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Management Summary

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E-Bridge
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MANAGEMENT SUMMARY

GOAL AND METHODOLOGY

Energy supply in Germany is facing a fundamental transition. Energy generation, to date characterised by nuclear and fossil energy sources, is to switch over to renewables within just a few decades. Massive technical, economic and social challenges must be overcome in the process.

Germany is playing a pioneering role in the expansion and integration of renewables in electric networks. Installations using renewable energies, with an installed capacity of approximately 61 GW, have so far been connected to the German national grid[1]. The special role assumed by Germany becomes apparent when it is compared with other European member states such as France (12.9 GW), Italy (21.3 GW) and Great Britain (9.3 GW). The integration of renewable energy installations is set to increase further still in the future. Pursuant to the goals set by the German Federal Government, this figure as a percentage of German gross power generation is to rise from the current figure of around 23% to above 50% by 2032 and to 80% by 2050.

Against the backdrop of the special role of distribution networks for the successful realisation of the energy transition, the expansion requirement in these networks is qualified as part of this study. Building upon this, the savings potential by using intelligent network technologies and the application of innovative planning and operational strategies are also investigated and appraised.

The following issues are at the heart of the study:

- How great is the network expansion requirement in German distribution networks in under consideration of current planning policies? How are these split across distribution network levels and the regions in Germany?
- By means of which planning and operational strategies, and by adopting which intelligent network technologies, can the network expansion requirement necessary, and associated costs of integration in the distribution networks, be reduced?
- Which information and communication technologies (ICT) are necessary for this, which implementation concepts are viable and what consequences for security of supply as a result of increased dependency on ICT can be expected?
- Which regulatory or regulative adaptations are required to facilitate the best possible integration strategy?

90% of the capacity of installed renewable energy installations is connected up to distribution networks. With an overall coverage of 1.7 million kilometres, these networks make up about 98% of the overall national grid in Germany.

The German distribution networks form the backbone of the energy transition strived towards. A wind power and photovoltaic capacity of about 55 GW (and so about 90% of the installed capacity of all installations) is already connected to the heterogeneously structured distribution networks[2].

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[1] As of 2012, BDEW
[2] As of 2012, BDEW

Around 500,000 low-voltage networks, and other networks, with a total coverage of around 1.1 million kilometres, are available for the distribution of the renewable energy generated. The medium-voltage level comprises around 4,500 networks with an overall network length of around 510,000 km, and the high-voltage level about 100 networks with an overall network length of around 95,000 km. Comparing this to the German transmission grid (around 35,000 km in length) means the distribution network makes up by far the biggest part of the German electricity supply network with a length of 1.7 million kilometres. Around 75% of all network operators are already affected by the integration of remote feed-in, partially at least. These network operators are primarily in rural areas.

The wind power and photovoltaic capacity installed is set to more than double, or even triple, by 2032 depending on expansion scenario.

The consequences of renewable energy expansion for German distribution networks are investigated on the basis of three scenarios. These cover the entire bandwidth of realistic growth paths to year 2032.

- "Renewable Energy Sources Act (EEG) 2014" scenario: This scenario reflects the current political goals of the Federal Government, used as the basis for the "EEG 2014" bill passed by the federal cabinet in April 2014. The "EEG 2014" scenario assumes an installed renewable energy capacity of 128 GW in 2032 (made up of 60 GW wind, 59 GW photovoltaics and 9 GW other). This corresponds to more than a doubling of the capacity of current renewable energy installations.
- "Network development plan (NDP)" scenario: This scenario brings together the estimation of transmission network operators from Scenario B of Network Development Plan 2013. It is assumed that the renewable energy capacity installed rises to a total of 139 GW by 2032 (made up of 65 GW wind, 65 GW photovoltaics and 9 GW other).
- "Federal states" scenario: This scenario reflects the accumulated goals and forecasts of individual federal states. The "Federal states" scenario leads to an installed renewable energy capacity of 206 GW in 2032 (made up of 111 GW wind, 85 GW photovoltaics and 10 GW other). This therefore more than triples the renewable energy capacity currently installed.

These scenarios characterise the corridor for the expected course of renewables, and so render possible a workable estimation of future expansion requirement in German distribution networks.

Necessary for the estimation of network expansion requirement is representation of the heterogeneous structure of the distribution networks and of locally differentiating renewable energy installation.

The German low- and medium-voltage levels, already making up the majority of energy from renewable energy installations, differ mainly in their network structure. It is important to note here that network expansion requirement has essentially a non-linear dependence on the combination of respective network structure, nature of supply and capacity of renewable energy installations. An analysis of average networks is therefore not adequate and requires individual representation of networks. So to determine expansion requirement, distribution network operators are split into representative model network classes (10 low-voltage and 8 medium-voltage model network classes), each exhibiting a similar penetration of renewable energy installations, such as "strongly characterised by photovoltaic installations" or "strongly characterised by wind power installations".

For each of these model network classes, typical model networks are created with which today's heterogeneous structure of distribution networks is represented. The parameters required for characterising typical network models are based upon comprehensive analyses of current networks. The high number of networks simulated (more than 2 million model networks) ensures that the heterogeneity of individual German distribution networks is taken into consideration in an appropriate and proper manner in the simulation too.

A similar approach is chosen for the distribution of renewable energy installations. The data of German wind power and photovoltaic installations is analysed and assigned to the respective distribution networks in the model network classes. For the growth of installation sizes, historical growths are used as the basis and compared with forecasted growths by industry experts. This way, several million combinations of expansion variants of renewable energy installations for the different distribution networks can be calculated for every scenario ("EEG 2014", "NDP" and "Federal states"). The high number of model networks determined this way enables expansion requirement to be ascertained properly, and conclusions to be drawn on the frequency of "critical" combinations of network structures and renewable energy growth requiring network expansion.

For the high-voltage level, models of all German high-voltage networks (down to line and station level) were developed and simulated as part of the study. This was necessary because the individually meshed network structures of the high-voltage networks and their low number do not permit a statistically workable assignment to model network classes.

RESULTS OF THE STUDY

THE EXPANSION OF RENEWABLE ENERGY REQUIRES CONSIDERABLE EXPANSION OF GERMAN DISTRIBUTION NETWORKS IN CONSIDERATION OF CONVENTIONAL PLANNING METHODS.

In the period to 2032, additional overall investment totalling €23bn to €49bn will be required depending on scenario.

Allowing for current planning policies, around €23bn ("EEG 2014" scenario), €28bn ("NDP" scenario) and even €49bn ("Federal states" scenario) must be invested in distribution networks by 2032 for the integration of renewable energy installations. Medium and high-voltage networks make up 80% of the investment requirement. It is assumed here that network expansion for the high-voltage level will be entirely in the form of underground cables. This cabling is responsible for around two thirds of network expansion costs on the high-voltage level and around a third of overall expansion costs.

Network expansion costs rise disproportionally in the "Federal states" scenario. Whilst here, compared to the "EEG 2014" scenario, around 50% more energy from renewable energy installations is fed in, at the same time the investment requirement in the distribution networks rises to more than double.

The network expansion requirement can also be measured from the length of additional lines required for integration of the renewable energy installations. Compared to reference year 2012, network lengths in 2032 will rise by 5%, 14% and 11% on the low, medium and high-voltage levels respectively. A total of between about 130,000 km ("EEG 2014" scenario) and about 280,000 km ("Federal states" scenario) of additional line kilometres must be constructed by 2032.

Annual costs of distribution networks are set to increase by 10-20% in the next 20 years.

Annual supplementary costs (capital expenditure and operating costs) to 2032 are set to grow to about €1.8bn per annum in the "EEG 2014" scenario. This corresponds to an increase in network costs of around 10% compared to 2012. In the "Federal states" scenario, this value is reached as early as 2017, and to 2032 even grows to around €3.8bn p.a. – or over 20% of the network costs of 2012.

Up to 70% of the network expansion requirement identified accrues in the coming ten years.

Up to 70% of network expansion measures identified must be in place by 2022, virtually regardless of the scenario considered. A major reason for this high level of speedy network expansion is strong renewable energy expansion within the same period (because to 2022 around 65% of renewable energy expansion will occur for the entire period to 2032 depending on scenario).

The rapid rise in network expansion requirement is also reflected in the increase in annual network costs. In the "EEG 2014" scenario, the annual costs rise four times quicker than in the following decade.

More than a third of low-voltage network operators, and two thirds of medium-voltage network operators, are affected by network expansion.

There is not a network expansion requirement in all model network classes. About 35% (or 64%) of distribution network operators are assigned to model network classes in which there is an appreciable expansion requirement on the low-voltage level (or for medium-voltage networks).

Some of these network operators are affected greatly by network expansion however. In the "EEG 2014" scenario to 2032 for example, the expansion requirement for medium-voltage at the distribution network operators affected most is up to 40% or even 70% of the network length of 2012. On the low-voltage level, the expansion requirement is far lower and is on average up to 13% in the model network classes affected most. The expansion requirement is far higher in the two other scenarios – especially in the "Federal states" scenario.

Expansion requirement is not distributed homogeneously over all distribution networks but is concentrated on a few networks. On the low-voltage level, only 8% of the 500,000 German low-voltage networks are affected by expansion. Network expansion is necessary first and foremost where high remote feed-in capacities are connected into networks not suitable for the connection of remote feed-in due to long feeder lengths for example. This situation is particularly common in rural areas. On the medium-voltage level, network expansion is pronounced at places where wind power installations are connected directly to the medium-voltage network, and where photovoltaic installations are often on secondary low-voltage levels. This pertains to about 39% of all medium-voltage networks.

The investment requirement by regions and voltage levels is highly different.

Irrespective of the scenario, network expansion will be necessary on the low-voltage level (most notably in South Germany - approx. 60%) because this region[3] will also be affected by an increase in photovoltaics installations in the future. Regionally, the network expansion requirement identified in the medium-voltage network has virtually the same distribution. On the high-voltage level, the network expansion requirement is concentrated on North Germany (around 39%) and East Germany (around 33%). This is attributable mainly to the facts that in these regions wind power plays a key role in power generation and there is large-scale transportation to the load centres.

Expansion requirement has direct effects on regional network charges. For low-voltage network charges, the expectation is that network charges in the "EEG 2014" scenario will rise up to 16% for customers without registering load curve measurement into 2022, primarily in the regions of North and East Germany (the reference is the network charge volume in 2012 amounting to approx. €18bn). The effects on the South Germany (10%) and West Germany (4%) regions on the other hand are not as great. In the "Federal states" scenario, network charges would even rise to about 30% in North and East Germany. There would be even greater regional differentiation given increased integration of renewable energies.

The technological or regional form of renewable energy expansion has a significant bearing on the network expansion requirement.

The consequences of modified technological or regional renewable energy expansion was analysed on the basis of two additional scenarios both showing a comparable annual feed-in volume from renewable energy installations. On the one hand, expansion of renewable energy installations was simulated with the allocation which leads to the lowest power generation costs. The assumption was made that investment is only made in renewable energy installations having the lowest power production costs. Given today's foreseeable cost trends, and current figures to 2032, coming years would see expansion mainly of wind power installations on land, and increasingly also photovoltaic installations from 2022 onwards. For the study of renewable energy technology potential, available areas in Germany were subjected to comprehensive statistical analyses of soil properties, land utilisation and distance requirements (from watercourses, etc.). Local potential of available areas was assessed and the most favourable areas identified.

On the other hand, the regional distribution and technologies used in the "Federal states" scenario were used as the basis and scaled such that the total energy fed in from renewable energy installations is the same as in the scenario with the lowest power production costs.

The resultant network expansion requirement differs mainly on the low-voltage level. Here network expansion is driven primarily by the PV capacity connected. Expansion requirement on the high-voltage level also differs in the scenarios examined. Here regional concentration in particular is a contributing factor for the network expansion required.

[3] North: Hanseatic cities of Bremen and Hamburg, Lower Saxony, Mecklenburg-West Pomerania and Schleswig-Holstein / West: Hesse, North Rhine-Westphalia, Rhineland-Palatinate and Saarland / East: Berlin, Brandenburg, Saxony-Anhalt, Saxony and Thuringia / South: Bavaria and Baden-Württemberg.

INNOVATIVE PLANNING CONCEPTS IN CONJUNCTION WITH INTELLIGENT TECHNOLOGIES CONSIDERABLY REDUCE THE NETWORK EXPANSION REQUIREMENT.

This study attempts for the first time to estimate network expansion requirement in consideration of heterogeneous network structures in German distribution networks and the horizontal and vertical renewable energy expansion scenarios expected, and to quantify the influence of innovative planning concepts using intelligent technologies. Such a comprehensive review has yet to be carried out.

There is essentially a broad bandwidth of different methodologies to satisfy the anticipated requirements made of distribution networks by the increasing level of renewable energy integration. To address the entire bandwidth, the following methodologies were examined in more detail following a preliminary analysis:

- Curtailment of renewables in network planning
  In network expansion planning, the specific regulation of feed-in levels from renewable energy installations is permitted for a few hours in the year to reduce or prevent a network configuration of 100% of feed-in capacity required for highly rare load peaks

- Reactive power management in network planning
  The provision of reactive power by decentralised power generation installations is being broadened in relation to the thresholds specified in today's regulatory requirements

- Load management in network planning
  In network expansion planning, the specific influencing of loads for a few hours in the year is permitted to compensate feed-in by renewable energy installations

- Intelligent network technologies
  Intelligent network technologies, i.e. controllable local grid transformers, linear voltage controllers and high-temperature stranded conductors, are deployed extensively

Individual measures are first analysed separately. Building upon this, the combination of diverse measures is examined to find out the effects of application together of different possible solutions and to derive the best possible combination of approaches. Finally, the technical and regulatory prerequisites necessary are also identified and appraised.

Even a low amount of curtailed energy from wind power and PV installations is enough for a significant reduction in network expansion requirement.

In the analysis of the effects of power generation management in network planning, the assumption is that a network expansion obligation for a maximum feed-in level from renewable energy installations is dispensed with, and instead curtailment of renewable energy feed-in may be factored into network expansion planning. As part of network planning, curtailment only of wind power and PV installations is assumed, as is that only renewable energy installations in networks with an expansion requirement are regulated.

Curtailment of the annual feed-in from these renewable energy installations by 1% is sufficient to reduce the network expansion requirement by around 30%. Regulation of 3% of the annual energy would be enough to make a saving of more than 40% of network expansion.

The effectiveness, i.e. the ratio of potential network expansion saving to regulated energy, reduces significantly from an annual regulated energy level of about 3%. The progression of effectiveness is independent of the renewable energy expansion scenarios investigated and also broadly independent of whether PV or wind power installations are regulated. Effectiveness can be increased further with selective regulation of renewable energy installations.

Taking into account curtailment in network planning means annual supplementary costs for integrating renewable energy installations into distribution networks can be reduced by at least 15%.

Cost savings as a result of network expansion prevented were contrasted against the additional costs for ICT for communication and control, and for the procurement of alternative energy. The costs for procuring alternative energy is equated to the costs for additional renewable energy installations, i.e. 100 EUR/MWh.

Taking into account power generation management in network planning then means overall costs can be reduced by at least 15%. The network expansion requirement induced by renewable energy expansion can then be reduced by more than 40% – around 55%, 32% and 45% on the low, medium and high-voltage levels respectively. However, this must be contrasted against the costs for regulated energy in particular. Power generation management will also mean that variable costs as a percentage of overall costs, 16% (conventional network expansion) will rise to just under 40% (power generation management).

The ability to regulate conventional power generation during ongoing operations means the costs for procuring alternative energy can be reduced as required. This means in turn that overall costs could be reduced further, and additional reduction of network expansion becomes economical.

Both the continued development of reactive power management and the introduction of load management reduce the network expansion requirement only marginally.

Starting from a cos(φ) control figure of 0.9 (0.95) in line with applicable BDEW guideline "Power Generation Installations in the Medium Voltage Network", the current VDE-AR-4105 VDE standard and technical connection conditions of network operators, the cos(φ) control figure was increased to 0.7. Whilst deployment of extended reactive power management can reduce network expansion on the low-voltage level, the quantitative requirement for transformers on the different transformation levels also increases. Extending reactive power management with a cos(φ) control figure beyond 0.9 brings no appreciable benefit for overall costs. This extension may be viable however to reduce voltage-related network expansion on the low-voltage level.

Load management beneficial to the network still contributes very little towards reducing network expansion. A major reason for this is that expansion requirement occurs mainly in networks in which the renewable energy capacity installed is higher than the peak load. These networks are generally in rural areas and have low overall loads. Network expansion is driven by the installed capacities of decentralised feed-in and is also influenced by the network structure, such as feeder lengths. Influencing the low load therefore changes relatively little for the shortfalls occurring.

Load management beneficial to the network can however be viable in networks in which the load itself has a relevance to network expansion and network operation. Load management beneficial to the network could be practicable, in particular for a future increasing level of concurrence of loads potentially caused by growing influencing capability. A corresponding analysis is beyond the scope of this study however.

Controllable local grid transformers reduce the network expansion requirement mainly on the low-voltage level and lead to a reduction in the average annual supplementary costs of just under 10%.

Average annual supplementary costs can be reduced by 10% compared to the additional costs for conventional network expansion with the deployment of controllable local grid transformers. The expansion of low-voltage networks can be bypassed almost completely. The accumulated investment volume in the period to 2032 drops by about 15% compared to conventional network expansion.

To attain the highest savings potential, these transformers must be deployed in all low-voltage networks affected by expansion, i.e. in around 8% of the 500,000 low-voltage networks in Germany. This means over 45,000 transformers must be installed by 2032, 30,000 of which by 2022 – meaning in turn that around 3,000 transformers must come on stream every year.

An optimal combination of innovative planning concepts and using intelligent technologies can half the investment necessary and reduce average annual supplementary costs by up to 20%.

Given combined deployment of curtailment in network planning and transformers, the latter are only required in networks in which remaining network expansion requirement is available following deployment of power generation management (approx. 2% of networks). The combination of measures reduces the investment requirement within the period observed by approximately 60% by the same amount on all network levels. Average annual costs fall by about 20%. In this case only 10,000 transformers need be installed by 2032 instead of more than 45,000. These savings could increase further still with optimal organisation of power generation management in network planning and transformer expansion.

Direct additional ICT costs of intelligent solutions are moderate overall.

ICT costs are made up of additional capital costs for the control of individual installations and operating costs for the communication infrastructure required. It is assumed here that all installations are configured and upgraded accordingly regardless of size, location and whether they are existing or new installations. The highest annual ICT supplementary costs occur in power generation management and on average amount to only about 4% of annual supplementary costs.

The costs for control-related integration of power generation management are not included. They are aligned towards existing IT systems (amongst other things) and individually can be far higher than the other investment costs for ICT.

ICT solutions developed previously include no common communication infrastructure of any kind as regards technical disciplines and result in most cases to parallel communication connections being established between components. With the expected establishing of intelligent measurement systems however, a solution developed with a focus on security will soon be available as a gateway that can also be used for services beneficial to the network. For this, an analysis is required from the viewpoint of communication requirements made of network benefit.

Different technological aspects still need to be coordinated in the standardisation to bring together previous solutions. If these issues are addressed adequately, a harmonised, cost-efficient solution complying with standards can be expected for the future, increasing ICT security and further reducing ICT costs.

The deployment of innovative planning concepts and the use of intelligent technologies can dampen the growing spread of regionally differentiating network charges.

For the case of conventional network expansion, the average network charge rise for customers without registering load curve measurement and in non-metropolitan area networks are very different regionally and can be up to just below 16% (in East Germany). The deployment of innovative planning concepts and use of intelligent technologies result in a lowering of the average network charge rise and also to an easing in regional differences. Only in West Germany are the effects on network charges far lower than in the other regions.

RECOMMENDED COURSES OF ACTION

In network expansion planning, curtailment of renewables should provide provision for preventing network expansion for the "last Kilowatt hour".

Inclusion of a selective reduction of the feed-in level from renewable energy installations in network planning can result in considerable savings in network expansion and lower overall costs by at least 15%. It must be possible to include remote-controllable and fixed reduction of the feed-in level in network expansion planning. An alignment of the regulation framework in regard to the requirements laid down in §§ 12 and 14 EnWG (Energy Industry Law) is required for appropriate inclusion of power generation management in network planning.

Only the regulation of wind power and PV installations should be included in network planning. Furthermore, a limited amount of curtailable energy from renewable energy installations could first be ascertained. Such an amount (e.g. 3% per installation) can give network operators sensible leeway for regulation (at optimum cost) of renewable energy installations in network planning without curtailing the feed-in levels of individual installations by too much. Specifications on limiting regulatable energy can be aligned over time on the basis of growing levels of experience.

The operative implementation should be in line with economic considerations as regards deactivation sequence and can be based upon the principles in the feed-in management guide from the Federal Regulation Authority (BNetzA). These must be checked as regards implementability and be developed further as required.

The savings potential shown with curtailment in network planning was determined by means of existing installations. The specific regulation of existing installations in network planning must therefore also be possible for this saving potential to be generated.

The application of power generation management in network planning results in a reduction in network expansion. This makes it necessary for the operative implementation in live operations to also work reliably. Reliable regulation of renewable energy installations must be guaranteed and it must be possible for network operators to request it.

Selection of appropriate planning concepts and intelligent technologies should lie with network operators.

An appropriate combination of curtailment considered into network planning, and the installation of controllable local grid transformers, enables the costs for network expansion to be reduced by at least 20%, and necessary network expansion measures even by a minimum figure of 60%.

However, the selection of correct concepts and intelligent technologies depends heavily on the circumstances in the respective network and should be made by network operators.

Implementation of curtailment includes the level within the upper threshold specified at which renewable energy installations are actuated across-the-board or selectively. The time and level of capacity to be regulated should be specified by network operators. Also, it must be possible for network operators to continue to specify the requirements made of ICT equipment (without making any impermissible restrictions upon others in the marketplace however). Similarly, decisions on whether and which existing installations are to be retrofitted with remote-controllable ICT or fixed feed-in limitations are to lie with network operators.

A prerequisite for network operators making correct decisions is that they bear the full costs and enjoy the full benefits of its application. The costs for procuring alternative energy from renewable energy installations also being aligned to the costs of virtual "alternative renewable energy installations" is a requirement to attain a macroeconomically viable level of network expansion. The costs for ICT retrofitting of renewable energy installations should also be borne by network operators.

Regulation should facilitate selection of planning concepts appropriate in each case and intelligent technologies in line with macroeconomic cost efficiency.

Whilst the application of innovative planning concepts can reduce considerably the overall costs of network expansion, a marked transition towards higher operating costs also generally takes place. So operating costs as a percentage of expansion costs increase to up to 40%, compared to around 16% for conventional network expansion.

The current incentive scheme is aligned towards revenues from equity return and short-term profit by cutting back operating costs. Measures resulting in reducing capital costs and increasing operating costs in the long-term are of less interest to a distribution network operator within the current regulatory framework, even if overall costs are reduced by these measures. So today's regulation regime is only sending out conditionally an adequate signal on cost optimisation that would be required to achieve the saving potential for the conversion and expansion costs in the distribution networks.

Today's regulation regime should be enhanced to stimulate every cost efficiency, regardless of whether it is attained with capital or operating cost reductions. Only when a clear signal on intelligent planning concepts is issued on the part of regulatory bodies can the benefits ascertained be attained. For this, the microeconomic optimum for network operators must be harmonised with the macroeconomic optimum. The long-term benefit of innovative concepts should also be taken into account adequately given the long-term service lives and recovery periods.

Network operators are affected to very different degrees by the energy transition – the regulation system must differentiate accordingly instead of generalise.

Investments induced by the renewable energy expansion in distribution networks are spread unevenly. These networks are operated by a large number of network operators whose network expansion requirements can therefore be very different. The distribution network operator categorisation carried out can if required serve as the basis for enhancement of the regulation system.

Although the effects on network costs are on average moderate (average increase of overall network costs of distribution network operators of just under 10% to 2032), the effects on individual network are considerable. Only just under 8% of the 500,000 or so low-voltage networks in Germany and just under 36% of the 4,500 or so medium-voltage networks are affected – but some of these to a considerable extent. In the "EEG 2014" scenario, the length of medium-voltage networks in the model network classes particularly affected will increase by approximately 65% to 2032 (conventional network expansion) and about 44% for application of power generation management in network planning.

For the effect on network operator costs, whether renewable energy installations need to be upgraded or whether they are subjected to fixed regulation, etc. is also crucial. It is therefore key for the fair treatment of network operators that these differences are taken into account properly in specifying the top revenue threshold. In particular, the increased heterogeneity of network operators caused by the expansion of renewable energies must be represented in the development of efficiency processes – such as with appropriate selection of comparison parameters.

Increased embedding of intelligent network technology is necessary within the regulatory framework.

After all, there is also a requirement to change current instruments of regulation. Specifically, controllable local grid transformers should be included in StromNEV (the Electricity Network Charges Ordinance). Furthermore, operating costs in the instrument of investment measures should be changed accordingly because the expectation is already that increased deployment of ICT is likely to result in an increase in operating costs in the investments.

Particular attention should be paid to power generation management. Important in the consideration of costs for procuring alternative energy is application on average funding costs of renewable energy installations and not the wholesale price. Only this way guarantees that renewable energy installations are not regulated excessively and macroeconomically inflated costs do not accrue. How these "virtual" costs are included in the determination of the top revenue threshold and in efficiency determination must be specified.

Given the growing significance of remote-controllability of renewable energy installations, resorting to a capacity-reduced default value should be supported in the event of failure of ICT.

The running of a parallel infrastructure for realising power generation management with intelligent measurement system and dedicated controller box (such as in accordance with IEC 618650-7-420 or similar) is presumably necessary until final specification and standardisation/regulation of technologies necessary for power generation management. A check of the network beneficial requirements of communication is constructive in ascertaining potential synergy. Absolute requirements by the committees responsible are regular checks of the ICT expansion paths as regards new technology developments and options, and analysis of the list of measures for the security of the critical infrastructure as regards ICT issues. Automatic resorting to a reduced default value should be supported to guarantee network integrity, also when ICT fails. For remote-controlled renewable energy installations, this could be the maximum feed-in value used as the basis for planning.

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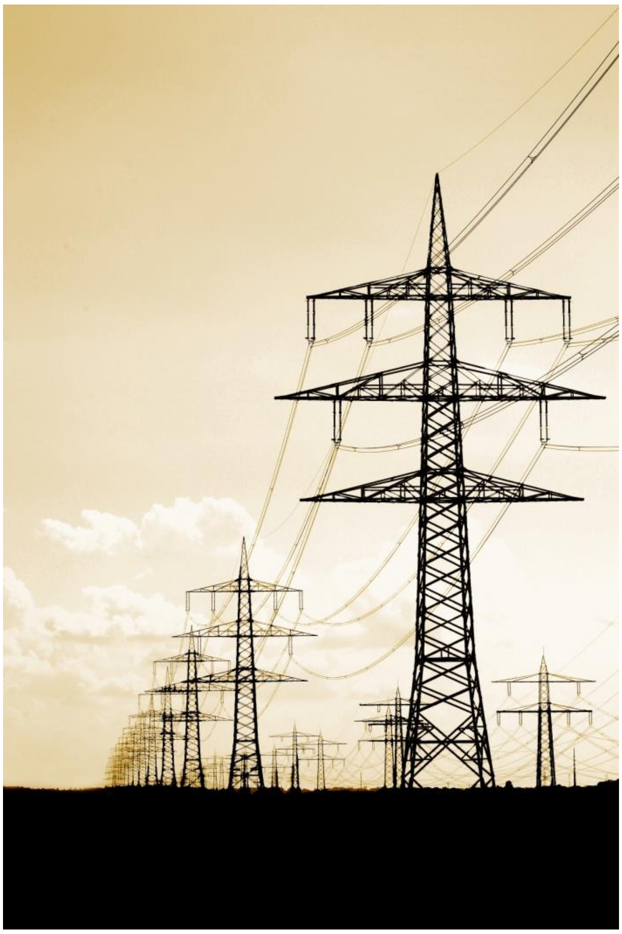

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