EXPLAINER

The Total Cost of Power Supply

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Version 9 March 2026

This short explainer addresses two questions:

- What is the cost of electricity from different sources?
- What is the overall cost of power supply?

These questions are surprisingly difficult to answer because of the complexity of electricity system interactions. There is a vast academic literature on the question of the calculation of total system costs (including Ueckerdt et al. 2013 and Hirth et al. 2016). A less scientific but more pragmatic three-step approach goes like this.

Step 1: generation costs. The first step is calculating the cost of power generation for relevant technologies. The full lifetime costs per MWh (levelized costs of electricity) include not only the variable cost of production like fuel and carbon permits, but also investment cost and other fixed costs. The Merit Order does not include investment costs, so the levelized cost numbers are different. Power generation is an investment-intensive business. For example, the new Hinkley Point C nuclear power station is expected to cost EUR 55bn. Also, the same technology can have very different investment costs. For example, compared to a large solar park, each kW of generation capacity of a small rooftop solar panel may cost three times more, because of the high installation costs. In Southern Spain the same solar panel produces twice the solar energy than in Northern Germany. A key parameter with huge effect on the result is the cost of capital, which is the higher the riskier an investment is. Table 1 reports some illustrative calculations based on German parameters that result in levelized costs between roughly 50 €/MWh (solar) and roughly 150 €/MWh (nuclear, gas). Detailed assumptions are reported note because of their accuracy but for transparency of the calculations. But this is not the end of the story. All numbers provided in this document are rough calculations meant to provide an idea of the orders of magnitude.

Table 1. Cost of electricity from different sources (middle-of-the-road generation costs for Germany)

	Solar (residential)	Solar (farm)	Wind (onshore)	Nuclear (EPR)	Gas (CCGT)
Investment cost (€/kW)	1,500	500	1,500	17,000	2,000
WACC (%)	6%	6%	6%	6%	6%
Lifetime (yr)	30	30	25	60	25
Generation p.a. (MWh /MW)	1,000	1,000	2,500	8,000	3,000
Fuel cost (€/MWh_e)	0	0	0	0	50
Carbon cost (€/MWh_e)	0	0	0	0	27
Land lease (€/MWh)	0	10	20	0	0
O&M (€/MWh)	10	10	10	10	10
LCOE (€/MWh)	119	56	77	141	139
Capture rate	50%	50%	80%	100%	130%
Capture-rate corrected LCOE	**238**	**113**	**96**	**141**	**107**
Grid costs	Highest	Higher	Higher	Lower	Lower

Assumptions: (1) Nuclear investment costs stem from the latest estimates for Hinkley Point C. Gas turbine prices are current market prices, after a significant recent price increase. Solar investment costs are for large (>50 MW) parks; small-scale rooftop solar can be >3x as expensive. (2) All investments are assumed to take place under a public investment scheme that provides de-risking, such as a (financial) CfD or a reliability option as part of a capacity mechanism. Absent such policies, the WACC would be roughly twice as high, increasing LCOE by 20% for gas but by 90% for nuclear. (3) Wind and solar conditions for Germany. By comparison, Andalusia has almost double the solar capacity factor, leading to an LCOE of 40 €/MWh. Similarly, wind conditions are much better in places such as Denmark, Sweden, Spain, or Scotland. (4) Fuel costs assume a gas price of 30 €/MWh. The assumed carbon price is 80 €/t. (5) Land lease can be very project specific. (6) Capture rates are roughly based on German 2025 data. They tend to decrease with penetration rate – see following figures – but depend importantly on the flexibility of the power system (storage, imports/exports, etc.).

Step 2: value correction. The economic value of a MWh crucially depends on when it is produced, because wholesale prices fluctuate. Nuclear runs around-the-clock. Gas plants run disproportionately when demand, and hence prices, are higher, so the average price they earn for each MWh may be 30% higher compared to nuclear. The opposite is true for wind and solar energy. When it is windy, the additional supply of wind energy pulls down the electricity price. As a result, the average per-MWh revenue of wind turbines over a year is less than gas or nuclear plants (Figure 1). As a result, the per-MWh revenue of wind energy is 10-20% lower than the average electricity price. For solar energy, the discount is as much as 50% (Figure 2). This has two important implications:

- The cost of electricity supply to consumers is higher than levelized costs of wind and solar energy suggest.
- Levelized costs cannot be compared between generators to judge their competitiveness vis-à-vis each other.

As a rough indication, Table 1 provides the “capture rate-corrected levelized costs” by dividing LCOE by the capture rate.

The mechanics of the wind value drop

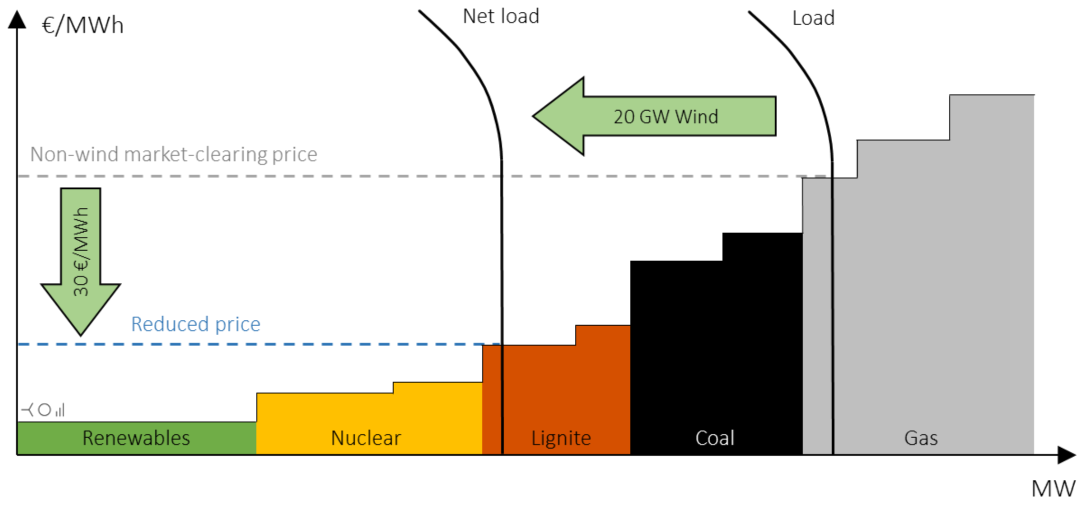

Figure 1. The chart shows the wholesale electricity market in an hour with high wind output vs. a still hour. In a windy hour, the additional supply depresses the market-clearing price. As a result, the average per-MWh revenue of wind turbines over a year is less than that of a constant power source, such as a nuclear power plant.

The market value of wind and solar energy

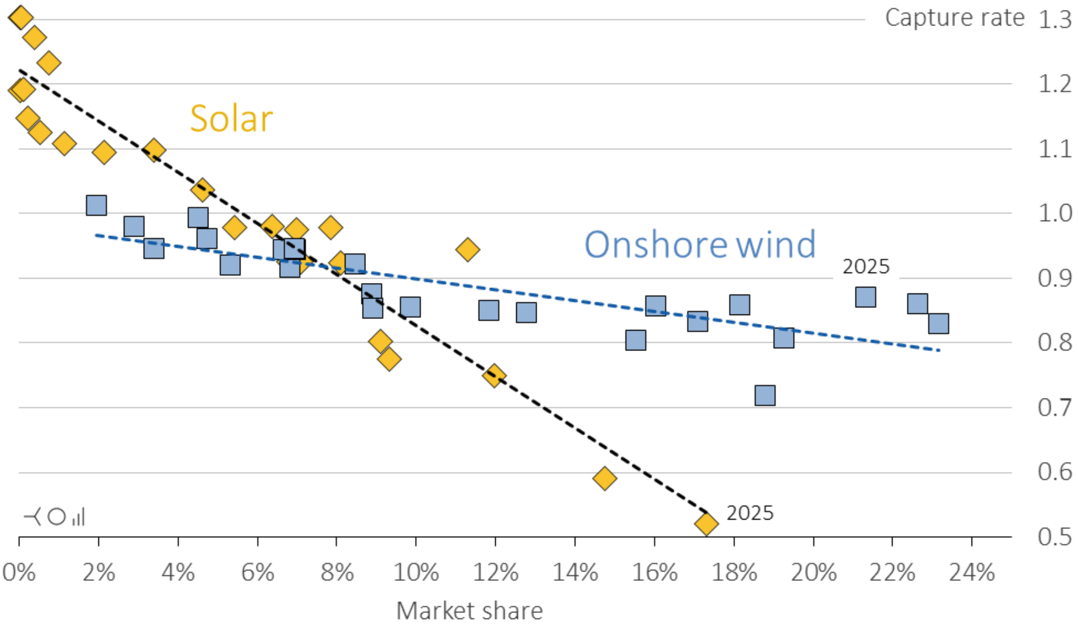

Figure 2. The capture rate (or "value factor") of wind and solar energy in Germany between 2001 and 2025. The capture rate is the per-MWh wholesale revenue relative to the average (base) electricity price of the same year. It declines because wind and sunny hours tend to have lower prices than other hours – and this effect becomes more pronounced as these technologies grow in size.

Step 3: grid costs. The third important step in the calculation of electricity costs is the grid. In Germany, the overall cost of power grids is comparable with the overall costs of electricity generation. In other words, grids make up a relevant part of overall power system costs. Grid costs are very location-specific and depend on the circumstances. For example, small volumes of decentralized renewables may be installed using existing grids, so they do not need any additional grid investment at all. At higher volumes, wind and solar energy tend to have higher grid costs than gas and nuclear plants, because of their lower capacity factor and because they tend to be located more distant to load centers. In addition, small assets are connected to low or medium voltage levels, increasing grid costs further.

Today's total system costs. What does power supply cost today, e.g. in Germany? These financial channels must be considered:

- Energy procurement cost, i.e. what consumers pay to buy energy on the wholesale market. In 2025, this was roughly €45bn (back of the envelope estimate, like all numbers in this document).
- Grid costs, i.e. what consumers pay to use transmission and distribution grids through grid tariffs and levies. In 2025 this was roughly €40bn.
- Public funds used to pay for electricity supply, in particular renewable subsidies. In 2025, this was roughly €15bn.
- What is *not* included in this calculation are taxes (electricity tax, value added), because they are not spent but transferred to the state.

With an electricity consumption of close to 500 TWh, this results in total electricity costs of about 200 €/MWh.

Expectations vs. reality. Some stakeholders in energy-intensive industries claim they need a final electricity price of 50 €/MWh to remain competitive, and some policymakers express the expectation that we will soon reach such levels. Realistically, this is far below what even the most efficient power system can deliver in any place in Europe, perhaps except for a few places with very good resources, e.g. Northern Sweden with good wind and hydro resources. Even a climate-ignorant power system built around new coal and gas plants is likely to cost more than 100 €/MWh (excluding the costs of climate damage). Even the most optimized low-carbon power system built around industrial-scale assets, flexible demand, deep European integration, large-scale use of the latest technologies, locational pricing and non-distortive policies, and least-cost grid and generation choices seem unlikely to deliver electricity to base-load industrial consumers at a price much below 150 €/MWh. But getting to such a number will require hard work and tough political choices. We are currently not on a trajectory to get there.