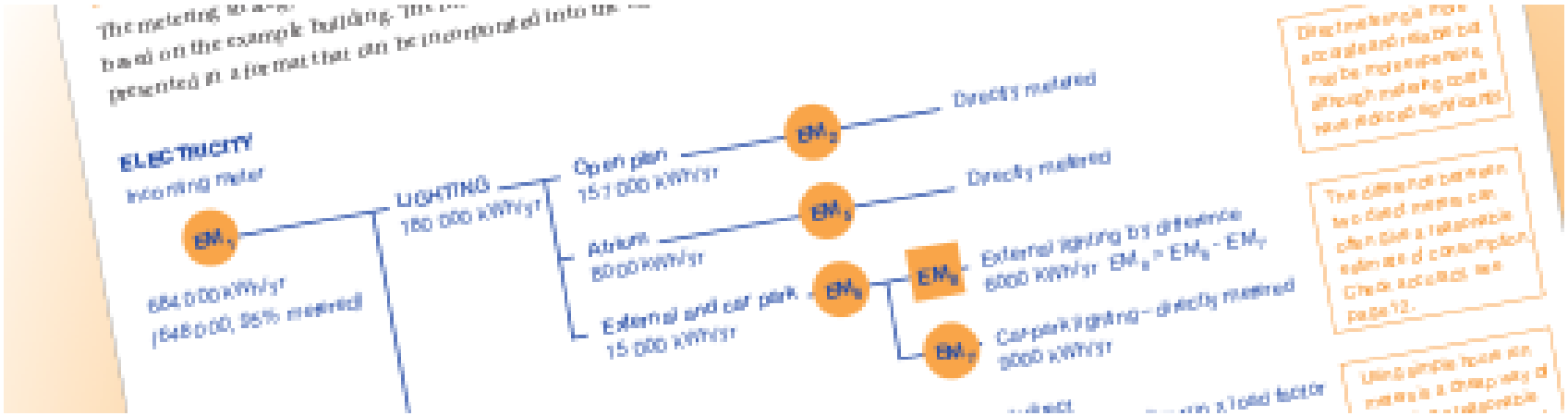
- Decreasing subscriber power therefore allows lower operating costs in grid systems and lower monthly costs in households and industry.

Conservation based on energy consumption decrease



- Power and energy metering is shown in intuitive way by blinking the LEDs.
- Employs energy limiter that prevents excess power consumption.
- Learns desired energy usage per tariff. *I.e. a water heater may operate once per day on high tariff and twice on second (lower cost) tariff.*
- Detection of standby currents, powered 24h a day.
- Per day and per tariff metering is logged in internal memory for more than a year.

Conservation based on hopping to lower energy classes.



- Progressive cost of the energy per average daily consumption is divided in several energy classes: (6 kWh: 0%, ..12 kWh: 10%, ..18 kWh: 30%, ..24 kWh: 50%, ..: 100%).
- Typical consumer hops to one energy class less by using EC (auto-)learning energy limiter.
- Average cost decrease of 18%.

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EC Key Features

- Protection against common over-current.
- Energy conservation, metering and issuing of energy efficiency certificates.
- Fault detection.
- Anti-smog: reduction of electromagnetic and electrostatic radiation.
- Integration of alternative sources.
- **Simple installation and usage.**

Highly integrated solution in a single EC module!

Protection against common over-current

highest priority

lowest priority

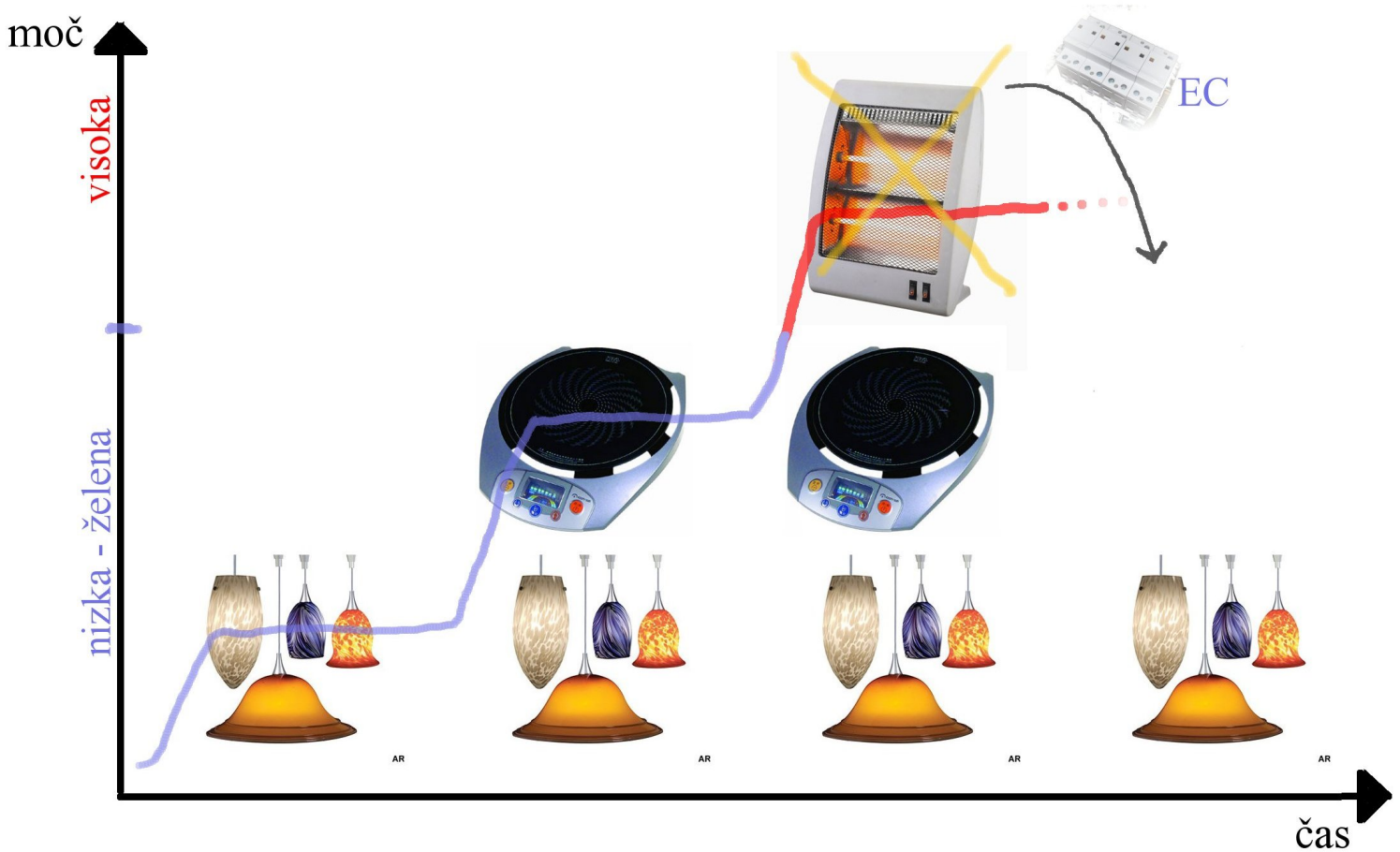
Example of minimal system requirements:

- lighting: 100 W
- water heaters: 1.5 kW
- heating: 0.7 - 1.8 kW

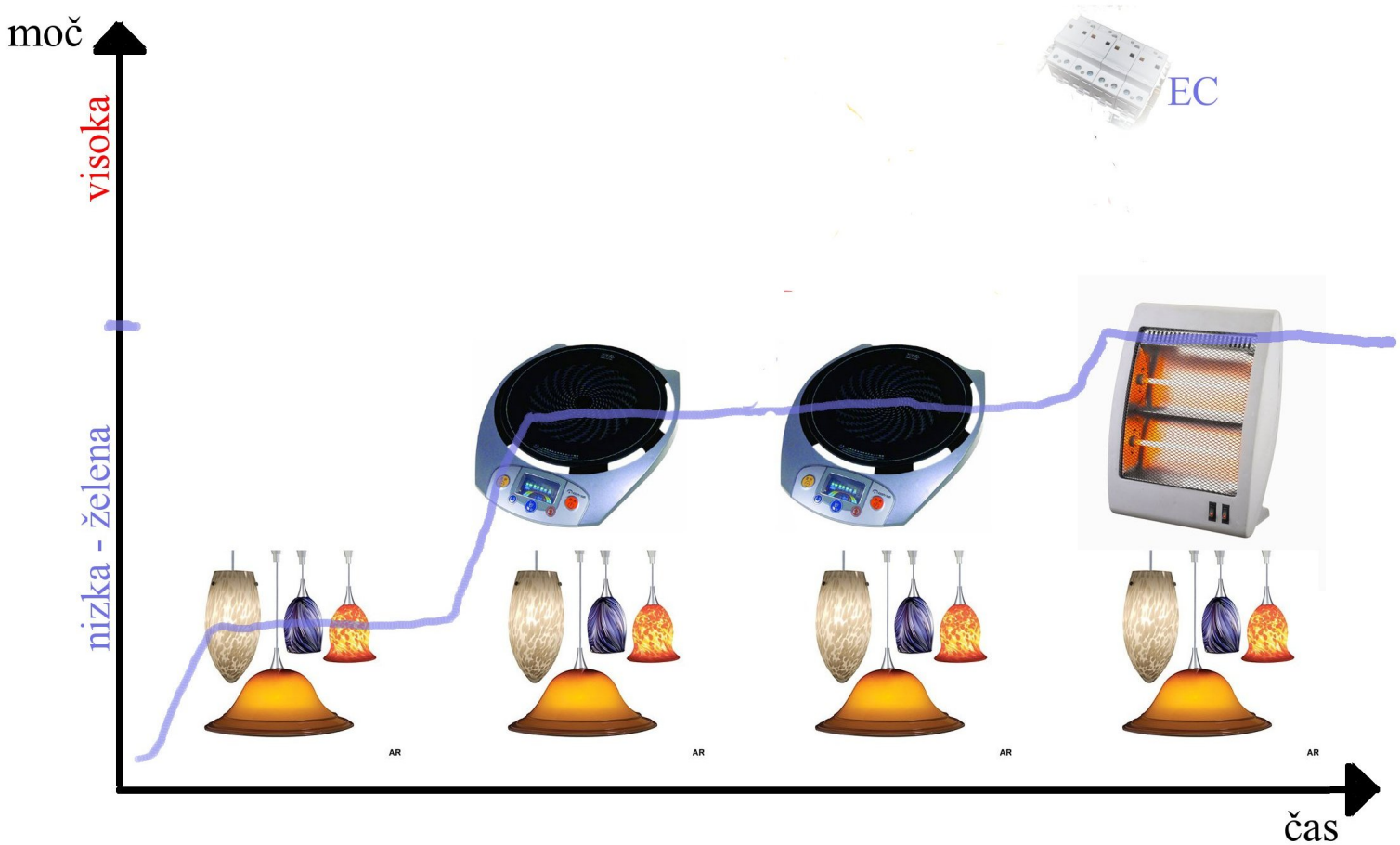
Total of 3.4 kW!

- ECs decrease present power and peak demands.
- ECs release grid and decrease losses.
- ECs adapts to present grid power availability.
- Dynamic marketing of the energy - dynamic cost.

Protection against common over-current



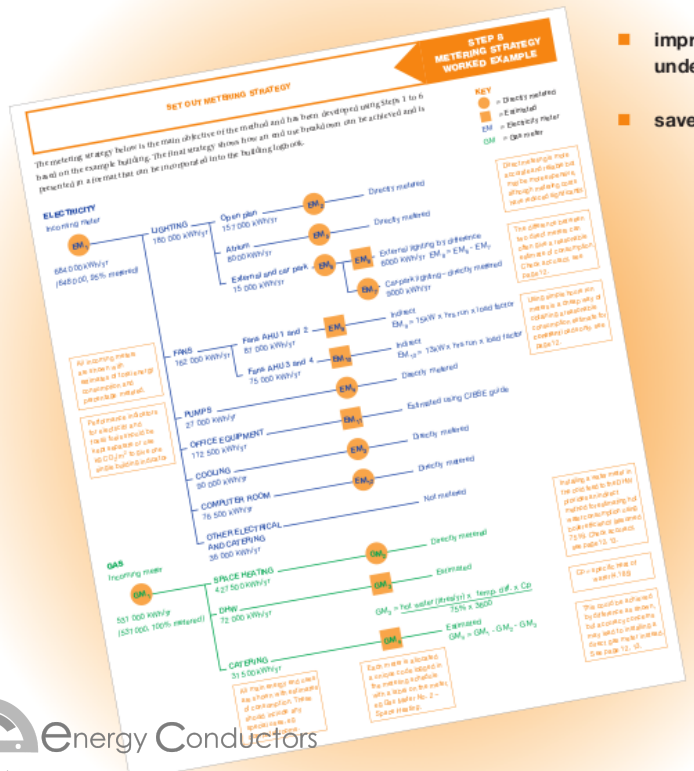
Protection against common over-current



Energy Conservation, Energy Certificates

Metering energy use in new non-domestic buildings

A guide to help designers meet Part L2 of the Building Regulations



Develop a metering strategy that can:

- optimise cost, practicality and savings
- improve operators' understanding of their buildings
- save 5-10% of energy or more

New European energy regulations:

- Power metering and energy conservation.
- Issuing of energy efficiency certificates.
- Retention of metering logs for more than a year.

Fault detection

Protects

- Fault generation on over-current event.
  (Fast response times below 50 A)
- Fault generation on excess energy consumption detection.
  (in case of water release from water heater)
- Fault generation on insufficient energy consumption detection.
  (in case of heater malfunctioning)

Anti-Smog: Reduction of Electric Radiation

- Typical household contains from 1 to 2 km of wires in electric installations.
- Typical electric field strength is from 15 V/m up to 100 V/m and magnetic field strength from 10 nT up to 10 μT.
- Radiation influences on human cells, causing sleep disorders and heart rate variability.
- EC anti-smog function reduces radiation for 40 dB (100x).

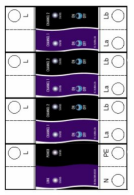
Integration of Alternative Sources

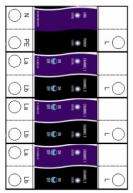
Room heaters are high power electrical appliances of 1 kW and more. They switch on and off according to the room temperature. Such a load produce a random power damand but can be switched off at any time.

Energy Control module - EC conducts power according to demand and availability.

Grid power serves as power source and drain as well. Limited subscriber power cannot always fit consumer demands. EC modules help to redistribute available power in combination with other power sources among all electrical appliances.

Water heater as room heater is high power device. EC modules take care over power consumption and cost using multiple tarif models and energy sources.





When wind power is available EC modules ensures its maximum utilization across all appliances and transmission to the grid.

Refrigerator is a medium power device but is more sensible to power cut offs. EC modules ensures it higher priority at power delivery.

ECmodules offer intelligent utilization of green power using different tarif models and transmission to the grid.

Cookers and oven are high power appliances and require electricity right on request. EC modules ensure it by switching off less important appliances and switching on additional power sources when needed.

Lighting, followed by computers, are the most sensible electrical appliances. To avoid black-outs EC modules ensure highest priority to these appliances and acts as emergency lighting system at the same time.

EC modules analyze total power income from sources and demand from appliances. When outcome is positive remaining power is stored in rechargeable accumulators to recover from cases when power damand is too high or sources are not working.

When end-user power damand cannot be ensured, EC modules trigger additional power sources to cover present power requirements.

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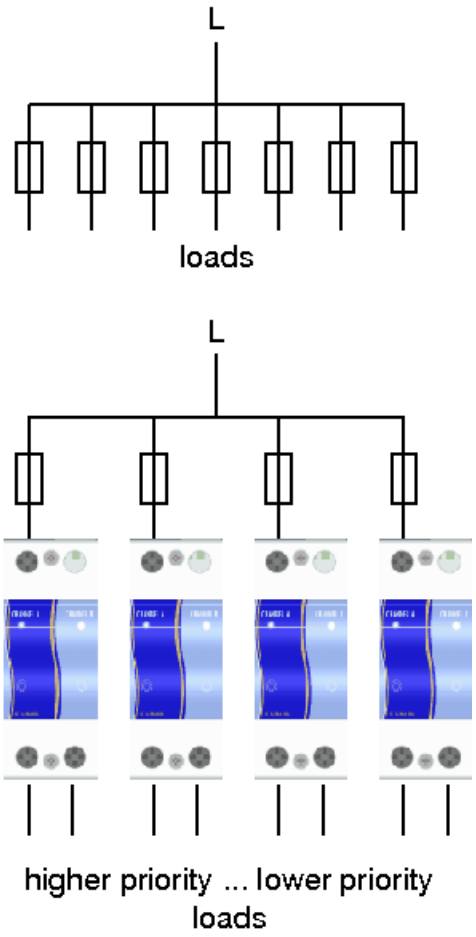
Installation



Simple installation

- Into existing and new electric housings.
- Connect after standard automatic fuses.
- Possible elimination of redundant fuses.
- Loads from the left have higher priorities. In case of common over-current event, loads from the right get disconnected first.

Usage

Simple usage

- No manual configuration - Fully automatic!
- Visual indication of daily consumption and present power by dual-colour LEDs.
- In cases of fault event generation it is automatically cleared after faulty load is disconnected.
- Automatic configuration of energy limiter. It learns about desired energy conservation and assures that energy consumption stays within the desired limits in the following days.
- Anti-smog function automatically turns on when load is disconnected.

Advanced users may obtain detailed metering report on their PC.

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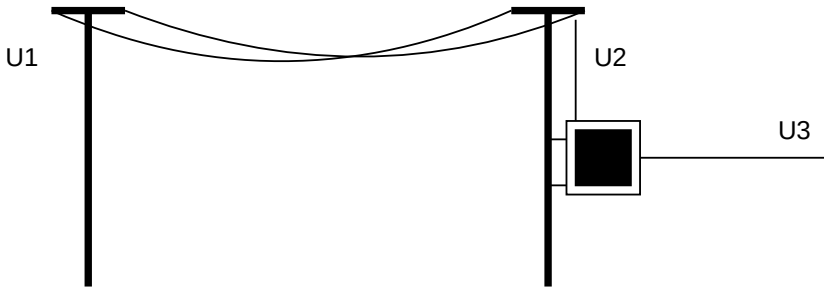
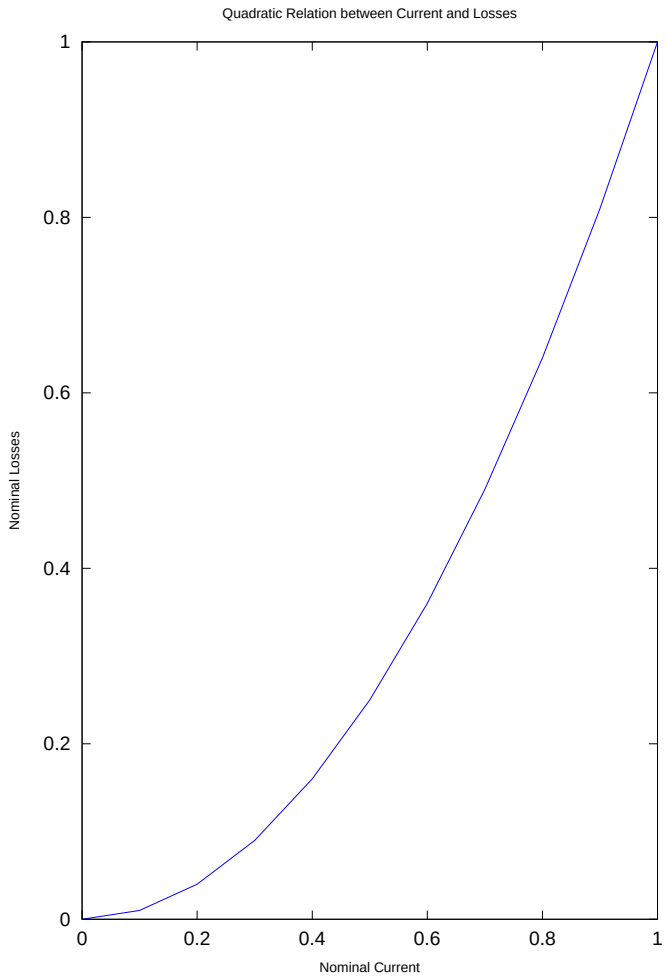
Power Losses



- Maximum power/energy transfer in transmission lines requires voltage drop be $<$5% yields 10% of power loss
- Maximum temperature of conducting material $<$100°C, over-loading for about 10-20% is allowable for short-time
- Additional power losses are in transfomers; maximum total voltage drop of $<$10% yields 20% of power loss

Power Losses



Maximum transmission current:

$$I_{max} = \frac{1}{R_T}(5\%)U_{in}$$

Present losses, according to present current I:

$$P_{loss} = \frac{I^2}{I_{max}}(5\%)U_{in}$$

The 10% current decrease reduces nominal losses for 20%, and 20% current decrease for 36%.

Power Losses and Limited Power

- Limited power of transmission lines and transformers
- Incorporation of self-limiting function based on end-voltages
- Distance from transformer estimation is based on voltage range and average drop

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Short-term Benefits

- Offer your customers an efficient way to conserve energy.
- Energy conservation in distribution grid, transfer greater amount of energy at lower cost.
- Elimination of peak power demands.
- Release over-loaded transformer stations and decrease investment/upgrade cost.
- Increase grid stability and prevent system black-outs.
- Reduce investment requirements in power plants.
- Comply new European regulation related to energy efficiency.
- Support for SME, business buildings, etc.

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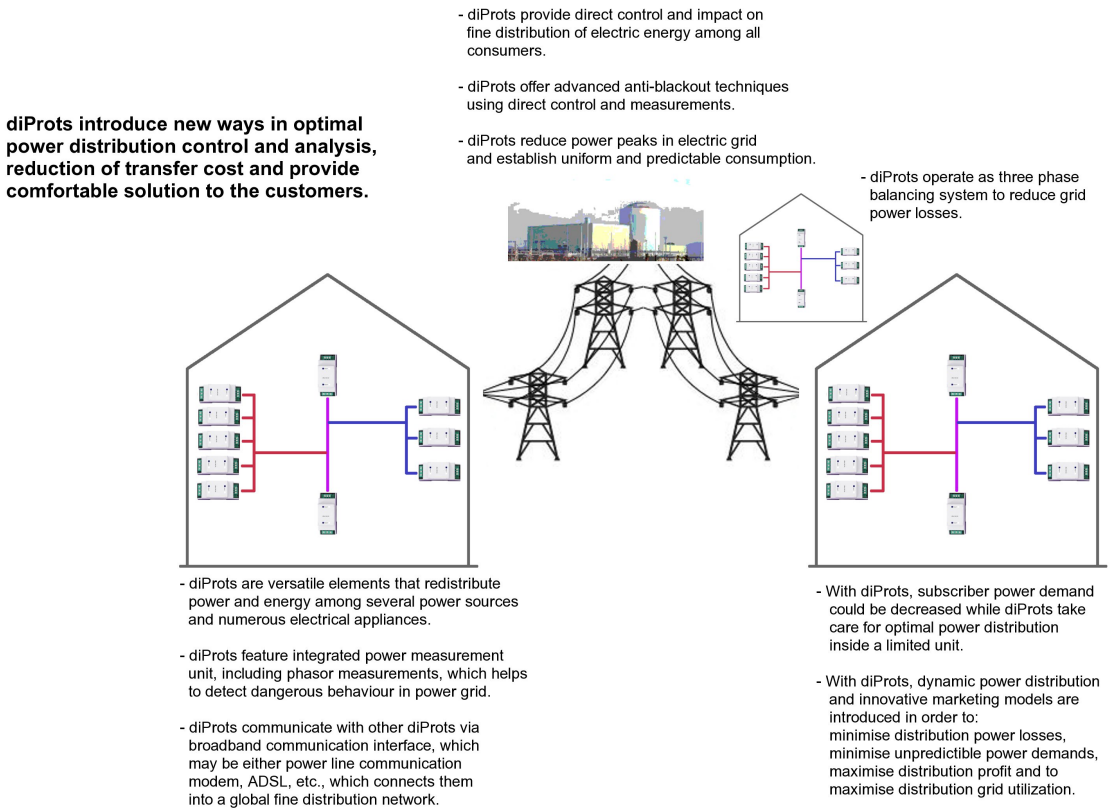
Long-term Benefits

- Connects with Power Meters (M-bus).
- Optimise present power demand vs. present power availability.
- Full control over distributed alternative sources.
- Introduce dynamic marketing model per energy availability.



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