Swisseiland®

126 KVA Isle Power System
Combined Heat and Power (CPH)

Project Herrliberg

Short Description of CPH Isle Systems

Project CHP Isle -Solution
Arbachstrasse 1, 8704 Herrliberg-Wetzwil

This project faces a pure electrical isle solution for single or multi-family houses. The premises pictured down below have no connection with a public electric or gas circuit.

The Herrliberg Project has an underground gas supply with liquefied gas-storage tank capacity of 4, 5 m³ this amount equals 1,900 kg of gas that corresponds to a thermic heating power of 26,600kWh.

The multi-single house site has no access to the public electric circuit but offers enough electrical energy and unlimited comfort with accessibility for the disabled.

Two energy-efficient hydraulic elevators (car and passenger elevator) are provided as well as electric baking oven, washing machine, dishwasher with warm water alignment, laundry dryer with heat pump etc. It has, of course, been taken in to consideration the usage of A++ in the area of domestic appliance, equipment and heating pumps inclusive energy-saving LED illumination.

The project was realized with a large energy reserve due to a battery storage and water tank which can buffer for up to 24 hours. The electrical energy for the 3-phase 400Volt 50Hz isle system is generated by 6 powerful alternating-current converters.

Through a well-developed technique of building-management-system, abbreviated BMS, the battery's condition, heat accumulator, BHKWs, PV solar panels and the alternating-current converter are constantly scanned and regulated.

The powerful modulated BHKW (Block Heating Power Plant) is steered and controlled by the BMS. Adjustment occurs by heightening or lowering the number of revolution as the BHKW regulates the power for the required project. The output line of the BHKW (current & electric tension) is circularized over the BMS.

The demand of when the BHKW is being switched on or off depends on the battery's state, warm water supply, the domestic hot water tank and the momentary individual consumption of each house. Those values are constantly retrieved and evaluated by the BMS. If the battery is full or enough solar current has been produced the BHKW switches off. This also occurs in the dependency of the consumed warm water.

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Overview of Technical Components

Current and warm water are firstly generated by a BHKW with an electric capacity of 20kW and a thermic capacity of 44kW and secondly pure electricity generation is available by a photovoltaic system with a capacity of 6kW.

There is a 48 Volt 2,800 Ah battery system for the power storage.

In case of any eventualities there is an emergency power supply aggregate with a capacity of 9, 3 kW.

Normally the emergency aggregate is activated by the building management system. The emergency power supply aggregate can be switched on directly from the BMS in the event of a fault. A complete separation of the emergency power supply aggregate from the automatic system can also be done manually. The emergency power supply aggregate works on its own: no BMS, no alternating-current converter and no battery, its supply goes directly to the domestic current circuit. That involves an additional security level.

Gas System

The Herrliberg project has its gas supply in the garden area, subterranean and the liquefied gas storage tank is provided from the company VITOGAZ Switzerland AG.

The above mentioned tank fill capacity is 4, 5 m³ corresponding 1‘900 kg of gas and a thermic heating power of 26‘600kWh.

1m³ gas tank corresponds to 441,86kg of gas heating power equivalent to a heating energy of 6‘186kWh.

1 kg of gas corresponds of a heating energy of 14kWh.

The 4 gas principal consumers are BHKW, emergency generator, heating thermes and the gas and water pump. Equally consumption is given for the house such as cooking and baking.

Calculation of a daily electrical consumption was estimated about max. 75kWh, this corresponds to 173kW thermic, which involves 1 hour electrical power of ca. 12 kW deriving from our BHKW for an operating time of 6 hours.

Therefore the gas content would suffice for ca. 150 days for our BHKW. The power generation from our solar panels which impact positively the gas consumption is included into the calculation as well, meaning that the refilling occurs less than 3 times a year.

BHKW

For the ecological energy extraction (heating and current) the combined heat and power generation (WKK) is being used for a 90% efficiency utilization of combustible material. Best adequate BHKW (Type PT20) comes from the German company PowerTherm EnergieSyteme.

This model of BHKW can be used with propane gas LPG (C3H8) or with bio/sewage gas and can be modulated. The number of revolutions is adjustable to the different requirements and outputs but the degree of efficiency still remains.

This BHKW technology can reduce the consumption of primary energy to one third. The CO2-emission can be decreased by 60% from with this kind of heat and current generation compared to the public one.

The here applied PowerTherm BHKW generates per kWh less than 0,425kg CO2 compared to a German power plant power mix.

These data were retrieved from the study **Globales Emissions-Modell Integrierter Systeme** (GEMIS) on behalf of the German Öko-Institut e.V. www.oeko.de

Reduction of CO2 was calculated during the first 240 days by evaluating the BHKW-Project and the resulting figures show about 22‘350kWh, a decrease of at least 10 tons of CO2per annum.

The BHKW functions with an adjustable number of revolutions of 900 - 2300 U/min corresponding to an electric power output of ca. 5 to 20kW and a thermic power output of ca. 10 to 43kW (without any utilization of latent heat).

For this special isle system the BHKW needed some adaptions which were undertaken by the company PowerTherm of Hamburg in collaboration and set points with the Engineering Office Aircraft Communication Engineering.

The BHKW has a max. power of 20kW electric and 43kW thermic a gas usage of 72kW/h or 5,6kg /h liquefied gas.

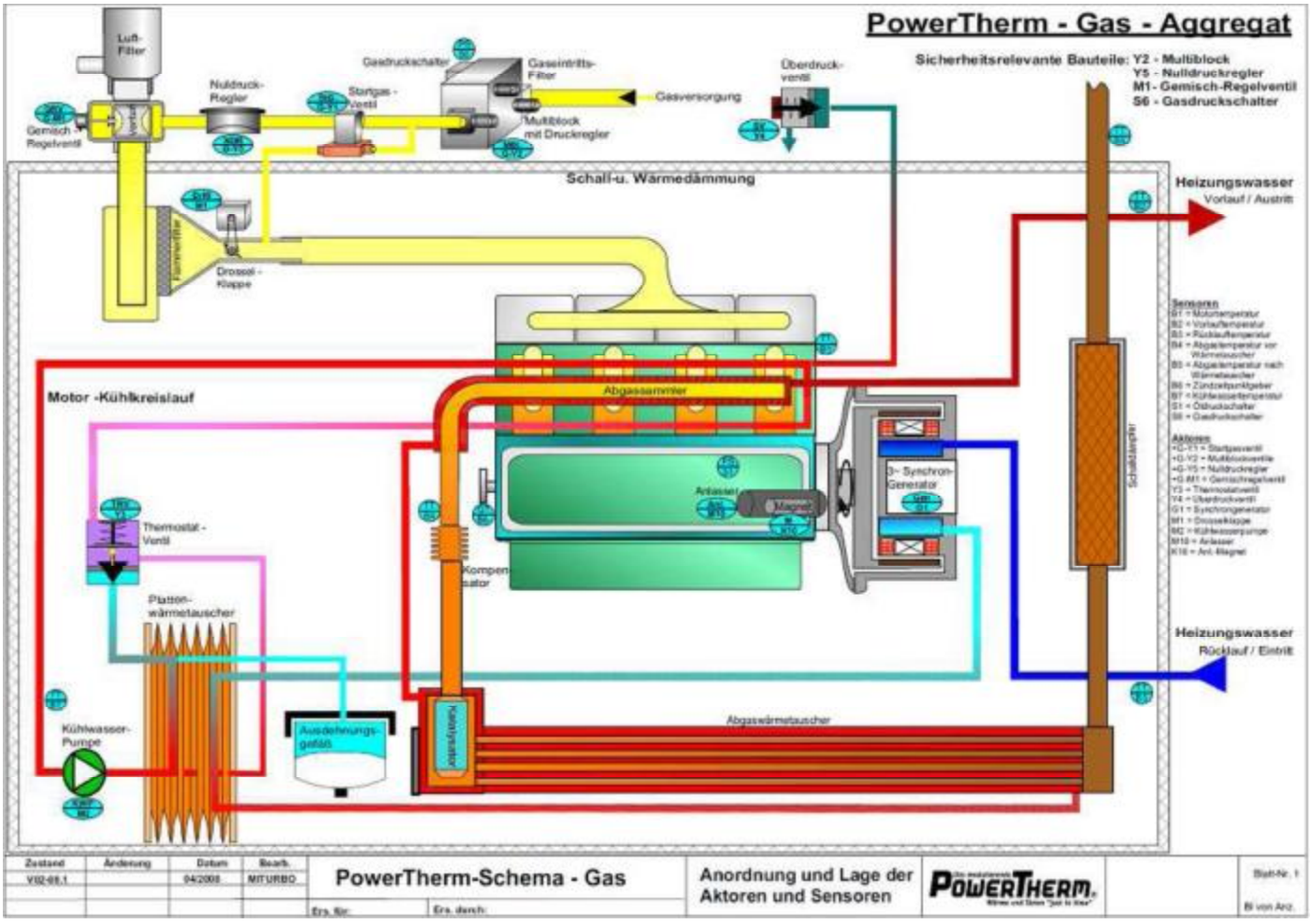
That means, for the generation of 1kWh electric 1,14kWh primary energy is needed corresponding to 0,089kg liquefied gas.

The BHKW is based on a 4 cylindrical industrial motor which was especially constructed for PowerTherm. It is an optimized lean engine for the operation in the field of energy-saving techniques. The motor is equipped with a maintenance free and wear less permanent magnet generator.

The special heat transmission philosophy enables a complete enclosure which makes the aeration superfluous. The high overall efficiency of >90% (with the utilization of latent heat up to 98%) of the BHKW is used intelligently of wasted motor heat, engine oil and exhaust gas.

The BHKW integrated permanent magnet generator is a water-cooled synchronous special generator. It is directly installed on the crankshaft without bearing. The generator is cooled by the reflux of the heating water. It reaches an electronic degree of efficiency of 96, 5% at a return temperature of 80 °C.

BHKW- System- Overview



Emergency Generator

Maintenance of operation of the isle current supply is secured by an emergency generator in case of a breakdown of the inverter or battery. Emergency generators are supplied by the Swiss company Hedinger AG.

The emergency generator has a max. power of 9,3kW a gas consumption of ca. 3,6 kg/h and an overall efficiency of ca. 90%.

Similar to the BHKW it functions with propane LPG (C3H8) or bio/sewage gas and it is also adjustable.

The emergency generator is only being used if a BHKW breakdown occurs for the missing power generation. It is able to charge the batteries even if the inverters are intact, for instance during maintenance work of the BHKW whilst switched off.

The inverters get synchronized on the emergency generator's frequency (50Hz) and are being switched on automatically after max. 2 sec parallel to it. With this interconnection the inverters are able to provide during elevator operation the necessary current peak from the emergency generator's batteries.

The emergency generator can be used on its own without the support of the batteries and inverters and provide current for the 3- phase isle network with a power of 9,3 kW. For that coverage the transfer switch needs to be activated manually in the plant room.

Battery System

Batteries are supplied by the Swiss traditional house in Oerlikon with a century's experience of lead batteries' cell. They are maintenance-free gel-block batteries for professional use. The acid is in a gel and kept in carded webs making the batteries unique. The batteries can be stored without charging over months due to a very low self-discharge rate.

This battery of the type 2 CP 3'000 has a nominal tension of 2 Volt. With this system 24 pieces in series are being switched on resulting a 48V-Battery with a capacity of 3'000 Ah.

The block compartments are gastight and therefore maintenance-free with an operation life of min. 15 years and rechargeable more than 2000 times without losing their capacity.

The discharge current of this battery system can amount up to 20 minutes of 1'50 20 minut0Amp.

The battery's conduct allows without any problems intense load operation due to required person elevator lift and auto elevator.

Inverters

For the current generator of the isle system Herrliberg an inverter system has being used with a powerful bi-directional 3 phases of 400V/50 Hz. For this standard 6 inverters of the type XTH 8000-48 are being used and produced by the Swiss company Studer Innotec in Sion.

Each inverter has a nominal power of 7kW and can also emit 8kW for 30mins. But an emission of peak current of 21kW for 5 sec. is possible, too. This involves that 6 inverters together give off a continuous output of 42kW and for the short time the car elevators start releases up to 126kW safely.

These inverters can be simultaneously connected to 3 different current sources. They have two different AC inputs which one of it can be used as an AC output. Additionally they have a common DC in-output connected to the battery. Over that DC in-output the battery supplies the inverters and at the same it is being used to charge the emergency generator battery.

They are also equipped with multiple potential free contacts which are programmed for different tasks. These signals are transmitted to the building management system and there evaluated. Given an inverter-system-information a reaction inner or outer exterior incidents of the inverters such as accessibility of network, or battery life span, or any failure indication are detected.

Although max. inverter power is never being reached there is a consumption sharing for elevator operation by the BMS. Automatic separation for usage of electric heating, washing machines, dryers and water pumps during ca. 25 sec duration of the car elevator is provided. This limits the car elevator operation (ca. 850Amp. DC) and reduces stress for the whole power-system, (battery and inverter) increasing the system's life expectancy.

The momentary average consumption of the isle system project Herrliberg is approx. 6kW per h and is ensured at all times.

Photovoltaic System

The PV-System was constructed by the Swiss company BE Netz AG in Ebikon in collaboration with the company Aircraft Communication Engineering GmbH and integrated on both flat roof areas of the car elevator building.

The PV-System comprises of 2 solar cell fields with 26 solar modules, 3 MPPT solar regulators, 3 surge voltage, modules and an equipotential bonding with lightning protection concept. The big solar cell field contains 20 modules and the small solar cell field 6 modules. The solar modules are of the type SunPower SPR-220-black.

The big roof is aligned towards south-south-east and 20 modules to 10 strings per 2 modules in series are being switched together resulting a string voltage of 82, 2 Volt at a current of 5, 37 Amp. producing a string voltage of 445 Watt. Furthermore 5 strings are being connected to each solar controller. For each solar controller there is an input stream of approx. 27 Amp. at 82,2 Volt. This corresponds to a power of approx. 2,2kW per solar controller. The overall operating performance for the big roof amounts to 4,5kW.

The small roof is aligned towards south-south-west and 6 modules to 3 strings per 2 modules in series are being switched together resulting a string voltage of 82,2 Volt at a current of 16 Amp. producing a string voltage of 1.3kW. The overall operating performance for the both roofs amounts to 5,8 kW.

Due to the photovoltaic technology for electricity generation 100% primary energies can be saved. According to the FOE (Federal Office of the Environment) mentioning the EU study, per generated kWh of solar current 0,420kg CO2 savings are partly credited to.

At present PV-System's operational figures of this project during the first 240 days show savings of 5 tons CO2 per a year's solar yield of approx. 12'000kWh.

MPPT Solar Charge Controller for 48 Volt Battery System

MPPT is an abbreviation for Maximum Power Point Tracker.

Those 3 solar charge controllers are installed in the battery room and connected to 2 high current cables with 3 solar distributors which are integrated in the car elevator building.

Part of these distributors there are 3 string protections, 3 surge modules and equipotential bonding modules.

The wiring of the big and small roof strings 10 and 3 come together and are distributed to 3 surge modules. Each solar charge controller has its own surge module and strings connected to its corresponding solar module. Die MPPT solar charge controller is of the type Out Back MX60.

The MPPT circuits are integrated to maximize available energy in our highly efficient charge controller. The maximum power peak (MPP) is dynamically determined and used to an optimized power adaption. The MPPT Controller can use the whole produced solar panel energy to charge the battery. A MPPT Charge-Controller comprises a DC/DC down-/upwards converter with an integrated microprocessor. A continuous maximized energy output throughout the day (Pmax=VI) is influenced by the weather condition (sunlight, clouds, shadow, rain) and depending also on the solar panel temperature, the controller is constantly calculating at new the voltage and current output so to adapt them to the load requirement of the battery.

The biggest advantage of the MPPT-Algorithm is however the improved efficiency which can reach some systems to 99 %.

Building Management System (BMS)

Besides of its energy independency the project Herrliberg has more innovation to offer. We are referring to a so called intelligent house because not only the current generation and heating control are linked and inter-linked amongst each other to a central building management system but all equipment such as lighting control, blinds and groundwater protection pumps as well.

In the selection of the appropriate company for building management system, the decision was taken upon the product line and service of domestic automation and building management specialization; the Swiss Firm iBricks Solutions. Another convincing factor was that iBricks System is one of the only ones which disposes over a range of function and has enough open architecture to manage the multitude and complex task of a self-sustaining house.

There was, with this concept of the Herrliberg Project, on the one hand, an optimization of the energy balance by an adjusted control of all consumer energy sources, on the other hand the comfort and safety for the owner or tenant was increased.

For instance one can leave the apartment by simply pushing a button and all running equipment or burning lights switch off as well as the temperature sinks if apartment is unattended for a longer period of time.

Also all apartments have an inbuilt touch panel, a computer screen in the wall, so to operate survey and configure the whole technique and most importantly in a self-sustaining house check the energy consumption in details.

Besides the usual consumers like light, blinds, heating and ventilation, the system is able to steer and survey the complex system of power generation. Moreover the system can effectuate the specific concept of energy distribution around the house.

For instance, to keep peak consumption of the house low there is an automatic switch-off for some of the consumers such as electric towel heater, washing machines, dryer and water pumps during approx. 25 sec in case the car elevator is being used.

The Building Management System is responsible for an accurate prediction of the whole current and heat consumption of the building and correlated control of energy generators. As this involves, on the one hand, battery and heat stores never to be found fully emptied, on the other hand enough capacity to add solar energy is always given. Precious solar energy is being used as tenants would not want to remain without light.

All system data such as system operating conditions are to be found on the touch panel under „Base System Electric" and „Base System Thermic" always in real time and clearly seen at one glance. Furthermore all system data are being graphically represented. It takes place by a simple tap on the requested display values.

In the background, "black box-wise" like in a plane, all illustrated data/values are being stored and evaluated enabling over a longer period of time a precise analysis. After one year the data are being overwritten and evaluation used for further optimization of the system.

Intelligent Living

Intelligent houses differ fundamentally in the structure of the electric installation. Common installation has each a device with an own control unit respectively an operating unit. No device is interlinked and knowledgeable of the other's performance. There is even a complete separated regulation of heat distribution and heat generation on behalf of the heating control. This does not benefit the operating convenience nor an optimal control or regulation. Finally no optimization of efficient energy utilization can be reached.

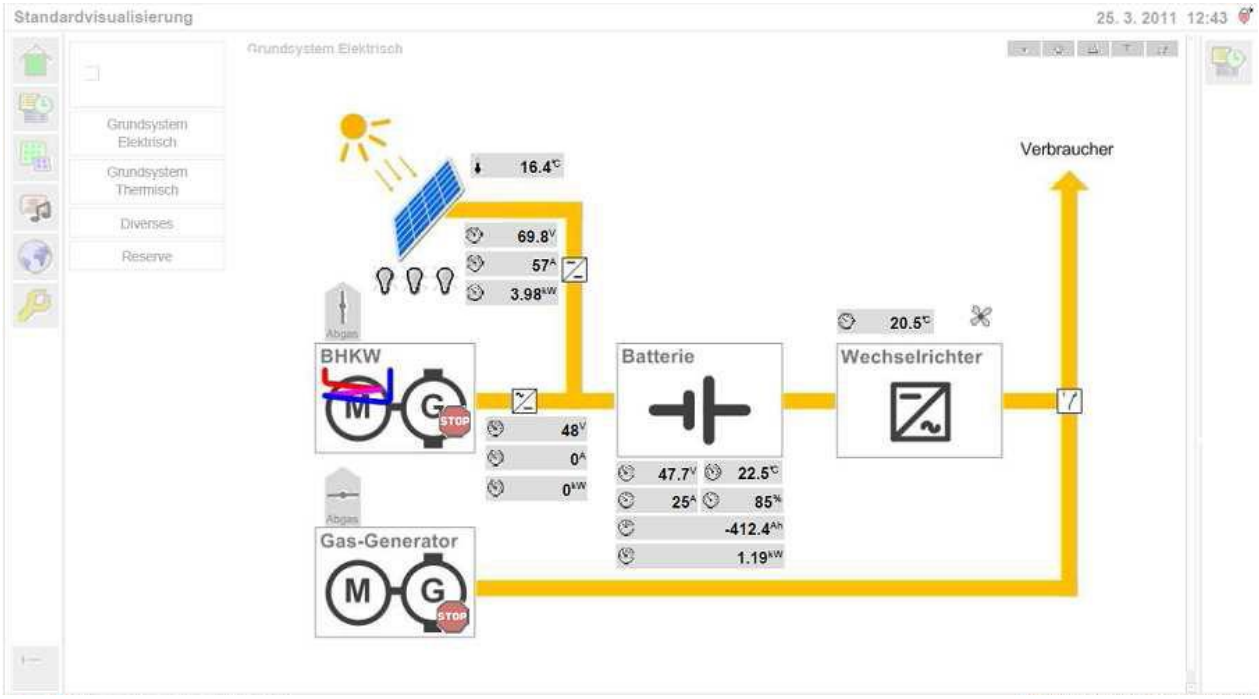
"Intelligent Living" has all devices interconnected a so-called bus system and each device and operating unit can "communicate" amongst each other.

In practice that means for example on a sunny day that the heater thermostat maintains a comfortable room climate by letting the blinds down if the room temperature would rise due to the heating being already switched off.

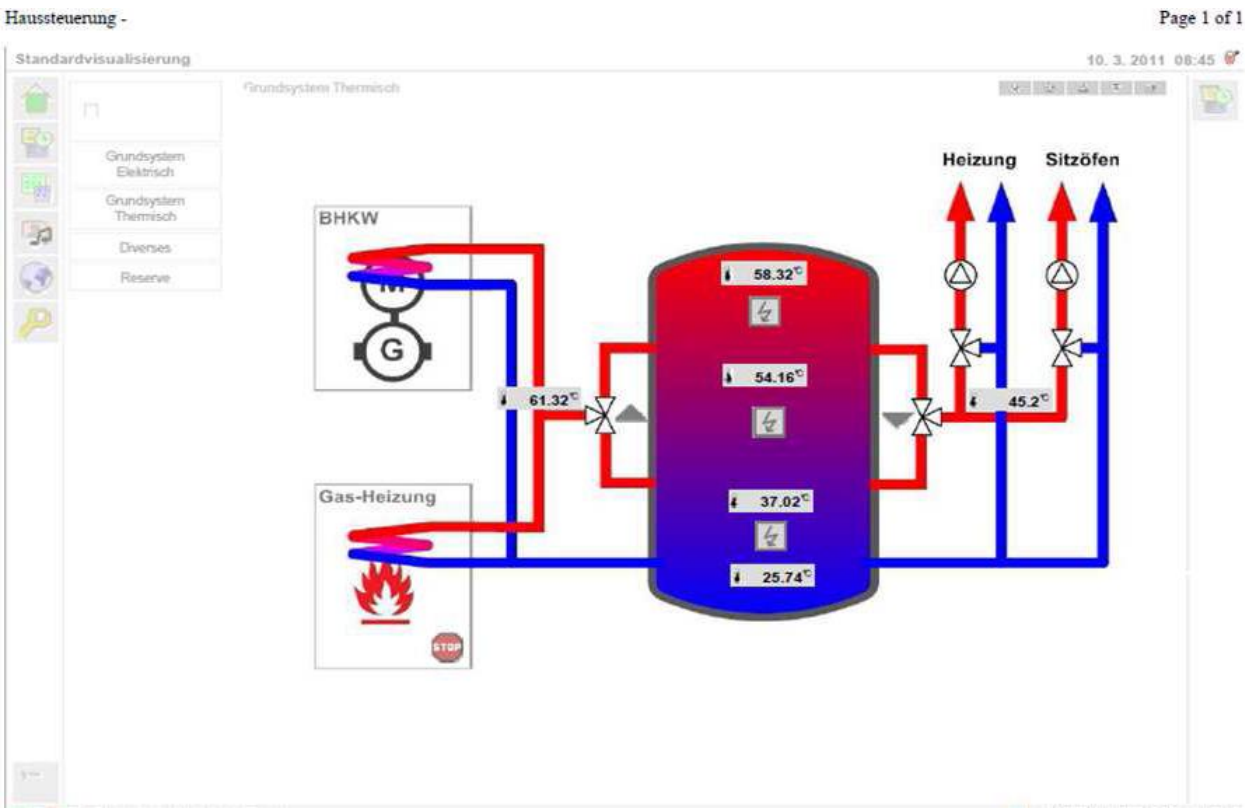
It is also possible that one switch manages to steer different devices such as lamps or blinds. The number of operating elements can so be reduced by enhancing it aesthetically.

The control unit of all devices is not based on each device singularly but for the whole house. Subsequently responsible for an intelligent centralized control unit is the bus system which links all devices together. The so-called brain of the house disposes all data and regulation models of the entire house technique for a wise steering.

Touch-Panel Illustration of „Electric Base System"



Touch-Panel Illustration of the Thermic Base System



Elevator-Systems, Auto- and Person Elevator

This project is equipped with two energy efficient hydraulic elevators from Swiss company Boltshauser in Tübach.

The car and person elevators are developed by the company Bucher Hydrauliks and equipped with an "economy line" hydraulics package including an electric controlled elevator valve C-LRV. This system can bear variation in load and temperature. Just as well the soft starter reduces the starting current.

The LRV hydraulics package enables an economical and low noise level during elevator operation for both elevators. This innovative hydraulics package reduces the energy consumption by up to 80% compared to a mechanic controlled hydraulic elevator system.

Reduction of the elevator motor is achieved by using current for the up travel and for the down operation a hydraulic pump, if left out works as a hydraulic generator which charges the hydraulic storages.

LED Illumination of Underground Parking

The underground parking with 13 motor vehicle parking spaces and car elevator cabin is illuminated by 80 LED lamps especially produced for this purpose.

The German company LuzLicht in Hamburg was given plans and requirements from Swisseiland. The illuminating diodes strips are built into aluminum profiles which are covered by a diffuse PMMA lens. The lens performance amounts to 60° illuminating a floor area of 3 x 2, 5 m; a lamp measures lengthwise 1 m and the ceiling's height is 2, 40 m. The wattage of the LED lamp amounts to an entire 4, 3 Watt with a voltage of 12 V.

The LED lamp strips' light output amounts to 95% and only 5% of the absorbed energy is being released in heat.

To minimize the amount of cabling work in the already mentioned underground parking area, 2 LED lamps were connected together in rows and stabilized on a 24VDC net. A stable voltage supply for those LED lamps increases enormously their life expectancy and their illuminating efficiency. The installation is conceivably simple because the mounting support is firstly fixed on the garage ceiling and the lamps locked in.

White light diodes were used on the LED strips with a light color of 5.500° K corresponding to the noon's sun. This decision was consciously taken to do justice to the special traffic situation in an underground parking. The color of sun light generates in the human brain highest degree of attention as the uplifting hormone Serotonin is being released.

Particular factors of traffic situation are as following

- Fast change of perception due to an entry in a narrow surrounding
- Sudden modified lighting condition
- In search of a parking space, visibility obstructed by pillars or already parked cars

The situation can lead to typical misjudgment known in underground parking areas with collision damages on walls and crash barriers.

To counter that, seemingly cold white light is being used. This light has an additional effect on the human eye it sharpens contrasts. The driver differentiates objects clearly and estimates their distance better.

To sum up : To illuminate a garage area of 450m2 with an energy input of 350 Watt and 80 LED lamps can be seen as indicative. This LED technique is a positive contribution to a decrease of CO2 emission.