



Final report for Output 2  
Regional cooperation framework  
to share balancing capacity reserve

November 2019

## Glossary

AC	Alternative Current
ADB	Asian Development Bank
AFG	Islamic State of Afghanistan
aFRR	Automatic Frequency Restoration Reserves
AGC	Automatic Generation Control
BSP	Balancing service provider
CAC PC	Central Asia Coordination Power Council
CASA OH	Central Asia South Asia Operation Handbook
CAPS	Central Asian Power System
CAR	Central Asian Republics
CAREC	Central Asia Regional Economic Cooperation
CASA-1000	Central Asia–South Asia Electricity Transmission and Trade Project
CCGT/CCPP	Combine Cycle Gas Turbine / Power Plant
CDC	Coordinating Dispatch Centre “Energy” of Central Asian Power System
CEPC CA	Coordination Electrical Power Counsel of Central Asia
CIS	Commonwealth of Independent States
CORES0	Coordination of Electricity System Operators
DABS	Da Afghanistan Breshna Sherkat
DC	Direct Current
DSM	Demand Side Management
DTS	Dispatcher Training Simulator
EMS	Energy Management System
ENTSO-E	European Network of Transmission System Operators for Electricity
ESCC	Energy Sector Coordinating Committee
EWP	Energy Work Plan
FCR	Frequency Containment Reserves
FRR	Frequency Restoration Reserves
GENCO	GENeration COmpanies
GEP	Generation Expansion Plan
GMP	Generation Master Plan
GT	Gas Turbine
GW	Giga Watt
GWh	Giga Watt hour
HPP	Hydro Power Plant
HVDC	High Voltage Direct Current
IES	Intersystem Electric Networks
IGCC	International Grid Control Cooperation
IPP	Independent Power Producer

KEGOC	Kazakhstan Electricity Grid Operating Company
K-Electric	Karachi Electric
KYR	Kyrgyz Republic
KOREM	Kazakhstan Operator of Electric Power and Electric Energy
KAZ	Republic of Kazakhstan
LFC	Load Frequency Control
LOLE	Loss of Load Expectation
MEW	Ministry of Energy and Water
mFRR	Manual Frequency Restoration Reserves
MLA	Multi Lateral Agreement
MW	Mega Watt
MWh	Giga Watt hour
NDC	National Dispatch Centre
NEPRA	National Electric Power and Regulatory Authority
NLDC	National Load Dispatch Centre
NTC	Net Transfer Capacity
NTDC	National Transmission and Dispatch Company
PATL	Permanent Admissible Transmission Loading (in an interconnection line)
PICASSO	Platform for the International Coordination of Automated Frequency Restoration and
PAK	Islamic Republic of Pakistan
PV	PhotoVoltaic
RCT	Remote Control and Telecommunication
RDC	Regional Dispatch Centres
RE	Renewable Energy
RES	Renewable Energy Sources
RR	Replacement Reserves
RSC	Regional Security Coordinator
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
SO	System Operator
TA	Technical Assistance
TJK	Republic of Tajikistan
TKM	Turkmenistan
ToR	Terms of reference
TPP	Thermal Power Plant
TUTAP	Turkmenistan-Uzbekistan-Tajikistan-Afghanistan-Pakistan Interconnection
UCPTE	Union for the Coordination of Production and Transmission of Electricity
UCTE	Union for the Coordination of Transmission of Electricity
UPS	Unified Power System
UZB	Republic of Uzbekistan

## Table of contents

<b>0. Executive summary</b> .....	<b>7</b>
0.1. Introduction	7
0.2. Background and objectives	7
0.3. Regional governance between the countries involved in the regional cooperation	8
0.4. Common technical rules for the operation of the system	9
0.5. Common specific rules and responsibilities for FRR cross-border procurement	10
0.6. Proposed missions of CDC	11
<b>1. Introduction</b> .....	<b>13</b>
<b>2. A cooperation with operational bodies between the countries involved in the regional cooperation</b> .....	<b>13</b>
2.1. Context and objectives	13
2.2. A Multi-Lateral Agreement to define the regional governance	14
2.2.1. Content of the MLA .....	14
2.2.2. The common operational rules shall be made mandatory .....	15
2.2.3. Effectiveness of the cooperation ensured by Central Asia Coordination Power Council	16
2.2.4. Implementation guidelines for establishing, testing and applying common operational rules.....	16
2.2.5. Governance of the steering group .....	18
2.2.6. Regional rules implementation steps.....	18
2.2.7. Operational phase.....	19
2.3. Amendments on the existing multilateral agreements	20
<b>3. Common rules and responsibilities for operating the system</b> .....	<b>21</b>
3.1. Adequacy forecast	22
3.1.1. Objectives .....	22
3.1.2. Proposed solution .....	22
3.1.3. Main steps.....	22
3.2. Outage coordination	23
3.2.1. Objectives .....	23
3.2.1. Proposed solution .....	23
3.3. Cross-border capacity calculation	24
3.3.1. Objectives .....	24
3.3.2. Proposed solution .....	24
3.3.3. Main steps.....	26
3.4. Scheduling and accounting rules for cross-border commercial exchanges	28
3.4.1. Objectives .....	28

3.4.2.	Proposed solution .....	28
3.4.3.	Main steps.....	29
3.5.	Harmonized rules for FRR dimensioning	30
3.5.1.	Objectives .....	30
3.5.2.	Proposed solution .....	30
3.5.3.	Main steps.....	31
3.6.	Harmonised training program for dispatchers	31
3.6.1.	Objectives .....	31
3.6.2.	Proposed solution .....	31
3.6.3.	Main steps.....	32
<b>4.</b>	<b>Common specific rules for FRR cooperation at a regional level .....</b>	<b>32</b>
4.1.	Trade model for cross-border procurement of FRR	33
4.1.1.	Objectives .....	33
4.1.2.	Model based on SO-SO agreements.....	33
4.1.3.	Main steps.....	34
4.2.	Centralized process of procurement of the FRR reserves (before real time)	34
4.2.1.	Objectives .....	34
4.2.2.	Proposed solution .....	34
4.2.3.	Main steps.....	35
4.3.	Reservation of a capacity band on the interconnections for FRR exchange	36
4.3.1.	Objectives .....	36
4.3.2.	Proposed solution .....	36
4.3.3.	Main steps.....	37
4.4.	Real time activation	37
4.4.1.	Objectives .....	37
4.4.2.	Proposed solution .....	38
4.4.3.	Main steps.....	39
4.5.	Metering	39
4.5.1.	Objectives .....	39
4.5.2.	Proposed solution .....	39
4.5.3.	Main steps.....	39
4.6.	Settlement	40
4.6.1.	Objectives .....	40
4.6.2.	Proposed solution for energy settlement .....	40
4.6.3.	Proposed solution for capacity settlement .....	42
4.6.4.	Main steps.....	42
<b>5.</b>	<b>CDC missions .....</b>	<b>43</b>
<b>6.</b>	<b>Capacity building .....</b>	<b>51</b>

**Appendix 1: TTC calculation with loop flows .....53**

## 0. Executive summary

### 0.1. Introduction

RTE International, in a joint venture with EdF, has been appointed by ADB as a Consultant for the Technical Assistance (TA) for a Regional Cooperation on Renewable Energy Integration to the Grid. This regional cooperation involves seven Central and South Asia countries, Afghanistan, Kazakhstan, the Kyrgyz Republic, Pakistan, Tajikistan, Turkmenistan, and Uzbekistan (the Region).

The four key outputs of this TA to be achieved are:

- Output 1: Grid reinforcement plan ready to accept intermittent renewable energy
- Output 2: Regional cooperation framework to share balancing capacity reserve
- Output 3: Dispatch operation support tool and approach analysis
- Output 4: Capacity building

The present report on Output 2 is dedicated to the regional cooperation to be introduced between countries in which networks are connected. One of the main objectives of the regional cooperation is to enable each national System Operator (SO) to acquire a part of the Frequency Restoration Reserve (FRR) they need for operating their own system.

### 0.2. Background and objectives

As experienced in other regions worldwide, notably continental Europe, regional cooperation leads to a more efficient use of the grid with many benefits. In the field of balancing activities and procurement of operational reserves, the main benefits are:

- The possibility to share the Frequency Containment Reserve (FCR) among the interconnected systems and thus reduce the FCR requirements of each system;
- The possibility to procure Frequency Restoration Reserve (FRR) and Replacement Reserve (RR) across the borders where these reserves are the cheapest and, in a more advanced stage of cooperation, to share them and thus reduce the overall requirement.

With regards to the Frequency Containment Reserve, a regional cooperation is already in force among the countries operating synchronously with the UPS, since Russia is providing FCR to the whole synchronized system. The main finding of Output 1 of this TA is that Tajikistan and Kyrgyz Republic can provide other countries with hydro reserves and balancing energy, Uzbekistan and Turkmenistan being the main beneficiaries. A cooperation based on FRR cross-border procurement will enable to reduce the annual regional operating cost of generation system by 140 to 200 million of US\$ per year, from 2020 to 2030.

Thus, a regional cooperation between countries with connected networks will enable each national System Operator to acquire a part of the Frequency Restoration Reserve they need for operating their own system in any country of the cooperation. A solution to develop balancing reserve for intermittent renewable energy is developed in this report Output 2 to minimize the cost of the FRR procurement at regional level.

More particularly, this report:

- Proposes a regional governance between the countries involved in the regional cooperation (chapter 2);
- Details the common rules to be adopted as prerequisite to enable a safe operation (chapter 3);
- Details the rules to enable FRR cross border cooperation (chapter 4);
- Details the missions of the CDC in order to change its role to that of a Regional Security Coordinator (chapter 5).
- Describes the capacity building provided during the workshops (chapter 6).

### **0.3. Regional governance between the countries involved in the regional cooperation**

#### **At national level**

At national level, as a pre-requisite before implementing the regional cooperation on FRR, each System Operator needs to balance its own system in a maximum time of 15 minutes, which requires:

- accurate short-term forecast for demand and generation, including intermittent generation;
- a precise schedule for commercial cross border flows, on an hourly basis: as a first step, each System Operator shall calculate day-ahead the net value of flows which are exchanged at each border;
- flexible mechanism for adapting in intra-day and real time unit commitment to balance each area with connected balancing capacities within the area;
- the implementation of national mechanisms, in order to ensure that the SO has access to the available FRR capacities<sup>1</sup>, either by introducing obligations in the regulatory framework or by developing incentive solution such as national FRR market.

#### **At regional level**

At regional level, common technical rules need to be established to ensure a reliable operation of the interconnected system. It is recommended to include them in a document that could be called “Central Asia South Asia Operation Handbook”<sup>2</sup> (or CASA OH in this document).

In this context, it is also recommended to establish a regional security coordinator (RSC) which will be entrusted with the coordination of certain activities allowing a safe operation and with specific activities related to FRR cross-border procurement., the existing Coordinating Dispatch Centre “Energy” of the Central Asian Power System (CDC) is a good candidate to be entrusted with these missions.

To achieve a regional cooperation, a Multi-Lateral Agreement (MLA) needs to be signed between the governments of the countries that wish to enter this cooperation. For 2020 regional cooperation involves Kazakhstan, Uzbekistan, Kyrgyz Republic, Tajikistan and Afghanistan. Turkmenistan has an interest to join the cooperation Even if the same study shows that Pakistan does not benefit a lot from the cooperation on FRR, it may join it

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<sup>1</sup> as soon as generation facilities are owned by entities that are separated from the System Operator, there is a need for institutional or contractual arrangements establishing the conditions under which the SO has access to the necessary FRR.

<sup>2</sup> by reference to the “Operation Handbook” in force in Continental Europe.



Turkmenistan has an interest to join the cooperation for FRR cross-border procurement as soon as possible once synchronized with Uzbekistan (with high potential benefits from the regional cooperation as identified in Output 1 of this TA). Pakistan may join the cooperation to increase its security of operation (with specific operational rules due to HVDC connection) even if few benefits can be expected from cross-border exchanges of FRR.

The regional MLA shall:

- set the principles of the frequency control in the region:
  - FCR provided by Russia,
  - obligation for the member countries to balance their generation and demand in a time of 15 minutes after the occurrence of an imbalance (by activation of the FRR),
  - trade model for cross-border procurement of FRR;
- make the CASA OH mandatory for the countries signing the agreement;
- define the new missions and role of CDC in order to change its role to that of a RSC;
- define the governance rules for the validation of new propositions or the update of existing regional rules.

The regional MLA describes implementation guidelines for establishing, testing and applying common operational rules.

So as to enter the cooperation, governments shall make their national legal framework compliant with the MLA and the technical rules, under a predefined delay.

The Consultant suggests starting this cooperation by establishing a steering group, with suitable prerogatives; this steering group is proposed to be established within the entity that is already in charge of supervising the CDC<sup>3</sup>.

For this, the governance of CAC PC must be extended to countries that are willing to join this regional cooperation, with suitable financial and legal means.

#### 0.4. Common technical rules for the operation of the system

The establishment of a regional cooperation on FRR in 2020, based on a cross-border procurement mechanism, implies that the interconnected countries shall adopt and apply harmonized rules, that are prerequisites in terms of system operation.

Each country remains responsible for its own balancing, whether in real time or upstream and up to the stage of long-term development plans. With the development of the wind and solar generation, which means more fluctuations in the system, critical situations may occur in the future in periods very different than those currently observed (several combinations of peak/low demand, high/low RES generation ...). In order to cope with this increasing intermittence coming from RES growth and enable SOs to correctly balance their own system, it is essential to implement a **day ahead coordinated scheduling process** to track the **cross-border commercial exchanges** planned to be implemented between the countries, on an hourly

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<sup>3</sup> CDC suggests that this entity be the Coordination Commission of Coordination Electrical Power Counsel of Central Asia (CEPC CA or КЭС ЦА) which is a consultative body of the Chief Executive Officers of the energy systems forming the United Power System of Central Asia (ОЭС ЦА), and is established to coordinate implementation of divisions and instructions made by the CEPC CA.

basis. At the end of this process, a binding hourly commercial exchange schedule is established and decided, shared by each SO and CDC at different timeframes.

In real time, each country shall balance their generation and demand in a time of 15 minutes after the occurrence of an imbalance; to facilitate it, **each country needs to perform in advance adequacy studies**, thanks to accurate load and production studies upstream of real-time and at different time frames.

Countries also need to agree on rules for sizing of reserves. **Concerning FRR dimensioning**, it is recommended to introduce an obligation or a minimum procured FRR for each country that should be at least equal to the size of the largest unit of the country and have a full activation time under 15 minutes.

In order to keep the network in secure operating condition and to guarantee a suitable level of security and non-discriminatory market access, it is also necessary to set up a **coordinated process for maintenance outage planning** between generating units and transmission facilities of each country. This will enable to **determine the export/import capacity available to the commercial exchanges**. This capacity called **cross-border Net Transfer Capacity (NTC)** results from several components:

- the maximum transfer capacity of each cross-border line, based on the technical limits calculated by each country;
- the coordinated load flow calculation taking in account the regional loop flows between the countries;
- the margin for unpredictable deviations.

NTC will be in a first step a weekly value (one value for export and another one for import). It is recommended that CDC be entrusted with performing this calculation and with publishing the results.

If Pakistan joins the regional cooperation, specific operational rules will have to be developed for **countries connected by DC systems**.

### **0.5.Common specific rules and responsibilities for FRR cross-border procurement**

Each System Operator can acquire from another country of the regional cooperation a part of the Frequency Restoration Reserve (FRR) it needs for operating its own system.

It is recommended that the **procurement of cross-border FRR** (capacity reservation) be done on the basis of the offers made by each country for a fixed monthly amount of reserve (same amount of FRR acquired abroad all the month along). The Consultant suggests that the **CDC centralizes this process of selecting the cheapest offers**, matching needs and offers transmitted by SOs at minimum cost. If necessary, in a first step, countries can be authorized to procure FRR by bilateral agreements; however, such agreements should stop after the entry in force of the Multi-Lateral Agreement and shall be approved by the CDC.

SOs are responsible for requesting the **activation of the FRR** when they detect deviations in power flows between countries compared to schedules. SOs have the choice to activate their own national FRR or to activate cross-border FRR through a **centralised regional activation process performed by CDC**. In the latter, CDC, upon the SOs requests, will select the best offers and send instructions of activation to the relevant SOs. The requesting SOs (SOs that are not balanced) pay for the activation. This trading solution is a System Operator – System Operator « SO-SO » model:

- Each balancing reserve provider qualified to provide FRR has a contract with its connecting SO for the procurement of reserve;
- SO-SO multilateral agreements are contracted (or bilateral at the beginning).

A multilateral agreement is needed to set up these centralized processes, both for capacity reservation and activation. The consultant proposes to use the previous MLA as legal instrument for that.

Regarding the whole process, CDC is entrusted with:

- verifying that a part of the NTC is reserved for the activation of reserves,
- calculating and publish the overall transfer capacity available for commercial exchanges at each border, after the procurement process (capacity reservation),
- sending instructions to the providing SO for activating cross-border FRR,
- ensuring that activation of a cross border procured reserve is always possible without congestion.

The **settlement of power flows** should be calculated on an hourly basis comparing real time flows with schedules (including commercial exchanges and FRR activation). A weighted average price for the FRR flows will ensure a unique price of energy in real-time and will guarantee a pay-as-bid remuneration for the delivered energy.

The **settlement of procured capacity** shall be based on the bid prices of the procurement phase. A “weighted average price”<sup>4</sup>, will ensure a fair share of the benefits between SOs.

## 0.6. Proposed missions of CDC

The missions proposed to be entrusted to the CDC are i) missions of a Regional Security Coordinator, such as CORESO in Europe, aiming to guarantee a safe operation of the interconnected system and ii) missions related to FRR procurement. These missions are listed hereafter:

1. Regional non-binding network long term development plan
2. Short- and Medium-Term Adequacy Studies
3. Coordinated Security Analysis (including Remedial Actions-related analysis)
4. Outage Planning Coordination
5. Coordinated Capacity Calculation
6. Scheduling verification
7. Individual Grid Model / Common Grid Model delivery
8. Procurement of reserves
9. Real-time reserve activation
10. Settlement
11. Operational Training

In order to establish cooperation on FRR procurement, CDC should be entrusted with the centralized processes for the procurement of reserves including capacity reservation (mission 8), real-time reserve activation (mission 9) and settlement (mission 10).

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<sup>4</sup> Similar to the IGCC process in Europe

It is also recommended that CDC is responsible for the operational activities aiming to guarantee a safe operation of the interconnected system: outage planning coordination (mission 4), coordinated capacity calculation (mission 5), verifying the commercial scheduled flows between SOs on an hourly basis (mission 6). In the context of a regional cooperation, it is important that all national operators in each of the National Load Dispatch Centre (NLDC) and in CDC have the same level of knowledge so that they will all be able to ensure the safety of the network; thus CDC must reinforce its role in performing **regional** training for operators (mission 11).

As soon as CDC is equipped with suitable tools & IT system, its missions can be strengthened with regard to the following week-ahead services: short- and medium-term adequacy studies (mission 2) and coordinated security analysis (mission 3). These services will be based on accurate grid models: CDC shall be entrusted to define the Common Grid Model (mission 7).

It is also proposed to adapt CDC missions about long-term planning activities, entrusting him with the establishment of a regional non-binding network long term development plan (mission 1). This mission consists in helping the countries to elaborate a common indicative transmission long-term development plan, based on shared methodology and shared socio-economic scenarios; this will allow CDC to assess the regional generation adequacy and evaluate the needs in term of transmission system expansion. The CDC will focus particularly on cross-border infrastructure, the benefit of which can only be estimated through a simulation of the future conditions of operation across the entire region.

## 1. Introduction

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The present report on Output 2 is dedicated to the regional cooperation to be introduced between countries in which networks are connected. One of the main objectives of this regional cooperation is to enable each national System Operator (SO) to acquire a part of the Frequency Restoration Reserve (FRR) they need for operating their own system.

A first chapter (chapter 2) describes the cooperation framework that is recommended to set up between the countries of the region (the regional Multi-Lateral Agreement or MLA).

Common technical rules need also to be established, as part of this cooperation framework. A first set of rules aims to ensure a safe and reliable operation of the system (see chapter 3), and a second set of rules aims to enable the countries to acquire abroad part of the FRR they need (see chapter 4).

The following chapter (chapter 5) describes CDC missions in order to change its role to that of a Regional Security Coordinator.

The last one (chapter 6) reminds the capacity building provided to Working Committee members in the framework of this TA.

## 2. A cooperation with operational bodies between the countries involved in the regional cooperation

### 2.1. Context and objectives

A regional cooperation is proposed to be introduced between countries in which networks are or will be synchronized with Russia. This Regional Cooperation will enable each national System Operator to acquire from another country of the regional cooperation a part of the Frequency Restoration Reserve (FRR) they need for operating their own system.

The regional cooperation aims to:

- Ensure security of the electricity system;
- Integrate large-scale renewable energy generation;
- Develop a cooperation for common FRR procurement.

The efficient and safe management of such an interconnected electricity system requires coordinated rules and organizational bodies at regional level.

An approach based on the European experience is proposed.

For this purpose, a regional Multi-Lateral Agreement (MLA or Agreement) needs to be signed between the governments of the countries involved in the regional cooperation. For 2020 regional cooperation involves Kazakhstan, Uzbekistan, Kyrgyz Republic, Tajikistan and Afghanistan. Turkmenistan has an interest to join the cooperation as soon as possible between 2020 and 2025 once synchronized with Uzbekistan (the estimation of potential benefit of the regional cooperation carried out in Output 1 of this TA shows that Turkmenistan is one of the countries with major benefit from the cooperation). Even if the same study shows that Pakistan does not benefit a lot from the cooperation on FRR, it may join it to increase its security of operation it (with specific operational rules due to HVDC connection).

From the European experience, it is also of utmost importance to implement Regional Security Coordinators (RSCs) (such as CORESO in the western part of Europe) to fulfil the objectives of the regional cooperation. In the Central Asia South Asia region, CDC could be entrusted with new missions to ensure this coordination.

## 2.2. A Multi-Lateral Agreement to define the regional governance

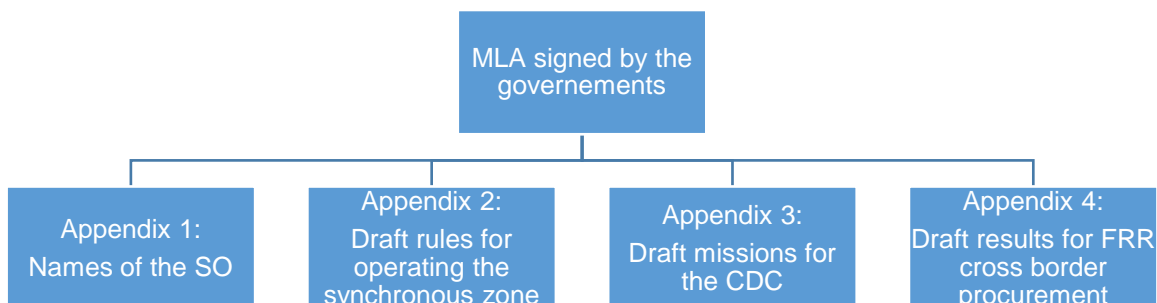
The MLA is an agreement proposed to be signed by the governments of the countries who wish to enter into this cooperation (see roadmap action 17).

It therefore intends to be mandatory for each of the signatory countries and for the SOs of these countries. It describes implementation guidelines for establishing, testing and applying common operational rules.

A prerequisite to FRR cross-border procurement is that common technical rules be established to ensure a reliable operation of the interconnected system in the framework of the regional cooperation. These rules are proposed to be included in a document that we propose to call “Central Asia South Asia Operation Handbook” by reference to the “Operation Handbook” into force in Continental Europe.

This Agreement consists of a main body and Annexes.

### 2.2.1. Content of the MLA



The MLA:

- sets the principles of the frequency control in the region: FCR provided by Russia<sup>5</sup>, obligation for the member countries to balance their generation and demand in a time of 15 minutes after the occurrence of an imbalance, trade model for cross-border procurement of FRR;
- makes the “Central Asia South Asia Operation Handbook” mandatory for the countries signing the agreement;
- define the missions and role of the regional security coordination centre (CDC);
- define the governance rules for approvals of new propositions or updating existing design.

The Appendix 1 contains the name of the System Operators involved in this cooperation; it is proposed to be in Appendix for it will make it easier for the countries in case of legal change such as unbundling process in a country.

The three following Appendices provide a framework for the preparation of final documents which, once approved, will be made mandatory for the System Operators and for the CDC:

- Appendix 2, “Draft rules for operating the synchronous zone” (detailed in chapter 3 of this report);
- Appendix 3, “Draft missions for the CDC”, includes the missions and role of the CDC: (detailed in chapter 5 of this report);
- Appendix 4, “Draft rules for FRR cross-border procurement” consists in the proposed rules to implement once the prerequisites are set up (detailed in chapter 4 of this report).

### **2.2.2. The common operational rules shall be made mandatory**

With view to the important nature of compliance with all system security operational provisions, the countries shall accept to comply with the methodologies, conditions and values adopted in line with the “Central Asia South Asia Operation Handbook”, to the extent they can enforce these requirements when taking into account their possibilities and responsibilities according to national law (see roadmap action 16).

The management of national transmission systems is regulated by national laws. Therefore, to enter the cooperation, the governments shall make their national legal framework compliant with the MLA, under a predefined delay (eg. 12 months) after approval of the CASA OH; once approved, the CASA OH is mandatory and is not subject to approval by any national regulation authority.

CASA OH will require a phase after approval, for both:

- Transitory phase;
- National law adaptation.

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<sup>5</sup> There is already a multilateral agreement on parallel work. But the proposed new MLA will not be concluded among the same countries, so it is not an addition to this existing agreement but another agreement.

### 2.2.3. Effectiveness of the cooperation ensured by Central Asia Coordination Power Council

The establishment of the cooperation starts by establishing a steering group, with suitable prerogatives. This steering group is proposed to be established within the Entity that is already in charge of supervising the CDC: the Central Asia Coordinating Power Council (CAC PC).

For this, the governance of CAC PC must be extended to countries that want to join this regional cooperation, with suitable financial and legal means.

On this basis, CAC PC is entrusted with the establishment of this cooperation and to set up in a predefined delay the steering group, in order to ensure the effectiveness of the cooperation between the countries.

The steering group has a permanent character and is responsible for establishing, and then setting up and functioning of the MLA.

In a first step, it will be in charge of writing the detailed rules of the document called CASA OH: rules for operating the synchronous zone, missions of the CDC, and rules for FRR procurement (based on the appendix 2, 3 and 4 of the MLA).

#### **Example provision regarding the Establishment of a permanent group within CAC PC**

*The CAC PC is responsible to set up and to establish a “Central Asia South Asia Steering Group” (CASASG) within its structure. The CASASG has a permanent character and is responsible for setting up and functioning of this Agreement;*

*The CAC PC has to adopt Terms of Reference of the “CASASG by two (2) months after entry into force of this Regulation, in order to ensure the effectiveness of the cooperation within the countries;*

*The CASASG will analyse the needed evolutions of the CDC missions and establish the new rules for their missions; these new missions are established according to Appendix 3: “Evolution of missions of the CDC”;*

*The CASASG will write the operational details of the CAO H and establish the final document, according to Appendix 2: “Draft CAO H”;*

*The “CASASG will monitor and analyse the implementation of the “New missions for CDC” and the “Central Asia Operation Handbook”.*

*The CASASG is composed of:*

- *1 representant per country of the Electricity System Operators (SO);*
- *1 representant per country of the Governments;*
- *1 representant of the CDC Energia.*

### 2.2.4. Implementation guidelines for establishing, testing and applying common operational rules

The MLA shall include implementation guidelines (see roadmap action 15.1) which will describe the 4 following phases:

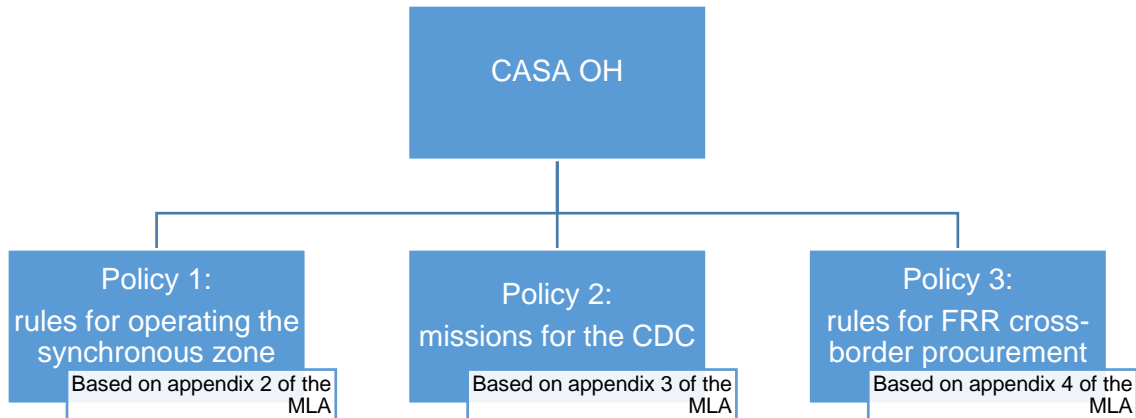
Phase 1 - Preparation phase:

It begins with the signing of the MLA, which will consist in establishing the steering group. It ends when the steering group is in force.

Phase 2 - Implementation phase:

It consists in the preparation of all detailed rules of the CASA OH by the steering group, that will be made mandatory for countries. This implementation phase ends when the detailed rules of the CASA OH have been approved. An implementation phase can be organized for each part of the CASA OH. In a first step it will consist in 3 main Policies, with possibility to add but additional Policies in further steps.





**Phase 3 – Transitory phase:**

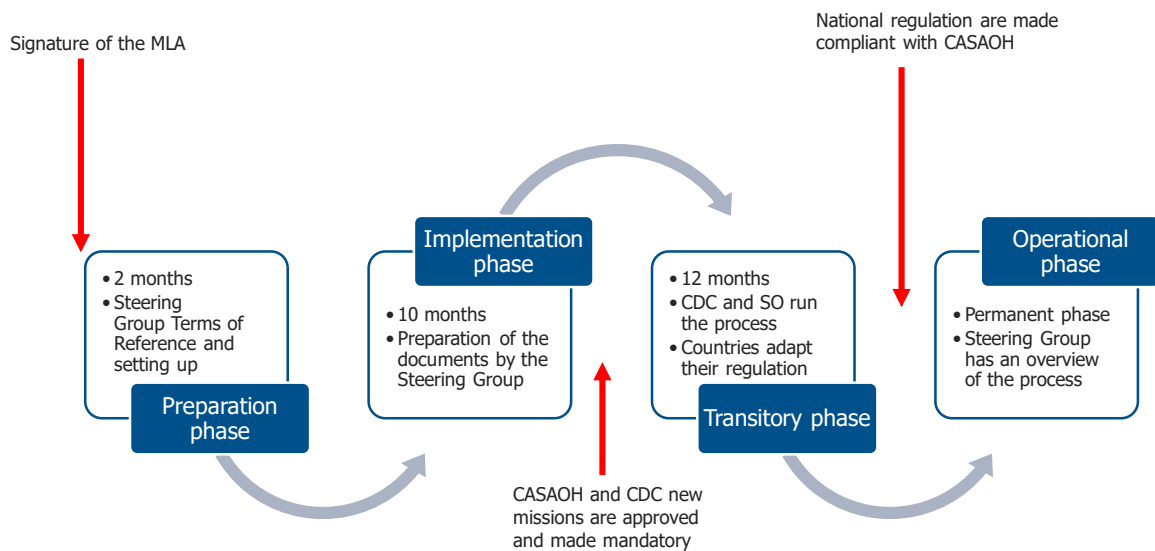
During a predefined delay:

- Countries' SO and CDC will run the process according to the approved Policies; if needed, SOs and CDC can jointly develop and agree on methodologies, conditions and values necessary to apply the CASA OH;
- countries will adapt their national regulation: at the end of this period, all national regulation are made compliant with the CASA OH Policies.

**Phase 4 - Operational phase:**

It is a permanent phase during which the steering group will be in charge of the process supervision.

**Example of implementation Guidelines to be included in the MLA**



On the date of the signing of this MLA, each government shall submit to the CAC PC secretariat the name of the SO, and the proposed members for the steering group.

The CASA OH contains obligations which countries are to comply with.

The MLA contains provisions regarding the liability of the countries in case of non-compliance.

### **Example provisions regarding the liability in case of non-compliance**

*The Parties agree to fully comply with the provisions of this Agreement and with all duties and obligations arising therefrom.*

*The Parties acknowledge that the CASA OH contain either obligations which the Parties are to comply with and non-compliance is subject to accountability and liability in accordance with this Agreement.*

*The Parties acknowledge that Breaches of the CASA OH may be addressed by the competent authorities under the applicable Uzbek legal framework. Any intervention of competent authorities shall be without prejudice to a Party's right to use the dispute settlement mechanism.*

## **2.2.5. Governance of the steering group**

The countries will cooperate in view of achieving the objectives of this MLA by means of the steering group which is the main decision-making body comprising representatives of the governments, with all necessary power and authority to take decisions binding upon their respective entity as far as strategic, organizational, operational and financial aspects under this MLA are concerned.

In particular, the countries will have to decide the financial and legal means of the steering group.

### **Example provisions regarding the steering group**

*The Parties agree that they will cooperate in view of achieving the objectives of this Agreement by means of the steering group which is the main decision-making body comprising representatives of the Parties, with all necessary power and authority to take decisions binding upon their respective entity as far as strategic, organizational, operational and financial aspects under this Agreement are concerned. The steering group has the power to create further sub-groups, working-groups, drafting groups or supporting bodies as it deems necessary, in accordance with the Central Asia Steering Group Terms of Reference.*

*The steering group may, upon the request of one or more Parties, carry out investigations or conclude on an alleged Breach and impose a penalty on a Defaulting Party.*

*Depending on the content of an Amendment Proposal the steering group may forward the Amendment Proposal and allocate the task to the CDC or to a SO.*

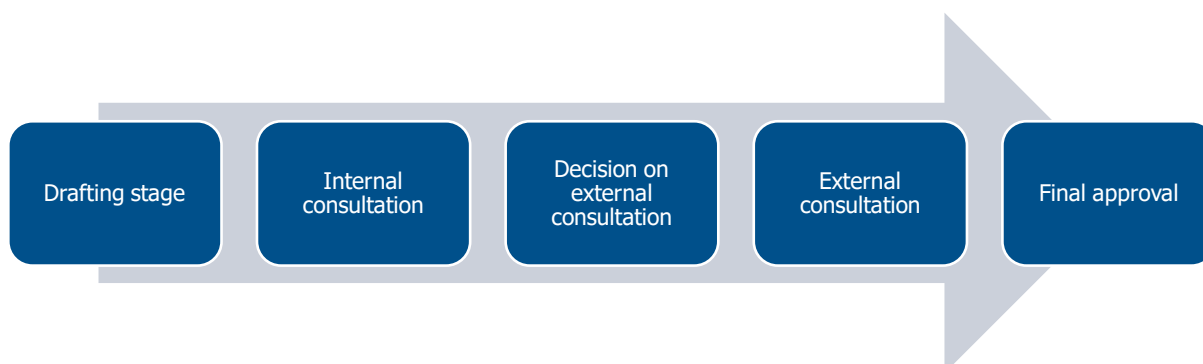
*Any decision can be taken by the steering group or any CAC PC body in meetings, conference calls or by circular resolution via e-mail according to the Central Asia Steering Group Terms of Reference, unless otherwise provided in this Agreement.*

*A SO can be a member of the steering group but not a Party to this Agreement shall not have voting rights with respect to any decision of the steering group that is governed by this Agreement.*

## **2.2.6. Regional rules implementation steps**

The steering group is in charge to prepare all the documents that will be made mandatory for countries. This implementation phase ends when all documents have been approved.

The implementation phases shall be described in the MLA and shall contain the five following steps:



### **STEP 1 - Drafting stage**

The steering group prepares the table of contents and a 1st draft of the Policy of the CASA OH, based on the Appendix 2, 3 and 4 then it presents the 1st draft for internal consultation.

### **STEP 2 - Internal consultation**

Comments on the 1st draft will be solicited from the concerned SOs. Based on the comments, the steering group prepares the 2nd draft of the Policy.

### **STEP 3 - Decisions on external consultation**

The 2nd draft must be approved by the steering group before presenting it for external consultation.

### **STEP 4 - External consultation**

Once the Policy is approved for the external consultation, it is published, and the external consultation process starts. The consultation period may last 1 or 2 months. Duration of the consultation process will be determined by the steering group. Comments on the 2nd draft will be actively solicited from all registered participants<sup>6</sup>. Based on its own review, the steering group revises the draft Policy as needed.

### **STEP 5 - Final approval**

The steering group approves the Policy and sends the final draft.

### **Policy implementation**

Once the steering group approves the Policies, all members are expected to implement and follow the Policy in accordance with national regulation, after the Transitory Phase.

An implementation phase can be organized for each part of the CASA OH.

## **2.2.7. Operational phase**

One of the main objectives of the CASA OH is to enable the SOs involved in this MLA to acquire FRR from any country of the cooperation with a cross-border procurement process.

In a first step, CASA OH needs to allow SOs to conclude bilateral contracts concluded between them, on a voluntary basis.

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<sup>6</sup> Large consultation is recommended from organization and external stakeholders, who expressed an interest in becoming involved and who had relevant expertise: institutional parties, private companies, associations...

The CASA OH may evolve in a later phase towards the implementation of a “centralized process” which date of implementation is decided by the steering group.

The MLA contains provisions regarding the confidentiality.

#### **Example provisions regarding cross border procurement**

*The CASA OH enables the SOs involved in this agreement to acquire FRR with a cross-border procurement process; to the extent that they will not come to disrupt the future cross-border procurement mechanism. Thus signature of bilateral contracts will be subject to the validation of the steering group.*

*The CASA OH may evolve in a later phase towards the implementation of a coordinated process which is presented for FRR cross border procurement in Appendix 4;*

*Pending the implementation phase common cross border procurement planned at a later stage, the SOs are authorized to enter into cross-border FRR agreements.*

#### **Example provisions regarding the confidentiality**

*Information considered as confidential shall include all commercially sensitive information clearly marked as “confidential” and information which by its nature must be considered or qualified as confidential*

*No recipient of confidential information shall use or otherwise process the confidential information obtained by it pursuant to this MLA for any purpose except as strictly required for the performance of its obligations hereunder or disclose any such information.*

*The SO are obliged to organize their data handling in such a way as to minimize the risk of unauthorized access of confidential information.*

*Nothing herein shall prevent a Party from disclosing confidential information (i) upon the order of any court or administrative agency, (ii) upon the request or demand of, or pursuant to any regulation of any competent regulatory agency or authority.*

### **2.3. Amendments on the existing multilateral agreements**

Existing agreements already in force are not fundamentally questioned; rules for operating parallel operation of CAPS with the UPS system are still necessary with this cooperation. However, special attention should be given to some points (see roadmap action 18):

1/ CDC was previously in charge of establishing the regional system long term planning. This mission remains among CDC responsibilities in the existing multilateral agreement even if each country is now planning and developing its own system independently, with few or no coordination with CDC. It is recommended that multilateral agreements recognise the responsibility of each country to develop its own national power system, the CDC playing a role of coordination and facilitator for the optimization of cross-border infrastructure (see roadmap action 19).

2/ Russia provides FCR for the Unified Power System (UPS) and therefore for the countries involved in the regional cooperation. This measure remains compliant with the proposed rules for FRR regional cooperation. It will be necessary to make sure that further evolution of the agreement with Russia is consolidating this rule.

It is therefore proposed that the steering group in charge of the establishment of the rules (see roadmap actions 15.2 and 15.3) analyse the need for adaptation of existing rules regarding these subjects.

### 3. Common rules and responsibilities for operating the system

At national level, as a pre-requisite for implementing the regional cooperation on FRR, each System Operator needs to balance its own system in a maximum time of 15 minutes after a disturbance, which requires:

- accurate short-term forecasts for demand, generation and for intermittent generation;
- a precise scheduling for commercial cross border flows, on an hourly basis: as a first step, each System Operator shall calculate day-ahead the net value of flows who are exchanged at each border;
- flexible mechanism for adapting in intra-day and real time unit commitment to balance each area with connected balancing capacities within the area;
- the implementation of national mechanisms in order to ensure that the SO has access to the available FRR capacities<sup>7</sup>, either by introducing obligations in the regulatory framework or by developing incentive solution such as national FRR market.

The establishment of a regional cooperation on FRR in 2020, based on a cross-border procurement mechanism, implies that the interconnected countries shall adopt and apply harmonized rules, that are prerequisites in terms of system operation.

Each country remains responsible for its own balancing, whether in real time or upstream and up to the stage of long-term development plans. With the development of the wind and solar generation, which means more fluctuations in the system, critical situations may occur in the future under several scenario combination (peak/low demand, high/low RES ...).

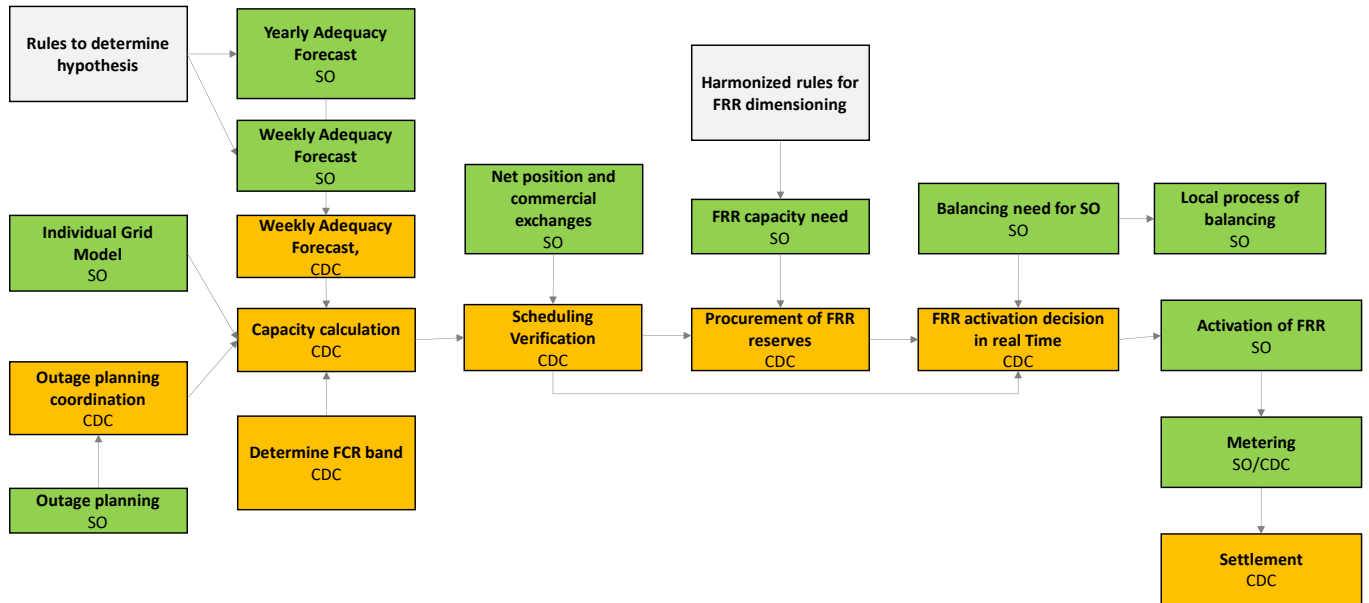
In real time, each country shall balance their generation and demand in a time of 15 minutes after the occurrence of an imbalance; to do so, each country shall perform its own adequacy studies, thanks to accurate load and production studies upstream of real-time at different time frames. Countries also need to agree on rules for sizing of reserves. Concerning FRR dimensioning, it is recommended to introduce an obligation or a minimum procured FRR for each country that should be at least equal to the size of the largest unit of the country. The procured FRR should have a full activation time within 15 minutes.

In order to keep the network in secure operating condition to guarantee a suitable level of security and market access, it is also necessary to ensure coordination of the maintenance outage planning between generating units and transmission facilities of each country, by a coordinated process. This will enable to determine the Capacity calculation (NTC).

In order to cope with this increasing intermittence coming from RES growth and enable SOs to correctly balance their own system, it is essential to implement a **day ahead coordinated scheduling process** to track the **cross-border commercial exchanges** planned to be implemented between the countries, on an hourly basis. At the end of this process, a binding hourly commercial exchange schedule is established and decided, shared by each SO and CDC at different timeframes.

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<sup>7</sup> as soon as generation facilities are owned by entities that are separated from the System Operator, there is a need for institutional or contractual arrangements establishing the conditions under which the SO has access to the necessary FRR.



Overview of processes, links and responsibilities

### 3.1. Adequacy forecast

#### 3.1.1. Objectives

To meet the demand and to face RE generation intermittency, the System Operator needs to perform an accurate and reliable unit commitment in day-ahead and intraday.

#### 3.1.2. Proposed solution

SOs need to introduce more accuracy and reliability in their unit commitment process (day-ahead).

It is also recommended to update the load forecast and RES generation forecast in intra-day, and to make the relevant adaptation of the unit commitment in intra-day and real time. To do so, SOs need to have available tools and rules and shall adopt the following measures:

1. forecast the demand and intermittent generation at different timeframe (day-ahead and intraday) and perform the unit commitment to meet the demand;
2. schedule at least day-ahead the commercial cross-border flows, on an hourly basis;
3. adopt flexible mechanism to modify cross-border exchanges of energy in intra-day and real time harmonized with common scheduling rules defined in the framework of regional cooperation and with FRR cross-border trading arrangement.

#### 3.1.3. Main steps

It is recommended that Afghanistan (DABS) and Kazakhstan (KEGOC) set up a demand forecast process and a unit commitment process, at least daily. If necessary, this new prerogative will have to be incorporated in regulation, that shall be adapted in accordance with this function.

In the present situation, KEGOC does not make its own demand forecasts as it is not part of its missions that are given by the Ministry of Energy of Kazakhstan. KEGOC only collects and compiles demand forecast provided by suppliers, distribution and industrial companies. The unit commitment is done day-ahead by producers. KEGOC does not interfere in the generation and demand forecast, and in real time, Russia provides or absorbs the differences between load and generation. The first step of improvement for Kazakhstan should be that the producers be more responsible for meeting the demand by performing a precise day-ahead commitment of their own units. The second step of improvement could be that KEGOC operates in intraday the balancing mechanism that is still under simulation mode at the present time.

In Afghanistan, as soon as import capacity is enough to supply the demand (by 2025), implementing a demand forecast process will be necessary to have a reliable schedule of the commercial exchanges on the interconnections.

Turkmenistan, Kyrgyzstan, Tajikistan and Uzbekistan already have their own forecasting rules and methods and make forecasts that need to become more and more reliable. Concerning unit commitment, they also have their own processes. Each country shall monitor these processes to ensure their gradual improvement. It is of the utmost importance that each country be able to carry out accurate forecasts and balance production with demand and commercial exchanges at all times.

Pakistan is not interconnected yet but should adopt similar rules to prepare the CASA-1000 project arrival by 2022. Pakistan already has its detailed rules for demand forecast, and for unit commitment at different timeframes; but these rules shall be detailed for day ahead unit commitment.

The improvement of these processes is a prerequisite to the implementation of a regional cooperation as summarised in the roadmap action 7.

## **3.2. Outage coordination**

### **3.2.1. Objectives**

The interconnected countries involved in the cooperation shall develop a regional outage coordination process.

In order to keep the network in secure operating condition to guarantee a suitable level of security and market access, it is necessary to regularly carry out maintenance or reinforcement works which requires outages of assets. Every SO has to develop its own operational planning organisation, and CDC must be entrusted with verifying that the planned outages do not interfere with the safety of the interconnected system and that all planned outages are compatible.

The outage coordination process starts approximately one year before actual operation.

### **3.2.1. Proposed solution**

It is proposed to entrust CDC with developing and then managing a regional outage coordination process. This mission is detailed in in chapter 5 – CDC mission 4. It is also detailed in the roadmap action 8.1.

### **3.3. Cross-border capacity calculation**

#### **3.3.1. Objectives**

The objective of a cross-border capacity calculation is to define the limit of the flows that could be exchanged between countries for each process (commercial, balancing). This calculation shall be performed before all the other processes, and both the commercial scheduling exchange process and FRR cross border procurement process shall include these limits as hypothesis. The objective is to avoid the capacity of the interconnection lines being saturated by the energy exchanges planned to supply the load, and that the reserves which the countries will have planned to procure via a cross border cooperation can no longer be activated, for lack of reserved capacity on the interconnections.

The calculation of the cross-border Net Transfer Capacity (NTC) needs several inputs:

- the maximum transfer capacity of each cross-border line, based on the technical limits calculated by each country;
- the coordinated load flow calculation taking in account the regional loop flows between the countries;
- the capacity needed to ensure that FCR flows do not saturate the cross-border lines;
- the margin for unpredictable deviations.

#### **3.3.2. Proposed solution**

The interconnected countries involved in the cooperation shall adopt and apply net transfer capacity calculation process, coordinated by the CDC: a centralized process will be more efficient as it allows to perform calculations with all the regional data.

The process of capacity calculation deals with the determination by SOs of cross-border capacity available to the market. However:

- due to the changing pattern of trade, congestions are likely to appear suddenly in any part;
- the mechanism of cross-border procurement of reserve will also reduce the available transfer capacity;
- the process shall ensure that the primary reserve provided by Russia can be delivered without congestion to each country of the cooperation.

Thus, capacity calculation should cover every interconnection and hence the maximum set of plausible situations to come. Due to the complexity of transit flows and interactions between areas, the capacity calculation process shall be coordinated. The accuracy of the capacity calculation depends on the availability of reliable information about each SO's network system, including expected load and generation patterns.

A particularity of a cross border interconnection is that the two sides of the line is operated by two different companies from two different countries. Most of the time, each country owns the part of the line that is on its territory. Thus, Each country is responsible for defining the maximum transit and operating characteristics according to its own constraints (material, environmental, regulatory, etc.) in each time range..

In order to avoid miscomprehension between different SO leading in a possible deterioration of the system safety, it is necessary to share information on operation rules.



Particularly, the following operational limits shall be shared with CDC<sup>8</sup> for each interconnection:

- Permanent Admissible Transmission Loading (PATL): the loading that can be accepted by a network branch for an unlimited duration without any risk for the material,
- List of outages that are part of the local “N-1 rule”,
- Main characteristics of the grid
- Planned outages as result of the outage coordination process (see chapter 3.2).

For the long term target, it is recommended that the process consists in:

- An annual calculation of the minimum NTC that will be available for the whole year,
- A monthly calculation of the minimum NTC that will be available for one whole month.
- A final calculation of day “D” values in a D-2 process, to be as close as possible of the Day ahead scheduling process,
- A process (yearly, monthly, daily) of NTC calculation following these steps:
  1. Each SO share its network characteristics with CDC (outage, PATL on interconnection lines, consumption forecast, generation shift key)
  2. CDC calculates NTC for import and export according to a shared methodology (see below)
  3. CDC shares the results
  4. Each SO shall validate the values or propose new values
  5. CDC publish the results (all NTCs) for the cooperation area.
- setting one couple of values of NTC (import and export) for each hour of a daily period.
- implementing PATL on the interconnection lines, by limiting the power exchange to the PATL in normal and in outage situations.

The NTC is the capacity value for commercial flows, but it differs from the real flows in case of loop flows (see appendix 1).

It must be ensured that when countries establish commercial bilateral contracts, the corresponding energy exchanges are feasible given the interconnection capacity. For this purpose, a yearly capacity calculation process and a monthly capacity calculation process should be implemented to ensure that “long term” commercial bilateral contracts are feasible.

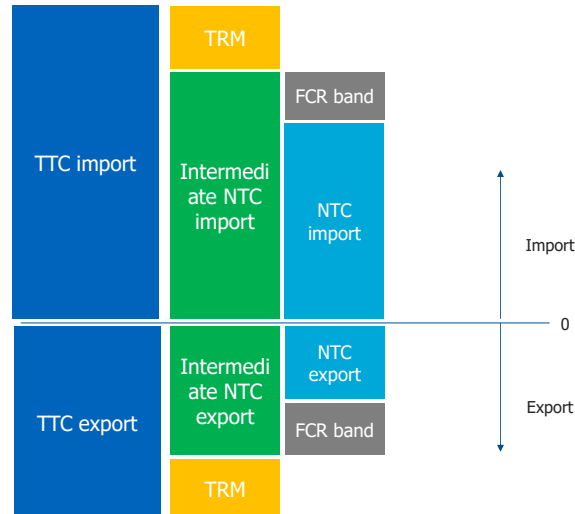
It implies that CDC shall know the commercial exchange (in MW for each period) and gives its agreement for each signed bilateral contract. If the capacity is not sufficient, the CDC shall formulate warnings and recommendations.

### **Net Transfer Capacity (NTC) calculation including margins**

Each NTC value shall include a margin for uncertainties and a band for FCR flows to ensure safety in real time.

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<sup>8</sup> If these rules are shared directly between the SOs, it will be easier during real time operation to prepare and take the better remedial actions. It will also be easier to understand the behavior of the neighboring SO if a failure occurs.



### Calculation of the FCR band

The FCR band is determined annually by the CDC and validated by SOs. The calculation is determined by calculating the maximum amount of upward and downward FCR flows coming from Russia that can go through an interconnection. As the FCR is procured by Russia permanently, it is not necessary to adapt the FCR band frequently.

The calculation of the FCR band shall take in account multiple unit tripping according to the existing rule for dimensioning the FCR.

### Calculation of the Transmission Remaining Margin (TRM)

The TRM is determined annually. The proposal is to fix the TRM so that the deviation seen between real-time flows and the scheduled flows (commercial + FRR + FCR) do not overshoot a determined value. This value is set to 95% of the time in Europe and is proposed to be taken as a reference.

#### *Proposed Methodology*

The proposal is:

1. Calculation of [Scheduled flow – Real Time Flow] during one year
2. In 95% of the situation, the gap between the 2 values is under a value that we call TRM (annual value)
3. Thus the TTC value is reduced of the TRM value.

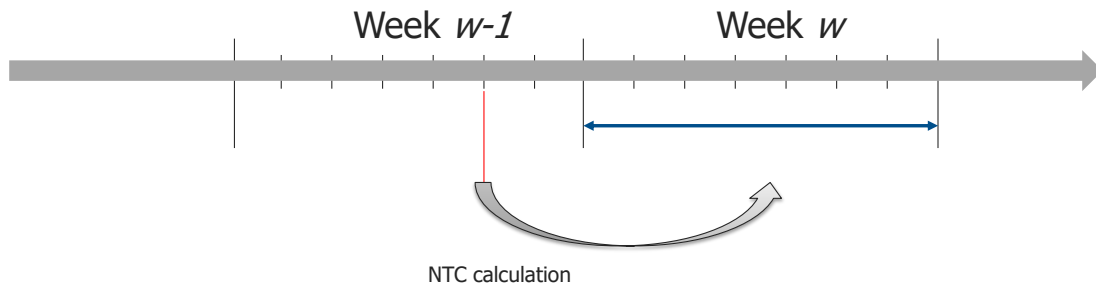
Consequently, 5% of the time, of the real flows will be over the TRM (but not necessary over the TTC, depending of the commercial use of the interconnection).

### **3.3.3. Main steps**

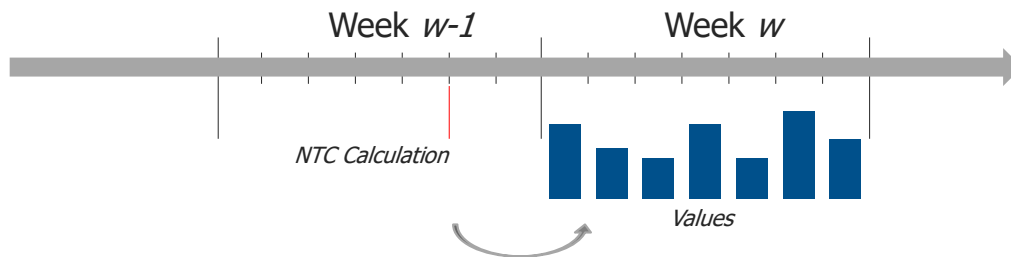
The process is proposed to start with a weekly calculation (action 8.3): NTC will be a weekly couple of values (one value for export and another one for import), calculation being performed and published by CDC.

In order to reach a D-2 capacity (action 8.4) calculation process, a step by step approach could be:

1. NTC calculated in a weekly process with one couple of values (import and export) for each calculated week,



2. one calculation per week with one couple of values of NTC per day (NTC vary depending on planned outages).



3. weekly calculation with 2 couple of values “peak” and “off peak” per day,
4. weekly calculation in D-2 before the first day of the next week,
5. D-2 calculation with one couple of values per day.
6. D-2 calculation with one couple of values per hour.

The first calculation of the TRM using the proposed methodology needs a data collection that is unavailable until a one year historical. In the first year after entry in force of the cooperation, a 20%<sup>9</sup> margin shall be applied by the CDC (see roadmap action 8.2).

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<sup>9</sup> Value agreed in May 2019 in Almaty which is a requirement of Policy guidelines for the calculation of sustainability, common to all energy systems of the CIS UES “Common Independent States Unified Energy System” / EЭC ЧИГ (value used in Central Asia in 2019 to take the dynamics constraints into account).

### **3.4. Scheduling and accounting rules for cross-border commercial exchanges**

#### **3.4.1. Objectives**

The objective is to exchange reserves between the countries and to monitor the balance between generation and demand in each country. It is necessary, beforehand, to define common rules for commercial cross-border exchanges (day ahead and intra-day).

The scheduling is a prerequisite process as:

- It is used to determine the available transmission capacity available for FRR cross border procurement,
- In the back-office process, it is used to calculate the difference between commercial schedules and physical flows and then settle unintentional deviations (compensate the programs afterwards to what they should have been).

#### **3.4.2. Proposed solution**

The interconnected countries part of the cooperation shall adopt the following processes.

##### **Preparation of commercial exchange schedule**

Concerning commercial exchange schedule, a first step is for all the countries to have the same time step for buying and selling energy.

At the end of this process, a binding hourly commercial exchange schedule shall be established and decided, shared by each country and CDC at different timeframes: this exchange is necessary and binding at a daily and day-ahead basis.

##### **Gap analysis:**

Today, exchanges are defined on monthly or annual bilateral contracts between the countries: they usually specify annual values for energy exchange, price, and how this program is adapted at the different time frame.

##### **Commercial exchange schedule monitoring**

In an interconnected region, different countries are able to perform commercial exchanges with each other. Then, every country will prepare its own commercial exchange schedule to prepare the real time operation and make sure that the generation-demand balance is fulfilled on its own perimeter. Following this, the generation-demand balance shall be verified within the whole interconnected area.

It is highly recommended that an independent entity shall be responsible to verify that all commercial exchange schedules of the interconnected area match together and are compatible. The objective is to verify that all individual schedules are correct and that, at the end, the forecasted generation-demand balance is correct.

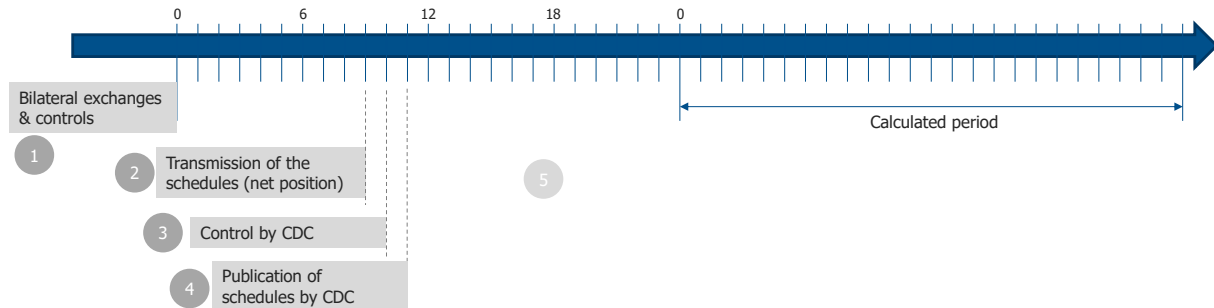
It is recommended that countries involved in the cooperation designate CDC as the entity in charge of the compliance of the commercial exchange schedule.

##### **Publication of the Available Transfer Capacity (ATC)**

It is recommended that countries involved in the cooperation designate CDC as the entity in charge of the calculation of the Available Transfer Capacity (ATC).

## General process

In detail, the proposed process is a day ahead process, centralized by CDC and performed in the D-1 morning.



## Detailed process:

1. Each SO needs to exchanges data and to agree on the amount of energy that would be exchanged each hour for day D.
2. each SO transmits to CDC, the net position of his area, and each use of capacity border (commercial)
3. CDC controls that:
  1. The net value for the cooperation area is 0, and then define new value that permit matching → rules have to be determined (based on data exchanged)
  2. The NTC is over the scheduled exchanges
4. CDC publishes hourly values for:
  1. Commercial Schedules
  2. ATC
5. A sufficient free period after the scheduling process and real-time operation is needed to enable the FRR cross border procurement process.

### 3.4.3. Main steps

This process is already being executed in the CDC but only for maximum load hour. As this process is a prerequisite for the other processes, it must be quickly implemented on a hourly basis.

The first step is to prepare the regional process to:

- Ensure that each SO has a national process to allow a process of unit commitment (self-dispatch with generation programs or central dispatch),
- Ensure that each SO produces good forecasts (especially demand and RES),
- A harmonization of the timeframe for selling and buying energy : in order to cope with intermittence, it is essential that each System Operator shall perform scheduling of the net value of flows who are exchanged on the energy market at an hourly basis, in day-ahead time (see roadmap action 7.1),

The second step that CDC performs the regional scheduling verification process (see roadmap action 7.2).

### **3.5. Harmonized rules for FRR dimensioning**

#### **3.5.1. Objectives**

In a context of regional cooperation, countries must agree on harmonized definitions on the products, the term of use, and on the minimum sizing of FRR. Then it must be ensured that these rules are respected by a compliance monitoring.

#### **3.5.2. Proposed solution**

##### **FRR dimensioning**

Concerning FRR dimensioning, it is recommended to introduce an obligation for the minimum FRR required procurement<sup>10</sup> in each country.

The recommended rule consists in having an amount of FRR at least equal to the size of the biggest unit of the country, and having it activated in 15 minutes. The dimensioning rule used in the chapter 1 of this report is more complex and precise: the loss of the biggest unit is compared to the reserve required to face 99,9% of the situations and the final requirement is the maximum value between these two criteria. For an operational rule, the probabilistic approach seems too complex to be used in daily operation and the adoption of a more simple and robust approach based only on the loss of the biggest unit is recommended. However, each SO remains free to use a more complex criterion if it considers that this approach can lead to a better level of security for the operation of the system.

This rule is already defined for Kazakhstan but should also be defined in national rules for Afghanistan, Kyrgyzstan, Tajikistan and Uzbekistan.

Pakistan has a similar rule in its Grid Code which requires the containment reserve (cold reserve) to be equivalent to the biggest generation unit (660MW) and to be available quite fast (15-30 minutes).

##### **Compliance monitoring**

The generation of power units connected to the interconnected network needs to be controlled and monitored for secure and high-quality operation of the synchronous areas. The load-frequency control, the technical reserves and the corresponding compliance monitoring are essential to allow transmission System Operators to perform daily operational business.

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<sup>10</sup> The procurement could be done in another country according to the common rules.

Control actions are performed in different successive steps, each one with different characteristics and qualities, and all depending on each other:

- Frequency Containment Reserve,
- FRR,
- Replacement Reserves.

### **3.5.3. Main steps**

The main step is to set the rule for the entire Region. In a second step, all the countries must be ensured that national processes are set:

- to monitor that the procured FRR reserve respect the dimensioning rule (see roadmap action 6.1) and
- to ensure that each generating unit comply with regulatory and contractual requirements. Any deviation from these requirements may affect the safety of the electrical system. Thus, it is recommended to carry out periodic checks (forecast and real-time), which requires to introduce a compliance monitoring process and to publish the results of control activities (see roadmap action 6.2).

## **3.6. Harmonised training program for dispatchers**

### **3.6.1. Objectives**

Appropriate training of real time operators is a crucial element of the security of the whole power system.

A standard framework for operational training ensures that the dispatchers of all the countries involved in the regional cooperation have and hold up the knowledge and skills to operate the power system in a safe and reliable manner under all conditions and at all time. It also gives feedback about the quality of the procedures and skills of the dispatchers especially in case of procedures in real time cross-border operation, which are applied rarely.

### **3.6.2. Proposed solution**

The 7 countries shall adopt and apply harmonized rules operators training curriculum.

In particular, this training should be focused on interoperability issues between countries, to prepare and realize and coordinated remedial actions required in normal and emergency operation.

The operators shall be trained in the language that they will use in real time, with neighbouring countries and with CDC.

The establishment of homogeneous shared training enhances the understanding and application of common rules, which is more and more necessary when cooperation between

the countries increases, and when intermittence of the energy increases. Therefore, it is proposed to reinforce the cooperation that already exists on training.

### 3.6.3. Main steps

It is first recommended to design a common training curriculum for the operators and organize periodic regional trainings (see roadmap action 10). In a further step, a Dispatcher Training Simulator (DTS) could be used to improve the trainings.

General recommendations are provided in the report “Dispatching Operation Practice Assessment – annex to report for Output 1 – task 1b/” – October 2018” and should be used as a guide.

The training cursus must be updated regularly, according to the evolution of FRR procurement process and missions of the different SO.

## 4. Common specific rules for FRR cooperation at a regional level

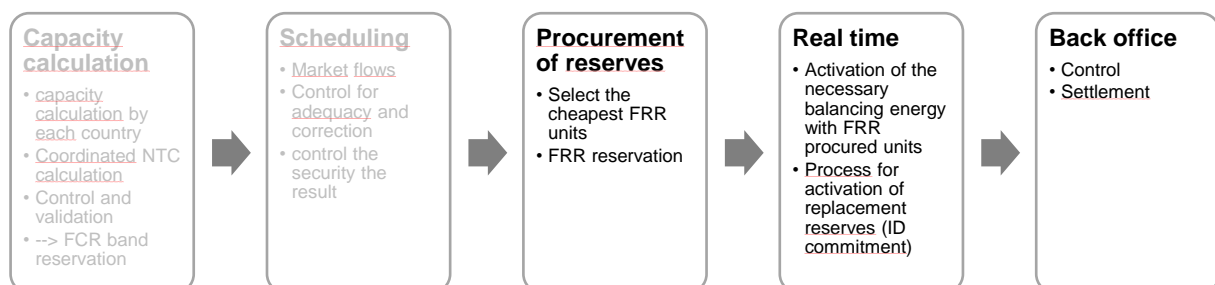
Each SO can acquire from another country of the regional cooperation a part of the Frequency Restoration Reserve (FRR) it needs for operating its own system. At a glance, a FRR cooperation process is composed of three main parts:

- The procurement of reserves (capacity reservation), to ensure the availability of FRR reserves at the power plants but also, in case of cross border procurement of reserve, the permanent availability a sufficient amount of transfer capacity on interconnection in case of FRR activation,
- The real time process, which consist of forecasting, for each area, the needed balancing energy and with a netting of the needs, lead to an activation of the cheapest (in \$/MWh) FRR units offered to the cooperation,
- A back-office process to determine the amount of exchanged energy in each process (commercial, FRR and unintended flows) and settle this flows.

This process needs therefore two ongoing process as a prerequisite:

- a robust capacity calculation made before the first step of the process (see chapter 2.3);
- a scheduling verification process for the regional area (see chapter 2.4).

These two prerequisites are necessary to avoid NTC limits violation in the balancing process with a previous calculation of the grid capacities, and the commercial flows scheduled.





Another prerequisite is that each SO determines the amount of FRR to be procured but it out of this operational process.

Target conditions for markets structure and financial compensation for ancillary service providers are proposed and a review of how balancing capacity reserve's contribution is compensated, in case private sector and IPP contributes to maintaining system frequency.

## 4.1. Trade model for cross-border procurement of FRR

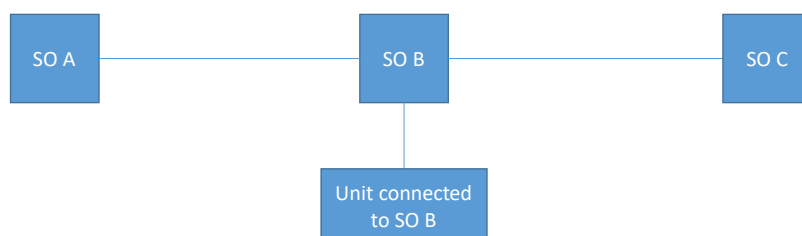
### 4.1.1. Objectives

A market solution is proposed to be introduced by year 2030, enabling balancing reserve providers to offer sufficient amount of reserve capacity.

### 4.1.2. Model based on SO-SO agreements

The scheme to provide cross border reserve is proposed to be a System Operator – System Operator « SO-SO » model:

- Each balancing reserve provider qualified for the FRR process has a contract with its connected SO for the procurement of reserve,
- SOs have agreements together.



There is no contract between balancing reserve provider connected with SO A or SO C. For activating a unit connected to SO B, SO A or SO C has to request an activation to the SO B through a centralized entity.

#### Benefit of SO-SO agreements over multiple bilateral agreement

A SO-SO agreement for the procurement of reserve allows all SO to access the most efficient capacities, with a fair access to the cheapest reserves<sup>11</sup>.

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<sup>11</sup> in a BSP-SO (Balancing Service Provider – SO) model, SOs contract directly with capacity owners, even in cross border. Then all SOs will want to procure the reserve from the cheapest unit and the first SOs to agree arrangements with them will capture most of the benefits of the process in an unfair way.

In a SO-SO agreement model, it is necessary to set a centralized process of activation. This centralized process in real time ensures an economical activation of the procured reserves, as a merit order of all of the contracted capacity can be done.

### 4.1.3. Main steps

As the target model should be reached in some years, a simplified frame could be set to allow cross border procurement with benefits.

Each of the interconnected country can undertake discussions with other SO according to the proposed framework.

Bilateral agreements between SOs could be enforced for providing FRR (see roadmap action 11.1). These bilateral agreements should be submitted to approval of CDC, to ensure a further integration in a centralized process. The bilateral contracts shall:

- Respect the frame of a SO-SO agreement (no contract between SO and balancing reserve provider connected to another SO),
- Ensure a process of activation performed by the CDC,
- Lapse after the entry in force of the Multi-Lateral Agreement.

## 4.2. Centralized process of procurement of the FRR reserves (before real time)

### 4.2.1. Objectives

A centralized process for the cross-border procurement of FRR maximizes economic benefits in a cooperation framework with multiple SOs by selecting the most efficient qualified balancing reserve provider for FRR regional procurement.

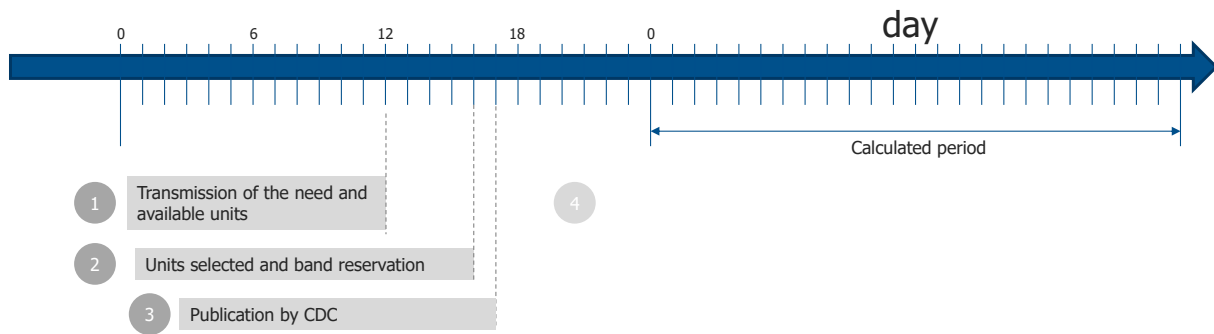
### 4.2.2. Proposed solution

The proposed solution for the target process is a daily process, after the day ahead scheduling process, so that:

- Commercial flows are scheduled,
- Units available for reserves are known,
- Units selected for production know their willingness<sup>12</sup> to stop producing and propose FRR while being replaced for production with an unit of higher cost,
- Available cross border capacities are known.

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<sup>12</sup> Difference between market incomes and cost of production.



The centralized process for FRR procurement consists in the following steps:

1. Each SO transmits to the CDC his need for reserve (upward and downward capacity) and the available units (price for reservation and price for activation)
2. CDC determines the set of units that can covers all needs, and allocate it to cover the need of each SO (process needed)
3. CDC publish results:
  - a. CDC gives to each SO, the amount of reserves that should be procured in its area and which SO contracted the reserve,
  - b. CDC reduces the available NTC that will be available for further intraday cross border commercial exchanges,
4. It remains enough time to ensure Intra Day (ID) commercial scheduling in future step of the cooperation.

After this process of cross border procurement, SOs are responsible to procure the determined reserves by ensuring the availability of the qualified units.

#### 4.2.3. Main steps

Begin with a daily process may be a too big challenge. Moreover, simulation performed in Output 1 of this TA shows that cross-border FRR procurement based on a fixed monthly amount enables to reach most of the potential benefit of FRR regional cooperation. Thus, it is proposed to perform FRR capacity reservation on a monthly basis.

A step by step approach with a process of reserve procurement can be:

1. On a monthly basis at the beginning, with bilateral contracts,
2. On a monthly basis with a centralized process (see roadmap action 11.4),
3. On a weekly basis with a centralized process (see roadmap action 11.5),
4. On a daily basis process (see roadmap action 11.6), after scheduling process, and a centralized process.

This step by step approach comes with a possible mismatch for the allocation of the transfer capacity. The two final steps (with cross-border procurement after commercial exchanges) will ensure that the procurement of reserves will be only able to take the residual transfer capacity after commercial exchanges.

On step 1 & 2, the procurement process comes before the capacity calculation process. Thus, the reserved capacity for the procurement of reserves could theoretically be incompatible with the energy flows.

On step 3, the cross-border procurement process is after the weekly capacity calculation process, but still before the commercial scheduling process.

The final step (with cross-border procurement after commercial scheduling) ensures that the procurement

of reserves will only take the residual transfer capacity, for it comes after commercial exchanges.

The step by step approach is feasible, as the transfer capacity seems to be enough at present time to ensure that this incompatibility should not happen soon.

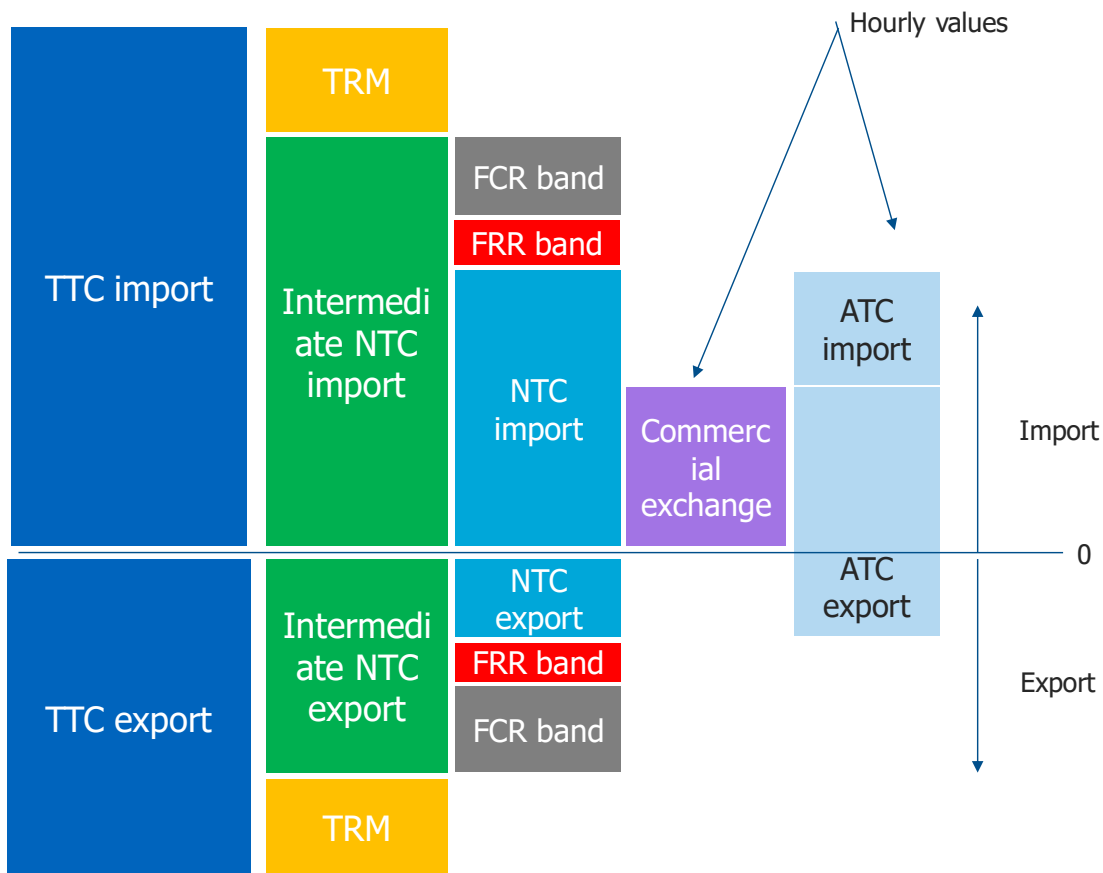
### **4.3. Reservation of a capacity band on the interconnections for FRR exchange**

#### **4.3.1. Objectives**

To ensure that activation of a cross border procured reserves is always possible without congestion, a process shall ensure that the cross border procurement is feasible and safe (during the steps 1 to 3 seen in chapter 4.2.3).

#### **4.3.2. Proposed solution**

To ensure that reserve shares are still possible when an energy exchange market between countries is in place, and when the cross-border procurement process is set before the commercial schedules, a reservation of a FRR capacity band, before trade between countries is established. This range must be sufficient to allow for reserve exchanges once trade for energy, the size of this band has been defined.



The Consultant proposes recommendations that must be compatible with further integration of energy market. The mechanism on which it seems most relevant to propose recommendations is the Reservation of a capacity band, which is to consider that a band of capacity will be reserved to allow the cross-border procurement of reserves. At a first stage, it is a simple method to ensure cross border procurement and the analysis shows that this will not limit the energy market in place.

#### 4.3.3. Main steps

This reservation of a FRR capacity band (see roadmap action 11.3) will be performed by CDC, and will stop as soon as the Day ahead cross border procurement will be in place.

### 4.4. Real time activation

#### 4.4.1. Objectives

The process of activation of the procured FRR is proposed to be triggered by SOs, based on the detection of deviations in energy flows between countries compared to schedules. Upon SOs request, an activation process is centralized by CDC. The SO that are no balanced pay for the activated energy.

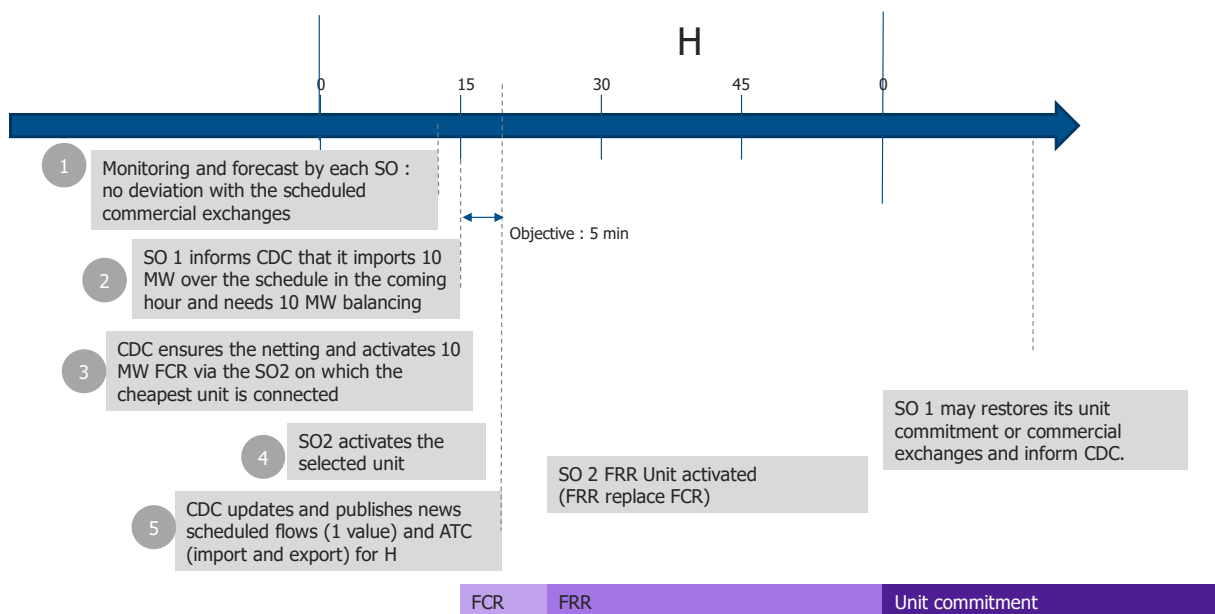
#### 4.4.2. Proposed solution

A centralized process for activation shall be set for the area. Such a process will ensure:

- that the activated capacities in real time do not violate the limits of the network, taking in account the last events on the network,
- that the activated capacities are activated in an economical way (merit order),
- that a netting process of needs is possible: if a country needs upward balancing energy and a second one need downward balancing energy, then the balancing need at the regional area is the netting of the two needs.

The proposed process for the real-time activation of FRR process is a scheduled process repeated each 15 minutes. The steps of the process are:

- SOs inform CDC of their balancing needs for the next hour<sup>13</sup>,
- CDC ensures a netting process and determines which FRR procured capacity shall be activated,
- CDC informs each connected SO to activate the selected FRR capacities,
- Each SO activates the selected FRR capacities (or another capacity if the selected one has a failure).



A local (country) balancing process shall still run in parallel:

- SO can choose between an activation of a reserve in the cooperation or an activation in its area (activation of a reserve which is not reserved by the cooperation or load shedding), depending on the availability of the reserve.
- the local process can be used as a fallback procedure if there is an operational failure in the centralized process,

<sup>13</sup> To ensure this step of the process, SOs need to monitor and forecast their area.

- It is recommended that each SO release the FRR capacity after a certain period of activation (for example one hour) by adjusting the unit commitment or by using RR if available.

If needed SO can ask more than the reserve that was covered in the procurement phase. If sufficient reserves are available for the period, the need will be covered.

The centralized process of activation can run with “Bilateral contracts” or “Centralized process” for the procurement of reserves. As it comes with benefits, this process shall quite early.

#### **4.4.3. Main steps**

The process of real time activation is performed by CDC (see roadmap action 11.2).

### **4.5. Metering**

#### **4.5.1. Objectives**

Metering is a milestone of a cooperation as it allows to control the physical that flows on lines and to compare with scheduled flows.

#### **4.5.2. Proposed solution**

All interconnections lines between these countries shall be equipped with metering devices that are checked regularly. The values are sent to CDC on a regular basis to be defined, for instance daily basis. The period for each metered value shall be harmonized to 15 minutes or less. This should be enlarged to the other countries connected to this synchronous zone, Russia in a first step and to further step to countries connected with HVDC systems.

Energy meters are compared by CDC in order to propose the metered flows and financial settlements (see above).

#### **4.5.3. Main steps**

This process should be set as soon as possible<sup>14</sup> (action 7.2).

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<sup>14</sup> It seems that each interconnection has already this equipment

## 4.6. Settlement

### 4.6.1. Objectives

The settlement of FRR regional cooperation process shall be designed in a way as to benefit each and every participant. This implies:

- fair principles for remuneration of FRR capacity procurement;
- fair principles for remuneration of FRR activated energy<sup>15</sup>;
- a transparent settlement process.

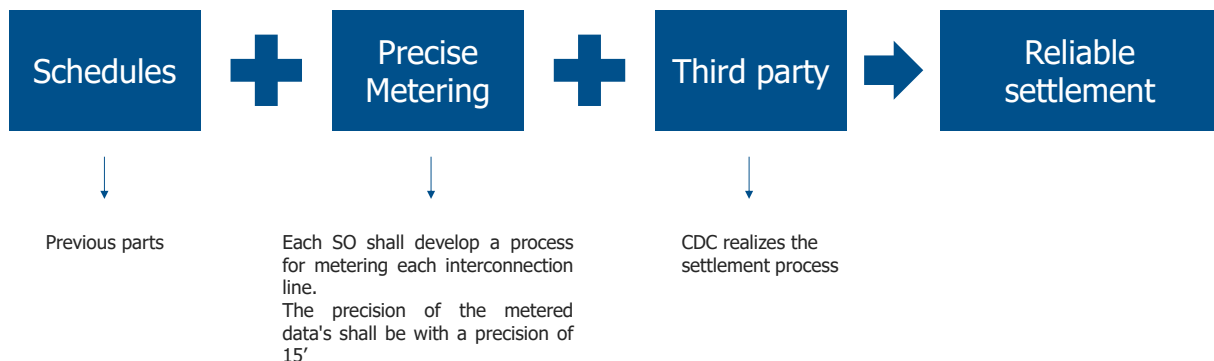
The following proposal is a first step to determine a settlement methodology for the cooperation. It is recommended that members of the regional cooperation make regularly evolve this methodology to ensure a win-win cooperation. The basic requirements that a settlement methodology shall respect are as follows:

- All participants shall win; otherwise there is no willingness to participate,
- Rules need to be updated accordingly if any disputes occur,
- Energy prices shall:
  - o reflect the imbalance situation and ensure that imbalances are settled at a price that reflects the real time value of energy,
  - o provide incentives to be balanced (or to help the system to restore its balance),
  - o avoid distorting incentives to SO (for example no generating high prices leading to use load shedding before the real need of it),
  - o ensure financial neutrality of the whole system.

### 4.6.2. Proposed solution for energy settlement

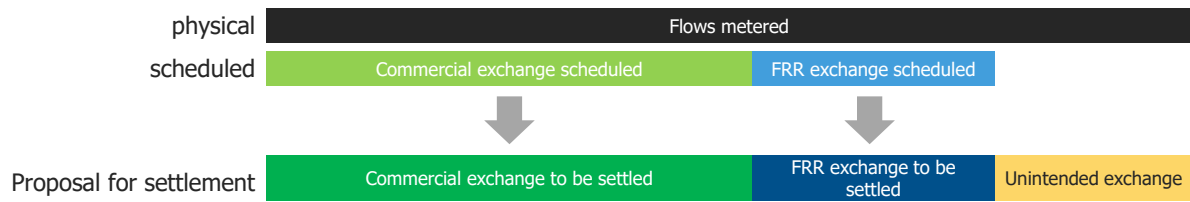
In real time, the flows are never exactly the scheduled flows. Consequently, the exchanged amount of energy is different from what was contracted (commercial exchanges and FRR exchanges). Thus, scheduled energy flows are compared to real flows (in real-time).

To perform a reliable settlement at a regional area, CDC acts as a third party and calculates the settlement according to the multilateral rule.





To determine the amount of energy that must be settled for each process, a residual amount of energy is called “unintended exchanges”. All scheduled flows are settled to the scheduled flows, and the residual flow has to be settled with a specific settlement rule.



The settlement is based on these principles:

Energy	Proposal for Settlement of a settlement period	Comments
<b>Commercial exchange</b>	Rules determined by commercial contract	Let commercial exchanges to be settled in a bilateral way.
<b>Unintended exchanges</b>	Settled with price defined according to rules agreed by all the participants of the cooperation.	The price should incentivize each SO to be balanced. The CDC seems to have rules <sup>16</sup> to determine a price that fit this requirement to settle the unintended flow.
<b>FRR exchange</b>	Weighted average price of activated balancing energy in the cooperation area.  When a SO asks CDC for a FRR activation and the activated energy comes from balancing service providers connected to its own area, its need is assumed to be provided by the cheapest units of the area and the weighted average price is calculated excluding this FRR activation.	The sellers have the guarantee to keep their cheapest units if needed in real-time. Each participant has a benefit to participate and is incentivized to share all of its capacities.  The neutrality of this process is ensured although the process determines a unique price for the activated FRR within the cooperation.

This settlement is proposed for the SO-SO settlement. At a local level, the payment of the owners is done by the connecting SO, based on local contract (that can include deviation prices, penalties for outages...).

<sup>16</sup> According to a discussion in Almaty Workshop (May 2019) but the Consultant did not access these rules.

### 4.6.3. Proposed solution for capacity settlement

The settlement of the cross border procured reserve should be based on a principle which ensures a fair sharing of the benefit of the cross-border cooperation between the countries. Prices of cross-border procured reserve could be established with a shared benefit principle, under the supervision of the CDC, which will be able to centralize reserve prices before their procurement, and will determine a unique price, based on the “weighted average price” of the cross-border procured reserve, that will ensure a unique price of energy in real time and will guarantee a “pay as bid” remuneration for the delivered energy.

The settlement of procured capacity shall be based on the bid prices of the procurement phase. A “weighted average price”<sup>17</sup>, will ensure a fair share of the benefits between SOs, while ensure units are paid on a “pay as bid” price.

$$Price = \frac{\sum_m C_{FRR,e} \times P_{FRR,e}}{\sum_m C_{FRR,e}}$$

- $C_{FRR,e}$  is the amount of FRR capacity procured for other areas
- $P_{FRR,e}$  is the cost of these capacities

When a SO requests FRR activation and the cheapest available FRR are located in its control area, a netting is done. The cheapest units are activated in priority according to its needs and this activation is excluded from the price calculation process.

If, in some case, it leads to losses for a SO, an ex post calculation is made to neutralize this effect (equal repartition of the losses to the participant with positives benefits).

This proposal is done for the SO-SO settlement. The payment of the owners is done by the connected SO, based on local contract (that can include deviation prices, penalties for outages or lack of availability...).

### 4.6.4. Main steps

This centralised settlement process is managed by the CDC and can be supported by a clearing house (see roadmap action 7.4).

The Consultant recommends having a settlement ensured by a clearing house, as it simplifies the process and supports the financial risk. Indeed, it is possible to begin a settlement process without a clearing house, however there are some minor drawbacks to this option: invoicing is more complex but still manageable : invoices need to be done between the SOs, and a repartition of the financial risk can be carried out by splitting each sellers’ invoice for all of the buyers (each buyer pays each sellers, with a set amount of risk shared amongst all parties).

At this stage, the Consultant does not propose a “pay as cleared” methodology, as there is no guarantee that this FRR market will have enough liquidity over the long term.

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<sup>17</sup> Similar to the IGCC process

## 5. CDC missions

The detailed 11 missions of CDC are resulting from the processes which are proposed to be implemented or adjusted with the setting-up of the regional cooperation, as described in chapters 2 and 3. CDC is already performing some of them such as verifying the cross-border exchanges between countries and doing the balance every month (now for Kazakhstan, the Kyrgyz Republic and Uzbekistan and soon for Tajikistan).

The CDC is proposed to be entrusted with the 11 following missions:

1. Regional non-binding network long term development plan
2. Short- and Medium-Term Adequacy Studies
3. Coordinated Security Analysis (including Remedial Actions-related analysis)
4. Outage Planning Coordination
5. Coordinated Capacity Calculation
6. Scheduling verification
7. Individual Grid Model / Common Grid Model delivery
8. Procurement of reserves
9. Real-time reserve activation
10. Settlement
11. Operational Training

These missions need first to be agreed by countries joining the cooperation in the MLA (see roadmap action 17) and then CDC need to evolve to change its role to that of a Regional Security Coordinator (see roadmap action 19).

### **Mission 1: Regional non-binding network long term development plan**

#### Objectives:

A regional non-binding network development plan will condense, enable and complement national grid development plans. It looks at the future power system in its globality and how power links and storages can be used to make the power system development happen in a cost effective and secure way. This plan is essential to the timely and effective development of transmission infrastructure. The CDC will focus particularly on cross-border infrastructure, the benefit of which can only be estimated through a simulation of the future conditions of operation across the entire region.

#### CDC mission:

From start to final publication of the network development plan, CDC will manage a team of experts and representatives of SOs and Ministries for the countries involved in the regional

cooperation. This team<sup>18</sup> will define tools and methodologies, collect and consolidates data, run market and network simulations and analyse the results in order to work out a coordinated network development plan. Stakeholders play a significant constructive role throughout the process through consultations on the different parts of this plan, according to the consultation process elaborated by the CDC.

The CDC needs to collect country information, coordinate and integrate the developments that are proposed by countries.

They must above all guarantee a methodological framework on the consumption assumptions, the assumptions on the ENR, the coherence of the hypotheses and the scenarios.

The cost-benefit analysis methodology must also be shared to decide on investments, to ensure that the rules applied are consistent.

#### Main steps:

- CDC already performs coordinated scenarios which is enough at this stage of the regional cooperation;
- In a second step the CDC needs to set up the regional expert group that will be in charge of defining and publishing the suitable methodologies, harmonising socio-economic scenarios
- In a last step, this regional expert group can be entrusted with specific studies or analyses (long term simulation for regional market and network operation...)

### **Mission 2: Short- and Medium-Term Adequacy Studies**

#### Objectives:

Central Asia countries will face with the challenge of responding to demand with sufficient electricity generation with increasingly intermittent contribution of renewable energy. If energy is not present – at any given time – in a country, potential help from other countries depends on the overall availability of electrical power system in the other countries and on the grid capacity to transmit it to the country in need of energy. Adequacy studies shall be made at short and medium term to ensure that demand will be met even in adverse conditions. These studies will include recommendations for optimizing the generation system and if needed recommendations on remedial actions to increase cross-border exchanges.

#### CDC missions:

CDC receives inputs from SO and performs a regional check/update of short/medium term active power adequacy diagnosis. This adequacy study will be made by comparing local adequacy inputs and grid capacity to carry cross-border exchanges. This calculation shall be

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<sup>18</sup> Comment from CDC on this point : in accordance with decision “Protocol No. 32” of CEPC CA (КЭС ЦА) CDC together with the power systems shall draft terms of reference (ToR) for development of "Joint Concept for development of the United power system of Kazakhstan and of the United power system of Central Asia " taking into account proposals from members of CEPC CA ; on the basis of this ToR, a company is hired to perform this work

based on CGM sent by the SO, a and performed in Year ahead (seasonal adequacy) Week-ahead and then in Day-ahead.

Main steps:

This mission will be performed as soon as a common methodology for short/medium term active power adequacy diagnosis is agreed, Common Grid Models are established (mission 7) and CDC is equipped with suitable tools.

Regional adequacy assessment based on individual SOs assessments can be provided at a week-ahead timeframe, respecting precise common rules and methodology. CDC shall collect these individual SO adequacy assessments and confront them to the grid capacity to carry cross-border exchanges. It shall be performed for shorter timeframes than seasonal outlooks and shall precise: load/generation forecast methodology (including methodology for RES forecast) and adequacy alert criteria (upward/downward generation margins).

**Mission 3: Coordinated Security Analysis (including Remedial Actions-related analysis)**

Objectives:

This service aims at identifying the risks of violating any operational security limit in any the regional network by:

- Applying common Security Analysis methodology;
- Checking robustness of results against uncertainties (e.g. study of variants with different level of RES generation);
- Finding relevant Remedial Actions (cross-border relevant ones);
- Coordinating findings and Remedial Actions proposal with other adjacent SOs.

CDC missions:

This service is rendered systematically by CDC in Day-ahead and in Intraday at specific times which have been regionally agreed upon. CDC provides a unique security analysis of the regional grid on a day-ahead basis. CDC gives advice, proposes solutions to participating SOs and coordinates agreements on the remedial actions needed to deal with constraints.

Security analysis delivered by CDC comprises several steps:

- simulate the tripping of any > 220 kV line or generator connected to the grid in areas of interest and under observation;
- special tripping cases are also simulated, such as double tripping, > 225 kV busbars;
- This comprehensive analysis is processed for 24 timestamps: the aim here is to generate a comprehensive 24-hour overview of the security risks on the grid for the following day;
- analysing the constraints detected for the following day and identifying remedial actions to solve them.

In any case, SOs are still ultimately responsible for deciding whether to implement these remedial actions.

Main steps:

This mission will be performed as soon as a common security analysis methodology is defined, Common Grid Models need also to be established (mission 7) as well as CDC to be equipped with suitable tools.

#### **Mission 4: Outage Coordination**

##### Objectives:

In order to operate the network in secure conditions, it is necessary to regularly carry out maintenance or reinforcement works which requires outages of assets. Every SO has to develop its own operational planning organisation, and CDC must be entrusted with verifying that the planned outages do not interfere with the safety of the interconnected system and that all planned outages are compatible.

The outage coordination process starts approximately one year before actual operation.

##### CDC missions:

- Identifying outage incompatibilities between relevant assets (grid elements, generators, loads) whose availability has cross-border impact;
- Coordinating the timing of necessary outages in grid and generation facilities to limit their impact on system operation;
- Proposing solutions to relieve these incompatibilities: at least non-costly remedial actions, adaptations of availability and outages' planning (firstly on grid elements, secondly on other elements if no solution is available);
- Coordinating findings and Remedial Actions proposals with other adjacent countries that are not part of the cooperation.

This service is requested for at least the following timeframes:

- Systematic coordination performed year-ahead: each October – November period of Y-1.
- Updates up to week-ahead: on TSO requests, based on requests for planning modifications or significant changes on expected operational conditions (e.g. important forced outages for long periods, dry periods...).

##### Main steps:

This service can be implemented as soon as a suitable organization is decided: at first it is not necessary that a CGM be established and this service can be realized by the CDC on the basis of notification of the outages and with a simplified grid model already existing at CDC. In a second step, to provide a more accurate service at a shorter timeframe, CDCs needs **common reference scenarios established by SOs** and corresponding CGMs. SOs and CDC shall define how the system security is evaluated, for a given period of outages located between two reference scenarios (e.g. several intermediate dates).

#### **Mission 5: Coordinated Capacity Calculation**

##### Objectives:

This service aims at identifying the Total Transfer Capacities between countries and the sharing of this capacity in capacities available for commercial exchanges, flows resulting from FCR and FRR activations, security margin.

#### CDC missions:

This service is rendered by CDC in Week-ahead in a first step.

The process operated by the CDC has several steps:

- A first calculation of the needs in terms of security margin and FCR band in an annual timeframe,
- A weekly operational process with
  - Transmission of data from SOs to CDC (outages, PATL of the lines, consumption forecast, generation shift key)
  - A first calculation of the TTCs (import and export) by CDC
  - A validation of the values by the SOs
  - A publication of all the values.

#### Main steps:

- Define and approve regional coordinated methodologies to compute parameters defining NTC; this calculation can be performed on the basis of simple data exchange, and using the simplified grid model already existing at CDC;
- In a second step, this calculation should be based on CGM and improvement proposals can be made to increase computation quality (such as coordination of net positions of each Individual Grid Model (IGM), if part of the regional methodology) and/or available capacity (such as proposal of at least non-costly Remedial Actions if part of the regional methodology);
- This process may evolve to extend the timeframe with both a 2 days ahead stage and a day ahead stage.

### **Mission 6: Scheduling verification**

#### Objectives:

This service aims at verifying the commercial flows between SOs. Each SO will prepare a schedule of the commercial exchange planned between its area of control and the neighbours. It is highly recommended that an entity be responsible to verify that all the commercial exchange schedules of an interconnected zone matches each other and are compatible. The objective is to verify that all individual schedules are consistent and lead to a correct generation-demand balance.

#### CDC missions:

The service is rendered by CDC via day-ahead process: it consists of ensuring that all the SOs have the same scheduled flows (at an hourly precision period) and that the schedules respects the transfer capacities

The process has several steps:

- Collect the net position of each SO and the commercial flows between SOs,

- Monitor that the net value of the flows of the Region is balanced,
- Monitor that the flows do not violate the transfer capacity that can be allocated for commercial exchanges,
- Publish the Available Transfer Capacity (ATC) after taking in account the commercial exchanges

#### Main steps:

This service can be implemented as soon as a suitable organisation is decided: at first it is not necessary that a CGM be established and this service can be realized by the CDC on the basis of the notification of the outages and with a simplified grid model already existing at CDC.

### **Mission 7: Individual Grid Model / Common Grid Model delivery**

#### Objectives:

Common Grid Models (CGM) are necessary to perform accurate calculation, based on the best data provided by the SO. This service consists in an iterative process starting from the collection of Individual Grid Models (IGM) shared by SOs on the Operational Planning Data Environment and aiming at delivering to all SO part of the cooperation CGMs adequate for the other services listed in this document, for all necessary timeframes as specified in their description.

#### CDC missions:

This service includes (at least for the timeframes from year-ahead to intraday):

- Checking quality and plausibility of IGMs provided by SOs and facilitating their improvement to meet the criteria of quality and plausibility;
- Merging of IGMs into CGM;
- CGM model improvement based on the CGM methodology on agreed procedure.

In addition, if regionally required for timeframes close to real-time (from h-1 to h), this service can be simplified when creating the corresponding CGMs, e.g. based on SOs snapshots. At this timeframe, CDC-SOs iterations regarding IGM are not relevant in most situations.

#### Main steps:

CDC will be able to render this service when (a) the CDC is equipped with a suitable tool, (b) when a common process and methodology is defined, and (c) when all the SO are able to deliver IGM according to this methodology.

### **Mission 8: Procurement of reserves**

#### Objectives:

This service gives the opportunity for each SO to procure a part of FRR in another country.

#### CDC missions:

The service will be provided by CDC on a day-ahead basis (or as a first step on a month-ahead basis).



The process has several steps:

- Collect the need of each SO and the offers of each SO
- Determine the balancing service providers that can covers the SO's needs (in respect of the ATCs)
- Publish the results (which SO that shall provide FRR reserves)

Main steps:

- In a first step CDC needs to validate bilateral contracts that countries wish to sign for FRR procurement, with regard to the already existing agreements and to remaining available capacity on cross-border lines;
- Then, it is proposed that CDC implements a centralise process to select FRR's offers in order to cover SOs needs;
- In a last step, this FRR procurement process can evolve to a daily process, performed after the cross border scheduling process, and the update of the available transfer capacity.

**Mission 9: Real-time reserve activation**

Objectives:

The service ensures a coordinated process for balancing each country of the region.

CDC missions:

The service provided by CDC in real time consists in the following process:

- Collect the real time offers (price for balancing energy),
- Collect the needs for balancing energy (upward or downward),
- Determine the units that have to be activated (merit order in respect of the ATCs<sup>19</sup>)
- Send instructions to the SOs that have to activate FRR reserves.
- Ensure that the new values for cross-border scheduled flows (including cross-border FRR activation) are implemented in the SOs control loops.

Main steps:

**Mission 10: Settlement**

Objectives:

Based on the cross-border energy flows calculated by the metering system, this process aims:

- to determine flows that need to be considered in the commercial process, the FRR process, and the remaining flow that are unintended exchanges;

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<sup>19</sup> The respect of this constraint shall be done at the procurement step. But a real time check is needed in case of deviation of the real time flows from the scheduled commercial flows.

- to settle between SOs the FRR energy and the unintended exchanges;

#### CDC missions:

The service provided by the CDC is to perform a third-party calculation so that each SO should trust the calculated amount of exchanged energy, and the settlement for this energy.

#### Main steps:

CDC is ready to perform this activity, which is already done at a hourly basis.

It will be able to provide accurate analyses as soon as the countries ensure their own adequacy and as soon it is equipped with suitable tools, enabling to perform this activity on the basis of CGM.

### **Mission 11: Operational Training**

#### Objectives:

The level of knowledge of the real time operators and their knowledge of the market and the management of interconnections must be homogeneous to ensure that the interconnected power system will be operated safely.

#### CDC missions:

SOs of the different countries shall organize at least yearly trainings with the objective to gather dispatchers from different countries. It will provide great benefit to the regional cooperation because it will enable the dispatchers to understand how their neighbours work, and the role and responsibilities of each entity, in a context where processes and rules evolve regularly. Also, it will help them prepare on the way to analyse a situation, react and coordinate in case of a major incident. CDC must play a major role in establishing and updating curricula and hosting training sessions.

A dispatching Training Simulator (DTS) is a dedicated tool enabling to simulate the behaviour of power systems. The simulator sessions are based on realistic power system situations and expected transmission system response to normal and abnormal conditions.

#### Main steps:

the CDC establishes, in relation to the SOs that mandate it for this purpose, recruitment criteria and an initial training cursus, detailing the stages of theoretical training and on the job, and final test leading to accreditation of the dispatcher.

In a further step, minimal prescriptions are established concerning the use of DTS for training (either integrated, based on the EMS in the dispatching centre or on a dedicated modelling of the real time network, or external).

The training cursus must be updated at least every year, according to the evolution of FRR procurement process and missions of the different SO.

## 6. Capacity building

Capacity building has been provided to working committee members on international best practices to secure balancing capacity reserves under regional cooperation framework.

The six workshops took place:

- Kick-off meeting, Astana (KAZ), January 2018
- Workshop n.2, Tashkent (UZB), April 2018
- Workshop n.3, Bichkek (KYG), July 2018
- Workshop n.4, Dushanbe (TAJ), November 2018
- Workshop n.5 and 6, Almaty (KAZ), May 2019

A review of the international best practices to secure balancing capacity reserve under regional cooperation framework was presented during the kick-off meeting and detailed presentations of the European mechanisms were presented during the 2nd and 3rd workshops.

During the 4<sup>th</sup> Workshop, thanks to the 2020 study results, prefiguring the main steps towards a regional cooperation on FRR, it was proposed to describe technical rules in a document called “Operation Handbook” and these rules should be set in force thanks to a regional agreement. Missions of CDC adapted to this new context started to be discussed.

The 5<sup>th</sup> and 6<sup>th</sup> workshop was mainly dedicated to capacity building related to the content of the Consultant proposal for the regional cooperation in Central Asia.

TA 9365 - Regional Cooperation on Renewable Energy integration to the Grid

Final report for output 2 – November 2019

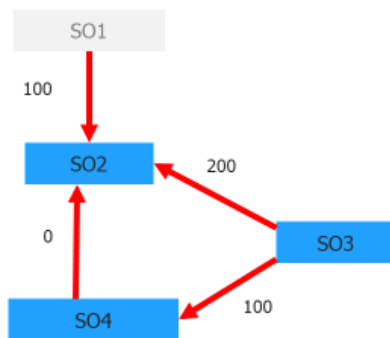
Presentations per output - v23052019											
WS1		WS2		WS3		WS4		WS5 and 6			
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2 TA_RE-integration_0127_lis ENG.pdf	NC	2 RTE I CAREC meeting final ENG.pdf	1 and 2	2 RTEi - Bichkek - reserves and procurement ENG.pdf	2	2 2020 Balancing capacity reserve assessment ENG.pdf	1	1405 PM 2020 results FRR regional cooperation.pdf	1	1705 grid code review WC Almaty May 2019 Rus.pdf	1
3 Kick-off meeting vdef ENG.pdf	1, 2 and 3	3 UZB Balancing capacity reserve assessment Tashkent ENG.pdf	1	3 RTE I WC Bishkek DSR TSO perspective ENG.pdf	2	3.1 2020_KYR Balancing capacity reserve assessment ENG.pdf	1	1505 AM - STAN - output 1 roadmap v6.pptx	1	1705 Policy Review vdef.pdf	1
4 Kick-off meeting Balancing ENG.pdf	1 and 2	4 RTE I WC Tashkent storage ENG.pdf	1	4 RTE I WC Bishkek hydro flexibility ENG.pdf	1	3.2 2020_KAZ Balancing capacity reserve assessment ENG.pdf	1	2030-Extension_AFG ENG.pdf	1	1705 Proposed Target Objectives for CDC Missions - V1.2.pdf	2
5 Kick off meeting RE Integration Coreso ENG.pdf	2	5 CORESO Presentation Tashkent ENG.pdf	2	5 European Connection Codes WC Bishkek July 2018 ENG.pdf	1	3.3 2020_TAJ Balancing capacity reserve assessment ENG.pdf	1	2030-Extension_KAZ ENG.pdf	1	1705 STAN - Output2 - Multilateral Agreement V1.pdf	2
		6 Dispatching Operation Practice ENG.pdf	1	6 RTE I WC Bichkek Renewable enregy forecast ENG.pdf	3	3.4 2020_TKM Balancing capacity reserve assessment ENG.pdf	1	2030-Extension_KYR ENG.pdf	1	2005 STAN - European practices for reserves	2
		7 Management of the Reserve ENG.pdf	1	7 RTE I WC Road map ENG.pdf	1 and 2	3.5 2020_UZB Balancing capacity reserve assessment ENG.pdf	1	2030-Extension_PAK ENG.pdf	1	2005 STAN - Rules proposal for Operation Handbook	2
		8 RTE I WC Tashkent Renewable energy ENG.pdf	3	8 Policy Review ENG.pptx	1	3.6 2020_AFG Balancing capacity reserve assessment ENG.pdf	1	2030-Extension_TAJ ENG.pdf	1	2105 STAN - IGCC and PICASSO	2
				9 KYR restoration reserve availability and cost ENG.pdf	1	4 Improvement of Dispatching Operation ENG.pdf	1 and 2	2030-Extension_TKM ENG.pdf	1		2
						5 RTE I Renewable forecast 11 2018 ENG.pdf	3	2030-Extension_UZB ENG.pdf	1		
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						7 RTE I Policy review ENG.pptx	1	1605 2030 results FRR regional cooperation.pdf	1		
						8 RTE I WC Road map 2020 ENG.pptx	1 and 2	1605 PM - STAN - Renewable forecast V1.1.pdf	3		

## Appendix 1: TTC calculation with loop flows

Transfer capacity calculation  
Loop Flows

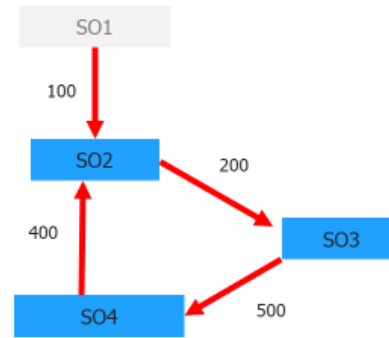
### Focus on loop flows

#### Commercial Exchanges



=

#### Real flows



Transfer capacity calculation  
Loop Flows

### Calculation of TTC by the countries

To calculate TTCs, there is a need to share data's at the cooperation level.

A common methodology can be elaborated to calculate a value

A simple example of methodology for calculate the TTC A→B :

1. Use the initial file (including schedules and balance for each country)
2. Increase the production for A (use the GSK (merit order) from SO A)
3. Analyze if the increase of production from SO A implies an increase of production in SO x.
4. Decrease the production for B (use GSK from SO B) to balance the system
5. If there is no constraints, repeat step 2, 3, 4. If there is a constraint in any line, the TTC is reached.

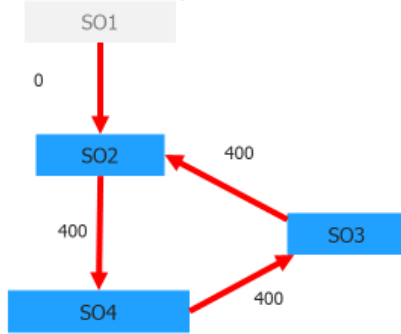
The methodology that could be proposed highly depends on what kind of data could be exchanged between SOs.



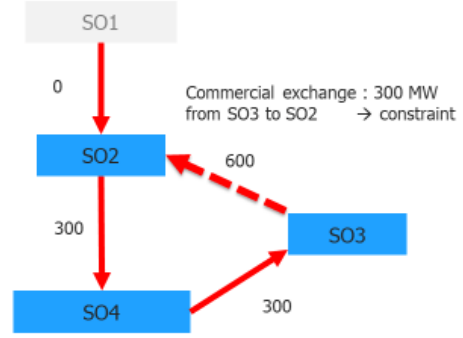
Transfer capacity calculation  
Loop Flows

Focus on loop flows

Step 1 : P=C in each country  
Natural loop flow



Step 2 : increase commercial flow to reach the first constraint



SO3→SO2 TTC is 300 MW

