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Nuclear Fission, Natural Gas, Geothermal Energy, Nuclear Fusion: The Future Role of Baseload Power Plants

What is a base-load power plant?

Due to the investment costs involved, **base-load power plants** have to be in operation almost continuously in order to be profitable. Typical base-load technologies are currently nuclear power plants and lignite-fired power plants.

Residual-load power plants are a different case. Although these are also always available, they are only occasionally actually operating – e.g. at the times when solar and wind energy are not supplying sufficient power. Residual-load power plants have comparatively low investment costs, but high fuel costs. One example of this technology is hydrogen-fuelled gas turbine power plants.

Assessment of low-CO₂ base-load technologies

- **Nuclear power plants** come with unanswered questions on safety, final deposition and proliferation. Most current new construction projects are running significantly behind schedule and over budget.
- **Natural gas power plants with CO₂ capture** could probably be realised on a large scale within the next 20 years. One challenge will be developing the infrastructure for CO₂.
- **Geothermal energy** has low potential for electricity generation in Germany; here it is better suited to providing heat.
- **Nuclear fusion** will not be able to make a notable contribution to electricity generation until after 2045, it is expected.

A secure energy supply is possible without base-load power plants

A reliable climate-compatible electricity supply is possible through the interplay of solar and wind energy with storage systems, flexible power consumption and residual-load power plants. The expansion of renewable energy and the European electricity and hydrogen grids is expected to cover Europe's electricity needs and most of the demand for hydrogen across the continent.

But base-load power plants could still contribute to the energy supply

Detailed modelling shows that base-load technologies can be integrated into an energy system dominated by solar and wind energy. The key here is a flexible hydrogen system that enables the power plants to run at high capacity utilization. During times when demand is low, their power would be used for electrolysis, allowing hydrogen imports to be reduced. Base-load technologies make little difference to the need to expand and develop the electricity and hydrogen grids, and should also have no impact on the transition to electric mobility and heat pumps. They make sense primarily when they are more cost effective than the alternatives. New base-load power plants do, however, represent a rather more long-term option, given their long construction and usage times.

Base-load power plants do not have a substantial impact on overall costs

The modelling shows that – even based on optimistic assumptions – the overall system costs of transforming to climate neutrality by 2045 are at the same level with the addition of base-load power plants as in the reference scenario, which focuses primarily on solar and wind energy. Additional risks arise through cost increases and delays in the construction of base-load power plants, which can be caused both by the lower technological maturity of the technologies involved and by the typical complexity of large individual projects.