Bundesministerium
für Wirtschaft
und Klimaschutz

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FAQs for the second stress test and measures to safeguard grid stability in the winter of 22/23

1. What is the second stress test? Who calculated it, and why?

Commissioned by the Federal Ministry for Economic Affairs and Climate Action, the four German transmission system operators (TSOs) 50Hertz, Amprion, TenneT and TransnetBW conducted a second stress test (second special analysis) in the period from mid-July 2022 until early September 2022 for the winter of 2022 / 2023.

The second stress test builds on calculations previously made by the TSOs. Once a year, the TSOs conduct an annual system analysis in line with the requirements of the Energy Industry Act; the analysis is published on 30 April of each year. This year's annual analysis was published on 30 April 2022, and found that the secure operation of the electricity supply system is ensured. The annual analysis is based on data up to and including December 2021, and therefore does not include developments following Russia's attack on Ukraine in violation of international law. For this reason, the TSOs conducted a first stress test, i.e. a first special analysis, in the period from March to May 2022, which took account of the Russian war of aggression and ensuing rise in energy prices and the possible interruption to supplies of gas from Russia. This first special analysis was also published. It also found that the secure operation of the electricity supply system is ensured in the winter of 22/23.

Since the uncertainties have intensified over the past few months and particularly over the summer, the Economic Affairs and Climate Ministry again asked the TSOs to calculate a stress test on 17 July 2022. The factors creating uncertainty in the coming winter of 22/23 include: the dramatic drought in the summer, the low river levels, the current loss of generation from half of France's nuclear power plants, and the generally tense situation on the energy markets since Russia's attack on Ukraine.

The outcome of the second stress test was published on 5 September 2022.

2. How is this type of stress test calculated? What are the assumptions and scenarios?

The second stress test investigates various scenarios. The analysis looks into the grid situation, including in particular the interplay with neighbouring European countries, since, in view of its geographical location and the fact that it has interconnectors to eleven other European countries, Germany's situation is particularly affected by developments across Europe.

Specifically, the analysis covers three critical scenarios (critical scenario +, very critical scenario ++ and extreme scenario +++), which deviate substantially from the reference scenarios in the statutorily prescribed analyses of power supply security from the end of April 2022. In comparison with the first stress test of May 2022, the assumptions about power plant availability and fuel prices were set much higher and were scaled up for the respective scenario. This means that a total of five scenarios now form the basis of the overall evaluation of the electricity supply situation – from the base scenario of the needs analysis required by law to the extreme scenario in this second stress test.

Possible effects of differing critical energy market situations on the electricity sector in Germany and Europe were examined on a precautionary basis and in several steps for the three scenarios of the second stress test. The new calculation was based not least on the following assumptions:

- A large proportion of the French nuclear power plants do not return to the market before the winter. In the extreme scenario (+++), output is available from just under two-thirds of the French nuclear power plants.
- Only some of the power stations potentially available under the Act on the Maintenance of Substitute Power Stations return to the market – to differing degrees, depending on the scenario.
- The low river levels continue to restrict hard-coal shipments. This means that, even at times of peak consumption, the hard coal-fired power stations can only produce far less electricity (the smallest amount being assumed in the extreme scenario).
- One quarter (+) to one half (+++) of the generating capacity in the grid reserve is not operationally ready.
- In the critical scenario, one quarter of the gas-fired power stations in southern Germany are not available, rising to half in the extreme scenario.
- The demand for power from fan heaters results in gigawatt-scale increases in the peak consumption levels.
- The gas price assumed in the calculations was increased uniformly to 300 €/MWh for all three scenarios.

3. What is the outcome of the second stress test?

Basically, we have a very high level of security of supply in our electricity system in Germany. We have enough energy in and for Germany; we are an electricity exporter. But we are part of a European system, and this year is a special year right across Europe. These special features were studied in combination with the possible European developments.

The second stress test shows the following: An hourly crisis situation in the power system in the winter of 22/23 is very unlikely, but cannot be entirely excluded at present. Additional measures to improve grid security need to be taken in order to ensure that there is no shortfall of supply or blackouts due to grid stress situations.

Specifically, the outcomes of the calculations show that, in some scenarios, demand cannot be fully covered in some regions of the European electricity market without additional measures being taken. In the very critical scenario (++) and the extreme scenario (+++) such situations also arise in Germany for very brief periods, i.e. just a few hours a year.

A special focus in the stress test was placed on the question of whether and to what extent there will be congestion in the grid. The finding here is that – caused by the delayed grid expansion and the lack of generation capacities in the south of Germany – there can be grid congestion in all three scenarios. Nuclear power stations located outside Germany (redispatch power stations) are needed to tackle this congestion, in some cases to a much greater extent than previously calculated and planned. Since the supply situation throughout Europe is tense, not least due to drought, low river levels and the problems with French nuclear power plants, it is extremely uncertain whether this power plant capacity can actually be provided by our European partners.

The second stress test therefore finds that a package of precautionary measures is needed to avoid grid congestion. Further to this, a number of ways to mitigate critical situations are recommended; these should be implemented in combination, as stand-alone measures will not be enough. Important contributions to grid security include higher capacity utilisation of the existing grids by accelerating the planned weather-dependent overhead line operation, better use of various power stations and reserve power stations, and contractual demand side management. These measures need to be implemented as a matter of urgency.

For the very critical scenario ++, an additional calculation studies the possible effect on the grid of an availability of the three nuclear power plants at Emsland, Isar and Neckarwestheim. The findings show that keeping the three nuclear power plants available can only be of limited assistance for the electricity grid in stress situations. In a very critical scenario, having all three nuclear power plants in operation would reduce

the need for foreign redispatch power stations not by the nominal capacity of the three plants, but only by 0.5 GW. There will continue to be a need for 4.6 GW of redispatch capacity from outside Germany (in the scenario ++, the calculated need for foreign redispatch is 5.1 GW). Redispatch power stations are power stations that can quickly provide the German market with electricity to offset grid congestion. Also, in terms of total gas consumption, only a minimal amount of gas would be saved (in the range of tenths of a per cent). In general, nuclear power plays a lesser role than the other urgent measures which need to be taken to ensure grid security in critical situations. Even if the three remaining nuclear power plants were to be used, significant intervention in the power plant fleet would be needed to ensure grid security.

4. <u>What does this mean? If there can be critical situations, what needs to happen to prevent blackouts?</u>

The second grid stress test cites in the analysis the afore-mentioned facts and figures whilst also providing recommendations for action and measures to be taken in the short term and on a cumulative basis so that the highly unlikely scenario of a short-fall of supply in Germany can be avoided.

Some the measures recommended in the stress test, such as the use of reserve power stations and the return to the market of coal-fired power plants, have already been implemented or are currently being rolled out. Further measures are now being prepared and will be implemented in the third revision of the Energy Security of Supply Act (EnSig 3.0), such as additional power generation from biogas plants and measures to increase the capacity utilisation of the grid / to improve transport capacities.

The results of the stress test also mean that, in order to cover ourselves for emergencies this winter, we will need a new deployment reserve for a specific period and specific situations which will consist of the two nuclear power plants in the south of Germany, Isar 2 and Neckarwestheim. These two nuclear power plants are to remain available until mid-April 2023 so that they can, if necessary, make an additional contribution to the power grid in southern Germany this winter. This also means that all three of the nuclear power plants currently still on the grid in Germany will be taken off the grid as planned at the end of 2022. We are sticking to the nuclear phase-out stipulated in the Atomic Energy Act. New fuel elements will not be used, and the deployment reserve will be terminated in mid-April 2023. Nuclear power is and continues to be a high-risk technology, and the highly radioactive waste will be a problem for many future generations.

It would therefore be wrong to simply delay the nuclear phase-out, not least in view of the safety status of the power plants. By setting up the deployment reserve, we are taking account of the risks of nuclear technology and the special situation in the coming

winter. This will enable us to act if necessary. The nuclear power deployment reserve is a targeted response.

5. Why set up a deployment reserve rather than extend the operation of the plants?

According to the calculations in the second stress test, the potential contribution by nuclear power is limited (cf. question 3).

In a very critical scenario, having all three nuclear power plants in operation would reduce the need for foreign redispatch power stations not by the nominal capacity of the three plants, but only by 0.5 GW. There will continue to be a need for 4.6 GW of redispatch capacity from outside Germany (in the scenario ++, the calculated need for foreign redispatch is 5.1 GW). Redispatch power stations are power stations that can quickly provide the German market with electricity to offset grid congestion. Also, in terms of total gas consumption, only a minimal amount of gas would be saved. In general, nuclear power plays a lesser role than the other urgent measures which need to be taken to ensure grid security in critical situations. Even if the three remaining nuclear power plants were to be used, significant intervention in the power plant fleet would be needed to ensure grid security.

Article 20a of the Basic Law requires that the state assume its responsibility for future generations by protecting the natural environment and animals in line with the constitution. The risks resulting from the use of nuclear energy to generate electricity and the burden placed on future generations by the nuclear waste are therefore only acceptable if interests are precisely weighed up and the reason for the use of nuclear power is explained in detail.

For this reason, Minister Habeck would like a targeted deployment reserve of nuclear power plants which is limited both in time and scope. The deployment reserve of nuclear power plants takes account of the risks of nuclear power and of the special situation in the coming winter, and is therefore limited in time to mid-April 2023. The scope is limited to the southern German nuclear power plants, Isar 2 and Neckarwestheim. A narrowly defined emergency deployment of the nuclear power plants is permitted only for this period, and only for the two southern German nuclear power plants, where this is needed to avert a specific danger to security of supply, meaning that the deployment is a reasonable decision by the legislature within the constraints of the constitution. In contrast, other, less risky instruments can be deployed for the north German region. For example, additional oil-fired power stations can be quickly deployed in the form of oil-fired power barges. In contrast, these are not available in the case of Isar 2 and Neckarwestheim.

Furthermore, the deployment reserve consisting of Isar 2 and Neckarwestheim is to be designed as a reserve, deployed only when it seems likely that the other instruments will be insufficient to avert a supply crisis. The design of the deployment reserve will take account of the necessary technical requirements of nuclear power. An extension beyond mid-April 2023 or renewed deployment in the winter of 2023-24 is not possible due to the safety status of the nuclear power plants and the fundamental considerations about the risks of nuclear power.

The rules governing the deployment reserve are to be set out in the Energy Security of Supply Act. Also, it will be subject to the proviso that the normal safety standards are fully upheld. A robust inspection of the safety status is therefore needed.

6. Why a restriction to Isar 2 and Neckarwestheim, given that the stress test calculated the effect for all three nuclear power plants?

It is correct that the stress test undertook a calculation and modelling using the three nuclear power plants still on the grid: Isar 2, Neckarwestheim and Emsland. The intention was to gain a full picture.

Nevertheless, when actual measures are designed, it is necessary to give consideration to the high hurdles imposed by Article 20a of the Basic Law, since nuclear power continues to be a high-risk technology. Every measure must therefore be necessary, appropriate and proportionate. This is not the case if other, less risky options are on the table. In the case of Isar 2 and Neckarwestheim, other options are not available due to the special situation in southern Germany – less renewable electricity than in the north, high demand from the industrial centres in the south, and in Bavaria in particular a more tense situation on the grid than in other parts of Germany.

In the case of Emsland, in contrast, other, less risky instruments can be deployed. For example, additional oil-fired power stations can be quickly deployed in the north German region in the form of oil-fired power barges.

7. How precisely is the deployment reserve to be designed?

The deployment reserve consisting of Isar 2 and Neckarwestheim is to be designed as a reserve, deployed only when it seems likely that the other instruments will be insufficient to avert a supply crisis. A monitoring process is established for this (cf. question 8). An extension beyond mid-April 2023 or renewed deployment in the winter of 2023-24 is not possible due to the safety status of the nuclear power plants and the fundamental considerations about the risks of nuclear power.

The rules governing the deployment reserve are to be set out in the Energy Security of Supply Act. Also, it will be subject to the proviso that the normal safety standards are fully upheld. A robust inspection of the safety status is therefore needed.

8. How is the decision to call on the deployment reserve taken?

The decision as to if and when the reserve is deployed will be based on monitoring by the Bundesnetzagentur (Federal Network Agency) to assess the electricity market and grid situation, which will identify the developments in the electricity system (coal reserves, power station availability, gas availability, etc.) at an early stage. This will permit an analysis of the security of supply on the generation side on the basis of various indicators. The outcome of this will serve as a basis for a decision on any activation of the nuclear power plant deployment reserve. Not least, the parameters will be monitored which, according to the stress test scenarios, can result in critical market and grid situations. The aim should be an assessment of the overall situation and early assessment of alternative measures.
Any critical or dubious developments will immediately result in an in-depth analysis with the Bundesnetzagentur and the transmission system operators. If necessary, and in response to a proposal from the Federal Ministry for Economic Affairs and Climate Action, the Bundesnetzagentur is to make the recommendation that the reserve be deployed; the decision is then to be taken via a government ordinance with the possibility for the Bundestag to challenge it. The competent nuclear supervisory authority is responsible for issuing the licence to recommence generation.

9. How is the reserve paid for?

Modest costs for personnel and technology are incurred for the maintenance of the deployment reserve. The operators are reimbursed for these by the state. As a result of the relief packages, these costs will not be borne by the consumers. Should a nuclear power plant in the deployment reserve be called on and make profits, the principle is that windfall profits are to be skimmed off via the market. This applies to nuclear power plants, as it does to other power plants.

10. Wouldn't extending the operational lifetime help save gas?

If all three nuclear power plants were to fully use up their fuel elements, this would only result in a minimal reduction in the amount of electricity generated in gas-fired power stations – 0.9 terawatt hours in Germany, or around one thousandth of German gas consumption.

11. Wouldn't extending the operational lifetime help cut electricity prices?

The electricity prices have risen extremely sharply in the last few months due to the tense situation on the gas market – even though the nuclear power plants are still operating. So the answer to the high electricity prices is not to operate nuclear power plants, but to have a brake on electricity prices. The Federal Government will be using a brake on electricity prices to mitigate the prices. To this end, the following has been agreed so far: windfall profits made by the energy companies are to be skimmed off, and the funding used to cut electricity prices. Minister Habeck will be discussing both of these on 9 September with the European energy ministers, and quickly flesh out the subject-matter. It is only fair to skim off windfall profits: energy companies which, for example, generate electricity from renewables, coal or nuclear power, do so at constantly low production costs, but are earning ridiculous amounts of money due to the current mechanisms of the European electricity market. This money is to be used to make a solidarity-based contribution to society and to invest it in cutting electricity prices and curbing grid charges: skimming off the windfall profits makes it possible to introduce a brake on electricity prices for households. Specifically, this means that consumers will pay a stable price for a certain basic level of consumption. This will ease the financial burden on the households whilst maintaining an incentive to conserve energy. There will be a similar model for small and medium-sized enterprises. Also, grid charges are to be reduced.

12. Why limit the deployment reserve to the coming winter of 22/23? Why won't the reserve be needed in the following years?

The situation in the electricity sector this winter cannot be compared with that in the winter of 2023-24. Next year, the fundamentals will be different, because the measures we are taking will have had more time to work, and further responses can be made. We are boosting our import capacities for gas via floating LNG terminals (FSRUs) to such an extent for the winter of 23-24 that we will not need to worry about a potential shortage of fuel for the gas-fired power stations. By then, we will have made more electricity available from biogas and renewable energy plants. The same goes for the capacity of the grids and the power stations, and for flexible loads. This means that the uncertainties facing us this winter will be much reduced by the winter of 2023-24, and the supply situation will be better.

Specifically, the Economic Affairs and Climate Ministry is working on a raft of measures to keep modernising the electricity system in 2023 and make it fit for the future. The following table shows what will be happening over the next twelve months:

Overview: More capacity in the electricity system in 2023/24

4-6 floating LNG terminals	Import capacity for gas is increased to such an extent that there will be no fears of a potential shortage of fuel for the gas-fired power stations
More electricity from biogas	Gradual increase in electricity generation from up to 2 GW of biogas capacity with immediate effect until next winter
More wind energy and PV	More than 10 GW in additional renewable electricity generation capacity
Fuel switching gas-fired power stations to alternative fuels	Fuel switch potential of up to 3 GW of conventional power plant capacity
Higher availability of coal-fired power plants in Germany due to improved stockpiling and logistics	The non-availability of up to 8 GW assumed in the stress test can be drastically reduced
Higher availability of gas-fired power stations in southern Germany due to additional gas imports and storage requirements	The non-availability of up to 2.5 GW assumed in the stress test can be drastically reduced
Possible measure: step-wise creation of additional crisis-preparedness facilities	Supplementary instrument of up to 5 GW added to the capacity and grid reserve in the medium term (up to 2025)
Expansion of flexible loads	Tapping of additional flexible loads of 1.5 - 3 GW in addition to the potential already in place, e.g. via contracts between grid operators and clients
Cut in heat load	The additional consumption from fan heaters assumed in the stress test scenarios disappears due to the secure gas supply
More efficient power grid	On top of the 1 - 2 GW of additional transport capacity in the winter of 22/23, the phase shifters already under construction which will steer the load flow will also be able to make a significant contribution towards the north-south transport of electricity. Further to this, the coming on stream of a new power cable between Italy and France

	will result in a further significant improvement in the European grid situation at times of stress (1.6 GW more capacity).

The various fields of action in detail:

Gas availability

The creation of LNG import capacities will mean that at least 25 billion m^3/year in capacity will be available from state-operated FSRUs in the winter of 23/24. Further to this, there is likely to be at least 4.5 m^3/year from the private project in Lubmin. In total, the FSRUs will be able to cover roughly one-third of gas demand (based on 2021: 90.5 billion).

More renewable energy

Overall, there will probably be more than 10 GW in new renewable generation capacity at the end of 2023 in the electricity system than was the case at the end of 2022.
In the biogas sector, the flexibility requirements for existing biogas installations are lifted for the 2022-2024 period. Of the nearly 6 GW of biogas capacity in Germany, roughly 2 GW is flexible at present, i.e. it only produces electricity at a few times in the year. The biogas installations will be able to increase their electricity output in the next few years. It is likely that the potential is developed gradually, and that the contribution from biogas for the winter of 23/24 will again be higher than that in the winter of 22/23.
In the field of PV, a special auction for large ground-mounted installations is scheduled for January 2023. This is to be targeted at installations of 1.5 GW which can be built within a short realisation period of nine months. In addition, there is the "regular new-build", as provided by the 2023 RES Act on rooftops and on open land. Overall, PV capacity is likely to grow by 9 GW in 2023.
In the case of onshore wind, we are expecting new-build of around 1.5 GW, similar to the preceding year. In the following years, the acceleration triggered by the recent legislative changes will then take hold. The rate of new-build will rise.

Conventional power stations

Retrofitting can enable some conventional power stations use a different fuel type (fuel switching). For example, gas-fired power stations can use oil as well as gas. In some cases, the power station itself can already do this, but construction work and planning approvals will be needed to put upstream infrastructure in place to supply the oil. The potential that can be gradually tapped via fuel switching is provisionally put at up to 3 GW. The Economic Affairs and Climate Ministry will examine what measures are needed to make part of this capacity available by the end of 2023.

Substitute power stations

The Act on the Maintenance of Substitute Power Stations permits coal-fired and oil-fired installations to return to the electricity market until, at the latest, 31 March 2024. This is initially predicted to affect installations with a capacity of 5.5 GW in the grid reserve (hard coal and oil) on a temporary basis until mid-April 2023. If necessary, the return to the electricity market can be extended until 31 March 2024. At the same time, the return of up to 1.9 GW from the supply reserve (lignite) from 1 October 2022 is being prepared. An altered procurement and stockpiling strategy and improved road and rail logistics mean that up to eight more gigawatts of power-plant capacity is available than assumed in the stress tests.

Crisis-preparedness installations

The Economic Affairs and Climate Ministry will examine whether new reserve installations (in the context of existing rules or as a new instrument) can quickly be procured, thus improving the security of supply. This could be designed as off-market crisis-preparedness and deployed on top of the capacity and grid reserve. The crisis-preparedness installations should gradually be built up and could increase to a capacity of up to 5 GW in the medium term, by 2025.

Expansion of flexible loads

This winter already, the high energy prices are likely to lead to a clear market-driven expansion in flexible loads. By the winter of 23/24, it is expected that demand side management will become much more prevalent, so that even more potential for flexible loads in industry will be in place. The Bundesnetzagentur is working with the TSOs to examine a further measure: the extent to which contractual agreements between the TSOs and industrial consumers can be used to support grid operations.

More efficient power grid

The efficiency of the transmission system will be appreciably increased in 2023. It is likely that roughly 350 km of new power lines will come on stream in the AC grid. Above all, however, new legislative possibilities to facilitate and optimise grid operations are being used, and phase shifters deployed to steer load flows, so that the grid can transport more electricity to southern Germany and thus also reduce the need for reserve power stations.
Further measures are being implemented at European level.

13. Don’t we need nuclear in the long term so that the increasing electrification of the energy supply can deliver energy security AND meet the climate targets?

Nuclear power is and continues to be a high-risk technology. It creates the problem of final storage of highly radioactive nuclear waste – and we still do not have a final repository in Germany. Germany has therefore decided to phase out the technology, and is sticking to this policy in view of the dangers of nuclear power. Many nuclear power plants have already been dismantled, the energy companies have adjusted their

investments to cope with the phase-out, and they are orienting their future to renewable energies. There are therefore several reasons why there is no possibility of a return to nuclear power: it would extend a high-risk technology which entails great dangers, it would exacerbate the final disposal problems, and it would be extremely expensive. For the climate and the environment, the best response is a clean energy supply from renewable sources. So the expansion of renewable energy is being continued at a high pace – not least in response to the current energy crisis.