

Connection Network Codes – Implementation in the EU Member States

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ENTSO-E in numbers



43 TSOs, **36** countries



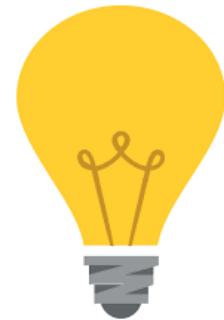
500+ million
citizens served



478 132 km
cross-frontier
transmission
lines



1 136 795 MW
net generation capacity



3 597,1
TWh electricity
consumption



424 139 GWh of
electricity exchanged
between TSOs

ENTSO-E the link between EU institutions and power networks



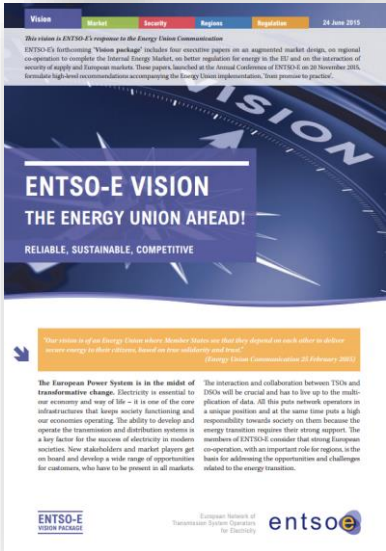
What does ENTSO-E do?

Contributes to the design and implementation of the Internal Energy Market

Develops the necessary IT tools for enabling the implementation

Provides regular reporting and recommendations for the development of the network

Develops pan-EU Research and Innovation plans.



The EU network codes: Made-in Europe rulebook for the smart system of the future

3 Market

- Capacity calculation
- Capacity Allocation and Congestion Management (CACM)
- Electricity Balancing

2 Operation

- Emergency and Restoration
- System Operation

3 Connection

- HDVC
- Demand connection
- Requirements for generators

All approved by
Member States

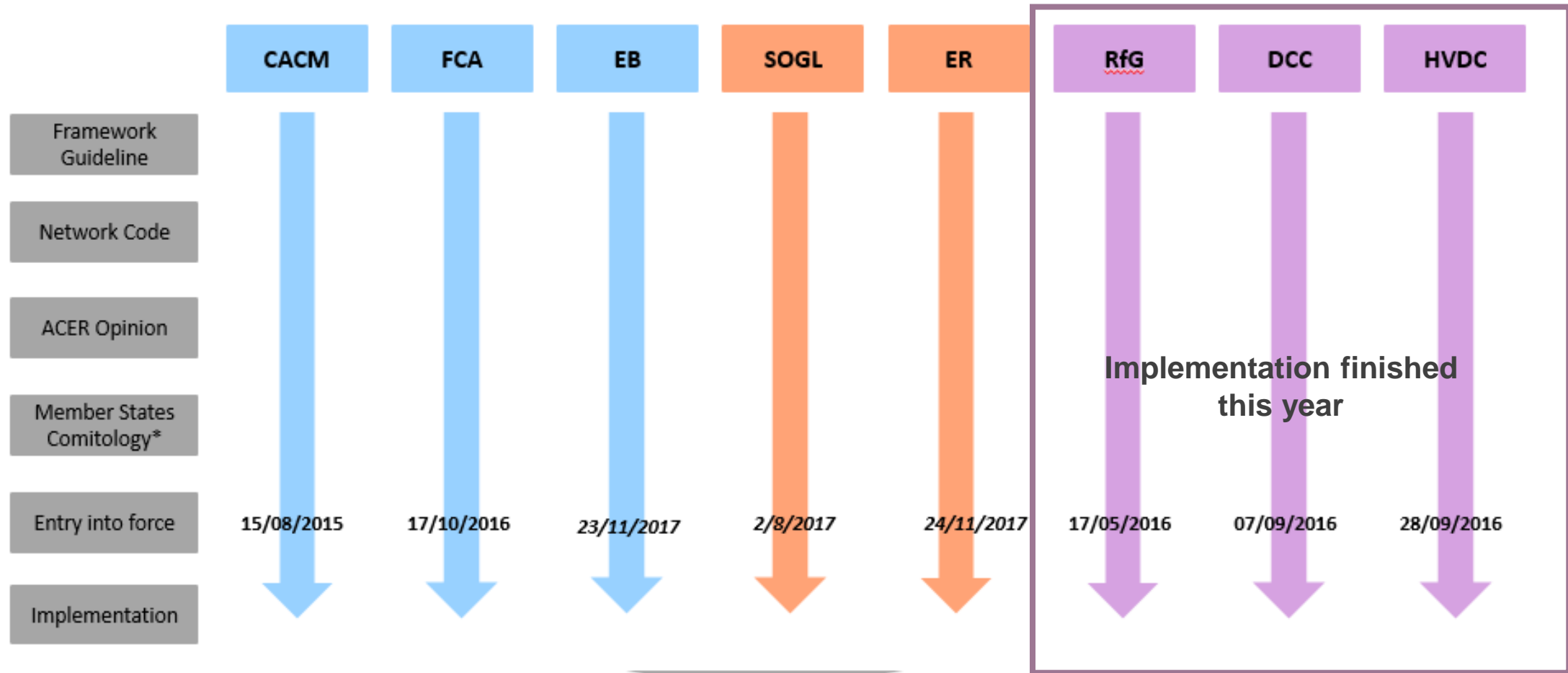
2017

FULL
implementation

2022


5 years

Ongoing implementation of the NCs until 2022 – CNCs are now applicable



TSOs and ENTSO-E, together with ACER and all stakeholders are already in the **implementation phase**

Substantial progress has already been made thanks to early implementation process, pilot projects and voluntary coordination of TSOs.

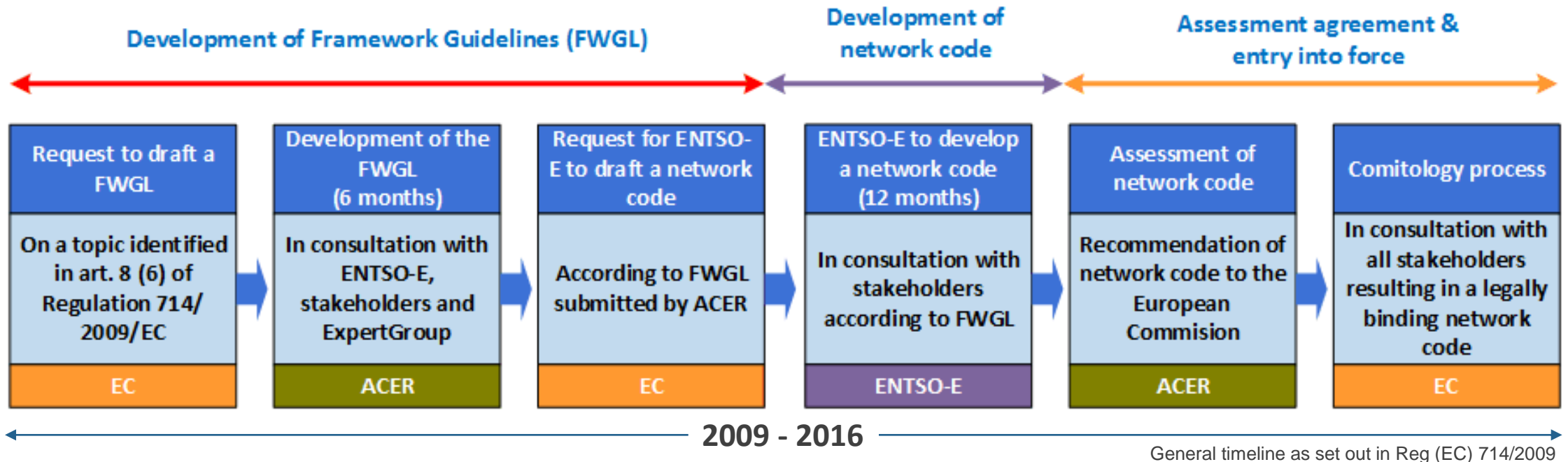


Background in CNC development and implementation

- **A 10-year project**

CNC development - A 10-year project

Joint effort by EC / ACER / ENTSO-E – with extensive Stakeholder engagement



General timeline as set out in Reg (EC) 714/2009

- **2016 – 2019**

- National implementation in the 28 EU Member States + aligned countries
- ENTSO-E implementation guidance by Implementation Guidance Documents (28 IGDs), consultations and workshops
- Discussions at the Grid Connection European Stakeholder Committee

- **≥ 2019**

- CNC application
- Identification of needs for amendments

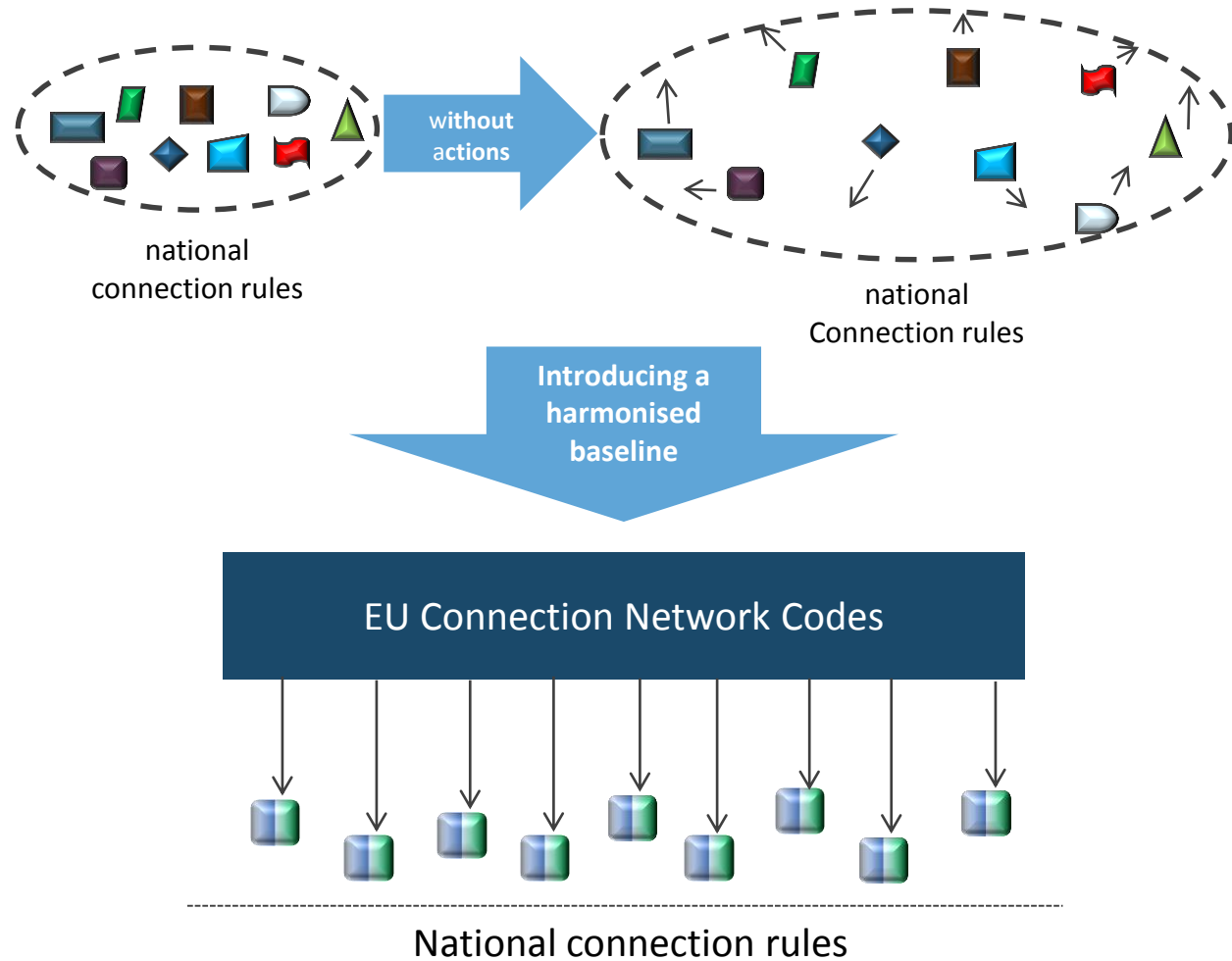
More information at:

https://www.entsoe.eu/network_codes/

The objective of Connection Network Codes (CNCs)

sustainability of connection requirements
over equipment life-cycles

- Build and maintain transmission networks for long-distance power flows
- Implementation of market mechanisms to facilitate a single European electricity market
- Continuous evolution and coordination of system operation
- Stable operation, robustness of and provision of ancillary services by system users



Guiding principle of CNCs – non-exhaustive requirements

To consider adequately regionally varying system needs/characteristics to ensure security of supply, but also to avoid unreasonably onerous requirements.

A non-exhaustive requirement at European level does not contain all the information or parameters necessary to apply the requirement, but needs to be further specified when implementing the Network Code at national level.

Site-specific non-exhaustive requirements to be considered on a case by case basis.

Non-exhaustive requirements of general application to be specified at either a synchronous area or national level through an established process, e.g. grid code review panel, user group, public consultation, regulatory or ministry approval

...other based on the Framework Guidelines on Electricity Grid Connections, 20/07/2011

- *Facilitate the integration of RES*
- *Retroactive applications subject to Cost Benefit Analysis (CBA)*
- *Alignment with standards (significant deviations to be justified)*
- *Derogations*
- *Acknowledge the distinct role of the DSOs*
- *Compliance testing/monitoring*

Connection Network Codes (CNCs)

Requirements for Generators (RfG) - Date of publication: 27.4.2016

COMMISSION REGULATION (EU) 2016/631 of 14 April 2016 establishing a network code on requirements for grid connection of generators

Demand Connection Code (DCC) - Date of publication: 18.8.2016

COMMISSION REGULATION (EU) 2016/1388 of 17 August 2016 establishing a Network Code on Demand Connection

HVDC Network Code (HVDC NC) - Date of publication: 8.9.2016

COMMISSION REGULATION (EU) 2016/1447 of 26 August 2016 establishing a network code on requirements for grid connection of high voltage direct current systems and direct current-connected power park modules

Selected CNCs commonalities

Entry into force: twentieth day following that of the publication

Date of application: by default three years after publication, unless provided otherwise by a Member State and without prejudice to certain articles, e.g. non-mandatory requirements, which can be introduced at any point in time

Equitable treatment: Connection to transmission or (public or closed) distribution network, Capacity (type A, B, C and D power generating modules), largely technology neutral, but with exceptions

Scope - CNCs don't apply to:

- system users which are connected to islands not operated synchronously with Continental Europe, Great Britain, Nordic, Ireland and Northern Ireland or Baltic synchronous areas
- storage devices except for pump-storage power generating
- existing system users, subject to CBA and NRA or, where applicable, a Member State approval

Mandatory and non-mandatory technical requirements which are exhaustively or non-exhaustively defined, the latter either of general application or site-specific

Compliance testing, simulation and monitoring requirements

No differentiation regarding stakeholder interaction

European Stakeholders Committees

- To contribute to monitor the progress in the NCs implementation process – as well as the application of the processes and arrangements established according to the NCs – at local, regional and pan-European level as an overarching structure of all network codes;
- To serve as a platform to share general views on the NC implementation, with a particular focus to enable stakeholders to express their views and receive feedback;
- To contribute to a more informed decision-making process for the methodologies and rules still to be developed for the implementation of the NCs.
- To initiate and facilitate technical and procedural discussions on the NC contents



https://www.entsoe.eu/network_codes/esc/

- Grid Connection Stakeholder Committee**
- Issue Logger
- Active Library
- Action List
- Expert Groups
- Members
- Terms of Reference
- Meetings**
- Presentations

Documents from 11/09/2019 Grid European Stakeholder Committee

[View Document List](#)

Documents from 05/06/2019 Grid European Stakeholder Committee

[View Document List](#)

Documents from 21/03/2019 Grid European Stakeholder Committee

National Implementation Process

National implementation is the Member States' prerogative

Defining the implementation process including the stakeholders involvement and approval procedures

Specifying the non-exhaustive requirements of general application

ENTSO-E supports with:

- Implementation guidance documents
- Overview of the national processes*

Overview of the national process is done through an Active Library where dedicated information on the implementation process in each country is publicly shared, unless confidentiality is claimed

<https://www.entsoe.eu/active-library/codes/cnc/>

ENTSO-E collects this information submitted by dedicated representatives for each country (not limited to EU Member States)

*when info available

Objectives of Implementation Guidance Documents

Implementation guidance shall...

...explain the technical issues, conditions and interdependencies which need to be considered when complying with the requirements of the Regulations

...inform and facilitate the national processes

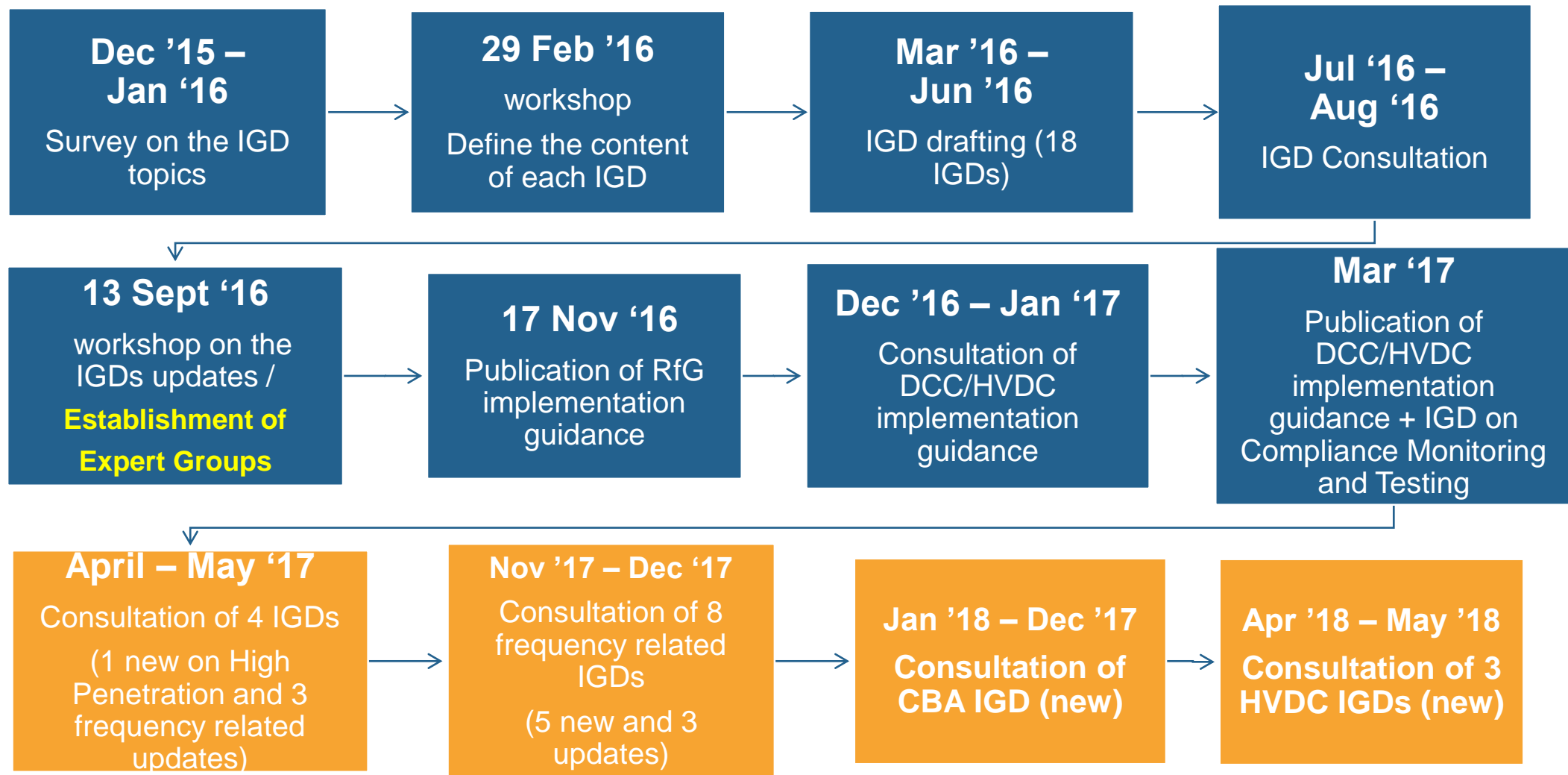
Implementation guidance shall not...

...ensure harmonized rules throughout the EU

...prejudge the national decisions nor lifting national decisions to a European level

...define the parameters of non-exhaustive requirements

Steps of ENTSO-E on RfG/DCC/HVDC implementation guidance



■ = beyond the legal mandate

Drafting of the IGDs

- Final drafts of the IGDs (before consultation) have been prepared and validated by ENTSO-E and the respective TSO experts
- In many cases ENTSO-E has conducted public workshops and surveys to gather consultation/guidance and information by the stakeholders to be considered for drafting the IGDs
 - E.g. the eight frequency-related IGDs were an outcome of a Roadmap that included one public survey and three public workshops before the final drafts were submitted for consultation.
- Expert groups have also been established to assist the development of some IGDs:
 - Compliance Monitoring and Testing
 - Cost Benefit Analysis
 - High Penetration of Power Electronic Interfaced Power Sources (HPoPEIPS)
- Interactions within the Grid Connection European Stakeholder Committee have facilitated the drafting of the IGDs

Implementation Guidance Documents and relevant stakeholder interaction

IGD	RfG	DCC	HVDC	Developed by Technical Group
Automatic connection/reconnection and admissible rate of change of active power	X			
Compliance monitoring	X	X	X	X
Cost benefit analysis	X	X	X	X
Demand Response – System Frequency Control		X		
Embedded HVDC systems – frequency schemes in case of system split			X	
Fault current contribution from PPMS & HVDC	X		X	X
Frequency ranges	X	X	X	
Frequency Sensitive Mode	X			
HVDC systems default parameters			X	
Harmonisation	X	X	X	

Implementation Guidance Documents and relevant stakeholder interaction

IGD	RfG	DCC	HVDC	Developed by Technical Group
High Penetration of Power Electronic Interfaced Power Sources (HPoPEIPS)	X		X	X
Instrumentation, simulation models and protection	X	X	X	
Interactions between HVDC systems and other connections			X	
Limited frequency sensitive mode	X			
Making non-mandatory requirements at European level mandatory at national level	X	X	X	
Maximum Admissible active power reduction at low frequencies	X			
Need for synthetic inertia (SI) for frequency regulation	X	X	X	
Parameters of Non-exhaustive requirements	X	X	X	

Implementation Guidance Documents and relevant stakeholder interaction

IGD	RfG	DCC	HVDC	Developed by Technical Group
Parameters related to frequency stability	X	X	X	
Post fault active power recovery	X		X	
Rate of Change of Frequency (RoCoF) withstand capability	X	X	X	
Reactive power control modes for PPM & HVDC	X		X	
Reactive Power Management at T – D interface		X		
Reactive power requirement for PPMS & HVDC at low / zero power	X		X	
Real time data and communication	X	X	X	
Selecting national MW boundaries	X			
Special issues associated with type 'A' generators	X			
Parameters related to voltage issues	X	X	X	

All IGDs can be found here: https://www.entsoe.eu/network_codes/cnc/cnc-igds/

All IGDs were subject to public consultation and many of them discussed in separate public workshops too

Terms of References of the Technical Groups found here: https://www.entsoe.eu/network_codes/cnc/technical-groups/

Structure of each IGD

Heading	Expected content
Codes(s) & Articles	CNCs covered Article references
Introduction	Briefly about the intended guidance and if useful what the requirement is for.
NC frame	Main body of guidance, key considerations. Process & methodology
Further info	Other sources of relevant information. References and where effective extracts IGDs by name External refs in full or to “other documents”
Interdependencies - Between the CNCs - With other NCs	Identify interaction of guidance to aspects in other Network Codes.
System characteristics	Consideration affecting the guidance, e.g. network characteristics and expected changes
Technology characteristics	Considerations affecting the guidance, e.g. technical limitations
Collaboration - TSO-TSO - TSO-DSO - RSO – Grid User	Aspects of collaboration between key parties
Example(s)	Examples of existing practices, e.g. high or low values already in operation / proven. References to work done already in countries in the lead on this topic
Exceptions from use of headings above	For non-technical / process IGDs e.g. CBA, choosing other headings may be preferable.

Frequency ranges IGD

Ranges	Synchronous area				
	GB	IE / NI	Baltic	Nordic	CE
47,0 Hz-47,5 Hz	20 seconds	-----	-----	-----	-----
47,5 Hz-48,5 Hz	90 minutes	90 minutes	To be specified by each TSO, but not less than 30 minutes	30 minutes	To be specified by each TSO, but not less than 30 minutes
48,5 Hz-49,0 Hz	To be specified by each TSO, but not less than 90 minutes	To be specified by each TSO, but not less than 90 minutes	To be specified by each TSO, but not less than the period for 47,5 Hz-48,5 Hz	To be specified by each TSO, but not less than 30 minutes	To be specified by each TSO, but not less than the period for 47,5 Hz-48,5 Hz
49,0 Hz-51,0 Hz	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
51,0 Hz-51,5 Hz	90 minutes	90 minutes	To be specified by each TSO, but not less than 30 minutes	30 minutes	30 minutes
51,5 Hz-52,0 Hz	15 minutes	-----	-----	-----	-----

IGD suggestions



Minimum time periods for which a power-generating module has to be capable of operating on different frequencies, deviating from a nominal value, without disconnecting from the network.

Ranges	Synchronous area	
	CE	Proposal of WG CNC
47,0 Hz-47,5 Hz	-----	-----
47,5 Hz-48,5 Hz	To be specified by each TSO, but not less than 30 minutes	30 minutes, but longer minimum time periods may be required for countries, which are exposed to a higher risk of islanding (e.g. peninsular area) to allow for an extended period of time for system restoration
48,5 Hz-49,0 Hz	To be specified by each TSO, but not less than the period for 47,5 Hz-48,5 Hz	30 minutes, but longer minimum time periods may be required for countries, which are exposed to a higher risk of islanding (e.g. peninsular area) to allow for an extended period of time for system restoration
49,0 Hz-51,0 Hz	Unlimited	Unlimited
51,0 Hz-51,5 Hz	30 minutes	30 minutes
51,5 Hz-52,0 Hz	-----	-----

Extract of the HVDC systems default parameters

Capability requirements – all requirements is referred to PoC	Mandatory (M) / Optional (O)	NC HVDC Article	Function	General (G) / Site specific (S)	HVDC	RE-HVDC	DC PPM	Proposed value(s) Note: references to NC HVDC unless otherwise specified
Frequency ranges (Annex 1, table 1)	M	11	FS	G	X	X		Annex 1, table 1 Ref – IGD on Frequency ranges. Values according to SAOA. (taken into account Annex VI NC HVDC)
Active power controllability, control range and ramping rate	O	13	FS	S	X	X		Minimum the capability required of Type D PPMs
Synthetic inertia	O	14	FS	S	X	X		Needs to be justified. Ref – IGD: Need for synthetic inertia (SI). SQ GL art 39 activities.
Frequency Sensitive Mode (FSM) (Annex II, figure 1)	M	15	FS	G	X	X		Annex II, figure 1 Ref – IGD on FSM Values according to SAOA.
Limited frequency Sensitivity Mode – over frequency LFSM-O (Annex II, figure 3)	M	15	FS	G	X	X		Annex II, figure 3 Ref – IGD on LFSM-O-U
Limited frequency Sensitivity Mode – under frequency (LFSM-U) (Annex II, figure 4)	M	15	FS	G	X	X		Annex II, figure 4 Ref – IGD on LFSM-O-U Values according to SAOA.
Frequency control	O	16	FS	S	X	X		No need identified.
Maximum loss of active power	M	17	FS	S	X	X		No need identified if not specified in the LFC area operational agreement.
Voltage ranges – from 110 kV to 300 kV (Annex, III, table 4)	M	18(1)	VS	G	X	X		Annex III, table 4 Minimum the same duration as for Type D PPMs

Frequency stability: FS;
Voltage Stability: VS;
Information exchange: INFO;
RE-HVDC: Remote End HVDC
PPM: Power Park Module



On-going work

Providing transparency

Active Library + Monitoring file <https://www.entsoe.eu/active-library/codes/cnc/>

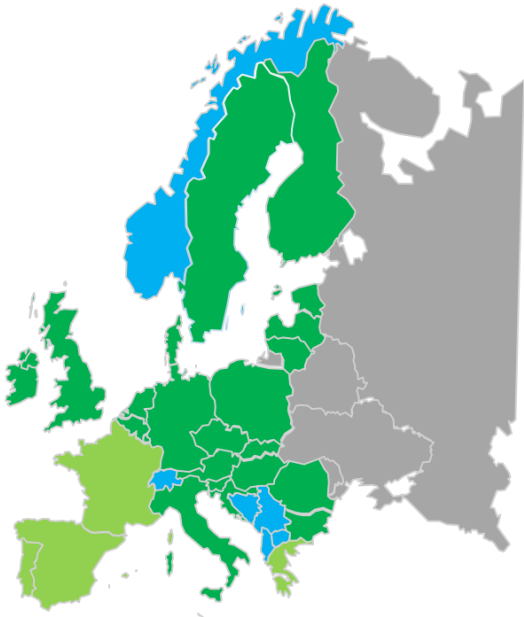
Issue Logger: To enhance public access to and exchange of information regarding the implementation of Network Codes and Guidelines approved in line with Regulation (EC) No 714/2009

<https://esc.network-codes.eu/>

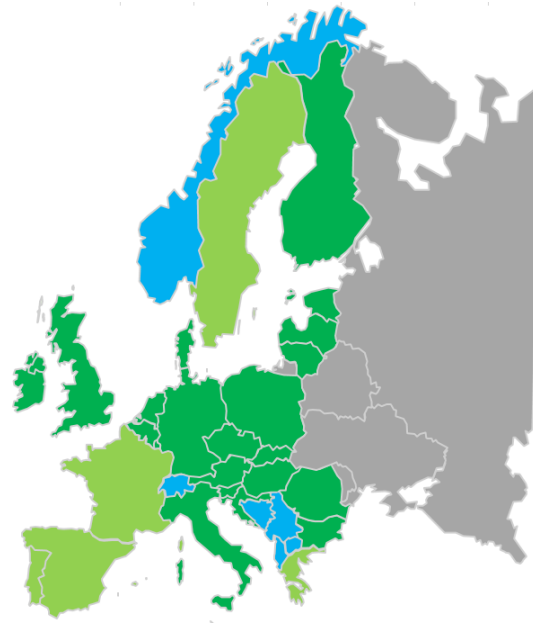
GC ESC: Relevant CNC updates + Minutes + Action list https://www.entsoe.eu/network_codes/esc/#gesc

CNC Implementation Monitoring – November 2019

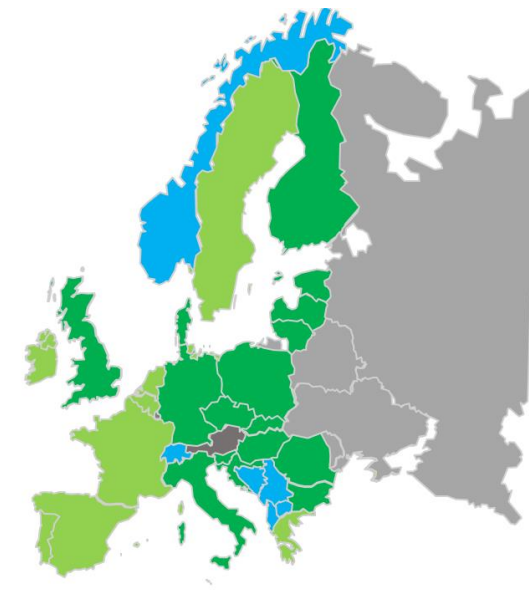
RfG NC



DC NC



HVDC NC



- In some countries there is partial approval e.g. thresholds approved but not all values of non-exhaustive requirements

Approved/binding
Submitted for approval
Non EU MS - implementation under different framework
No proposals

More details on the proposals of the TSOs [here](#)

Expert Groups

In accordance with the GC ESC ToR, the ESC Chair, acting upon a recommendation of the ESC, can propose a creation of time-limited or longer-term Expert Groups, which will focus on specific issues and projects or groups of projects. The topics should reflect considerations with relevance to CNCs, as recommended by the GC ESC.

The EGs will create a knowledge base which will remain publicly available and may be used as input information in potential amendment processes to the CNCs, if appropriate. The EGs do not initiate any process to amend the CNCs.

 https://www.entsoe.eu/network_codes/cnc/expert-groups/

EG PSH

Requirements for pump-storage hydro power generation modules.

Annex

EG PSH Reporting 14th GC ESC

EG PSH Reporting 13th GC ESC

EG PSH Reporting 12th GC ESC

EG STORAGE

Identification of storage devices.

Annex

EG STORAGE Reporting 14th GC ESC

EG STORAGE Reporting 13th GC ESC

EG STORAGE Reporting 12th GC ESC

EG MCS

Mixed customer sites with generation, demand and storage, and definition of system users.

Annex

EG MSC Reporting 14th GC ESC

EG MSC Reporting 13th GC ESC

EG MSC Reporting 12th GC ESC

Thank you for your attention!

Questions?
