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ELECTRICITY DISTRIBUTION NETWORKS AND THEIR CONTRIBUTION TO THE ENERGY TRANSITION

Electricity distribution network operators are important enablers for the energy transition

The whole energy industry is facing **enormous challenges** in relation to the **energy transition.** The declared aim of a carbon-free energy economy will require the phase-out of CO_2-emitting power generation and replacing them with CO_2-neutral alternatives such as wind and PV plants. Most of these plants will need to be connected to the distribution networks. In addition, decarbonisation from other sectors such as heating and transport will lead to an increasing number of heat pumps and electric vehicles – which will again come along with additional requirements for electricity distribution networks.

Integrating renewables and new loads requires network investments …

Our study shows that expansion and replacement **investments into the German electricity distribution networks** of around **111 bn € until 2050** will be necessary in order to allow for an integration of wind and PV plants, electric vehicles and heat pumps.

… which will bring considerable benefits for the energy transition

Without necessary network investments (expansion and replacements) costs will occur for network customers and the whole national economy. These system costs consist of:

- costs arising from the curtailment of renewable plants, restrictions with regards to charging of e-vehicles and the use of heat pumps as well as from unplanned supply interruptions; minus
- net investments saved from under-dimensioned electricity distribution networks.

The bottom line shows that end consumers are not compensated from savings arising from lower net investments as a result of under-dimensioned networks. **If networks were under-dimensioned in the long term, relevant system costs would rise from between 0.1 € bn to 0.3 bn € in 2030 to between 2.6 bn € to 4.2 bn € in 2050.** Consequently, the price paid for savings from low network investments would be very high and would exceed possible savings especially in later years. **So from a general economic perspective, avoiding under-investments is always advantageous.**

The risk of economic costs resulting from low network investments …

The extent of undertaken investments to enable energy transition strongly depends on **legal requirements and regulatory decisions**. Uncertainty about future developments implies that regulatory parameters are always set within a certain scope of discretion[1] on the part of the regulator. The challenge for the regulatory authority is that there does not exist the „crystal ball" for the upcoming regulatory period(s). The regulatory authority can only act to the best of its ability and make use of recognised techniques to reach its objective, i.e. to ensure a cost-effective, safe, consumer- and eco-friendly and efficient electricity supply in Germany[2]. But uncertainty still remains within the regulatory decisions[3]. Hence, the regulatory authority needs to balance the **risk of a „too strict" compared to a „too light" regulation** and assess the related risk of under-expanded or over-expanded networks.

There are two downsides to an unintended „too strict" regulatory system:

- electricity network companies may „avoid" or defer necessary investments in order to minimise their losses (but this would generate costs elsewhere in the energy system); and
- the steady underinvestment may result in substance losses in the networks and may have an adverse impact on companies' long-term innovation potential.

… exceeds the cost risk of „excessive" network investments

If regulation is „too light", this may result in an over-dimensioning of networks. However, the **extent of over-dimensioning would not be comparable to under-dimensioning due to a „too strict" regulation**. For example, it is much easier not to realise projects than to realise several projects at the same time. Additionally, the amount of investment budgets and financial capabilities is limited. Finally, there is still a risk for the DSO that a „light" regulation turns into a „strict" one at a later stage. The same applies to changes to the regulatory system, as such. They may also lead to a retrospective devaluation of investments made in the past. All this will have a moderating effect on possible overinvestments. Hence, the underinvestment effect is likely to exceed the effect of overinvestments.

A comparison of risks associated with an under-/over-dimensioning shows that

- the **economic costs of under-dimensioning** caused by a „too strict" regulation (expressed by the costs in the electricity system mainly due to congestion costs from curtailment of renewable generation and restrictions for customers minus the saved network investments);

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1 Here, the term discretionary scope is used in its general sense and without the legal discussion that would ask whether there is any scope left in terms of the facts or the legal consequences and what legal consequences this would imply in each case.

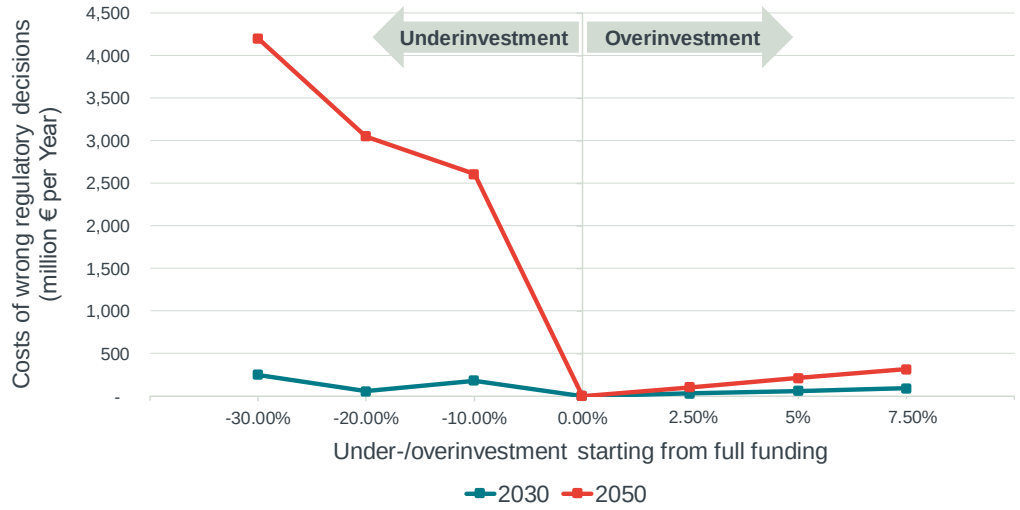
2 "Here, the Bundesnetzagentur is paying particular attention to ensuring that the network operators can cope with the major tasks of energy system transformation without imposing an excessive financial burden on consumers. While the German electricity supply system is undergoing a restructuring process that is unique in the world, supply security for private households and industry must be guaranteed at all times".https://www.bundesnetzagentur.de/DE/Allgemeines/DieBundesnetzagentur/UeberdieAgentur/Aufgaben/aufgaben-node.html

3 This uncertainty about the future is additional to the permanent question of information asymmetry between network operators and regulators which is supposed to be addressed by incentive regulation and revenue caps implied therein.

- **exceed** the **economic costs of over-dimensioning** (expressed by network costs from excessive network investments)

There is a **significantly asymmetric risk to the disadvantage of under-investments** with weak networks rapidly causing high costs.

Figure 1 **Economic costs (without distribution effects) of an under-/over-dimensioning of electricity distribution networks in Germany (= costs of under-dimensioning minus saved network investments or network costs in case of over-dimensioning)**



Source: Frontier Economics

An analysis of economic costs resulting from over- or under-investment resulting from „too strict“ or „too light“ regulation shows:

- There is an **asymmetric risk** from an economic perspective, i.e. “too strict” regulation will rapidly and absolutely become more expansive than “too light” regulation.
- There is a **disproportionate rise in risk over time** (see 2030 vs. 2050). In the under-investment scenario, the existing network still has a „dampening“ effect on costs. But in the long term supply tasks will differ so much from today that a cost explosion will be unavoidable unless the network is adopted to the new challenges. Congestion costs are “stepwise fixed costs”, i.e. once the capacity limit of a network element is reached, any congestion exceeding this limit will cause further (congestion) costs.
- Even there is a **short-term “overinvestment“**, these network elements would still be **needed in the long term**, i.e. in the case of a “too light” scenario. The „too early“ network expansion would be still suboptimal, but most of the network elements will be needed in the future.
- The **negative effect of an under-investment substantially increases over time so measures to preventive this under-investment should already be taken today** – Existing networks will become more and more “inadequate” to fulfil their (different from today’s) future supply task. In real world, it will also be challenging to catch-up under-investments from periods of tight regulation, if

the requirements for a robust electricity distribution network constantly increase in the future. A “pile” of network under-investments should therefore be avoided particularly in the short term, as it will lead to high and disproportionate increases in costs in the long term.

- The **difficulty of „catching up“ under-investments** will also effect the **suitability of indicators used to identify under- investments.** If these indicators are based on historic data (e.g. yearly balances, which are normally characterised by a t-2 delay), there is a risk that these indicators might recognise under-investment too late so that it could hardly be corrected afterwards.

Considering the value of electricity distribution networks as an enabler of energy transition in future regulation decisions …

The **economic value of** a timely and efficient expansion of **electricity distribution networks** is **high**. If this economic value of electricity distribution networks is not taken into account when setting the regulatory regime, there is a risk that the focus of regulatory decisions might be too narrow. In this case, the focus is limited to the direct impact regulatory measures would have on short-term network costs but the positive economic effect of well-dimensioned electricity distribution networks on the whole energy system would be partly neglected.

… is in the interest of end customers.

From an economic perspective, **regulation should aim to minimise the economic costs from over-/under-dimensioned networks**. If, however, the risks of over-/under-dimensioning are asymmetric, i.e. the costs of under-investment exceed those of over-investment, it might be sensible from an economic perspective to have a tendency of being on the safe side. In case of decisions under uncertainty, the safe side may be to accept even slight over-investments in order to avoid the negative implications from under-investment.

One option to minimise the adverse effect of under-dimensioning due to a „too strict“ regulation might be to apply discretion in future decisions on regulatory parameters in favour of the energy transition (and consequently in favour of network companies). In individual cases, of course, it will always be necessary to find the right balance between the different levers of the regulatory regime, especially if a regulatory decision is based on several individual decisions. But one thing always needs to be considered: **The economic costs of under-dimensioned electricity distribution networks on end consumers will be considerable and should, if possible, be avoided.**