Part 9:

Electricity generation costs - how much does electricity really cost?

Calculating production costs:

It is important to note that the calculation of the cost of electricity is used to compare different types of generation. Electricity generation costs are usually measured as LCoE which means "Levelized Cost of Electricity. The LCoE is a measure of the average cost of electricity generation for a power plant over its lifetime. The idea is to compare different technologies in a uniform way. The LCoE however does not take into consideration how economical a specific power plant operates or how flexible or volatile a specific technology produces electricity. Also LCoE does not take into account the external costs, such as environmental pollution, or social costs that do not show on the electricity bill.

What about health and environmental damage?

External follow-up costs, which result in damage to health or environmental problems, are not taken into account when determining the electricity generation costs (calculated by Fraunhofer Institute in Euro Cent per kilowatt hour, Ct/kWh).

However, Germany's Federal Environment Agency published data on those external add-on costs. Emission factors such as pollutant values for fine dust, sulfur dioxide, ammonia or CO_2 emissions are included in the calculation to determine environmental costs.

The follow-up costs are plentiful as fossil fueled power plants affect public health and ecosystems in many ways or damage land so that it can no longer be used properly. These consequences are not included at all or only partially in the calculation of the external costs. It is hardly possible to put a price tag on eternity costs.

How much does coal energy cost?

Among conventional power plants, lignite coal power plants produce electricity the cheapest: for 4.59 to 7.98 Ct/kWh.

Hard coal power plants generally produce a bit more expensive: for 6.27 to 9.86 Ct/kWh.

The production costs of coal electricity strongly depend on how much the respective plant is used. However, coal-fired power plants are quite inflexible with regard to electricity generation, which means that they cannot adjust output as required. That is why they are only of limited use when it comes to compensating for the fluctuating electricity production from renewable energies. In addition, the prices of fuel and CO_2 certificates are increasing. As a result, production costs for coal electricity are likely to increase further and renewables are likely to muscle out fossil fuels for economical reasons.

According to Germany's Federal Environment Agency, environmental costs of coal-fired power plants are currently around 21 Ct/kWh for lignite and almost 19 Ct/kWh for hard coal.

The majority of the costs result from greenhouse gases - almost 19 Ct/kWh for lignite and 17 Ct/kWh for hard coal-fired power plants.

In addition to environmental costs, eternity costs will still incur long after coal mining has ended. They include mine water management, groundwater cleaning and treatment of permanent mountain damage. Mining, for example, creates sinks in which water would accumulate which requires regular pumping. The perpetual burden from hard coal is estimated at around 280 M. Euro (RAG Foundation), primarily for water drainage. Lignite coal mining will cost 384 M. Euro in mining damage and 172 M. for relocations of local population.

How much does energy from gas power plants cost?

The production costs of gas and steam power plants (combined cycle power plants) are between 7.78 and 9.96 Ct/kWh.

More expensive production costs are offset by higher production flexibility and lower CO_2 emissions. Modern highly flexible gas turbines are even more adaptable, but at 11.03 to 21.94 Ct/kWh, again produce significantly more expensive than combined cycle power plants.

The environmental costs of gas power plants are relatively moderate at around 8.60 Ct/kWh.

How much does nuclear energy cost?

With the phase-out in sight in 2022, there is simply no longer an interest to calculate the current actual production costs. Until now, the production costs for nuclear energy amounted to approx. 13 Ct/kWh. It is extremely difficult to obtain reliable figures for the follow-up costs of nuclear energy, as the figures fluctuate greatly depending on the chosen research studies. In 2017, Greenpeace put the price tag in a range of 6.2 to 15.2 Ct/kWh including external costs and costs for greenhouse gas emissions.

However, phasing out will lead to high decommissioning costs: the operators of nuclear power plants are responsible for handling and financing the decommissioning as well as dismantling and proper packaging of the radioactive waste. The German Government is responsible for the implementation and financing of the interim and final storage. 24.1 bln. Euro paid by nuclear operator into a fund are made available to the operators of the power plants.

How much does wind energy cost?

Wind power is - and above all, a major competitor to conventional electricity generation. The production costs of wind energy depend heavily on the location and how intensively the plants are actually used. Under optimal conditions, wind power can be produced cheaper than electricity from fossil power plants. As for onshore wind, the cost of energy is only between 3.99 and 8.23 Ct/kWh.

At very good locations, offshore plants achieve production costs of 7.79 to 9.95 Ct/kWh. In less favorable locations, for example in coastal waters, the costs can be up to 13.79 Ct/kWh. Offshore is more expensive, as more resistant and expensive materials are needed than for onshore wind turbines. In addition, installations and logistics are significantly more expensive and maintenance costs are higher out in the sea.

External environmental costs are only 0.28 Ct/kWh, incl. 0.18 ct/kWh from greenhouse gases. Greenhouse gases are primarily caused by the manufacturing of the equipment, during construction and final dismantling. Hardly any emissions occur during the operation of wind turbines.

How much does solar energy cost?

Depending on the type of system and the level of solar radiation, electricity production in PV systems costs between 3.71 and 11.54 Ct/kWh (and in some regions evens less). Large ground-mounted systems are particularly cheap to produce; small roof-top units are the most expensive per kWh. Solar energy is so profitable that now, for the first time in Germany, solar parks are built without any subsidies.

Solar energy is getting significantly cheaper as global demand soars and component costs are falling, among others the wholesale price for crystalline modules. PV system manufacturers now guarantee a life-span of over 25 years on the performance of their modules. Since the operating costs of PV systems are generally rather low, an extended service life of the systems lowers the production costs yet again. In the future, electricity from PV systems should be produced even cheaper than it is today.

The environmental costs of PV systems are currently ranging at 1.64 Ct/kWh including 1.2 Ct/kWh for greenhouse gas emissions.

In contrast to fossil fuels or nuclear power, there are no eternity costs for renewables.

Further reading

Maybe Overview of IRENA: Development of LCoE for renewables between 2010 and 2017
https://www.irena.org/Statistics/View-Data-by-Topic/Costs/LCOE-2010-2017

https://www.quarks.de/technik/energie/welche-art-von-strom-ist-am-guenstigsten/