ENTSO-E Annual Report 2017

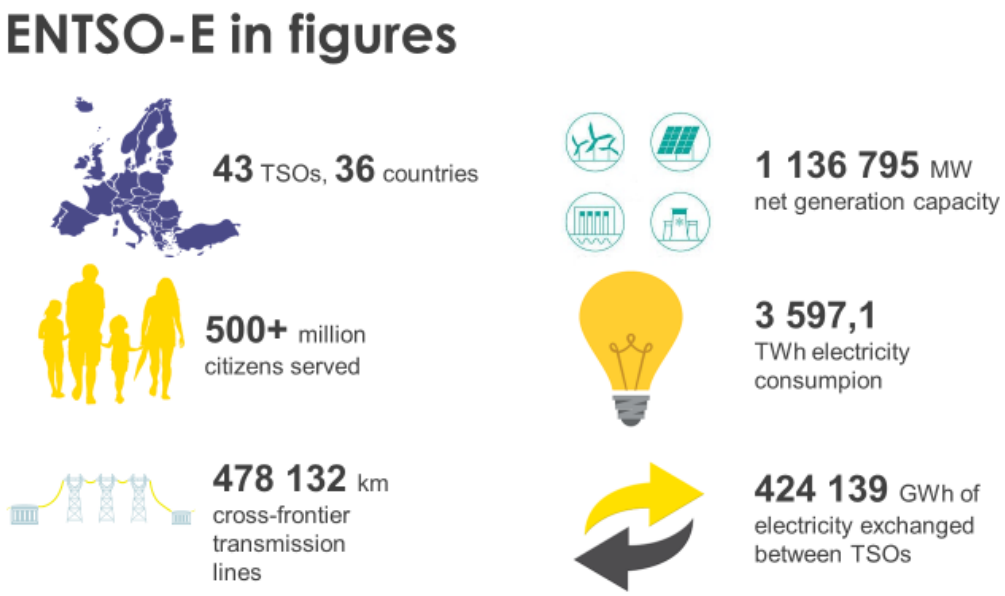
Final version

18 May 2018

Table of contents

About ENTSO-E

ENTSO-E, the European Network of Transmission System Operators, represents 43 electricity transmission system operators (TSOs) from 36 countries across Europe. ENTSO-E was established and given legal mandates by the EU's Third Legislative Package for the Internal Energy Market in 2009, which aims at further liberalising the gas and electricity markets in the EU.



About this Annual Report

ENTSO-E's Annual Report is a legally mandated document, released every year and submitted to ACER for Opinion (Article 8(3)(e), Regulation 714/2009). ENTSO-E's Annual Report 2017 covers activities that took place between 1st January and 31st December 2017. Because the release date is expected in Q2 2018, and to ensure the reader is better informed, it also includes relevant activities that took place between 1st January 2018 and 31st March 2018.

Highlights of 2017

- Entry into force of the three remaining network codes - System Operation Guideline, Electricity Balancing Guideline, Emergency & Restoration Network Code.
- Following the cold spell of January 2017, ENTSO-E improved its methodology to anticipate and respond to critical grid situations.
- ENTSO-E and ENTSOG developed common scenarios as part of their Ten-year Network Development Plans, co-constructed together with stakeholders, and aimed at reducing CO2 emissions by 80 to 95% by 2050.
- ENTSO-E completed the first phase of a major evolution plan of its Transparency Platform to improve the quality and readability of the data.

- ENTSO-E has decided in 2017 to prioritize until 2022 the six following topics: Provide leadership on the future power system and facilitate market design solutions; develop a new ICT approach and capability, including cyber security; develop the DSO partnership; coordinate and facilitate regional developments; develop transparency; and develop a solid governance of ENTSO-E and strengthen long-term financial planning.
- As a result of ENTSO-E's legal mandates, especially the development of the Common Grid Model, the Assembly decided to increase ENTSO-E's budget by 40%.

Executive summary

This Annual Report 2017 looks back at the achievement of the objectives set in our annual work programme for 2017 and at the main challenges we met in its completion. Our work programme foresaw five main areas of activity: the implementation of the network codes; the planning of the future grid, including adequacy and innovation; the implementation of the single electricity market; connecting with neighbouring regions; and work on improving transparency and closer cooperation with stakeholders.

2017 saw the turning of a page, as the three remaining codes (the System Operation Guideline, the Electricity Balancing Guideline and the Emergency and Restoration Network Code) entered into force, triggering a countdown for many of the implementation deliverables specified in the codes (Chapter 1). The implementation of the CACM Regulation is already well under way while the implementation of the latest codes to enter into force will take place over the coming years, as late as 2022 for the Emergency & Restoration Code. Progress has been made in the development of the Common Grid Model and of its information platform the OPDE, who are instrumental in the implementation of the CACM and FCA regulations and of the SO Guideline.

ENTSO-E has been tasked by Regulation 714/2009 with a monitoring role, looking in particular at the network codes' effect on the harmonisation of applicable rules aimed at facilitating market integration. Our analysis on the implementation of the single day-ahead and intraday coupling in 2017 highlights the progress made in the delivery of implementation deliverables including the Multi-Regional Coupling project and the intraday market coupling project XBID. It also points to some expected challenges, notably the establishment of the CORE Capacity Calculation Region, for all parties involved including TSOs, NEMOs and NRAs.

Chapter 2 details the development of ENTSO-E's Ten-Year Network Development Plan (TYNDP) 2018 and its set of scenarios, elaborated for the first time jointly with ENTSOG and stakeholders. The TYNDP 2018 has evolved in its methodology, regarding the involvement of stakeholders, regulators and member states, as well as the indicators considered and the modelling approaches. A novelty in the TYNDP package, the pan-European system needs analysis 'Europe Power System 2040: completing the map' examines the need for additional capacity increases. It finds significant costs – environmental and in terms of electricity supply - of not investing in the network. The 207 applications received from transmission and storage projects will, after a cost-benefit analysis and selection, feed into the TYNDP 2018 to be released this summer.

The cold spell in the winter of 2016-2017 put the spotlight on our adequacy work (Chapter 3). Our special report 'Managing critical grid situations' and the accompanying market analysis identified focus areas for action to better anticipate and respond to similar events in future. The measures singled out to detect critical grid situations were implemented in time for the Winter Outlook 2017-2018, which examines worst-

case situations that could occur in 1 year out of 20 (instead of 1 year out of 10 previously) and analyses the risks associated with extreme climate conditions taking place simultaneously in all of Europe.

Looking at the next decade, the findings of the Mid-term Adequacy Forecast 2017 point in particular to the important effects of climate conditions and to complex and strong system interdependencies, calling for a pan-European perspective.

Regarding innovation (Chapter 4), ENTSO-E plans and coordinates TSOs' R&I efforts and promotes the real-life application by TSOs of R&D results (see our R&I Application Report released last June, with 20 concrete examples). We integrate TSOs' R&I activities with those of all other energy stakeholders to support Europe's energy transition via the ETIP SNET.

Our R&D work focuses for a large part on developing solutions for the TSO-DSO partnership. That partnership is becoming increasingly important due to the increase in decentralised systems, the development of demand-response and the inclusion of new actors, e.g. aggregators, in the market. We participate in the Horizon 2020-supported project TDX-Assist, which aims at designing and developing new, modern and safer ICT tools and techniques that enable information and data exchange between TSOs and DSOs. In addition to R&D projects, ENTSO-E is working closely with DSOs' representatives at EU level – EDSO for Smart Grids, eurelectric, Geode and CEDEC – and stakeholders to develop common positions on data management, active system management and the use of distributed flexibility.

ENTSO-E and the Transparency User Group have brought a number of improvements to the Transparency Platform (Chapter 5). Work conducted in 2017 covered data quality and readability, while the platform's user-friendliness is being tackled in 2018.

ENTSO-E ensures TSOs coordinate the operation of their networks (Chapter 6), via the use of common network operation tools. Among these tools, ENTSO-E's Awareness System, allowing TSOs to monitor energy flows and the state of the network across Europe in real time, is being upgraded and reviewed to ensure compliance with the System Operation Guideline. The physical infrastructure connecting TSOs, the 'Electronic Highway', is being merged with ATOM, the data exchange communication network used for the Common Grid Model, thus creating one single physical infrastructure for TSOs' communication network. The Common Grid Model (see Chapter 1) is the foundation for running the five services provided by Regional Security Coordinators, and as such is the basis for TSOs' coordination at regional level.

ENTSO-E views the arrival of increasingly advanced digital technologies as an opportunity to foster coordination even further. We have developed over the course of 2017 a digital strategy, that looks at designing a new IT architecture to allow TSOs and market players to take advantage of the digital transformation to design more efficient processes and methods. Its implementation began in 2017 with, as a first step, a new governance for ENTSO-E's IT-related activities.

This annual report features an assessment of our transparency and openness to stakeholders over 2017 (Chapter 7). Its findings are mixed. Innovative engagement activities have been undertaken, such as the creation of the network codes issue logger tool and a training on network codes. The overall feedback received from stakeholders is encouraging (3.6% increase in our stakeholder survey compared to 2016); in particular, our independent Advisory Council is perceived as making our governance, decision-making and work product deliberations more transparent and accessible. However, specific points are flagged for improvement, especially as regards our consultation process. The overwhelming majority of our legally mandated tasks foresee a public consultation. ENTSO-E is currently reviewing its consultation rules and

assessing potential options so that stakeholders are better informed and have more time to contribute, and the overall process is less constraining.

Finally, Chapter 8 provides an overview of the financial and staff resources engaged to deliver our work programme. In 2017 our result showed a loss of -0,7 M€. A 40% increase of the budget to 28,7 M€ was decided for 2018, driven by our mandate to deliver the Common Grid Model.

1. Network codes: One set of rules

Building a secure, competitive and low-carbon European electricity sector and the internal energy market are ambitious targets, based on a common set of rules. These rules are the network codes. The codes are a technical rulebook, that complements existing legislation by defining a common 'code of conduct' for all. Generators, grid operators, traders and all other players in the sector will adopt the same practices and business processes.

State of play: where do we stand after eight years?

> ENTSO-E shall elaborate network codes in the areas referred to in paragraph 6 of this Article upon a request addressed to it by the Commission in accordance with Article 6(6) (Regulation 714/2009, Article 8(1))

Between 2009 and March 2017, ENTSO-E has developed, jointly with ACER and stakeholders, eight network codes. The approval of the Electricity Balancing Guideline by EU member states in March 2017 marked the end of that process. All codes have now entered into force, and ENTSO-E's resources are now mostly focused on their implementation, detailed hereafter. The codes need to remain up-to-date with market and technological developments. Their review is an ongoing process which ENTSO-E will work on jointly with ACER over the years to come.

The codes are grouped into three families:

- **Market codes** move market integration forward, for more competition and resource optimisation. They set rules for capacity calculation and allocation, day-ahead and intraday markets, forward markets and balancing markets.

The CACM Regulation entered the third year of its official implementation period in August 2017. The Forward Capacity Allocation Regulation entered its second year of implementation in October 2017. Finally, the Electricity Balancing Guideline was approved in comitology in March 2017 and entered into force on 18 December 2017. Several implementation projects at the European and regional levels are already ongoing or planned.

- **Operational codes** reinforce the reliability of the system through state-of-the-art and harmonised rules for operating the grid. They cover system operation, regional cooperation and emergency situations.

The System Operation Guideline entered into force on 14 September 2017 and the Emergency and Restoration Network Code on 18 December 2017. Several implementation projects with deliverables on the pan-European and regional levels have already begun.

- **Connection codes** set the EU-wide conditions for linking all actors safely to the grid, including renewables and smart consumption. They include the technical requirements for generation and demand facilities and high-voltage direct current (HVDC) connections.

Although their implementation is the responsibility of each EU member state, ENTSO-E acts as a platform to share information and good practices, especially through the publication of implementation guidance documents. ENTSO-E also monitors the implementation of the three codes, looking in particular at divergences in national implementation.

THE CODES BEYOND THE EU

ENTSO-E's membership includes non-EU countries, including Albania, Bosnia and Herzegovina, Switzerland, Iceland, Montenegro, FYR of Macedonia, Norway, Serbia and Turkey as observer. These countries, depending on their legal ties with the EU, may have to implement the network codes. For example, Norway must implement the 3rd package and the network codes, while Switzerland does not have an electricity agreement with the EU and does not implement the network codes.

Implementing the codes: A collective exercise

Entry into force of the codes means they become binding EU law, to be applied by European and national players. Implementation often requires a combination of national decisions, regional agreements, and pan-European methodologies and tools. All market participants, DSOs, TSOs and regulators are involved in various ways.

WHAT ARE ENTSO-E AND TSOS' ROLES IN THE IMPLEMENTATION?

The codes define which entity is responsible for each implementation task.

- ENTSO-E oversees part of the implementation tasks.
- Additionally, ENTSO-E facilitates the tasks attributed to 'all TSOs'. 'All TSOs' refers to the TSOs of all EU countries (pan-European 'all TSOs'), or to the TSOs of a specific EU region (regional 'all TSOs'). The TSOs whose countries are not member of the EU are also involved in the development phase. Because TSOs have decided that ENTSO-E's structures are the most suitable vehicle to facilitate the delivery of pan-European tasks and some regional tasks, ENTSO-E facilitates the decision-making process. However, the validation of the deliverables to be submitted to NRAs is made by 'all TSOs', not by ENTSO-E.

Once submitted to all EU NRAs (or to those of the respective region), all NRAs must similarly reach a decision to formally adopt the deliverable and make it legally binding. In case they cannot reach a consensus, a safety net process involving ACER is foreseen.

TASK	RESPONSIBILITY	APPROVAL	
ENTSO-E	ENTSO-E	ACER	
Pan-European 'All TSOs'	All TSOs (with ENTSO-E acting as facilitator)	All NRAs	Stakeholders involvement from European and regional groups to national bodies
Regional 'All TSOs'	TSOs of the region (with ENTSO-E acting as facilitator for some tasks)	NRAs of the region	
National	Depending on national legislation (TSO, DSO)	National NRAs	Monitoring by ACER, EC, ENTSO-E

EUROPEAN STAKEHOLDER COMMITTEES

Implementing the codes requires the involvement of the whole electricity community, at the EU, regional and national levels. Implementation tasks for all codes require extensive public consultations and the organisation of workshops involving stakeholders. In addition, ACER and ENTSO-E have set up European Stakeholders Committees, with three main missions:

- to contribute to a more informed decision-making process for the methodologies and rules still to be developed;
- to monitor progress in implementation;
- to serve as a platform to share general views on implementation.

The Market Stakeholders Committee launched in 2015, followed by the Grid Connection Stakeholders Committee in 2016, and the System Operations Stakeholders Committee in 2017. The Balancing Stakeholder Group also meets regularly to discuss the implementation of the Electricity Balancing Guideline. ENTSO-E supports these committees by taking charge, with ACER, of the preparation and development of meetings, providing secretariat services, informing stakeholders of progress, and making available all minutes and documents of the meetings on its website.

In 2017, ENTSO-E launched the Q&A, or Issue Logger tool, with the support of ACER, the European Commission and stakeholders participating in the European Stakeholders Committees. Each meeting of the Committees concludes with the elaboration of a list of technical questions on the implementation of the codes. The questions that are deemed of wider interest are recorded in the Issue Logger Tool, and a responsible party (most often ENTSO-E, but also the European Commission and ACER) is appointed to provide an answer to each question. By making questions and answers available to all, the Tool aims to enhance public access to and exchange of information regarding the implementation of the codes.

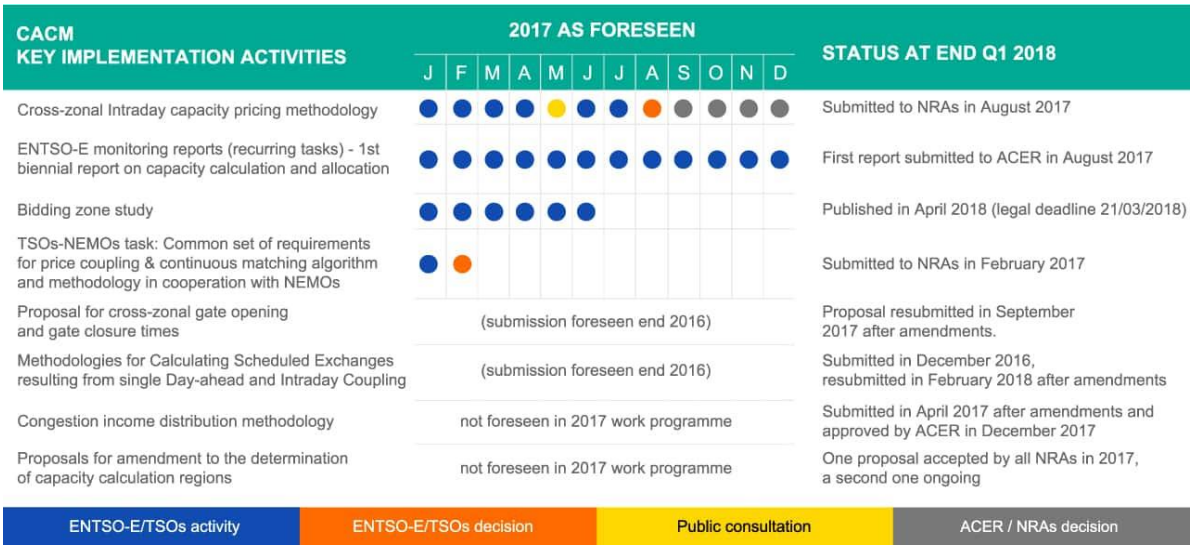
Better information for better stakeholder engagement

To help improve the understanding of the codes and their implementation, online training on network codes was initiated by ENTSO-E with the Florence School of Regulation, in collaboration with the European Commission and ACER. The pilot was launched in October 2017, focusing on the market codes, and the interactions with the system operation codes. The training was very successful, with around 140 participants and positive feedback. After the first pilot, the training will be further developed to cover all electricity codes.
In parallel, ENTSO-E has entirely reviewed its webpages on network codes, so that information on the latest and upcoming implementation steps is more easily accessible to all stakeholders.

Overview of implementation activities in 2017

THE CACM REGULATION

The rules set by the CACM Regulation provide the basis for the implementation of a single energy market across Europe. The CACM Regulation sets out the methods for allocating capacity in day-ahead and intraday timescales and outlines the way in which capacity will be calculated across the different zones. Because it was the first code to enter into force, in August 2015, the implementation of the CACM Regulation is well under way. The following implementation steps were ongoing in 2017.



The Bidding zones study

The CACM Regulation (Article 34) organises the regular reporting by ENTSO-E on the efficiency of the existing bidding zone configuration. Current bidding zones generally correspond to member state boundaries. For completion of the IEM, it is important to analyse the robustness of this structure and whether it is appropriate for future market needs. An efficient configuration of bidding zones maximises social welfare by optimising electricity exchanges across Europe. Since 2012, ENTSO-E and the TSOs of central Europe have been working on the early implementation of CACM Article 34, via a pilot project to elaborate methodologies for the assessment and a review of bidding zone configurations.

In December 2016, ACER issued a request for a review of the bidding zone configuration as specified in CACM Article 32(4). This review covered Austria, Belgium, Czech Republic, Denmark, France, Germany, Hungary, Italy, Luxembourg, the Netherlands, Poland, Slovakia and Slovenia, with a legal deadline of 21 March 2018. Over 2017, the participating TSOs have re-defined the scope of the project so as to be able to deliver by the legal deadline, run the computations and formally submitted the methodologies and assumptions to NRAs. ENTSO-E's role was that of a facilitator, supporting the participating TSOs in the process.

26 Oct 2017: formal submission to NRAs of methodologies and assumptions, for a three months consultation, as per CACM Article 32 (4) (a)

Dec 2017: workshop with NRA representatives on the methodologies, the difficulties encountered and what could realistically be achieved in the time available

9 Feb-9 Mar 2018: Public consultation on the draft Bidding Zone Review

5 April 2018: Publication of the Bidding Zone Review

The chosen approach is based on a selection of ex ante defined configurations, encompassing a splitting or merging of the existing bidding zones. They include a separation of Austria from Germany / Luxembourg, a split of the 'big countries' France, Germany / Luxembourg and Poland and a further split of France and Germany / Luxembourg into three zones. To also consider the implications of merging zones, the combinations of Belgium with the Netherlands and the Czech Republic with Slovakia have also been considered.

These configurations were analysed and compared over large physical areas using a flow base methodology, which is a first anywhere in the world. TSOs used detailed grid and market models to simulate market and system operations for the different configurations analysed. Assumptions had to be made on the future grid, generation and demand developments as well as on the future generation cost structures.

This first attempt at analysing bidding zone configurations in Europe demonstrated the significant technical complexity of the task. The participating TSOs considered that the evaluation presented in the first edition of the Bidding Zone Review did not provide sufficient evidence for a modification of or for maintaining of the current bidding zone configuration. Therefore they recommended that, given the lack of clear evidence, the current bidding zone delimitation be maintained. Further work is ongoing on the TSOs side to assess and learn from the current review, so that more concrete recommendations will be available in future.

Aug 2016: All TSOs submitted 1st version of the methodology

Feb 2017: NRAs requested amendments

Apr 2017: all TSOs submitted the amended proposal to NRAs

June 2017: NRAs forwarded the decision to ACER

14 Dec 2017: ACER approved the final methodology

The cross-zonal intraday capacity pricing methodology

This methodology aims to provide signal for use of scarce capacity, provide signals for investments and contribute to the efficient functioning of the intraday market.

✓ By 14 August 2017 (24 months after entry into force), all TSOs must submit a proposed methodology for cross-zonal intraday capacity pricing to all NRAs (Article 55, CACM)

The legal framework for this proposal is described in the CACM Regulation Article 55, but specific provisions of the Transparency Regulation (Articles 11(1) and 11(2)) were also considered. When elaborating the proposal, all TSOs considered several models for this methodology and concluded that the most appropriate would be a combined model with continuous trading and pricing of intraday cross-zonal capacity through auctions.

11 April - 12 May 2017: Public consultation and workshop

Aug 2017: all TSOs submit the proposal to all NRAs. At the time of finalisation of this report, NRAs' decision had not been received.

The advantage of the chosen methodology is that it is compatible with the concept of the Single Intraday Coupling as introduced in the CACM Regulation (XBID project). It allows for an efficient pricing of the intraday cross-zonal capacity through the intraday auctions and can be implemented without a fundamental review of the algorithm of the XBID solution.

Congestion income distribution methodology

Congestion income should be understood as the revenues received as a result of capacity allocation. It will be assigned to each bidding zone border based on the rules described in the distribution methodology, and then distributed to the TSOs on each side of a bidding zone border or, via the relevant TSOs, to third party asset owners.

In August 2016, all TSOs submitted to NRAs a first version of the proposed methodology as per Article 73 of the CACM Regulation. However, NRAs requested that TSOs amend their proposal, principally because NRAs considered that specific arrangements for socio-economic benefits, capacity allocation constraints or potential future principles related to capacity allocation were not legitimate grounds for congestion income sharing.

✓ By 14 August 2016 (12 months after entry into force), all TSOs must submit a proposed methodology for congestion income distribution to all NRAs (Article 73, CACM)

Methodologies for calculating scheduled exchanges resulting from single day-ahead and intraday coupling

TSOs submitted individual proposals for methodologies for calculating scheduled exchanges by the legal deadline of 14 December 2016. However, NRAs considered that the proposal should come from 'all TSOs', and not from individual TSOs, and requested that all TSOs resubmit the proposals by February 2018.

The proposed methodologies as re-submitted by all TSOs cover scheduled exchanges between bidding zones and scheduling areas resulting from single day-ahead and intraday coupling. All NRAs' decision is expected in June 2018.

By 14 December 2016 (16 months after entry into force), all TSOs shall submit to all NRAs proposals for methodologies for calculating scheduled exchanges resulting from single day-ahead and intraday coupling (Article 43 and 56, CACM)

3 Nov – 3 Dec 2017: Public consultation and workshop on all TSOs proposals for scheduled exchanges methodologies
Feb 2018: all TSOs submit the two proposals to all NRAs

Cross-zonal gate opening and gate closure times for intraday coupling

In accordance with Article 59(1) of CACM, all TSOs submitted a proposal to all NRAs end 2016. Upon NRAs request, all TSOs submitted an amended proposal in September 2017. NRAs requested that ACER adopt a decision, due by May 2018, because they could not reach an agreement regarding specific capacity calculation regions or bidding zone borders.

By 14 December 2016 (16 months after entry into force), all TSOs shall be responsible for proposing the intraday cross-zonal gate opening and intraday cross-zonal gate closure times (Article 59(1)

Proposals for amendment to the determination of Capacity Calculation Regions

Attributing new bidding zone borders in a timely fashion is essential for providing the clearest possible framework for the implementation of the CACM (Article 15) and FCA (Article 8) regulations. All TSOs' initial proposal for Capacity Calculation Regions (CCR) delimitation, submitted in November 2015 and approved by ACER the following year, only considered bidding zone borders due to interconnections that were planned to be commissioned before 2018. Consequently, the bidding zone borders created by newly established interconnectors were not yet attributed to a CCR. This is the case of the future Belgian – Great Britain bidding zone border, resulting from the Nemo link, the installation of which began in the summer of 2017 and which is expected to be taken into use in early 2019. All TSOs proposed in 2017 to attribute it to the Channel CCR.

Belgium-GB BZ border:
7 Apr – 8 May 2017: all TSOs put proposal to public consultation. No responses were received.
18 Sept 2017: all NRAs adopted the position that BE-GB proposal meets the requirements of the CACM Regulation
Q1 2018: all NRAs proceed with national decisions

Also not yet included in the CCR delimitation are the Denmark 1 – The Netherlands (DK1 – NL) border resulting from the Cobra cable interconnection, two future interconnections of the France-Great Britain (FR-GB) bidding zone border and the future ALEGrO interconnection on the bidding zone border Belgium - Germany/Luxembourg.

DK1-NL, FR-GB and ALEGrO
15 Nov – 20 Dec: all TSOs put proposal to public consultation. At the time of completion of this report, all TSOs proposal was foreseen to be submitted in mid-April 2018.

Maps: Capacity Calculation Regions

Capacity Calculation Regions' tasks

The main deliverables at CCR level in 2017 were the delivery of proposals for fallback procedures and for capacity calculation methodologies. ENTSO-E supports the CCRs in these tasks by providing its Consultation Hub.

Fallback procedures

Fallback procedures ensure that cross border capacity can be provided to the market, even in the event that the single day-ahead coupling process is unable to produce results. Fallback procedures must be robust, timely and non-discriminatory.

> By December 2016 (16 months after entry into force) all TSOs in each CCR shall submit a proposal for fallback procedures (Art 44 CACM)

This deliverable was due by December 2016, however, due to the lengthy decision-making process within CCRs, several CCRs only submitted their proposal on the fallback procedures in 2017[1]. All proposals were submitted to a public consultation process.

[1] The Channel CCR's proposal was being re-submitted to public consultation in March 2018.

Capacity calculation methodologies

All TSOs in each CCR must develop a capacity calculation methodology based on a flow-based approach (or coordinated NTC approach with justification), as specified in Article 20 CACM. This is only the first step in the process, as Article 21 further requires that CCR's capacity calculation methodology be harmonised by 31 December 2020.

> By September 2017 (10 months after the approval of the proposal for the determination of CCRs) all TSOs in each CCR shall submit a proposal for a common coordinated capacity calculation methodology (Art 20 CACM)

Over 2017, CCRs put their proposals to public consultation and submitted them to the relevant NRAs[2]. Not all CCRs' proposed capacity calculation methodologies have been approved yet, because some NRAs have requested amendments. Approval of the methodology triggers a four months delay for the TSOs of the concerned CCR to jointly set up the coordinated capacity calculators needed for the deployment of the Common Grid Model.

NEMOs tasks

As required by Article 9 of the CACM Regulation, all Nominated Electricity Market Operators (NEMOs) – defined as the entities designated to perform tasks related to single day-ahead or single intraday coupling – submitted to NRAs in February 2017 proposals on methodologies around the intraday and day-ahead algorithms (Art. 37 (5) and 37 (1)) and related products (Art. 40 (1) and Art. 53 (1)), as well as backup methodologies (Art. 36 (3)), and a proposal on minimum and maximum clearing prices (Art. 41(2) and Art. 54(2)). All proposals were submitted to public consultation in November-December 2016.

In July 2017, NRAs requested amendments to NEMOs' proposals on algorithms and back-up methodologies. Revised proposals were resubmitted in November 2017. NRAs referred the proposal on minimum and maximum clearing prices to ACER, who published on 20 November 2017 two decisions on the harmonised maximum and minimum clearing prices SDAC and SIDC.

Plan for the market coupling operator function

The market coupling operator (MCO) Plan includes all the steps necessary to accomplish a European market coupling operator function to integrate European day-ahead and intraday power markets. It will serve as the framework enabling the successful development and operation of market coupling in all EU member states in the years to come. In April 2016, all NEMOs submitted to all NRAS a first version of the MCO Plan. Following a request to amend the proposal, all NEMOs submitted a reviewed Plan in December 2016. In June 2017, NRAs approved the MCO Plan.

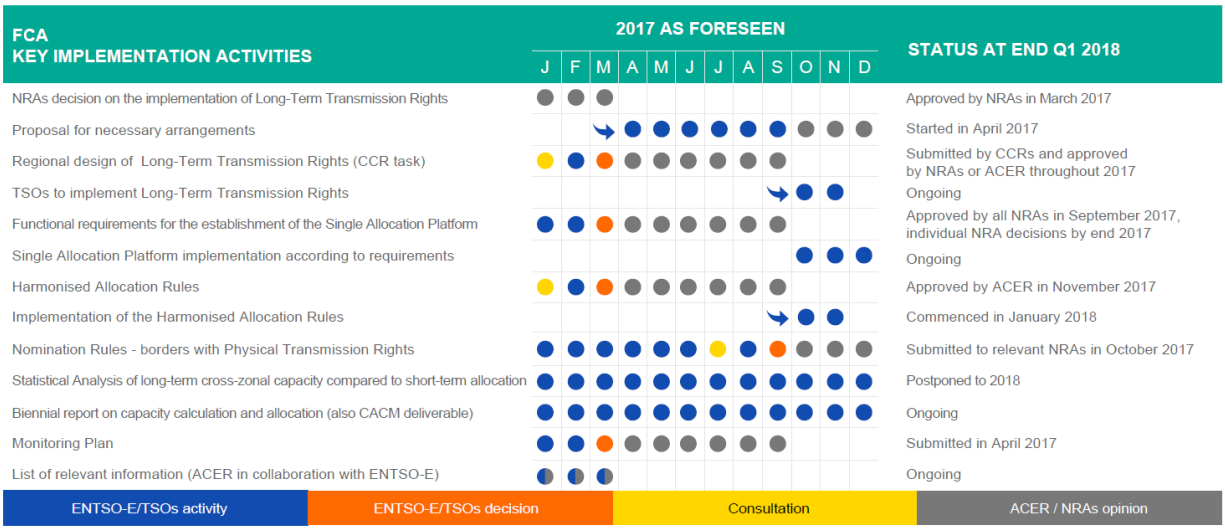
The MCO Plan confirms the adoption of Price Coupling of Regions[3] solution as the basis for pan-European single day-ahead coupling. Regarding intraday, it enshrines the adoption of the Cross-Border Intraday XBID solution as the basis for pan-European single intraday coupling. According to the MCO plan, the implementation of the SDAC and SIDC shall in any case not last longer than 12 months following the date of approval of the MCO Plan. The CACM Regulation requires that NEMOs and TSOs jointly organise the day to

[2] Two of the CCRs submitted their proposals to public consultation after the legal deadline, the South-East Europe CCR in December 2017 and the IT North CCR in Feb-March 2018.
[3] Our Annual Work Programme for 2017 foresaw the drafting of a plan to extend the Multi-Regional Coupling to neighbouring regions. This activity has been cancelled following the identification in the MCO Plan of the Price Coupling of Regions as the solution to implement the SDAC.

day management of the SDAC and SIDC. The NEMOs and the TSOs are now defining the governance structure for this management with the aim of having it implemented by 2019.

THE FORWARD CAPACITY ALLOCATION REGULATION

The FCA Regulation, which entered into force on 17 October 2016, sets out rules regarding the type of long-term transmission rights that can be allocated via explicit auction, and the way holders of transmission rights are compensated in case their right is curtailed. The overarching goal is to promote the development of liquid and competitive forward markets in a coordinated way across Europe, and provide market participants with the ability to hedge their risk associated with cross-border electricity trading.



Harmonised allocation rules for long-term transmission rights

An important component of the FCA, harmonised allocation rules (HAR, Article 51 of the FCA Regulation) deal with the procedures for auctioning transmission rights, the terms on which market participants may participate in explicit auctions and the terms for use of cross-zonal capacity. The rules, submitted by all TSOs in April 2017 and approved by ACER in November, apply to the long-term allocations as from 1st January 2018.

16 Jan – 17 Feb: Public consultation

Apr 2017: all TSOs submit the HAR proposal and the regional or border specific annexes to the relevant NRAs

Aug 2017: NRAs request ACER to adopt a decision

Nov 2017: ACER approves the HAR

The current version of the HAR was the outcome of previous steps taken as part of the early implementation of the FCA Regulation. The first HAR proposal, approved by relevant NRAs in 2015, applied for the long-term auctions of 2016. An updated version applied for long-term auctions in 2017.

Functional requirements for the establishment of the Single Allocation Platform

The Single Allocation Platform (SAP) will facilitate the allocation of long-term transmission rights and the transfer of these rights among market participants at European level. In addition, it should contribute to a transparent and non-discriminatory allocation of long-term transmission rights.

✓ By 17 April 2017 (6 months after entry into force), all TSOs shall submit to all NRAs a proposal for the establishment and development of the SAP and for its cost-sharing methodology (FCA Regulation Article 49 and 59)

In their joint proposal submitted in April 2017, all TSOs proposed to entrust the operation of the SAP to the Joint Allocation Office (JAO). The JAO is a joint service company of 20 TSOs from 17 countries, performing the yearly, monthly and daily auctions of transmission rights on 27 borders in Europe. The JAO allocates capacity on TSOs' behalf and is not independent from them: allocation of cross-border capacities remains ultimately the responsibility of TSOs. It is already allocating forward capacities in line with the main body of the HAR since 2015.

Apr 2017: all TSOs submitted proposal for the establishment of the SAP to all NRAs

18 Sept 2017: NRAs adopted position that TSOs' proposal meets the requirements of the FCA Regulation and as such can be approved by all NRAs.

By end 2017: each NRA adopted national decision

For AC borders having allocations on the SAP, the platform should be operational by December 2018 (i.e. within 12 months after all NRAs' approval). Forward capacity allocations on DC interconnectors is due to take place on the SAP no later than December 2019 (24 months after NRAs' approval).

Long-term transmission rights

One of the key deliverables at the regional level under the FCA Regulation is the regional design of long-term transmission rights (Article 31). TSOs in each capacity calculation region where long-term transmission rights exist must jointly develop a proposal for the regional design of long-term transmission rights to be issued on each bidding zone border within the capacity calculation region.

✓ By 17 April 2017 (6 months after entry into force), TSOs in each capacity calculation region where long-term transmission rights exist shall jointly develop a proposal for the regional design of long-term transmission rights to be issued on each bidding zone border within the capacity calculation region. (Article 31 FCA Regulation)

Throughout 2017, the proposals for each CCRs were elaborated by the respective TSOs and put to public consultation. For most CCRs, the proposals were approved by the concerned NRAs. When that was not possible, the decision was forwarded to ACER.

Nomination rules - borders with physical transmission rights

As per Article 36(2) of the FCA Regulation, a proposal on nomination rules was due by all TSOs issuing physical transmission rights on a bidding zone border. Nomination rules describe the process by which a holder of a physical transmission right and its counterparty notify the respective TSOs of the use of the respective long-term cross-zonal capacity.

✓ By 17 October 2017 (12 months after entry into force), all TSOs issuing physical transmission rights on a bidding zone border shall submit a proposal for nomination rules for electricity exchange schedules between bidding zones (Article 36(2) FCA Regulation)

The understanding of the TSOs issuing physical transmission rights is that the proposals had to be submitted per bidding zone border. Therefore, the proposals have been prepared, consulted and submitted at least at bidding zone border level. Overall, 14 proposals were submitted to the relevant NRAs in October 2017.

27 June – 18 Aug: Public consultation and webinar

17 Oct 2017: concerned TSOs submitted the proposals to the relevant NRAs for approval. At the time of finalisation of this report, the NRAs' decision was expected in April 2018.

Statistical analysis of long-term cross-zonal capacity compared to short-term allocation

Because of the delay in the approval of the CACM capacity calculation methodologies (CCR task under CACM, see above), this activity has been postponed. In addition, it has been decided that it will be conducted primarily at the regional level.

THE ELECTRICITY BALANCING GUIDELINE

Electricity balancing is the process by which TSOs ensure, in real time, sufficient energy to balance inevitable differences between supply and demand. The Guideline on Electricity Balancing (GLEB) aims to move Europe from the current situation, in which most balancing is carried out at a national level, to a situation in which larger markets allow the resources available in Europe to be used in a more effective way.

16 March 2017: EU member states approve the GLEB in comitology
18 Dec 2017: The GLEB enters into force

The Guideline sets a framework for common European rules and European platforms for cross-border balancing markets for imbalance netting, frequency restoration reserves with automatic activation (aFRR), frequency restoration reserves with manual activation (mFRR) and replacement reserves. The role of the European platforms is to secure the economically-efficient purchase and in-time activation of balancing energy. Work is ongoing on TSO-TSO settlement, imbalance settlement harmonisation, cross-zonal capacity allocation, reporting, coordination of the tasks and on the implementation frameworks for the European platforms.

Early implementation projects

For establishing the European platforms, the International Grid Control Cooperation (IGCC) project and the Trans-European Replacement Reserves Exchange (TERRE) project have been identified as implementation projects for imbalance netting and for replacement reserves in 2016. In 2017, the Platform for the International Coordination of Automated Frequency Restoration and Stable System Operation (PICASSO) project and the Manually Activated Reserves Initiative (MARI) project were approved as European implementation projects for aFRR and mFRR respectively.

The four European balancing implementation projects have greatly grown during 2017 and now cover practically all members of the regions that are mandated by the GLEB to implement the European platforms. The European implementation projects also developed further the principles for TSO-TSO and TSO-Balancing Service Provider settlement.

- ***The International Grid Control Cooperation (IGCC) project***

The imbalance netting implementation framework was drafted during 2017. After a public consultation in early 2018, ENTSO-E is studying the feedback received from stakeholders and regulators and will prepare a final proposal of the implementation framework. In 2018, IGCC will continue working on the implementation of the platform, including decisions on communications requirements, an update of the IGCC multi-lateral agreement and the study of different invoicing solutions.

IGCC Members (11 TSOs)			
Austria	APG	Germany	50hertz, amprion, TenneT, TRANSNET BW
Belgium	elia		
Czech Republic	ČEPS		
Denmark	ENERGINET	Switzerland	swissgrid
France	RTE	The Netherlands	TenneT

➢ *PICASSO*

The PICASSO TSOs signed a Memorandum of Understanding in July 2017. The first public consultation on the design of the aFRR Platform was launched in November 2017. The implementation framework for the exchange of balancing energy from aFRR is being prepared, and a proposal for the TSO-TSO settlement of aFRR exchanges will be drafted during 2018. The go-live of the platform is foreseen by the end of 2021.

PICASSO Members (5 TSOs)
Austria
Belgium
France
Germany
The Netherlands

PICASSO Observers (17 TSOs)			
Bulgaria	ESO EAD	Poland	PSE
Croatia	HOPS	Portugal	REN
Czech Republic	ČEPS	Romania	Transelectrica
Denmark	ENERGINET	Slovakia	SEPS
Finland	FINGRID	Slovenia	ELES
Greece	ADMIE	Spain	REE
Hungary	MAVIR	Sweden	Svenska Kraftnät
Norway	Statnett	Switzerland	swissgrid
Italy	Terna		

➢ *MARI*

In April 2017, MARI TSOs signed a Memorandum of Understanding for the design, implementation and operation of a new mFRR platform. MARI TSOs developed an mFRR platform design, which was published for public consultation in November 2017. In addition, regular communication with the NRAs through the Implementation Group meetings was established. The go-live is foreseen by end of 2021. MARI TSOs are preparing the mFRR Implementation Framework, which shall be submitted by December 2018.

MARI members (25 TSOs)			
Austria	APG	Lithuania	Litgrid
Belgium	Elia	Norway	Statnett
Czech Republic	ČEPS	Netherlands	TenneT
Denmark	Energinet	Portugal	REN
Estonia	elering	Poland	PSE
Finland	FINGRID	Romania	Transelectrica
France	RTE	Slovenia	ELES
Germany	50Hertz, TenneT, Amprion, TRANSNET BW	Spain	REE
Greece	ADMIE	Sweden	Svenska Kraftnät
Italy	Terna	Switzerland	swissgrid
Latvia	AST	United Kingdom	nationalgrid

MARI observers (5 TSOs + ENTSO-E)			
Bulgaria	ESO EAD	Serbia	EMC
Croatia	HOPS	Slovak Republic	SEPS
Hungary	MAVIR	ENTSO-E	entsoe

➢ *TERRE*

The TERRE TSOs performed a second public consultation on the design of TERRE in July and August 2017. Moreover, the TSOs performing the reserves replacement process are preparing the RR Implementation Framework to comply with the GLEB and ran a public consultation in February-April 2018. During 2018, TERRE will continue to work on incorporating comments from stakeholders and regulators into the

Implementation Framework final proposal, as well as on the implementation of the IT platform (LIBRA). The TERRE go-live is foreseen in the second half of 2019.

TERRE members (6 TSOs)
France
Great Britain
Italy
Portugal
Spain
Switzerland

Participants under the RR IF and not yet TERRE members
Bulgaria
Hungary
Poland
Romania

TERRE Observers
ADMIE
Czech Republic
Norway
ENTSO-E secretariat

Potential interest (4 TSOs)
Croatia
Denmark
Finland
Sweden

Frequency containment reserve

A voluntary pilot initiative supporting the implementation of the GLEB, the common market for procurement and exchange of Frequency Containment Reserve (FCR) involves 10 TSOs who procure their FCR in a common market. The project partners launched a public consultation in early 2017 to assess possible market design evolutions. The consultation collected market participants' views on detailed design options and proposed choices to be implemented in the next phase of the project. Based on the answers received, project members prepared a proposal for the market design of FCR cooperation, as per Article 33(1) of the GLEB. The proposal was submitted to public consultation in early 2018, before submission to NRAs for approval.

FCR Members (10 TSOs)			
Austria	APG	Germany	50hertz, amprion, TenneT, TRANSNET BW
Belgium	elia		
Western Denmark	ENERGINET		
France	RTE		
Switzerland	swissgrid	The Netherlands	TenneT

THE SYSTEM OPERATION GUIDELINE

The System Operation Guideline sets out harmonised rules on how to operate the grid to ensure the security of supply with increasing renewables. Its implementation entails several challenging tasks for TSOs at pan-European, synchronous area, and regional (CCR) levels[4]. Work at pan-European level is steered by ENTSO-E, while synchronous areas' activities are steered by TSOs in the respective regional groups with the aim of harmonising as much as possible.

[4] The SOGL sets a number of implementation tasks at regional - meaning Capacity Calculation Regions – level. These are not the same as the areas covered by Regional Security Coordinators. The services rollout by RSCs is a pan-European task, steered by ENTSO-E.

A large part of the implementation of the SOGL is prepared through the rollout of the five standard services by the Regional Security Coordinators[5]. This includes the establishment of year ahead scenarios for assessing the operation of the interconnected transmission system (Article 65), year-ahead/day-ahead/intraday common grid models from individual grid models (articles 67(1) and 70(1)), the methodology for coordinating the operational security analysis (Article 75), agreeing on the principles for assessing the relevance of assets for outage coordination (Article 84), establishing the processes for outage planning coordination (Article 83) and regional adequacy assessment (Article 81).

The SOGL entered into force on 14 September 2017, later than previously foreseen. For this reason the gantt chart showing implementation activities foreseen in our Annual Work Programme for 2017 is not displayed here, because the delayed entry into force of the SOGL has rendered it outdated.

Synchronous area operational agreements

All TSOs of the following synchronous area – Continental Europe, Nordic, Great Britain and Ireland-Northern Ireland[6] – must develop a proposal for an operational agreement.

In particular, regarding the synchronous area Continental Europe, a Synchronous Area Framework Agreement (SAFA) will replace the multi-party agreement of the Operation Handbook[7]. The Synchronous Area Operational Agreement will be part of the SAFA, as required by SOGL Article 118. Developed over 2017, the new policies incorporated within the SAFA are expected to be submitted (in part to NRAs, in part to all TSOs and to TSOs of the Continental Europe synchronous area) for approval in September 2018.

> By 14 September 2018 (12 months after entry into force), all TSOs of each synchronous area shall jointly develop common proposals for [synchronous area operational agreements] (Article 118, SOGL)

Dynamic stability assessment

The SOGL (articles 38 and 39) provides that each TSO shall perform a dynamic stability assessment at least once a year to identify the stability limits and possible stability problems in its transmission system. All TSOs of each synchronous area must coordinate the dynamic stability assessments, which shall cover all or parts of the synchronous area. In June 2017, ENTSO-E published guidelines to support TSOs in the interpretation of Article 38 and ensure consistency among the dynamic stability assessment carried out by each TSO.

> Each TSO shall monitor the dynamic stability of the transmission system (Article 38, SOGL)

ENTSO-E set up a dynamic model able to reproduce the same results with a high variety of dynamic simulation tools available and in use at the different Continental Europe TSOs. In addition, a group was created to monitor and evaluate inter-area oscillations in the Continental Europe synchronous area. Its analysis show that all the oscillations have been properly damped by the affected TSOs. This group will be in charge of executing coordinated dynamic analysis for the regional group Continental Europe, in case a stability issue is detected.

In the Nordic synchronous area, the dynamic stability assessment is calculated by an embedded application in the SCADA systems of the TSOs, with the aim of monitoring the stability continuously. In both the Nordic

[5] Note that, among the five tasks of RSCs, coordinated capacity calculation is not specified in the SOGL but in the CACM and FCA regulations.
[6] The Baltic synchronous area is exempted from this requirement.
[7] The parties of the Multilateral Agreement committed themselves to fully comply with the Operation Handbook. The Operation Handbook is a comprehensive collection of technical standards for the operation of the interconnected grid of Continental Europe.

and CE areas, several actions are ongoing to develop a coordinated method of calculating the minimum inertia by the end of 2018.

Other ongoing implementation activities

In addition, upon entry into force of the SOGL, preparatory work has begun on several other deliverables, including all TSOs' proposal for key organisational requirements, roles and responsibilities in relation to data exchange; LFC block proposals (activity at synchronous area level); new transparency requirements for information on load-frequency control and reserves; and annual reports for implementation monitoring.

8 June 2017: Informal workshop with stakeholders on data exchange

31 Oct – 1 Dec 2017: Public consultation on all TSOs proposal on data exchange
Jan 2018: submission to NRAs of LFC block proposals (except Nordic, in April 2018)

March 2018: all TSOs proposal on data exchange submitted to all NRAs

Regional Security Coordinators

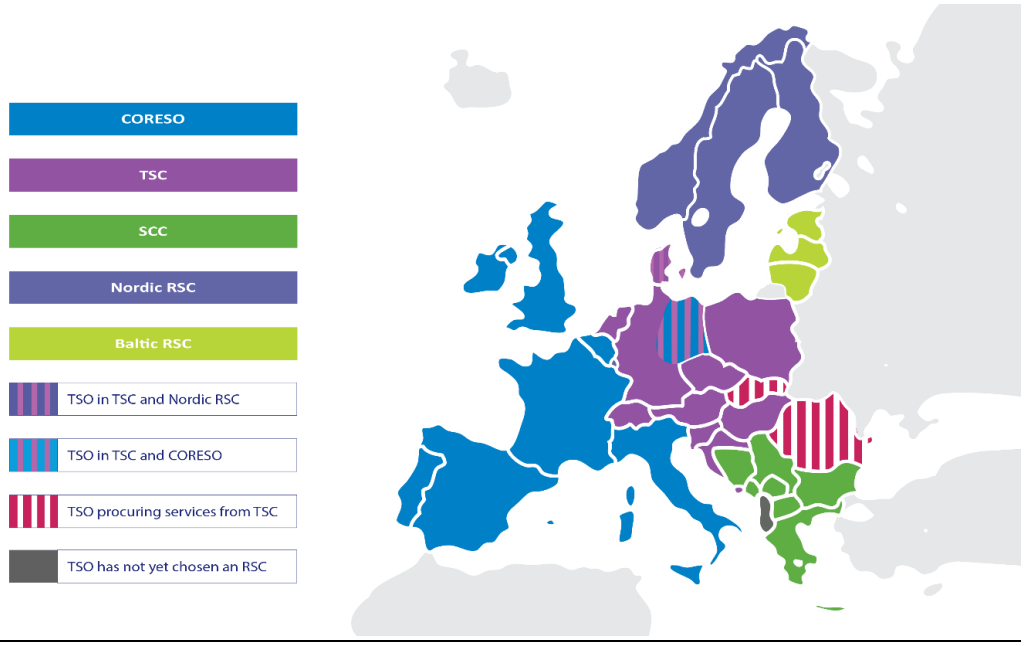
The System Operation Guideline formalises the name, existence, and role of the RSCs and makes it legally binding for all TSOs to take part. It defines RSCs as the entities owned or controlled by TSOs, in one or more capacity calculation regions, performing tasks related to TSO regional coordination.

TSOs participation in RSCs was previously ensured via a 2015 multilateral agreement between ENTSO-E and TSOs, making it mandatory for ENTSO-E members to participate in RSCs or to contract five services from them.

✓ By end of 2017 all TSOs must confirm which RSC(s) they intend to procure services from (Multilateral agreement signed by TSOs in 2015)

RSCs must perform five tasks for the TSOs, including coordinated capacity calculation (specified in the CACM and FCA regulations), and operational planning security analysis, outage planning coordination, short-term and very short-term adequacy forecasts, and a common grid model with hourly updates (all four services specified in the SOGL).

The RSCs' work increases efficiency in system operation; minimises risks of wide area events, such as brownouts or blackouts; and lower costs through maximised availability of transmission capacity to market participants. By end of 2017, five RSCs were established and operational, covering the whole of Europe well before the legal deadline of 27 months after entry into force of the SOGL. Only the Albanian TSO OST, ENTSO-E's newest member since 30 March 2017, is still to appoint an RSC.



Map: Overview of the RSCs from which TSOs procure the five tasks (simplified illustration)

Roll-out of the five tasks

All five tasks are to be provided based on the Common Grid Model, and all data is shared via ENTSO-E's Operational Planning Data Environment (more information on the Common Grid Model below).

28 Sept 2017: Informal workshop with stakeholders on coordinated security analysis
26 Feb – 6 Apr 2018: Public consultations on all TSOs proposals for methodologies on outage coordination and coordinated operational security analysis

Throughout 2017, the methodologies and the functional requirements for the tools to deliver short and medium-term adequacy and outage planning coordination have been prepared by ENTSO-E, with RSCs' support. In 2018, the common (pan-European) tools will be developed for two of the tasks, outage planning coordination and adequacy assessment.

Five tasks	Benefits for TSOs and market participants	Status
Regional operational security coordination	Identify operational security violations in the operational planning phase. Identify the most efficient remedial actions and recommend them to the concerned TSOs.	All RSCs are providing the service. It will evolve once the methodology for coordinating the security analysis is approved by NRAs (expected March 2019).
Regional outage coordination	Detect outage planning incompatibilities and the solutions to solve the incompatibilities.	Regional experimentation ongoing, development of common tools in 2018.
Coordinated capacity calculation for CACM	Calculate available electricity transfer capacity across borders (using flow-based or net transfer capacity methodologies). Maximise the capacity offered to the market.	All RSCs are already providing the capacity calculation service, which will evolve after the approval of the capacity

		calculation methodologies developed regionally according to CACM (see in Chapter 1 under CACM/CCR tasks).
Regional adequacy assessment	Provide TSOs with short (day-ahead) to medium (up to week-ahead) adequacy forecast, in order to be able to foresee possible critical grid situations and deal with these accordingly.	Regional experimentation ongoing, development of common tools in 2018.
Building of common grid model	Provide the common grid model for all timeframes and applications, to all TSOs which are served by an RSC.	(Described under 'Common Grid Model')

Regional Energy Forums

In October 2017 ENTSO-E adopted its position paper "Power regions for the Energy Union: Regional Energy Forums as the way ahead" as a contribution to the broader discussion on how regional cooperation between EU member states could underpin the Energy Union. The proposed concept complements regional security coordination (which is TSO-led) by regional regulatory cooperation (NRA-led) and political cooperation (government-led) including likewise important stakeholders. In essence, the triangle of governments, regulators, TSOs plus stakeholders would form flexible Regional Energy Forums to promote holistically regional cooperation, which we consider to be crucial for further advancing the single market for electricity.

THE COMMON GRID MODEL

The Common Grid Model (CGM) finds its legal basis in three of the network codes: the SOGL (article 64), the CACM Regulation (Article 17) and the FCA Regulation (Article 18). The CGM, and its data exchange system the Operational Planning Data Environment (OPDE), are indeed a prerequisite for several processes harmonised in the network codes, including capacity calculation, operational security analysis, outage planning and adequacy analysis.

The CGM compiles the individual grid model of each TSO, covering timeframes going from one year before real time to one hour before real time. TSOs' individual (in most cases, national) grid models are picked up by RSCs, who, following a quality assessment and pan-European alignment process, merge them into a pan-European Common Grid Model and feed the merged Common Grid Model back into the system.

The pan-European data exchange capability within the CGM program is expected to be available for application in the business process by August 2018. The CGM is a major project for ENTSO-E, with capital expenditures in 2017 representing 2 M€ and totalizing 6 M€ since 2016. Its operating costs represent 2,2 M€ in 2017 driven by the setup of the communication network, at full deployment the overall operating costs will reach 10 M€ per year (representing in the long term more than 32% of ENTSO-E's budget).

Methodologies

Implementation of the CGM needs to be consistent throughout the various processes set in the SOGL, CACM and FCA regulations, and this is why all TSOs have been tasked with the preparation of two methodologies: the CGM methodology and the generation and load data provision methodology.

The CACM generation and load data provision methodology was approved by all NRAs in early 2017, while the CACM CGM methodology was resubmitted in March 2017 following a request for amendment. Following the entry into force of the FCA Regulation, both methodologies were updated and resubmitted to NRAs in July 2017. In March 2018 all NRAs approved the FCA generation and load data provision methodology, and requested amendments to the FCA CGM methodology. In the meantime, all TSOs began reviewing both methodologies following the entry into force of the SOGL in September 2017, and a third version of the CGM methodology was submitted to all NRAs in March 2018.

Operational Planning Data Environment

The OPDE, specified by Article 114 of the SOGL, is the information platform that will support the data exchange associated with the CGM merging process. It is also the foundation of the data exchange platform for running the five core services of RSCs.

> By 14 September 2019 (24 months after entry into force), ENTSO-E shall implement and operate an operational planning data environment for the storage, exchange and management of all relevant information (SOGL, Art 114)

The delivery of the main software components of the OPDE is ongoing. Central components of the distributed software (protocols EDX/ECP, Operational Planning Data Management) are up and running and their roll-out in TSOs is ongoing. The effective roll out of the minimal set up of OPDE began in 2017 and is expected to be completed in 2018.

ATOM: All TSOs' network for non-real-time operational and market-related data communication network

The OPDE will run on a dedicated communication network called ATOM. In 2017 the fully meshed core of ATOM was established and is now operational. The core interlinks four TSOs: RTE (France), Swissgrid (Switzerland), Amprion (Germany) and APG (Austria). Other TSOs will then be linked to one of these four TSOs, with a maximum of two degrees of separation from the core. Some TSOs, such as the Nordics, are part of a regional network – meaning that they are connected to one-another via a meshed network. The connection of these regional networks to the ATOM core began in 2017 and will continue in 2018.

It was decided in 2017 that ATOM will be merged with the Electronic Highway to become the Communication Network for Market and Operations (COMO).

Standardisation of information exchange

Standards facilitate cross-border exchange and allow for efficient and reliable identification of different objects and parties relating to the internal energy market and its operations. Standards support the implementation of network codes in various ways and several of ENTSO-E's IT tools and data environment, such as the OPDE, rely on standards.

In September 2017 the specifications developed by ENTSO-E on the exchange of data in electricity systems in Europe - the Common Grid Model Exchange Specification, or CGMES – were adopted by the International Electrotechnical Commission (IEC). This adoption makes the CGMES an internationally recognised technical specification for electricity data exchange.

ENTSO-E maintains the Electronic Data Interchange library, which regroups documents and definitions for the harmonisation and implementation of standardised electronic data interchanges between actors in the electrical industry in Europe. Several IEC standards from the European Style Market Profile have been updated in 2017 thanks to the input of ENTSO-E: Transparency, MADES (Market Data Exchange Standard), etc.
In 2017 ENTSO-E cooperated with CENELEC, contributing to the Smart Energy Grid-Coordination Group and other high-level groups focused on network code implementation chaired by CENELEC.

THE EMERGENCY & RESTORATION NETWORK CODE

The Emergency & Restoration Network Code sets out harmonised rules on how to deal with emergency situations and restore the system as efficiently and as quickly as possible. It entered into force on 18 December 2017, and is primarily subject to implementation at a national or TSO level, although RSCs will play a role in the consistency assessments of each TSO's system defence plan. Implementation is planned to extend until 2022.

An expert team supported by ENTSO-E has been drawn from TSO representatives involved in drafting the original Code. The particular and legally mandated aim is to facilitate the rollout of the "6th legally mandated service of the RSCs" which (in line with Article 6(2-4) of NC ER) relates to consistency assessments of the measures of system defence and restoration plans of those TSOs which are served by a given RSC. Moreover, the expert team will also establish widely applicable guidelines for the rules for suspension and restoration of market activities, which in turn are in the responsibility of each TSO to be implemented.

THE CONNECTION CODES

While 2016 was the year when all the three connection codes (Requirement for Generators, Demand Connection, and High-Voltage Direct Current) were approved and entered into force, 2017 focused on national implementation.

Each EU member state had to follow its own national process to define the parameters i.e. non-exhaustive requirements and boundary thresholds. The final submission of those was - by regulation – May 2017 for RfG and September 2017 for DCC and HVDC.

✓ By six months after their entry into force (and thereafter every two years), ENTSO-E shall prepare non-binding written guidance concerning the elements of each of the three connection codes requiring national decisions. (Article 56 DCC, Article 75 HVDC, Article 58 RfG)

ENTSO-E's role is to monitor this implementation process, but also to assist with the development and delivery of non-binding written guidance - Implementation Guidance Documents (IGDs) - to its members and other system operators. The IGDs were drafted and published by October 2016 (for RfG) and by March 2017 (for HVDC and DC), in compliance with the legal requirement of six months after the entry into force of each regulation, and are expected every two years.

In order to further support TSOs and other system operators in their comprehension and implementation of the connection codes, ENTSO-E continued to develop additional IGDs. The new IGDs were developed with the support of stakeholders from the development/drafting phase onward, via workshops, public surveys and expert groups. The IGDs that were elaborated heavily during 2017 were the eight frequency-related IGDs, an IGD on cost-benefit analysis and an IGD on compliance monitoring. Three IGDs on HVDC-related aspects were also developed during 2017, and published for consultation in March 2018.

Mar, Jul, Oct: Three workshops with stakeholders on the connection codes frequency parameters
2 Mar 2017: Workshop with stakeholders, decision to set up an expert group on CBA
8 Mar 2017: Publication of updated IGD on Compliance Testing and Monitoring
10 Aug 217: Publication of IGD on high penetration of power electronic interfaced power sources
Jan 2018: Publication of report on Inter-TSO coordination in connection network codes implementation
5 Feb 2018: Publication of IGD on the frequency related parameters
29 Jan – 2 Mar 2018: Public consultation on the IGD on CBA
26 Mar – 4 May: Public consultation on the HVDC-IGDs

Development of the IGDs is fuelled by discussions with stakeholders, taking place through the three expert groups on compliance monitoring, fast fault current injection (both set up in 2016) and cost benefit analysis (set up in May 2017) and in the Grid Connection Stakeholder Committee. The improvement and use of the active library and the creation of the Issue Logger tool have also contributed to the exchange of knowledge, experience and good practices.

Additionally, ENTSO-E emphasised the enhancing of inter-TSO coordination activities, via the elaboration of a report on inter-TSO coordination released in January 2018. The connection codes require TSOs to coordinate when establishing certain requirements, either at synchronous area level or between adjacent TSOs.

Monitoring the implementation: Are the codes delivering?

ENTSO-E is entrusted with the tasks of monitoring and analysing the implementation of the network codes and guidelines, and their effect on the harmonisation of applicable rules aimed at facilitating market integration (Article 8(8) of Regulation (EC) No 714/2009).

Monitoring activities entail the elaboration of monitoring plans and monitoring reports, as well as the collection of data (so-called 'Lists of information'), including the identification of data to be collected and the design and implementation of interfaces for data collection. Work started in 2016 for CACM and continued over 2017 for CACM, FCA and the connection codes.

Progress and potential problems with the implementation of the Single Day-Ahead and Intraday Coupling

ENTSO-E's biannual reports provides an account of the current state-of-play and challenges in the implementation of single day-ahead and intraday coupling, and take stock of the progress achieved so far in the coupling of electricity markets

✓ ENTSO-E must report every six months on the progress and potential problems with the implementation of the Single Day-Ahead and Intraday Coupling, including the choice of different available options in each country (Article 82(2)(a) CACM & Monitoring Plan)

through the different projects in place, namely the day-ahead market coupling project (Multi-Regional Coupling project (MRC)) and the intraday market coupling project (XBID).

13 Feb 2017: Publication of the 2nd report on the progress and potential problems with the implementation of the Single Day-Ahead and Intraday Coupling
14 Aug 2017: Publication of the 3rd report

The 2nd (covering the period from August 2016 to February 2017) and 3rd (February 2017 to August 2017) reports highlight the transversal progress in day-ahead and intraday coupling in terms of all TSOs' and all NEMOs' deliverables. In particular, the reports note the approval by ACER of the all TSOs proposal on CCR delimitation, stressing that the establishment of the Core CCR in a single step will likely prove to be a challenge for all involved parties including TSOs, NEMOs and NRAs.

In addition, the reports find that the MRC project continued to operate day-ahead coupling without any major incident. Progress and achievements in the MRC extension projects include the extension of flow-based in MRC operations to Austria in November 2016 and the recognition of PSE as a full member as of July 2017. ACER's decision to establish a Core CCR is being followed through, as TSOs and NEMOs in the former CEE Region which are not yet coupled via the MRC project have started the joint Core Flow-Based Market Coupling project.
Regarding XBID, the reports find that the project continues to make substantive progress, despite the go-live date having been postponed from Q3 2017 to Q1 2018[8].

REPORTING ON CAPACITY CALCULATION AND ALLOCATION

✓ By 14 August 2017 (two years after entry into force), ENTSO-E shall submit to ACER a report on capacity calculation and allocation (Article 31, CACM)

ENTSO-E's report on capacity calculation and allocation was delivered to ACER on 14 August 2017. The CACM Regulation specifies that it is up to ACER to decide whether to publish the report. It has not been published so far.

FCA'S MONITORING PLAN AND LIST OF RELEVANT INFORMATION

✓ By 17 April 2017 (six months after entry into force) ENTSO-E shall submit to ACER the plan for monitoring the implementation of the FCA Regulation and the establishment of the SAP (Article 63, FCA)

The Monitoring Plan submitted in April 2017 outlines how ENTSO-E will perform its monitoring tasks, based on the reports and updates to be delivered by ENTSO-E, TSOs and the SAP Operator in accordance with the FCA Regulation. The main reports to be delivered will be the following: (i) a report on the progress and potential problems with the implementation of forward capacity allocation; (ii) a report on the effectiveness of splitting long-term cross-zonal capacity; (iii) a report on capacity calculation and allocation; and (iv) a report on the effectiveness of the operation of the forward capacity allocation and the single allocation platform.

Moreover, ACER delivered to ENTSO-E a list of data that should be communicated by ENTSO-E to ACER in accordance with Article 63(3) of the FCA Regulation. The exact details of the data items in this list are currently being further clarified.

[8] In January 2018 it was announced that the go-live date of XBID has been postponed to 12-13 June 2018. User Acceptance Testing is complete and final readiness preparation is underway.

MONITORING THE IMPLEMENTATION AT NATIONAL LEVEL OF THE CONNECTION CODES

ENTSO-E's monitoring activities will be based on the list of information shared by ACER. This task is already under coordination.

> ENTSO-E shall monitor the implementation of each of the three connection codes, looking in particular at any divergences in the national implementation and whether the choice of values and ranges in the requirements specified in each regulation continue to be valid (Article 76, HVDC; Article 57, DC; Article 59, RfG)

Implementation of the connection codes takes place at national level. Therefore, to collect all relevant information necessary to monitor their implementation, ENTSO-E has developed the so-called 'Active library', compiling relevant information and documents for each country. In 2017, ENTSO-E worked on improving the Active Library by adding public information for each EU member state and for some other countries (e.g. some Energy Community Members).

In addition, ENTSO-E has developed a summary monitoring excel file where all the non-exhaustive requirements (values, ranges and status) are integrated as soon as they are available. This table aims to provide a high-level view of any possible divergence among the TSOs. This activity is still ongoing and will be completed by Q2 2018.

Monitoring the implementation of the connection codes is proving to be a challenge, due to the multiple national implementation processes. Retrieving information is a continuous effort. ENTSO-E will continue supporting the TSOs with internal coordination activities and by providing non-binding guidance when needed.

Overall, network codes have already delivered, and will deliver further, as early implementation and pilots show. The process itself of developing the codes has led to substantial improvements in aligning market design, operations and rules to converge towards a common target approach. Further monitoring and assessment of the value created by network codes can be found in ACER's market monitoring reports.

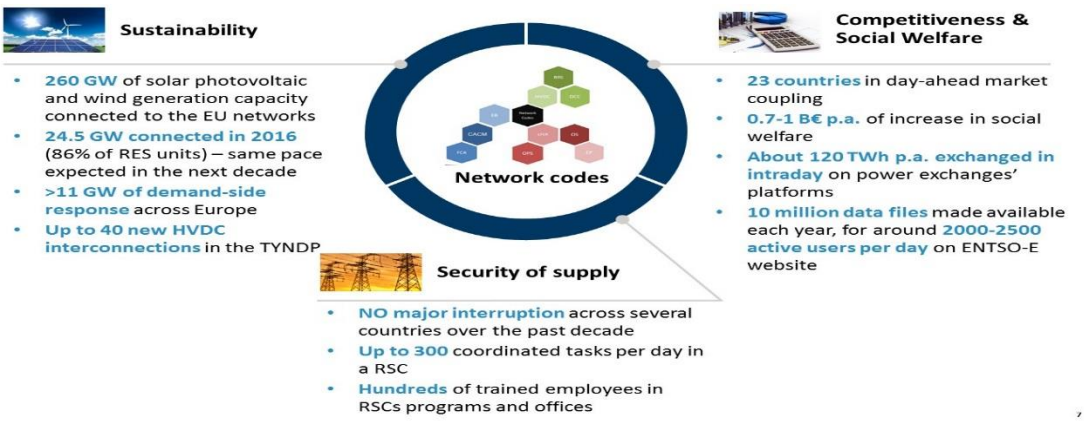
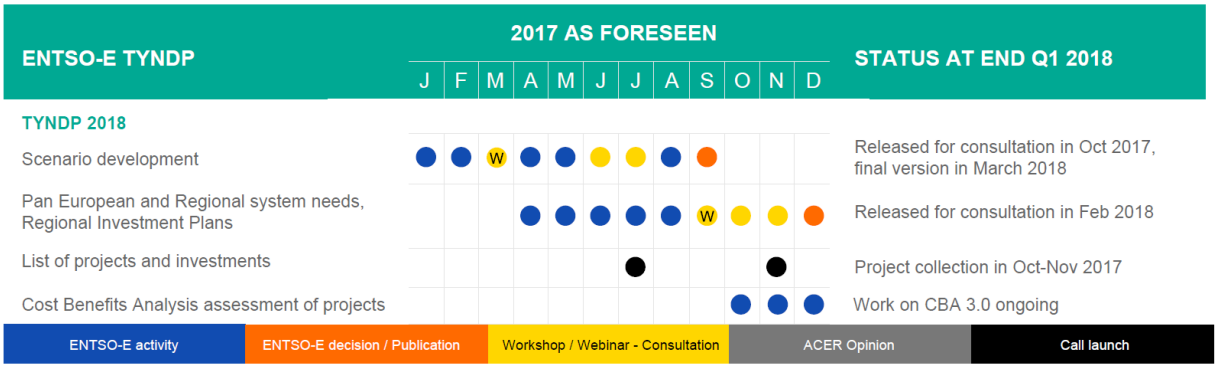


Figure: The value created by network codes[9]

[9] FTI / ENTSO-E 2018, presented at the joint conference on network codes with ACER, the EC and ENTSOG of 4 May 2017

2. Grid development and planning

A fundamental role of TSOs is the planning and development of a secure, environmentally sustainable and economic transmission system. At its creation in 2009, Regulation 714/2009 tasked ENTSO-E with the elaboration of a pan-European network development plan, or TYNDP. In 2013, Regulation 347/2013 on guidelines for trans-European energy infrastructure made the TYNDP the basis for the selection of European projects of common interest. It also mandated ENTSO-E to develop a cost-benefit methodology for the assessment of transmission infrastructure projects.



Europe's Ten-Year Network Development Plan

What grid do we need to achieve Europe's CO2 and interconnection targets? This is the question ENTSO-E has been tasked to help answer with its Ten-Year Network Development Plan. The TYNDP is a pan-European network development plan, providing a long-term vision of the power system. A legally mandated deliverable published by ENTSO-E every two years (Article 8, Regulation 714/2009), it is the foundation of European grid planning and the basis for transmission projects that are eligible to be labelled as 'projects of common interest' (PCI).

The TYNDP 2018 has evolved significantly in its methodology, regarding the involvement of stakeholders, regulators and member states, as well as the indicators considered and the modelling approaches.

ENTSO-E shall adopt and publish a [EU]-wide network development plan every two years. (Article 8(10), Regulation 714/2009)

12 May – 12 June 2016: Public consultation on TYNDP scenarios
2 June 2017: Public workshop with stakeholders on the 2030 and 2040 scenarios
5 July 2017: Public workshop with Member States, NRAs and European Commission on the 2030 and 2040 scenarios
2 Oct – 10 Nov 2017: Public consultation on the TYNDP 2018 scenarios report
2 Feb – 28 Feb 2018: Public consultation on the Regional Investment Plans and pan-European report Europe Power System 2040
30 March 2018: Publication of final Scenarios Report

THE THREE PATHS TO DELIVER ON EUROPE'S EMISSION TARGETS

The TYNDP 2018 features a new set of scenarios, with, for the first time, storylines co-constructed with stakeholders, member states and NRAs, and developed jointly with the European Network of TSOs for gas ENTSOG. Co-construction implied a change in methodology: for previous editions, we had proposed already defined 'visions' on which stakeholders were invited to comment. Instead, for the TYNDP 2018 ENTSO-E and ENTSOG have involved interested parties from the very beginning of the process in 2016, starting from a blank page and asking stakeholders to 'Build your own 2030 and 2040 scenarios'. This approach resulted in three clear storylines which we named 'sustainable transition', 'distributed generation' and 'global climate action'. In all scenarios, European climate targets are met or exceeded.

A fourth scenario considered, EUCO 30, is a core policy scenario produced by the European Commission, modelling the achievement of the 2030 climate and energy targets.

The draft scenarios were discussed with stakeholders and with member states representatives and NRAs. After further refinement, they were submitted to a public consultation in October-November 2017, with the consultation seeking to gather feedback on the scenarios themselves but also on the co-creation process that led to their development. The scenarios have been finalised based on the answers to the consultation and on additional checks and calculations, and will feed into the draft TYNDP2018 to be released mid-2018.

BETTER UNDERSTANDING THE IMPACT OF DEMAND AND RENEWABLES

The scenarios benefited from several improvements to ENTSO-E and ENTSOG's tools and methodologies. The main enhancements concern demand and RES. New approaches and algorithms were developed to more precisely forecast the penetration of electricity demand side technologies (including demand response, electric vehicles, heat pumps and home storage), as well as to refine the impact of temperature variations on electricity demand.

Additionally, the TYNDP 2018 will be the first to consider several climate conditions. The electricity mix in each scenario is assessed using three different climate situations: a wet year, a dry year and a normal year.

BUILDING THE TYNDP 2018

To comply with Regulation (EU) 347/2013 Annex III.3 (3), electricity transmission and storage projects must be part of the latest available TYNDP to be eligible for inclusion in the EU's list of projects of common interest (PCIs). PCIs are electricity projects that have significant benefits for at least two Member States.

The guidelines for inclusion of projects in the TYNDP were revised thanks to project promoters' input, collected during a workshop organised by ENTSO-E in June 2017.

From October to November 2017, ENTSO-E collected applications of transmission and storage projects for inclusion in the TYNDP 2018 package. 195 applications were received from transmission projects and 12 from storage projects. All project candidates for PCI-status will be evaluated based on the assumptions, analyses and methodology developed in the TYNDP[10].

AN ENHANCED ASSESSMENT OF SYSTEM NEEDS & REGIONAL INVESTMENT PLANS

Based on the scenarios identified, ENTSO-E drafted and released in early 2018 the pan-European report Europe Power System 2040: completing the map. A novelty in the TYNDP package, the report examines the needs for additional capacity increases for each of the three 2040 scenarios. The study focuses on the 2040 timeframe, and identifies needs for grid expansion between 2030 and 2040.

It finds that the right set of increases of the transmission capacity between and within European countries could decrease market prices in most of the countries, strengthen security of supply and allow the integration of a high share of RES in the system. The cost of not investing in the power network is high, for instance in terms of consumers' electricity bills, as the 'No Grid' extra bill would reach €43 billion a year in the average case. Costs are also environmental: all scenarios considered show that without grid extension, Europe will not meet its climate targets.

[10] The PCI selection is a process separate from the TYNDP process, under the responsibility of the EC Regional Groups led by the European Commission.

Released alongside the report Europe Power System 2040, the regional investment plans show the needs for additional capacity in six European regions, and include the promoted projects in each region that will be analysed in the TYNDP 2018.

Both the regional investment plans and the Europe Power system 2040 are now being edited to answer stakeholders' comments, and will be released in their final form with the TYNDP 2018 report in mid-2018.

The TYNDP 2018 system needs package also includes new analysis aiming to better understand future operational challenges in an electricity system with a very large amount of RES (frequency stability, voltage). The report identifies decline in the amount of inertia which will be kept on the system which, in smaller synchronous areas, could lead to rapid and large frequency excursions following a normal generation loss.

The Cost-Benefit analysis - What's in it for citizens?

The assessment of projects included in the TYNDP uses a cost-benefit analysis (CBA) methodology drafted by ENTSO-E, in consultation with stakeholders and published by the European Commission. The CBA results are also used as the basis of the PCI selection process.

The TYNDP 2018 is the first one based on the CBA methodology 2.0, developed throughout 2016. Discussions with stakeholders held in 2017 led to the conclusion that further enhancements of the methodology would be necessary in the future. In particular, three key areas for improvement of the CBA methodology were identified by stakeholders: security of supply, socio-economic welfare and storage. ENTSO-E has therefore started work on developing a third version of the CBA methodology, and plans to publish it for consultation in 2018. ENTSO-E's objective, along with the stakeholders involved, is to prepare a methodology which will be fit for use in many successive TYNDPs. If adopted by the European Commission, this CBA 3.0 will be used in the TYNDP2020.

Interlinked model: exploring sector coupling

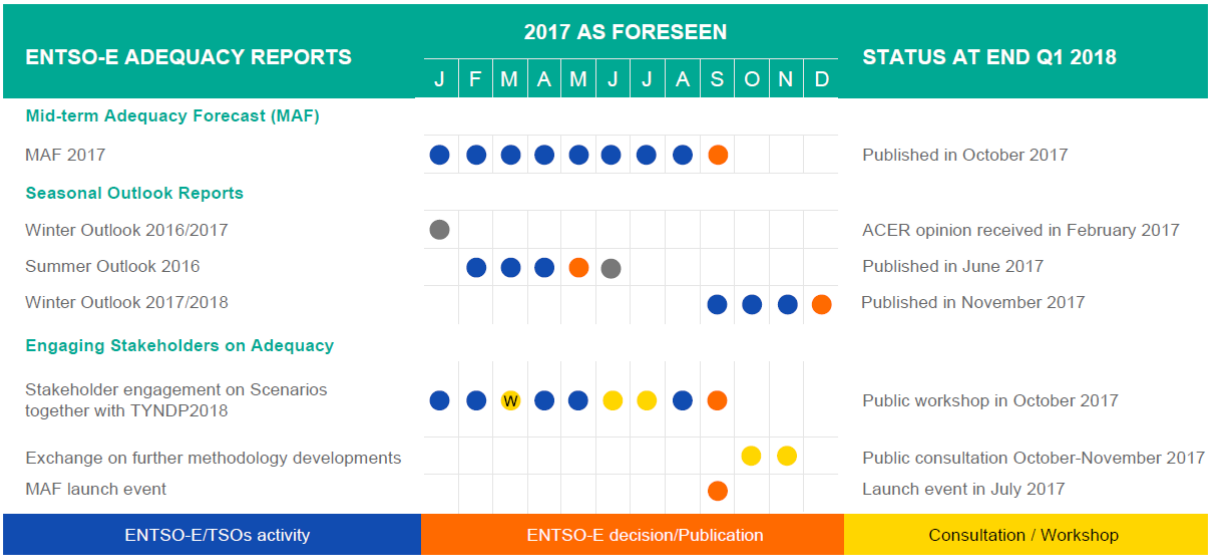
As part of the scenario building process with ENTSOG, sector coupling has been explored. This examines how the need for decarbonisation of various sectors leads to electrification, notably in the heating and transport sector. The viability of power to gas was explored, where the excess production of renewable electricity is used to create hydrogen.

In view of the further adaptation of this interlinkage, the ENTSOs have identified the need to further investigate the interlinkage between gas and electricity scenarios and infrastructure project assessment and seek to investigate all possible interactions between the gas and electricity sectors, including interactions between the gas and electricity infrastructure projects.

Considering the infrastructure projects, the main question addresses synergies and competition, e.g. can a gas pipeline replace an electricity line or can an electricity line replace a gas pipeline? Can you avoid building a new infrastructure by considering the existing infrastructure in both sectors? ENTSO-E and ENTSOG aim to outline criteria which could be used to identify gas and electricity projects with a strong interlinkage, and how the interlinkage between said projects may impact their respective valorisation.

3. System adequacy

Assessing system adequacy is part of TSOs' tasks, and, consequently, one of ENTSO-E's most important mandates. Resource adequacy requires advanced methodologies to capture and analyse rare events with adverse consequences for the supply of electric power. Over the past decade, ENTSO-E has been continuously improving its methodologies and forecasts.



Looking ahead: the Mid-Term Adequacy Forecast

The Mid-term Adequacy Forecast (MAF) is a pan-European assessment of power system adequacy, spanning the next 10 years. Released on a yearly basis, it goes beyond the legal mandate as set by Regulation 714/2009, to better answer the needs identified by the Electricity Coordination Group[11]. Indeed, the ECG found that adequacy assessments are more useful when focussed on the mid-term horizon (up to 10 years ahead), as these can be used to assess potential load shedding risks and send signals to both market players and decision-makers of the need for the generation fleet to evolve[12].

> ✓ ENTSO-E must develop a European generation adequacy outlook, every two years covering the overall adequacy of the electricity system to supply current and projected demands for electricity for the next five-year period as well as for the period between five and 15 years from the date of that outlook (Article 8, Regulation 714/2009)

The MAF is based upon a probabilistic analysis conducted using sophisticated market modelling tools. Used for the first time in the 2016 edition, this approach has been further consolidated and standardised in the MAF 2017. The MAF 2017 establishes a pan-European standard and 'common language' of power system adequacy.

[11] The Electricity Coordination Group is a platform for strategic exchanges between Member States, national regulators, ACER, ENTSOE and the Commission on electricity policy.
[12] Report of the European Electricity Coordination Group on The Need and Importance of Generation Adequacy Assessments in the European Union, Ref. Ares (2013)3382105 - 30/10/2013

To this end, extensive collaborative effort has been made by representatives from TSOs covering the whole pan-European area under the coordination of ENTSO-E. The same modelling tools used in 2016 have been further developed and aligned, to conduct a comprehensive market-based probabilistic assessment of adequacy throughout Europe.

4 July 2017: Presentation of the preliminary outcomes of the MAF
2 Oct-10 Nov 2017: Publication of the final MAF 2017 and public consultation. The comments received will be considered in the elaboration of future MAFs.

The MAF 2017 is the first to introduce a representation of demand side response (DSR) based on the information collected by TSOs. DSR was modelled with different price bands, to allow for a more detailed representation, e.g. of industrial and domestic DSR. In addition, a new sensitivity simulation with estimated risk of generation mothballing or capacity exit was performed. Finally, the pan-European climate database was extended to cover more samples of the climatic variations.

Lessons learnt

Power systems are increasingly affected by climate conditions. To realistically forecast possible future events, it is necessary to deploy a comprehensive set of climate data, covering a large range of possible outcomes, including 'normal' as well as 'extreme' conditions.

The MAF 2017 also demonstrates complex and strong system interdependencies calling for a pan-European perspective. Measures to overcome adequacy problems may be allocated to the supply, demand storage or grid sector, e.g. additional interconnection may supersede the need to enhance the generation capacity within a country. Therefore, decision-makers need to coordinate their activities to ensure an efficient deployment of partially complementary measures.

In addition, the results demonstrate the massive impact on adequacy of generators mothballing or closure, not only in the country with generation exit risks but in a much larger European area. It will be crucial to monitor mothballing activities on a broader European scale.

The present pan-European assessment inevitably faces limitations. In particular, as the examples of the cold spell in winter 2017 and the winter outlook show, the European assessment may fail to capture some particular elements and interdependencies necessary to forecast and assess in sufficient detail all the potential tense situations.

Continuous improvement of the future MAFs will require work on three dimensions: additional data collection, further improvement of the modelling tools, and further convergence to common standards in terms of data and methodology. In addition, future MAFs will be embedded in a broader set of stakeholder activities, also including complementary regional and national analyses focusing on local specificities. Learnings and new developments will then be fed into the next edition of the MAF to ensure continuity and consistent improvements.

The Seasonal Outlooks

✓ ENTSO-E shall adopt annual summer and winter generation adequacy outlooks (Article 8, Regulation 714/2009)

ENTSO-E's winter and summer outlooks are pan-European, system-wide analysis of risks to electricity security of supply. They present TSOs' views on the risks to security of supply and

the countermeasures they plan for the coming season, either individually or in cooperation.

The winter 2016/2017 saw the European power system facing tensions due to an unforeseen cold spell combined with low availability of nuclear generation in France. Consequently, ENTSO-E launched several important improvements in the preparation of the Winter Outlook 2017/2018. Instead of considering situations that only happen in 1 year out of 10, the Winter Outlook 2017/2018 examines worst-case situations that could occur in 1 year out of 20, thus covering more potential risks. In addition, ENTSO-E analysed the risks associated with extreme climatic conditions taking place simultaneously in all of Europe, and performed several qualitative risk assessments and stress tests.

1 June 2017: Publication of Summer Outlook 2017 and Winter Review 2016/2017

29 Nov 2017: Publication of Winter Outlook 2017/2018 and Summer Review 2017

Each outlook is accompanied by a review of what happened during the previous season, based on qualitative information by TSOs presenting the main events that occurred during the past period and comparing them to the forecasts and risks foreseen in the corresponding outlook. Because of the unusually low temperatures, the Review of Winter 2016/2017 is complemented by a dedicated ENTSO-E report on the cold spell of January 2017, looking in detail at the consequences of the cold spell on systems and markets in the most impacted countries.

Managing critical grid situations: the January 2017 cold spell

January 2017 saw an extended cold wave that created a stressed situation for the TSOs in Continental Europe. The severe weather conditions placed significant stress on the power grids in France, Italy, Switzerland, Belgium, Romania, Bulgaria and Greece, and to a lesser extent on the surrounding countries which supported their neighbours. The extended nature of the cold spell affecting multiple countries simultaneously was coupled with the challenges faced in terms of generation adequacy and unscheduled flows issues over this period.

ENTSO-E's Winter Outlook 2016/2017 foresaw that cold weather combined with reduced generation capacity in some areas could lead to adequacy problems in France and in some neighbouring countries. However, the methodology did not allow to forecast the situation as it unfolded in South East Europe, where a very severe cold wave occurred with temperatures much lower than the one-in-ten-year situations assessed in ENTSO-E's seasonal outlooks.

To better address similar situations in future, in 2017 ENTSO-E launched a taskforce mandated to set a definition of critical grid situations, define a general coordination process, propose process improvements to ENTSO-E's seasonal outlooks and conduct a market analysis of the January 2017 events. Prepared in coordination with the Electricity Coordination Group, the report 'Managing critical grid situations - Success and Challenges' released in May 2017 provides an overview of the sequence of events and analysis of the situation in each country affected and identifies focus areas for action.

It finds that the measures applied by TSOs were effective in preventing supply interruption and helped to avoid the use of extraordinary measures such as manual load shedding at the most critical times. Thanks to efficient cooperation between TSOs and RSCs, the cold spell was managed effectively at both regional and local level. The RSC service 'short-medium term adequacy', although still under development, demonstrated its added-value in the Continental Western Europe region to better manage the adequacy

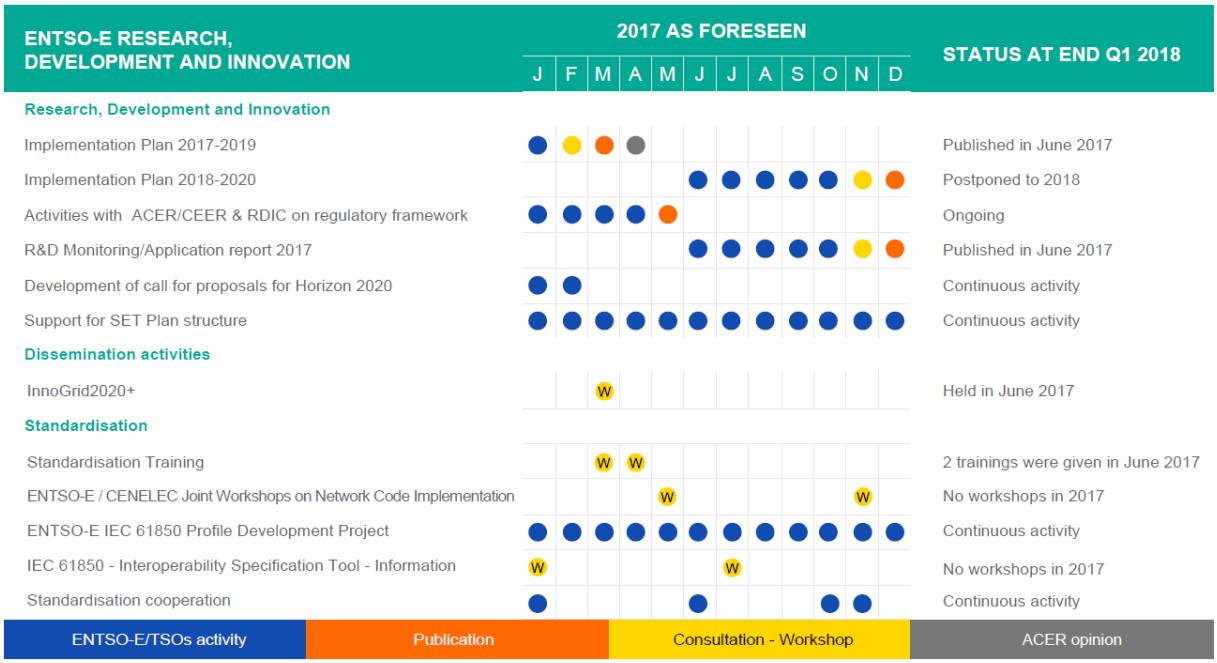
issues at regional level. Focus areas include an improvement in seasonal outlook's methodologies and improved coordination at regional level.

Measures identified to detect critical grid situations were implemented in time for the winter 2017-2018. In particular, the coordination issues experienced in South-East Europe were addressed with the support of SCC, the RSC in Belgrade. ENTSO-E received positive feedback on the improved coordination in South-East of Europe.

Released in November 2017, the market analysis of the cold spell focuses on identifying market distortions and potentially identifying parameters that could hint at or forecast critical situations. In particular, it finds that market integration and coordinated actions among TSOs played a key role in dealing with extreme situations. Without cross-border exchanges, some countries, such as Belgium, Italy or Switzerland, might have faced shortages in supply. The report, however, also identifies several measures to increase transparency and information in the day-ahead and week-ahead forecasts.

4. Innovation

With Europe's power grid evolving quickly into a smart grid, the steady growth of renewable energy sources (RES) that need to be integrated, and new actors in the market, TSOs are facing new challenges that require innovative ways of thinking. ENTSO-E's R&D activities, as legally mandated by Regulation (EC) No 714/2009 and Directive 2009/72/EC, involve promoting and coordinating research, development and innovation activities of TSOs, including monitoring of their implementation and real-life application.



Planning, implementing, monitoring

R&I Implementation Plan 2017-2019

In May 2017, ENTSO-E released its R&I Implementation Plan 2017-2019: Power System Innovation for all Europeans. The Implementation Plan is one of the key planning instruments for coordinating TSOs' efforts in R&I. It seeks to prioritise and address the R&I activities identified in ENTSO-E's R&I Roadmap 2017-2026, with the overarching goal of establishing and maintaining an efficient, cost-effective, reliable and secure European power system.

The Implementation Plan 2017-2019 streamlines the R&I priorities for 2017 and outlines topics to be tackled through 2018 and 2019. The main activities for 2017 focused on providing flexibility to the grid and assessing and further developing stability mechanisms, mainly with regards to the integration of RES. The Plan also tackled the need to deploy ICT infrastructures for data management, also with the objective of promoting the increasing cooperation between TSOs and DSOs.
The 2018-2020 edition of the Implementation Plan, initially scheduled for June 2017, was postponed to 2018 to align the R&I implementation activities of TSOs with those of the European Technology & Innovation Platforms (ETIP). ENTSO-E is an active partner of the ETIP Smart Networks for Energy Transition, which is

currently developing its vision on research and innovation for the grid for 2050. ENTSO-E and ETIP SNET collaborate closely to develop a coherent implementation plan for 2020 (more on this below).

R&I Application Report 2016

ENTSO-E's R&I Application Report 2016, released in June 2017, highlights concrete results from 20 EU-funded R&D projects which have led to real-life applications. Upon ACER's recommendation (Opinion 11-2016 on ENTSO-E's R&I Roadmap 2017-2026) this report is more result-oriented than the 2015 edition. It aims to demonstrate the concrete impact and benefits of TSOs' RD&I activities on the power system.

Most of the projects analysed led to the development of concrete applications to address specific challenges faced by TSOs, e.g. unification of several market modelling tools, and real-life assessment of the capabilities of distributed energy resources to provide flexibility services. TSOs then integrated these applications in their procedures and shared them among themselves.

The report illustrates how these applications have not only resulted in measurable benefits – safer methods, cost reduction and better cost-benefit analyses, harmonisation and product improvement, CO2 footprint reduction – but also in non-measurable gains: by developing these applications, knowledge of TSOs and their partners, and inter-TSO cooperation at the pan-European level, have greatly increased.

R&D projects & partnerships

ENTSO-E is a key partner in several projects awarded by the Horizon 2020 programme, including the following:

- The TDX-assist project aims at designing and developing new, modern and safer ICT tools and techniques that enable information and data exchange between TSOs and DSOs.

- INTENSYS4EU is an ongoing project that puts the customer at the centre of the energy system by addressing the integration challenges identified by the SET Plan.

Other awarded projects include OSMOSE, EUSYSFLEX and FLEXITRANSTORE. ENTSO-E also contributed to the elaboration of the Horizon 2018-2020 work programme and gave input to the FP9 for innovation - the new framework programme that will replace Horizon 2020 as of January 2021 - through a stakeholder consultation. ENTSO-E will continue to actively participate in the drafting of the FP9 throughout 2018 and 2019.

The INTENSYS4EU project, as well as ENTSO-E's activities within the European Technology & Innovation Platform for Smart Networks for Energy Transition (ETIP SNET), fall under the umbrella of the European Strategic Energy Technology Plan (SET Plan). The SET Plan is part of a new European energy R&I approach designed to accelerate the transformation of the EU's energy system and to bring promising new zero-emissions energy technologies to the market. It promotes cooperation amongst different stakeholders and institutions, including ENTSO-E.

SMART NETWORK FOR THE ENERGY TRANSITION

The European Technology & Innovation Platforms (ETIPs) have been created by the European Commission in the framework of the new Integrated Roadmap Strategic Energy Technology Plan (SET-Plan) by bringing together a multitude of stakeholders and experts from the energy sector. The role of the ETIP Smart Networks for Energy Transition (SNET) is to guide RD&I to support Europe's energy transition. ENTSO-E participates in four of the six working groups, focused on power system integration, storage technologies and sector interfaces, digitisation, customer participation and innovation implementation. ENTSO-E's former Secretary General Konstantin Staschus chaired the ETIP SNET platform from its creation until the beginning of 2018[13].

ENTSO-E is also involved in the elaboration of the ETIP SNET vision for research and innovation, a high-level document that provides a roadmap for R&I activities for the next decade. The ETIP SNET vision for 2030 concentrates on the need to develop an integrated approach towards the energy system to fulfil the climate targets while ensuring security of supply. The vision will also envisage the possibility of users actively engaging in the marketplace.

InnoGrid2020+

On June 2017, ENTSO-E organised the 6th edition of InnoGrid2020+ jointly with EDSO for Smart Grids, who gathered 34 electricity distribution system operators (DSOs) to promote the development of smart grid models and technologies. This annual conference provides a space for TSOs and DSOs to showcase their R&D innovative projects and share the results with policymakers and stakeholders alike. The 2017 edition focused on active customer and active system management, data management and regulation and the technological needs to ensure the sustainable development of the smart grids.

Customers as active market participants – the TSO-DSO project

The energy transition carries with it a series of transformations that are giving customers a more active role in the system, consequently placing the customer centre stage. This will imply the inclusion of new actors in the market, like aggregators, an increase in decentralised systems and further development of demand-response. With these changes already taking place, both the electricity market and network are facing new challenges that require TSOs and DSOs alike to rethink their current interface.

Following a 2016 common TSO-DSO report outlining the needs, roles and responsibilities in data exchange, 2017 was focused on designing more concrete models for data management. ENTSO-E commissioned a report describing the state of play of data exchange platforms in Europe. The report shows how centralised data exchange platforms existing in several European countries provide a simple data access point for customers and new service providers. The report concluded that, overall, data platforms improve market efficiency, remove market barriers and ultimately empower the consumer to participate in the market by giving them and authorised third parties of their choice access to their data. Based on this state of play, ENTSO-E intends to further investigate the possible applications of data exchange platforms in different business processes.

[13] He currently acts as ETIP SNET Vice-chair.

A second area of collaboration for TSOs and DSOs, which has been the main priority of 2017, concerns active system management and the use of distributed flexibility. Storage, distributed generation and customer participation through demand side response have the potential to generate new services for the grid and the system. These have been known as distributed flexibilities, and they will be key to efficiently managing the electrical system of the future and developing new market products. Rules are needed to ensure a fair and operative market, limit the upsurge of non-coordinated local market places and guarantee that the new services are sufficiently valued.

A core question remains the interaction between balancing the electrical system and managing congestions on the grid. TSOs and DSOs work together to understand their respective challenges and responsibilities towards creating an integrated market. Several expert workshops were conducted in 2017 to share best practices, define upcoming challenges and design possible solutions. The step forward in 2018 consists of involving stakeholders so their expectations can be heard.

A common report on active system management is planned for 2018, aiming to define the uses of active system management and distributed flexibilities, studying the interactions between balancing and congestion management and assessing whether common European guidelines will be required.

In addition to the above, ENTSO-E contributes to the European Commission Expert Group on demand side response, under the Smart Grid Taskforce, which focuses on deployment of explicit DSR in Europe, contractual arrangements between different players and market solutions for accessing and using distributed flexibilities. An interim report was produced in January 2018. A paper with recommendations on best practices and regulatory gaps is expected to be released by the end of 2018.

5. The Transparency Platform: Information for all market participants

ENTSO-E's Transparency Platform, specified in Article 3 of Regulation 543/2013, centralises data relating to the generation, transportation and consumption of electricity at European level. The data is collected from data providers, including TSOs and other qualified third parties. Depending on the users' needs, this data can serve various purposes, such as market analysis, research or trading. In 2017 about 4000 new users registered on the platform, which shows continuous interest in energy market data.

Upon ENTSO-E initiative and users' request, ENTSO-E developed in 2017 an evolution plan of the Transparency Platform aimed at improving data quality and readability. The plan includes technical upgrades, as well as an update of the Manual of Procedures, a technical guide that ENTSO-E had developed in 2015 as required in Article 5 of Regulation 543/2013, following discussions with ACER and stakeholders.

The upgrade of the platform was divided into two major phases. The first phase, completed in December 2017, involved updates on several data items: actual generation output, aggregated generation per type, consumption unit outages, transmission grid outages, total capacity nominated, commercial schedules, installed capacity by production unit, day-ahead generation for wind & solar, production unit and generation unit outages.
Additionally, in September 2017, the ENTSO-E Transparency User Group conducted a workshop to improve and further clarify the data to be uploaded to the platform. As a result, reports informing of missing data, questionable data quality based on predefined rules or potential delay of publications, will be automatically generated and sent to data providers.

The second phase of the evolution plan, covering updates on balancing and redispatching, is going live in April 2018. The next major challenge is to make the platform more user-friendly with a new Graphical User Interface. ENTSO-E, in close cooperation with the Transparency User Group, is already working on the design of the new interface, of which some parts are expected to go live in 2018.

6. TSO coordination and digitalisation

One of ENTSO-E's mandated tasks is to support TSOs in coordinating their efforts and to develop information networks and procedures that can help them achieve Europe's energy policy goals. Several factors render coordination among TSOs more important than ever, e.g., increased variable generation, more interconnections. TSO coordination is fundamental to maintaining the security and quality of the network supply; it is also important to adequately plan infrastructure investment at the regional level, and to improve operational cost efficiency (see the Regional Security Coordinators, under 'Network codes').

Additionally, ENTSO-E sees digital technologies as an opportunity to foster coordination even further. 2017 saw the establishment of a digital committee advising ENTSO-E's Board, reflecting this new priority. The important budget increased decided at the end of 2017 is another example.

Digitisation enabling more coordination: ENTSO-E's Common network operation tools

In addition to the Common Grid Model (see under 'Network codes'), TSOs have developed several common operation tools that allow them to better coordinate.

ENTSO-E shall adopt common network operation tools to ensure coordination of network operation in normal and emergency conditions, including a common incidents classification scale (Article 8(3)(a) Regulation 714/2009)

The ENTSO-E Awareness System

The ENTSO-E Awareness System (EAS) is the technological platform allowing TSOs to exchange information in real time. It allows TSOs to monitor energy flows and the state of the network across Europe as it happens. Operational since 2013, it is used by all TSOs with interconnections.

Quarterly EAS user tests performed in 2017 under the lead of the two Hosting Entities (Amprion and RTE) showed the tool was fully operational. ENTSO-E began a project in September 2017 that focuses on upgrading the European Awareness System, for both the hardware and the software part. In addition, the team in charge of keeping up-to-date the EAS operational procedure engaged in an alignment exercise to ensure consistency between the EAS statistics and the Incident Classification Scale reporting[14].

Following the entry into force of the SOGL in September 2017, ENTSO-E began to review all requirements in the SOGL to ensure the compliance of the tool.

The Electronic Highway

The electronic highway is a meshed router network (separate from the internet) connecting the European TSOs, and is designed for real-time data exchange between them. It is being used by the 38 TSOs directly connected since 1999.

A security analysis performed in 2017 revealed several issues with the Electronic Highway. Considering these issues, the decision was taken to merge Electronic Highway with ATOM, the data exchange communication network used for the Common Grid Model[15]. This will create one single physical infrastructure for TSOs' communication network. The new infrastructure will be called COMO (Communication Network for Market and Operations) and will support multiple services.

[14] Requirement under Regulation (EC) 714/2009 where TSOs are asked to develop a common incidents classification scale.
[15] ATOM is a pan-European private network based on TSOs' owned backbone network. It allows the exchange of non-real-time operational and market-operations related data.

Besides, ENTSO-E finalised in 2017 an (internal) Security Framework for the Protection of Electronic Highway and ATOM, consisting of a set of minimum security requirements for physical, organisational and cyber aspects that are expected to be implemented by each TSO.

CYBERSECURITY

Protecting TSOs' systems and network operation tools against cyber-attacks is obviously of paramount importance for the security of electricity supply. ENTSO-E supports TSOs by acting as a platform to share best practices

In May 2017, ENTSO-E signed a Memorandum of Understanding with the European Network of Cyber Security (ENCS), with the objective of developing a partnership in the cybersecurity area. The focus will be on developing good security regulations and effective cybersecurity practices. ENTSO-E TSOs joined the *Red Team - Blue Team* training organised by ENCS in December 2017. The goal of the course was to raise awareness of Industrial Control Systems (ICS) cyber security risks, to share knowledge of attacks and defensive measures and to experience hands-on practices of cyber security within the ICS domain.

In addition, ENTSO-E is participating in the European Commission Smart Grid Task Force, EG 2 – Working group on Cybersecurity. The working group focuses on energy networks and prepares the ground for a possible network code on cyber security.

A new IT governance

ENTSO-E and TSO, and all electricity market players, are engaged in a digital transformation, as exemplified by the rise of smart grids and the development of tools such as the Common Grid Model and the Operational Planning Data Environment. The IT architecture must be adapted to allow TSOs and market players to take advantage of this transformation for designing more efficient processes and methods.
ENTSO-E elaborated in 2017 an IT strategy, spanning the period from 2017 to 2020, including as a first concrete step the creation of a Digital Committee to advise ENTSO-E's Board on digital.

Cooperation with third country TSOs

ENTSO-E released in January 2017 a report presenting recommendations for the coordination of technical cooperation between Union and third Country TSOs[16], as required by Regulation 714/2009 Article 8(3)(c). The report sets a non-binding framework for technical cooperation, to be continuously improved in future.

✓ ENTSO-E shall adopt recommendations relating to the coordination of technical cooperation between Community and third-country transmission system operators (Article 8(3)(c) Regulation 714/2009)

Areas for cooperation include data sharing and information, knowledge-sharing, technical standards, network development planning, coordinated system operation, protection of critical infrastructure including cyber-security, and interconnection. ENTSO-E's role is to facilitate the cooperation and coordination between TSOs, to ensure effective and transparent access to the transmission networks and to provide coordinated and forward-looking planning.

[16] To be understood as TSOs who are not member of ENTSO-E

2017 also saw closer ties with the Ukrainian TSO Ukrenergo and Moldovan TSO Moldelectrica. Two agreements, signed between Ukrenergo/Moldelectrica on the one hand, and the TSOs of Continental Europe on the other, entered into force in July 2017, specifying the conditions for the future interconnection of the power system of Ukraine and Moldova with the power system of Continental Europe.

Ukrenergo and Moldelectrica will have to implement within the next five years a catalogue of measures, including a series of technical requirements. These agreements open the way to a possible synchronous connection of Ukraine and Moldova with the Continental European power grid within the coming 4 to 6 years.

In addition, in July 2017, ENTSO-E organised in Kiev a workshop with Ukrenergo to discuss electricity system development, market and operations. Data concerning the Ukrainian power system has become available on ENTSO-E's real-time market data platform (Transparency Platform).

2017 also saw the Albanian TSO OST join ENTSO-E as a member.

Synchronisation of Baltic countries to Continental Europe

Baltic States are currently synchronised with the IPS/UPS system from Russia and Belorussia. However, the Baltic States have expressed their wish to be part of the Continental European synchronous area by 2025. Several direct current interconnections link them to the Nordic synchronous area and one such interconnection to the Continental European synchronous area via Poland.

After a JRC study 'Integration of the Baltic States into the EU electricity system: A technical and economic analysis' released at the end of 2016 demonstrated that the interconnection with the Continental European power system is the preferred option, representatives of the Polish and Baltic transmission system operators – PSE, Litgrid, AST and Elering - met in September 2017 to start a technical study on the Baltic States' synchronisation with the system of Continental Europe with the objective of analysing the dynamic stability of the interconnection. In addition, it was decided to perform a frequency stability study in parallel. ENTSO-E facilitates the process.

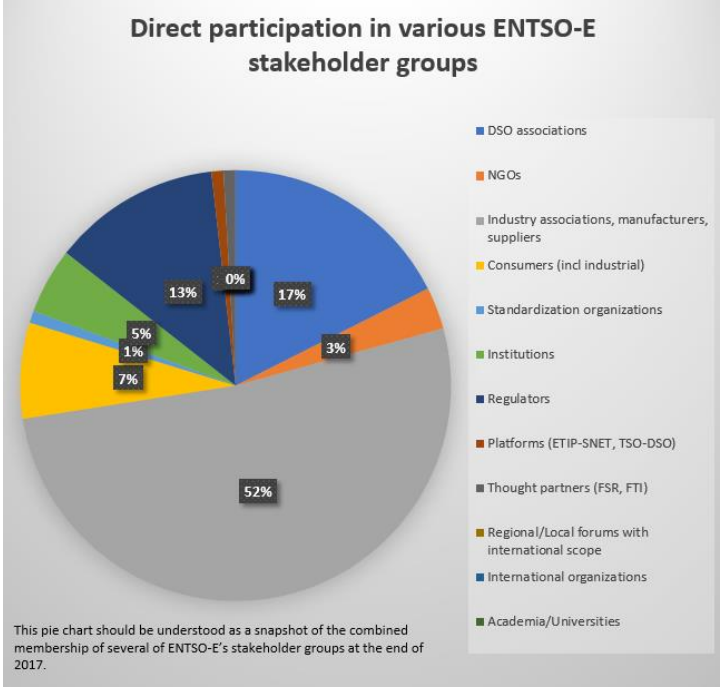
The dynamic stability and frequency stability studies are crucial to determine the feasibility of the interconnection and the possible additional costs to which the Baltic TSOs will be confronted once decoupled from the IPS/UPS power system. Several interconnection variants are under investigation: (i) using the existing AC double circuit line between Poland and Lithuania, (ii) using the existing line and another yet to be constructed AC double circuit line, and (iii) using the existing line and an HVDC link (submarine cable) between Poland and Lithuania.

The synchronisation of the Baltic States has numerous political implications, including regarding Kaliningrad. These are on the agenda of the involved policy makers and most notably of the European Commission. It is expected that the political decision to submit the system extension request will be taken in June 2018. It will be formulated on behalf of Baltic TSOs as a request of one member of ENTSO-E's Regional Group Continental Europe and, if approved, the corresponding Connection Agreement with the Baltic TSOs would be signed by the end of 2018.

7. Looking back at stakeholder engagement in 2017

ENTSO-E engages with stakeholders via a number of dedicated groups, public consultations, its annual conference, its workshops and other events, training and individual contacts. Overall stakeholder satisfaction with ENTSO-E's work has increased by 3.6% in 2017 compared to 2016[17].

Stakeholders' feedback is generally positive regarding **stakeholders groups**, who are seen as providing adequate fora for discussion. These include for example the Advisory Council, the three Network Codes European Stakeholder Committees, the Balancing Stakeholders Group, the Network Development Stakeholder Group and the Transparency Platform Users Group. Involved stakeholders represent a wide range of interests across the electricity sector. However, ENTSO-E has noted an under-engagement of NGOs, RES and consumer representatives, likely due to limited staff resources. This discrepancy tends to be more important regarding highly technical topics. To restore the balance, ENTSO-E engages in individual contacts on an ad-hoc basis.



ENTSO-E's **independent Advisory Council**, which met four times in 2017, has provided advice to ENTSO-E's Board on ENTSO-E's general strategy and on our main work products (such as our Annual Work Program 2018 and policy papers), TSO-DSO cooperation, network code development, and the role of TSOs regarding storage (its minutes and recommendations to ENTSO-E are available here). ENTSO-E's Board has approved the proposed extension of the Council's membership to increase the representation of NGOs and RES associations, and the invitation of additional stakeholders. A final decision is expected to be taken by ENTSO-E's Assembly at the end of June 2018.

Our Stakeholder survey shows mixed results regarding our **public consultation process**, with stakeholders highlighting a number of shortcomings regarding the length, timing and foreseeability of consultations. ENTSO-E's Consultation rules of procedure specify that ENTSO-E should strive for a two-months consultation period, and that the minimum length should be one month. Over the 54 online consultations launched in 2017, the majority (45) ran for 4 to 6 weeks. One was shorter than 4 weeks. Additionally, stakeholders report difficulties meeting consultation deadlines set during the summer holidays.

As required by Regulation 714/2009 (Article 5(1)), ENTSO-E's public consultations follow a number of rules set in our Consultations Rules of procedure, approved in 2011 and submitted to ACER (these rules are currently being reviewed). The Regulation (Article 10) further specifies that ENTSO-E must conduct „an extensive consultation process, at an early stage and in an open and transparent manner, involving all relevant market participants". Consultation are required by the Regulation on the network codes, on our annual work programme and on the TYNDP. In addition, the network codes themselves specify that a number of implementation deliverables must be consulted upon.

[17] According to the results of our Stakeholder Survey 2017, conducted in January 2018.

Three consultations running for 4 and 5 weeks largely over August 2017 did not allow for proper engagement.

Public consultations were announced in advance in our annual work programme for 2017 published end 2016, with a rather good level of accuracy overall. However, the consultations announced in the AWP did not include those organised under the responsibility of Capacity Calculation Regions as part of the CACM implementation, which represented just under one-third of all consultations ran in 2017[18]. To provide better information on upcoming consultations part of network code implementation in future, ENTSO-E is keeping up-to-date a planning of upcoming activities, including consultations and workshops, for each code on the new website electricity.network-codes.eu. ENTSO-E is also in the process of reviewing its consultation rules, with a view to making it easier for stakeholders to answer.

2017 saw the introduction of **innovative engagement practices**. The network codes Issue Logger tool centralises stakeholders' queries on network code implementation, including answers provided by the EC, ACER or TSOs. In addition, ENTSO-E co-developed with the Florence School of Regulation training on network codes, to which a diverse range of stakeholders participated in September-October 2017. Both initiatives received positive feedback.

[18] 17 CCRs consultations on fallback procedures and capacity calculation methodologies

8. Resources

Key figures

ENTSO-E AISBL is a non-for-profit organisation governed by Belgian law. Its 2017 financial statements are reviewed by KPMG statutory auditors who will issue an opinion at the 25 June 2018 General Assembly. The following figures are non-audited but give a fair view of the activities performed during the year.

2017

20,2 M€	-0,7 M€	2,7 M€	5,7 M€	78,5
Total Membership fees	Net result	Capital expenditures	Net cash position	Total average FTE

In 2017, the operational expenditures of the Association ended up to 20,9 M€ and addressed the following activities:

- 40% Association member's services: association governance support, Secretariat administration, strategy and communication;
- 38% Legal mandates' services: network code implementation, TYNDP, R&D activities;
- 22% IT legal mandates' services: data and IT infrastructure (Common Grid Model under the network code implementation, Transparency Platform, ENTSO-E Awareness System).

This year our result is showing a loss of -0,7 M€ driven by the non-budgeted cost of the bidding zone study. These costs were funded from the cumulated reserves of the Association.

The 2,7 M€ capital expenditures are mainly related to the Transparency Platform improvement (0,7 M€) and the development of the Common Grid Model (2 M€).

In 2017, the total average full-time equivalent (FTE) ended up at 78,5, which corresponds to an increase of 6 FTEs compared to 2016 and is mainly driven by the adequacy and network code implementation activities. It includes permanent staff, TSOs secondments as well as outsourced "on site" services (such as the IT support services). This is in addition to the numerous TSO staff members who bring their expertise to the Association via the 100 bodies (Assembly, Board, Committees and subgroups).

2018 perspectives

The 2018 Budget was approved on 13 December 2017 by the Assembly, the operational expenditures increasing by 40% compared to 2017, to 28,7 M€. This increase is driven by our legal mandate to develop and maintain the Common Grid Model.

Glossary

Acronym	Definition
aFRR	Automatic Frequency Restoration Reserves
ATOM Network	All TSO network for non-real time Operational and Market-related data
BRP	Balancing Responsible Parties
BSP	Balancing Service Provider
CACM	Capacity Allocation and Congestion Management
CBA	Cost-Benefit Analysis
CCR	Capacity Calculation Region
CENELEC	European Committee for Electrotechnical Standardisation
CGM	Common Grid Model
CGMES	Common Grid Model Exchange Standard
DCC	Demand Connection Code
DSO	Distribution System Operator
EB	Electricity Balancing
EDSO	European Distribution System Operators' Association
ENTSOG	European Network of Transmission System Operators for Gas
FCA	Forward Capacity Allocation
HVDC	High-Voltage Direct-Current
IEC	International Electrotechnical Commission
IEM	Internal Electricity Market
ICS	Incident Classification Scale
JAO	Joint Allocation Office
MAF	Mid-term Adequacy Forecast
mFRR	Manual Frequency Restoration Reserves
MRC	Multi Regional Coupling
MVS	Minimum Viable Solution
NEMO	Nominated Electricity Market Operator
NRA	National Regulatory Authority
OPDE	Operational Planning Data Environment
PCI	Project of Common Interest
Prosumers	Neologism to designate producers and consumers
RES	Renewable Energy Sources
RfG	Requirements for Generators
RGCE	Regional Group Continental Europe
RR	Replacement Reserves
RSC	Regional Security Coordinator
SAP	Single Allocation Platform
SET Plan	Strategic Energy Technology Plan
TSC	TSO Security Cooperation
TSO	Transmission System Operator
TYNDP	Ten-Year Network Development Plan
XBID	Cross-Border Intraday