

# GEO THERM supports East Africa - regional boundary conditions for geothermal energy use

## Geothermal energy use and its benefit

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The geothermal energy resources can be exploited by different types of power plants depending on the characteristics of the resource. If there is hot steam with temperatures above XXX °C conventional power plants are used (Figure 15).

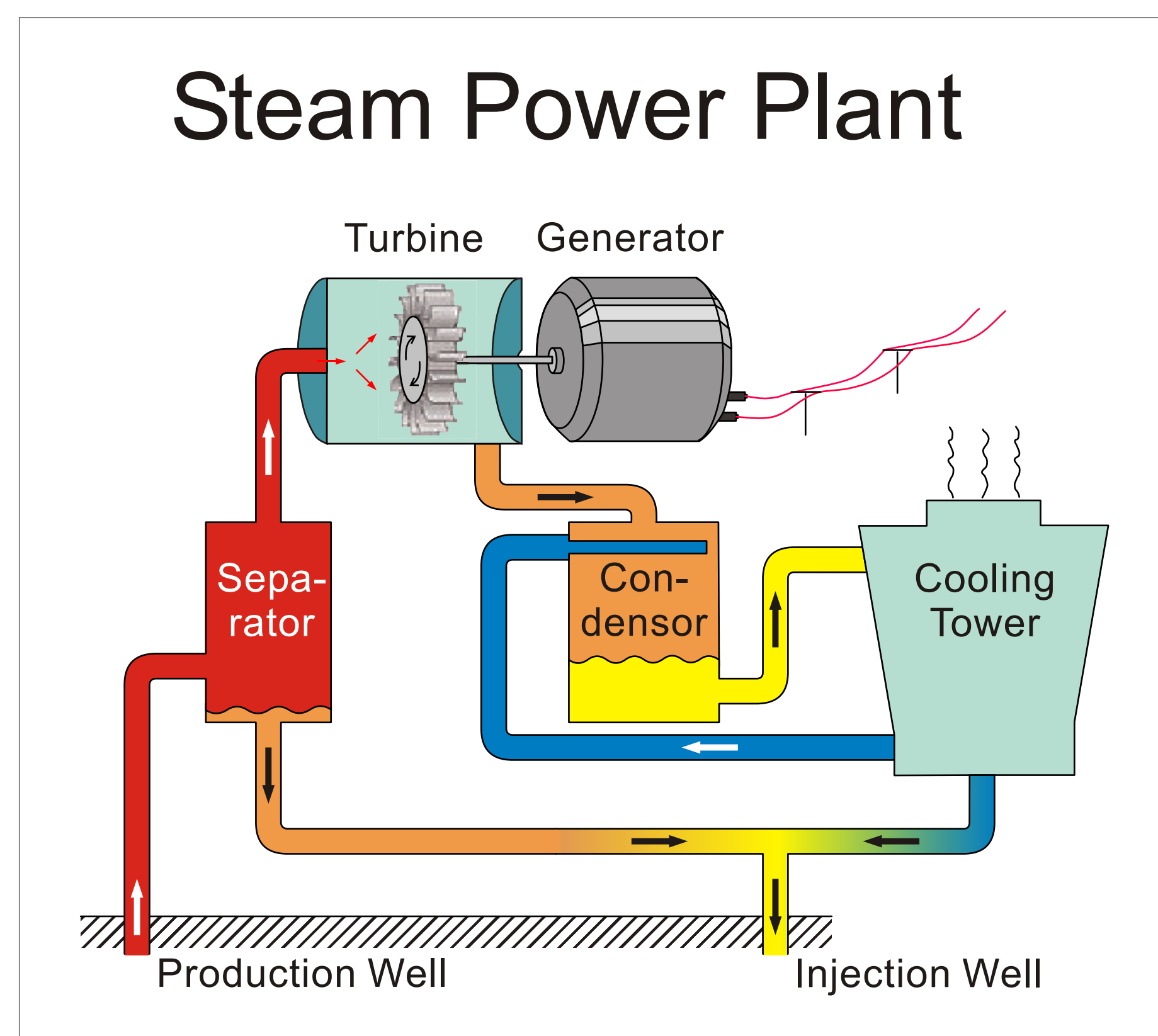


Figure 15 Schematic sketch of a hot steam power plant

In a first step water droplets are removed from the steam of the subsurface reservoir within a separator to avoid damage of the turbine. After having passed the turbine for electricity production the expanded steam is cooled within a condenser and the resulting condensate is injected together with the fluid of the separator in the deep reservoir again. This avoids environmental pollution with unwanted constituents of the injected water and refreshes the reservoir causing a longer life time of the power plant.

If the temperature of the resource is lower and there is hot water in the reservoir than a binary power plant is needed for electricity production (Figure 16).

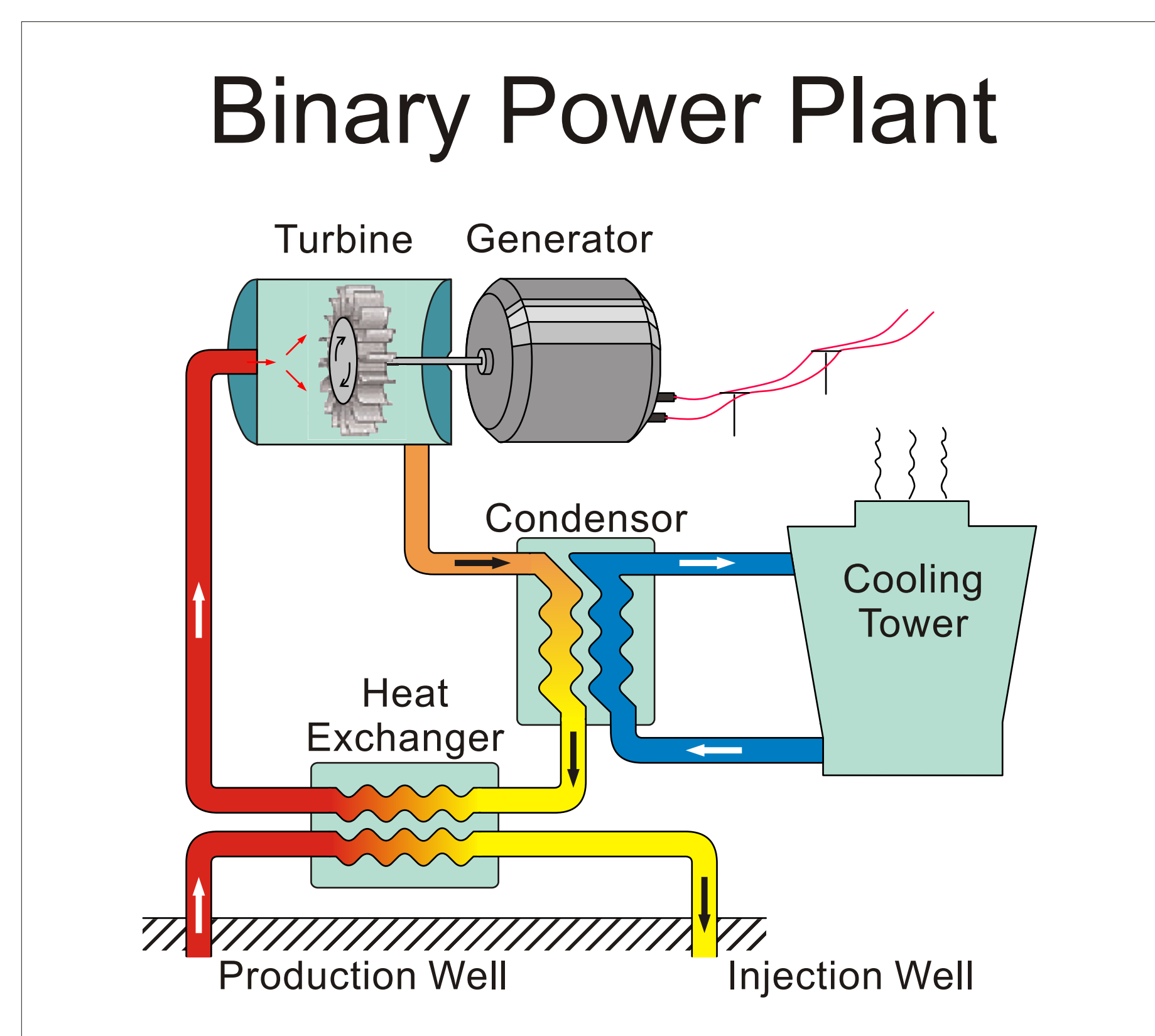


Figure 16 Schematic sketch of a binary power plant

In this case the geothermal water cycle is completely separated from the cycle of the working fluid which has a lower boiling point than water. To produce vapour only the heat is transferred from the geothermal water to the working fluid using a heat exchanger. After having passed the turbine the vapour of the working fluid is cooled and fluidised within a condenser and the cycle starts again. Also in this case the re-injection of the geothermal water avoids pollution and refreshes the reservoir.

The heat can additionally be used depending on the temperature range (Table 1).

Table 1 Main applications of directly used geothermal heat

Temperature [°C]	Application	Category
180	Refrigeration by ammonia absorption	conventional plant electricity generation
170	Digestion in paper pulp (kraft)	
170	Drying of diatomaceous earth	
160	Drying of fish meal	
160	Drying of timber	
150	Alumina via Bayer's process	
140	Drying of farm products at high rates	
140	Canning of food	
130	Evaporation in sugar refining	
130	Extraction of salts by evaporation	
120	Fresh water by distillation	binary plant electricity generation
110	Concentration of saline solutions	
110	Drying and curing of cement slabs	
100	Drying of agricultural products	
090	Washing and drying of wool	
090	Drying of stock fish	
080	Space heating	
070	Refrigeration (lower temperature limit)	
060	Animal husbandary	
060	Greenhouses	
050	Mushroom growing	
050	Balneology (spas)	

Beside spas for recreation the geothermal heat is suitable for drying of agricultural and industrial products like diatomaceous earth. In Kenya the heat of Olkaria power plant is used for soil sterilisation at nearby Oserian flower farm.

The countries of the East African rift valley have very low electrification rates especially in the rural areas which comprise the major part of the countries. These rural areas are not connected to the national grid and receive electricity mainly by few isolated diesel generators. This method of electricity production leads to an enhanced local air pollution and affects global climate by releasing the greenhouse gas CO<sub>2</sub>. Note that the actual consumption of fossil fuel in developing countries is small compared to highly industrialised nations but due to high future demand the growth rate will rise exponentially (Figure 17).

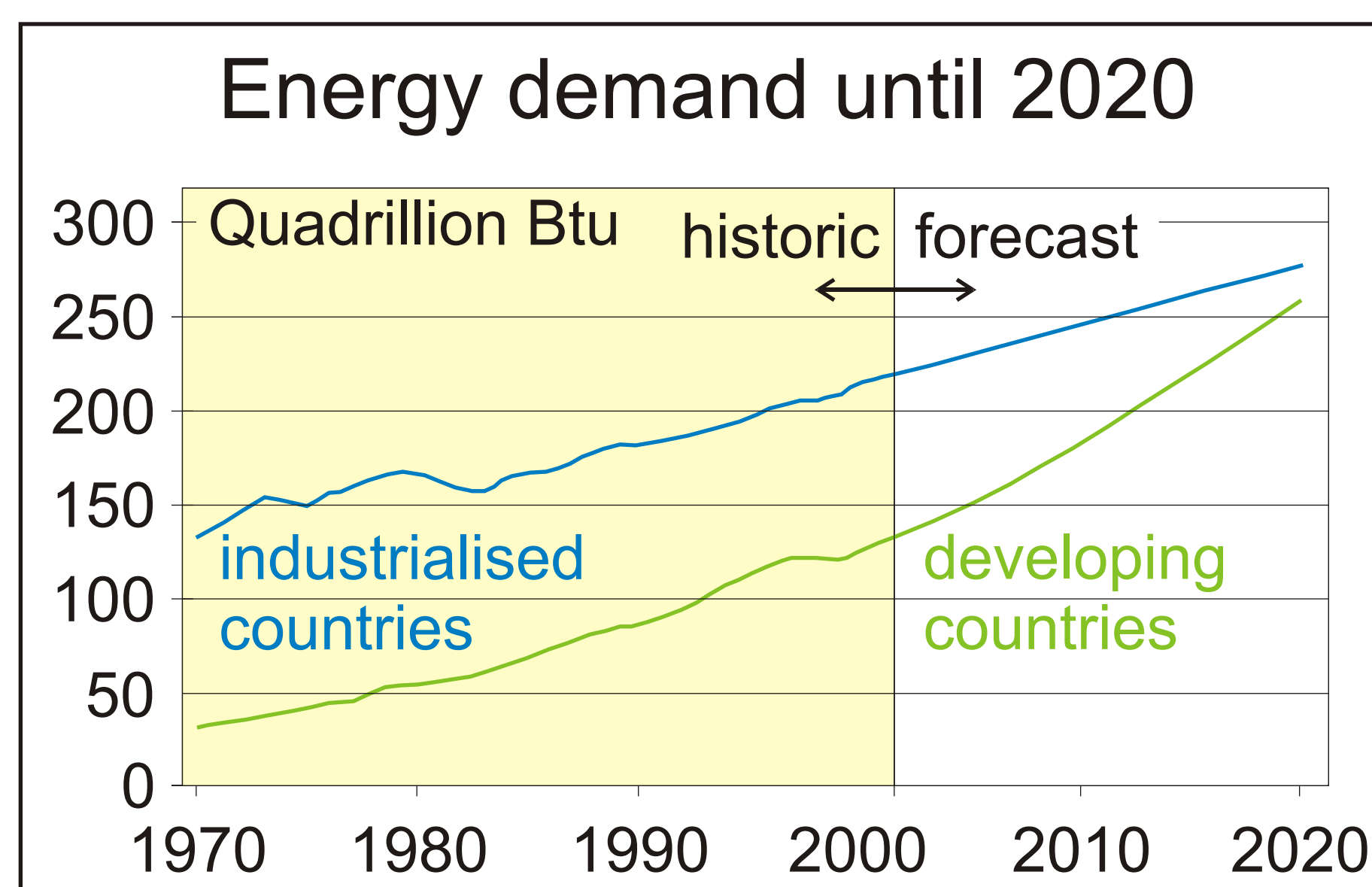


Figure 17 Energy consumption and demand until 2020 (source IEA). Btu = British thermal unit (1 Btu = 1060 Joule = 1060 Watt-Seconds)

Additionally the electricity costs for the consumers and dependence on imported fossil fuel of the nation are very high. Even in comparison to other renewable energies geothermal power has several advantages:

- 1) geothermal power is a base load energy which is independent from local weather conditions and [changing] climate in contrast to other renewable energies
- 2) the land area requirement is low compared to other renewable energies
- 3) it increases the energy diversity and reduces the risk of cost fluctuations as well as the risk of outages and shortages e.g. in contrast to hydro power which is affected by draughts
- 4) it is an environmental friendly and secure energy without environmental impacts such as acid rain, radioactive waste disposal or the damming of rivers and with a low risk in case of a plant accident
- 5) it is local indigenous energy source for sustainable development
- 6) it helps to decrease deforestation
- 7) it alleviates poverty not only through access to electricity necessary for e.g. industrial processes but also offers jobs
- 8) it decreases the dependence on imported fuel and therefore the foreign currency outflow
- 9) the electricity production costs are much less than electricity from diesel generators
- 10) the reliable power plants are designed to run 24 hours a day (e.g. the more than 20 year old power plant Olkaria East in Kenya has an availability and load factor of about 97% and 92%, respectively)
- 11) the output of the power plant is modular expandable according to the demand e.g. in remote areas which avoids the need for a high initial capital outlay
- 12) geothermal energy allows multiple usage

More than 60 million people are living within a 200 km wide zone along the rift which could benefit from geothermal electricity production (Figure 18). Let's take the chance for poverty reduction and a sustainable development now.

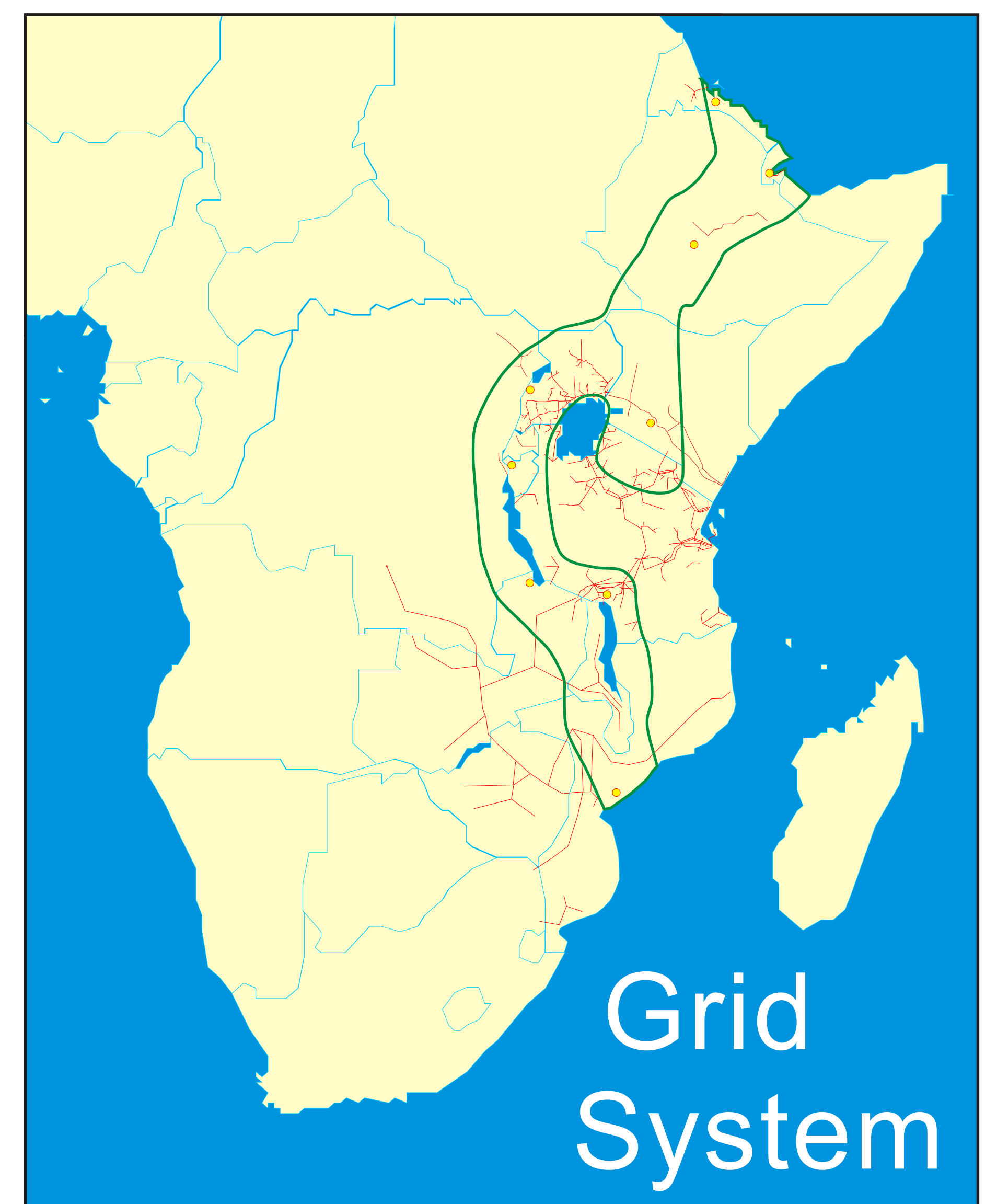


Figure 18 Grid System (red lines) along the East African Rift System. A 200 km wide zone along the rift (green line) with a population of more than 60 million people is shown.

