



# Cross-Border Energy Trade within the Central Asian Power System (CAPS)

## System Reliability angle

KPMG

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# Supply Reliability is the top national priority for utilities around the globe, so a sound power exchange is subject to the 3 simple principles

## Principle №1

**«National» System Adequacy** - ability of a national bulk power system to supply the aggregate electric power and energy requirements of the customers at national level ANY TIME to avoid loss of load

## Principle №2

**«International» System Security** – ability of power interconnection to better withstand disturbances compared to isolated national systems to free reserves for commercial cross-border exchange

## Principle №3

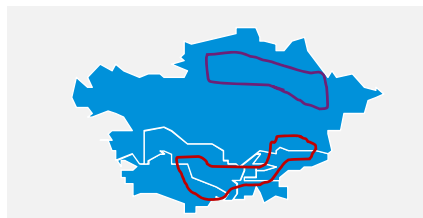
**Virtual Consumer Unbundling** - administrative separation of commercial power exchange from any uncompetitive matter such as supply security to make it subject of price decision of consumers only



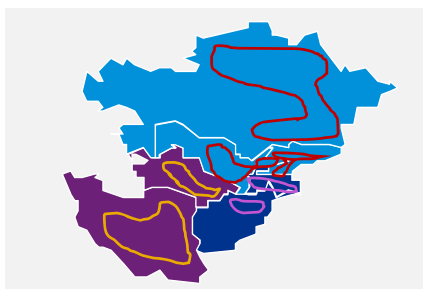
System Reliability Framework developed by KPMG helps to seize risks and opportunities to develop a sound and future looking CAPS interconnection master plan

# Central Asian Power System (CAPS) interconnection evolution and map

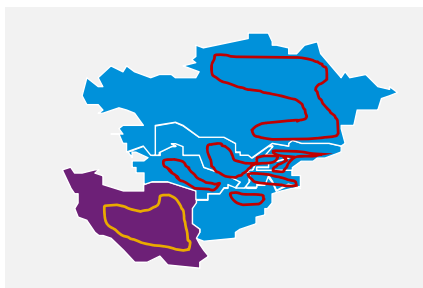
**Before 1991 – 2003 (Single power system owned by 5 countries)**



**2003 – ongoing 2019 (National Systems Formation)**



**After 2025 – a Scenario (Interconnection of National Systems)**



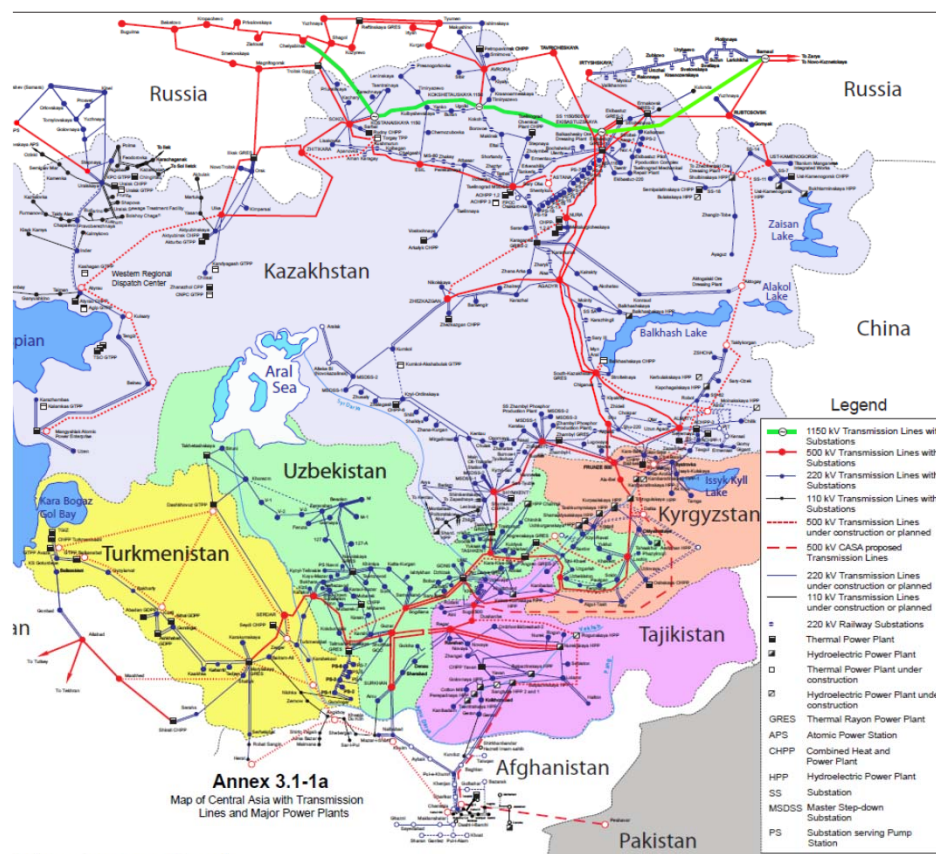
Synchronous Interconnections in Central Asia

CAPS (part of UPS/IPS)

Iran-Turkmenistan

TJ- North Afghanistan

— National Power System Boundaries (sketchy only)



Source: USAID

# Power Sector of Central Asian countries has been IFI focus over last 10Y, but progress within Reliability and Cross-border domains remains slow



## CAPS interconnection overview

The power system of South Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan and Turkmenistan has been developed in 1960-s to 1980-s as single Central Asian Power System (CAPS) based on a shared water and fossil fuel balance. Over the past 30 years of independence significant changes political and economic changes challenged existence of CAPS interconnection:

- Issue:** Priority of national energy security and investments in self-sufficiency. Risk of CAPS degradation. TM (2003) and TJ (2009) leaving interconnection, KZ becoming self-sufficient through new TPPs and 500kV North-South power lines.
- Issue:** Power exchange dropped, resulting increasing water use for power generation in winter by TJ and KG causing environmental problems for UZ and KZ
- Issue:** Deterioration of generation assets due to age and underinvestment, resulting in large unserved demand, in particular in TJ. Low and not cost reflective tariffs challenge ability of Utilities to handle rehabilitation.
- Issue:** Issue: Degradation of System Dispatching. The CDC Energia (former ISO office) misses technical means and authority for maintaining reliability in CAPS
- Issue:** Power export extension activities to Afghanistan and Pakistan ongoing.

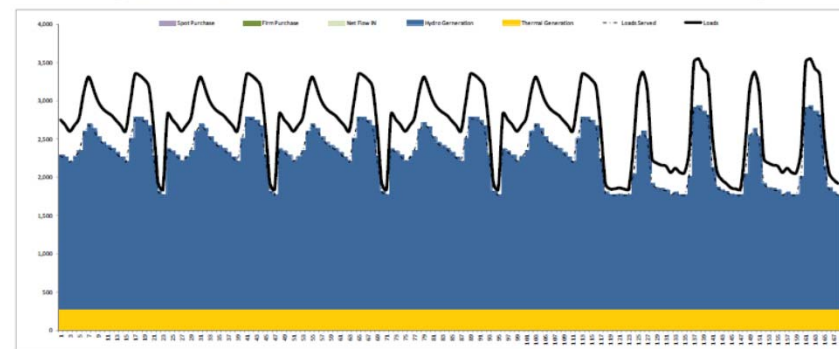
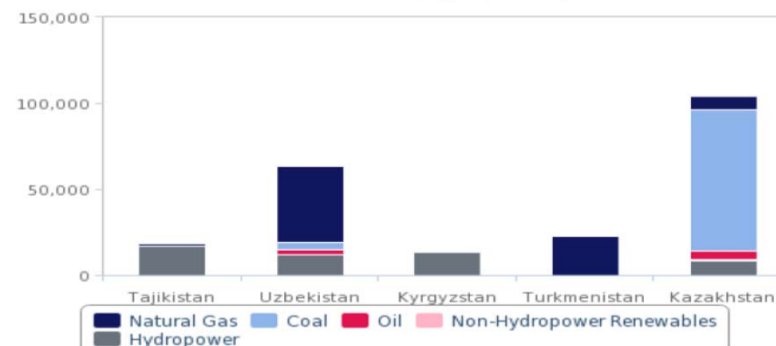
CAPS is part of IPS/UPS interconnection of CIS and Baltic countries. The operating rules and system security standards are coordinated within KOTK commission



## Cross-Border Energy Trading Project by ADB

The ADB plans to finance Technical Assistance project to increase Cross-Border Energy Trading within the Central Asian Power System to at least 11.000 GWh (around 10% of CAPS load) by 2021 per annum from the current 2.000 GWh to increase system reliability, allow TJ to re-join and increase of efficient use of energy resources

Cooperation To Boost Regional Energy Security  
Central Asia - Power Mix By Type By Country, TWh



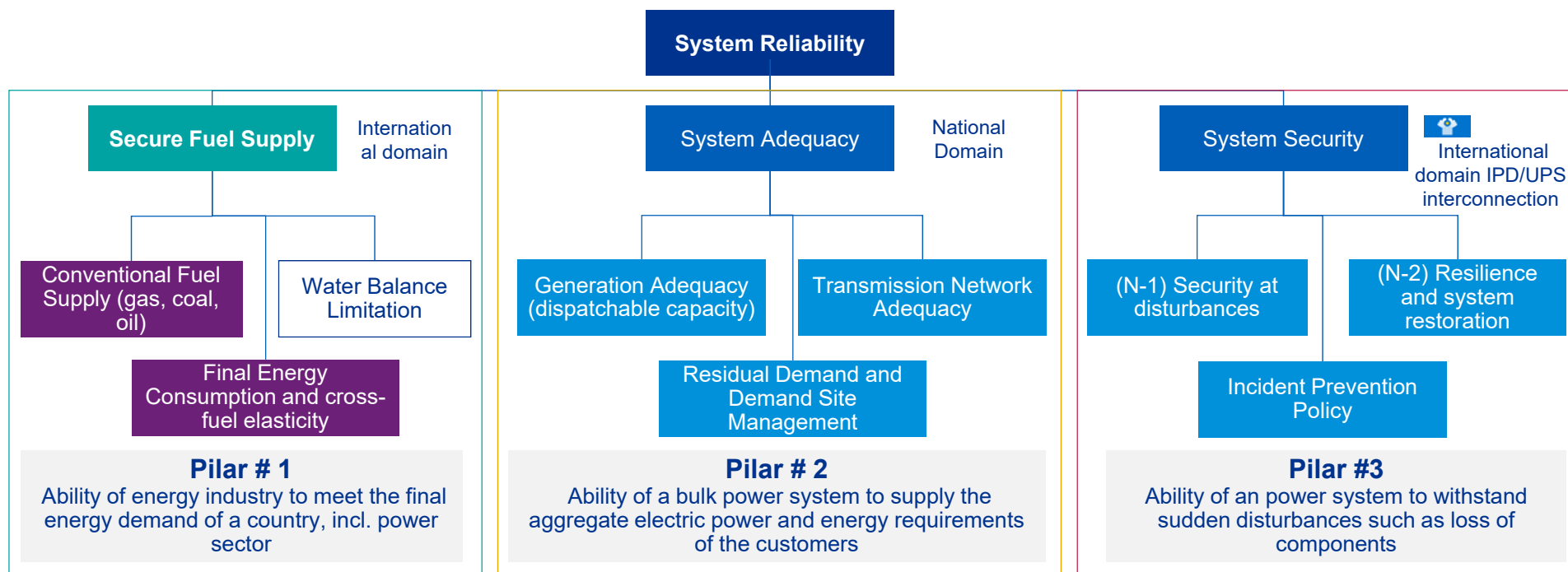
Tajikistan (Таджикистан)

Power mix by country in Central Asia (top), Unserved power load in Tajikistan in Winter (bottom). Source: Fitch (2019), Fichtner (2012),



This presentation describe possible KPMG approach to support the ADB in Project "Increasing Cross-Border Energy Trading within the Central Asian Power System"

# Understanding of System Reliability Framework helps to look at risks and opportunities in CAPS cross-border cooperation from a different angle



Source: CIGRE, KOTK, SO UPS, ENTSO, KPMG analytics

To understand barriers and opportunities for cross-border exchange it is critical to differentiate between Adequacy, Security and Commercial exchange issues within CAPS



# Principle #1: National "System Adequacy" self-sufficiency in supply meeting demand is the must have pre-condition for cross-border trade



## System Adequacy

Ability of a bulk power system to supply the aggregate electric power and energy requirements of the customers – called System Adequacy – is one of the most essential energy planning parameter. It shows, if the national power generation fleet is capable to cover power demand at anytime 24/7 - 8760 hour per year.



## National priority and Value of Lost Load

Cuts in power supply cause significant damage to economy and society, so the system adequacy is measured on Lost of Load Expectation (LoLE) – expected hours per annum, when demand is not met. Other indicator Value of Lost Load shows the economy costs for unserved energy. Value of Lost Load is x100-1000 higher (5-300 USD/kWh) compared to normal power price (2-10 c/kWh)\*. This means that no commercial cross-border trade is feasible upon national System Adequacy restored (consumers are willing to pay any price to be supplied)



## What this means for CAPS power exchange

National self-sufficiency in supply meeting demand is the must have pre-condition for commercial cross-border trade. For at least two countries TJ and KG the System Adequacy is not provided now (winter period sever cuts up to 40% of loads according to Fichtner, 2012). UZ aging generation and growing demand endangers its position too.

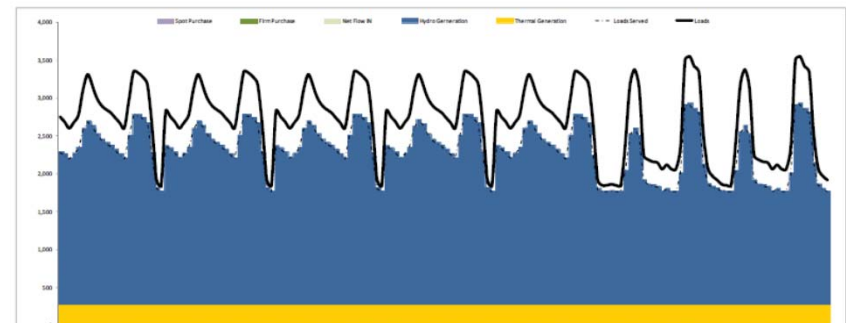


Fig. estimated unserved demand of Tajikistan in winter (non filled gaps), Fichtner 2012

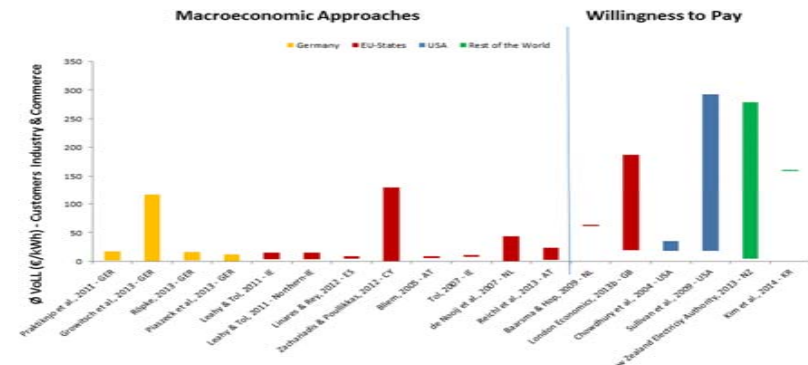


Fig. International benchmark of Value of Lost Load costs, Forschungszentrum Jülich, 2015



Value of Lost Load is x100-1000 higher (5-300 USD/kWh) compared to normal power price (1-10 c/kWh) making cross-border trade non-feasible upon national System Adequacy restored

\* Sources: Forschungszentrum Jülich, 2015; Word Bank - Analysis of the Kyrgyz Republic's 2016 Energy Sector

# Generally CAPS energy-water and grid interdependence is seen beneficial for cross-border power trade. International experience proves it wrong



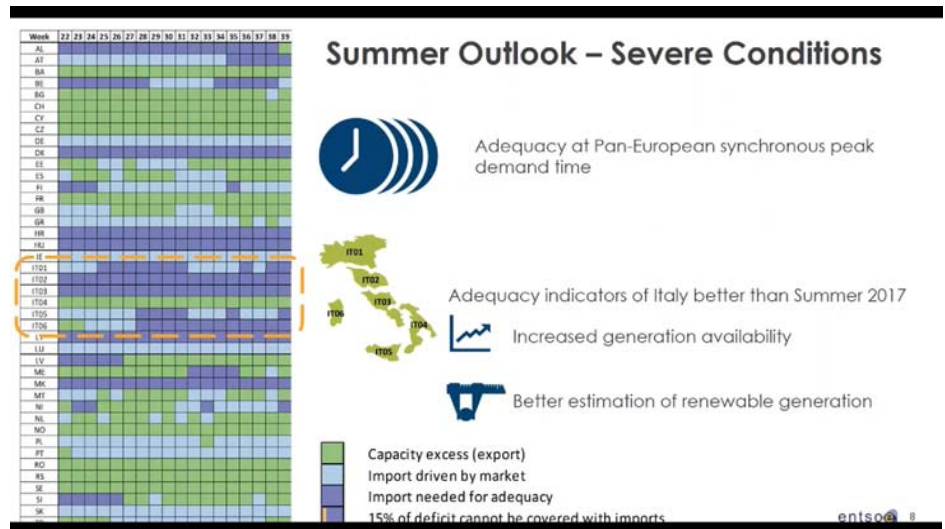
## Interdependence and power exchange: is there a link?

This example shows results of summer outlook system adequacy assessment within ENTSO interconnection during WK22-39 2018 (severe condition at high ambient temperatures). Dark blue highlighted cells show Free flow interconnection zones dependent on imports to meet supply and demand balance. It is to note that:

1. Despite EU integration processes power system adequacy (self-sufficiency) has to be provided by every national state.
2. National self-sufficiency is not regarded as a risk for maintaining ENTSO interconnection
3. Self-sufficient countries may have significant power exchange with neighbors driven by market

So power exchange is not necessarily a matter of missing self-sufficiency of interconnected power systems

Source: Summer Outlook 2018 Public Presentation, ENTSO



Italy case 2018: dependence on power imports to maintain supply adequacy is seen as a risk by the ENTSO despite in depth EU economics integration

# Principle #2: "System Security" or ability to withstand disturbances is better achieved collectively within CAPS interconnection



## System Security

Security is the measure of how an electric power system can withstand sudden disturbances such as electric short circuits or unanticipated loss of system components.

- (N-1) Security at disturbances
- (N-2) Resilience at cascade emergencies
- Emergency Restoration Plan



## Auxiliary Service Market and Co-operation

Following faction services are provided by generators and grid assets to provide system security:

- Frequency (load flow control)
- Q / Voltage regulation
- Load shedding
- Line / generators disconnection



## What this means for CAPS power exchange

Proper System Security level is necessary pre-requisite for cross border trade, as this allows commercial entities to use power generation reserves for trade, over wise being on "standby" as reserve is maintained collectively. However, large amount of power exchange is simply not needed to warranty system reliability. There are many technically sound power systems with "near zero" commercial power trade.

CAPS is part of IPS/UPS interconnection of CIS and Baltic countries. The operating rules and system security standards are coordinated within KOTK commission. According to Fichtner the Dispatching and emergency systems are depredated. In particular, ARChM (frequency and load flow control system) has been liquidated due to lack of budget.

Средства автоматического управления

Режимная автоматика	Противоаварийная автоматика
АРЧМ	АОПЧ, АОСЧ
АРН	АОПН, АОСН
ГРАМ (ГРАРМ), САУ ГА ГЭС САУМ (САРЧМ) энергоблоков, РЧВ турбин ТЭС	АРПМ
	АОПО

### Регулируемые параметры

$f_{ном} = 50 \text{ Гц} \pm \Delta f_{доп}$   
 $U = U_{ном} \pm \Delta U_{доп}$   
 $P \leq P_{макс.доп.}$   
 $I \leq I_{макс.доп.}$

### Время реакции систем первичного, вторичного и третичного регулирования

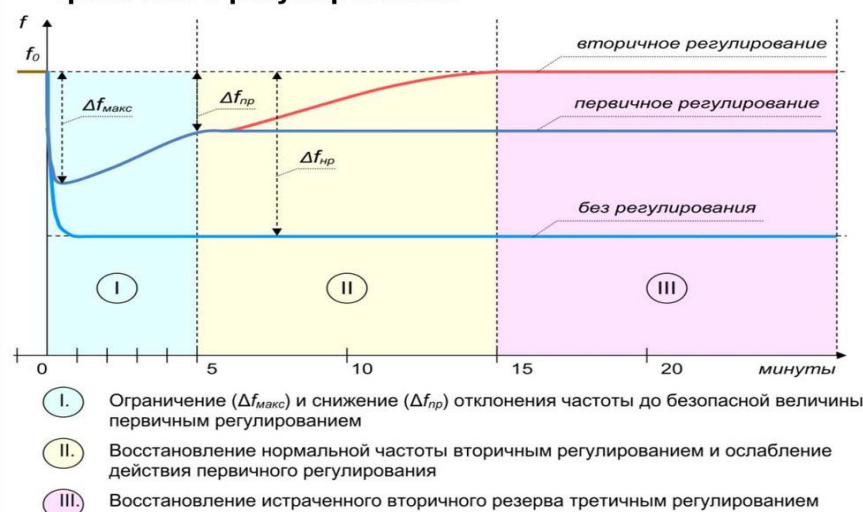


Figure: Principles of provision of system security measurements within UPS/IPS interconnection (CAPS is part of). Source: SO UPS

# Principle #3: Commercial power exchange is maximized if separated from any supply security and driven by price decision of consumers

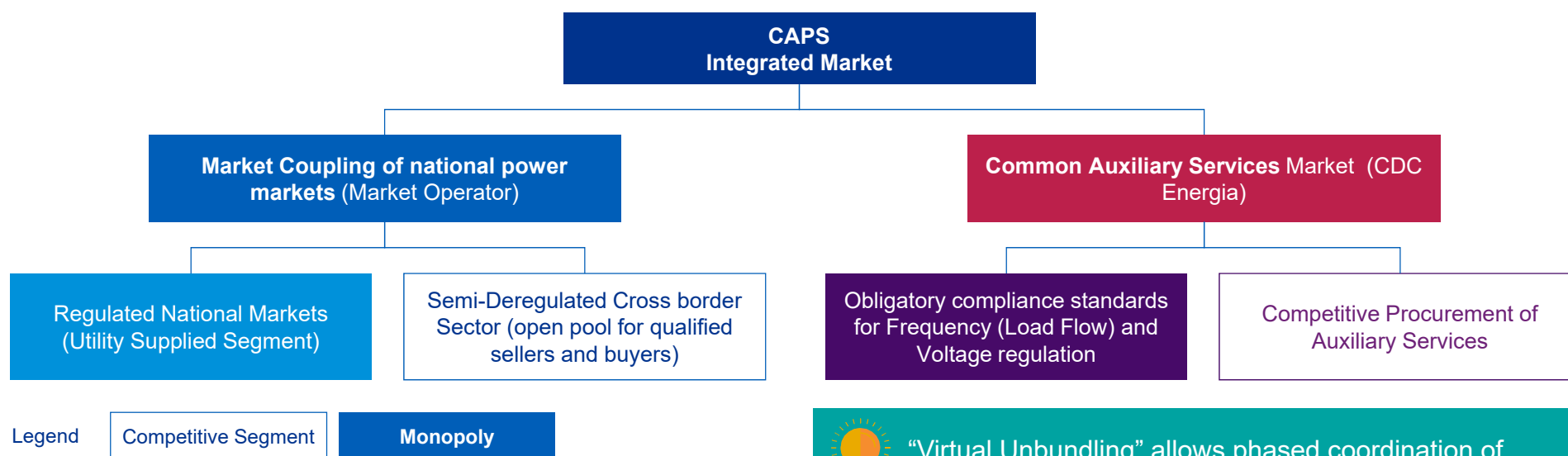
Table. Option for power exchange market arrangements within CAPS (illustrative only)


	Option 1 Bilateral National Trading (Utilities exchange)	Option 2 Partial Market Coupling (Virtual Unbundling for Qualified Buyers)	Option 3 Market Splitting (Common Power Market)	System Service - Auxiliary Services Market
<b>Description</b>	Cross-border exchanges are executed between national Utilities on bilateral basis	Large (qualified) consumers / traders are entitled to procure part of the energy abroad	Consumers procure energy on common market unless transmission congestion exist	Auxiliary Services (e.g. Primary Reserve) are procured by ISO to maintain secure operation
<b>Product</b>	Saldo of Power Flow measured at national borders	Power procured at consumer premises	Power procured at consumer premises	Availability of generation (consumer flexibility) units
<b>Market Operator</b>	Not required	Required to register exchanges and settle imbalance at border	Required to administer power pool and imbalances at balancing units	Independent System Operator procures and controls availability
<b>Sellers</b>	National Utilities / Single Entity	National Utilities / Single Entity	Generation companies / Single Entity	Qualified GenCon (on Units level)
<b>Buyers</b>	National Utilities / Single Entity	Qualified consumers (Suppliers)	Wholesale consumers (Suppliers)	ISO (Usually 1-2% of total CF)
<b>Advantage</b>	Simple to administrate "status quo" Consistent with utilities vertical integration	Direct commercial interest of multiple consumers Transparency in decision making and financial flows Coupling of different markets possible	(Close to) perfect competition Efficient use of capacities	Improvements in dispatching quality and reduced outages Effective fiscal instrument to enforce technical operation rules and penalize non-compliance
<b>Disadvantage</b>	— Limited interest -> low volumes — Conflicting with "cost+" tariffs — Risk of debts and barbers	Regulatory and tariff reform (transmission fee) needed More complex metering	Complex to administrate Require market regulation at super-national level	Regulatory changes needed to entitle ISO to operate Auxiliary Market Trust creation challenge
<b>Example</b>	CAPS (as is situation 2019)	EU; OREM-NordPool; RU-KZ	NordPool; OREM (nodal pricing)	System Services (RU), ENTSO (partly)



"Virtual Unbundling" - Institute of qualified consumers (buyers), entitled to procure power internationally in full or partly, is a stronger driver for energy exchange compared to any utility driven power trading model

# Partial Market Coupling with pro-rate “Virtual Unbundling” for Qualified Buyers may boost cross-border exchange in CAPS (Option 2)



 “Virtual Unbundling” allows phased coordination of national markets with very different regulatory framework and unbundling progress in place



# What actions can be taken to separate of commercial power trade from non-competitive matters of supply security to boost CAPS exchange

## CAPS Cross Border Exchange Energy Trading within Central Asian Power System: scenario considerations

Given provision of Security of Supply is the national priority for Utilities / TSO-ISO around the globe, establishing of a sound power exchange is usually subject to principles:

1. National System Adequacy or self-sufficiency in supply meeting demand
2. Strick System Security regulation within interconnection to free reserves for cross-border exchange
3. Competitive price-based Power Trade with qualified consumers in security limits (free from tariff or admin issues)

Similar rules apply for EU/ NORDEL, BRELL, Russia-KZ and other markets



### Action #1 National Grids Looping within CAPS interconnection

CAPS countries have to complete looping its 500/220 kV transmission network as USSR derived topology do not meet national grid adequacy criteria's. KZ North-South interconnection is most advanced example over 2000-2010-s. UZ and TG follow.

### Action #2 National Generation Rehabilitation & Adequacy

Aging generation fleet and partly increasing power demand challenges capability of national supply to meet demand, in particular in TJ (high LoLE in winter) and Uzbekistan (lowering availability of TPPs) resulting in high lost of load costs.

### Action #3 Unbundling of System and Market Operator's duties

Separation of Independent System Operators' duties (CDC Energia duties to be redefined) responsible for supply security from Market Operator (to be established) to allow free administration of commercial transactions either bilateral or pooled

### Action #4 Partial Market Coupling & Establishing Qualified participants pool

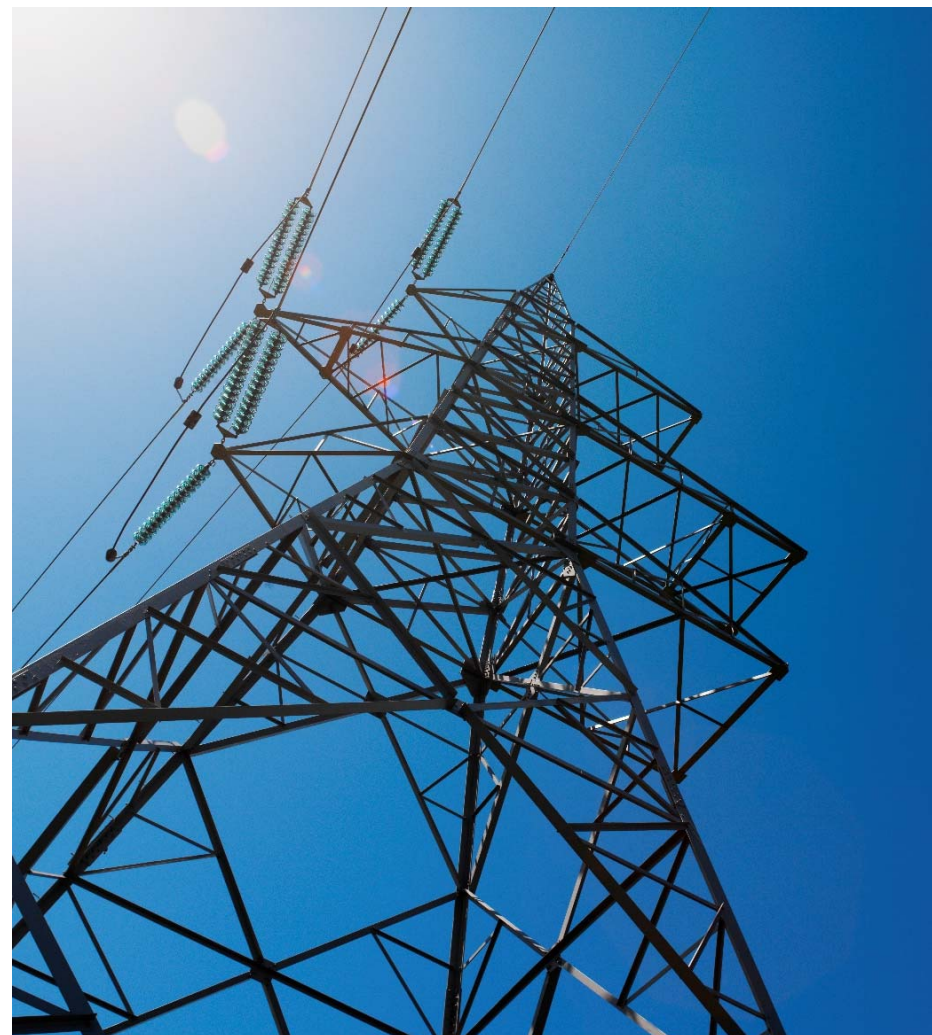
Final power consumers not utilities drive market competition. Central Asian Countries progressed differently in unbundling, so a phased change from bilateral to quoted "market coupling" (10-20% of volume) for qualified consumers and traders is possible

### Action #5 Dispatching Rehabilitation & Common Auxiliary Service Rules / Market

System Security (ability to withstand disturbances) is better achieved collectively within interconnection. Establishing of a common Auxiliary Services market (frequency, load flow and voltage) serves as a strong monetary stimulus to hold on rules

# Glossary

<b>CAPS</b>	Central Asian Power System (part of UPS/IPS)
<b>UPS/IPS</b>	United Power System / Integrated Power System interconnection (Synchronous interconnection of CIS and Baltic states)
<b>SO UPS</b>	System Operator of United Power System of Russia
<b>KOTK</b>	The Commission for Operational and Technological Coordination of the Collaboration of the Power Systems of the CIS and Baltic States (COTC) is a working body formed by the Electric Power Council of the CIS
<b>ENTSO</b>	European Network of Transmission System Operators for Electricity Association
<b>CDC Energinia</b>	Coordinating Dispatch Center (CDC) Energinia (Tashkent)
<b>LoLE</b>	Lost of Load Expectation
<b>TPP</b>	Thermal Power Plant
<b>kV</b>	Kilovolt
<b>MW</b>	Megawatt
<b>BRELL</b>	Belarus-Russia-Estonia-Latvia-Lithuania power interconnection (part of UPS/IPS)
<b>UZ</b>	Uzbekistan
<b>TJ</b>	Tajikistan
<b>KGZ</b>	Kyrgyzstan



# Our energy team



## Vassily Savin

**Partner,**  
Head of Deal Advisory, KPMG  
Central Asia

Head of Power & Utilities, KPMG in  
Russia and the CIS

### Qualification

- The Financial Academy under the Government of the Russian Federation
- Institut d'Etudes politiques de Paris
- The Moscow State University of International Relations
- Certified appraiser
- ASA certificates (BV201 - BV204) and CCIM certificates 101-104
- Member of the Partnership Council and Expert Board of the Self-Regulating Inter-Regional Association of Appraisers (SMAO)
- Head of Power & Utilities sector, KPMG Russia and the CIS

### Industry experience

Service of high quality and professional approach established Vassily's excellent reputation in the advisory market. His clients include major fuel-and-energy enterprises from Russia and the CIS. Prior to joining KPMG (in 2006) Vassily has been working for more than 7 years as a head of the department for large Russian advisory companies accredited with RAO UES of Russia, LUKOIL, Russian Railways, Federal Agency for the Administration of Federal Property (FAUGI), the Moscow City Property Department, FAUGI for Nuclear Industry, Russian Federal Property Fund, Federal Service of Russia for Financial Rehabilitation and Bankruptcy, Federal Children Centre, ARKO, etc.



## Sergey Rozhenko

**Manager,**  
Power & Utilities KPMG in Russia  
and the CIS

### Qualification

- Warwick Business School, Global Energy Futures and Transitions Programme, post-graduate award
- TU Ilmenau (Germany), Master of Electrical and data engineering
- The National Research University Moscow Power Engineering Institute, engineer, Energy systems and grids

### Industry experience

Sergey is an experienced consultant in electricity systems and energy markets development with more than 12 years professional background. His main focus is market analysis, management and control of designing and construction as well as technical audit and consulting on engineering related to construction of generation, industrial and infrastructure objects in Russia and the CIS.



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