

HORIZON-CL5-2022-D3-01-11

Demonstration of innovative forms of storage and their successful operation and integration into innovative energy system and grid architectures



AGISTIN

Advanced Grid Interfaces for
innovative STorage INtegration

SoA Connection Network Codes

Date: 02/2023

Document : Milestone 2-WP2

Version: V1.0

Task Leader: RINA-C



Le réseau
de transport
d'électricité



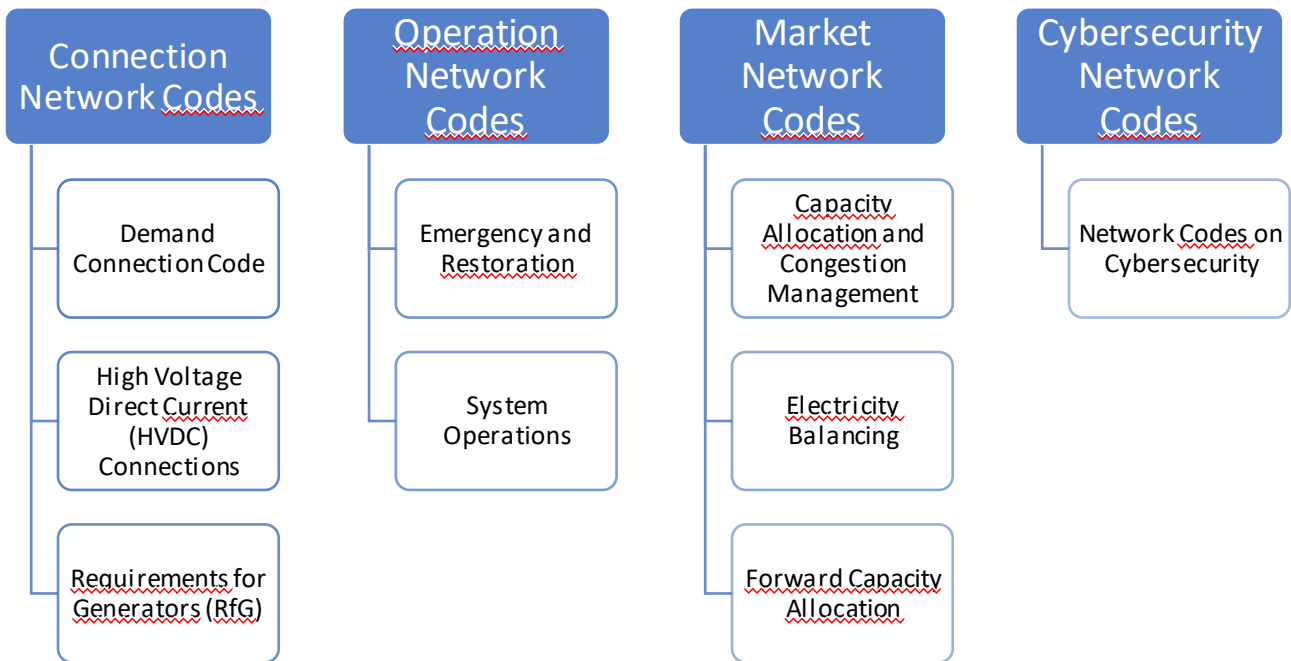
The Advanced Grid Interfaces for innovative STorage INtegration (AGISTIN) is supported by a project that has received funding from the European Union's Horizon 2022 research and innovation programme under grant agreement N°101096197

1. Introduction

In order to improve the harmonization, integration, and efficiency of the European energy market, ENTSO-E developed, mandated by the EC, a set of regulations known as network codes under the direction of the Agency for Cooperation of Energy Regulators (ACER). Each network code is essential to the effort to complete the internal energy market and meet the following energy goals for 2030 of the European Union: At least 32% of energy consumption must come from renewable sources, and there must be at least 32.5% energy savings relative to the business-as-usual scenario. GHG emissions must be reduced by at least 55% from 1990 levels.

The new EU DSO Entity and ENTSO-E collaborate on the creation of the Network Codes and Guidelines, particularly those related to cybersecurity and demand side flexibility.

There are multiple families of network codes:



These families of network codes are all useful in order to have a development of the European grid network, in this document the Connection Network code family and its benefits is presented.

2. Connection Network Codes

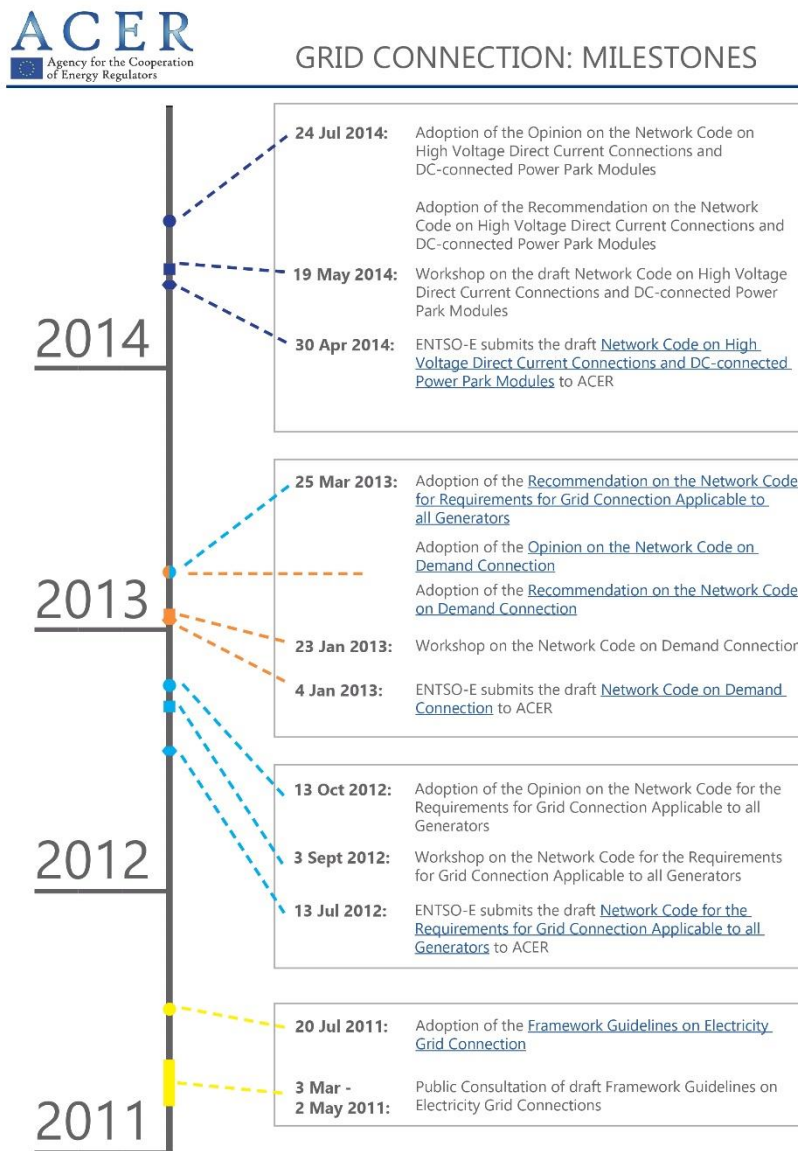
Grid connection, commonly referred to as network connection, is one of the domains covered by the specific network codes. These rules aim to support safe, reliable operations and a consistent foundation for electrical grid connections. This is particularly important given the system's growing reliance on renewable energy sources. European grid connection regulations, which also make it simpler to sell electricity inside the Union, also guarantee fair competition in the electrical market. The Framework Guidelines on Electricity Grid Connectivity, which ACER adopted on July 20, 2011, outline the specifications that must be included in the relevant network codes:

- Minimum standards and requirements for connection,
- Derogations,
- Adaptation of existing arrangements to the network codes,
- Compliance testing, monitoring and enforcement,
- Exchange of information between parties and improved coordination.

The network codes that result from these Framework Guidelines put a strong emphasis on achieving the requirements for renewable power and offering a way to integrate demand-response.

Three network codes were developed following the Framework Guidelines on Electricity Grid Connection:

- The Network Code for Requirements for Grid Connection Applicable to all Generators (**RfG Regulation**), entered into force on 17 May 2016,
- The Network Code on Demand Connection (**DCC Regulation**), entered into force on 7 September 2016,
- The Network Code on HVDC Connections and DC Connected Power Park Modules (**HVDC Regulation**), entered into force on 28 September 2016.



3. Demand Connection Network Codes

The Demand Connection Network Code (DCC Regulation) establishes uniform standards for integrating demand response and connecting sizable renewable energy producing facilities. The code will make it easier to integrate 11 gigawatts of demand response and 260 gigawatts of photovoltaic and wind energy throughout Europe, which is almost a tripling of the continent's existing installed capacity (which could mean the sparing of 11 coal generation plants).

You may find the complete policy at the [link](#).

The DCC Regulation provides that:

- New transmission-connected demand and distribution facilities, new distribution systems, and demand units providing demand response are all subject to the connection standards (including any pumping module within the station that provides pumping mode only).
- Where the Regulation's standards are not met and, if applicable in a Member State, when a derogation is not approved by a regulatory or other authority, the relevant system operator has the right to deny the connection.
- Demand facilities and distribution systems connected to transmission and distribution networks of islands of Member States that are not operated synchronously with either Continental Europe, Great Britain, Nordic, Ireland, and Northern Ireland, or Baltics synchronous area should not be subject to the connection requirements. With the exceptions noted, the DCC Regulation will not be relevant to any existing transmission-connected demand facility, distribution facility, or current distribution system.
- The Regulation does NOT apply to storage devices except for pump-storage power generating modules that only provides pumping mode that will be treated as a demand facility

4. High Voltage Direct Current Connection Network Codes

The High Voltage Direct Current Connections Network Code (HVDC Regulation) establishes the requirements for the connection of HVDC systems. These are used to link offshore wind parks to mainland or to connect countries over long distances (for example the longest existing interconnector in Europe, NorNed, links Norway and The Netherlands with an HVDC submarine cable of 580 km long).

You may find the complete policy at the [link](#).

The HVDC Regulation provides that:

- The connection requirements apply to embedded HVDC systems within one control area and connected to the transmission network, as well as embedded HVDC systems within one control area and connected to the distribution network when a cross-border impact is shown by the relevant TSO. They also apply to embedded HVDC systems connecting power park modules to a transmission network or a distribution network. If a new HVDC system or DC-connected power park module does not meet the requirements and, when applicable in a Member State, is not covered by an exemption granted by a regulatory or other body, the relevant system operator may refuse to connect it.
- Unless there is a significant cross-border impact, the connection standards do not apply to HVDC networks whose connection point is below 110 kV. The HVDC systems and DC-connected power park modules connected to the transmission and distribution systems of islands of Member States whose systems are not operated synchronously with either the Continental Europe, Great Britain, Nordic, Ireland and Northern Ireland or Baltic synchronous area are exempt from the provisions of the Regulation.
- Certain provisions of the Regulation do not apply to a system having at least one HVDC converter station owned by the relevant TSO or the HVDC system owned by an entity controlling the relevant TSO.
- Existing HVDC systems and existing DC-connected power park modules are not subject to the Regulation.

5. Requirement for Generators Connection Network Codes

The network code on the requirements for generators (RfG Regulation) establishes a set of harmonized rules for generators to connect to the grid, namely synchronous power-generating modules, power park modules and offshore power park modules.

These harmonized standards across Europe will boost the market of generation technology and increase competitiveness.

You may find the complete policy at the [link](#).

The RfG Regulation provides that:

- The connection standards apply to new power-generating modules, including units or groups of units that generate energy connected to the network or via power electronics, as well as pump-storage power-generating modules if they meet the necessary criteria. However, certain restrictions do not apply to facilities' power-generating units for combined heat and power production that are integrated into industrial sites' networks (unless otherwise stated in the national framework).
- If a power-generating module does not follow to the Regulation and is not exempt from it, connection to the grid may be refused.
- The connection requirements do not apply to existing power-generating modules.
- The requirements do not apply to the power-generating modules classified as an emerging technology.
- The Regulation does not apply to power-generating modules connected to the transmission and distribution systems that are not operated synchronously with either Continental Europe, Great Britain, Nordic, Ireland and Northern Ireland or Baltic synchronous area. This system shares the same utility frequency and is electrically tied together during normal system conditions.
- Power-generating modules used by system operators to temporarily supply power when normal system capacity is partially or totally unavailable and do not have a permanent connection point are not covered by the Regulation.
- With respect to power-generating modules embedded in the networks of industrial sites, power-generating facility owners, system operators of industrial sites and relevant system operators whose network is connected to the network of an industrial site shall have the right to agree on conditions for disconnection of such power-generating modules together with critical loads, which secure production processes, from the relevant system operator's network.
- Storage devices are NOT subject to the Regulation.

6. Implementation and Monitoring

ACER and ENTSO-E monitor the implementation of the RfG Regulation, DCC Regulation and HVDC Regulation.

These tasks usually serve two purposes. First, ACER and ENTSO-E keep an eye on how well TSOs are implementing the standards and rules. In order to promote market integration, non-discrimination, effective competition, and the efficient operation of the market, ENTSO-E and ACER monitor the impact of the harmonization of applicable rules once the specific requirements have been put into place. Both aspects will be addressed in different monitoring reports issued by ACER and ENTSO-E.

Moreover, in order to ease the implementation, a variety of CNC – Implementation guidance documents for connection network codes are available on the ENTSO-E website at the [link](#).

6.1 Requirements for Generators Monitoring

The first Implementation Monitoring Report of the Network Code on Requirements for Grid Connection Generators was published by the Agency in October 2017.

This report covered:

- Non-binding guidance of implementation
- List of Relevant information for implementation monitoring
- Criteria for granting derogations
- Transitional arrangements for emerging technologies

The Agency also monitored the effects of all the provisions applied after the end of the transitional period (from 17 May 2016), as well as on the harmonization of applicable rules.

In 2019 and 2020 ACER published respectively the Second and Third Implementation Monitoring Report on the Network Code on Requirements for Grid Connection of Generators.

These reports included:

- Application of the NC RfG to PGMs
- Non-exhaustive requirements
- Operational notification procedure and
- Amendments of contracts and general terms and conditions

6.2 DCC and HVDC Regulation Monitoring

The Agency released its initial Implementation Monitoring Report for the Network Code on Demand Connectivity in August 2018. This report details the Network Code's requirements for grid connection of high voltage direct current systems and direct current-connected power park modules.

The implementation status of the specific NC DCC provisions that were due by mid - 2018 was reviewed in the report.

This report included:

- Non-binding guidance on implementation.

- List of relevant information for implementation monitoring; and
- Criteria for granting derogations.

The second edition of ACER Implementation Monitoring Report on the Network Code on Demand and HVDC Connections was published in December 2020. This report covered:

- Application of the NC DC and NC HVDC to all relevant users
- Requirements of general application
- Interim operational notification procedure, and
- Amendments of contracts and general terms and conditions

6.3 Requirements for Generators Monitoring

In November 2021, ACER released the follow-up Report on Monitoring the Implementation of the Grid Connection Network Codes. The document provides an updated analysis of the compliance issues identified in previous monitoring exercises by clustering them in seven topics concerning NC RfG and seven topics concerning NC DC and NC HVDC, including:

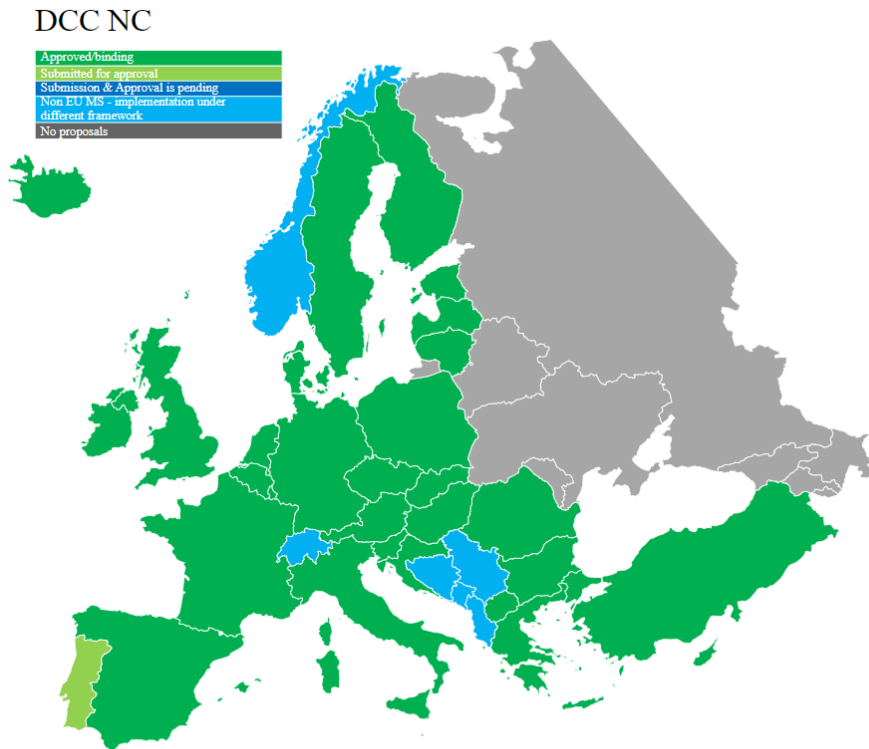
- the approval of the requirements of general applications, and
- the presence of discrepancies (at national level) compared to the values in the corresponding Network Codes.

6.4 Current Situation in the European Union

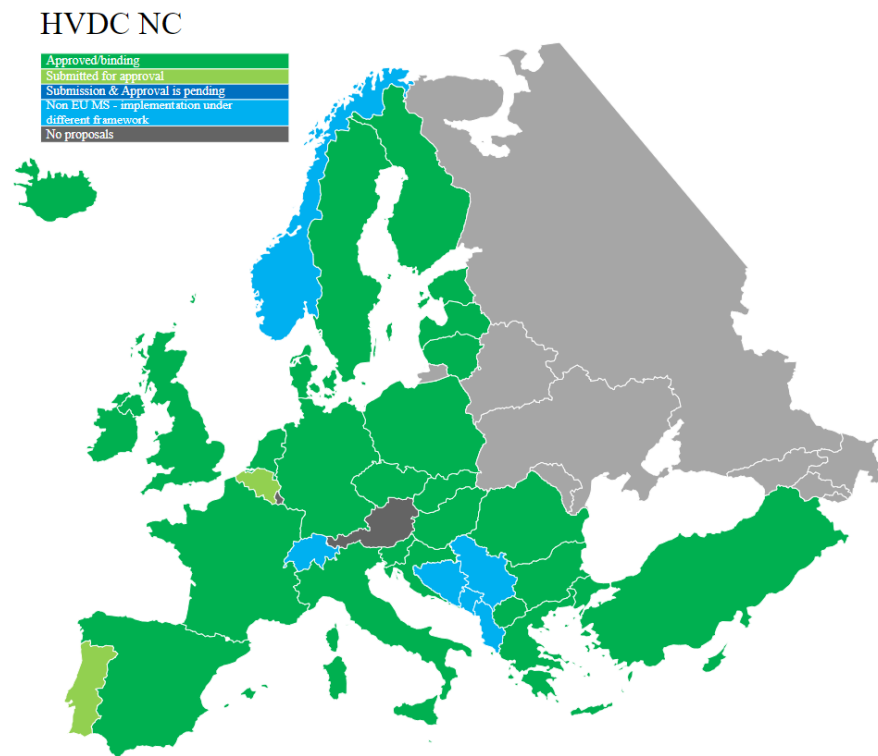
ENTSO-E's monitoring of the implementation of the Regulations covers in particular the identification of any divergences in the national implementation, and the assessment on whether the selection of values and ranges in the requirements applicable to power-generating modules continues to be valid.

At CNC ActiveLibrary is possible to view a monitoring file that can be downloaded which summarizes all the proposals for non-exhaustive requirements for all Connection Network Codes and their status for all the countries under the scope. Moreover, is possible to visualize the regulatory documents provided by the local TSO. From the below figures is possible to have a general idea about the current situation for the three different connection network codes that have been presented.

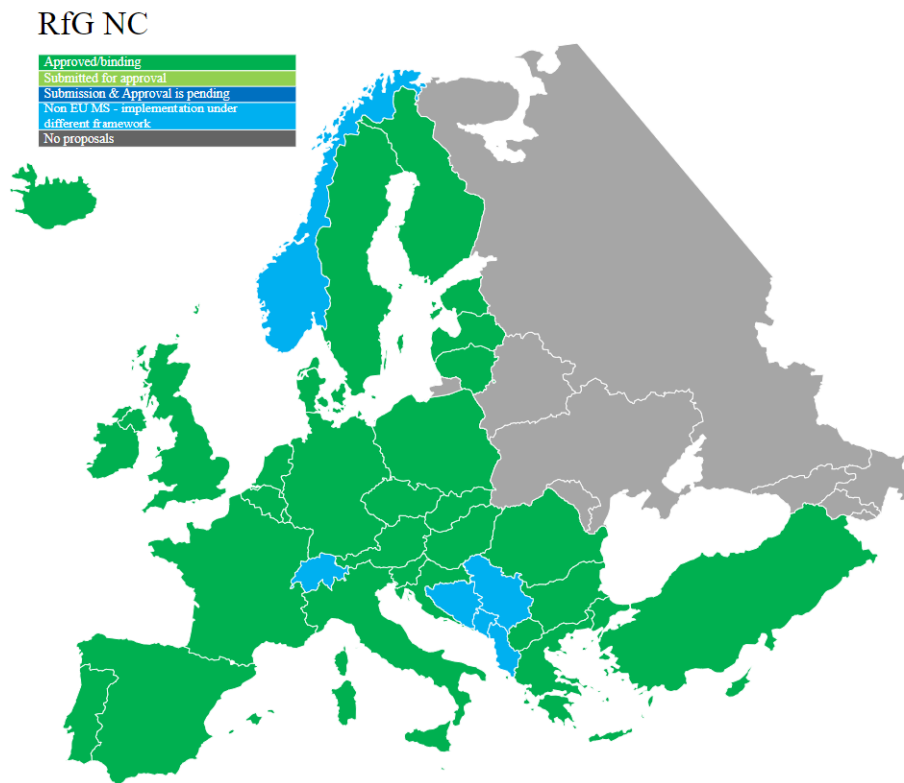
6.4.1 Demand Connection Code Network Code.



6.4.2 High Voltage Direct Current Network Code



6.4.3 Requirements for Generators Network Code



More details can be seen in the Monitoring Report on Connection Network Codes Implementation published in December 2021. ([Link](#))

7. Amendment to the Connection Network Codes

The EU Commission asked ACER to start the procedure for changing the current EU network codes. After releasing a draft Policy Paper in May 2022, ACER solicited early input from interested parties at a public workshop and public consultation in June 2022. (access the responses of the June 2022 public consultation in the Evaluation of Responses Report). A thorough public consultation has been held by ACER from September 26 to November 21, 2022.

The objective is to upgrade the network codes so that the EU power grid can better handle new technologies like e-mobility, storage, and energy communities.

7.1 Policy Paper

The primary areas to improve the Network Code on Requirements for Grid Connection of Generators and the Network Code on Demand Connection were outlined in general terms by ACER in its Policy Paper, which was issued in September.

In light of feedback from stakeholders over the summer of 2022, the ACER Policy Paper on Grid Connection Network Codes reflects ACER's thoughts on potential changes to the grid connection network codes.

The Policy Paper addresses potential amendments to the European network codes concerning among others:

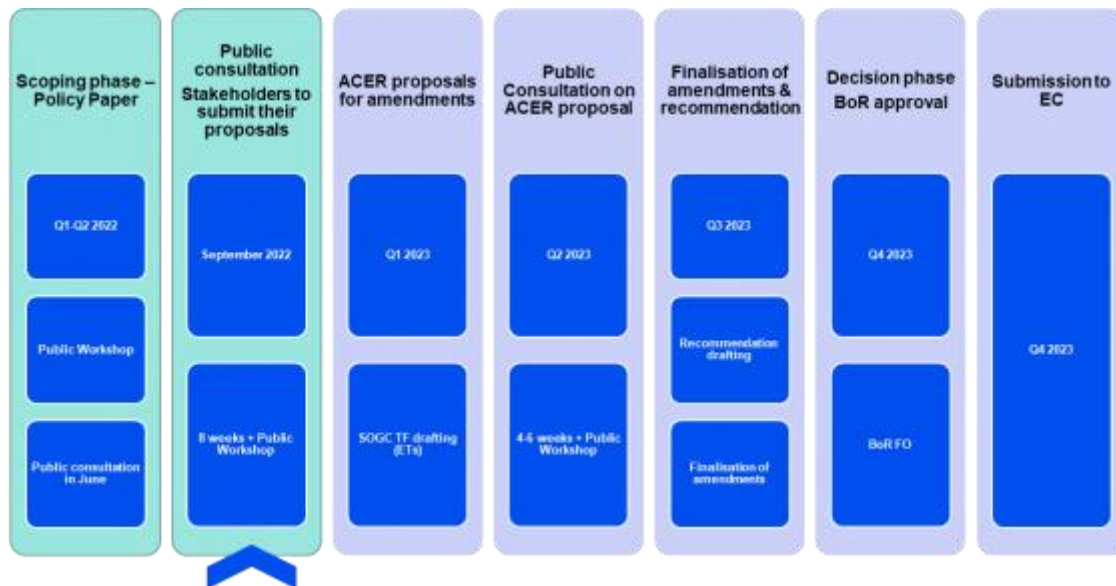
- technical requirements for storage, mobile storage (e.g., electric vehicles) and electrical charging points;
- requirements for mixed customer sites (MCSs), active customers and energy communities;
- significant modernisation of system users' facilities and equipment;
- advanced capabilities for grids with significant distributed energy resources (DER) and converter-based technologies; and
- criteria to determine generators significant for the system

7.2 Next Steps in Europe Future Scenarios

Following the full-fledged public consultation, ACER will consider the suggestions for changes made by stakeholders. Submissions with a motivation should help ACER's own suggestions for network code revisions, which will be written in Q1 2023. Then, in Q2 2023, ACER will conduct a public consultation on its proposed amendments.

By the end of 2023, ACER intends to submit its suggested changes to the grid connection network codes to the European Commission.

The workplan of activities planned by ACER in this new scenario policy deployment is presented in the figure below



8. Bibliography

- https://www.entsoe.eu/network_codes/
- <https://www.acer.europa.eu/electricity/connection-codes/history>
- <https://www.acer.europa.eu/electricity/connection-codes>
- https://www.entsoe.eu/network_codes/rfg/
- https://www.entsoe.eu/network_codes/dcc/
- https://www.entsoe.eu/network_codes/hvdc/
- https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2016.223.01.0010.01.ENG#d1e307-10-1
- <https://www.acer.europa.eu/electricity/connection-codes/demand-connection>
- <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32016R1447#d1e211-1-1>
- <https://www.acer.europa.eu/electricity/connection-codes/high-voltage-direct-current-connections>
- https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:JOL_2016_112_R_0001#d1e1386-1-1
- <https://www.acer.europa.eu/electricity/connection-codes/implementation>
- <https://www.acer.europa.eu/electricity/connection-codes/monitoring>
- <https://www.acer.europa.eu/electricity/connection-codes/requirements-for-generators>
- https://www.entsoe.eu/network_codes/cnc/cnc-igds/
- https://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Publication/First%20ACER%20Implementation%20Monitoring%20Report%20of%20the%20Network%20Code%20on%20Requirements%20for%20Grid%20Connection%20of%20Generators.pdf
- https://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Publication/Second%20ACER%20Implementation%20Monitoring%20Report%20of%20the%20Network%20Code%20on%20Requirements%20for%20Grid%20Connection%20of%20Generators.pdf
- https://acer.europa.eu/Official_documents/Acts_of_the_Agency/Publication/3rd%20edition%20NC%20RfG%20implementation%20monitoring%20report%202020.pdf
- https://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Publication/Demand%20connection%20NC%20and%20requirements%20for%20grid%20connection%20NC.pdf
- https://acer.europa.eu/Official_documents/Acts_of_the_Agency/Publication/2nd%20edition%20Monitoring_Report_NC_DC_and_NC_HVDC%20Implementation%202020.pdf
- https://acer.europa.eu/Official_documents/Acts_of_the_Agency/Publication/Report_on_GCNCs_monitoring_final.pdf
- <https://www.entsoe.eu/active-library/codes/cnc/>
- https://eepublicdownloads.azureedge.net/clean-documents/Network%20codes%20documents/CNC/211202_Implementation_Monitoring_Report_2021_final_f2867db293.pdf
- https://acer.europa.eu/Official_documents/Public_consultations/PC_2022_E_02/GCNCs%20Policy%20Paper-%20public%20consultation.pdf
- <https://www.acer.europa.eu/public-events/acer-ceer-public-workshop-potential-amendments-european-grid-connection-network-codes>
- https://extranet.acer.europa.eu/Official_documents/Public_consultations/Pages/PC_2022_E_02.aspx
- <https://www.acer.europa.eu/sites/default/files/documents/Media/News/Documents/260908%20ACER%20GCNCs%20Evaluation%20of%20PC.pdf>
- <https://acer.europa.eu/documents/public-consultations/pc2022e08-public-consultation-amendments-grid-connection-network>
- https://www.acer.europa.eu/sites/default/files/documents/Media/News/Documents/260908%20ACER%20GCNCs%20Policy%20Paper_final.pdf