European Network of
Transmission System Operators
for Electricity

NETWORK CODE FOR REQUIREMENTS FOR DEMAND CONNECTION

EXPLANATORY NOTE

27 JUNE 2012

CONTENT

1 INTRODUCTION

1.1 BACKGROUND

Political decisions to rapidly increase the use of renewable energy sources (RES), to implement smart grids, to implement effective competition and the efficient functioning of the internal electricity market while ensuring system security will lead to massive changes to the electrical power system as we know it today. This will require a new framework to cope with these challenges and all participants of the energy market will have to face significant changes.

In this context, ENTSO-E elaborates the Network Code on “DSO and industrial load grid connection rules in electricity”, including dedicated requirements for distribution networks and demand facilities. This Network Code is referred to as the “Demand Connection Code” (NC DCC). The NC DCC is based on ACER’s framework guidelines on electricity grid connections (FWGL) [1] and ERGEG’s Initial Impact Assessment [2], both documents dealing with electricity grid connections for all users. The NC DCC responds to the EC’s mandate to develop this Network Code [3].

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Other Network Codes that are being developed by ENTSO-E are largely harmonizing existing procedures and requirements and are to a large extent based on existing rules and procedures. The NC DCC will implement a completely new approach for some requirements at European level which can be seen in the preliminary scope [4] and in the consultation process "Call for Stakeholder Input"[5]. Most countries have already a few connection requirements for demand users, but there has never been before a need for a common set of requirements for demand users across Europe. Now, in order to help to accomplish the task of increasing the use of RES, implementing smart grids and contributing to the functioning of the internal electricity market, the NC DCC has been initiated to define common requirements. Some of them will be completely new, to face the new challenges and some may not have been widely used in Europe before.

The aim of this document is to explain the challenges to be addressed by the NC DCC and to put forward the main *new* topics that have to be addressed in the NC DCC. With this document ENTSO-E is sharing the view on alternative approaches that were addressed to stakeholders and the outcome of the consultation in the "Call for Stakeholder Input"[5].The stakeholder feedback from this consultation is reflected throughout this document. A more in depth overview of the responses received is presented in Appendix 7.

1.2 CHALLENGES AHEAD: RES

TSOs cannot ensure the security of the system regardless of the technical capabilities of all users. Historically large synchronous generation facilities have formed the backbone of providing technical capabilities. The energy system is changing rapidly especially with the massive integration of RES (wind generators, PV installations, etc) in the European electricity network. Today RES usually provides, even at peak generation, less than 30 % of the power and most of the time much less. However, in some countries (Ireland, Spain and Portugal) RES generation is already supplying up to 50 % of the load during some hours of the year. In 10-15 years' time it is expected that in some synchronous areas (e.g. Ireland and GB) up to 100 % of the load may be supplied by RES alone. The EC goal is that by 2050 the electricity generation of the EU will be nearly 100 % CO_2 free which implies that during many hours of the year RES has to supply 100 % of the load in some regions[7]. The case studies provided in the "Call for Stakeholder Input" [5] for some of the envisaged options for the NC DCC focus on the synchronous areas of GB and Ireland where contracted RES penetration is already ahead and in line with what is expected in other European countries.

In terms of RES penetration it is common to discuss average RES figures, e.g. the EU target of 20 % by 2020 is an average target for a year. In contrast to the average figures real-time RES production as a percentage of the total demand at a point of time is highly variable, typically with the highest percentage about 5 times larger than the average. The reality of this large ratio has been illustrated by the case of Denmark, the country in EU with highest penetration of wind. When Western Denmark (Jylland connected to Continental Europe) exceeded 100% of demand from wind alone a few years ago the average wind penetration over the year was still "only" about 20 % [8]. Incidentally, Denmark manages to cope with this challenge to a large extent through a connection capacity to Nordic countries and Germany exceeding 80 % of its maximum demand. This is being extended further as Denmark continues to expand its RES capacity. This example shows the urgent need to develop the RES-integration capabilities of the system further as more and more countries will increase RES generation to comparable levels.

Operating conditions with the highest real time RES penetration (typically in windy / sunny conditions with moderate demand) present major system challenges for the network operators especially if the RES penetration reaches high values in the total synchronous area. Studies in Ireland, the European synchronous area with the highest RES (wind dominated) instantaneous penetration of non-synchronous generation plant (these days normally supplied via converters) in respect to their installed capacity indicate that these challenges increase dramatically above 50 % for the synchronous area. A range of system technical counter measures have to be planned to avoid a total block on RES development above about 10 % average (50 % highest). Alternatively, massive constraining off (wasting) of RES (wind) has to be accepted to maintain secure operation. These system technical capabilities are shared between transmission (linking resources over longer distances), generation and increasingly in the future also demand. The demand component can be developed to deliver an increasing contribution during high RES generation in real-time to replace some of the system technical services normally provided by synchronous generators when these are connected (i.e. during normal or lower RES production).

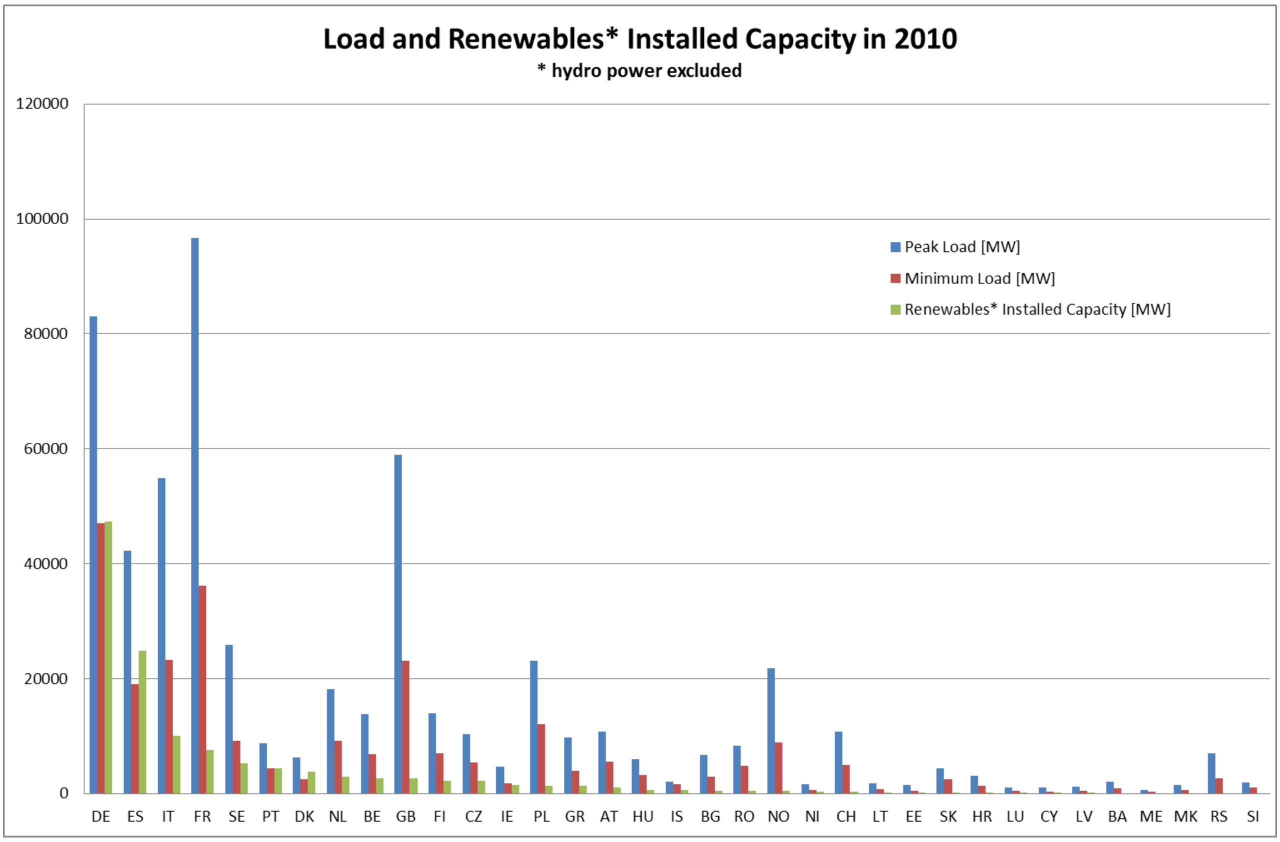

FIGURE 1 - PEAK LOAD VERSUS INSTALLED RES GENERATION IN 2010[9]

In this context, the electrical power system will have to deal with the following challenges:

- RES generation predominately varies with weather conditions (sun, wind). The characteristic of variability and also uncertainty (difficult to forecast accurately) until close to real time of RES generation, introduces significant new challenges in the system operation (power imbalances, lower levels of firm generation capacity, loss of services from displaced generation). This leads to concerns about how to maintain a stable operation in an electricity network with high penetration of RES. The main answer to this concern is to increase the controllability and the flexibility of all power system elements. This can then deliver a power system which can react and cope better with the volatility of RES [13].

- The larger uncertainty arising from adding large generation forecasting errors (e.g. wind) to the familiar demand forecasting errors will require greater volume of reserves to be available a few hours ahead of real time. These reserves will have to be available even when synchronous generators, the traditional reserve providers are for increasing time periods displaced (disconnected from the system) by RES. See section 3.1 and Appendix 1 of the "Call for Stakeholder Input"[5].

- Renewable generating units are mainly non-synchronously connected. Consequently, the inertia of the system will be reduced when an increasing amount is connected to the grid. This will increase the frequency sensitivity of the power system to power imbalance and will need to be compensated by additional frequency regulating capabilities with fast acting frequency controls.

- High levels of embedded generation are threatening the effectiveness of existing power system defence plans, because they have been elaborated considering pure load connected to the distribution networks. With the development of embedded generation, in the case of a major disturbance it may not be possible to secure at least parts of the system, with the potential risk of a complete system breakdown. For these two aspects, see section 3.2 and Appendix 2 of the “Call for Stakeholder Input” [5].

- RES is to a significant extent connected to the distribution network. As a consequence the DSOs have to increase their role in facilitating the connection and integration of RES while at the same time they have to guarantee their customers a high level of power quality. Additionally, as embedded RES generation at times takes up a higher proportion of the total generation, it displaces central transmission connected generation. This creates a new challenge to have adequate reactive power resources to regulate the transmission system voltage. The freedom of the DSO networks and transmission connected demand in respect of consuming reactive power at times of high demand and generating reactive power at times of low demand therefore needs to be reviewed. See section 3.3 and Appendix 3 of the “Call for Stakeholder Input” [5].

The electricity power system as it is designed today will not be able to cope with the expected amount of RES generation without significant changes. To achieve Europe’s political and environmental goals it has to be decided which participants of the energy system are to provide support to cope with each of the technical challenges. The different theoretical options are stated in the next chapter.

1.3 OPTIONS TO INCREASE RES PENETRATION IN THE SYSTEM

There are several options on how to deal with high RES penetration. The main options are described on a high level with their advantages and disadvantages in Table 2. To keep it as a high level introduction the major points raised by stakeholders were taken up in Table 2 and especially in the conclusions.

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Option	Pros	Cons
Synchronous conventional generators are required to provide the most significant system services	▪ No significant change from today	▪ Cost of constraining off RES and on synchronous generation when synchronous plant are not needed by the market ▪ CO_2 emissions because simultaneously RES generation is constrained off ▪ Risk of a lack of system services in the future if only this option is followed
RES generators to provide their share of the system services	▪ No additional CO_2 emissions for voltage support services	▪ In order to create headroom to provide the service, RES has to be constrained (and therefore wasted) with additional CO_2 emissions ▪ Embedded generation needs to be fully controlled (difficult with dispersed small units)
Extensive building of storage systems	▪ Only limited CO_2 emissions (from a less than 100% cycle efficiency) ▪ Supports RES integration	▪ New storage systems have to be built Europe wide ▪ Feasibility of building storage is not given in all areas ▪ High environmental impact to build large storage systems
Demand facilities provide their share of system services	▪ No additional CO_2 emissions ▪ Supports RES integration ▪ Services can be provided at low costs and at no or minimum consumer inconvenience ▪ Highly reliable as the risk is spread ▪ Consumers are enabled to participate in the electricity market and take action to reduce CO_2 and will pay less	▪ Public perception of possible inconvenience ▪ Public acceptance ▪ DSOs need to contribute more towards managing a system with high RES (e.g. voltage)
Transmission grid investment	▪ TSOs can initiate grid transmission capacity and reactive compensation and can deliver it. ▪ European transmission investment plans are published transparently in the TYNDP[11].	▪ Power related services can technically not be delivered by the network itself but have to be provided by generators or DSR services.

Table 2: Overview of options to increase RES integration

Table 2 shows that all options to integrate RES in the system have to be considered based on the strength of their merits. The scale of benefits appears to be especially clear from making use of demand side response (DSR). DSR also supports the EU goals to integrate RES and to empower customers to participate in the energy market. Customers can contribute as active players to reduce CO_2 emissions and to reduce the costs of their electricity bill by accepting a modest level of flexibility.

Conclusions:

Although Table 2 clearly identifies that DSR has a major role to play, it is not anticipated that it could either be the immediate single solution to the RES integration challenge or be exclusively relied upon to be developed in sufficient scale and/or profile to resolve the challenge. Instead, all the options are envisaged to be combined in varying proportions. The development of the transmission and distribution grid allows benefits to be obtained from these services on a wider geographical basis. In addition flexibility is needed to cope with the large uncertainty reflected in the wide range of future development scenarios.

1.4 DEVELOPMENTS AHEAD: SMART GRIDS

Smart grids are a strategy/concept to increase the flexibility through smart and integrated system operations of flexible sources, loads and network components. Especially in the distribution network, where a growing part of RES will be connected, the smart grid initiatives are believed to be a key solution to the flexibility challenge, balancing at every moment in time the generation and consumption in the system.

There is a concern in the EC that there are too many players and initiatives in the field of the smart grids, not all the time being in line. The EC Smart Grid mandate (M490) describes the situation as:

"The scope of the Smart Grids is large; thus the risk is that too many standardisation bodies work on this issue, providing inconsistent sets of technical specifications, causing non-interoperability of equipment and applications and that the priorities will not be precisely defined."

The NC DCC addresses this concern in the following way:

- The NC DCC has its main focus on cross-border issues, influencing operational security and the stability of the whole power system. Smart services including DSR for these specific TSO purposes are within the scope of the NC DCC.

- The integration of RES with the help of smart grids in the DSO distribution network including use of DSR for DSO network management and questions regarding market issues are not addressed by the NC DCC, nor are the time of use of demand (in aid of flattening the daily demand curve or matching it to production availability). These important aspects are out of scope.

The approach in the NC DCC will be to set out requirements which facilitate the capabilities of DSR resources to contribute to a safe operation of the networks. The NC DCC requirements will therefore be an important building block allowing DSR services to be utilised effectively and efficiently in order to facilitate the introduction of RES in a smart grid environment. The NC DCC will maximise DSR services potential and hence impact, providing capabilities for each cross border DSR service which are complimentary so that these DSR services cover the needs for operation and system security in a wider smart grid deployment.

The progressive nature of both smart grid development and DSR services needs to be borne in mind when the requirements for the NC DCC are developed. As a result the requirements must be suited to both small percentage penetration of DSR and also to wide spread RES deployment throughout all voltage levels of the network. Being fit for purpose for interaction with the wide range of potential future generation portfolios is important.

1.5 GUIDING PRINCIPLES

The guiding principle of the NC DCC is to develop requirements for grid connection of demand facilities and distribution networks, including closed distribution networks and DSO networks, from the perspective of maintaining, preserving and restoring the security of the interconnected electricity transmission and distribution systems with a high level of reliability and quality in order to facilitate the functioning of the EU-internal electricity market now and in the future.

It is important to note that the purpose of the NC DCC is to **set capabilities that facilitate markets.** It is **not** the purpose to determine how markets should be developed. Therefore the NC DCC describes which capabilities should be provided to allow various users to provide useable services to the market place, not to define who must contribute to the market place.

Secure system operation is only possible by close cooperation between all users of both distribution and transmission networks and the network operators. In the context of system security the transmission and distribution networks and all their respective users need to be considered as one entity from a systems engineering approach. It is therefore of crucial importance that demand users are obliged going forward to meet the relevant technical requirements concerning system security as a prerequisite for network connection. Appropriate dynamic behaviour of all users and their protection and control facilities are necessary in normal operating conditions and in a range of disturbed operating conditions in order to preserve or to re-establish system security.

In this context existing national connection requirements as well as events from the past have been analysed. As stated above a technical framework not taking today's and tomorrow's challenges into account will limit the amount of RES integration, will bear the inherent risk of jeopardising system security, and in some cases it may even lead to (partial) black-outs. Consequently, the NC DCC also takes into account that future generation will be based on more volatile generation and that both generation and demand facilities providing DSR will be connected to all voltage levels. Therefore ENTSO-E will ensure that the NC DCC is compatible with the Network Code on "Requirements for Grid Connection applicable to all Generators", as well as with the following network codes to be developed.

2 GENERAL APPROACH TO NC DCC

2.1 STRUCTURE

A major goal of all Network Codes is to enable secure system operation by equitable treatment of all users. In particular, the goal of the NC DCC is to ensure effective and efficient development of demand facilities and distribution network connections to meet upcoming needs to maintain secure system operation. The choice was made to provide in the NC DCC a framework that covers all relevant cross-border aspects of demand connection to ensure equitable treatment of all demand users by maintaining a consistent set of requirements for demand facilities and distribution network operators.

The main principles for drafting this code are based on ACER's FWGL [1] and are given in the DCC preliminary scope document [4], which was based on early stakeholder discussions. Topics that are new compared to present practices (for many or even for all countries) are discussed in Section 3.

2.2 LEVEL OF DETAIL

A choice has to be made on the level of technical detail of requirements in the NC DCC. The need for detailed requirements in the distribution networks can be challenged, claiming that these are not relevant in a network code facing cross border issues and should be dealt with at national level. On the other hand, there may exist a need for harmonization of the national practices and therefore the need for clearly defined requirements for industrial networks in the internal network.

Bearing in mind the importance of demand facilities to contribute to operational security in the transmission and distribution systems, the NC DCC, which has its main focus on cross-border issues, must then include requirements to local demand facilities which have an impact on wide area power system security. The aspects here of major importance are:

- In several of the past black outs of transmission networks (also cross-border), cascading effects of "local" problems have played an important roles[12], [14], [15], [16]. Furthermore, it is clear that considering the amount of the local demand, its response (or lack of response) has played an important influence on the criticality of these issues.
- Aggregation effect of similar behavior of local demand facilities has an important impact on the power system security. Furthermore, this issue is becoming more and more stringent with the rise of intelligence in protection and control algorithm used in local demand facilities.

However, recognising and respecting the specific character of the networks by each single TSO or region, the impact of local demand on operational security will vary over Europe. Therefore the level of detail of the requirements varies and takes into consideration the principles of subsidiarity and proportionality. Consequently some requirements could have a rather prescriptive nature, when the effects on system security requires not only common methods and principles, but common parameters and settings as well. Other requirements could determine just the principles on an EU or synchronous area level and provide the necessary flexibility to be detailed at the most appropriate level (national or regional) in order to consider specific system conditions. Following the finalisation of NC DCC, the provisions in national codes or national regulation level will have to be adapted to fit the requirements of this network code.

Based on the outcome on the consultation ENTSO-E has chosen to use the following principles:

- The necessary degree of detail is adjusted to the purpose of each requirement and is determined by the extent of the system-wide impact of each requirement. The relevant entity from the perspective of system security is predominantly the synchronous area and five of them are in the scope of NC DCC (Continental Europe, Nordic States, Great Britain, Ireland and Baltic States).
- The NC DCC focuses on significant users which regarding each requirement are either
    - transmission connected demand facilities,
    - demand facilities (or closed distribution networks) offering DSR services, or
    - distribution networks (including closed distribution networks) connected to the transmission system.
- ENTSO-E wants to facilitate all players to participate in the market place. To achieve this, all users must be allowed to be significant grid users in the context of DSR.

2.3 APPLICATION OF NC DCC PROVISIONS TO USERS

As requested by the FWGL the NC DCC requirements will apply to all significant grid users as stated above. The chosen approach is to focus on new connections. It should be noted that modernized/replaced elements of the significant user connections is considered in the same way as a new connection and will also require DCC compliance.

Currently the European power systems are changing rapidly: the internal market is evolving, RES is increasing and new technologies are being introduced. These factors result in some uncertainty in anticipating the needs for power system security for the next 20 years. The requirements of the NC DCC will become binding EU legislation, which mean that starting today they will be applicable for a long time and changes/amendments to them can only be implemented in accordance with the relevant EU procedures. Hence, it is essential to have the possibility to apply NC DCC requirements to existing facilities or networks. Such application will, however, only be pursued in well justified cases with the safeguards in the provisions of the FWGL.

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The FWGL states that the NC DCC will apply to both pre-existing distribution networks connected to the transmission grid and existing demand facilities based on a proposal from the relevant TSO. The proposal to apply a network code requirement to an existing demand facility or distribution network before modernisation has to be justified by a quantitative cost-benefit analysis. It must be shown that the costs to fulfil this requirement are adequate in relation to the benefits to the power system. A consultation at the national level is also required. As a final step this has to be approved by the National Regulatory Authority (NRA) (see FAQ 11).

3 REQUIREMENTS OF NC DCC IN THE LIGHT OF FUTURE CHALLENGES

The NC DCC under ACER's FWGL shall cover a set of requirements for each type of significant grid user, defining the connection point and including the requirements related to the relevant system parameters that contribute to secure system operation. The vast majority of these connection requirements were in existence in the past, and addressed to grid users in dispersed and separate documents such as grid codes, connection agreements or contracts which were given to grid users before connection. However, as part of this process, some new requirements are proposed to be added to the NC DCC taking into account the future challenges and opportunities based on the evolution of the system, including RES development and smart grids implementation. DSR is already becoming a reality and therefore some new technical requirements are also needed to facilitate the capabilities of DSR resources to support transmission system security and to give many more demand users access to markets for ancillary services acquired by TSOs.

To evaluate the need for transmission system security and to ensure adequate and proportionate coverage of DSR services the definition of significance of these devices will be periodically reviewed by each of the TSOs in co-ordination across Europe.

Other non-TSO initiated uses of DSR will remain outside the scope of this NC DCC. This includes expected application of DSR for DSO network management and DSR to influence the general demand profile for energy suppliers. However, the capabilities that are specified in the NC DCC and facilitated through European Standards will support the introduction and wider use of these services.

The new capabilities identified by ENTSO-E cover

- DSR delivering reserve services,
- DSR delivering system frequency control,
- Reactive power exchange capabilities at transmission interface level,

To support these capabilities and to maintain stable systems voltage withstand capabilities and frequency withstand capabilities were defined.

Those requirements were discussed in the "Call for Stakeholder Input" [5] in detail and stakeholders were asked to provide their opinion and data. The approaches chosen are described in the following chapters based on the outcome of the consultation.

3.1 DEMAND RESPONSE DELIVERING RESERVE SERVICES

One of the major consequences of the RES development is a massive increase in the demand for reserves caused by a greater forecasting uncertainty. This is combined with reduced availability at time of high RES production of reserve services by synchronous generators.

Furthermore, according to the FWGL "*The network code(s) shall provide for regular re-assessment (including public consultation) of the "significance test" and cost-benefit analysis to cope with evolving system requirements (e.g. penetration of renewable energy sources, smart grids, distributed generation, household demand response, etc.).*" also it is stated that *"The network code(s) shall set out necessary minimum standards and requirements to be followed when connecting a consumption unit to the grid, to enable demand response and/or participation of consumption units in other grid services, on a contractually-agreed basis."*

Demand which is capable of being deferred for extended periods, preferably up to 4 hours, can in principle be considered for such a service. The TSOs will need to know what level of reserve is available at any time and will wish to have an adequate cover (security), but not excessive cover (economics). Demand suitable to deliver these services exists in industry, business premises and at the house hold level. The potential for all these may be explored to give the least societal cost. The household level has not been used for those services so far but ENTSO-E proposes to include this demand in view of the increasing need for this service from this type of demand.

In many countries industrial and business demand already provide reserve capacity as an ancillary service. These services are expected to continue, and to be encouraged through the market to expand in volume to meet the increasing demand.

The aim of the NC DCC is to set technical requirements necessary to provide DSR services. The way these services will be used is not in the scope of this NC.

The NC DCC acknowledges the view of the outcome of the consultation "Call for Stakeholder Input" [5] that standard service capabilities covering active power control, for devices deemed significant at household level are an effective way to promote voluntary service uptake. The following approach covering the household level has been chosen for DSR delivering reserve:

- The decision to enter and to leave (fully or temporarily) the market place will be a voluntary decision by the user as this was a strong and acknowledged stakeholder request in the consultation.
- The identification of devices deemed significant will be done at national level and in coordination at European level and be updated not more often than every three years.
- The NC DCC requirements are set in the form of functional capabilities in order to ensure technology neutrality, facilitating future market designs.
- The NC DCC lowers market entry barriers by providing a legal enabling framework for European standards to deliver basic enabling capabilities.

The NC DCC requirements for delivering DSR reserve services are mandatory for those users who voluntarily offer these services, either individually or as part of aggregated facilities. Requirements are made such as to guarantee the final effect of the services without limiting how the players will participate.

3.2 DEMAND RESPONSE DELIVERING FREQUENCY CONTROL

The two other major consequences of the RES development are

- less capability to guarantee system security in a traditional way (low frequency demand disconnection) in case of extreme frequency excursions due to mixing on the same circuits of embedded generation with demand, and
- a reduction in the availability of economic generation-based frequency response.

Therefore, based on CBAs for small and large synchronous zones (see FAQ 31) as recommended by responses received in the "Call for Stakeholder Input", the NC DCC has set technical requirements that can be used by the TSO to efficiently sup-

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port security of supply: DSR for System Frequency Control (SFC) requirements can be set on temperature controlled devices, for example, refrigerators, freezers, heat pumps, immersion heaters built for service within the ENTSO-E network area after the enforcement period of this requirement in the network code. This DSR service can deliver a smarter, robust and more user friendly alternative to low frequency demand disconnection-capability. This service, which avoids disconnection, reduces the probability of the activation of the defence plan which automatically sheds load [12]. This helps to avoid frequency collapse without noticeable impact on the users. Frequency statistics of the past years of the Continental European system show that such activation of the service is a rare event, typically less than once per year.

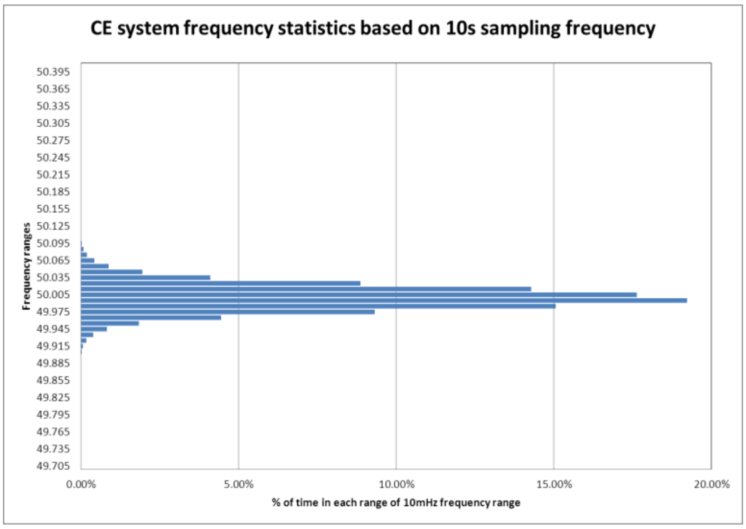

FIGURE 2 – CONTINENTAL EUROPE SYSTEM FREQUENCY STATISTICS

In GB there is also experience with different application providing continuous frequency response using temperature controlled devices [18],[19]. As a consequence this scheme may be used as a defence plan for rare events or on a more operational basis to cope with continuous system imbalances. Proceeding with either system is prepared as a national choice relating to system need and preparedness to proceed. In both applications this DSR SFC service will not affect the primary function of the equipment (i.e. in a fridge to keep the contents within a safe temperature range) and will not be noticeable to consumers since only the timing of temperature response of the device is targeted. The requirement of the NC DCC is set to facilitate good system response considering the aggregated effect of a large number of devices sharing the same frequency while leaving margins for the manufacturer to integrate this functionality into their products. This has been set following responses received in the “Call for Stakeholder Input”[5].

The identification of suitable devices deemed significant will be done at national level and in coordination at European level and to be updated not more often than every three years. For these devices DSR SFC services shall be mandatory, which means that devices identified as significant will have the capability to deliver this service. This will ensure the sufficient development of this service in the future and will reduce its costs.

3.3 REQUIREMENTS ON REACTIVE POWER EXCHANGE AT TRANSMISSION LEVEL

The consequences of greater contribution from RES in context of system voltage and availability of reactive power capability has to be considered. With the highest level of RES penetration many synchronous generators will be displaced at the times of high RES production (e.g. windy/sunny). This removes a key source of reactive power. In many countries during such conditions the generation (mainly from RES) is located away from the system/load centres to coastal areas (e.g. large wind) and also embedded (e.g. solar PV and smaller wind).

Moreover, the development of underground cables on the distribution grid and even the transmission grid and the development of embedded generation, on the distribution networks (including closed distribution networks) have an increasing impact on the reactive power flows at the interface between transmission and distribution networks.

The above leaves the transmission systems with less reactive resources to:

- be able to compensate the reactive demand of the DSO networks, and
- cope with its own transmission related reactive demand.

Consequently, ENTSO-E believes that the voltage stability of the system should be supported by all the stakeholders (including the TSOs). This view was generally supported by stakeholders. However, ENTSO-E acknowledged the view that the requirement should be limited to transmission connected users only.

Some requirements exist already in some countries, for generators and/or for customers and distribution system operators, but they need to be improved and the provision of reactive support spread (and hence harmonized) across Europe in order to cope with the new challenges.

Overall system performance is improved, either technically or economically, if appropriate measures are taken concerning reactive power management for transmission connected distribution networks or demand facilities at the connection point. Reactive power delivered where needed is more cost effective allowing also for loss reduction, higher active power loading, less need for system reinforcements and lower capital cost of lower voltage installation. Voltage stability is also recognised as an important basis for system security. The CBAs provided in the “Call for Stakeholder Input” [5] and supplemented by additional synchronous areas analysis (see FAQ 22) have shown that from a socio-economic viewpoint the total cost to meet the DSO system need for reactive power is lower if the reactive compensation is undertaken lower down in the system (closer to the demand) than if invested at the higher voltage level.

Therefore the following requirements have been introduced in the NC DCC.

- Transmission connected demand and distribution networks shall be capable of maintaining their operation at their connection point within a range of reactive power specified by the TSO, but not wider than a limit defined in the NC DCC. This limit takes into account the reactive power capacities of embedded generation when applicable.

- Based on network design, the transmission connected distribution networks shall have the capability at the connection point to maintain approximately 0 Mvar exchange at nominal voltage for a load exchange of no higher than 25% of the maximum import capacity.

- In order to allow continuous reactive compensation, the TSO shall have the right where justified and in an adequate timeline to require from the transmission connected distribution networks the capability at the connection point to maintain a Mvar exchange for a range of active power exchange specified by the TSO. A control method of this Mvar exchange shall be agreed between both parties to ensure their respective needs for security of supply. This provision of reactive power has some similarity to the provision of reactive power by generators but much slower (steady state).

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3.4 VOLTAGE WITHSTAND CAPABILITIES

Voltage stability is a key issue for system performance and security. Recent experience has shown that most of the large-scale disturbances to electricity transmission system in the recent years were caused by a loss of voltage stability (low voltage), particularly in Continental Europe[12].

Generator units used to contribute most to voltage stability. In future the increased volatility resulting from the intermittency of RES, coupled with a less controllable, wider and more dispersed generation portfolio increases the needs for stability and certainty in response from other elements in the network. Failure to do so is likely to increase the risk to all users of system events resulting in indiscriminate loss of demand. ENTSO-E is of the view that all network users into the future need to contribute to support voltage stability, taking into account their technical capabilities and their connection voltage level.

The following approach has been chosen for voltage withstand capabilities after the assessment of responses received in the "Call for Stakeholder Input":

- In this context, it is important to make sure that users with a connection point at 110 kV and above remain connected within specific voltage ranges, to support the network. In addition, demand facilities connected below 110 kV providing DSR have to remain connected across the normal operational voltage range to allow delivery of these services.
- The NC DCC acknowledges the stakeholders' general view that the requirements regarding voltage withstand capabilities shall be set at the connection point. The requirements concern the equipment at the connection point, not all the demand units connected below, to allow the demand user to alter their demand when needed.
- The NC DCC establishes that, if required by the relevant network operator, a distribution network or demand facility shall be capable of automatic disconnection at specified voltage.

These voltage ranges are aligned with the requirements to be placed on generators and represent potential voltage ranges that could occur at higher transmission voltages following a wide spread adverse system event. The need of distribution networks and demand facilities to have the capabilities to reliably continue to support both power transfer and demand usage, throughout these events is essential to ensuring a predictable and controlled response from users to restore the network to within a normal operational state.

3.5 DESIGN FOR FREQUENCY RANGE EXPECTATION AND WITHSTAND CAPABILITY

The frequency of the system is around 50 Hz. If there is an imbalance between generation and demand the frequency deviates from this target value. In this case a predictable reaction from demand is invaluable in the return of the system to its target value so that stable operation can be ensured. In the future the generation is predicted to be based on more volatile energy sources and if demand trips during a frequency deviation this will bring a further dynamic element to the frequency control challenge.

Distribution networks (both DSOs and closed distribution networks) provide a pathway for embedded generation and users providing DSR to contribute to frequency response. Given the penetration of generation and DSR and their role in security of supply, frequency withstand capabilities of networks are therefore also essential.

The following approach has been chosen for frequency withstand capabilities after the "Call for Stakeholder Input" [5] assessment:

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- The NC DCC acknowledges the general view that frequency withstand capability requirements are desirable but not fully attainable and that associated costs would vary significantly concerning networks and demand facilities. Therefore, the NC DCC provides that all demand facilities (either connected to the transmission network or to the distribution network) and closed distribution networks will be designed with an expectation of system frequency being typically within a specified frequency range. It is important to clarify that frequencies outside of this range could always occur and that the user retains the natural prerogative to disconnect, according to his specific needs and decisions, at any frequency.
- The NC DCC acknowledges the general view that enforcing frequency withstand capability requirements for demand providing DSR is sensible. Therefore, the NC DCC provides that all demand facilities providing DSR shall be capable of operating across specified frequency ranges. However, in order to ensure the best use of the technical capabilities of a demand facility if needed to preserve or to restore system security, the NC DCC foresees the possibility, under defined terms of considering a reduced frequency range to be capable to operate when providing DSR.
- ENTSO-E acknowledges that frequency withstand capabilities should be coordinated with low frequency demand disconnection ranges. Therefore the NC DCC establishes that, if required by the relevant network operator, a distribution network or demand facility shall be capable of automatic disconnection at specified frequencies

4 CONCLUSION

The energy system is changing rapidly especially with the massive integration of RES. This requires a new framework to cope with the challenges ahead. All participants of the energy market are faced with significant changes and the implementation of new processes and technologies. The NC DCC is proposing to break new ground to help to accomplish this task on a European level. ENTSO-E acknowledges that significant changes to the existing framework are necessary. To find out the best solutions for the development ENTSO-E conducted a “Call for Stakeholder Input” [5] on the most challenging new topics. The results of the survey are stated in this document (Annex 7) and used as guidance for this NC DCC.

The goal of the NC DCC is therefore to ensure secure system operation and to support the integration of RES into the system now and in the years to come. As a consequence, not only today’s situation that reflects the historical development was taken into account, but the development as described by European and national policy makers was considered as well. As a result the requirements for distribution networks and demand facilities are described.

In conclusion ENTSO-E believes that the NC DCC is in line with ACER’s FWGL, meets the needs for system operation for the European network for the foreseeable years and takes an appropriate balance in the wide diversity of views and opinions provided by stakeholders.

The approach taken by ENTSO-E based on extensive stakeholder consultation is explained in this document.

5 ANNEX: LITERATURE

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6 ANNEX: STAKEHOLDER INTERACTIONS

6.1 BILATERAL MEETINGS

During the scoping phase, before receiving the formal EC mandate to develop the DCC, ENTSO-E engaged early in a set of bilateral meetings to pursue a common understanding on the principles based on which this code is to be drafted. These have continued during the formal drafting period. All outcomes of these meetings are accessible on the ENTSO-E website.

- DSO Technical Expert Group – consisting of experts appointed by Eurelectric DSO, CEDEC, Geode and ED-SO4SG
  - 6 July 2011
  - 14 September 2011
  - 4 November 2011
  - 29 November 2011
  - 7 December 2011
  - 3 February 2012
  - 24 February 2012 (conference call)
  - 19 April 2012
  - 14 May 2012 (conference call)
  - 6 June 2012 (conference call)
- IFIEC Europe – the European association of industrial energy consumers
  - 23 November 2011
  - 24 February 2012
- CENELEC – in the context of Mandate 490
  - 5 December 2011
- CECED – the European association of domestic appliance manufacturers
  - 19 February 2012 (conference call)
  - 15 March 2012

6.2 PUBLIC WORKSHOPS / USER GROUP MEETINGS

On 18 April 2012 ENTSO-E hosted a public Brussels-based workshop to support the "DCC – Call for Stakeholder Input" phase which attracted over 50 participants.

In March 2012 ENTSO-E published an open letter for interested parties to join a DCC User Group which will be contacted on a regular basis at relevant phases of the DCC development. A first meeting was held on 19 April 2012. After closure of the "Call for Stakeholder Input" the User Group clarified and discussed its contributions in the Call during a conference call on 14 May 2012.

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7 ANNEX: EVALUATION OF RESPONSES IN THE DCC – CALL FOR STAKEHOLDER INPUT

7.1 GENERAL ASSESSMENT OF COMMENTS RECEIVED

The DCC "Call for Stakeholder Input" (5 April – 9 May 2012) resulted in feedback from 18 stakeholder organizations with diverse backgrounds offering a valuable stakeholder reflection on the key issues highlighted in this Call. The organizations that responded are

nr	Organization	respondent	country	sector
1	Entelios AG	Stephan Lindner	Germany	Demand Response Full Service provider
2	Electricity North West	Mike Kay	UK	DSO
3	SP Distribution and SP Manweb	Graeme Vincent	UK	DSO
4	Finnish Energy Industries	Ina Lehto	Finland	Association (DSO, Supplier)
5	IFIEC – Europe	Jean-Pierre Bécret.	Eur	European federation of the national associations of intensive energy consumers.
6	UK Power Networks	Dave Openshaw	UK	DSO
7	Western Power Distribution UK	Andy Hood	UK	DSO
8	VSE	Christoph Maurer (Jürgen Schmitt)	Switzerland	DSO, Association of Swiss Electricity Companies (VSE)
9	Danish Energy Association	Allan Norsk Jensen	Denmark	Association of DSO, power producers and wholesalers of electricity
10	EdF Energy	Mark Cox / Paul Mott	UK	
11	CECED	Celine Herion	Eur	Industry association for household appliance manufacturers
12	E.ON AG	Siegfried Wanzek	Eur	European wide active utility
13	SEDC	Jessica Stromback	Eur	Non-profit industry group representing active demand side programmes such as Demand Response
14	Renewable UK	Guy Nicholson	UK	Association representing the wind wave and tidal power sector in the UK.
15	Edison SpA	Andrea Pompa	Italy	Energy company
16	EdF	Délégation aux régulations	France	Energy company
17	Enel Distribuzione spa	Eugenio Di Marino	Italy	DSO
18	CEDEC, EDSO for Smart Grids, EURELECTRIC, Geode	Pavla Mandatova	Eur	Electricity industry associations

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A short general assessment of the feedback received is given in this chapter. First of all ENTSO-E would like to point out that the stakeholders who gave feedback in this consultation cover a large range of users. The feedback given is very valuable for further drafting the NC DCC as well as the supporting documents.

At the highest level the consistency of responses in various topics varies. Stakeholders express a wide range of opinions so that for some topics there is little stakeholder agreement. This reflects the different roles of stakeholders in the market as well as varying experience.

One lesson learned in assessing the stakeholder responses is that it was evident that in some cases improvements need to be made by ENTSO-E in communication of the issues and proposals as in some cases stakeholders have not interpreted these the way they were intended by ENTSO-E.

Concerning the topics raised ENTSO-E would like to give its assessment of the topics discussed:

- Reactive support has perhaps the highest level of response. There is almost general agreement from stakeholders that the principles of providing localised reactive support should be followed and that as a consequence some requirements would seem to be appropriate.

- The stakeholder input also indicates general agreement, albeit with some supplemental information on options, on the need for requirements to reflect RES integration and the options provided to respond to this. The quantitative nature of analysis was generally accepted as the only pragmatic, if not desirable method of presenting the issues and options.

- The CBAs provided also received a lot of stakeholder input. One consistent point is the need for examples from every synchronous system beyond the examples given to demonstrate European requirements. This is accepted and supplemental information is included as part of the accompanying documents with the public consultation document (see FAQs 22, 31 and 32). The CBA examples provided were in general not challenged. Stakeholders provided further information on some costing parameters or aspects in CBAs but no alternative cost benefit analysis was provided. ENTSO-E will utilise this further information where appropriate.

- The principle of including both frequency and voltage requirements are less clear. At the high level these principles were generally accepted, but in the many more detailed options provided support was restricted to only those parts of the network or users whom have the potential to provide a cross border impact. Opinions on the change in cost to meet these requirements vary from negligible to significant, dependant on those impacted, notably with regards to retrospective application.

- There were also a number of perceived omissions in the form of options, technologies and requirements, which will be individually assessed. If possible further information is provided.

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7.2 ASSESSMENT OF FEEDBACK ON SPECIFIC TOPICS

Topic		Options to increase RES penetration in the System
DCC - Call for Stakeholder Input	*Initial position for feedback*	*1.1. What is your view of the high level analysis presented in Table 2?* *1.2. What is your view of the conclusion that the "Benefits from demand side response (DSR) are clear and that DSR has the potential not only to be relatively inexpensive, but also supports the EU goals to integrate RES and to empower customers to participate in the energy market"?* Table 2 seeks to consider the options to integrate RES based on the strength of their merits. The benefits from Demand Side Response (DSR) are clear. DSR has the potential not only to be relatively inexpensive, but also supports the EU goals to integrate RES and to empower customers to participate in the energy market. Customers can contribute as active players to reduce CO_2 emissions and their cost of electricity by accepting a modest level of flexibility.
	Overview of feedback	The stakeholder feedback varies from highly positive to negative. The new paradigm of 50% renewable coupled with non-synchronous generation in which each option in table 2 is needed under different conditions has not been taken on board by many respondents. There was also a call for an explicit statement of what the TSOs can do themselves, e.g. contribute to voltage control including installations of synchronous compensators. Some respondents also do not recognise DSR for TSO services, focusing instead on other uses of DSR such as "time of day". DSO respondents are particularly interested in DSOs role in system operation and to a lesser extent technical issues. In summary: • Several stakeholders indicated general agreement with the statements. • A collaborative approach by the main users of DSR (TSOs, DSOs and Suppliers) providing a simple uniform interface with small DSR providers is critical in order to maintain public acceptance. Question 1.1 • The qualitative nature of the initial analysis (Table 2) received a varied response as some stakeholders were looking for a more detailed illustration of the main contributing solutions. The expectation that all options have their part to play was not shared by some. • Some stakeholders appeared to misunderstand the limited scope of the code. It is intended only to establish capabilities, not to facilitate how the operation of the markets should be developed, which will be the focus of other codes. • Some stakeholders identified a further alternative of Network Operators providing services themselves, with a specific mention of synchronous compensators. • On the one hand, a large GB energy supplier agreed explicitly with the analysis concluding "a significant challenge" and information in context of GB energy developments. Agreed DSR could play a least cost role in solving future problems. • On the other hand, other respondents object strongly from a vari-

		ety of stand-points. • Some respondents do not find Table 2 acceptable as a broad high level review of options. In many cases this rejection is either unsupported or is based on a misconception, for example that only one option (mandatory) from a range of options (voluntary to mandatory) is being proposed in subsequent questions. Question 1.2 • The focus of the high level analysis on societal least cost was challenged, with alternatives including value of service to purchasers. • Several respondents believe market based DSR cannot work economically at domestic level. Danish Energy Association believes 2-way communication is not economical below MW size. Consequently the conclusion would be that domestic contribution can only be realistically provided through a broad legal basis for example by this Network Code and in turn via European Equipment Standards.
	Assessment	1. Responses varied, no definitive conclusion available., 2. A holistic approach is needed to DSR if the contribution of domestic demand is to be facilitated 3. Best achieved through DCC light touch legal enablement with European Standards providing the details. 4. Who does what remains a major question for stakeholders which is not appropriate for this code to resolve 5. No consensus on the bodies to fulfil the roles in this process. In conclusion, a full consultation is needed on extending industrial &business balancing services to domestic market, by • facilitating European Standards to develop domestic DSR capabilities with take up released at national level; • ensuring, whenever consumer inconvenience is possible, that the facility provides for allowing the consumer to make choices regarding its use.

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Topic		Level of Detail
DCC - Call for Stakeholder Input	*Initial position for feedback*	*2.2.1. What is your view on ENTSO-E's interpretation of the level of detail required in the NC DCC?* Section 2.2 concluded • The necessary degree of detail is adjusted to the purpose of each requirement and is determined by the extent of the system-wide impact of each requirement. The relevant entity from the perspective of system security is predominantly the synchronous area and five of them are in the scope of NC DCC (Continental Europe, Nordic States, Great Britain, Ireland and Baltic States). • The NC DCC focuses on significant users which are either Demand Facility or Distribution Networks (DSO or Closed Distribution Network Operator) connected to the transmission system. • Furthermore, ENTSO-E proposes to facilitate all players to participate in the market place. To achieve this, all users must be allowed to be significant grid users in the context of DSR.
	Overview of feedback	The level of detail still needs to be clarified for some respondents. A **classification** of grid users is needed, based on the size and /or types or voltage level. Overall, most agree that a differentiated level of detail, dependent on the **significance of the requirement on cross-border issues and system stability** is appropriate. No reference is made on whether or not the synchronous area level is a relevant perspective for requirements On the appropriate **connection point** where requirements are to be set, some state that it should be restricted to the transmission/distribution interface, while others consider that small units can be considered as significant grid users if their combined response on the system can be proven or argued without reasonable doubt, especially in the context of DSR. On the **level of detail of specific DSR requirements** stakeholder feedback diverges. Some indicate that the technical implementation should be left to product standards (see DSO responses) while others consider that the functional capability itself needs to be well described at European level (see IFIEC response). Some feedback indicates DSR should be kept out of scope of the DCC completely (Renewable UK). Most of the stakeholders consider that there should be **no mandatory requirements for DSR**. Several respondents indicated that the NC should not be too prescriptive. Even if all the stakeholders agree that market issues are out of the scope of the DCC, some insist on the link between DSR requirements and the market: some think that the NC should stay neutral and impose nothing to the market design while others ask ENTSOE to take into account the limits for DSR development due to the present market design (impact on 3rd parties, management of balancing in Germany,…)
	Assessment	Generally feedback is in line with the initial position as presented in the Call for Stakeholder Input. The level of detail of DSR has been reviewed in light of stakeholders answers on DSR (see next topics), especially mandatory requirements.
Impact on draft DCC	*General approach*	The level of detail in the draft NC DCC varies with respect to the requirement at hand. Generally not all requirements are applied to all possible types of users. There is no motivation for a one size fits all approach. Classification is not made purely on the maximum capacity, but is based on transmis-

		sion/distribution connection, offering of DSR services, voltage level. Most of the requirements are set at the connection point (except DSR).
	Examples(s)	Exhaustive requirements: e.g. on frequency withstand capabilities (Art 7) Non-exhaustive requirements with ranges: e.g. on reactive power exchange capabilities (Art 10) in which a power factor range is set at national level. Non-exhaustive requirements with general principles or links to other codes: e.g. on Information Exchange (Art 12) or Low Frequency Disconnection (Art 14). A general overview of types of significant users and which requirements apply to them is provided in Art 3.

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Topic		Demand Side Response for Reserves

DCC - Call for Stakeholder Input	*Initial position for feedback*	*3.1.1. What is your view of the analysis presented on the challenge ahead associated with reduced availability of reserve services from synchronous generators at time of high RES production?*
		3.1.2. Is there any class of users that should be excluded from providing these reserve services?
		3.1.3. What would be the technical and economical limits to the development of DSR for industrial customers, commercial premises and Closed Distribution Network operators?
		3.1.4. In Appendix 1, options for the provision of mitigating the shortfall of reserves are given, are there any comparable alternative options other than the ones provided in Appendix 1?
		3.1.5. What would be the typical cost to equip one appliance (e.g. a washing machine or a heat pump controller) under each of the 3 alternatives?
		3.1.6. What form and level of incentive do you believe is required to encourage consumers not to switch the reserve off under option 1 and 2?
		3.1.7. Considering the cost and consequences of the alternatives, do you support use of DSR for this purpose?
		3.1.8. Which of the 3 DSR alternatives (1, 2 or 3) would be your preferred option to achieve the greatest societal benefit and for what reason?
		3.1.9. If the services proposed here are provided, what further uses of these technical capabilities (see Appendix 1) would be most beneficial and why?
		
		Section 3.1 Stated:
		• Overall the consequence of RES development is a massive increase in the demand for reserves caused by greater forecasting uncertainty. This is combined with a reduced availability at time of high RES production of today's provision of these same services by synchronous generators.
		• Demand which is capable of being deferred for extended periods, preferably up to 4 hours, can in principle be considered for such a service. Demand suitable to deliver these services exists from industry, from business premises and at household level. The potential for all these may be explored to give the least societal cost.
		• The household level has not been used for those services so far and ENTSO-E proposes to explore this in view of the increasing need for this kind of service.
		• The aim of the NC DCC is to set technical requirements necessary to provide DSR services. The way these services will be used is not in the scope of this NC.
		• Different options:
		    • Do nothing, just leave it to the existing market players.
		    • Open markets to share reserve services beyond the existing control areas.
		    • Open up for reserve service provision even between synchronous areas.
		    • Define DSR reserve services, 3 alternatives considered.
		• Alternatives
		    • 1: Define optional service capability, leave delivery to market
		    • 2: Define standard service capability, leave delivery to market
		    • 3: Define standard service capability, with mandatory delivery

	Overview of feedback	Question 3.1.1.: • **It is generally accepted that:** The topic is relevant and a credible view of the future is presented; The need for DSR delivering reserve

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services, which is accepted, will vary on different systems and on different generation mixes.

- **Some opinions stated that:** Broad CBAs including all related costs and applied on different systems should be a base for any decision; Market approach is favoured and DCC requirements should be neutral to market designs; DSR should be seen as a complement to other solutions such as synchronous compensation; Other players than DSR can participate in the reserve services market; Requirements for DSR should be set via standards not code; Need stronger role for DSOs in DSR; RES to invest in good prediction models; Availability of users is an important issue and costs should be attributed only to interested players; Operational approach to use of DSR missing; Stated problems with thousands will become unmanageable when we move to millions.

Question 3.1.2.:

- **It is generally accepted that:** All demand users should be allowed to participate.
- **Some opinions stated that:** Users should decide for themselves in a market driven environment and no one should be forced; Users should have clear and relevant information for decision; Large size consumers should be the focus since smart grids and communication are not fully deployed; Users are missing including cell phone chargers, wet appliances, electric vehicles, heat pumps; Sensitive load would need to be carefully looked at and could be excluded - hospitals, some industry.

Question 3.1.3.:

- **It is generally accepted that:** There is a big potential for DSR but it depends on the overall economic viability of individual cases; Limits will be set by requested services, type of business, remuneration and market, technical capacity, frequency of requests, impact in operation and maintenance costs.
- **Some opinions stated that:** Agreement of Relevant Network Operator should be taken into account before participation in DSR market due to eventual network security and constraint issues; Reliability and quality of supply must be preserved; Small scale consumers may find an opportunity in aggregation; Some industrial processes will need to be restricted to a limited number of constraints to be attractive to industry to take place i.e. number of times DSR used per year.

Question 3.1.4.:

- **It is generally accepted that:** All possible alternatives could play their role (storage plants, classical generation, RES) however that is recognised as being out of the DCC scope.
- **Some opinions stated that:** Relative competitiveness among options against other alternatives is not presented; Requirements should be made so as to guarantee the final effect and not to limit the possibility of players participating since this will drive the price of the service higher (e.g. use of less than 4 hours DSR provision managed by aggregators or similar bodies that with higher numbers of DSR providers same effect can be achieved); Effective use of interconnections and integration of intraday and balancing markets also an important issue; Good forecasting for RES is necessary; Scale of need for reserve for RES in examples is challenged; Smart meters are not for aggregators, only for RNOs.

Question 3.1.5.:

- **It is generally accepted that:** Appliance manufacturing costs, although reasonable, are not the only costs. Control, communication and

		infrastructure costs are also significant and may increase and vary significantly the overall cost. • **Some opinions stated that:** Customer is likely to expect a discount on respective tariff to compensate for the inconvenience; New solutions must not compromise what is already being made today in non-real-time load deferral; Industrial users can provide DSR with far greater capacity for marginal lower cost; Higher costs also indicated for smart appliances. Question 3.1.6.: • **It is generally accepted that:** It is difficult to know since many aspects are important, ranging from requested service, to market pricing, to user availability over time and social acceptance. • **Some opinions stated that:** The cost of electricity is a key driver; Some suggestions are made concerning various models for rewards and penalties either in turning the reserve on or off or in a mandatory or voluntary way; Transparency for users is a key issue; Full automation is a facilitator; Concern by some that any opt out options will effectively diminish service dramatically or be too much of a burden on demand users. Question 3.1.7.: • **It is generally accepted that:** DSR for reserve is a positive option; DSR for reserve is not the only solution but should not be ruled out. • **Some opinions stated that:** CBA should take all costs and options into account keeping options open; Mandatory delivery is not favoured; User benefits and awareness is a key issue. Question 3.1.8.: • All three options may have pros and cons; No clear direction between alternatives is given, except that alternative 3 is the less favoured. Question 3.1.9: • **It is generally accepted that:** Further uses may be found, e.g. DSOs network constraint management, balancing of commercial positions, reinforcements defer. • **Some opinions stated that:** Network codes should not limit other services for DSR (e.g. forecasting, business intelligence, etc.); Stressed that both TSOs and DSOs may use DSR services; Regulation and market rules are needed.
	Assessment	Generally DSR delivering reserve services is seen as a positive alternative with high potential. All users should have the opportunity to participate in these services and aggregation may be a way to include small scale users. Less favoured option for the delivery of these services is a mandatory one. Relevant Network Operators should be consulted. Only functional capabilities can be requested in the NC DCC since all infrastructure not fully deployed and NC DCC requirements for DSR should not compromise future services nor market use.
Impact on draft DCC	*Article(s)*	Article 15 (1).a),b),c); Article 15 (2).; Article 15 (3).a);
	Type of Users	Demand Facilities and Closed Distribution Networks providing DSR.
	DCC Connection requirements	Demand Facilities and Closed Distribution Networks may voluntarily provide the services. Requirements, in the form of functional capabilities, are mandatory for those who offer these services, either individually or as part of aggregated facilities.
	Alternative solutions rejected	In this context there is not truly an alternative that is rejected. DSR for reserves by mandatory uptake in capability facilitates voluntary DSR services in addition to alternative solutions (network/generation management).

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Topic		DEMAND SIDE RESPONSE DELIVERING SYSTEM FREQUENCY CONTROL
DCC - Call for Stakeholder Input	*Initial position for feedback*	*The initial position regarding the DSR application related to temperature controlled demand to deliver a smarter, robust and a more user friendly LFDD-capability to avoid frequency collapse and hence contain the impact of rare events with large system frequency excursions:* *3.2.1. Do you agree with the conclusion to apply this service universally using European Standards proposed as a result of the initial CBA based on Irish data?* *3.2.2. ENTSO-E believes this service can be introduced for new appliances (and temperature controllers) without any detectable difference to the primary purpose of the service of the appliance. Can you share any specific knowledge or experience and associated data you may have on this topic?* *3.2.3. If this further DSR for temperature controlled demand is introduced should this be arranged by each nation rather than at European level and if so should there be a requirement for **harmonising** within a synchronous area in order to provide burden sharing?* *3.2.4. Are the **types of demand** suggested in Appendix 2 the most appropriate to provide this service giving continuous response to system frequency deviation away from the target frequency (50.0Hz)?* *3.2.5. Please provide comments on the **specific data** used in the initial CBA presented.* *3.2.6. The initial CBA indicates that alternative 1 (Voluntary service capability – mandatory usage) may be able to provide the required services quicker than alternatives 2 and 3 (due to higher uptake). Do you have any comments about this **conclusion** and the underpinning **assumptions**, including* • *20% uptake for voluntary service capability;* • *Increased unit cost for lower volume and supplying more than one option;* • *The costs identified.*
	Overview of feedback	Question 3.2.1 and 3.2.5: **It is to be noted that:** None of the respondents challenges the published numbers used for the presented CBA. However, it is clear that, in order to validate the relevance of such requirement, a CBA for each of the synchronous zones of Europe should be performed using a robust, well accepted methodology and clearly motivated assumptions. Question 3.2.2a: **Some opinions stated that:** Today's remote-controlled load disconnection has noticeable impact on the end-users but none of the stakeholders has mentioned experience with similar load modulation methods such as the one proposed in this requirement. Question 3.2.2.b: **Some opinions stated that:** Respondents share doubts on the aggregated impact of frequency control using temperature controlled device on frequency stability, on primary control reserve, secondary control. Furthermore, some respondents have raised concerns of such requirement on possible temperature oscillations, resonance effects or aggregated effect when frequency returns to normal (cold pick up).

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		Question 3.2.3: **It is generally accepted that**: From the answers of the stakeholders it is clear that the need for system frequency control should be harmonized by synchronous areas. However, several stakeholders propose that the repartition of the system frequency control reserves should be a national concern as this has a strong impact on national system operating costs. However high level harmonization of the requirement is needed at European level and should be placed in the Network Code. Finally, strong cooperation between ENTSO-E and EU standardization organizations is recommended. Question 3.2.4: **It is generally accepted that:** From the answers of the stakeholders it is not questioned that temperature controlled devices are able to provide this service. However, other devices such as electric vehicles, industrial pumping could be considered as well. Question 3.2.6: **It is generally accepted that**: Stakeholders state that it is difficult to estimate the customer pick-up of DSR-SFC in case "voluntary service capability" is foreseen. However, several of the stakeholders raised the concern that mandatory requirements could distort generation-based reserve markets and that mandatory requirements will have low public acceptance. **Other comments:** Several of the stakeholders have doubts about the financial benefits and the benefits repartition among users of such requirements if a mandatory requirement is foreseen for some user only (i.e. temperature-controlled devices only). Furthermore some stakeholder state that the functionality aimed by this requirement could be more cost-efficiently achieved using industrial load system frequency control.
	Assessment	Main guidelines in Article 16 and 17 of the NC DCC: 1. An explanation and proof of the technical robustness of the approach should be given in the FAQ document 2. The misunderstanding between Low Frequency Demand Disconnection (binary behavior) and the proposed DSR-SFC needs to be clarified. 3. The motivation and approach paper will provide past frequency statistics (number per year and amplitude) to make the debate based on clear figures. 4. The NC will only define the behavior foreseen by the device to reach efficient and safe aggregated effect and will not detail the way manufacturers should deliver it. 5. ENTSO-E is in contact with EU standardization organizations. 6. Requirements will be defined in coordination with other synchronous area TSOs based on the results of CBAs of each synchronous zone and of national CBAs. 7. Requirements will be made voluntary unless required to be mandatory at national level.
Impact on draft	*Article(s)*	Article 16 and 17

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DCC	*Type of Users*	Temperature-controlled devices and industrial users for system frequency control services.
	DCC Connection requirements	The requirement of Article 16 is set to be mandatory as soon as it is applied at national level in coordination with other control zone. The requirement is defined in a high level way while guaranteeing good system behavior considering the aggregated response of all devices sharing the same frequency. The requirement of Article 17 will set the way devices that choose to voluntarily provide the service should provide it to guarantee good aggregated system response.
	Alternative solutions rejected	Industrial load system frequency control or voluntary demand side response delivering system frequency control could only provide a part of the needed support for system frequency stability.

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Topic		Reactive Power Exchange Capabilities
DCC - Call for Stakeholder Input	*Initial position for feedback*	*3.3.1. General questions* *a. Do you agree that increasing displacement of synchronous generation is a significant new challenge?* *b. Do you agree that a review of existing requirements is needed, to take into account the new challenges mentioned above in Section 1.2 and 1.3?* *c. Do you agree with the conclusion from the initial CBAs (Ireland & GB) that the societal benefits are greater for reactive management to occur closer to the reactive demand? In either case please provide the rational with supporting evidence where available on the aspects of the conclusion of the CBA that you agree or do not agree with.* *3.3.2. Question specifically relevant for DSO connections* *a. Do you agree that the development of cables and embedded generation introduce further challenges regarding reactive power control, including risk of high voltage during minimum demand?* *b. Is it reasonable to ask DSOs to avoid adding to the problem of high voltage on the transmission system during minimum demand by avoiding injecting reactive power at these times?* *3.3.3. What is your view on the most appropriate way forward, including but not limited to the following options:* • *Do nothing. Leave the TSO to sort out reactive balancing. The CBA of the transmission located re-active capability option in the CBA is relevant here.* • *General limit on power factor at transmission to distribution interface, e.g. better than 0.90 or 0.95, with the value set in each country by each TSO subject to public consultation and NRA decision or an equivalent process as provided by the applicable legal framework, such as the definition of a limit in MVAr.* • *As in the previous point except the power factor limit set on a local (or zone basis) by the TSO fol-lowing CBA & consultation / NRA decision.* • *Total separation between distribution and transmission reactive flows (i.e. 0 MVAr at the interface).* • *The DSO at network exit points treated in the same way as generation is treated in network entry points with the DSO expected to regulate voltage continuously. Should this be limited to slow time scales of minutes (e.g. achieved by means including transformer tapping) or extended to fast acting reactive power support for disturbed conditions?* • *Establishment of full reactive markets (e.g. in zones) encompassing DSO contributions as exist in some countries with respect to generation today?* Section 3.3 concluded • ENTSO-E defence plan analysis had identified voltage stability as a catalyst for most system black-outs, hence voltage and reactive compensation a cross border issue. • Costing analysis concluded that reactive support best provided as close to source of use as possible. Hence demand facilities and distribution networks should compensate within their networks. • The NC DCC focuses on significant users which are either Demand Facility or Distribution Networks (DSO or Closed Distribution Network Operator) connected to the transmission system. • The NC DCC recognised the need to set ranges to make best

		use of embedded and transmission, generation and DSR, to minimise overall costs. Hence reactive ranges set to allow for use of these devices. • Network charging requirements should normally be mainly supplied by both TSOs and demand users for their respective networks. • New challenges may require more dynamic control of reactive power at connection points
	Overview of feedback	**It is generally accepted that:** loss of synchronous generation is a significant new challenge; The need is demonstrated; Reactive compensation is optimal close to the source of use; Network operators should mainly reactively compensate their own networks; CBA findings are correct but individual questions raised on various aspects **Some opinions stated that:** Concerns are raised that reactive ranges should not be too restrictive and should allow for effective use of embedded generation/DSR.
	Assessment	Generally feedback is in line with the initial position in the Call for Stakeholder Input
Impact on draft DCC	*Article(s)*	Article 10
	Type of Users	Transmission Connected Demand Facilities, Distribution Networks (including Closed Distribution Networks)
	DCC Connection requirements	Set maximum European wide power factor (or equivalent) ranges with Nationally set ranges within these for demand facilities and distribution networks. Set deterministic distribution reactive power compensation requirements to compensate for distribution network charging requirements TSO optional use of dynamic reactive power provisions at the Distribution Network connection point. Ranges and implementation plan to be agreed between TSO and DNO.
	Alternative solutions rejected	TSO provide reactive power needs. Whilst TSOs do and will install reactive power on their systems, Cost Benefit Analysis studies have shown that it is most cost efficient and effective as close to demand as possible. Therefore, as a general principle suitable reactive power ranges should require the majority of reactive power needs of demand and networks to be sourced below the transmission connection point.

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Topic		Voltage withstand capabilities
DCC - Call for Stakeholder Input	*Initial position for feedback*	*3.4.1. Do you agree with the analysis concerning the need of voltage withstand capabilities?* *3.4.2. What are the technical limitations to voltage withstand capabilities in your Demand Units in option iii?* *3.4.3. What are the technical limitations to voltage withstand capabilities in your Demand Facility or Distribution Network in option iv?* *3.4.4. What would be the costs induced by such requirements in option ii, iii and iv?* *3.4.5. Which alternative would you prefer? In case of option ii, iii or iv, shall the requirements be defined for all Demand Units/ Demand Facilities/ Distribution Networks or with specific voltage connection levels only?* Section 3.4 stated: • Voltage is a key issue for system stability and security. Due to the development of underground cables and embedded and intermittent generation, the need of support from all grid users will increase. • Only users deemed significant regarding their cross-border impact shall be required withstand capacities • ENTSOE recognise that all users shall have the right to alter their demand for their own reasons and only seek to avoid equipment limitations within the connection of the demand facility. • 4 options were proposed: i. Do nothing. ii. Withstand capacities only for users offering DSR services. iii. Withstand capabilities Demand Units connected directly to a transmission-connected Demand Facility or Distribution Network (applicable to all or part of transmission connected demand users). iv. Withstand capabilities only at the transmission connection point (applicable to all or part of transmission connected demand users.)
	Overview of feedback	The most detailed answers came from DSOs (either individually or by the joint DSO associations response) and IFIEC. Suppliers and other stakeholders gave little or no comments • Question 3.4.1: **It is generally accepted that:** stakeholders **agree or partially agree with the analysis**, but some still wonder if Voltage withstand capacities are a cross-border issue. Some ask for a clarification of the requirements needed (dynamic deviations and/or steady state situations). A few disagree because they think there are other solutions to maintain voltage (IFIEC) or need some guarantees from the TSOs on the voltage level provided at the connection point (EDF) or more information to conclude (VSE, Western Power) • Question 3.4.2 (technical limitations to option iii): **It is generally accepted by DSOs that:** DSOs want some conditions associated with withstand capacities. The technical limit they provided is the **destruction of components and it depends on the voltage level considered**. Several DSOs proposed a **deviation of +/- 10%of the nominal voltage level.** For IFIEC, the limitation is due to the **standards characteristics** of the motors and loads; **duration is also an important criteria.** • Question 3.4.3 (technical limitations to option iv): **only the DSOs and IFIEC answered this question.** The technical limitations are

		the **same as for option iii**, except for UK Power Network, which underlines that requirements at the connection point shall not be too restrictive to permit the use of embedded generation capacities. • Question 3.4.4 (costs): **only the DSOs and IFIEC answered this question.** Half of the stakeholders think the cost shall be low, because the withstand capacity shall be already covered in current standards (if deviation of +/-10 % nominal value). The other half thinks that it will depend on the values and IFIEC add that it will also depend on the durations required. UK Power Network thinks it will increase the costs for Demand users. • Question 3.4.5 (which option?): **It is generally accepted that:** Most of the stakeholders who answered are **not convinced that something other than the "Do Nothing" option is needed**. They think that this point should be left at national level. Nevertheless, if there must be some requirement in the NC DCC, they expect a combination of the option i, iii and iv, which leads to requirements at the Connection Point, only for transmission connected Demand Users. Some DSOs think that option ii shall limit the development of DSR, if the requirements are too stringent.
	Assessment	There is a general agreement on the need of voltage withstand capacities, but the necessity to have the related requirements in the NC DCC is not shared by the majority of the stakeholders. The technical limits are the same for the options iii and iv. Such a requirement would not be expensive if it doesn't deviate from existing standards.
Impact on draft DCC	*Article(s)*	8. 1)
	Type of Users	Demand Facilities and Transmission Connected Distribution Networks with a connection point above 110 kV
	DCC Connection requirements	Requirements on voltage withstand capability defined in the code only for users connected above 110 kV(because of their cross-border impact). The duration in some range shall be defined at national level, to take into account local specificities. Option iv is retained: the requirement concerns only the equipment at the connection point. The withstand capability is required only in case of high voltage situations. Demand Users connected below 110 kV and providing DSR shall be able to stay connected within the unlimited range. The ranges defined by synchronous areas are in line with NC RfG.
	Alternative solutions rejected	Do nothing in the code, leave to national level. It doesn't guarantee the harmonisation within a synchronous area.

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Topic		Frequency Withstand Capabilities

DCC - Call for Stakeholder Input	*Initial position for feedback*	*3.5.1. Do you agree that certainty is required in the performance of elements in the electrical power system to ensure stable frequency operation and to minimise the cost of procuring frequency response?*
		3.5.2. Which option (i or ii) would you prefer and for which reason?
		3.5.3. Please provide cost information to establish frequency withstand capability over the full range from 47.5 Hz to 51.5 Hz for Distribution Networks and Demand Facilities and explain which typical apparatus are needed.
		3.5.4. Please provide cost information to establish frequency withstand capability over a limited range from 49 Hz to 51 Hz for Distribution Networks and Demand Facilities and explain which typical apparatus are needed.
		3.5.5. Which frequency-sensitive installations do you have in your Distribution Networks or Demand Facility?
		3.5.6. Please provide cost information to reinforce frequency-sensitive installations with frequency withstand capability over the full range from 47.5 Hz to 51.5 Hz.
		3.5.7. Please provide cost information to reinforce frequency-sensitive installations with frequency withstand capability over a limited range from 49 Hz to 51 Hz.
		
		Section 3.5 Stated:
		• If there is an imbalance between generation and demand the frequency deviates from the target value. A (predictable) reaction of demand returns the system to its target value ensuring stable operation.
		• In the future the generation is predicted to be based on more volatile energy sources and if demand trips during a frequency deviation this will bring a further dynamic element to the frequency control challenge.
		• As a consequence ENTSO-E evaluates if requirements to withstand frequency deviations should be required.
		• Distribution networks (both DSOs and CDNs) provide a pathway for embedded generation and DSR to contribute to frequency response.
		• Frequency withstand capabilities within prescribed ranges are therefore essential.
		• Two options are possible to deal with this issue in the NC DCC:
		  ◦ i. Frequency withstand capabilities are mandatory for Distribution Networks and all Demand Facilities.
		  ◦ ii. Frequency withstand capabilities are mandatory for Distribution Networks and for the Demand Facilities or Closed Distribution Networks, which offer DSR services.

	Overview of feedback	Question 3.5.1.: • **It is generally accepted that:** Frequency Ranges are desirable to limit frequency regulation; Certainty in the performance of elements is desirable but is not attainable by any solution. • **Some opinions stated that:** Concerning frequency deviations, there is a difference in risk for the system in over and under frequency situations; Some confuse frequency withstand capabilities with frequency response; It is very difficult from the plant point of view, since not only frequency withstand capability in itself is necessary but also the capability of the whole plant to operate correctly through the frequency range. Question 3.5.2.: • **It is generally accepted that:** Frequency range to match DSR requirements appears to be sensible.

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		• **Some opinions stated that:** Arguments were presented for both options i and ii (Mandatory requirements), if in a reasonable range; Larger range only for DSR providers but compatible with LFDD; Preference to option ii due to voluntary approach; Option i for DSO plants since that is not an issue; Concern that option ii might limit DSR development); Concern that DSR take out could be restricted by too many requirements; Standards should be applied not DCC requirements; Household level not perceived as significant grid users; Requirements should be applied to all users of same significance; CBA is needed. Question 3.5.3.: • **It is generally accepted that:** Costs may vary in Industrial Facilities but would be low to implement a frequency range in networks since most equipment is not sensitive. • **Some opinions stated that:** Operating under different frequencies might have other implications such as harmonics or resonances, so not easy to respond; CBA is needed. Question 3.5.4.: • **It is generally accepted that:** Costs may vary in Industrial Facilities but would be low to implement a frequency range in networks since most equipment is not sensitive. • **Some opinions stated that:** Operating under different frequencies might have other implications such as harmonics or resonances, so not easy to respond; CBA is needed. Question 3.5.5.: • **It is generally accepted that:** There is none for networks; There are many internal to Industrial Facilities (asynchronous motors, some large synchronous ones, Transformers, Consumption units internal protections, Watches, Present LFDD schemes required by grid codes). Question 3.5.6.: • **It is generally accepted that:** Costs may vary significantly in Industrial Facilities but would be low to implement a frequency range in networks since most equipment is not sensitive. • **Some opinions stated that:** Full replacement in some cases may be necessary (e.g. electronic speed drivers instead of direct motors). Question 3.5.7.: • **It is generally accepted that:** Costs may vary significantly in Industrial Facilities but would be low to implement a frequency range in networks since most equipment is not sensitive. • **Some opinions stated that:** Full replacement in some cases may be necessary (e.g. electronic speed drivers instead of direct motors).
	Assessment	The need of frequency withstand capability requirements in the NC DCC is generally seen as desirable but not fully attainable. Costs for networks are low. Costs for Demand Facilities may be high and vary significantly. Frequency withstand capability requirements for demand providing DSR seems sensible but should be coordinated with LFDD ranges.
Impact on draft DCC	*Article(s)*	Article 7; Article 16 (1) c)
	Type of Users	Demand Facilities and Distribution Networks. Demand providing DSR.
	DCC Connection requirements	All Demand Facilities and Closed Distribution Networks will be designed with an expectation of system frequency being typically within specified frequency ranges. All Demand providing DSR shall be capable of operating across specified frequency ranges.
	Alternative solutions	Besides doing nothing in the code, there is not truly an alternative that is rejected since the NC DCC acknowledges the general view of the stakeholders.

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