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Planning Code

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Table of Contents

1 OBJECT AND SCOPE OF THE PLANNING PROCESS

J.[1] The objectives and the willingness of **Member States** are the driving forces of investments in strategic infrastructures like the **Electricity Systems**. To the purposes of this **Code**, the **General Agreement** is the binding document that summarize the goal of boosting the development of the PAEM. The compliance with the **General Agreement** and its goals are reminded in this Chapter.

The object of the **Planning Code** is the **Long-Term Planning** of the **International Interconnections** of the **PAEM Electricity System**. Development means the modification of the resources of the **Bulk System** made available to the **Operation**. The main scope of this code is the expansion of the **Relevant Grid**. The development of the generation is considered, and its adequacy assessed, but it is not regulated in this code. Energy policies are assumed to be under full responsibility and autonomy of the **Member States**.

1.1 Key Goals

This **Code** assumes that the key goals of the planning of **International Interconnections** are to:

a) increase the reliability of the **Electricity Systems** of the **Member States**;
b) enhance a sound PAEM;
c) design a sustainable PAEM Electricity System, also from the environmental point of view;
d) contribute to the stability of the investments.

To these purposes, **TSOs** shall give high priority to the harmonization of the **National Development Plans** and their integration.

1.2 Compliance Goals

Each **TSO** must comply with the national transmission planning criteria and the **National Grid Codes** taking into consideration the main drivers of development in its country and the conditions of its **Grid**. The goal of harmonization in planning is that the **National Development Plans** will gradually acquire the more general objectives of a common **Master Plan** of the **International Interconnections** for the benefit of the whole **PAEM Electricity Systems**.
This **Code**, as stated in Paragraph 3.4.1.1.4 of the **General Agreement,** is not intended to replace or merge the individual **National Grid Codes** on planning, but it aims at interfacing them and harmonizing the process of development of the **International Interconnections**.
In order to give continuity to the process, the **TSOs** shall set up **National Development Plans** that consider the last approved **Master Plan** and propose new or updated cross border **Projects** as input to the **Master Plan** in progress. This cycle shall be concluded in two (2) years.

1.3 The Master Plan Outline

The **Master Plan** shall consist of:

a) The summary of the **National Development Plans** of the **Member States** concerning the **Relevant Grid** in the time horizon of the **Master Plan**.

[1] **J.** : Justification

b) The description of the **Projects** on **International Interconnections**, consisting of:
   i. The **International Interconnections** between neighboring TSOs.
   ii. The expected increase of **NTC** between the interconnected areas associated to each **Project**.
   iii. The **Transmission System** reinforcements and/or the refurbishment needed to reach the targets and comply with the security of operation.
   iv. The cost benefit analysis and the **Key Performance Indicator** (**KPI**) values.
c) The recap of criteria and decisions adopted in the process.
d) **Projects** aiming at increasing the utilization of the existing infrastructures.

The ranking of the **Projects**, in discharge of duties of Paragraph 3.3.1.7.3 of the **General Agreement**, shall be based on the cost benefit analysis and on the parameters that better reflect the policies of the Pan Arab region.

Seasonal reports or outlooks on **Adequacy**, considering the benefits from the **Energy Transfers,** are part of the **Operation Code**.

2 THE PLANNING PROCESS IMPLEMENTATION

J. The complexity of the planning activities and the need to create the conditions of fruitful cooperation call for an active participation of the involved **TSOs** to **Committees** and **Working Groups**. Moreover, the necessity to give continuity to the harmonization process and deliver a reference **Master Plan** of the interconnections require a clear schedule of activities.

2.1 Resources of TSOs to the Arab TSOs Committee

The planning process starts with the preparation of the **Projects** that each **TSO** will include in its **National Development Plan**. This activity is performed autonomously by each **TSO** considering the conclusions and indications of the latest and current **Master Plan**. The part of the **National Development Plans** concerning the **Relevant Grid** and **International Interconnections** between **TSOs** is subject to coordination.

The co-ordination of the **Projects** requires the collection of the initiatives, the analysis of the contents, the drafting activity of the **National Development Plan**, **Comitology** of the **Members States** and administrative issues. To this purpose, the **Arab TSOs Committee** will establish the **C4-Plannning Committee** and the **TSOs** agree to contribute with qualified resources. Scope of **C4**, according to the **General Agreement** is:

a) may be permanent or temporary and reports to **Arab TSOs Committee**
b) shall work according to a ToR, approved by **Arab TSOs Committee**,
c) shall strive for unanimous decisions or decide according to rules accepted with the signature of the **General Agreement**,
d) decides how to share the activities between internal working groups.
e) can propose to hire external expertise for specific studies.

C4 shall be chaired by an elected representative of one of the **Member States** staffed with a secretary and representatives of the Member States. The work shall be organized and shared among internal groups to be confirmed at any edition of the **Master Plan**:

a) By **Expert Groups** (**EG**) assisting **C4** in carrying out market, network studies, and what else **C4** will consider necessary.
b) **Area Groups** (**AG**), one per each **Synchronous Area** as defined in Article 0.

TSOs shall contribute to the activities of **EGs** and **AGs** with qualified personnel and guarantee the needed time to accomplish the assigned tasks.

The **C4** shall support the **TSOs** in the assessments and in modelling their **Electricity System**, if required. **C4** shall suggest modifications to the **Projects** as well. Despite such relationships the responsibility of the **Projects** still belongs to the **TSOs**. **TSOs** are free to accept or reject the suggested modifications.

In discharging his duties, **C4** may propose to **Arab TSOs Committee** for approval new ad-hoc groups.

2.2 Timing for the planning process

The main scope of the planning process is to deliver a 10-year long-term **Master Plan** for the **International Interconnections** updated every two (2) years and covering the years from Y to Y+10. The Planning Process is therefore rolling, which is updated every two (2) years.

The target data for publishing shall be the 31st of December of Y-1. Hence the common planning process shall start the 1st of January of each year Y-2 (**Planning Process Starting Date**).

During two years of activity cooperation among the **TSOs**, it is required to harmonize the interconnection initiatives with the **Grid** expansion, generation and distribution plans and define **International Interconnections Projects**.

The time schedule of the planning process is formulated in eleven steps, described in sequence. It is a **C4** decision to shorten the schedule if possible and carry out some of these steps in parallel. The timeline is reported in Figure 2-1.

Step	Week	Year	Y-2				Y-2	Y-1						Y-1
		Progressive Week	8	24	34	42	46	62	66	72	82	86	94	100	104
		Preliminary Phase (Appointing completed)	8												
1	A	*STEP 1* (National Development Plans sent)		16											
2	B	*STEP 2* (Scenarios discussed)			10										
3	C	*STEP 3* (Data collected for studies)				8									
4	D	*STEP 4* (Scenario approved)					4								
5	E	*STEP 5* (Market / Adequacy studies concluded)						16							
6	F	*STEP 6* (Market / Adequacy studies approved)							4						
7	G	*STEP 7* (Grid Model Preparation)								6					
8	H	*STEP 8* (Network Studies concluded)									10				
9	I	*STEP 9* (Outcome of Network Studies discussed)										4			
10	J	*STEP 10* (Cost Benefit Analysis)											8		
11	K	*STEP 11* (Master Plan Approved and published)												6	
		Time margin for contingency													4
		KEY	x	Extimated weeks after last step											

Figure 2-1. Timeline of the planning process.

2.2.1 Preliminary Phase

As a first step, before week 8 of the Y-2, the **Arab TSOs Committee** should nominate the **C4** and the TSO Members of it, staffing the Area Groups and the **Expert Groups**.

The **Expert Group**, under proposal of **C4** and approval of **Arab TSOs Committee**, can be supported by qualified external resources, recruited according the rules of the **General Agreement**

C4 shall propose and the **TSOs** shall approve as soon as possible a binding detailed schedule in line with the requirements of Section 2.2 of this **Code**.

2.2.2 STEP 1. Collection of the National Development Plans including the interconnection initiatives

Almost 3 months are granted to the **TSOs** to update their **National Development Plans** and align them to the priorities and targets of the **PAEM**.

By the week *twenty-four* (refer to Figure 2-1) each **TSO** involved in development **Projects** should forward to **C4** its **National Development Plan** for the planning horizon prescribed by their applicable national regulations.

By the same date, **TSOs** should forward indications to extrapolate the **National Development Plans** till the 10th year ahead if their **National Development Plans** are shorter.

The **National Development Plans** should at least highlight:

a) The **Projects** of new cross border **International Interconnections**, the reinforcements needed and the expected increase of **NTC** for each of them and in total.
b) The **Scenarios** and assumptions under which the **Projects** have been developed.
c) Forecast data for the time horizon of the plan (load demand and generation at the detail of kind of generation source).
d) Main goals associated to the **Projects**.

Projects shall be presented in uniform editorial pattern to speed up analysis and presentations, without risk of misinterpretations.

Projects can be single initiatives or **Clusters** of **Projects.** If aiming at the same objective, they complement each other.

Projects are considered finalized only when techno-economic benefits are estimated and the costs of the cross-border **Project** plus the reinforcements are assessed though cost-benefit analysis. Therefore, **C4** may recommend changes and **TSOs** may propose solutions during the process, to meet the recommendations received.

2.2.3 STEP 2. Definition of Scenarios and drivers for the interconnection

On the ground of the **PAEM** targets and considering the instances of the **TSOs** received, **C4**:

a) analyses the topics that drive the development of each **TSO**;
b) performs an analysis of the drivers in each **Member State** and defines the reference **Scenarios** for the **Synchronous Areas** involved by the **Projects**. The number of **Scenarios** should be between 3 and 6, according to the **C4** decisions.

c) classifies **Projects** received by the **TSOs** according to their maturity (proposals, bilateral agreements, government requests), goal (economic benefits, **VRE-units** accommodation, reliability, reduction of losses, **Adequacy**).

C4 shall draw the conclusions on the way to approach the **Scenario** analysis, draft the investment list and - after approval - call for market and network studies at **Synchronous Area** level by week *B* (refer to Figure 2-1).

2.2.4 STEP 3 and STEP 4. Data collection for market and network studies

By week *C* (refer to Figure 2-1), and on the basis of the previous analysis, the **TSOs** complement the information with the set of national data needed for the market analysis, as per Paragraph 3.4.1.2.1 of the **General Agreement**.

The required Information for each of the **Scenarios** consists of forecast of the **Demand**, the power generation mix, the conventional merit order in dispatching **Power-Generation Facilities (**based on standard costs of fuel and standard efficiency per type of unit) and the **NTC** between neighboring interconnected **Electricity Systems** in the format required by the adopted simulation tool and the network models with and without the proposed **Projects**.

C4 defines market **Scenarios**, driving parameters and **KPIs** (economics, reliability, adequacy) and by week *D* (refer to Figure 2-1) approval by **TSOs** is required.

2.2.5 STEP 5 and STEP 6. Market Analysis

C4 / SG performs the market studies. Hourly simulations are performed adopting a probabilistic approach. Market studies shall produce, for each **Scenario** and **Project,** the values of the **KPIs** taken as reference for **Adequacy** and **Socio Economic Welfare**.

C4 shall deliver also gradually **Project** by **Project** results and complete the delivery of them not later than week *E* (refer to Figure 2-1).

TSOs have the faculty to discuss results and endorse final versions by the week *F* (refer to Figure 2-1).

2.2.6 STEP 7. Network set-up

Based on the results of market study, network analysis must be performed in order to check the compliance with the security standard if the conditions of the market studies are applied. To this aim, the **Area Group** of each **Synchronous Area** of **C4 / AG** agrees on several **Snapshots** per **Project** recognized as significant to the operation in peak and off-peak hours and in various seasonal situations. The market simulation variables of the **Snapshots** are taken by the 8760 hourly simulations of the market studies and mapped on the **Individual Grid Models** and merged in a **Common Grid Model** per **Synchronous Area** and per **Snapshot**.

Each **Area Group** agrees on the portions of **Transmission Systems** that can be represented with equivalents to reduce the calculation burden, without appreciable loss of accuracy.
The preparation of the **Common Grid Models** shall be concluded by week *G* (refer to Figure 2-1).

2.2.7 STEP 8 and STEP 9. Network Studies

Each **Area Group** of **C4** coordinates the network studies by running load flow studies on the **Common Grid Models** set up according to Article 2.2.6. Security standards are assessed with such studies and reinforcements ,if needed, are considered.

The applicable security standards are the same prescribed in the **Operation Code**. AC load flow simulations are recommended. Simplified models are allowed if consistent with the uncertainties of the **Long-Term Planning** processes.

Short circuit studies should be carried out under the responsibility of the **TSOs** and include the needed provisions to improve the withstand capability in the reinforcements, according to the **National Grid Codes,** or applicable technical rules.

In case the **C4** considers the voltages and power flows adopted in the load flow studies less restrictive than the ones needed to comply with stability limits, **C4** can decide to perform stability studies.

Stability studies shall include, according to the triggered problems, transient and frequency stability, small signal stability and voltage collapse.

TSOs coordinated by **C4** shall deliver results by week *H* (refer to Figure 2-1).

Discussions, if any, shall be concluded by week *I* (refer to Figure 2-1).

2.2.8 STEP 10. Cost Benefit Analysis

TSOs in the **Area Groups** shall implement the cost benefit analysis per **Project** and send results to **C4** by week *J* (refer to Figure 2-1)

2.2.9 Approval and publication of a Master Plan

After approval of the **Master Plan** by the **TSOs**, **C4** shall publish the **Master Plan** for public enquiry timely to publish it definitely in the **Regulation Report** by **Pan-Arab ARC** by week *K* (refer to Figure 2-1).

2.3 Project Ranking against Targets

The **Master Plan** shall include quantitative elements for a transparent ranking process, if needed.

C4 is entitled to draft merit order against given targets, at the end of the analysis and compile the list only if required.

2.4 Disputes on the results

Disputes are regulated by Chapter 8 of the **General Agreement**. In the most complicated cases, the **Arab TSOs Committee** shall launch a commission to support and advise **Pan-Arab ARC** and to instruct the debates.

3 THE DATA INFRASTRUCTURE

J. The planning process of the interconnection is a continuous process based on the deep knowledge of the **Electricity Systems**. T**SOs** should contribute to create and sustain permanent infrastructures fit for the above-mentioned purposes.

3.1 Central Database for Network and Market Studies

The planning process – designed to guarantee the coordination among **TSOs** – requires efficient **Data Exchange** and a secure repository of data to be managed by the **Arab TSOs Committee**. To this purpose, **TSOs** shall cooperate to set up a relational **Central Database** to be gradually implemented no later than two (2) years from entering into force of this **Code**.

The basic contents of the **Central Database** shall be organized in logical sections as follows:

a) section dedicated to the **Market** and **Adequacy**;
b) section dedicated to Network Analysis; and,
c) section dedicated to Statistics and Reporting.

Dedicated interfaces shall guarantee efficient exchanges of information between the **Central Database** of the **Arab TSOs Committee** and the **Individual Database** of each **TSO**, primarily to avoid double work in uploading data in more than one **Individual Database**.

The **C3** shall coordinate the central activities in co-operation with **C4**. **Arab TSOs Committee** will be responsible for the acquisition of the resources to design, deployment and maintenance of the **Central Database**.

The location of the **Central Database** in physical servers or cloud solutions, shall be agreed among the **Member States** according to costs and cyber security.

3.2 Interoperability of Evaluation Tools

Evaluation Tools are basically the package of models for market and adequacy analysis and network analysis. In principle, each **TSO** shall have the faculty to verify results of its interest.

To the purposes of such evaluations, data uploaded or downloaded to the database must be easily converted in formats of software used by **TSOs**. The database shall guarantee the interoperability of such **Evaluation Tools** if the **TSOs** specify the needed interfaces.

The **TSOs** shall actively contribute to the database implementation since the specification phase. They are required to provide the following :

a) The declaration of the tools used in their respective companies.
b) The declaration of any changes of packages used.
c) The decision on common formats to be adopted.
d) The availability to share costs.
e) The availability to take part in the design.
f) The availability to perform type and acceptance tests and population.

The **TSOs** of the **Member States** shall evolve their analysis packages, including interoperability, in their priorities.

4 GUIDELINES & METHODOLOGY

J. The **Planning Methodology** is based on the evaluation of the costs and benefits of the interconnection projects proposed by the **TSOs**. The benefits of the projects are assessed simulating the market and the physical load flows. Such simulations are repeated in more than one **Scenario** to assess the improvements of the **KPIs** taken as a reference. Costs are evaluated at the end and they include the costs of the project and the ancillary.

4.1 Synchronous Areas and macro Sub-Regions definition

In the application of this **Code**, the **TSOs** shall consider the wide extension of the Pan Arab region and the differences in development of the **TSOs** including the fact that not all of them are connected to any of the current **Synchronous Areas** and some of them have **Islands**.

Even if the socio-economic growth can be more easily referred to a region, the network study approach in this **Code** shall refer to the **Synchronous Areas** because the physical constrains must be correctly simulated.

Synchronous areas are defined in Table 4-1.

Table 4-1. Synchronous Areas in the Pan-Arab region.

Maghreb Synchronous Area (or Western Area);	**Central Synchronous Area (or Central Area)**	**60 Hz Gulf Synchronous Area (or 60Hz Eastern Area)**	**50 Hz Gulf Synchronous Area (or 50Hz Eastern Area)**	**Islands**
Sub-Region Maghreb Interconnection (1)	**Sub-Region** EIJLLPST **(1)**	**Sub-Region** GCC **(1)**		- -
• Morocco • Algeria • **Tunisia** • **(Libya) west**	• (Libya) east • Egypt • Jordan • Palestine • Syria • Iraq	• KSA • GCCIA (2)	• Kuwait • Bahrain • Qatar • U.A.E. • Oman • GCCIA (2)	• Djibouti • Somalia • Comoros • Sudan • Mauritania

(1) As per 2.2.2 of **General Agreement**
(2) As TSO of the Backbone
(3) **In brackets TSOs belonging to more than a Synchronous area**

Synchronous Areas are revised as soon as International Interconnection **Projects** will connect the Islands to the **PAEM Electricity System**. Revisions could result in an enlargement of the **Synchronous Areas** when an **Island** is synchronously connected to a **Synchronous Area,** or a merger in case a new **International Interconnections** connects two of them.

As far as market studies are concerned, the building blocks are the **Bidding Zones** which usually can be the same as the **TSO**. Each **Bidding Zone** is simulated with a node and

connected with the others with a link whose capacity is the **NTC** existing or proposed in the projects.

4.2 Objectives of a Long-Term Master Plan

TSOs are committed to convene and issue long term **Master Plans** for the **PAEM Electricity System**. The main objective of transmission system planning in the Pan Arab region is to ensure, based on multilateral cooperation sponsored by **Member States**, the development of an adequate transmission system to facilitate the development of the **PAEM** and:

a) Provide a high level of security of supply in all the **Synchronous Areas** of the Pan Arab region.
b) Ensure the security of operation of the whole region.
c) Contribute with the availability of electricity at reasonable costs to a sustainable development of the Pan Arab region.
d) Contribute to the economic efficiency of the entire region.
e) Promote and potentiate the integration of **RES** in the region.
f) Contribute to the internal market integration and the harmonization of the rules.
g) Facilitate access to the Transmission System to all Market Participants.

4.3 Assumptions

To the purposes of 4.2, **C4** shall verify the degree of relevance of the **TSO Projects** for the purpose of the objectives shared among **Member States** in the **General Agreement**, throughout a transparent assessment process based on the following assumptions:

a) The data received by the **TSOs** are reliable and consistent with the ones adopted in their **National Development Plans**.
b) The **Scenarios** are defined and shared among **TSOs**.
c) The methodology and the algorithms for market and **Adequacy** studies and for network studies are shared and agreed.

TSOs shall be responsible for the input data and the assumptions made as a basis for further assessment.

Methodology and algorithms shall guarantee the traceability of the processes.

4.4 Planning Data Requirements (to be made available)

Each **TSO** shall make provide the **C4** with the following data about its **Electricity System**, in the format, definition and detail specified in the Data Base or agreed within **C4**:

a) Load curves of the **Demand**.
b) Thermal generation in terms of size, primary source, maintenance, base load, must run, reliability, flexibility degree.
c) Generation and CO_2 costs. The Member States should harmonize this information with fixed cost in relation to primary source and efficiency.
d) Value of loss of load associated to unsupplied electricity.
e) Electricity production from hydro-based **Power-Generating Facilities** (run of a river, natural inflow) and pump/storage capacity.
f) Electricity production profiles or producibility from solar- and wind-based **VRE-units**.
g) Electricity production profiles or producibility from all the other **VRE-units** and **Power-Generating Modules**.

h) Power reserves (shared or strategic reserve).
i) Number of nodes needed for the market modelling by each **Member State**.
j) **NTC** and **TTC** at all its borders.
k) **Energy Transfer** towards neighboring **Electricity Systems** that do not belong to the Pan-Arab region.
l) Others, such as (limitations in the use of water, exchanges planned and long terms **Bilateral** or **Multilateral Contracts** between **TSOs**).
m) load flows on **Reference Networks** at the end of the planning horizon (i.e. **Individual Grid Models**)

4.5 Reference Scenarios

Scenarios are possible situations that can happen in the future. **Scenarios** are quantitative descriptions of the future status or statuses of an **Electricity System**.

Scenarios have a fixed number of parameters in common, but they differ from each other in the weighting factor that each of them assumes.

Unless arranged otherwise by **C4** to represent the socioeconomic and the environmental policies of the Pan-Arab region, **TSOs** shall weight and define no more than six (6) macro factors expressed by one or more significant parameters:

a) Economy (Gross Domestic Product (GDP) growth, population growth, **Demand** forecast, primary resources price).
b) Renewable energy penetration plans and boosting tendency.
c) Technology development (storage, load management, smart grid).
d) Expected new **Demand** load (water desalination, electric cars, public transportation, energy efficiency).
e) Market integration (internal market, regional market, or global market);
f) Thermal carbon free and neutral technologies.

C4 and **TSOs** in SG shall agree on a set of **Scenarios** based on the parameters that were previously chosen.

C4 and **TSOs** shall define from (4) to six (6) **Scenarios** as a combination of the weights assigned to each of the selected parameters.

Unless arranged otherwise by **C4** and **TSOs**, or in case of lack of agreement, the following typical six (6) **Scenarios** could be considered by default:

a) **S1**. **Security of Supply** improvement in a flat business trend.
b) **S2**. Gas and local integration of renewable sources (main sources for the future).
c) **S3**. Fast economic growth supporting the development of **International Interconnections** but low thermal plants development.
d) **S4**. Sound environmental targets and market integration at Pan Arab level.
e) **S5**. Environmental Sustainability mutually approached. That is, the environmental challenges represent a common objective of more **Member States**.
f) **S6**. Low economic development with security of supply improvement.

C4 may decide to modify the **Scenarios** on the base of the preliminary results of the analysis.

Unless arranged otherwise by **C4**, the following indicators shall be calculated for each **Project** and for each scenario by means of simulation of the coverage of the **Demand** performed according to the applicable market rules. Such indicators shall be included in the category of the benefits within the cost-benefit analysis of the new **Projects**, and defined as follows:

a) *Improved* ***Security of Supply*** *(SoS),* that is the ability of an Electricity System to provide an adequate and secure supply of electricity under ordinary conditions. To this purpose, the **Expected Energy Not Served** (**EENS**), **Loss of Load Expectation** (**LOLE**), and **Loss of Load Probability** (**LOLP**) are calculated.

b) ***Socio Economic Welfare*** *(SEW)* or *market integration*, that is the ability of a power system to reduce the power **Congestions,** and thus provide enough capacity of the **Transmission Capacity** for the electricity markets and allow the development of a trading system in an economically efficient manner. The increase of **NTC** shall be calculated.

c) *Integration of renewable energy*, that is the twofold ability of an **Electricity System** to accommodate new renewable energy-based **Power-generating Facilities** and to minimize the curtailment of the renewable generation.

d) Reduction in CO_2 emissions that is the characterization of the reduction of CO_2 emissions in the **Electricity System**. Volume of reduced CO_2 shall be calculated.

The evaluation of the impact of single **Projects** on the indicators can be performed by comparative analysis of the values with and without the **Project**:

a) Method 1: to calculate the differences between the values assumed by simulating as if all the **Projects** have been implemented, and the same values assumed by excluding the **Project** to be assessed.

b) Method 2: It is also possible to start from the situation where no **Project** has been implemented and calculate the differences in values assumed by the parameters adding the effects of the **Project** to be assessed.

4.6 Adequacy and Market Studies Methodology

Stochastic simulations of the coverage of 8760 values of hourly demand in each **TSO's Control Area** are performed in the market studies.

Simulations are driven by the applicable rules of the **PAEM.** They assess the **Adequacy** in the Electricity System of each **Member State**, with and without the **Project**.

Bidding zones are simulated as single nodes. The exchanges between bidding zones are characterized by the TTC between them.

The benefits of each **Project** shall be evaluated in terms of the selected indicators.

The market studies shall highlight the number of hours in which one or more borders are saturated by the resulting **Energy Transfer** and the cases where there is still room for beneficial development of **International Interconnections**. **C4** shall make available such indications to the **TSOs** as a signal to be taken into consideration for the **Master Plan** in progress and for the future. Indications can be used by **Pan-Arab ARC** to suggest and encourage investments in these borders.

4.7 Network Study standard Methodology

Network studies shall verify the capability of the **Network** to sustain the load flows in the conditions simulated by the market studies and comply with the security standards for all the hours of the year.

To simplify the process, it can be allowed to reduce the number of simulations, by relying on relevant **Snapshots**, performing calculations for the hours considered significant for the whole year, as prescribed hereto.

4.7.1 Snapshot selection

A set of **Snapshots** in situations where the zone under study imports energy and a set where the same zone exports shall be selected. Each of such sets shall include one subset significant of peak hours and one of the off-peak hours.

4.7.2 Steady state simulation against contingency lists

Each **Snapshot** shall be merged with the **Reference Network**, by assigning the in-feeds and out-feeds of the **Snapshots** to the nodes of the **Reference Network**. Such generated networks shall be processed until convergence in order to have as many consistent situations as the selected **Snapshots**.

The security assessment is performed on each of the **Snapshots** according to the criteria adopted, assumed in the **Operation Code,** and to the requirements prescribed in the **Connection Code**.

Simulations shall not include the already applied **Wide Area Protection Systems** if introduced by **TSOs** to overcome momentary insufficiency of the **Transmission System**.

In case of violation of security limits, reinforcements can be suggested by **C4**. **TSOs** take the responsibility to accept or refuse or proposing further solutions to be verified again.

After the network studies, two further indexes shall be calculated:

c) The variation of losses with and without the **Project** under assessment.
d) **Security of Operation** improvement with the **Project** under assessment.

Technical operation limits shall be the ones prescribed in the **Operation Codes** and the **Connection Codes.**

Security standards shall be the ones prescribed in the **Operation Codes** and the **Connection Codes**.

Contingency Criteria and list shall be the ones prescribed in the **Operation Codes** and the **Connection Codes**.

4.8 Short circuit studies

Three phase faults and single phase to ground faults shall be calculated according to IEC 60 909 systematically in the simulations to verify the breaking and making capacities of the circuit breakers.

If the **Short-Circuit breaking capacity** exceed 90% of the rated value, the replacement of circuit breakers shall be included in the reinforcements associated to the **Project** under assessment and this shall be added to the cost of the **Project** under assessment, for the purposes of the cost-benefit analysis.

Minimum **Short-Circuit Power** calculations shall be required at the terminals of the **HVDC Systems** to guarantee their correct functioning.

4.8.1 Stability Studies (future)

Stability studies should include: voltage collapse, frequency stability, transient stability and small disturbance angle stability.

In case of first AC **International Interconnection** between two **Synchronous Areas**, all those studies shall be performed by the proponent TSOs. In this case the stability studies go beyond the simple assessment of the **Project** because they could concern a general assessment of the compatibility of two **Synchronous Areas**. **C4** shall manage these cases with special commissions tasked to assess all aspects of such **International Interconnection** as per 4.9

In other cases, given the complexity of the studies, the amount of data and their quality, **C4** may allow the performance of such studies or part of them with simplified models or postponement when the detailed design of the **International Interconnection** starts.

4.9 Additional Studies

In case a **Project** is the first **International Interconnection** between two **TSOs** belonging to different **Synchronous Areas**, or one of them is an **Island**, **C4.** in cooperation with **C2** and the involved, **TSOs** shall carry out and submit an overall feasibility study covering at least:

a) **Short-Circuit** studies.
b) Compatibility of practices adopted in operation
c) Compatibility of the **SCADA** systems.
d) Time required to bridge the gaps, if any.

In case the same first **International Interconnection** is in HVAC technology, the following is required:

a) stability studies with due attention to the **Power System Stabilizer** policy and settings.
b) **Automatic Generation Control** (**AGC**) standard.

If such studies show that modifications are necessary, ways and deadlines to carry out them must be scheduled before the time of its implementation of the **Project** reported in the **Master Plan**.

4.10 Cost Benefit Analysis

Cost-benefit analysis shall be presented **Project** by **Project** in uniform editorial pattern, in order to facilitate its reading. For each **Project** the following sections are required:

a) General settings: where at least the technical features of the **Project** are described, and the status of the **Project** is reported. It is required to specify if the **Project** is in

one of the following stages: under consideration; planned, but not yet in permitting; under construction; commissioned; cancelled.

b) A section dedicated to the investment shall report:
   i. The total costs of the **Project** and the ratio between the main work and the reinforcements.
   ii. Costs for compensation works.
   iii. A description of the investment costs per item. Items shall be described in number or engineering quantities at functional level (e.g. line, circuit breaker) and voltage level.

c) A section dedicated to the benefits shall include the results of simulations per scenario. For each scenario at least:
   iv. The **TTCs** (in import and in export and for both interconnected **Electricity Systems**) with and without the **Project**.
   v. The ratio between the **TTC** and the sum of all the **Generation Capacity** installed to evaluate what could be a limit to the import / export of electricity.
   vi. The **KPIs'** scenario by scenario mentioned in Article 0.
   vii. Residual indicators like environmental impact, social Impact, and other impacts to be highlighted by the **C4**.

Standard unit costs shall be adopted in cost-benefit analysis. Unit costs shall be approved by **C4** before starting the cost-benefit analysis process. **C4** shall also approve the differences country by country where applicable (e.g. due to labor cost, special laws, compensations).

4.11 Cross Border Cost Allocation

Cross border cost allocation is subject to **Bilateral Contracts**. Fairness on the evaluations is recommended.

4.12 Individual Databases and evaluation tool minimum requirements

Individual Databases should contain at least the same information and set of data of the corresponding sections of the **Central Database**.

Market simulations, based on probabilistic algorithms, should be run with software compatible with the one used at central level or the same, to facilitate the comparison of results.

Network studies can be performed using tools whose only constraint is the easy interface with the software adopted at central level.

To bridge the gap on modelling of **HVDC System** inverter-based **Power-Generating Facilities**, sharing the models, should be mandatory for the benefit of the quality of the simulations.

4.13 Role of Sub-Regional TSOs/Market Facilitators

As per 3.6.2.1.12 and 3.6.2.2 of **General Agreement**, a **Sub-Regional TSO** / **Market Facilitator**, without prejudice of the participation of TSOs, may:

a) Represent in **C4** the sub region against the rest of the Pan Arab region.

b) Develop the **Sub-Region Electricity System** according to the **Planning Code** adopted in the region.
c) Contribute to the **Master Plan** with the conclusions on expansion **Projects** of the **Member States** of the sub region. **Projects** shall be described with the same information adopted for the entire Pan Arab region.

This implies that if the **Sub-Region** is isolated and no **International Interconnections** with **Electricity Systems** outside the **Sub-Region** are proposed, the **Sub-Regional TSOs / Market Facilitator** is not obliged to take part in the simulations.

In case of **Projects** of **International Interconnections** between a **TSO** of the **Sub-Region** and an external one, the **Project** will be developed according to the applicable bilateral agreement but evaluated with the criteria stated in this **Code**.

5 GENERATION ADEQUACY FORECAST

J. This activity helps to share the structural problems of each Member State. It is also an important input to the planning process. **TSOs** shall contribute being aware of its importance and to fulfil the obligations of the **General Agreement**.

5.1 Long term Adequacy Forecast

Evaluations are required at single **TSO** level within the energy policy that each **Member State** shall perform by law. In the individual evaluations, the exchange with other **Member States** is simulated.

Based on individual **Adequacy** forecast, the **KPIs** are derived by the market and **Adequacy** centralized studies, as described in Section 4.6.

Seasonal **Adequacy** forecast is matter of the **Operation Code.**

6 FORMAL OBLIGATIONS

The protection of sensitive information is further stressed by the fact that both independent **TSOs** and **TSOs** belonging to vertically integrated utilities take part in the market studies.

Market studies require processing sensitive **Information**. This circumstance compels the use conventional standard costs in the cost-benefit analysis.

TSOs are recommended to use as much as possible aggregated and anonymous **Information** to avoid the identification of the unit.

No **Party** may disclose data and information.

7 CENTRALIZATION OF PROCESS OR COLLECTION OF INITIATIVES

The planning process, as prescribed in this **Code**, requires part of activity performed by the **TSOs** in autonomy and part which need to be performed in a centralized way.

The centralization is required by the assessment of the benefits of an **International Interconnection Project**, by the market simulations, the arrangement of **Common Grid Models**, the drafting, the presentation, and the publication of results.

An efficient **Central Database** contributes to the efficiency of periodical centralized **Long-Term Planning** activities.

Setting up a coordination body, in this **Code** indicated as **C4**, is needed also to develop a transparency mindset.

TSOs of the **Member States** shall:

a) Forward proposals of **Projects** as much as possible defined between neighbor **Member States**.
b) Forward **National Development Plans**.
c) Carry out analysis of security.

8 TRAINING

J. Training aims to acquire confidence, common understanding of the issues and autonomy in performing the **Master Plan**.

Pan-Arab ARC shall be available to organize seminars on planning.

First topic to be released concerns the results of the planning activity and the **Master Plan**.

TSO personnel and members of the **C4** shall receive training on:

a) Basics on market principles.
b) Probabilistic approach (theory and practice).
c) Use of most diffused simulation tools for market and network studies.

TSOs shall receive training on the management of the database and data needed for planning.

9 ANNEX A: DEFAULT SCENARIO SELECTION

This Annex describes an example of possible **Scenarios**. The example can be proposed as a base for discussion and to trigger the first time the planning process. Two macro areas are taken as part of generic region. They are called Northern and Southern Area. Northern Area is characterized by mature level of development with signals of stagnation while the southern one is characterized by a fast growth in economy and population.

9.1 Scenarios

9.1.1 S1. Security of Supply improvement in a flat business trend

This is a conservative scenario.

The load consumption increases with the same trend in each **Member State**.

The economic development in most **Member States** is between 4 and 6% on average.

Energy policy is marked by the continuation of the current trend in each country. The policy of supporting renewable energies is pursued but their growth remains well below the level seen in other Northern countries.

The scope of International Interconnection **Projects** and internal Grid **Projects** are based on the improvement of the security of supply.

9.1.2 S2. Gas and local integration of renewable sources (main sources for the future)

This scenario is a more environmentally sustainable scenario, based on a bottom-up approach.

Each **Member State** decides a common policy to integrate renewable energy sources and maximize the effort to reduce climate changes.

The CO_2 price is high in Northern countries. The policy of the Southern countries is based on an attentive use of primary resources and the development of renewable energy funds with primary resources incomes.

Gas power plants are built in the South of the region for the guaranty of supply and to minimize CO_2 emissions. These gas power plants also will have to be flexible to deal with a new energy mix based on renewable energy.

The load consumption increases higher than the same S1 trend in each **Member State** because of the development of new electricity uses like public transportation in the Northern Countries and for the demographic increase.

The hypothesis on the economic environment is one of the partial cash-up phases of global demand in the Northern TSOs. The development in the southern Area is between 4 and 6%.

Interconnection development in the South is based on the improvement of the security of supply and exportation of renewable energy resources.

9.1.3 S3. Fast economic growth supporting the development of the International Interconnections but low thermal plants development

This scenario assumes that following the availability of new primary resources, the economy of the region increases especially in the southern **Member States**. A 7% GDP growth could be expected in the southernmost **Member States** and 2% for the Northernmost **Member States**.

Southern **Member States** decide to develop free carbon thermal power plant to support the electricity demand without consuming their primary resources.

New **International Interconnections** are built to share the low-cost electricity of this kind of power plants and to share production margins.

9.1.4 S4. Sound environmental targets and market integration at regional level

This scenario is based on an approach with two issues:

a) The CO_2 reduction for electricity production and for transportation (new electricity uses);
b) High technology development for load and generation management especially in the Northernmost **Member States**;
c) The investment in renewable energy and carbon-free thermal generation in the South to support electricity demand, to limit the consumption of primary resources and to export the surplus of electricity.

This scenario is based on many **International Interconnections** to support a global electricity market all around the region.

9.1.5 S5. Environmental Sustainability mutually approached.

This scenario is an in-between scenario regarding S3 and S4, where the **Member States** shall increase their cooperation to optimize their electrical system and setting national environmentally sustainable energy policies.

9.1.6 S6. Low progress with security of supply improvement.

This scenario is the worst-case scenario for the region. Due to a low economic development of the economy, each Member State limits the implementation of **International Interconnections**. **Grid** reinforcements are focused on the security of supply.

9.2 Weight of parameters vs. Scenarios

The simulations shall be performed using the following weights for each scenario (in scale from 0 to 3).

Parameters \ Scenarios	WEIGHTS					
	S1	S2	S3	S4	S5	S6
Economy (GDP growth, population growth, demand forecast, primary resources price);	2	2	3	2,5	2	1
Renewable energy penetration;	2	2	2	3	2	1
Technology development (storage, load management, smart grid);	2	3	2,5	3	2	1
New load (water desalination, electric cars, public transportation, energy efficiency);	1	3	2	3	2	1
Market integration (internal market, regional market, or global market);	1	1	3	3	2	1
Thermal carbon free technologies (i.e. nuclear development in the South of the region area).	1	1	3	3	1	1