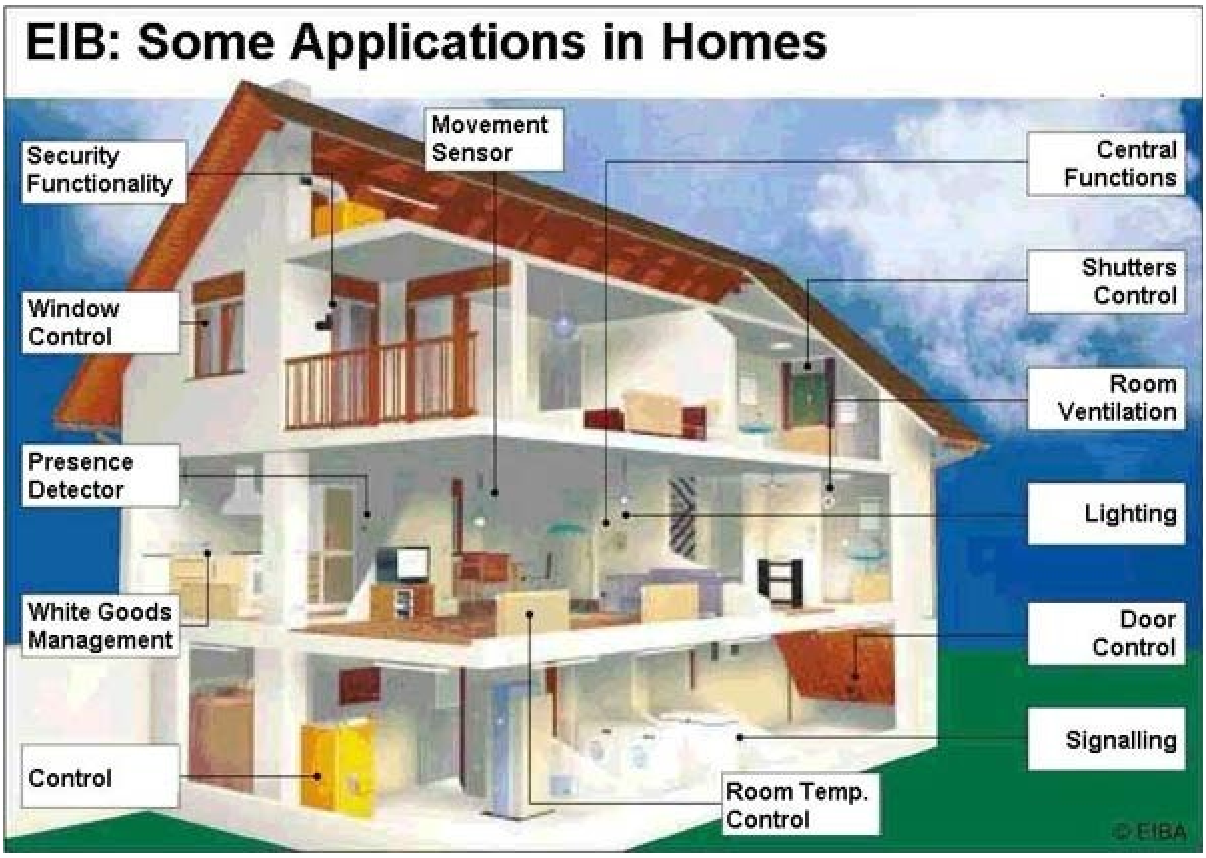
Based on current development in electrical engineering, I try to explain two important themes, because of energy saving and kontrole.

1. European Installation Bus

2. Gas and steam combined cycle power plant

1. European Installation Bus

The European Installation Bus (EIB) is a standard according to EN 50090, in the current version as KNX standard and ISO / IEC 14543-3, describes how you can be connected when installing sensors and actuators in a house together, determines how sensors and actuators communicate with each other (the protocol). Its official name is now only KNX.
The KNX controls for the lighting and blinds or shading devices, building heating, as well as locking and alarm system. Using EIB (KNX) is the remote monitoring and control of buildings. A control is via the user or a computer equipped with appropriate software.
KNX is currently being installed primarily in new residential and commercial buildings, can be done on the modernization of old buildings built later. KNX installations are now found not only in luxury homes. There are already integrated as standard even in inexpensive prefabricated houses KNX networks in the building.



Contents

1.History

In the mid-1980s are the first considerations for the application of bus technologies for the electrical installation industry and building services have been stimulated in parallel by different companies. It has been recognized that the introduction of proprietary systems to a broad market penetration would stand in the way and bring the clients a wide variety of proprietary "standards" and "systems" would. Leading manufacturers of electrical installation technology have 1990 as part of the European Installation Bus Association (EIBA) (founding members were Berker, Jung, Gira, Merten and Siemens) and later of the KNX Association (KNX standard) together with the aim of establishing a standard in the introduce market. This standard ensures compatibility and interoperability of various devices and systems from different manufacturers in many sectors, not only the electrical installation technology, but also from other areas such as climate and ventilation and household appliances (eg cookers).
After the first products were offered in accordance with this standard in 1991 at the market, there are now nearly 4,000 product groups with a multiple of different products from over 200 companies. These products cover the various functions and applications in the building under the protection of the interchangeability of products, so they can work together in a running system with the KNX.
Meanwhile, KNX is the world's first open standard for home and building automation. This is regulated in Europe since 1994 [1] in the EN 50090. The standardization by IEC as ISO standard ISO / is 14543-3.

2.Differences from the old switching technology

Substantial difference to the electrical control system is the separation of power and control devices.
So far, all electric appliances were turned on or off. This was done via the power cable via the parallel or series connection. Power and control devices is made via a network, operated at 230 V AC. This type of control was standard in the past 100 years, until today, so since the beginning of the electrification.
With the 1992 introduction of technology now to power devices and their control are first separated. There are now two networks, the power grid to supply power at 230 volts AC and the control network (= KNX-network) with a maximum of 30 VDC. These will be moved independently or in parallel in the house. There is also a Powernet variant, wherein the control signals are sent over the normal (phase locked) power supply. Powernet KNX is mainly suitable for retrofitting.

2.1 Technology of the KNX network

Between the consumer (for example, electrical appliance, lamp, window) and the mains voltage, a control device, "actor" called, installed. The actuator is connected to the KNX network and receives data. This data comes directly from a sensor (for example, switches, light, temperature, CO2 concentration) or indirectly by a computer (for example, this timed circuits, any other interpretation of sensor data sets, depending on its programming).
The actuator receives the order to supply power to the consumer, he turns on the power supply to the device. The command may come from different sensors.
The KNX-line (including name JY (St) Y 2x2x0, 8 EIB or YCYM 2x2x0, 8) consists of two separate pairs of wires (red and black and white and yellow), which is however only used red and black. The bus will meet IEC 189-2 or at least the equivalent provision of national law.
The lines with the above terms are recommended in this regard. As more lines are JH (St) H 2x2x0, 8 and A-2Y (L) 2Y 2x2x0, recommended 8th All lines have in common is the conductor diameter of 0.8 mm. As the maximum diameter of 1 mm is specified. In all the lines recommended by the installation must be observed, only in the so-called certified EIB (KNX) line (YCYM) should the line be routed next to power lines.
The KNX system is supplied from a power supply with 30 V nominal voltage [DC]. This voltage powers the bus coupler, each of which communicates with the KNX device KNX other networked devices. The exchange of data between devices via the KNX telegrams.
With the CSMA / CA telegram losses are excluded in the event of collisions. The KNX bus communicates with a data transfer rate of 9.6 kbit / s, which is sufficient for correct programming for more than 10,000 devices.
Could have been the proliferation of Ethernet IP-KNX coupler developed rapidly, so that the parent lines (field lines) communicate through the much faster Ethernet connections (10 Mbps) and thus take advantage of this high speed. Through this development, the previous maximum size was 15 range lines, each with 15 lines, each with up to 256 participants blown up (devices).

2.2 Advantages of KNX networks

With the new KNX technology can now offer all types of electric consumers are served quickly and easily. By reprogramming, any kind of connection to be redefined. A switch that was previously determined not to turn on a ceiling light, can be reprogrammed in minutes to turn on the irrigation system from within. Likewise, any system to query a variety of sensor data.

For example, the data from the anemometer will be used to retract or close blinds or awnings on all windows and doors at a certain wind speed automatic. What actions should be made in each case, can be here within a few minutes through programming of the system can flexibly. Here, various trades are linked. Heating, ventilation, alarm, intercom, irrigation, lighting and automatic weather station can communicate over a single network and automatically respond to changing environmental conditions.

2.3 Disadvantages of KNX

In direct comparison with a conventional electrical installation, a KNX installation is more expensive. This results in cost advantages, but then, when multiple trades (such as lighting, shading and heating) are combined and result in synergy. Through the use of actuators near the consumer to be switched can be an expensive parallel power cabling can be avoided. Ideally, each room has a sub-distribution, is up to the one power cable and a bus line. It was from there, is split to individual consumers. Sensors for the installation of expensive, specially Aligned test leads are greatly reduced, leaving only the relatively inexpensive bus cabling must be used.
The potential energy savings through centralized control of lighting, heating and air conditioning technology is facing its own power consumption of the KNX system. Per standard actuator or sensor is to be expected with 5 to 8 mA. Therefore, actuators and sensors with the highest possible port density are used so that the proportional energy consumption per connected or monitored function is reduced, are also lower at high port density, the share of costs at the bus interface, the price per port so low.

3. Examples of the use of KNX

For example, "turn on a ceiling light"

In general, the command to turn the ceiling light, given by a "normal" light switch. A person pushes the button and the light goes on. The turn-on command can also be cumulative over sensors. A light sensor measures, for example, at dusk, the light intensity decreases in the room. He therefore issued an order to the ceiling light to turn on. He also, however, could continuously in the twilight, the ceiling light can always be brighter. When the sun has set completely, the light is at maximum brightness. With this continuous dimming the room light is then held constant. If there are several ceiling lights in the room, different lighting scenarios can be programmed, if every single ceiling light was connected separately via actuators. These can then be switched on a regular switch. Using a central computer can be programmed to this button in any room lighting types, since it can be driven every single light.

For example, "opening / closing of windows"

In one room there are three windows. They have an automatic opening / closing mechanism. Via a switch mounted in the room, any or all of the windows are opened together at your fingertips. In addition, in the space, a CO2 sensor to be installed. Is this a bad area / stuffy air (= high CO2 concentration), then one or all windows automatically open and the room is ventilated. After the windows are closed automatically. In addition, this can be combined with a rain sensor. Join the rain sensor in the rain outside, may be given on the EIB network, the command to close all windows.
Problem, these functions with other systems (= trades) are combined.
It is conceivable, a coupling with the locking system. When the door closed, all open windows in the house is closed automatically.
It is also a combination with a gas sensor. Natural gas comes from a natural gas line, and is focused around the boiler room, this can register a gas sensor. Then automatically all the relevant windows open so the gas has evaporated. In order for a gas explosion is prevented. In addition, an electrical controllable closure the natural gas main pipe seal, so that no further gas continues to flow into the room.

3.3 summary

Using KNX allows the

lighting
shading
heating
climate
ventilation
alarm
information
Remote access (via phone, telephone, Internet)
Centralized control of the House

integrated interconnect.

4.Structure of the KNX

4.1 Physical structure (= network topology)

The KNX is divided into 15 areas, each with 15 lines and 256 stations per line. Couplers are needed as a participant, thereby reducing the maximum number of participants. Thus, up to (255x16) x15 +255 = 61 455 bus can be controlled individually. This refers, for example, the physical address in the field 8.7.233 8, line 7, the participants 233rd Coupler will always find the device number 0!
Per line, 64 bus (TLN) are connected. This number is determined by the voltage supply. To extend a line can be mounted up to three line repeaters. This ensures that three additional line segments with 64 to turn to TLN. The couplers and amplifiers can reduce the count as a participant and therefore the number of possible devices on each 63 TLN. Each segment requires a power supply.
To extend the lines in their structure, they are connected via a so-called main line with each other. These lines are connected via line with the main line. The main line itself requires at least one power supply and in turn can contain up to 255 bus. A main line connects a maximum of 15 lines with each other, forming an area.
Over a range line and backbone at maximum 15 regions are interconnected. The field line requires at least its own power supply. A maximum of 255 users per sector, including the 15 lines are involved.
The parent lines, main line and the field line, will usually offer devices that are central functions involved. These are, for example, physical sensors, visualization, logic components and actuators in distribution, the switching outputs for sensors from different lines are available.

4.2 Logical structure (programmable)

The collection of actuators and sensors are connected to a so-called group address that can be easily programmed. This provides the opportunity to change the affinity of such switches and lamps at any time, without having to run new cables. The communication of the devices is done with standardized commands. This ensures that equipment from different vendors work together. For the first time a uniform standard was created, which is open to all manufacturers of electronic devices and control components. Meanwhile, hundreds of thousands of buildings worldwide with a KNX system were fitted. Accordingly, there is also the variety of control devices from different manufacturers.
KNX is an open standard that any manufacturer / developer has full access to all necessary technical information he needed for further development. However, this requires the contributory membership of the union of open KNX Association.

Therefore, there is criticism that this was not a truly open standard, because basically caused by the membership costs. Only when such membership is free too, could be "open standard" of the question. Here, however, recognize that this is a common and particularly for smaller companies very effective way is to get the necessary patent rights.

4.3 Control and Programming

The programming of the participants and the assignment of group addresses is done with a special, but also standardized software, the Engineering Tool Software (ETS). The ETS is provided by the umbrella organization KNX Association and ensures the smooth cooperation of components from different manufacturers (now over 175 manufacturers worldwide).
The KNX standard has now been adopted by the United States and many Asian countries to build houses.
All major manufacturers of heating equipment and electrical installation products now offer KNX-compatible devices.
As the successor to the EIB, the KNX standard in 2002 by the Konnex Association (now the KNX Association) developed in accordance with standard EN50090 on. KNX is backward compatible to the EIB, so that existing facilities with EIB KNX modules are field upgradeable.

4.4 Packet structure

Octet	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**...**	**N-1**	**N<=22**
Control byte	**Source address**		**destination address**		**DRL**	**TPCI** **APCI**	**DATA APCI**	**Data**			**Checksum**

The control byte defines the packet priority and distinguishes between a standard and an enhanced package:

7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
1	**0**	**R**	**1**	**p1**	**p0**	**0**	**0**

The repeat flag R is the initial sending of the package 1, in a repeat 0 such that participants who have already received the packet correctly, can ignore the repeat.

The priority levels are allocated among the bits:

p1	p0	significance
0	0	system function
1	0	alarm function
0	1	high priority
1	1	normal priority

The source address (.. Typical notation <Range> <Line> <Subscriber>) consists of two bytes, where the MSB is first transmitted:

7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
0	H3	H2	H1	H0	M2	M1	M0	U7	U6	U5	U4	U3	U2	U1	U0
	main group				Central Group			subgroup							

The structure of the DRL-bytes (from destination-address-flag, counter-routing, Length) is:

7	6	5	4	3	2	1	0
D	R2	R1	R0	L3	L2	L1	L0

D	destination address
0	physical address
1	group address

The routing counter R0 .. R2 is initialized to 6, and decremented by each line and backbone. A package with a value of 0 will be discarded. A value of 7 prevents decrementing the package and can often pass freely. The bits L0 .. L3 indicate the length of the following user data to minus two, ie = 0 corresponds to a length of 2 bytes, length = 15 corresponds to 17 bytes.
The Transport Layer Protocol Control Information (TPCI) describes the communication at the transport layer, eg establish a point-to-point connection. The Application Layer Protocol Control Information (APCI) for the application layer services (read, write, reply, ...) in charge. A possible variation of the payload is the standardized communication to EIS (EIB Interworking Standard). Here there are 15 different EIS formats:

EIS1	switch
EIS2	dimming
EIS3	time
EIS4	date
EIS5	Value, number of decimal places
EIS6	Relative value, 0 ... 100%
EIS7	drive control
EIS8	forced control
EIS9	floating-point
EIS10	16-bit value
EIS11	32-bit value
EIS12	access control
EIS13	ASCII characters
EIS14	8-bit value
EIS15	string

The checksum is an inverted, bitwise XOR of all bytes sent before the packet. For a long frame even N <255 octets are possible.

5. Software framework

5.1 Plattformübergreifend

- OSGi - middleware standard (Java Framework) for integrating EHS / CHAIN, EIB, KNX, LON, etc. Services Gateways
- Mister House - Perl-based framework for home automation (EIB, X10, etc.)

5.2 Windows

In the 1990s, OPC (OLE for Process Control) as a standardized software interface for the Windows platform designed to integrate different, so far mostly to

facilitate manufacturer-dependent and therefore proprietary automation buses in a system. Originally located in the industrial automation, it was soon as possible, through the OPC with other interdisciplinary areas - such as for example the building automation - to be effective.
Has been simplified with the OPC Server 1998 came logically, the software tool on the market, facilitate the involvement of the EIB (KNX) in hybrid automation systems strong. Thus, for now create software solutions, the classical building functions such as heating and lighting control of a manufacturing plant using EIB as well as visualization and automation of industrial production process of other bus homogeneously merge. The coupling of different building buses, such as EIB, LON, is an integrated management system with the existing OPC Server for KNX and LON easy.

5.3Linux

The KNX-daemon provides an interface to the EIB / KNX bus in Linux

6.Variants of KNX networks

- Power Line, also called Powernet (The phase-locked power lines serve as a network medium, thus no separate bus lines are required.)
- Radio (In this case the components controlled by radio.)
- KNX cable run (comparable with an Ethernet architecture.)
- KNXnet (latest development. Merger of LAN networks and the entire KNX building automation system is controlled via a computer network (Ethernet).)

7. alternative Technologies

PLC - Programmable Logic Controller
Radio systems for building automation
Local Operating Network (LON)
Local Control Network (LCN)

Elec. eng. Bakhtiar Abdullah Salih

2. Gas and steam combined cycle power plant

A gas-steam combined cycle power plant or gas and steam turbine power plant (CCPP short) is a power plant in which the principles of a gas turbine power plant and a steam power plant are combined. A gas turbine is used as a heat source for a downstream waste heat boiler, which in turn acts as a steam generator for steam turbine.
With this combined procedure in a thermodynamic cycle is reached, a higher efficiency than gas turbines operating in open or in conventionally-fired steam power plants. Combined cycle power plants are among electrical efficiencies of up to 60% of the most efficient conventional power plants (see gas engine).
Combined cycle power plants are in the power management is very flexible: Due to a fast start times and the possibility of rapid load changes, they are an ideal medium load power plants. Primarily, these power plants in the medium load range, and if necessary, even in the peak current to operate. In theory, the operation as a baseload power plant is possible, however, because in Germany the price of gas is not economical and therefore is not common.

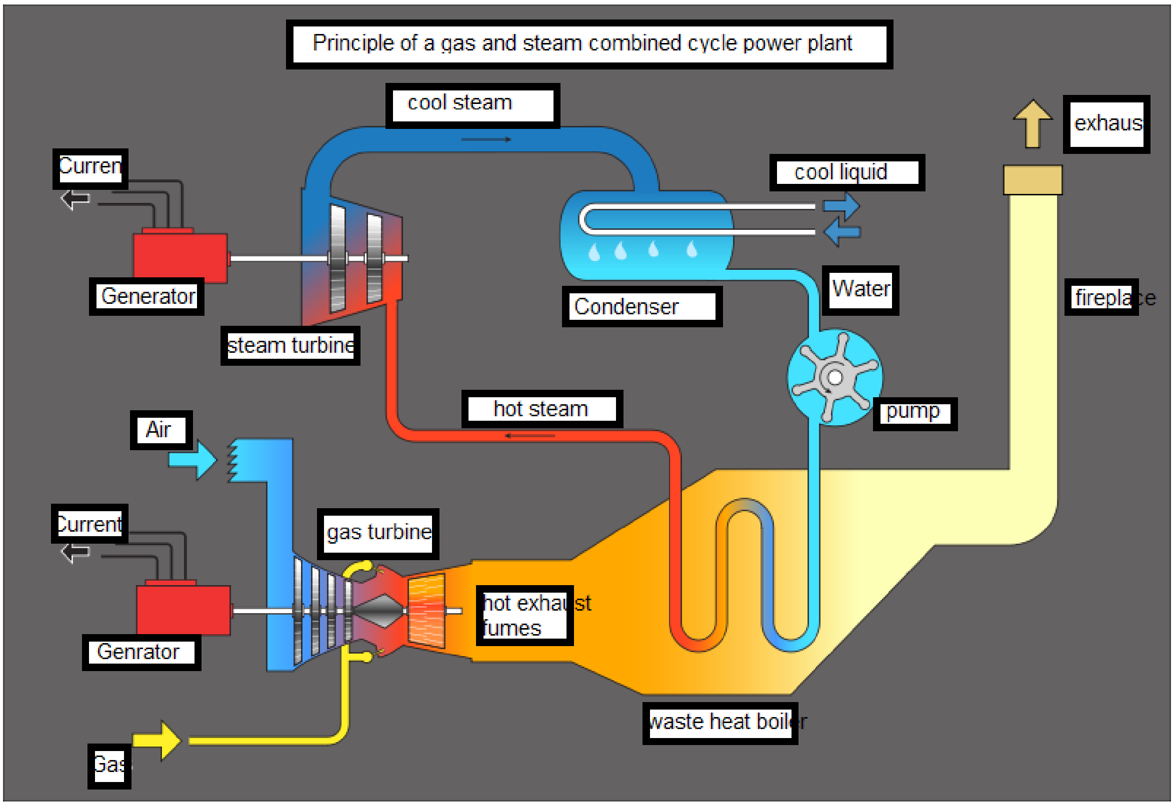
Contents :

1. Nomenclature

The short-term combined cycle power plant has long been a protected designation of Siemens,. Since late September 2009, however, no longer [1] Even as GUD was a brand yet, this term was often used as a generic term. Generally, this type of plant is called combined cycle power plant, with a likelihood of confusion, for example, with combined heat and power there. Other trade names are, for example, steam and gas (STEAG) or combined-cycle plant of General Electric (KA) of Alstom. In the English speaking world is known as Combined Cycle Power Plant (CCPP) or combined cycle gas turbine (CCGT).

2. Principle of operation

In the combined cycle power plant is with a generated by four gas turbines and one steam turbine electricity, either each turbine each driving a generator (multi-shaft system, Eng. Multi detention) or English, a gas turbine with a steam turbine (uncoupled) on a common shaft generator (single-shaft, . single stick). The hot exhaust gases of the gas turbines are used in a waste heat boiler for generating steam. The steam is then expanded through a conventional steam turbine process. It accounts for about 2/3 of electrical power to the gas turbine and 1/3 to the steam process.
If in addition the use of exhaust heat from the gas turbine with supplemental firing (supplementary) of the steam boiler, steam power and the electrical power of the steam turbine is increased, it is called a combined process. To operate the gas turbine, gaseous or liquid fuels such as natural gas or fuel oil can be used. For the operation of the burner in the boiler, other fuels are used.



Schematic of combined cycle power plant (two-wave system)

3. power

The performance of combined cycle plants are in the range between 80 and 860 (eg Irsching) megawatts per unit of gas turbine / steam turbine, a power plant can consist of several units. By comparison, a block of a nuclear power plant, a power 400-1600 MW.
The combination of both types of turbines results in very high power plant efficiency.

4. Efficiency

The extremely high efficiency in combined cycle power plant is achieved in that the heat is supplied from the flue gas to the process at high temperatures. The stoichiometric ($\lambda = 1$) internal combustion temperature of natural gas with air at normal pressure is about 2200 ° C. By the excess air inlet temperatures of gas turbines may be reduced. The current maximum possible gas inlet temperature is 1600 ° C [2]. The exit temperature is 650 ° C. The gas turbines will depend on the performance efficiency (electric power based on heat input) of 35% (10 MW) to 40% (100 MWe).

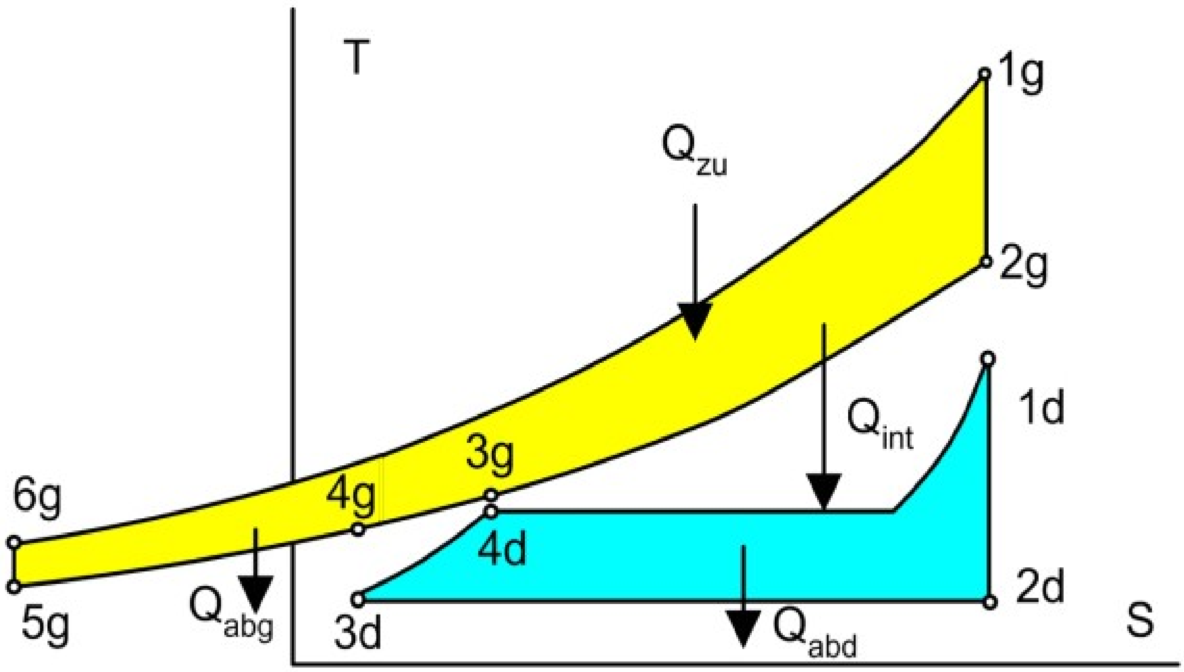
The exhaust gas is utilized in a boiler to produce superheated steam at a temperature> 500 ° C. Much of the heat (enthalpy), however, needed for the evaporation at the pressure-dependent saturated steam temperature. At 100 bar, for example, this is only 311 ° C. This means that for a system with only a vapor pressure level (see first diagram on the right) at the inlet of the flue gas in the evaporator, the temperature difference between flue gas and water is very large, and are correspondingly high energy losses in heat transfer. The flue gas is cooled to within a few degrees above the vaporization temperature, residual heat can be content just to feed water to be used (heat transfer diagram and compare TS diagram at right). The original computational active file, the scheme shown on the right is taken from calculated an efficiency of 52% based on the calorific value. Based on the calorific value is the efficiency of 52% / 1.11 = 47%.

The water side of the tank circuit can be very different depending on operational requirements. In addition to those shown here forced circulation boilers and boiler natural circulation and once-through boilers are (Benson) are common.

To avoid higher exergy losses, that is, to improve the efficiency, several pressure levels are used. The second diagram shows a two-tier system. The feed water is removed either with separate feed water pump to the feedwater tank and fed to two separate feedwater heaters, or it will - as in the figure - the pressure stages in series. The evaporation and overheating is thus at different temperature levels.

State of the art combined cycle power plants for clean power generation, that is, without any further use of waste heat for heating or as process heat, the three-pressure reheat process. Here, usually a gas turbine, the so-called F-class is used. The electrical performance of these systems is about 400 MW. The pressures are about 130 bar (high pressure), 30 bar (medium pressure) and 8 bar (low pressure). The high-pressure steam is superheated to about 570 ° C. After expansion in the high pressure part of the turbine, the steam is returned to the boiler, with the medium pressure steam is mixed again and superheated to about 570 ° C. Theoretically, even more pressure levels to better match the characteristics of the vapor in the flue gas would be conceivable, however, then the additional investment in relation to the technical improvements to high heat. The three-pressure process is currently using a reheat the economic optimum measurement with a gas turbine for power generation efficiency of 40% and an efficiency of waste heat recovery of 18.4% (in each case based on the net calorific value) is the best ever achieved total efficiency at 58.4%.

At E.ON Irsching currently a test site created for the world's largest and most powerful gas turbine SGT5-8000H (375 MW), which was newly developed by Siemens Power Generation. After completion of the testing phase, the gas turbine combined cycle with a modern overall efficiency is integrated by 60%. On 11 May 2011 reached the power plant unit 4 in Irsching in trial operation efficiency of 60.75%, which is a new world record holder. [3]



Simplified representation of an idealized single-stage combined cycle process in the TS diagram. When pure steam power process occur in the heat transfer from the boiler flue gas (combustion chamber temperatures such as 1700 ° C) to steam (maximum steam temperature is usually below 600 ° C) for large energy losses. The combined cycle uses this temperature gradient for the gas turbine process. The advantage of the high temperature of the heat input to the combustor of the gas turbine from 6g to 1g (about 1200 ° C) is coupled with the low temperature of the heat removal in the condenser of the steam cycle of 2d to 3d. Even with the in-process heat transfer of heat from the gas turbine cycle in the steam cycle occur due to the constant evaporation temperature (right side in the TS diagram) to energy losses. In a two-tier system, they are less (see Diagram heat transfer). The waste heat from the overall process is in addition to the condensation enthalpy of the steam in the Rauchgasenthalpie point 4g.

4.1 Waste heat recovery

By using a back pressure turbine or by a Turbinenanzapfung, the thermal energy of the water vapor still be used for district heating. Due to the higher back pressure is reduced, however, then the generated mechanical work and the exergetic efficiency of the overall process. Looking at the bottom of the power plant cycle in TS diagram (condensation) may be approximated as a Carnot cycle (see steam power plant, section TS diagram) with a counter-pressure instead of 0.037 bar (= 30 ° C condensing temperature), then reduced at a bar back pressure (= production of district heating at 100 ° C) the Carnot efficiency based on the achieved efficiency by 17%. Thus, instead of only a 58% efficiency for the generation of mechanical work is achieved of 48%. After the extraction steam at 1 bar 52% of the fuel energy are at a temperature level of 100 ° C are available. This enthalpy of the steam consists of the condensation or evaporation enthalpy at 1 bar / 100 ° C; it amounts to

$$\Delta h_v = 2256 \text{ kJ/kg}$$

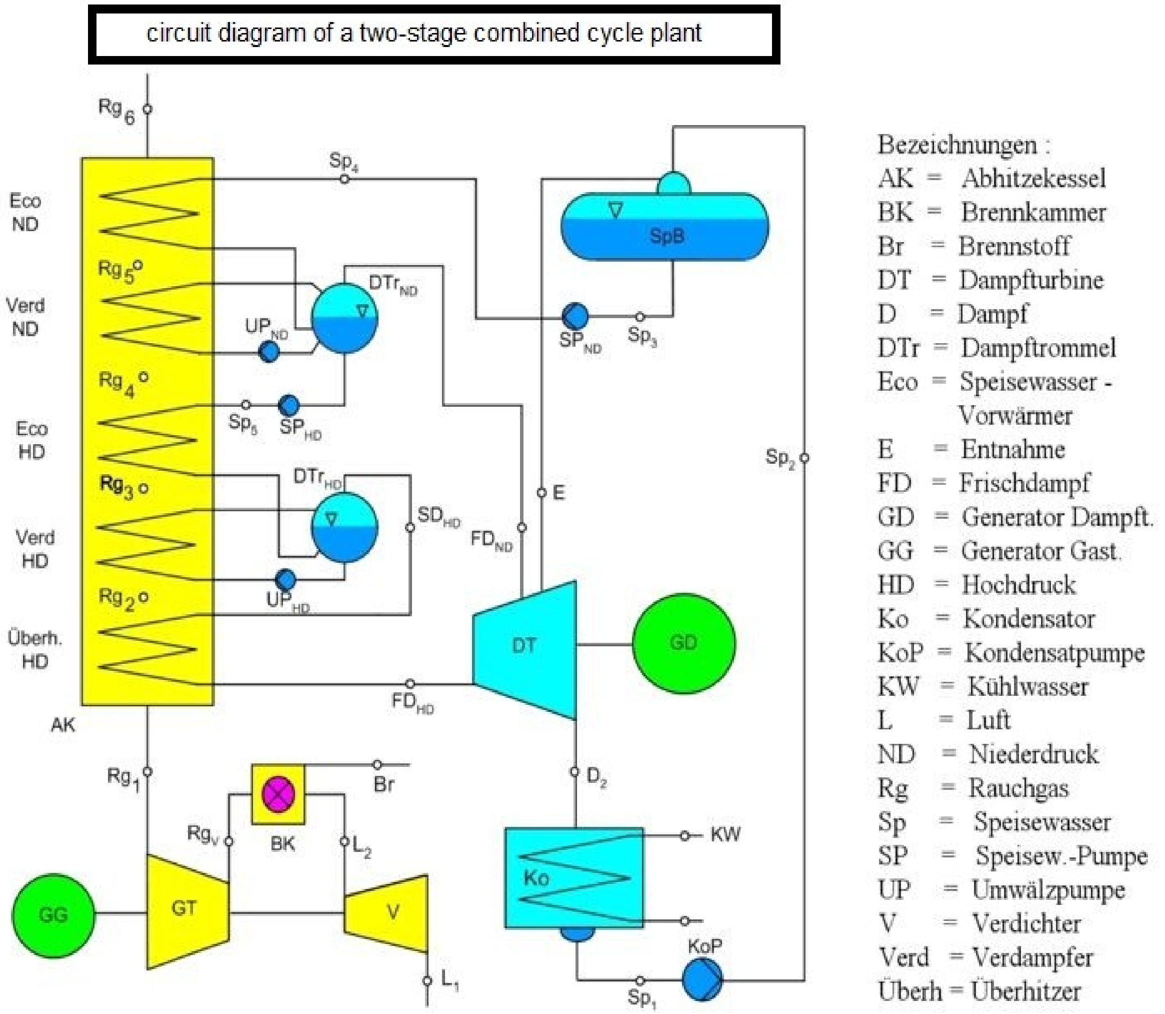
and the remaining sensible heat in the condensate is no longer usable by

$$h = c_p \; (100\,°\text{C} - 30\,°\text{C}) = 292 \text{ kJ/kg}$$

Without heat recovery are at the condensation temperature of 30 ° C, the enthalpy of Δhv = 2430kJ / kg dissipated through the cooling tower to the environment. This is reduced in the case of full utilization of heat in the 292 kJ / kg. Then stand next to the conversion of 48% of the fuel energy into mechanical work for 45% of the input energy as heat energy at 100 ° C are available. It should be noted that the energy in the heating water only 19% of exergy and the remaining 81% consists of anergy. Therefore, should not the different degrees of efficiency are added up. The sum of the two efficiencies can exceed 100%.

The total emissions are therefore compared to the total energy produced is very low. Besides the high efficiency are other advantages of a combined cycle power plant, the short construction period and the short lead time of the gas unit, which is why this type of power plant can be used to compensate for peak loads. However, a combined cycle power plant requires a relatively expensive fuel, which is why recent research dealing with combined-cycle coal-fired power plants.

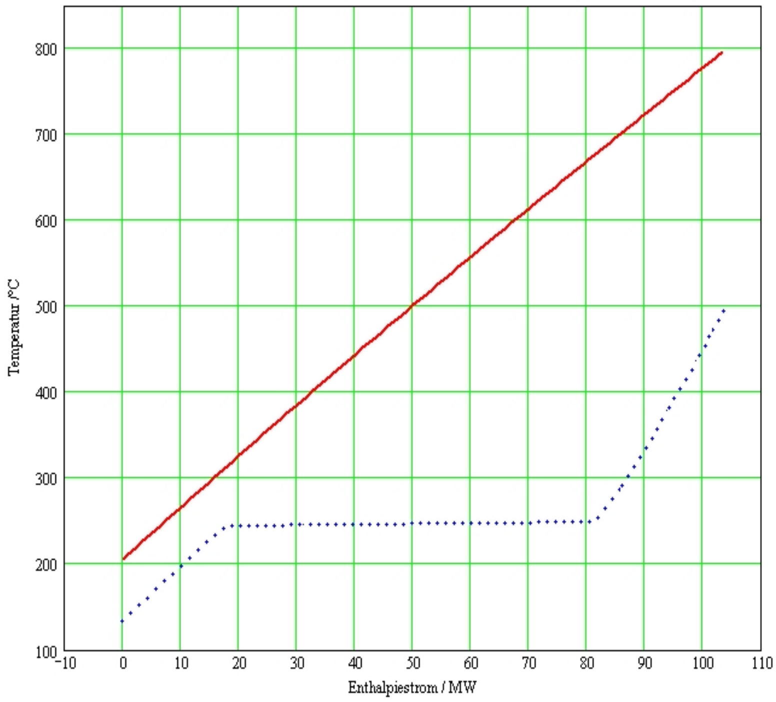
The construction of combined cycle power plants in Germany is tax benefits, if the efficiency is about 57.5% of conditioning. The state waives its rightful gas tax of 5.50 € per megawatt hour, if this is exceeded, and efficiency, the total availability of the power plant more than 70%. In other countries have similar benefits.



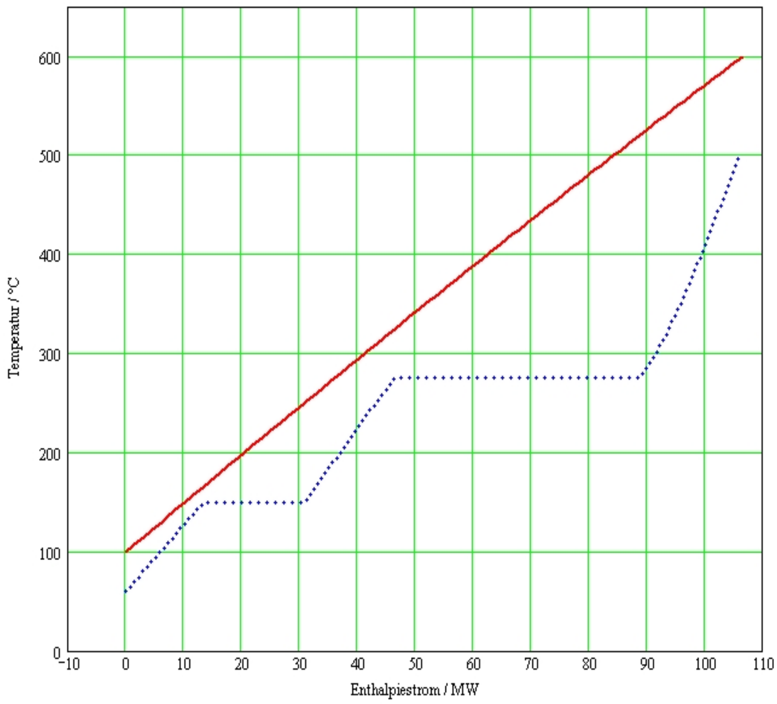
5.Costs

Combined cycle power plants can be built relatively quickly and inexpensively. [4] The construction and investment costs amount to only about half of a coal power plant of equal capacity. The base load of 8,000 operating hours per year can not compensate coal power plants because of lower fuel costs, higher construction costs. The flexible combined cycle power plants are therefore used primarily for peak and intermediate load range with 4000 operating hours per year.

Das Wärmeübertragungsdiagramm, einstufige Anlage



Das Wärmeübertragungsdiagramm, zweistufige Anlage



blau: Wasser und Dampf
rot: Rauchgas

Heat transfer diagrams for a system with a pressure range (above) and two pressure levels (bottom).

6. combined cycle coal plants

An operation of the gas turbine with coal dust is not possible at first, since the combustion of coal ash is formed, which would destroy the blades of the gas turbine quickly by abrasion. A deposition of ash from the hot gas stream is large and technically difficult part of current research. However, there is the possibility to first convert coal into a coke oven to at least partially in coke oven gas and using them in a combined cycle power plant. The remaining solid coke can be converted in a conventional steam power plant into electricity.

Another form is the coal-fired combined cycle power plant, which presents itself as a coal-fired steam power plant in combination with a gas turbine. The gas turbine is operated with natural gas and drives a generator for themselves. The exhaust gases leaving the gas turbine having a high temperature and high oxygen content, so that they can still serve as a supply air with coal-fired steam generator, which in turn supplies the steam for a steam turbine coupled generator. The process operates with a high overall efficiency of 41%. A running system is the Gersteinwerk in Werne an der Lippe.

Another variation on an industrial scale represents coal-fired power plants gasify the coal and oxygen. The heat generated - nearly a third of the total energy - is converted into electricity in a normal cycle power plant, while the resulting carbon monoxide burned to ash in the removal of a gas turbine - that is converted to CO_2 - will. The overall efficiency is also higher than the simple cycle power plants.

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8. External links

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2.GuD-Kraftwerk
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