



Conclusion

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The Grid Development Plan deals with the expansion requirements of the German onshore energy transportation network and is based on the legal requirements as stipulated by the German Energy Management Act (Section 12a-d). The transmission system operators are planning, developing and building the grid of the future. The GDP is used to show how power generation in Germany can successfully be restructured and renewable energy can be integrated within ten and twenty years.

Process and methodology

By presenting the assumptions regarding the generation and consumption structure, the calculation method used and the resulting requirements for grid expansion on a public stage, the whole process of grid development planning is made very transparent. The GDP 2014 uses the same methodology as the Grid Development Plans for 2012 and 2013 and as approved by the German Federal Network Agency. In terms of assumed energy generation capacity and the consumption situation in the future, the scenario framework, as approved by the Federal Network Agency on 30 August 2013, is used as a starting point for creating both the Grid Development Plan and the Offshore Grid Development Plan 2014 (in accordance with Section 12b and Section 17b of the German Energy Management Act).

Whilst the GDP presented here was being drawn up, at the same time, fundamental framework conditions for the energy industry were being redefined by German legislative authorities as part of the amendment of the German Renewable Energy Act (*Erneuerbare-Energien-Gesetz* or *EEG*).

Needless to say, it is not possible for the scenario framework that has been approved for the GDP 2014 to comprehensively represent the probable development of energy generation situation in Germany following the amendments made to the Renewable Energy Act. The transmission system operators have therefore used this second draft to include several anticipated alterations within the approved scenario framework, for instance a new regionalisation within Scenario B 2024, which better represents the future development of renewable energy input.

In the second draft, Scenario B 2024 with an altered regionalisation that better reflects the new EEG and updated grid connection points is referred to as Scenario B 2024*. For this reason, a complete market simulation and consequent recalculation of the demand for grid expansion was carried out for Scenario B 2024* contained in this second draft.

Just like its predecessors, the GDP 2014 highlights the transmission requirements between start and end points. As a rule, starting points are located in regions with surplus energy generation whilst end points are in regions with high levels of consumption or where energy is currently supplied by nuclear power stations, which are to be closed by 2022. Like its two predecessors, the present Grid Development Plan 2014 does not detail any specific routes for new transmission lines, but rather documents the levels of transmission demand required between grid nodes. Future





line connections from one grid connection point to another grid connection point are calculated. Specifically named locations to denote start and end points are purely technical statements that serve to identify existing grid connection points. Exact line corridors or routes are not determined until later stages in the approval procedure (e.g. federal sectoral planning, planning permission). The GDP does not define locations for future power stations, renewable energy facilities or a market design for the future, nor does it give recommendations or suggestions for optimisation.

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Alongside the expansion of the 380 kV alternating current system, high voltage direct current (HVDC) connections are also planned to handle the long-range transmission requirements from north to south as well as sometimes acting as an interconnector with neighbouring countries. These enable low-loss transmission over long distances and, thanks to the use of modern technology, help to stabilise the alternating current network. The otherwise necessary, far more large-scale, expansion of the alternating current network is thus avoided. Converter facilities are required for injection and withdrawal, which significantly limit the number of potential tension points along the route.

The combined use of direct current and alternating current technology as proposed in the GDP enables the collective optimisation of the transmission network to match with the development of supply tasks over time as well as future transmission requirements with regard to network stability, economic efficiency and spatial demands.

The transmission system operators are constantly working to further develop the methods and simulation tools used for network planning. This has allowed them to make improvements to the market simulation methodology for the Grid Development Plan 2014 compared to the Grid Development Plan 2013 (see Chapter 3).

Furthermore, with the first draft of the GDP 2014, the transmission system operators also presented a more advanced methodological approach for evaluating grid expansion measures; this method is exemplary in more comprehensively demonstrating the necessity and effectiveness of certain extension measures described in Scenario B 2024 (see Chapter 1).

As with the last two Grid Development Plans, network optimisation and development measures were given priority over pure network expansion measures. This means that as a basic principle, it is always the existing network that is optimised. The constructing of a new power line is only proposed once all technical options already available have been tested. The “NOVA principle” (NOVA is a German acronym for the optimisation, enhancement and expansion of the grid [*Netzoptimierung, -verstärkung und -ausbau*]) that forms the basis of the Grid Development Plan is already guided by the optimal usage of existing power line routes. So as to minimise the demand for new transmission routes, it is planned in the subsequent planning and approval procedures that the expansion of the 380 kV alternating current network will use the routes of the current 220 kV network insofar as is possible.





Network analysis results

Due to the scope of three different scenarios, the network measures investigated cover a wide range of possible future developments. It is the view of the TSOs that the Grid Development Plan presented here contains all effective measures necessary for the optimisation, developments and expansion of the energy grid Section 12b (1.2) of the German Energy Management Act.

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The results of the calculations made based on the modified Scenario B 2024* show that although the scope of demand to develop the German energy grid is not fundamentally different to that seen in Scenario B 2024 in the first draft of the GDP, the change in regionalisation is however very likely to have a noticeable impact on certain individual measures. The other Scenarios – A 2024, C 2024 and B 2034 – were not completely recalculated for the second draft of the GDP 2014. However, the repercussions of the changes identified in Scenario B 2024* on individual measures were also reassessed for these Scenarios. An analysis performed based on selected sample cases showed that the changes triggered by Scenario B 2024* could also be accounted for in the grids depicted by the other Scenarios.

The measures reported in previous Grid Development Plans have still proved to be consistent even when parameters in the relevant scenario framework are changed. Thus, all four direct current corridors are still required to handle long-distance north-south transmission demands in all three scenarios (including the modified Scenario B 2024*). It is also clear that in all scenarios a starting grid that is simply expanded according to the measures included in the Federal Requirements Plan will not suffice to cover the levels of transmission demand. This confirms the necessity of all the measures stipulated in the Federal Requirements Plan. Together with the assumptions taken from the new Renewable Energy Act, the previously approved section of the Grid Development Plan continues to act as a robust core for the grid expansion required in the future. The stability evaluation clearly shows that the levels of network load occurring in the GDP 2014 are comparable with those in the GDPs for 2012 and 2013. In general, no changes can be seen in the indication of problems regarding transient stability and voltage stability.

In Scenario B 2024*, the volume of grid enhancements along existing routes (re-cabling or circuit requirements, construction of a more efficient power line along existing routes) amounts to 5,300 km. By way of comparison – the entire length of today's extra-high voltage network is around 35,000 km. In Scenario B 2024*, the required level of power line route expansion is calculated at 3,800 km, 2,300 km of which are HVDC corridors. This also includes the German share in the three direct current interconnectors between Germany and Belgium, Denmark and Norway with a total overland length of approximately 200 km. The transmission capacity of the HVDC corridors totals 12 GW.

The investment costs for the network measures are calculated in the Grid Development Plan on the basis of specific cost estimations and are of a provisional nature. Depending on the scenario, the total volume of investments over the next ten years totals between 22 and 26 billion euro. No conclusive statements can be made in the Grid Development Plan regarding cabling and partial-cabling as these are subject to later approval procedures.





In addition to the GDP, the transmission system operators also presented their report on factors influencing grid development, which provides the first review of the impact of individual parameters from the planned Renewable Energy Act policy reform on grid expansion. This highlights how grid expansion would specifically be affected by extending the timeline of offshore grid expansion, by injection management for the installation of new onshore wind power facilities and by a significant increase in CO₂ emissions certificate prices. However, these factors that influence grid development cannot be seen as anything more than additional indicators and do not allow for the investigation of a new, to-be-confirmed target grid.

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Review and approval of the Grid Development Plan 2014

In light of the changes to the framework conditions of the energy industry caused by the Renewable Energy Act reform, the transmission system operators believe that it would be appropriate to concentrate on the approval of all four HVDC corridors including the proposed changes and the measures from the Federal Requirements Plan 2013 as well as the measures that were already confirmed in the GDP 2013 and remain identical in this GDP 2014. Furthermore, the TSOs' projected calculations show that it would also be advisable to give approval for three additional projects, which are directly related to previously approved measures. This covers the projects 112 Pleinting – Pirach – St. Peter, 154 Siegburg Connection and 44 Altenfeld/Schalkau – Grafenrheinfeld area. Further measures, which are investigated in the network analysis, are to be assessed and, where appropriate, then prioritised based on their economic and ecological efficiency and their effectiveness in stabilising the network in a later GDP 2015, which will be based on new scenarios.

As long as progress in implementing the turnaround in German energy policy continues along the same path that has already been started, i.e. phasing-out nuclear power and the dynamic expansion of renewable energy sources for electricity supply, the GDP measures approved from 2012 and 2013 – with a few specific, regionalised changes – are still just as urgently needed as before. The ramifications of the new Renewable Energy Act do not mean a fundamental reversal in policy, but rather a simple extension of the time given to develop individual generation methods, such as wind power and slightly more regionalised redistribution of this development. This means that certain network development measures will also be postponed, without becoming obsolete in the long-term.

The transmission system operators are merely building an energy network that is needed in order to facilitate the turnaround in energy policy efficiently and securely on the part of the energy infrastructure. The Federal Requirements Plan has proven itself to be a solid foundation for network development over the coming years. This forms the basis of the target networks reported in Scenarios A 2024, B 2024 and B 2024*, even in light of the current Renewable Energy Act reforms.

Grid expansion is a fundamental requirement for the success of the turnaround in German energy policy. The speed of grid expansion determines the speed that the turnaround in energy policy can be implemented. If this continues to remain behind the speed at which renewable energy generation facilities are expanding, the aims





of the turnaround in energy policy and the security of power supply will both be placed in jeopardy. Furthermore, high costs would be incurred in other places if the optimisation, enhancement and expansion of the transmission network were to be neglected.

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The plan presented here constitutes the second draft of the Grid Development Plan, which has been comprehensively revised on the basis of the numerous responses received during the consultation process. It is the result of a constructive examination of the first draft of the GDP carried out by the general public within the scope of the public consultation process, which specifically raised the question of the validity of the measures in light of the revised German Renewable Energy Act. Therefore, this year saw the complete recalculation of a new regionalised Scenario B 2024 based on the latest findings. This transparent process, which particularly focusses on open dialogue, ensures that all stakeholders interested in the GDP are given the opportunity to voice their opinion and that the GDP is the result of a process of mutual recognition and development.

