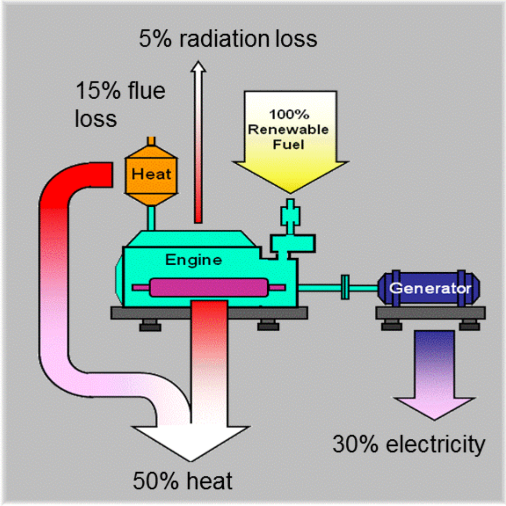
Combined heat and Power

Combined heat and power (CHP – also sometimes referred to as co-generation) describes technologies that generate electricity simultaneously with useable heat in one single, highly efficient process at or close to the point of energy use (Fig.1). When the captured heat is then cooled by linking it to absorption chillers the technologies provide cooling as well as heat and power and are then referred to as tri-generation CHP (CCHP).



The reciprocating engines used in CHP systems are internal combustion engines that operate on the same principles as their petrol and diesel automotive counterparts. There are two types of reciprocating engine used in CHP systems:

- Spark-ignition gas engines are available at outputs of up to around 4 MW, and operate on gaseous fuel only.
- Compression-ignition ('diesel') engines are available at power outputs of up to 15 MW and can be designed to operate on gas-oil, heavy fuel oil or a mixture of gas (up to 95%) and oil (5%).

Fig 1

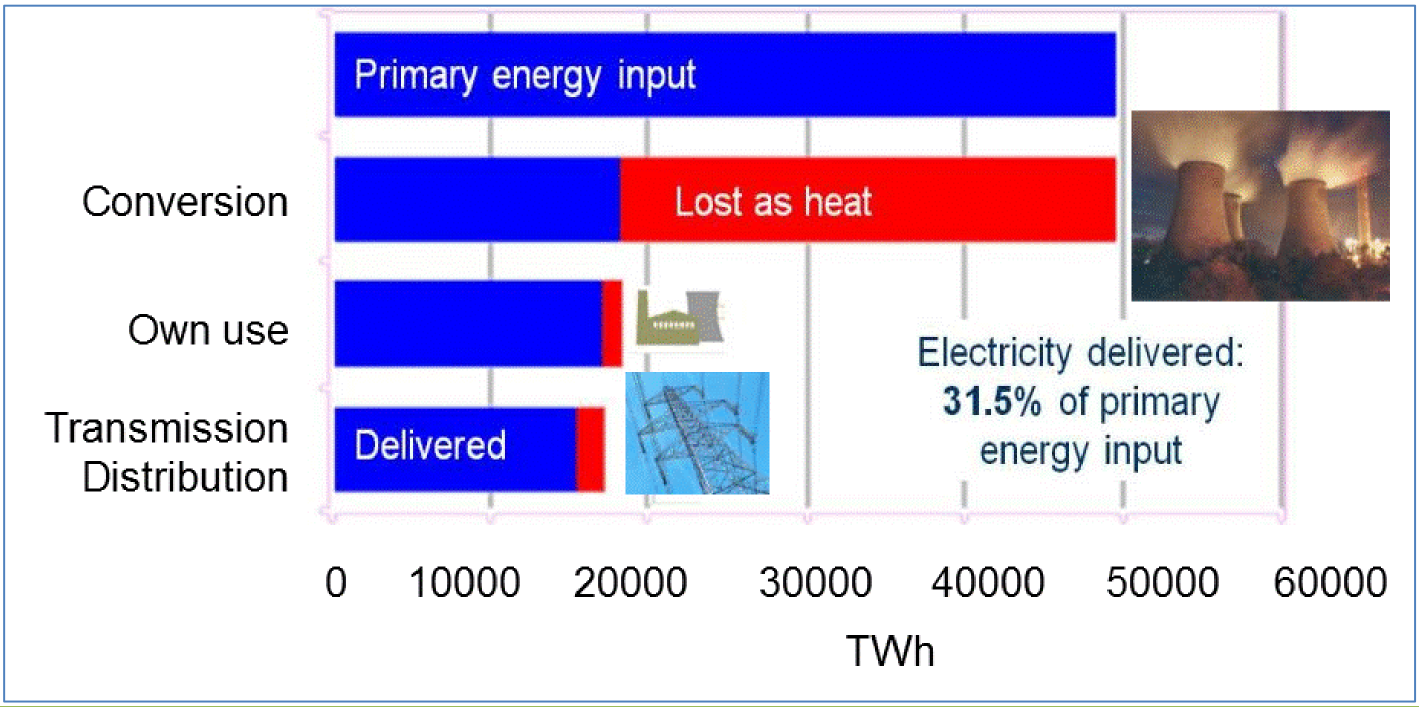
They are efficient and can achieve long-term availability levels of 85-92%, depending on how hard the engine is worked. Engines and their lubricating oil must be cooled and there is, therefore, a 'compulsory' supply of heat in the form of hot water at up to 120°C. This is produced irrespective of whether or not it can be used.

Heat produced by the engine can be recovered in CHP systems from two sources:

- The engine exhaust – gases at a temperature of about 400°C.
- The engine and lubricating oil cooling systems – hot water typically at 80°C.

Cooling and exhaust heat comprise roughly equal proportions of the total heat produced by the engine. The usable heat to power ratio ranges from about 1:1 to 2:1 and, as the exhaust can contain large amounts of excess air, supplementary firing is sometimes feasible, which could raise the ratio to 5:1. The driving force behind CHP lies in provision of an efficient, integrated system that combines electricity production and a heat recovery system.

Conventional ways of generating electricity in coal and gas fired power stations generate vast amounts of heat which is wasted, (up to two thirds of the overall energy generated), with further 7-9% of electricity lost in the process of transmission and distribution to end-users through centralised grid and local distribution networks (Fig.2). By contrast the relative sophistication of CHP systems means that CHP plants can reach in excess of 90% overall efficiency at the point of use.



Electricity generation in parts of Europe is starting to move from a centralized to a distributed model more like that of the Internet using CHP. These systems are typically designed to meet the thermal demand of the end user at industrial, individual building or city-wide levels.

CHP systems can encompass a range of technologies and they can be applied to both renewable and fossil fuels. When supplied with locally-sourced biofuels (e.g. plant oil, wood and wood wastes, combustible agricultural wastes, or biogas created in anaerobic digesters from the breakdown of waste organic matter), CHP systems can provide energy with a low/zero carbon footprint.

CHP systems can also combust glycerol, which has the safest handling properties of all known fuels, at very high efficiency without chemical alteration or the addition of combustion enhancers using a new compression ignition innovation called the McNeil cycle.

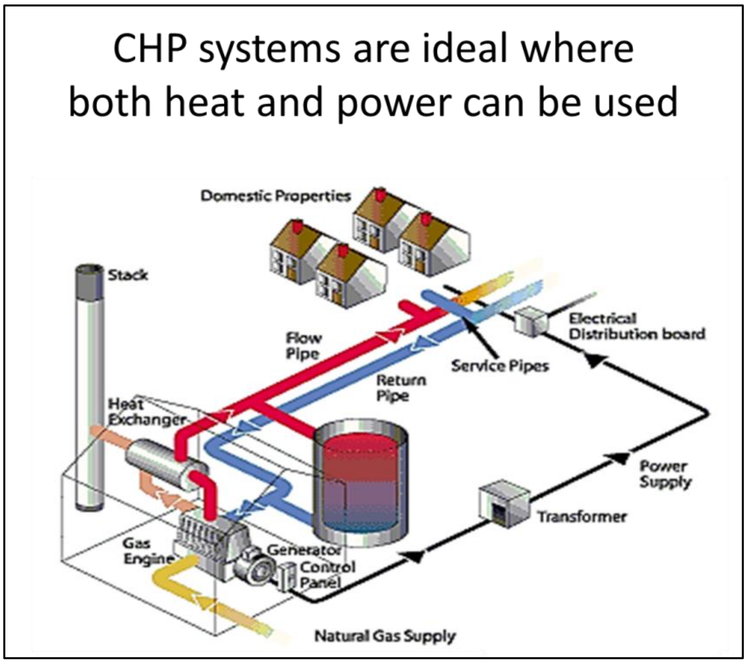


Fig 3

A complete CHP scheme (Fig 3) would include:

- The Combined Heat and Power plant (Fig.4), perhaps including boilers and absorption chillers
- District Heating and/or Cooling distribution system.
- Power cable distribution system.
- Consumer installations, connected via sub stations to heating and hot water supply from hydraulic boards with meters for reading consumption.
- Internal dwelling or building installations.
- Operation, service and maintenance of the entire scheme.
- Financing of the project.

To summarise, CHP benefits include:

- Dramatically-increased fuel efficiency with concomitant cost-savings.
- Reduced emissions of CO2 and other pollutants
- Reduced need for transmission and large distribution networks.
- Beneficial use of local energy resources providing a transition to a low-carbon future.

As a result, the G8 leaders meeting in 2007 issued a direct charge that nations must increase their use of CHP to deliver a “clean, clever and competitive energy future”. Analyses conducted by the International Energy Agency (IEA) indicate that CHP currently generates only 10% of global electricity, but argue that this could rise to 24% with thoughtful, well implemented policy intervention.

In Africa, CHP installations running on biofuels will be of tremendous value because they can deliver electricity to small rural communities for which connection via the grid is too costly. They can target poverty eradication at the small-scale farmer level, increase living standards, lower fossil fuel use and improve the ecological footprint of energy production.

Fig. 4 A Combined Heat and Power (CHP) Station designed and installed by Aquafuel Research (UK) to deliver 1.5 MWe and 1 tonne/h steam powered by renewable biofuel