Framework Guidelines on System Operation

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Initial Impact Assessment

15 July 2011

Agency for the Cooperation of Energy Regulators
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1 PROCEDURAL ISSUES AND CONSULTATION OF INTERESTED PARTIES

1.1 Identification

System Operation covers the complete area of activities for operating an electrical network, including security, control and quality in terms of fixed technical standards, principles and procedures, but also the synchronous operation of interconnected power systems. In the context of this Initial Impact Assessment (IIA) System Operation requirements are considered as features and rules which primarily the system operators, but also significant users have to meet, in order to maintain the system security, availability and the proper functioning of the electricity market from a technical point of view.

1.2 Rationale behind the Initiative and ERGEG/ACER Mandate

At the heart of the 3rd Legislative Package[1] is the development of EU-wide Network Codes on topic areas for the integration of EU electricity and gas markets, enabling cross-border trade and competition to develop across EU energy markets. The process for developing these codes is stipulated in the legislation and includes the elaboration by energy regulators (Agency for the Cooperation of Energy Regulators, ACER) of Framework Guidelines, which set out the key principles for the development of the Network Codes by the transmission system operators (European Network of Transmission System Operators for Electricity, ENTSO-E).

Since the provisions of the 3rd Legislative Package are applicable since 3 March 2011, ERGEG have been previously committed to making as much progress as possible in preparing the work on FG during the interim period and will therefore provide input to the European Commission and ACER on the preparatory work on Framework Guidelines.

The 16th Florence Forum in June 2009 outlined the essential elements of the 3rd Legislative Package and made suggestions on how to efficiently use the interim period in order to pave the path for the implementation. In particular, the electricity pilot project to prepare the Framework Guidelines and the related Network Codes was discussed. Further on, the specific approach for the System Operation topic was discussed and agreed in the 19th Florence Forum in December 2010. This is why ERGEG has been committed the Project on System Operation.

It is within this context, that ERGEG has been invited by the European Commission to draft the related Framework Guidelines – the background information and expected results were outlined in the letter [8] from the Director of the European

[1] The 3rd legislative Package proposals for the European Internal Market in Energy were finally adopted on 13 July 2009 and include 5 legislative acts, which can be viewed at: http://eur-lex.europa.eu/JOHtml.do?uri=OJ:L:2009:211:SOM:EN:HTML

Commission DG for Energy to the ERGEG President, of 22nd December 2010 (enclosed in the Annex).

In order to ensure that the development of the Framework Guidelines meets the best regulatory practice, the Project is organised in two steps:

1. Step 1: Initial Impact Assessment for justification (this document);

2. Step 2: Drafting of Framework Guidelines on System Operation, 2 months of public consultation (including public workshop) and revision of the Guidelines accordingly after the consultation

An ad hoc Expert Group was set up with the purpose to provide an input/assistance to ERGEG (later ACER) in relation to the specific issues relevant to a particular topic. The expert group members are listed in Chapter 1.4.

1.3 Organisation and Timing

The Article 6 of the Regulation (EC) No 714/2009 (Regulation) on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No 1228/2003 (old Regulation) sets out the provisions for the establishment of Network Codes. The European Commission shall request that ACER submits to it within a reasonable period of time not exceeding six months non-binding Framework Guidelines setting out clear and objective principles for the development of Network Codes relating to the areas identified in Article 8, paragraph 6 of the Regulation. ACER shall formally consult ENTSO-E and the other relevant stakeholders in regard to the Framework Guidelines. Following the preparation of the codes by ENTSO-E, ACER provides its reasoning and opinion to ENTSO-E on the draft codes, which may then require amending by ENTSO-E. Once ACER is satisfied that the Network Codes are in line with the relevant Framework Guidelines, ACER shall submit the Network Codes to the Commission and may recommend that it be adopted within a reasonable time period.

In view of these provisions, ERGEG in 2010 began preparing the work of ACER, who is in charge starting March 2011. During 2011, the regulators will complete the Framework Guidelines on System Operation. The high-level project plan is shown in figure 1 below.

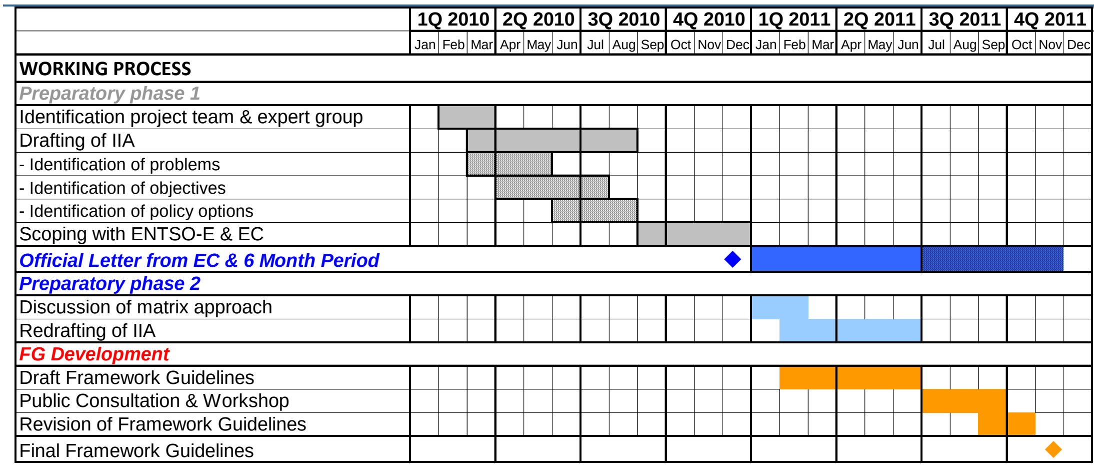
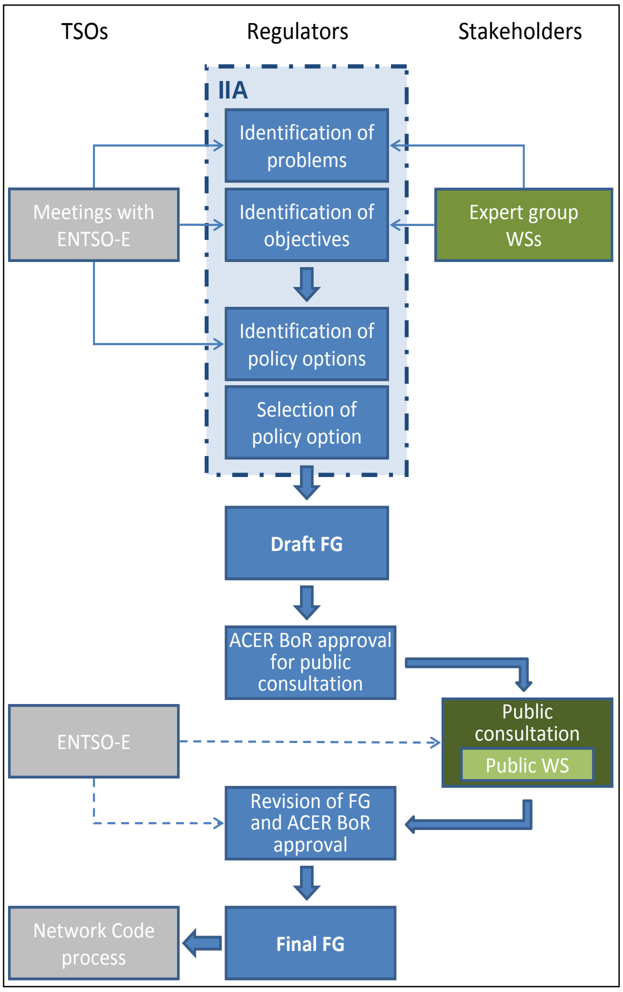


Figure 1: Project plan

This planning is outlined further from the procedural viewpoint in the following block diagram in figure 2, which shows the involvement of stakeholders in the development of the draft Framework Guidelines on System Operation by workshops and public consultation.



TSO … Transmission System Operator
IIA … Initial Impact Assessment
WS … Workshop
FG … Framework Guidelines
BoR … Board of Regulators

Figure 2: Block diagram of the process primarily foreseen for the development of the Framework Guidelines

After the public consultation, the draft Framework Guidelines will be revised accordingly as the finalised Framework Guidelines on System Operation. When this work is completed, the FG will be submitted to the European Commission, who would request ENTSO-E to draft the Network Codes for System Operation on this basis.

1.4 Consultation and Expertise

Following the 16 February 2010 publication of an open letter inviting candidates for an ad hoc Expert Group on electricity system operation, ERGEG appointed 14 members, as part of the process for the development of Framework Guidelines. This ad hoc Expert Group participated in the project, most notably in the problem identification and definition of objectives within this Initial Impact Assessment.

The terms of reference for the Expert Group on system operation, with specific expertise criteria for the experts, were provided in Annex 1 of the open letter (www.energy-regulators.eu).

The Expert Group members are:

Rudolf Baumann, Switzerland (Swissgrid Ltd)
Guido Cervigni, Italy (Lecg Italy)
Peter Christensen, Denmark (Vestas Technology R&D)
Steve Drummond, UK (SMD Consultants)
Eckart Lindwedel, Germany (Fichtner Management)
Jonathan O'Sullivan, Ireland (Eirgrid)
Javier Paradinas, Spain (Iberdrola Generacion)
Peter Rasch, Germany (Transpower)
Juan Manuel Rodriguez Garcia, Spain (Red Electrica de España)
Carlo Sabelli, Italy (Terna)
Christoph Schneiders, Germany (Amprion)
Jörg Teupen, Germany (E.ON Netz)
Marek Zima, Switzerland (Axpo Holding)
Michael Zoglauer, Austria (TIWAG)

The Expert Group members have participated in the work on this Initial Impact Assessment in their capacity as experts in their specific fields of expertise, but not representing interests of their companies. The details on the roles of experts and work of the Expert Group have been described in the invitation letter and are also available at www.energy-regulators.eu.

Before setting up of the Expert Group, ERGEG conducted a number of coordinating and scoping discussions with the European Commission and ENTSO-E, in order to exchange the views and establish the preliminary common understanding.

2 PROBLEM DEFINITION

2.1 What is the general / policy context?

System operation addresses all the aspects of synchronous operation and interworking/interaction of interconnected European transmission networks. This includes: load-frequency control, voltage and reactive power management, scheduling and balancing, data exchange and, when coping with contingencies, emergency control measures and restoration procedures.

System operation is central to the power delivery process and its management and procedures can be highly complex, yet requiring short reaction times and fast decision making, in order to maintain a safe and secure power system.

Safe and secure operation is dependent on the behaviour of grid operators (TSOs and DSOs) and grid users. Therefore the Network Code should be mandatory for all participating parties.

Safe and secure operation is a necessity to develop an efficient energy market, without creating any barriers.

The existing framework

The European power system started as several independent power systems partly interconnected into larger synchronous and coordinated systems (UCTE, NORDEL, etc.). Interconnectors had the function of supporting the power companies in operating their own systems optimally and economically and of supporting each other's system security by mutual reserve.

However, the achievement of an overall common EU-approach will be a challenge in a liberalised market context. The European power system experienced some significant and fundamental changes since the times of isolated national markets, where the power system was run by vertically integrated companies with often monopolistic positions.

Increase of flows and transactions at interconnections

With the continuing process to create an internal energy market, the transactions and load flows across interconnections have increased significantly, and will continue to do so. For example, between 2000 and 2007 the volume of commercial cross-border exchanges in the UCTE synchronous area increased by more than 50 per cent.

Opening and integration of the electricity markets and increased number of electricity market participants

The opening of electricity markets in Europe has changed the energy exchange scenery. The industry structure is shifting from one dominated by vertically integrated TSOs to one driven by commercial influences and with many new (types of) stakeholders. This makes system operation an increasingly complex activity and more difficult to coordinate within and between control areas.

To ensure and speed up the creation of a fully integrated European electricity market, the 3rd legislative package was adopted in 2009. Its proper implementation will provide for efficient integration of the national electricity markets to a truly integrated European energy market. It sets a new harmonized European regulatory framework consisting of new institutions for the co-operation of transmission system operators (TSOs) and for the cooperation of regulatory authorities. Moreover, the 3rd Package sets the possibility to adopt legally binding and harmonized rules for cross-border exchanges in electricity. Such a framework will encourage the emergence of a well-functioning and transparent wholesale market with a high level of security of supply in electricity.

Increase in variable generation

In 2008, electricity generation from renewable energy covered 16.6% of gross electricity consumption for the EU-27. The growing share of renewable electricity, 15.1% in 2006, 15.8% in 2007 and 16.6% in 2008 with normalised hydro and wind electricity is mainly due to the increasing installed capacity of wind turbines and solar energy installations (PV and CSP). The non-normalised share of electricity from renewables in total gross electricity generation in 2008 was 16.7% for the EU-27.

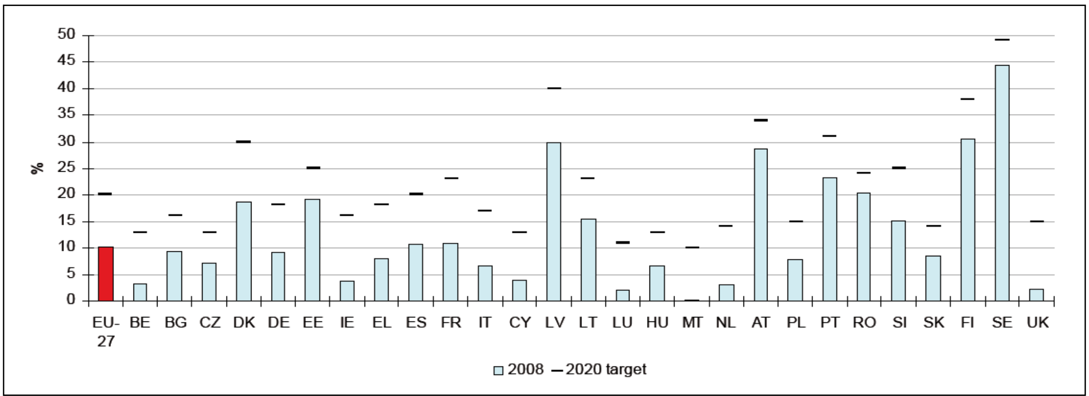


Figure 3. Contribution to renewable energy to gross final energy consumption in 2008 (Eurostat)

Given the binding targets for renewable energy set out in Directive 2009/28/EC compared to the present (Figure 3) one can easily ascertain the potential of increase of penetration of variable generation until year 2020.

Variable generation can hardly be modulated alongside system load curve, the locations of it are often irregularly distributed, usually far away from significant loads (even from shore), and therefore prone to suffer bottlenecks and induce energy spills. Even in densely meshed networks, massive, irregular variable power intakes may induce big scale loop-flows difficult to anticipate, which occasionally make previously well-known, easily predictable cross-border flows extremely variable.

Variable generation is hard to predict. However, accuracy of forecasts mainly depends on the given timeframe.

Consequences of the increase of higher load flows

As a consequence, the system will be operated closer to the security margins and the actions of a TSO in one operational area will increasingly impact on the operational areas of surrounding TSOs.

Today the power systems are operated by TSOs, separate from generators and suppliers, on the basis of mostly national regulations, with different prerogatives/conditions and reflective of their own national market design. Circulation of information is in many cases still segregated at national level; information needs to be available throughout control areas and voltage levels horizontally and vertically. This is one of the most important challenges for well coordinated and coherent evaluations of operational security.

The technical side and adequacy of system operation rules must be in line with experiences and operational practices. They must also be defined and able to be modified in a coherent and coordinated way taking into account forthcoming changes through increasing cross-border exchanges, changes in technology and socio-economic requirements. To maintain a necessary level of security within this system the different operational rules of national or territorial systems have to be harmonised in respect of:

- technical schemes (e.g. security criteria, common grid model)
- data exchange (e.g. timing, content)
- coordination processes (e.g. TSO-TSO, TSO-DSO, SO-significant grid user)
- roles and responsibilities (e.g. TSO, DSO, significant grid users)

It is very important that these rules – defined by a regulatory framework – are agreed amongst the system operators (TSO and DSO) and grid users.

Innovations in terms of grid applications have already taken place in national or regional rules but more will come within the next years and a European-wide approach is needed to withstand future challenges (e.g. DC-links, massive deployment of variable generation, etc.).

Consequences of the liberalisation of the energy market

Today the interconnectivity is growing and will grow even more as numerous new players enter the field through liberalisation and free market access. With the integration of additional players within the European market, larger and more frequently changing load flows are likely to occur in the interconnected system.

Additionally, the growing number of players operating on the power system and in the market increases the complexity of operation.

In an effort to address this, the system operation rules will have to cover several important issues. As listed in the discussion paper published by the European Commission[2] in September 2009, Framework Guidelines will be comprehensive and cover wide issues like e.g. these specific topics for Network Codes:

[2] Discussion paper (EC) D(2008)/C2/MS/MvS/FE of 18 September 2009

- Load-frequency control and reserve power
- System operation
- Data exchange
- Emergency

Consequences of the increase in variable generation

The increase of volume and dynamics of intra- and inter-regional power flows is expected to significantly affect the security of system operation. Furthermore, the increased variable and dispersed generation on medium and low voltage levels replaces the conventional generators (synchronous generators installed on the transmission system) in operation and thus reduces TSOs possibilities to manage the transmission system in the safe and secure manner.

Accuracy of variable generation forecasts is an issue and influences both operational planning and system operation itself. Nonetheless, the accuracy can be significantly improved closer to the real-time system operation. This implies that the information exchange in terms of content and frequency remains in a centre of attention. Several steps in this direction have been made in recent years; however, there are still gaps (e.g.: D-2, after D-1 gate-closure) and a significant margin of improvement left (e.g.: accuracy in terms of nodal injections, roles and responsibilities) being important for further market integration.

It goes without saying that the existing rules, procedures and practices will become increasingly affected by the growing penetration of variable generation.

2.2 What is the issue or problem that may require action?

The integration of the Internal Electricity Market and the changes in generation mix and location, further increased by the integration of variable generation from renewable energy sources (e.g. wind, PV), lead to a growth in cross-border and cross-regional exchange over long distances including interconnections between the control and synchronous areas (i.e. whether they are AC or DC, public-funded or merchant lines), to the consumers or storage (e.g. pumped-storage hydro, compressed air energy storage). This also leads to increased interdependence of control areas, with numerous cross effects for the interconnection capacities and transfers and for system operation as a whole. Without agreed and harmonized rules, this can lead to misunderstandings on planning and operating the system.

It is an agreed political aim to promote the integrated European power market and to reduce price differences for electricity. However, bringing the markets and the physical systems closer together can bring about unintentional effects, like increasing loop flows. This can endanger the system security because of operating the system closer to its security and stability limits. Therefore increased interconnection transfer capabilities across Europe will be necessary.

Indeed, security is the overarching principle permeating all operation-related proceedings, and system security dispositions beyond any other prioritisation: operational security stands at the first place.

This said, priority should be granted to other issues too, which are not yet tackled in a comprehensive way. Pending information and standardisation needs are underlined, as well as increasingly complex coordinated scheduling. The development of already existing procedures ruling core tasks of system operation (e.g. load-frequency regulation) should be addressed. Finally, incoming challenges such as the implementation of massive, distant renewable generation (wind) connected by meshed bulk DC lines should be dealt with.

Need for more — and better — information exchange

Information exchange and communication is a key issue, in terms of both forecasting the power flows and dealing with them in real time. A sound set of adequately harmonised requirements for grid operators (TSOs and DSOs) and users in an interconnected power system is needed to preserve system security and reliability EU-wide. This is also most needed to refine operational scheduling of — usually scarce — interconnection capacity.

When rules and their accuracy and binding character differ between TSOs, Member States and regions, the divergence can lead not only to adverse consequences in the markets / control areas but it can also have an impact on adjacent control areas through the interconnections.

However, harmonisation should be kept to a level such that any system or market changes, especially the need for investment in equipment of grid and power installations, should be subject to a thorough analysis of related benefits.

Having standardised rules as such will not fully solve the problem. Currently, some major issues are already the subject of standardisation (e.g. at regional level). However, the enforceability of these rules is weak because they are bilaterally or multilaterally agreed on by TSOs and/or DSOs, but are not mandatory for connected DSOs and generators who play an increasingly important role regarding system operation and safety.

Lastly, even standardised, enforceable policies are bones on which flesh need to be put on, and it is persons — system operators in front of real-time control screens — who apply the rules in their everyday practice. Staff training and certification proceedings are therefore relevant to define a common understanding of expertise and skills needed for such a demanding job, which is of high significance not just for the electricity supply and market, but also for the European society as a whole.

Increasing interdependence of control areas

As already mentioned, the interdependence of control areas is growing, but the lack of the awareness of the respective roles and responsibilities is still evident, along with gaps and overlaps in existing rules, all of which can lead to inefficiencies and misunderstanding. Coordination and cooperation are important also for the overall security (of the interconnected system) to avoid emergency situations and long restoration times. Furthermore technical standards across Europe have to be aligned to ensure the same system behaviour in each national electricity system in emergency and critical operational conditions.

In particular, within a synchronous area coherent security criteria must be used; otherwise, it could lead to severe system failures or disruptions when the availability and security of a system are not matching the requirements.

Well-known as these topics may be, a clearer, shared identification of purpose and scope of system operation key functions is still pending. Load-frequency control, operation under emergency and critical conditions and system restoration, all point to robustness and resilience as targets that cannot be waived.

Past disturbances in the European power systems have indicated that, when trying to relieve the contingency, the security of the system has been in danger when generation and consumption units have tripped from and were reconnected to the grid in an uncoordinated manner. Such behaviour was in most cases due to either not adhering to the related (mostly national) provisions, to the divergence and differences between the national provisions, ignoring effects on neighbouring systems.

The existence of common rules would have averted the system disturbances in many such cases. A common interpretation and implementation of requirements may have resulted in a decreased risk of emergency or critical operating conditions.

Growing amount of distributed and variable generation capacity

The growth of distributed generation – connected at the distribution (i.e. medium or low voltage) levels – is another challenge in the context of system operation. In the way as it is currently possible for most of conventional, centralized generation, the TSOs also need to be able to observe the performance behaviour of significant generation connected in the distribution networks, both in normal operational state and during emergencies and pass down instructions when necessary in case of critical conditions.

Generation units and large consumption units currently connected to the distribution grid in most cases do not have to follow the same rules as those customers connected to the transmission system. This could also lead to problems concerning system operation.

Moreover, once the generation is made up of a large proportion of variable energy sources (mostly wind and solar), the grid operators need to have the most reliable generation information (e.g. production forecast) at timescales that allow them to fulfil their duty of operating the transmission grid in a secure way.

Higher uncertainty in power output calls for more sophisticated reserve management; beyond critical, automatically activated reserves, manually activated ones and its usage should be subject to closer coordination, allowing for reserve interexchange across control area borders.

The inflows often enter the network far away from consumption centres, thus posing new technical challenges in terms of rapidly increasing number of long-range DC lines and cables. Moreover, these new network elements will soon no longer be just point-to-point solutions but (a new kind of) meshed grids on their own.

Such interconnections will play a role linking different synchronous areas not only on trade/commercial basis, but also in terms of emergency and restoration support in accordance with procedures yet to be defined.

Additionally, distributed generation often participates less in network control and ancillary services than centralised generation, either because it is not required for connection at lower voltage levels or because of a lack of capability. This could lead to a necessary increase of ancillary services asked for from conventional generators connected to the transmission grid – either on a contractual basis or compulsory grid connection condition – if it is not dealt with accordingly by respective obligations and rules applicable also to distributed generation. This challenge will increase with the growing share of distributed generation and generation from renewable sources.

The expected increase in distributed and variable generation and demand response requires standardised communication between TSOs and DSOs and other grid users like generation and consumption units. Furthermore, facing new operational needs derived from such generation will require new applications so as not to compromise security.

Lack of rules between synchronous areas

An additional problem is the lack of rules between synchronous areas. Detailed rules on system operation exist within synchronous areas, but in relation to system operation, equivalent rules do not exist for interconnectors between synchronous areas. With initiatives such as the Baltic Sea and North Seas Grid Initiatives, the degree of interconnection between synchronous areas will increase.

2.3 Who is affected, in what ways, and to what extent?

	Operation closer to limits	Inadequately harmonised requirements	Changing generation (and consumption) mix / integration challenge	Adverse market consequences	Cooperation / communication / data exchange
EC	Decrease in security of supply leads to suboptimal market and economic framework	High effort to effectively enact 3rd package dispositions	Complying with 2020-targets	Different price regions and market systems	Insufficient set of information for decision making
Member States / National Regulators	Intensified compliance monitoring; Disturbance (crisis, blackout) management	High effort for compliance monitoring	Supervise and direct change management for the integration process; Ensure sustainable system adequacy mechanisms	Need to strengthen competition	High effort for compliance and market monitoring
Agency (ACER)	Need for research; Harmonisation procedures	Complex and inefficient procedures for aligned rules and benchmarking; High effort for compliance monitoring	Increasing need for cross-border cooperation as to successfully face generation paradigm shift	Various complex market rules	Higher coordination management effort
ENTSO-E[1]	Need for research; Harmonisation procedures	Complex procedures for aligned rules and benchmarking	Need for research		Higher coordination management effort, need to follow up
TSOs	Tightened operation requirements; Cost of security	Difficult TSO-TSO, TSO-DSO and TSO-Generators cooperation conditions	Changing regional load flows and profiles, more volatile flows; Aging assets and human resources	Reserve & balancing increased market power (where TSO-contracted under incentivised schemes)	Insufficient availability of information triggers problems in system operation
DSOs	Tightened operation requirements	Difficult TSO-DSO and DSO-Generators cooperation conditions	Changing regional load flows and profiles, more volatile flows Aging assets and human		Insufficient information availability triggers problems in system operation
Generation units	Tightened connection and operation requirements; Possibly generation shedding	Technical requirements differ, causing the need for various technical solutions	Tightened connection and operation requirements	Market entering and access difficult	Transparency, more requirements
Consumers	Higher risk of outage; Possibly load shedding; Market benefits	Barriers to competitive relocation, market failure, no trust in the market	Changing grid cost level	Relevant for price level; Market failure, no trust in the market	Transparency

[1] ENTSO-E is explicitly listed here because of its specific role in the whole process.
Legend: white for marginal, yellow for secondary and red for significant extent

2.4 How should the problem evolve, all things being equal? Should the EU act?

The existing approach to system operation is not viewed as sufficiently robust to deal with the problems identified above. As the both volume commercial and physical cross-border flows increases with European integration, the risks posed by uncoordinated system operation increase These challenges are exacerbated by the higher integration of renewable energies in the system, along with the changing profile of the generation units to account for the intermittency of renewable generation, will cause different system behaviour in normal as well as in emergency conditions. Greater TSO and DSO collaboration and coordination in relation to system operation is required to deal with these challenges.

The EU power system and transmission grid operation may now be on the verge of a breakthrough leading to a much more dynamic environment. Therefore, framework to be drawn cannot just encompass one-off measures - it should devise flexible mechanisms to progressively updating induced by a variety of stakeholders: a change management process, be it either a general, multi-purpose one, or rather a range of code-by-code change proceedings following a more specific approach.

Furthermore, the related procedures for compliance verification will increase in number and complexity, and new actors will play their role fulfilling them.

Are some existing rules sufficient?

The European Commission has a clear role to enforce agreed and harmonised common codes, standards and procedures which have to be fulfilled by all system operators within EU/EEA. Different structures and specifics among Member States should be taken into consideration in an appropriate manner. To avoid unnecessary changes and investment needs, regional and national differences in rules can still exist as long as they are clearly defined, and reasonable. The subject of this impact assessment, as well as the framework guidelines for the European system operation rules and codes, will therefore be an essential contribution towards that direction.

The aim is to create a set of facts, procedures, responsibilities and rules – simple, clear, applicable and based on the physics of the system – that is transparent to everybody concerned and to which all parties can commit. This will help bring concerned parties together for a reasonable exchange, because their points of discussion are understandable and their importance is clear. For that, the European Commission shall provide the framework and point out issues of particular interest.

Some issues are of greater importance

In the process of drafting the Framework Guidelines, the first positions on the vital topics of electricity system operation should be addressed. This document provides a high-level prioritisation as a proposal to lead possible first tasks to be tackled. Furthermore, positions on issues and topics interlinked with European rules of system operation should be communicated, in order to allow market participants to assess the relevant issue. Any work done previously should be taken into account, as far as relevant.

The main objective of the Framework Guidelines is to highlight all relevant emerging questions/problems with regard to system operation that should be solved, in a more detailed, transparent, non-discriminatory and agreed way in the Network Codes by system operators (TSOs/ DSOs) and users (generation and consumption).

This framework should be detailed enough to cover all necessary issues on their merits, leaving space for arrangements to be defined in the Network Codes. It has to take into account the fact that different synchronous zones exist which differ e.g. in size and used techniques and therefore have different requirements.

3 OBJECTIVES OF THE INITIATIVE

3.1 General Objectives

Safe operation of the European electrical systems: From agreements …

Originally, European transmission networks have been developed on a national basis. Their increasing interconnection has largely been carried out to provide the power systems with better operational security and to pool power reserves.

European or regional associations of TSOs (within synchronous areas) have established common policies on partial aspects of system operation, but their enforcement was made on a contractual basis.

In the preamble of the Directive 2009/72/EC the general objective of the directive is defined, among others as:

> The internal market in electricity, which has been progressively implemented throughout the Community since 1999, aims to deliver real choice for all consumers of the European Union, be they citizens or businesses, new business opportunities and more cross-border trade, so as to achieve efficiency gains, competitive prices, and higher standards of service, and to contribute to security of supply and sustainability.

Similarly according to Article 12 of Directive 2009/72/EC, (tasks of transmission system operators), each TSO shall be responsible for:

(a) ensuring the long-term ability of the system to meet reasonable demands for the transmission of electricity, operating, maintaining and developing under economic conditions secure, reliable and efficient transmission systems with due regard to the environment;

(b) ensuring adequate means to meet service obligations;

(c) contributing to security of supply through adequate transmission capacity and system reliability;

(d) managing electricity flows on the system, taking into account exchanges with other interconnected systems. To that end, the transmission system operator shall be responsible for ensuring a secure, reliable and efficient electricity system and, in that context, for ensuring the availability of all necessary ancillary services, including those provided by demand response, insofar as such availability is independent from any other transmission system with which its system is interconnected:

(e) providing to the operator of any other system with which its system is interconnected sufficient information to ensure the secure and efficient operation, coordinated development and interoperability of the interconnected system;

According to Article 4 of the Regulation 714/2009, TSOs “shall cooperate […] in order to […] ensure the optimal management, coordinated operation and sound technical evolution of the European electricity transmission network." This is indicative that the safe and secure system operation has highest priority to ensure full integration of the energy markets.

Furthermore there are political goals defined which have to be fulfilled within the context of system operation.

… to binding codes

Specifically to address the operational issues arising from the historically derived state of the national networks and to address the problems set out in the previous section, the overarching objective of this initiative is to develop a harmonised system operation regime that does not compromise the security and stability of the power systems, enabling at the same time the proper functioning and technical evolution of the European electricity market and transmission network through coordinated action from TSOs, DSOs and grid users.

The objective of the initiative is to provide clarity on the relationship between national and European system operation rules. A standardised system operation regime should set out the intended relationship between national codes and the European Network Codes for System Operation.

It should also seek to establish the appropriate relationship between the Network Codes for System Operation and other possible areas to be covered by European Network Codes, such as the Framework Guidelines and Network Codes on Grid Connection, Capacity Allocation and Congestion Management, Compliance Monitoring and Electricity Balancing Markets Integration.

3.2 Specific Objectives

A common system operation scheme should clearly identify and explain those areas where further harmonisation or coordination of rules in different Member States is necessary and possible.

Drafting guidance for the System Operation Framework Guidelines will consider the stakeholders' needs as well as the needs proven by feedback. The drafting will also be based on TSOs' and DSOs' best practices and on provisions of i.e. existing agreements of the former coordinated synchronous areas (e.g. UCTE, NORDEL, etc.). As mentioned in Article 8 (6) of Regulation 714/2009, it should also "take into account, if appropriate, regional specificities."

Based upon the aforementioned general objectives, specific objectives can be derived for the electricity system operation:

Objective #1: To operate the electrical system in a safe, secure, effective and efficient manner

This objective includes:

- Maintain or improve (overall) system safety and security
- Operate the electrical system in a safe and secure manner within normal – not critical – operation limits including cooperation between TSOs and DSOs and grid users.

- Reduce the number of critical incidents
- Avoid major incidents
- Limit the consequences of major incidents when they occur
- Provide conditions for specific, ongoing human resources development

Objective #2: To enable the integration of innovative technologies

This objective includes:

- Enable the integration of renewable energy sources, especially regarding variable generation
- Prepare the network for integrating distributed generation
- Make efficient and effective use of smart grid applications
- Provide conditions for exploiting the demand-side potential (incl. smart metering)
- Integration of advanced power electronic systems (e.g. FACTS, VSC)
- (Meshed DC-lines concepts)

Objective #3: To apply same principles for different systems

This objective includes:

- Apply same principles, and ensure strict rules within synchronous areas and modified rules across asynchronous systems (e.g. merchant lines)
- Improve alignment of European rules (technical standards) in third countries connected to ENTSO-E systems

Objective #4: To make full use of information and communication technologies

This objective includes the following aspects (as far as beneficial for the other specific objectives):

- Provide conditions for improved data collection, handling and exchange
- Provide framework for compatibility of e.g. forecast, simulation and modelling tools
- Strengthen the TSOs and DSOs in terms of auditing and monitoring capabilities and performances of generation units and consumers

In general, the evolution of Framework Guidelines needs a definition of an improvement process to consider the dynamic market environment. Increasing cross-border and cross-regional exchange claims for ensuring the consistent application of interconnection capability assessment techniques and standardised analytical tools. On the other hand flexibility is required when setting market rules across DC interconnectors and merchant lines, taking into account that trading operations happen in timescales as close to real-time as possible.

4 POLICY OPTIONS AND THEIR ASSESSMENT

4.1 Policy Options and Delivery Mechanisms

For each of the identified problem areas that require action and in relation to the objectives defined in preceding chapters, most suitable solutions are described and assessed, thus proposing the preferred alternative.

From a high level perspective, strategies range from a so-called "Option 0" (i.e. *status quo* is maintained) to a comprehensive compound of Framework Guidelines and binding Network Codes at EU level; in between, national and regional scope is also deemed possible: different problems may call for different approaches.

The way a certain option is taken into effect relies on a number of dimensions to be considered regarding policy assessment. Different combinations of mechanisms can be considered alongside a particular policy option to achieve the final result; impact assessment should underline where a determined mechanism would have a significant role in driving a policy option's impact.

It is also worth highlighting that:

- Network Codes to be prepared by the ENTSO-E are not intended to replace the necessary national network codes for non-cross-border issues[3];
- Network Codes shall further focus mainly on the cross-border, IEM related and market integration issues and shall be without prejudice to the Member States' right to establish national network codes which do not affect cross-border trade[4].
- Network Codes should state important principles and rules impacting DSOs and grid users (producers and consumers)

4.2 Evaluation Criteria and Main Stakeholders

According to the IA guidelines [1], the screening process should consider the main policy options and then eliminate the not-applicable ones immediately.

Moreover, for the policies considered (including also the *Option 0*), it is important to consider all the relevant positive and negative impacts alongside each other, regardless of whether they are expressed in qualitative, quantitative or monetary terms.

Thus a screening process allows obtaining the most promising option(s), whose impact assessment can be further analysed. Policy options are gauged for their suitability in meeting objectives of each area against these three high level criteria:

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3 (7) Regulation (EC) No 714/2009

4 Article 8.7 Regulation (EC) No 714/2009

- **Effectiveness**: The extent to which options can be expected to achieve the objectives of the proposal,

- **Efficiency**: The extent to which options can be expected to achieve the objectives for a given level of resources with least cost and highest benefit (cost-effectiveness),

- **Consistency**: The extent to which options are likely (not) to limit trade-offs across the economic, social and environmental domain.

Policy options scoring high in screening process are subject to a cost-benefit analysis for diverse parties affected. Although a quantitative approach is not straightforward at this stage, a differentiated view on all influencing and influenced factors is provided.

Key stakeholders groups considered in this IIA are:

- **System Operators** (both TSOs and DSOs)

- **Generators**: Either fossil-fired or RES (Renewable Energy Sources) - based; conventional or distributed,

- **Consumers**: End-users from large industries to domestic customers, and

- **Others**: Equipment manufacturers, facility constructors, project developers...

4.3 Assessment of Impacts

Impact assessment of policy options by action area and associated delivery mechanisms aims at clarifying the probability of achieving the identified objectives, i.e. the likeliness to solve problems previously detected, given a number of underlying problems. It helps to predict policies' consequences, too – both intended and unintended.

This exercise allows gathering information about likely impacts on stakeholders and against the three main criteria above, as well as potential trade-offs and synergies. It's also useful to identify enhancing measures, i.e. the ways to 'fine-tune' a policy option.

In this context a cost-benefit analysis is particularly important. Whereas this provides a good qualitative view to orientate a sound decision-making process, a fully fledged quantification might only be feasible ex-post, within the scope of the implementation of Codes.

As long as implementation of 3rd legislative package is still ongoing, it is not foreseeable how key issues will develop, but they will be interrelated; forthcoming guidelines and codes will influence each other.

In the following different policy options and related delivery mechanisms are assessed in terms of their suitability to reach the objectives defined in Chapter 3, which in turn are required for resolving of problems identified in Chapter 2.

The following policy options cover the complete range from maintaining the status quo to full EU-wide harmonisation/standardisation:

- No action
- Standardisation at MS level
- Standardisation at synchronous area level
- Partial standardisation at synchronous area or EU level Full EU-wide harmonisation with detailed framework
- Full EU-wide harmonisation with a structured process

4.3.1 Screening

No action will clearly not solve the existing problems and therefore is no reasonable policy option.

Standardisation at MS level is a policy option, which is always open to the MS and does not need an EU-wide approach, which is represented by the Framework Guidelines.

Partial standardisation at synchronous area level allows for reduced technical scope and for more emphasis on the the regional focus; hence, it is a weak combination not fulfilling the 3 high-level criteria.

EU-wide harmonisation could be based on a detailed framework when referring to mature topics, but could as well be building on a structured process only, in case of future issues.

This leaves just 3 different policy options for advanced analysis, namely:

- (A) Standardisation at synchronous area level
- (B) Partial standardisation at EU level
- (C) Full EU-wide harmonisation
  - (1) with detailed framework
  - (2) with a structured process only

4.3.2 Policy Option Analysis

The impact of the different policy options (A), (B), (C1) or (C2) for each topic considering the objectives is analysed below. The sequence of topics is from high to low priority:

System operation issues are universally appealing: they affect all kinds of stakeholders and the multiple relationships between them. Therefore the policy options chosen should be flexible and expressed as a combination of complementary alternatives, among which the most suitable one is selected depending on the topic and parties it deals with.

In this regard, the Objectives identified in Chapter 3 have been matched with the possible policy options to achieve them and the impacts of these policy options evaluated in terms of effectiveness, efficiency and consistency.

Objectives		Operational Security
1	To operate the electrical system in a safe, secure, effective and efficient manner	(A): Operational Security covers the main principles of System Operation and is already today agreed on synchronous area level. So this option is the status quo and will not solve the problems identified in chapter 2. (B): Partly standardisation of the important high-level principles will at least not fulfil Objective 2. (C1): Full EU-wide harmonisation is reasonable to fulfil the objectives and builds a strong frame for the more detailed System Operation topics.
2	To apply same principles for different systems	
3	To enable the integration of sustainable technologies	
4	To make full use of information and communication technologies	

Objectives		Operational Planning & Scheduling
1	To operate the electrical system in a safe, secure, effective and efficient manner	(A): Scheduling & Operational Planning is a topic on detailed level with different historical development paths. Standardisation on synchronous area level seems reasonable to fulfil the objective. (B): This option is fitting to fulfil the objective, but will be over sufficient in terms of coping with the high-level criteria. (C1): Also this option will overachieve the objective.
2	To apply same principles for different systems	(A): The main principles are already today agreed on synchronous area level. So this option is the status quo and will not solve the problems identified in chapter 2. (B): Partly standardisation of the important high-level principles will not fulfil this objective. (C1): Full EU-wide harmonisation is reasonable to fulfil this objective and builds a strong frame for the Operational Planning & Scheduling details.
3	To enable the integration of sustainable technologies	(A): Scheduling & Operational Planning is a topic on detailed level with different historical development paths. Standardisation on synchronous area level seems reasonable to fulfil the objectives, especially as sustainable technologies (e.g. generation from renewables) are strongly depending on the natural resources and compensation for the volatile generation profile has to be solved synchronous area-wide. (B): This option is fitting to fulfil the objective, but will be over sufficient in terms of coping with the high-level criteria. (C1): Also this option will overachieve the objective.
4	To make full use of information and communication technologies	

Objectives		Load-Frequency-Control
1	To operate the electrical system in a safe, secure, effective and efficient manner	(A): Load-Frequency-Control is a topic on detailed level with different historical development paths. Standardisation on synchronous area level seems reasonable to fulfil the objective and has progressed far, but some gaps are still left to cover. (B): This option is fitting to fulfil the objective, but will be over sufficient in terms of coping with the high-level criteria. (C1): Also this option will overachieve the objective.
2	To apply same principles for different systems	(A): The main principles are already today agreed on synchronous area level. So this option is the status quo and will not solve the problems identified in chapter 2. (B): Partly standardisation of the important high-level principles will not fulfil this objective. (C1): Full EU-wide harmonisation is reasonable to fulfil this objective and builds a strong frame for the Load-Frequency-Control details.
3	To enable the integration of sustainable technologies	(A): Load-Frequency-Control is a topic on detailed level with different historical development paths. Standardisation on synchronous area level is a step in the right direction, but as the handling and participation of sustainable technologies (e.g. generation from renewables) are a European challenge and crucial for Load-Frequency-Control, this option will be too weak. (B): Some crucial issues have to be agreed on EU-level. This option is fitting to fulfil the objectives. (C1): This option is fitting to fulfil the objectives as well, but will be over sufficient in terms of coping with the high-level criteria.
4	To make full use of information and communication technologies	

Objectives		Staff Training & Certification
1	To operate the electrical system in a safe, secure, effective and efficient manner	(A): Quality requirements (e.g. in terms of education, capabilities) for System Operation staff should not be synchronous area specific. Hence, this option is not reasonable. (B): Also partly standardisation of the important training & certification principles will not fulfil the objectives. (C1): Full EU-wide harmonisation is reasonable to fulfil the objectives and builds a strong base for cooperation and coordination, but also development of System Operation tasks on European level.
2	To apply same principles for different systems	
3	To enable the integration of sustainable technologies	
4	To make full use of information and communication technologies	(A): Quality requirements (e.g. in terms of education, capabilities) for System Operation staff should not be synchronous area specific. Hence, this option is not reasonable. (B): In case of information and communication technologies, partly standardisation will open a level of freedom for specific synchronous area tools by nevertheless stating common European principles. (C1): This option is fitting to fulfil the objectives as well, but will be over sufficient in terms of coping with the high-level criteria.

<table>
<tr><th colspan="2">Objectives</th><th>Emergency & Restoration</th></tr>
<tr><td>1</td><td>To operate the electrical system in a safe, secure, effective and efficient manner</td><td>(A): Emergency & Restoration is a topic on detailed level with different historical development paths. Standardisation on synchronous area level seems reasonable to fulfil the objective and has progressed far, but some gaps are still left to cover.
(B): This option is fitting to fulfil the objective, but will be over sufficient in terms of coping with the high-level criteria.
(C1): Also this option will overachieve the objective.</td></tr>
<tr><td>2</td><td>To apply same principles for different systems</td><td>(A): The main principles are already today agreed on synchronous area level. So this option is the status quo and will not solve the problems identified in chapter 2.
(B): Partly standardisation of the important high-level principles will not fulfil this objective.
(C1): Full EU-wide harmonisation is reasonable to fulfil this objective and builds a strong frame for the Emergency & Restoration details.</td></tr>
<tr><td>3</td><td>To enable the integration of sustainable technologies</td><td rowspan="2">(A): Emergency & Restoration is a topic on detailed level with different historical development paths. Standardisation on synchronous area level is a step in the right direction, but as the handling and participation of sustainable technologies (e.g. generation from renewables) are a European challenge and crucial for Emergency & Restoration, this option will be too weak.
(B): Some crucial issues have to be agreed on EU-level. This option is fitting to fulfil the objectives.
(C1): This option is fitting to fulfil the objectives as well, but will be over sufficient in terms of coping with the high-level criteria.</td></tr>
<tr><td>4</td><td>To make full use of information and communication technologies</td></tr>
</table>

<table>
<tr><th colspan="2">Objectives</th><th>New Applications</th></tr>
<tr><td>1</td><td>To operate the electrical system in a safe, secure, effective and efficient manner</td><td rowspan="4">(A): Technical requirements concerning the impact of European future developments (covered in New Applications) on System Operation should not be synchronous area specific. Hence, this option is not reasonable.

(B): Also partly standardisation of the important innovations will not fulfil the objectives.

(C2): Full EU-wide harmonisation is reasonable to fulfil the objectives and builds a strong base for future development of System Operation tasks on European level. Due to the strategic character of this topic the issues to be harmonised are more structured processes than detailed terms.</td></tr>
<tr><td>2</td><td>To apply same principles for different systems</td></tr>
<tr><td>3</td><td>To enable the integration of sustainable technologies</td></tr>
<tr><td>4</td><td>To make full use of information and communication technologies</td></tr>
</table>

4.3.3 Preferred Policy Options

The preferred policy options for the future system operation regime in the EU are therefore expressed in the following matrix:

<table>
<tr><th colspan="2" rowspan="2">Objectives</th><th colspan="6">Topics (from high to low priority)</th></tr>
<tr><th>Operational Security</th><th>Operational Planning & Scheduling</th><th>Load-Frequency Control</th><th>Staff Training & Certification</th><th>Emergency & Restoration</th><th>New Applications</th></tr>
<tr><td>1</td><td>To operate the electrical system in a safe, secure, effective and efficient manner</td><td rowspan="4">(C1)</td><td>(A)</td><td>(A)</td><td rowspan="3">(C1)</td><td>(A)</td><td rowspan="4">(C2)</td></tr>
<tr><td>2</td><td>To apply same principles for different systems</td><td>(C1)</td><td>(C1)</td><td>(C1)</td></tr>
<tr><td>3</td><td>To enable the integration of sustainable technologies</td><td rowspan="2">(A)</td><td rowspan="2">(B)</td><td rowspan="2">(B)</td></tr>
<tr><td>4</td><td>To make full use of information and communication technologies</td><td>(B)</td></tr>
<tr><td colspan="8">Policy options
(A) Standardisation at synchronous area level
(B) Partly standardisation at EU level
(C1) Full EU-wide harmonisation with detailed framework
(C2) Full EU-wide harmonisation with a structured process</td></tr>
</table>

Within this scope and contents, the Framework Guidelines on System Operation shall be developed, to be followed by the respective detailed Network Codes.

Moving to jurisdiction attribution, TSOs should be entitled to impose the fulfilment of, and monitor the compliance with, the defined system operation requirements. Their authority in this field should be assured in the same terms across all EU territory, as a steady, homogeneous reference.

A mandatory enforcement is suggested further in order to ensure compliance with the Framework Guidelines and Codes, since the experiences with a voluntary approach suggest that it will not deliver results, at least not in a reasonable timeframe.

Whereas the above described preferred policy options will require extensive adaptations of the existing framework in some cases, the level of such adaptations must be carefully governed by the overarching goal to address only cross-border relevant system operation issues.

Furthermore, the main objective of the Framework Guidelines is to highlight **which** emerging questions/problems with regard to system operation issues should be solved, leaving the approaches on **how** to solve them to the related Network Codes.

Nevertheless, the Framework Guideline should be detailed enough to cover all necessary issues on own merits, but leaving space for detailed and customised arrangements where applicable to be defined in the Network Codes.

Hence, a clear role for the European Commission is to enforce common codes, standards and procedures. The subject of this Initial Impact Assessment the Framework Guidelines for System Operation is therefore being an essential contribution towards that direction.

4.3.4 Cost-Benefit Analysis

Cost-benefit-analysis is an important element of the Impact Assessment.

Hence this has been discussed extensively in debates within the project team, as well as with the expert group.

The resulting qualitative cost-benefit analysis for harmonisation measures for System Operation is presented in Fig. 4 below:

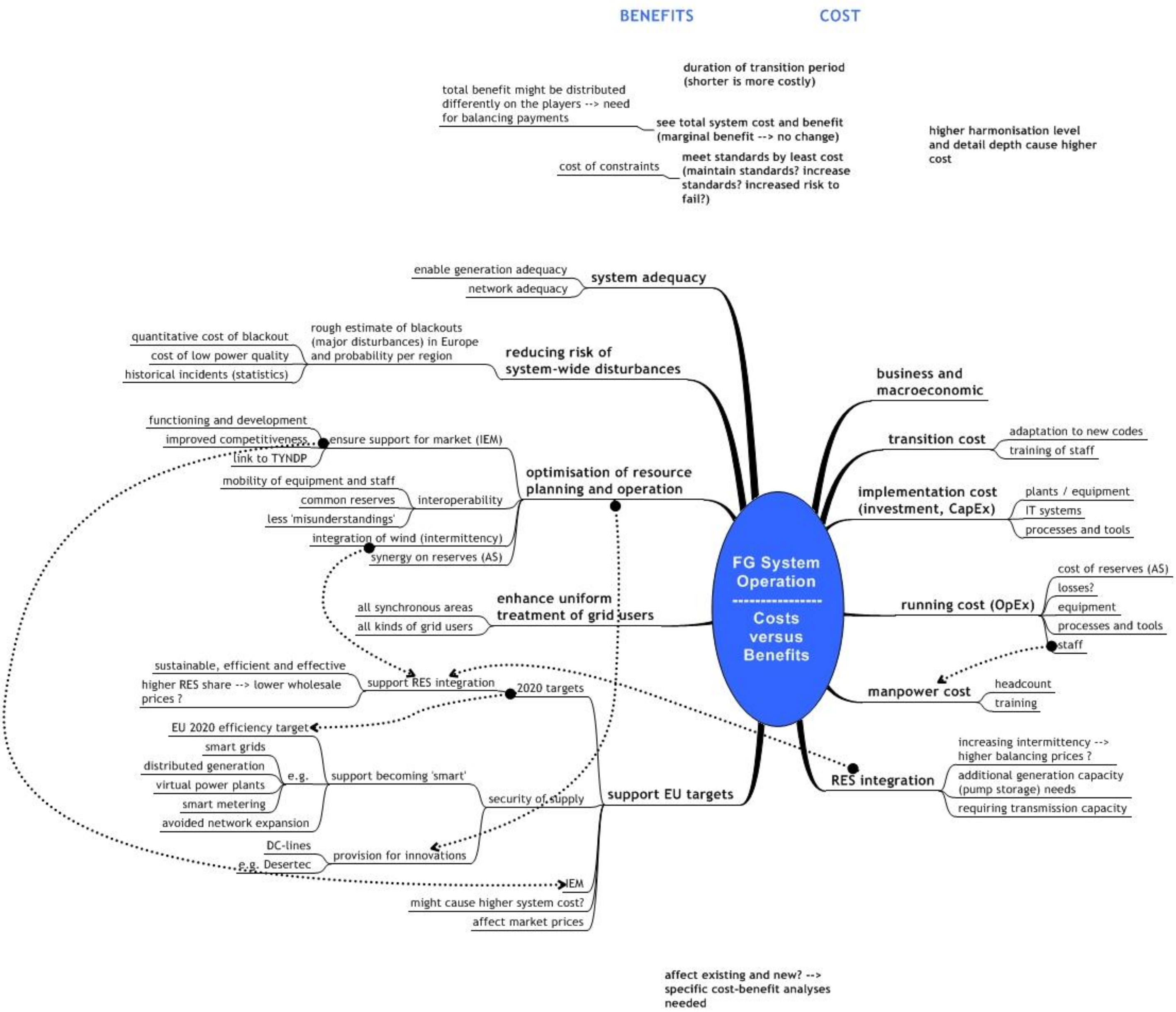

Figure 4: Structured cost-benefit analysis results

An analysis of the quantitative aspects of harmonisation measures for System Operation would require an assessment of implementation cost and additional operation cost by the TSOs and grid users. The related benefits cover e.g. operational synergies, but - much more important – the improvement of system security and hence the avoidance of blackouts.

EU Commissioner Oettinger stated in his speech at the High-level Infrastructure Conference in Budapest on 16th of May 2011:

'Just remember the November 2006 black-out, which originated in Central- Western Europe and hit several EU countries from Austria to Spain with around 15 million people literally "sitting in the dark". For a country like Germany, it is estimated that a full black-out would cost about 500 million euro per hour!'

This number provides an idea of the economic dimension. Anyway, such numbers depend strongly on the underlying disturbance scenario and the region. Moreover, the probability of such events must be taken into account.

5 PRIORITIES

The effective and efficient way of approaching and structuring this crucial, but complex and extensive topic System Operation is to introduce a chronological structure expressed in different priority levels for the various topics, considering the specific ratio of existing and missing rules, and hence the importance and urgency of the topics. From highest to lowest priority the sequence of topics is:

- Operational Security
- Operational Planning and Scheduling
- Load-Frequency-Control
- Staff Training and Certification
- Emergency and Restoration
- New Applications

Figure 5 shows the development of terms from key challenges to topics. The key challenges are identified to highlight existing and expected future problems within system operation. The objectives go one step further and translate the diffuse challenges into bounded target statements, which subsequently provide base for policy option analysis. A final modification spreads the objectives on core processes of system operation, in order to enhance both, execution of the selected policy option in the Framework Guidelines and operational implementation as Network Codes.

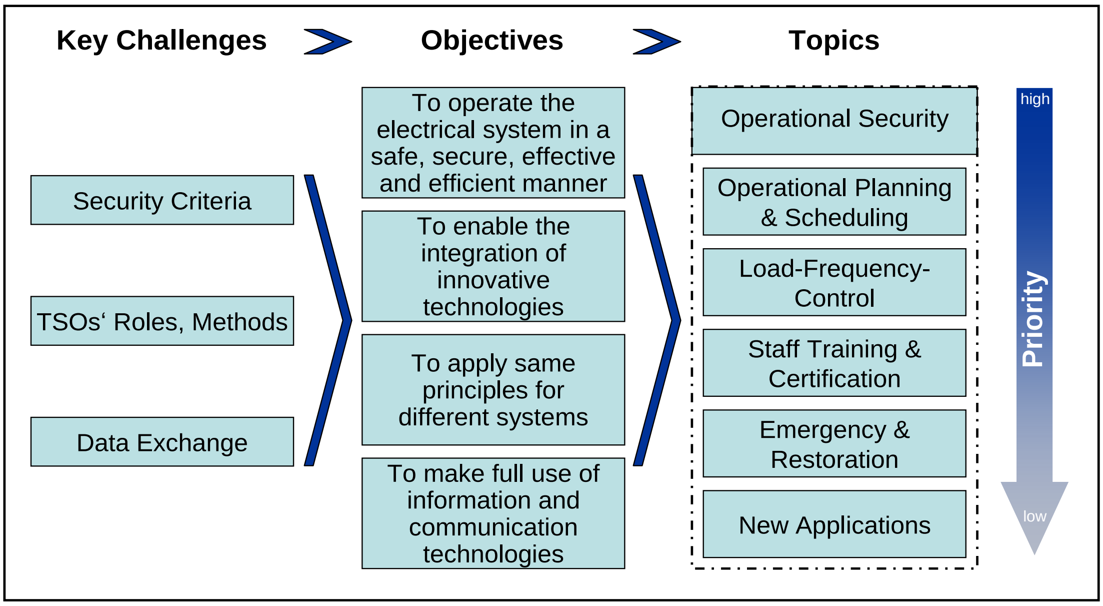

Figure 5: Development of terms

6 ANNEX I

Mandate for ERGEG to develop the Framework Guidelines on System Operation

EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR ENERGY

Directorate B - Security of supply, Energy markets & Networks
The Director

Brussels, 22 DEC. 2010
ENER B2/MS/mta/1074923

Lord John Mogg
ERGEG
Rue Titien
B-1000 Brussels

Dear John

Subject: **Mandate for starting the work in the area of system operation**

With this letter I would like to launch the six month period for the preparation of the framework guideline in the area of electricity system operation starting from 1 January 2011. The scope of the work has been discussed in the latest Florence forums and it has been also subject to scoping discussions between ERGEG, ENTSO-E and the European Commission. A presentation on the scope of the Framework guideline and network codes on system operation was given by ERGEG and ENTSO-E in the Florence forum of 13.-14.12.2010.

According to our initial view, the work on the system operation framework guideline should be comprehensive regarding the overall topic. However, as the area of system operation is large, the work should first concentrate on rules which are the most urgent and which give the biggest added value when implemented. In particular the focus should be on system operation rules needed to integrate variable electricity generation sources and on rules which support the development of the European day-ahead, intra-day and balancing markets.

With my best wishes for 2011 Yours sincerely,

Heinz Hilbrecht

c.c.: ENTSO-E, Florence forum participants