



ERERA

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ARREC

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Banjul - The Gambia

Operation Manual of the interconnected system, EU experience

Session 3 : HARMONIZATION OF NATIONAL MARKETS

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Introduction - Content

Elia-Tractebel consortium has been asked by ERERA to give an informed opinion on the application of the grid code for the WAPP area

Based on our expertise we can present the following

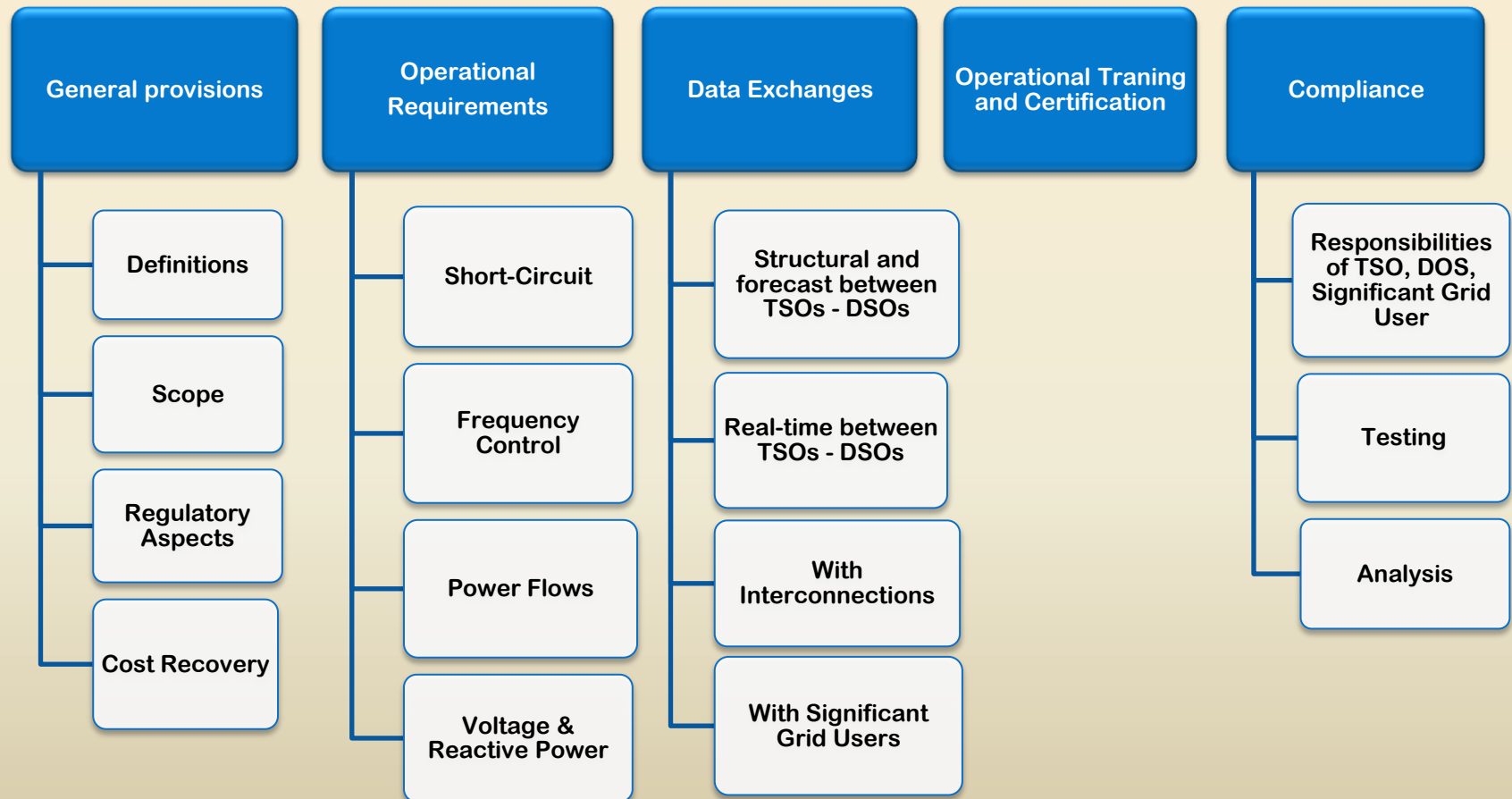
- The EU experience of system security
- Priority goals for the WAPP area
- How to achieve these goals?
- Directives to be applied
- Compliance monitoring and Enforcement of Grid Code

EU experience on system security
The OS code - objectives

- Maintain Operational Security 24 hours a day, 365 days a year by providing the global Operational Security Framework.
- Focus on common operational security principles, pan-European operational security, coordination of system operation, and some important aspects for grid users connected to the transmission grid.
- The code determines the roles and responsibilities for TSOs, DSOs, significant grid users and market players
- “The network code(s) for System Operation shall elaborate on relevant subjects that should be coordinated between TSOs, as well as between TSOs and Distribution System Operators (DSOs); and with significant grid users, where applicable”.

EU experience on system security

The Operational Security (OS) code – important elements



EU experience on system security
The Operational Planning and Scheduling (OP&S) code

General Provisions

(Common) Grid Models

Coordinated Security Analysis

Outage Coordination

Adequacy

Ancillary Services

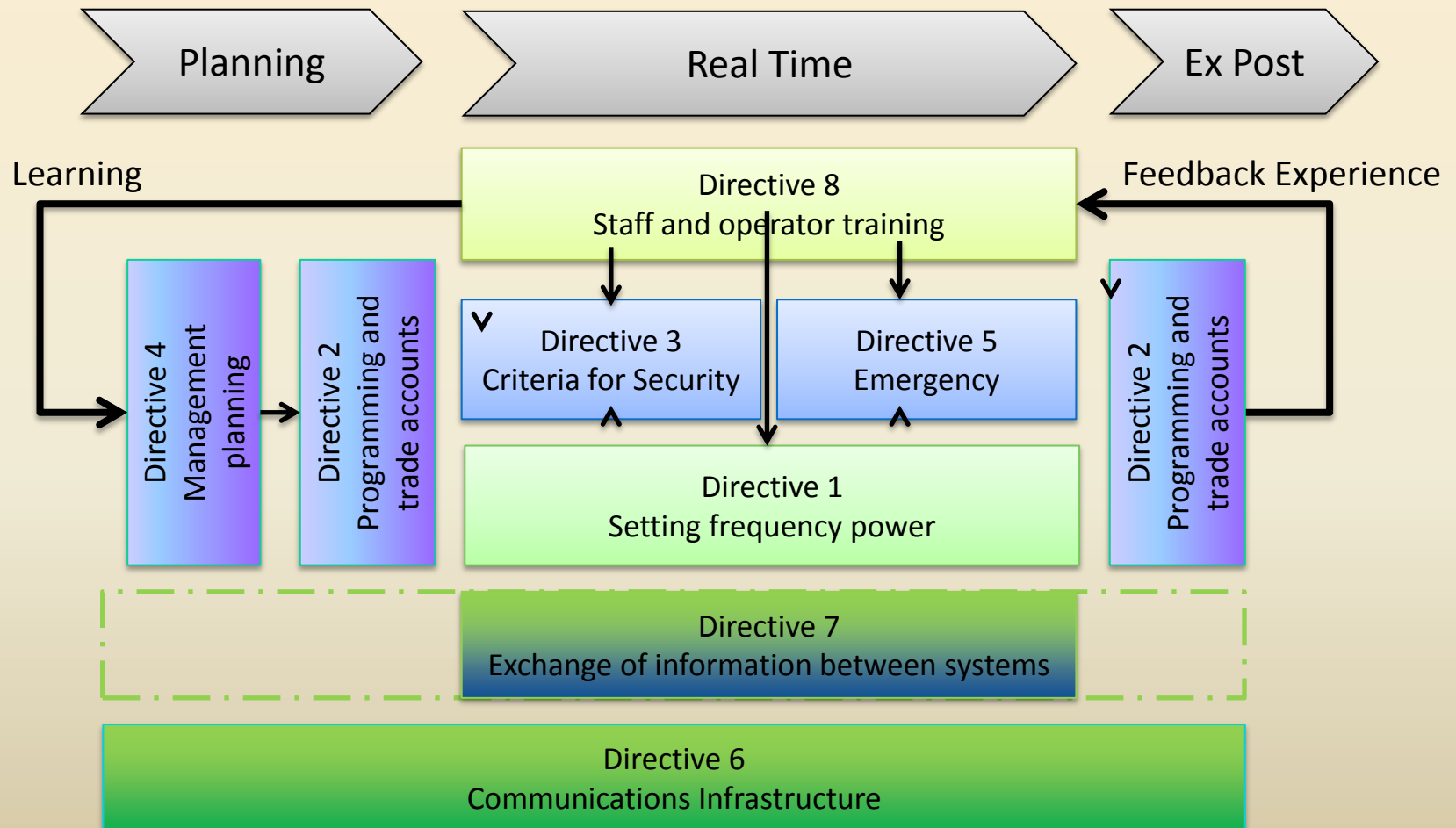
Scheduling

ENTSO-E Operational Planning Data Environment



EU experience on system security
The OP&S code

- TSOs shall establish individual and common grid models for security analysis studies
- TSOs shall coordinate operational security analysis and coordinate remedial actions
- Coordination regions need to be set up including procedures (year ahead planning and updates)
- System adequacy studies need to be performed on regional level (summer and winter outlook)
- General provisions on usage of ancillary services for frequency and voltage control

WAPP Grid code
Directives structure

WAPP area status The situation today

The WAPP organisation is working on creating an interconnected region and has prepared an operation manual to realise a regional market and a secure grid operation

However,

- The region is partly interconnected and the number of interconnections is very limited

- The region is not yet synchronised (AC interconnections)

- Some countries are not interconnected. There are sub electrical regions where the manual could be applied inside each electrical region.

- Not all loads can be supplied at all times

- Primary reserve directives can not be applied as they should as all production units are needed to cover the load

- The N-1 rule can not be applied as the system is not sufficiently meshed

Goals for WAPP

The full list, which needs prioritisation

1. Institutionalise a wide collaboration in the region
2. Develop infrastructure for production and transport of electricity
3. Growth of the energy offered
4. Improve the reliability of the electricity system for the region
5. Improve the security of supply
6. Reduce the cost of operation of the system
7. Optimise investments in the grid
8. Create a transparent and reliable mechanism for commercial electricity exchanges
9. Improve the electricity availability in the region

Short term goals for WAPP Consultant opinion

The consultant is convinced that it is impossible and inefficient to focus on all goals at once

Each TSO should focus on the same goals first to faster reach the benefits for the region

Some goals require other developments as prerequisite

For instance it is not possible to have an electricity market without reliable and sufficient interconnection

The consultant proposes to focus first on the goals which are set as first priority and move towards an enforcement of the directives related to these goals

Once the previous goals are secured, move to the next priority.

The process will take time and investment

Short term goals for WAPP Consultant opinion

First priority / phase

Ensure the **stability of the system** : Strong need to apply the Frequency control and Primary reserves principles

Second priority / phase

Synchronise the region, in order to share frequency control, to balance the system on regional instead of local level, and to exchange emergency assistance

Third priority / phase

Stay connected. Avoid disconnected relays, respect programmed exchanges between control areas, but allow deviations to be controlled by the common balancing of the region

Goals for WAPP Prioritised

1. Develop infrastructure for production and transport of electricity
2. Improve the reliability of the electricity system for the region
3. Improve the security of supply
4. Improve the electricity availability in the region
5. Growth of the energy offered
6. Institutionalise a wide collaboration in the region
7. Reduce the cost of operation of the system
8. Optimise investments in the grid
9. Create a transparent and reliable mechanism for commercial electricity exchanges

Analysis of the directives on the WAPP grid code

An analysis was performed by the consultant resulting in 3 types of directives

1. Applicable now : directives can and should be applied already today to achieve the set of priority goals
2. Nice to have : directives are not necessary to achieve the set goals and are sometimes more restrictive than needed and/or that are difficult to be monitored
3. Necessary but not yet applicable : developments are needed to apply these directives, but they are needed to achieve the set of goals of WAPP (9 goals)

The following slides will focus on the first and third categorie



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Corresponding directives to be applied

Nr	Rule	Reasoning
101	A control area is an area managed by one grid operator, which is the control area operator.	The must be one master control for balancing per control area: the control area operator
104	Control reserves have to be spread uniformly across the grid	This useful but currently maybe too limitative. First priority is to find reserves, one of the next priorities will be to optimise placement
115	Each control area must have state of the art telecontrol to conduct the power-frequency control	This is indeed necessary, and the rule could also be included in directive 3
123	Primary control has to cover the largest double incident (220 MW in Nigeria + 170 MW in Ghana) without load shedding	The double incident rule is enough the maintain integrity of frequency in normal operation
124	The primary reserve is spread between synchronous areas. Each control area contributes to the reserve according to its contribution coefficient, which is established yearly based on produced energy in each area by the ICC	It is necessary to distribute primary reserve needs by a central organism, for instance ICC
150	All interconnectors are equipped with real time measurement of power (in MW) and energy (in MWh) exchanged. The measurements are installed at both ends of the interconnector and transmitted to both grid operators, both control area operators and ICC	Very strict rule, in a first step measurements on one side could be sufficient for efficient control
158	Each dispatching must have reliable power supply, regularly tested in order to guarantee the functioning of secondary control at all times	This rule is necessary but misplaced, it makes more sense to have this rule under directive 3
159	Each production unit participating to secondary control must be telecontrolled in real-time	It is important for the control to be fast acting, therefore telecontrol is important



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Corresponding directives to be applied

Nr	Rule	Reasoning
212	If a programmed exchange jeopardises system security a party may request another party to reduce import or export until a value determined by the control zone. This value becomes mandatory	This rule is important as it enables exchanges subject to system security
236	The sum of all control errors of all control areas must be equal to 0	OK as check, but is not essential for system security
237	In case the sum of measured exchanges or the sum of control programs is not 0, ICC has to inform the control area operators	Useful to coordinate
238	In case of measurement problem the control area operator has to inform ICC and the interconnected control area operators	To have working (and correct) measurements on all interconnections is important
301	The control area operator ensures secure system operation, in normal and exceptional situations	It is necessary to identify the party responsible for grid security
311	The purpose of the criterium is to ensure system security and a good quality of service. The criterium is applied by all control areas.	Necessary, however maybe not yet applicable everywhere, the must be sufficient grid redundance before N-1 can be applied
312	An N-1 should not endanger the security of the grid or lead to significant loss of load (except for load shedding)	Necessary, however maybe not yet applicable everywhere, the must be sufficient grid redundance before N-1 can be applied
313	Each control area operator is responsible to apply to the N-1 criterium for its area.	Necessary, however maybe not yet applicable everywhere, the must be sufficient grid redundance before N-1 can be applied
314	The N-1 criterium must be verified at all times	Makes sense, but what does "at all times" mean
319	No cascading loss of lines can occur after N-1, due to the overloading of a network element	Useful to specifiy, as this is essential for avoiding partial blackouts

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Corresponding directives to be applied

Nr	Rule	Reasoning
326	Interconnections should not be disconnected, unless agreed between control area operators	This is important to avoid blackouts
328	Control area operators will exchange data on grid topology, active and reactive transits, and production programs, including models, which are required for system security analysis	It is difficult to enforce this rule, data exchange requires agreements between member states, confidence in each others ability to provide data and to monitor the sysytem, etc...
333	Each control area operator has to evaluate the security of the system	This is necessary, and it is good to leave the details to local responsibility
335	Each control area operator has to perform ex-post analysis	Not needed to enforce this through regional code, this is local responsibility
343	All protections in the interconnected system which can influence another system have to be coordinated	As experience has shown in the past, and elsewhere, this is important to avoid blackouts
344	Each system is responsible for keeping its protections up to date and inform others of changes which can impact others	As experience has shown in the past, and elsewhere, this is important to avoid blackouts
346	Systems will be informed of important changes in operations which could require changes in protection settings	It is useful to keep the other member states informed, but this also covered by other parts of the directive
355	Each operator has to take corrective measures, including load shedding, when needed in order to avoid voltage collapse	The general principle should be followed, the details can be left to local procedures
401	Adequacy of the electricity system: ability to cover the demand respecting all limitations	To make progress on the security of supply (SOS)
402	Obligation to prepare a power balance report for Y+1 until Y+10	Can be a next step after achieving sufficient level of SOS
406	ICC will make a power balance report for the WAPP region based on the individual report	To make progress on the security of supply (SOS)

Corresponding directives to be applied

Nr	Rule	Reasoning
411	ICC to determine the need to develop the grid based on the grid adequacy report	In a first step focus will be on individual adequacy. ICC can assist in the defense of the development plans
423	Yearly report on the security of the system (n-1). Mid term previsions reports on Y+5. Long term previsions reports on Y+10	Long term reports can be achieved in a later stage
424	Provisional reports contain the best estimate of grid development costs to maintain security inside the norms of WAPP	Short term reports will assist to increase security of supply
437	Studies will determine the need for grid development	Useful to specify this goal for studies
502	Normal grid operation respects maximum current, minimum and maximum voltage and maximum short circuit power values	Useful additional which explicits a part of the N-1 definition missing in directive 3
503	Normal grid operation implies stable voltage profiles, reducing losses and improving stability of the grid	Not needed to enforce this through regional code, this is local responsibility. Also this rule is probably not applicable to all systems in the same way.
522	All production must remain connected between 48.5 and 51 Hz	This is important for avoiding blackouts, but might prove difficult to enforce
533	The procedures include the black-start capabilities (restoring power to ancillary services of production units via autonomous sources)	Difficult to enforce on regional level
537	Telecommunication and telecontrol must remain operational during the whole restoration period	Necessary rule, which will be difficult to implement in practice.

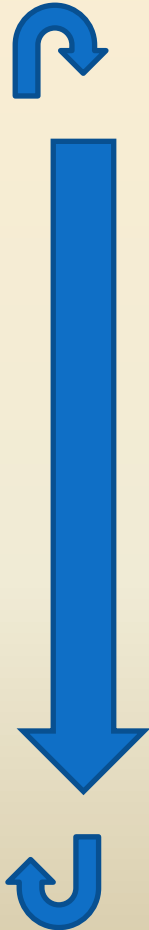
Corresponding directives to be applied

Nr	Rule	Reasoning
601	Each system and each control area has reliable communication infrastructure	The rules have all the same kind of priority, as the communication between interconnected dispatching centers is of the utmost importance for the security of supply of the region
602	Redundancy has been installed on different telecommunication carriers	
603	The availability of telecommunication must be higher than 99.8%	
604	Maintenance teams to restore communication must be available 24/7	
605	Norms for telecommunication: TCP/IP for the WAN, ICCP for dispatching telecom, IEC standards for real-time data, FTP protocol for off-line data, SMTP protocol for e-mail	
606	Communication is done in English and French	
607	All verbal communication can be stored at the dispatchings and at ICC for at least one month. Eac party and ICC can request access to the stored communications	
608	Procedures exist to organise communication between dispatchings	
609	Availability of telecommunication, telecontrol, and telecounting must be coordinated between electrical systems	
610	Procedures must exist which allow the continuity of operation during telecommunication failures	

Corresponding directives to be applied Summary

- Organisation of primary control reserves
- Primary reserves sufficient to cover N-2 production
- Balancing with secondary reserves to be organised
- Define the roles in the control areas and the control area leader role
- Real-time telecontrol of production (from dispatching)
- Grid adequacy report to investigate N-1 coverage
- Investment in the grid to be able to cover N-1
- No disconnection of grids especially during emergency
- Production to remain connected between 48,5 and 51 Hz
- Data exchange (off-line and real-time) to be organised between TSOs
- Communication infrastructure must be available 24/7 with redundancy
- Defense plans to be set up to avoid frequency and voltage collapse

Compliance monitoring and enforcement Principles



The consultant proposes to work with a phased approach

1. Compliance monitoring of the directives which are « applicable now »
2. Enforcement process for these directives based on the outcome of the monitoring
3. Monitoring of the developments needed for the directives which are « necessary but not yet applicable »
4. Compliance monitoring of these directives
5. Enforcement of these directives

And this is to be performed for each goal, in different phases

Compliance monitoring and enforcement Role of ERERA

The role of ERERA is to establish the monitoring of the directives which are necessary for the goals that are set

This monitoring should lead to guidance on the developments which are needed to be able to comply to the directives

ERERA should

- Obtain necessary rights to be able to perform monitoring
- Receive an enforcement role on the priority directives
- Guide the developments and set priorities for the region

Conclusions

The consultant recognises the importance of progressively introducing the grid code

It is necessary to set goals in different development stages

The consultant proposes to focus first on

- System stability & frequency control
- System synchronisation & regional balancing
- Staying interconnected at all times and provide assistance to each other to avoid black-outs