Activities in the Syr Darya River Basin

- **Hydropower**: Main source of electricity
- **Hydro Power Development Upstream**
- **Water Required for Irrigation in Summer Downstream**

Map: WATER REQUIRED FOR IRRIGATION IN SUMMER DOWNSTREAM • HYDRO POWER MAIN SOURCE OF ELECTRICITY • HYDRO POWER DEVELOPMENT UPSTREAM
NEXUS INTERLINKAGES IN THE SYR DARYA RIVER BASIN
INTEGRATED WATER-ENERGY ANALYSIS - BASIS FOR IDENTIFYING OPPORTUNITIES

Development of a **multi-country power systems model** focusing on the electricity generation facilities located in the Syr Darya River Basin.

- Investigate the dependencies between the Syr Darya water resources and the power systems sector;
- Study the trade dynamic-response of the multi-country energy system under different scenarios for the power systems in the region;
- Identify opportunities for cooperation through the integrated analysis of the power systems of the four riparian countries;
- Assess the impact of the diversification of the power generation mix through the expansion of non-hydro renewable energy technologies;
- Understand how aligned energy efficiency efforts can enhance regional energy security.
Electricity demand of the SRB countries;
Regional fuel costs for electricity generation, projected according to WEO (2015);
Countries’ load profile based on monthly electricity consumption for 2014;
Existing and planned electricity generation facilities;
Kazakhstan Green Strategy 2050;
CO₂ emission factors;
Electricity trade in the region based on historical data.
SCENARIOS

Baseline Scenario

- Energy Efficiency (EE)
- Expansion of Renewable Energy Technologies (RET)
EE measures

Kyrgyzstan
- Decrease of T&D losses
- Measures impacting the Residential sector: use of energy efficient appliances (refrigerators) and shift of 10% of electricity use to gas for space heating in winter.

Kazakhstan
- Decrease of T&D losses

Tajikistan
- Decrease of T&D losses
- Increase of pumping efficiency in agriculture, affecting summer demand;

Uzbekistan
- Decrease of T&D losses
- Increase of pumping efficiency in agriculture;
- Shift to efficient lighting options (ILBs to CFLs)
**RENEWABLE ENERGY TECHNOLOGIES (RET)**

**Kyrgyzstan**
- 20% generation from wind and solar photovoltaic (PV) power plants by 2030

**Kazakhstan**
- 40% generation from renewable energy sources (hydro, wind, PV) and nuclear power by 2030

**Tajikistan**
- 20% generation from wind power and photovoltaic (PV) plants by 2030

**Uzbekistan**
- 20% generation from wind power, photovoltaic (PV), and hydropower plants by 2030

**Figure 10. Estimated geospatial distribution of wind capacity factors for Kazakhstan, Uzbekistan, Tajikistan and Kyrgyzstan (Syal et. al., 2015 and Mentis et. al., 2015).**

**Global Horizon Irradiance for Kazakhstan, Kyrgyzstan, Uzbekistan and Tajikistan (developed from (NASA, 2008).**
The scenario analysis will focus on the role of hydropower generation in the Syr Darya River basin to investigate:

- how EE and RET can impact the development of hydropower infrastructure in the basin and in the region;
- the impact on the dynamics of electricity trade in the region.
Both EE and RET scenarios suggest a decrease in dependence from hydropower production in the Syr Darya basin;
HYDROPOWER GENERATION IN THE SYR DARYA RIVER BASIN: SCENARIO COMPARISON

• Both EE and RET scenarios suggest a decrease in dependence from hydropower production in the Syr Darya basin;
• For Kyrgyzstan, the EE measures lessen the requirements for earlier investments in hydropower infrastructure in the basin; while the deployment of non-hydro RET to 20% of generation by 2030, proves to have a similar effect than the implementation of EE measures.
HYDROPOWER GENERATION IN THE SYR DARYA RIVER BASIN: EXPLORING TRADE DYNAMICS

REPRESENTATION OF ELECTRICITY TRADE

- Electricity trade was represented based on historical data and on the inventory of existing interconnectors between the countries (FICHTNER, 2012; WB, 2011; MERCADOS, 2010; KEGOC Annual Reports 2009-2015).

- In the EE and RET scenarios, trade was allowed between all countries for the period 2021-2030.

- Trade with non-riparian countries, not modelled in this exercise (Russia and Afghanistan), was constrained through the definition of lower and upper limits.
HYDROPOWER GENERATION IN THE SYR DARYA RIVER BASIN: **EXPLORING TRADE DYNAMICS**

- Tajikistan role as net exporter and Kazakhstan net importer;
- Kyrgyzstan and Uzbekistan changing role in trade;
- Tajikistan role as net exporter and Kazakhstan net importer;
- Kyrgyzstan as net exporter throughout all period in comparison to the baseline;
- Uzbekistan decrease in exports due to lower demands of neighbouring countries.

- Tajikistan role as net exporter and Kazakhstan net importer;
- Increased %RET in Kazakhstan reduce the import requirements from 2026;
- Similarly to the baseline, electricity flowing to Kyrgyzstan results in a lower cost option to fossil fuel or hydropower development.
- Low gas prices in Uzbekistan enhance electricity exports.
Higher hydropower generation in the Syr Darya basin is linked to increased export capacity (Baseline and EE);

- A negative export balance matches increased import requirements.
HYDROPOWER GENERATION IN THE SYR DARYA RIVER BASIN: **EXPLORING TRADE DYNAMICS**

**BASELINE SCENARIO**

**Kazakhstan imports/exports (PI)**
Baseline Scenario

**Uzbekistan imports/exports (PI)**
Baseline Scenario

**KG imports/exports (PI)**
Baseline Scenario

**Tajikistan imports/exports (PI)**
Baseline Scenario
HYDROPOWER GENERATION IN THE SYR DARYA RIVER BASIN: **EXPLORING TRADE DYNAMICS**

**EE SCENARIO**

Kazakhstan imports/exports (PJ)

Uzbekistan imports/exports (PJ)

KG imports/exports (PJ)

Tajikistan imports/exports (PJ)
HYDROPOWER GENERATION IN THE SYR DARYA RIVER BASIN: **EXPLORING TRADE DYNAMICS**

**Kazakhstan imports/exports (PJ)**
**RET Scenario**

**Uzbekistan imports/exports (PJ)**
**RET Scenario**

**KG imports/exports (PJ)**
**RET Scenario**

**Tajikistan imports/exports (PJ)**
**RET Scenario**
Electricity trade between countries allows for the seasonal balancing of electricity demand;

Electricity generation in Uzbekistan and Kazakhstan, is mostly exported to Tajikistan and Kyrgyzstan in winter months;

Electricity exports from Tajikistan and Kyrgyzstan to other nations is higher during summer;

Lower fuel prices in downstream nations allow for winter exports to upstream nations. Complementary, these imports are mostly compensated as exports to downstream countries in summer.
SELECTED TECHNICAL FINDINGS

- Hydropower expansion in the Syr Darya basin will be required under a BAU scenario, representing over 40% of the hydropower production in the region, (32% in Kyrgyzstan). If EE measures are implemented the dependency from water resources for electricity generation can decrease to 38%, while the diversification of the generation mix in the region, through integration of RET (windpower and PV) can lower the contribution to 37% of hydropower generation.

- Reestablishment of interregional electricity trade can reduce investments in expansion of hydropower generation in the Syr Darya basin.

- Low fuels prices for electricity generation in the downstream nations can compensate for deficits in seasonal electricity demands in upstream nations, via electricity trade.

- The implementation of EE measures in a concerted manner in the region would decrease the electricity import requirements from upstream nations. Further efforts would likely increase the capacity for exports.
DATA GAPS

- Time slices and load profile (yearly and daily);
- Validation of generation technologies list (operating and planned infrastructure, investment costs, variable & fixed costs, efficiency of power plants);
- Cross-border transfer capacities (including trade agreements, operating and planned infrastructure);
- Continuous historical records of electricity trade;
- Fuel prices for electricity generation;
- Transmission and distribution losses and updated/validation of targets;
MODEL LIMITATIONS

• Electricity trade was limited to the inventory of interconnectors in the region. Uncertainty exits in regard to the cross-border capacities in practice and planned interconnectors. Information on trade agreements.

• Temporal resolution in the model is currently limited to two seasons, winter and summer. More disaggregated representation would allow for the refinement of conclusions.

• The variability of hydrological conditions is yet to be included in the modelling framework - capacity factors for existing hydropower plants have been kept constant throughout the modelling period, while generic capacity factors were considered for new projects.

• Electricity demands require validation or update, so to be aligned with national projections.

• Power generation technologies were grouped per fuel and location in respect to the Syrdarya basin. Monthly generation of power plants would allow for a reduction in uncertainty in power plants outputs.
Thank you

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