Grid-code ready

Meeting the Requirements for Generators of the European Union Network Code

KOHLER SDMO

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Abstract

With the uptake of renewable energy leading to a more distributed model of electricity generation across Europe, the European Commission is looking to establish a more interconnected internal energy market that can cope with a much larger number of energy producers. The aim is to effectively manage the integration of distributed generation without causing instability on the grid.

In support of this ambition, the EC has established the European Union Network Code on Requirements for Generators, aimed at harmonising connection rules for power-generating modules and at increasing the security of the grid. However, some individual countries such as Germany have already transposed their own set of rules (VDE-AR-N-4110) in advance of Grid Code implementation [1].

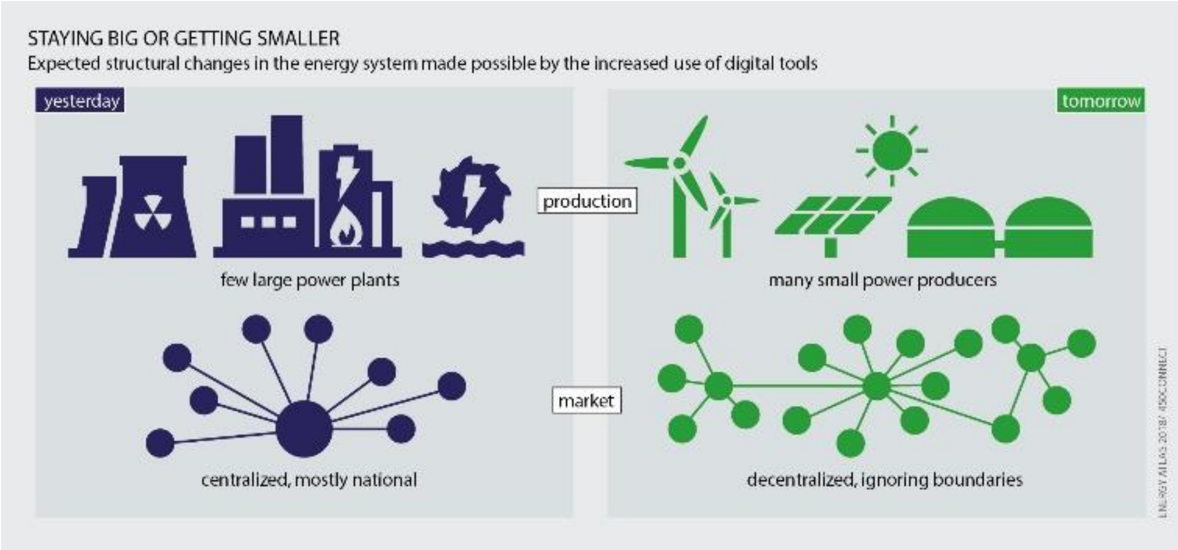
This whitepaper assesses the background to Grid Code and looks at its impact on units running in parallel with the grid. It also outlines Kohler's innovative approach to 'frozen' generator system design, which has resulted in the availability of 'Grid Code-ready' generator models – providing industrial organisations with peace of mind around compliance.

The changing face of the energy-generation sector in Europe

There has been a fundamental shift in Europe's energy market, transitioning from a centralised to a distributed electricity generation model.

Traditionally, electricity has been provided through the centralized use of a small number of largescale power stations - primarily gas, coal and nuclear. The power produced by these often multi megawatt-scale plants is then sent to consumers over long distances through centralised transmission grids.

More recently, though, distributed energy resources characterised by solar panels, wind turbines, electric vehicles and other sources have come to the fore. Indeed, according to a recent study by Navigant Research, most countries are investing heavily in distributed energy resources (DERs) – with the ratio of DER capacity deployment expected to outstrip centralised generation by more than 5 to 1 by 2024 [2]. In some countries, renewable power generation already plays a dominant role in overall installed capacity. In Germany, for example, it accounted for around 46 per cent of power consumption in 2020, with that figure expected to rise further still over the coming years.



Source: Energy Atlas 2018

Grid connection of power-generating devices

The changing face of the energy-generation sector in Europe begs an important question: what impact will the influx of variable renewable energy from multiple sources have on a grid infrastructure designed and built for a more traditional form of supply? This quandary has been considered at length within the European Union, which is keen to establish a fully functioning and interconnected internal energy market that can both fairly and effectively maintain the security of supply as a growing number of DERs come on to the network. The response has been to establish a set of rules that lay out minimum technical design and operation requirements to connect power-generating modules to the European Union-wide system.

Those requirements, says the EU, will maintain, preserve, and restore system security to facilitate the proper functioning of the internal electricity market within and between synchronous areas. By establishing harmonised rules for grid connection for power-generating modules, the EU wants to provide a clear legal framework for grid connections. This will enable the union-wide trading of electricity, underpin system security, support the smoother integration of renewable electricity sources, foster fair competition, and result in the more efficient use of the network and resources.

But system security depends partly on the technical capabilities of power-generating modules such as diesel generators running in parallel with the grid. Therefore, adequate performance of the equipment connected to the transmission and distribution networks is seen as a critical factor, with a requirement for sufficient robustness to cope with disturbances and to help to prevent any significant disruption or facilitate the restoration of the system.

This ambition is only possible through close cooperation between power-generating facility owners and system operators, the EU points out. Specifically, the functioning of the system under irregular operating conditions depends on the response of power-generating modules of specified voltage and frequency. When it comes to system security, the networks and the power-generating modules must be considered as a single entity from a system engineering point of view, given that those parts are increasingly interdependent. Therefore, as a prerequisite for grid connection, the EU has laid out what it considers relevant technical requirements for power-generating modules.

Introducing Grid Code in relation to diesel generators

The outcome of these deliberations has been the creation of Grid Codes – a set of requirements covering each of the constituent parts of the systems connected to the grid. The Network Code on Requirements for Grid Connection of Generators (NCRFG), specifically, harmonises standards that generators must respect when connecting to the grid – helping to keep it stable in case of issues on the network [3]. Whereas previously, a diesel generator might have operated in isolation, the new Grid Code will enable it to maintain a connection to the network and export energy to help bring the grid back to normal conditions.

These requirements take a segmented approach depending on the size of the generator - ranked as types A, B, C and D, depending on factors such as voltage and capacity - with larger generators being able to take over more extended responsibilities for system stability and operation. System aspects covered by the rules cover a broad range of parameters, including active power and frequency, reactive power and voltage, and connection and reconnection conditions. Moreover, dynamic grid support ensures the capability of the generator to cope with fluctuations in voltage – commonly referred to as fault ride-through. These features enable the generator to manage any problems on the grid while supplying the network with reactive power to maintain voltage at an acceptable level. Generally, the requirements of NCRFG cover the application of new generators running in parallel with the grid rather than for installations such as island mode or stand by.

Implementation of grid codes is proving to be a protracted affair – as individuals nation-states have struggled to clarify their own rules. This confusion has meant that EU-wide adoption of the regulations has been postponed several times, making life difficult for energy developers and providers, who have often found it hard to track the progress of these codes, understand their implications and ultimately be confident of managing the resultant compliance.

In the meantime, individual nation-states have transposed their own set of rules based on NCRFG but considering the specifics of their particular market – with, for example, VDE-AR-N-4110 in Germany and G99 in the UK. These developments have brought added complexity to the energy markets, representing an additional challenge for organizations, which often need support and guidance to ensure compliance at a national level.

Kohler's response to Grid Code implementation

For energy suppliers, transmission system operators, and distribution system operators, then, complying with Grid Codes can be a complex and technically challenging affair. And it can have a significant effect on how new energy projects are designed, modelled, built, and finally connected.

With Grid Codes being developed and expanded across Europe, Kohler has sought to assist end-users who have had concerns about compliance. These efforts have resulted in the forward-looking decision to establish a range of 'Grid Code-certified' generators helping customers avoid uncertainty when connecting to the network. The first of these bespoke ranges have been designed to fully comply with Germany's VDE-AR-N-4110 regulations – taking account of Germany's position as the most proactive European country around standardization of the connection of power-generating modules to the grid.

A total of eight generators powered by Volvo engines were identified as being the most applicable for Grid Code certification. FGH, an independent third-party certification body based in Germany, was employed to test, assess, and verify the models in relation to a broad spectrum of Grid Code conditions. This work package included developing a numerical simulation model, which was used to provide comparison benchmarks, along with operational testing confirming accurate correlation with real-world performance.

To ensure no deviance from the simulation modelling required for certification, it was necessary to develop a variety of specific systems and components that cannot be swapped out for alternative replacements when in use. These parts are effectively frozen to ensure ongoing adherence to the regulations and included in the scope of supply for those eight 'Grid Code-certified' generators. The equipment has been designed to help the generators manage different active and reactive power requirements and connection/reconnection conditions.

Firstly, an oversized alternator has been selected with a permanent magnet generator (PMG) that provides the capacity to maintain short-circuit at 3*In for 10 seconds. This design is better suited to managing fault ride-through conditions. Meanwhile, a specific type of automatic voltage regulator for the alternator has also been installed, providing full compliance with Grid Code requirements even if there are updates to the system’s firmware.

A 12-inch touchscreen control panel with backlighting and a wide viewing angle has been configured for running in parallel with the grid. The control panel provides accurate system monitoring and diagnostics and can display a broad range of critical electrical values, including power, power factor, reactive power, frequency, voltage and current. Meanwhile, protection relay is offered by using a grid code-certified device for grid feeding monitoring, while a specific circuit breaker with protection unit "micrologic 5.0”.

This list of frozen equipment cannot be modified. Otherwise, the genset would no longer meet VDE-AR-N 4110 certification. Therefore, the eight models form a dedicated set of options within the Kohler product range – and are denoted with the letters VDE after the product code. Although the design of some specific parts must remain constant as outlined, each of the generators can still be customised in other ways, such as through the addition of a canopy, double wall and large autonomy fuel tank, etc… – without impacting certification compliance.

The models are built and tested at Kohler’s EMEA main production facility in northwest France and are shipped direct for installation. The ability to design, build, test, and ship generators from one site – under one roof – boosts quality and repeatability, ensuring that the end-product can operate consistently after installation. Kohler has also developed a numerical simulation model that can show how the selected model will perform under varying grid conditions – giving the developer confidence that the generator will be fit for purpose in the context of a broader project. This software model has been validated through extensive testing performed by Kohler’s engineers and third-party certification body FGH.

The availability of the eight ‘Grid Code-ready’ generators, thoroughly tested and ready for installation, simplifies the process of compliance for the project developer and ultimately provides peace of mind. As a result of this product development, customers can now be assured of swift and efficient grid connection approval for generators – every time, as and when required.

Market prediction for grid code compliant generators

Looking forward, Kohler is considering the launch of a broader range of VDE-ready generators, with higher power outputs. That expansion of product offering would provide a technological stepping-stone in preparation for the introduction of European-wide standards, whenever that might emerge.

Also, while Germany remains at the forefront of ensuring that grid-connected generation projects are future-proofed for Europe-wide harmonization, other countries are also following suit. For example, the UK's G99 regulations provide guidance on how generators must control their power output in response to frequency changes on the grid [4]. That, too, requires generators over a certain output to support the system during a fault by quickly injecting reactive current to stop the voltage from dropping too low. Other countries such as France and Belgium are adopting similar nationwide regulations in their home market.

In conclusion, then, the route of direction is clear: an increasing number of industrial organisations require technical guidance to ensure they are ready for the adoption of Grid Codes.

Kohler is committed to supporting the industry and helping it keep abreast of all the relevant incoming rules and regulations. This commitment is characterised by a significant investment in research and development, resulting in the development of Grid Code-compliant products. These products are complemented by many years of experience in managing large-scale projects in multiple countries – with Kohler acting as an indispensable source of guidance and advice.

References

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