Applying IRENA FlexTool for Russia

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The main idea of FlexTool study

Just a first experience with IRENA FlexTool model.

Optimal solution (capacity mix) of our in-house long-term capacity expansion model EPOS was used as an input for FlexTool.

Main questions asked:

1) Is the amount and structure of capacity identified by our in-house EPOS model could satisfy hourly electricity demand in 2040 – flexibility check?

2) What is the effect of capacity mix change on "spot" shadow electricity prices?

Main features of EPOS model

EPOS optimization model is the least-cost multi-year, multi-regional modeling tool for the power sector strategic planning:
• 2050 planning horizon
• >400 major existing and planned power plants + >30 types of new generating technologies
• capacity (incl. reserve) and wholesale electricity balances by 42 nodes
• heat and retail electricity balances by 80 regions
• only basic flexibility check – rated capacity balances for min/max load hours of representative winter day by 7 integrated power systems
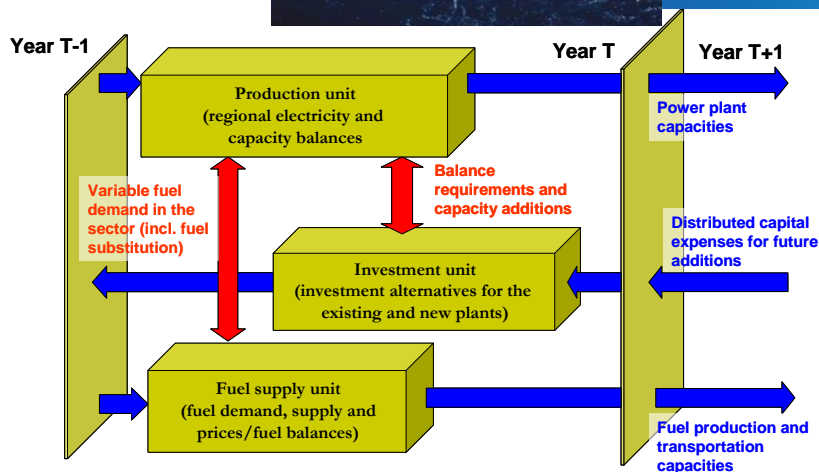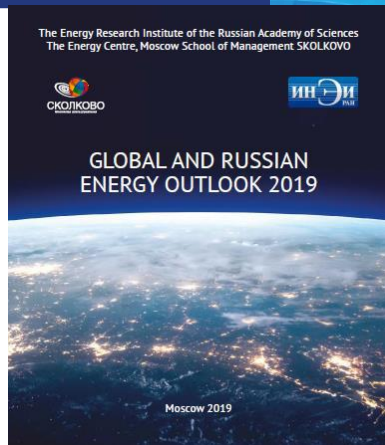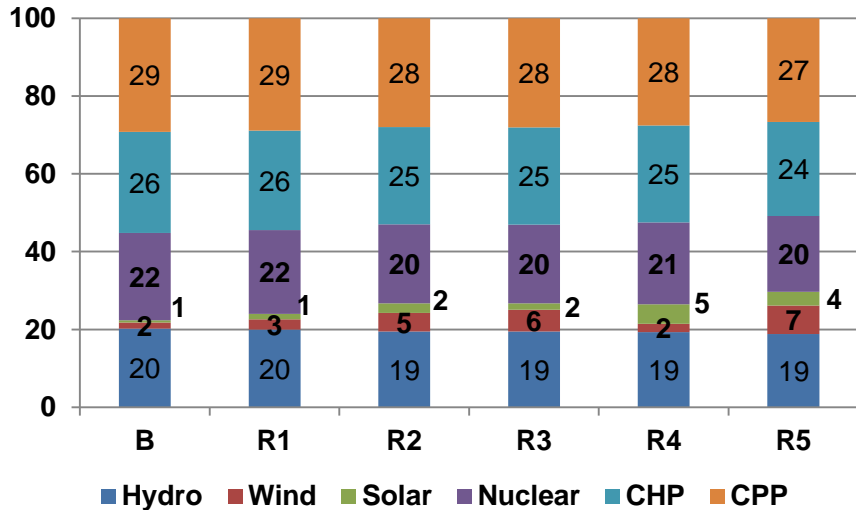
Representation of Russian power sector in FlexTool

- We used now outdated version of FlexTool where CHPs couldn't be properly described. So we modeled them as RES plants, generating only according to the heat demand curve with no fuel costs (no additional generation in condensing mode);

- Instead of 42 power nodes and 80 heat regions, balances were modelled only for 5 integrated power systems (IPS) of European part of Russia. Eastern regions poorly connected to the European part of Russia were dropped for now;

- Only 9 aggregated generating technologies in each IPS were modelled (CHP, CCGT, OCGT, CPP ST gas, CPP ST coal, Nuclear, Hydro, Wind, Solar); Optimal capacity and aggregated characteristics were obtained from EPOS model;

- Real historical load curves for each of the IPS were used;

- Due to lack of historical data typical hourly generation curves for wind and solar plants in each IPS were used;

- No ramping constraints were activated.

The main results of FlexTool study

Capacity mix in 2040, %

Legend: ■ Hydro ■ Wind ■ Solar ■ Nuclear ■ CHP ■ CPP

	B	R1	R2	R3	R4	R5
CPP	29	29	28	28	28	27
CHP	26	26	25	25	25	24
Nuclear	22	22	20	20	21	20
Solar	1	1	2	2	5	4
Wind	2	3	5	6	2	7
Hydro	20	20	19	19	19	19

Analyzed scenarios are not very ambitious in terms of RES and nuclear development

Results for most ambitious R5 scenario

- No flexibility issues were detected with ramping constraints deactivated.

- Dispatch results is quite realistic but some capacities are over- or under-utilized=> need of min/max utilization

- Compared to more detailed EMPS model (SKM Market Predictor) values of shadow prices differ, but the dynamics of change from scenario to scenario is similar
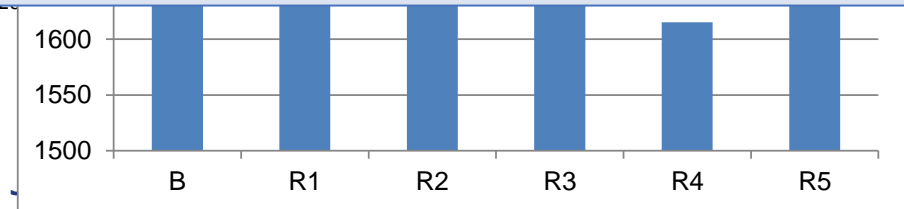
- FlexTool is a very handy tool for quick check of the results of capacity expansion models for flexibility issues (It only took 2 days to get satisfactory results from the scratch).

- FlexTool is flexible enough to model different types of power systems not necessary with high shares of RES.

- But some model improvements were needed (CHP representation, min/max utilization rates, etc.) and they have already been done, so we are going to switch to the newest version and use it in our further research.

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Thank You for Attention!