Central Asia Power System Study.

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MERCADOS
ENERGY MARKETS INTERNATIONAL
Finding new paths for energy markets

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- SWOT of isolated operation.
- Economical estimation of benefits of joint operation:
  - Methodology applied;
  - Results.
- Short, medium and long term issues.
- Recommendations.

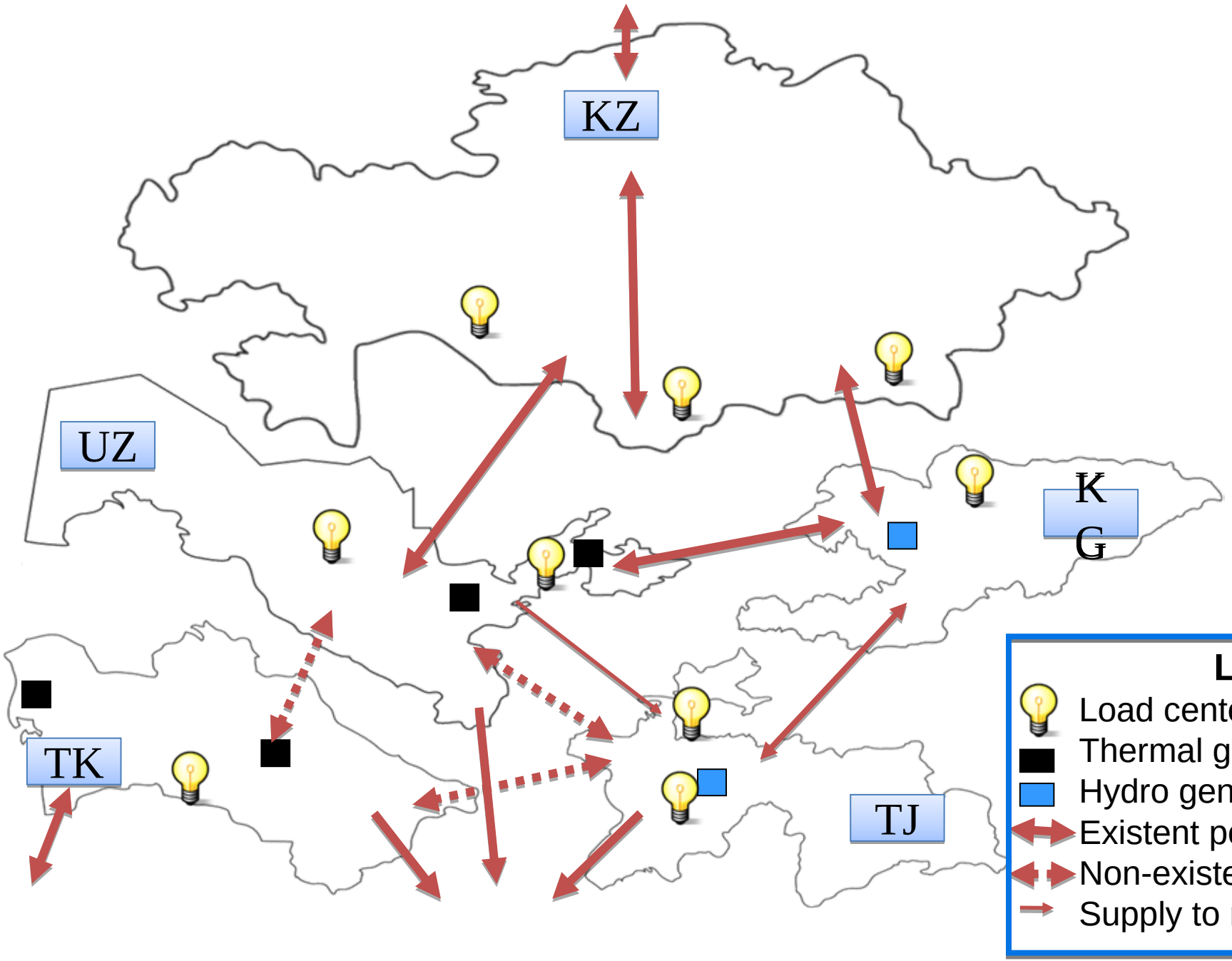
Main objectives.

- Opportunities and challenges in improvement of electricity joint dispatch and system operations across Central Asia.
- Diagnostic of the Central Asia Power System (CAPS).
- Assess the economic impact of isolated operation compared to joint operation.
- SWOT analysis.
- Immediate opportunities for system improvement, without any major investments.
- Medium and long term opportunities.

Status of the project.

- 2 missions to the field
- 5 countries visited
- Meetings with industry representatives
- Lack of data provided by the CAPS members
- Modeling approach to estimate benefits
- Results analysis
- Development of recommendations

Current situation in CAPS.



Current situation in CAPS.

- Lack of confidence in the joint operation, based on real problems that can be solved with joint cooperation and work.
- Unequal distribution of natural resources.
- Complementary structure of the generation mix in the region.
- Benefits maximization network design: topology, load distribution.
- Security of supply issues:
  - Interdependence between CAPS countries.
  - Low security of supply if operating in isolated mode.
  - Uneven distribution of generation capacity if operating in isolated mode.
  - Need to develop national power sectors and to improve national energy security.
- Different values of security, quality of primary and secondary regulation.
- Large volume of unscheduled and un authorized power drawls that lead to the decrease of grid stability and difficulty in power management.
- Lack of transit compensation mechanism.
- Linkages with sensitive water allocation issues.

Current situation in CAPS.

- Kazakhstan
  - Old, insufficient and expensive generation.
  - Frequency and capacity regulation problems.
  - Increase of losses caused by overloading North-South connection.
- Kyrgyz Republic
  - Unable to supply consumers in the Southern regions.
  - Power deficit in the North of the country.
  - Lack of transmission and distribution links/facilities.
  - Sensitive water issues
- Uzbekistan
  - Expensive thermal generation.
  - Lack of capacity reserve for regulation purposes.
  - Gas losses and extra wear on the equipment of TPPs in order to cover the daily peak.

Current situation in CAPS.

- Tajikistan
  - Seasonal power generation with deficit in winter and excess in summer.
  - Power deficit in remote areas.
  - Transmission system constraints.
  - Lack of import-export opportunities.
  - Sensitive water issues.
- Turkmenistan
  - Lack of export opportunities.
  - Need for frequency control.

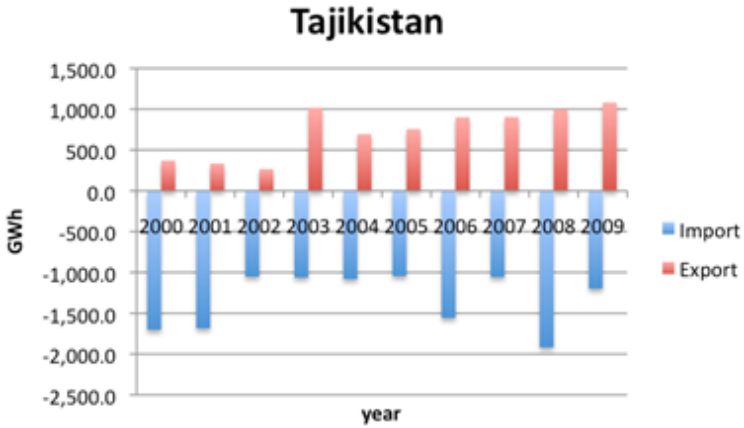
Present power exchanges in the CAPS

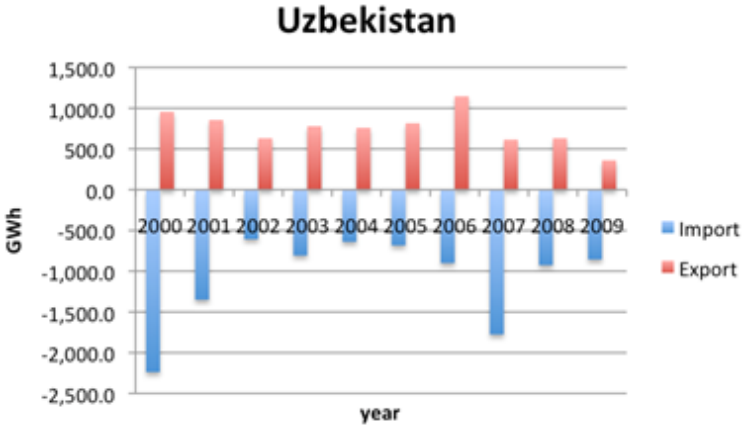
- Kyrgyz Republic-Southern Kazakhstan: electricity and regulation services.
- Kyrgyz Republic-Uzbekistan: no payment for transit services – selling/buying on the border.
- Uzbekistan-Tajikistan: supply to the particular remote regions.
- Technical exchanges.

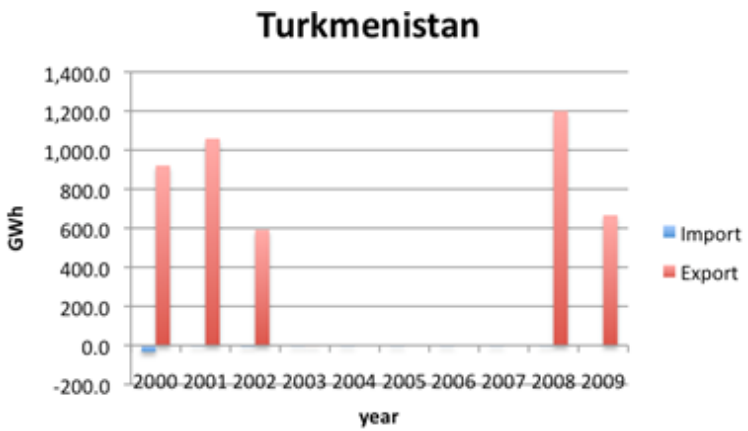
		Power Flows To (GWh)				
	2010	Kazakhstan	Kyrgyz Republic	Tajikistan	Turkmenistan	Uzbekistan
Power Flows From (GWh)	Southern Kazakhstan	X	0	0	0	0
	Kyrgyz Republic	850	X	N/A	0	N/A
	Tajikistan	0	75*	X	0	0
	Turkmenistan	0	0	0	X	0
	Uzbekistan	0	0	360	0	X

*-data obtained for January-May 2010

History of export-import in the CAPS.







SWOT. Strengths of integrated operation.

- Optimal use of natural resources:
  - Less water spillage
  - Decrease in fuel consumption
- Optimal dispatch and balanced generation mix.
- Efficient thermal generation running.
- Less need for investments.
- Make use of developed regional network.
- Less grid elements' disconnection and decrease of economic losses caused by interruptions.
- Increase of security of supply.

SWOT. Strengths of integrated operation.

- Less secondary reserve needed.

	Secondary reserve if Isolated operation, MW	Secondary reserve if Integrated operation, MW
CAPS-3	±299	**±234**
CAPS-4	±383	**±274**
CAPS-5	±430	**±293**

Country	Secondary reserve, MW
Southern Kazakhstan	±73
Kyrgyz Republic	±62
Tajikistan	±84
Turkmenistan	±47
Uzbekistan	±164

SWOT. Weaknesses of integrated operation.

- Potential risk related to the failure of other parties to comply with agreements.
- Potential risk caused by emergencies in the neighbor countries (but compensated by the possibility to be supported by other countries).
- Loss of energy supply resulting in social suffering and economic losses.

SWOT. Opportunities of integrated operation.

- Opportunity to find solution for:
  - Electricity and water issues (complex solution is needed)
  - Transit and customs office issue
  - Import/export issues.
  - Security of supply issues.
- More incentives and better conditions to develop regional-scale projects.

SWOT. Threats of integrated operation.

- National energy security, mainly independence of external sources, is not considered.
- Private investors may face more risk (country and regulatory), as far as they will have to absorb risks from all countries in the region.

Benefits of joint operation. Economical estimation.

- Methodology:
  - A model that identifies optimal generation/transmission expansion in a multi-country system was used (ORDENA Plus®).
  - Supply Cost-minimization approach is applied.
  - The model optimizes the joint operation/expansion of 5 countries and the result is compared to the results of the isolated operation/expansion country-by-country.
  - Stochasticity in hydro operation is considered.
  - Three hydro scenarios are built: Dry, Medium and Wet.

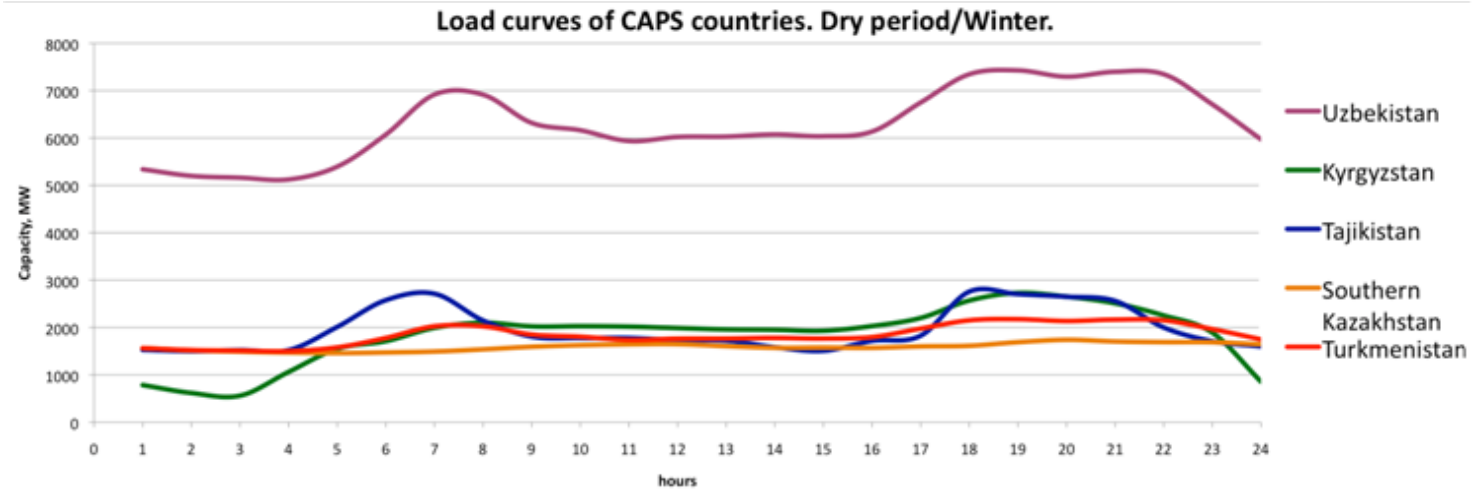
- The outputs of the model do not intend to represent the current operational practices (no enough information), but to show the expected benefits of a joint operation of the CAPS aiming to minimize costs and security. I.e. shows the forecasted costs of joint operation VS forecasted costs of isolated functioning.
- Conservative approach. Modeling stylizes the operation, real life benefits are greater.

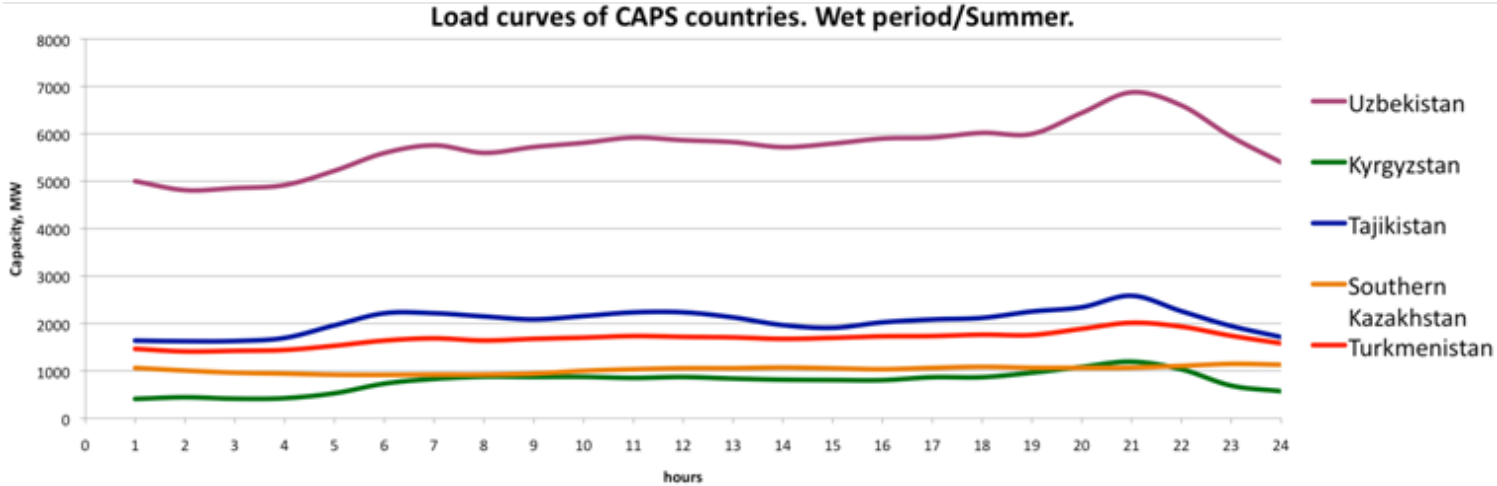
Variables considered in the estimation.

- Demand:
  - Figures are obtained from the information provided by countries.
- Generation and Interconnections:
  - According to the information provided by countries.
  - Expansion possibilities are considered on a conservative basis.
  - Projects informed by countries + standard projects that depends on fuels available in each country.
- Fuel:
  - Fuel constraints in some countries of the region.
  - Opportunity costs based on netback of international prices for coal, oil by-products and natural gas.
- Capacity:
  - Installed capacity is considered on a country-by-country basis.
  - Existing expansion plans are taken into account in order to construct the candidate expansion scenarios. In the cases when expansion plans are not available, there are assumed standard expansion candidates, which depends on the fuel as available in each country.

Variables considered in the estimation.

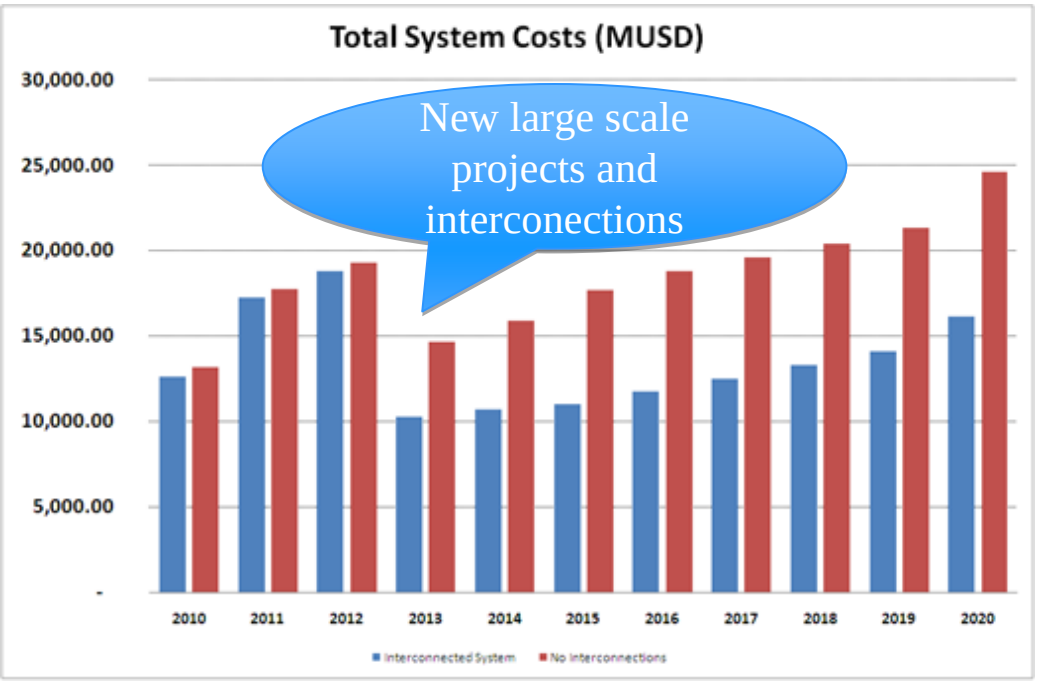
- Load curves considered in the analysis:

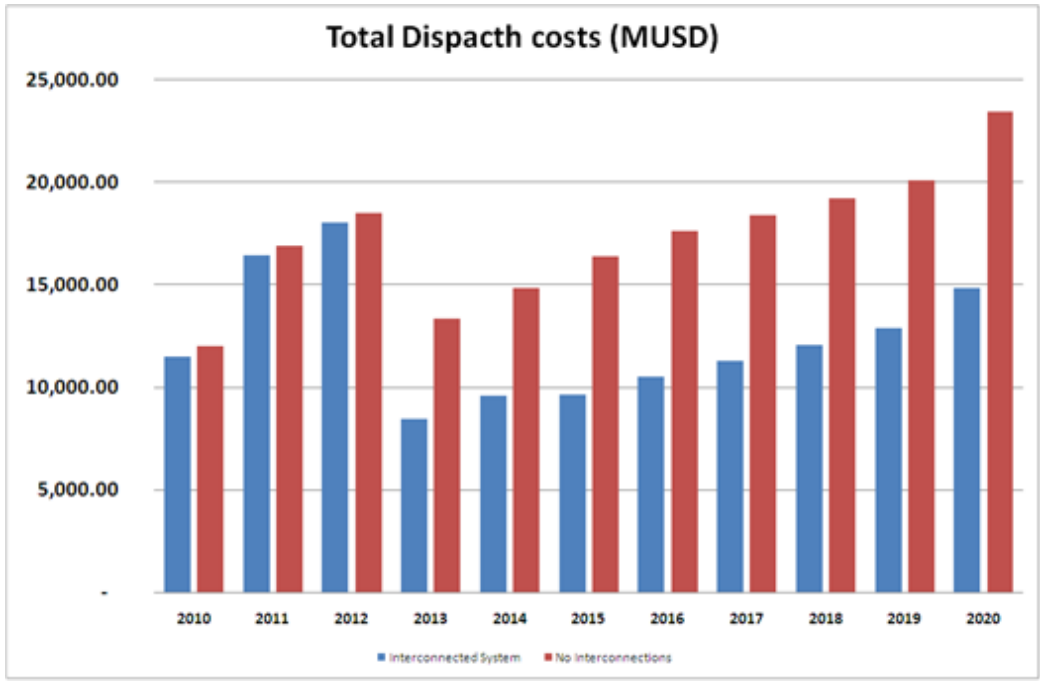




Economical estimation. Results.

- A great reduction in the system costs can be seen due to the joint operation of the system.
- The underlying reason is the optimization of generation resources as can be seen in the dispatch cost reduction.
- More than 1,500 MUSD can be saved in just 3 years of joint operation.





Note: ***Blue => Interconnected System*** ***Red => No Interconnection***

Economical estimation. Results.

- About 1,500 MUSD of fuel costs can be saved in just 3 years of joint operation:
  - Dispatch Costs:

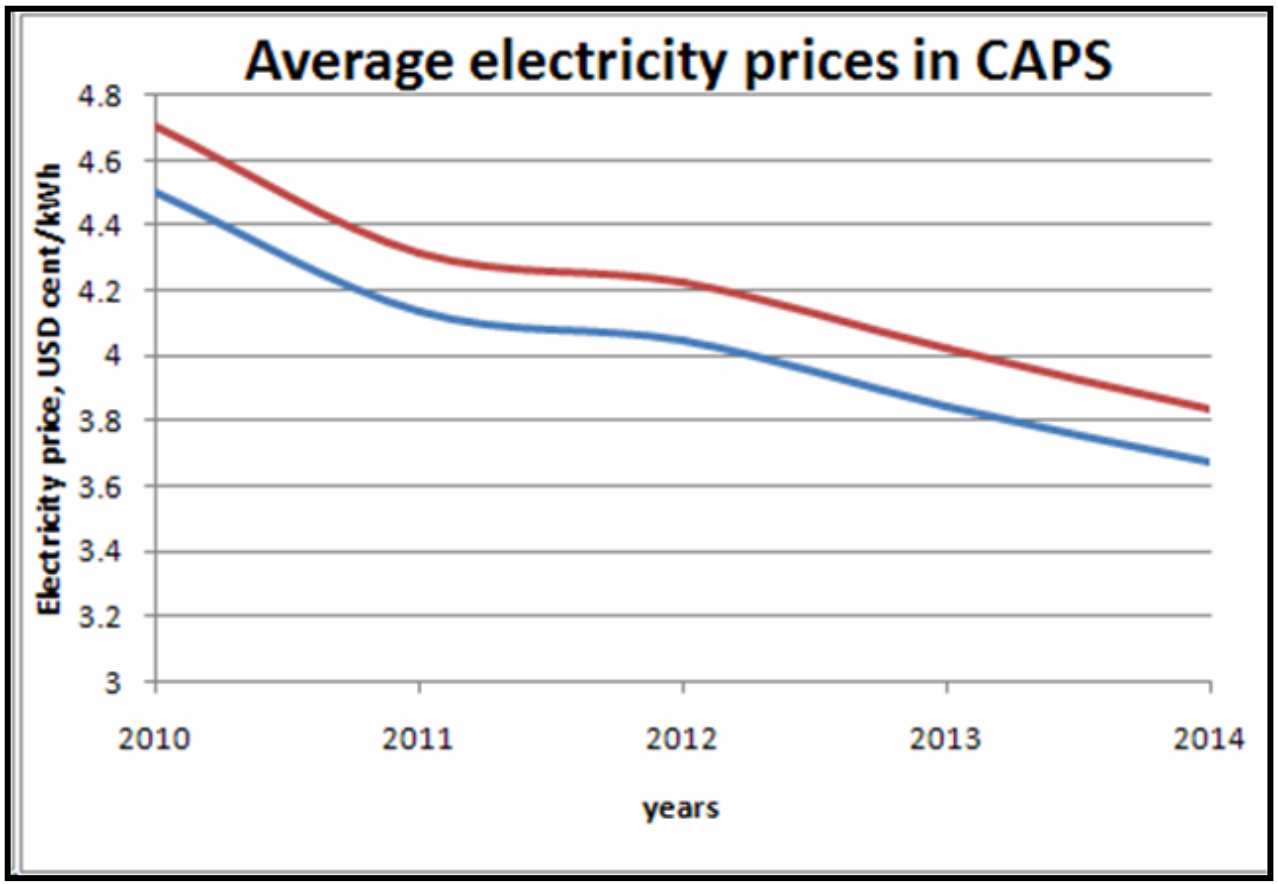
Year	Interconnected System, MUSD	No Interconnection, MUSD	Savings, MUSD
2010	11,490.30	12,000.80	510.50
2011	16,446.27	16,910.15	463.88
2012	18,036.30	18,520.19	463.88
		Total Savings, MUSD	1,458.27

  - Total costs:

Year	Interconnected System, MUSD	No Interconnection, MUSD	Savings, MUSD
2010	12,599.60	13,161.40	561.80
2011	17,240.71	17,732.70	491.99
2012	18,794.47	19,296.02	501.55
		Total Savings, MUSD	1,555.34

Economical estimation. Results.

- Electricity price (marginal costs) in the case of joint operation in CAPS is 5% lower than in the case of isolated operation.



Note: ***Blue => Interconnected System*** ***Red => No Interconnection***

Short-term issues in CAPS.

- Three (not five) countries coordination:
  - Turkmenistan and Tajikistan are not connected to the main grid.
  - The longer Tajikistan and Turkmenistan are disconnected, the more difficult will be to restore the joint operation in CAPS-5: additional time and money will be needed for adaptation

- Inefficient use of natural resources
  - Water spillage caused by:
    - No possibility to store more water: summer excess of 4.5 TWh hydro power
    - Lack of export opportunities
  - Gas losses:
    - No agreements with neighbors to import cheap hydro energy
    - Bulk thermal generation side

Short-term issues in CAPS.

- Lack of coordination in network reinforcement:
  - Uncoordinated transmission development in the region
  - Need for adequate coordination of the automatic protection system:
    - modernization of existent automatic protection system
    - installation of new automatic protection system
    - should be analyzed on the regional level
  - Can cause emergency situations in CAPS
- Failures to comply with the agreed daily schedules (deviations):
  - Energy withdrawals from the neighboring power systems
  - Lack of dispatch discipline
  - Netting of debts and pay-in-kind practice is an incentive for the countries with seasonal excess/deficit
- Frequency regulation issues:
  - Common synchronous zone with Russia
  - Agreed hourly net power flows should be fulfilled
  - In the case of emergency situation if the North-South Kazakhstan connection is disconnected, frequency control services provided by Kyrgyz Republic and potentially Tajikistan
  - Decrease in base-load consumption

Medium and long term issues in CAPS.

- Fossil fuel availability problem in the some parts of the region.
- Customs office issue.
- Water issues (conflict between power and irrigation uses):
  - Mutual dependence of water and power issues
  - Intergovernmental complex agreements
  - Beneficial equilibrium of interests can be reached
- Possibility of construction of convenient regional scale hydro projects.
- Limited financial and monetary resources.
- Lack of transparency in electricity sector.

Short-term issues. Recommendations.

- Short-term and low cost (less than 2 million USD) and high profitability measures:
  - Organize seminars and discussions of all involved stakeholders.
  - Training and strengthening of CDC “Energy” staff.
  - Improve and/or implement:
    - Regional Grid code
    - Balancing and settlement procedures
    - Disputes resolution methodology
    - Methodology to make decisions on issues of regional scope

  - Improve protections coordination.
  - Coordinated planning of network operation modes.
  - Harmonization of the commercial approaches for determining the adequate cost of the provided energy system services.

Short-term issues. Recommendations.

- Short-term and low cost (less than 2 million USD) and high profitability measures:
  - Identify reasons of unscheduled power flows.
  - Proposing methodologies for settlement of deviations and transit service compensation.
  - Define a timeline for information of transactions to CDC “Energy”, which would be included in the CAPS member daily dispatch.
  - Introduce commercial basis for the lack of dispatch discipline represented as a payment bar depending on the type of misconduct.

  - Improve the control system. Review the whole primary frequency control and AGC coordination.
  - Implement a AGC based control area system.
  - Define a scheme for mutual support during emergencies, including an appropriate price for the support energy.

Short-term and low cost measures are of primary priority.
Discussions and direct interaction between stakeholders will help to re-create countries’ confidence in the CAPS joint operation.

Medium and long term issues. Recommendations.

- Medium-term targets and intermediate costs (1-10 million USD) measures:
  - Improve supervision and control hardware.
  - Install commercial metering.
  - Implement software for daily dispatch, real time re-dispatch, post operation calculations and settlement of deviations and transit compensations.
  - Identify the requisite expansion of regional transmission system that would optimize the joint operation of CAPS members, including transactions with neighbouring countries.
- Long-term targets and higher costs (100+ million USD) measures:
  - Developments of regional scale hydro projects, aimed to provide energy and regulation and reduce emissions
  - Reinforcement of the transmission and generation system.

After a successful implementation of stage 1, stages 2 and 3 would aim to further increase benefits of joint operation