

Competitiveness of nuclear power plants in the context of decarbonization strategies

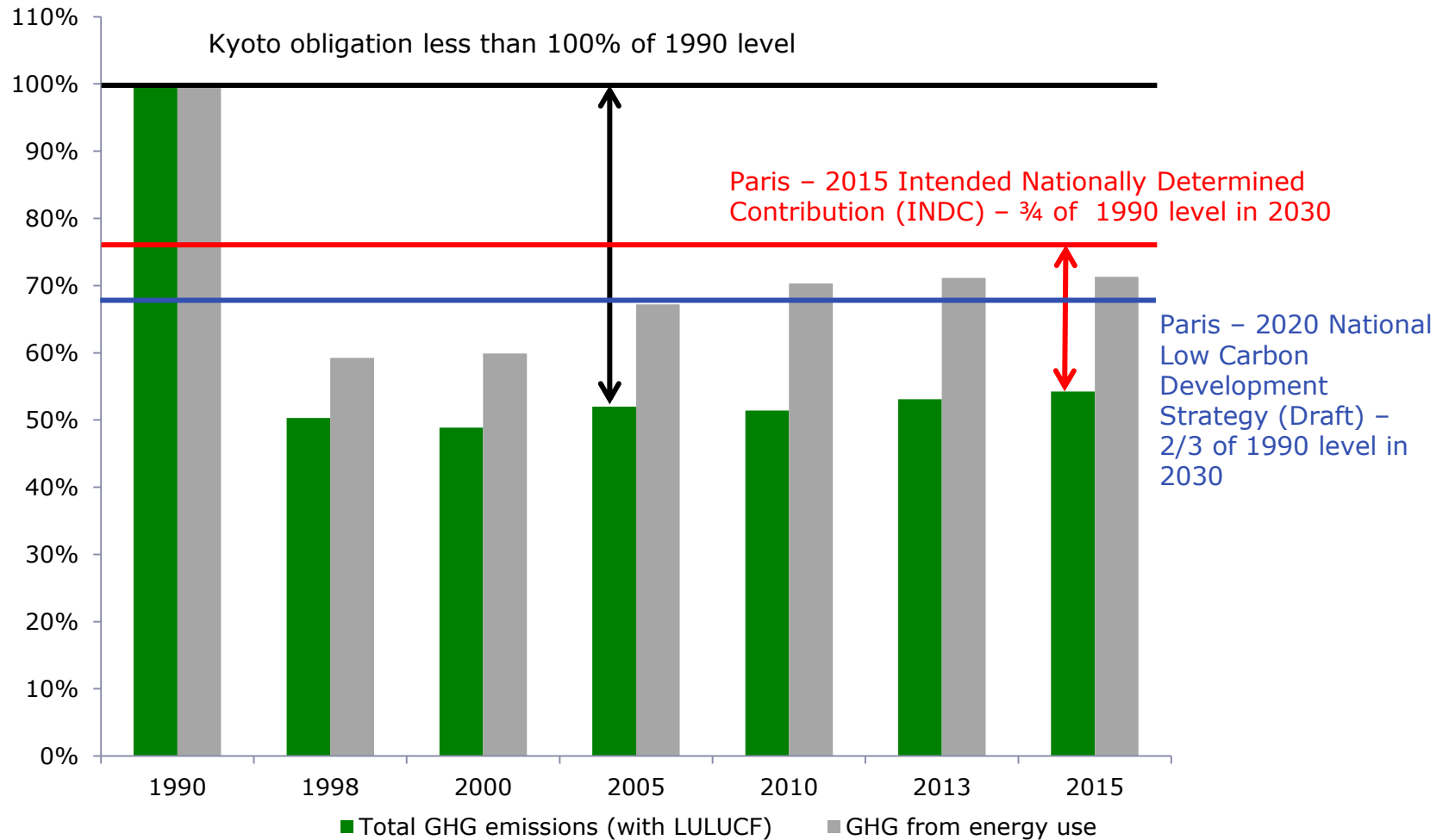
Fedor Veselov, Energy Research Institute of RAS

NICE Future webinar

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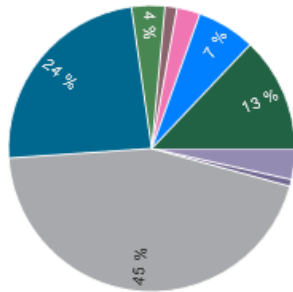


From Kyoto to Paris - strengthening of the national GHG obligations



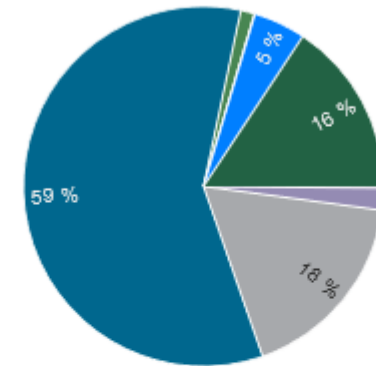
Russian electric power sector.

World (2017)
Total: 5 313 Mtoe



Oil products	185 Mtoe
Oil	41 Mtoe
Coal	2 374 Mtoe
Natural gas	1 264 Mtoe
Biofuels and waste	200 Mtoe
Geothermal	72 Mtoe
Solar/tide/wind	139 Mtoe
Hydro	351 Mtoe
Nuclear	687 Mtoe

Russian Federation (2017)
Total: 339.6 Mtoe



Oil	0.5 Mtoe
Oil products	6.7 Mtoe
Coal	59.6 Mtoe
Natural gas	199.2 Mtoe
Biofuels and waste	4.2 Mtoe
Geothermal	0.1 Mtoe
Solar/tide/wind	0.1 Mtoe
Hydro	15.9 Mtoe
Nuclear	53.3 Mtoe

Russian power sector is one of largest in the world

- 4th place in the total generation of electricity (1092 TWh in 2017)
- Gas-fired plants forms 48% of total capacity (264 GW)
- CHP forms 50% of thermal plants' capacity

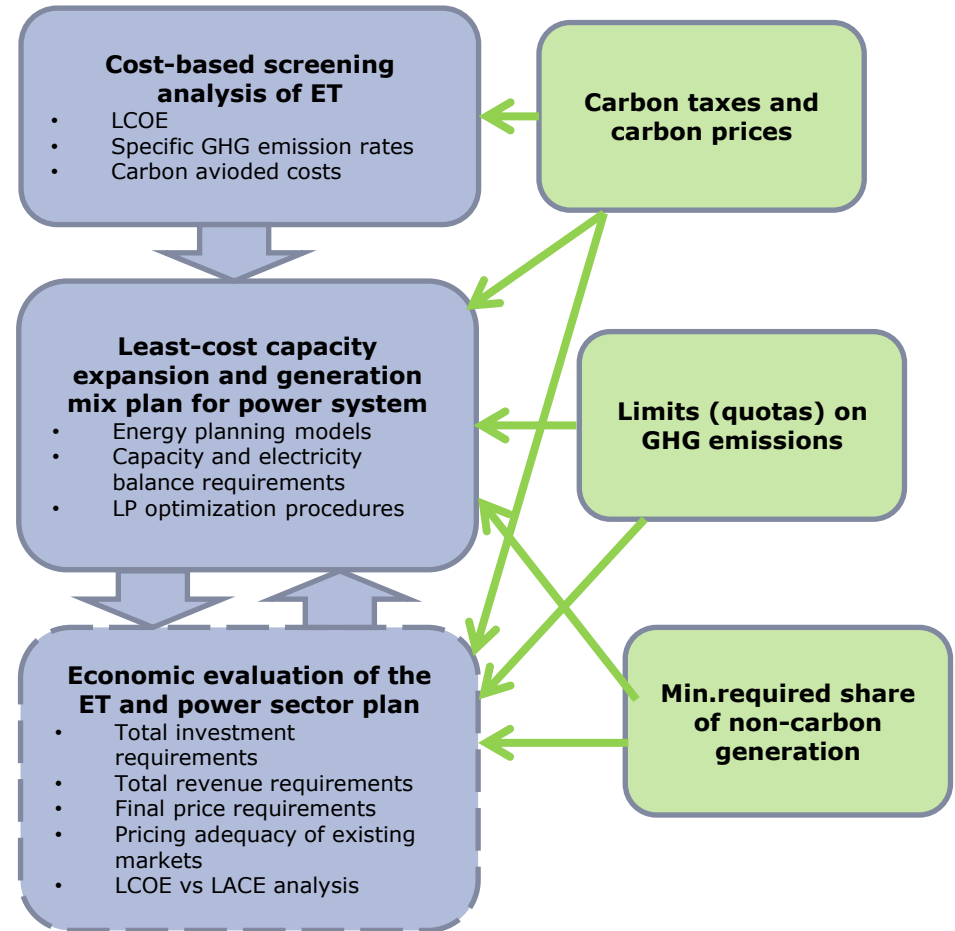
Russia has 29 GW of nuclear plants (11% of total installed capacity) and takes 5th place in world (203 TWh in 2017)

Assessment of the non-carbon energy technologies (ET) competitiveness in the multistage energy planning procedure

Diversity of energy technologies for the low-carbon transformation of the national power sector

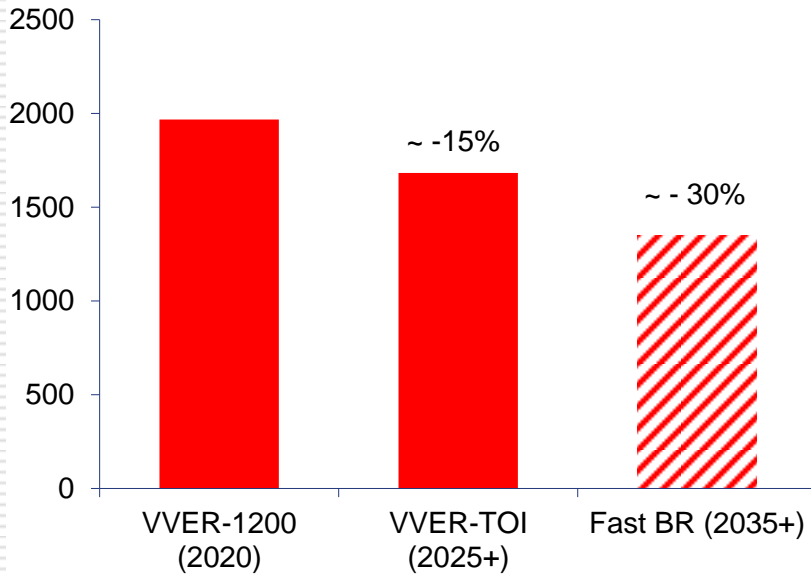
Multistage energy planning procedure with detailed GHG abatement options

	Low carbon emissions	Zero carbon emissions
Use depletable resources	CCGT Gas-fired CHP CCGT+CCS Coal+CCS	Nuclear (all types)
Use renewable resources	Biomass/biogas plants, incl. CHP	Hydro Wind on/offshore Solar PV/CSP



Nuclear plants – technological improvements as a key factor of their competitiveness

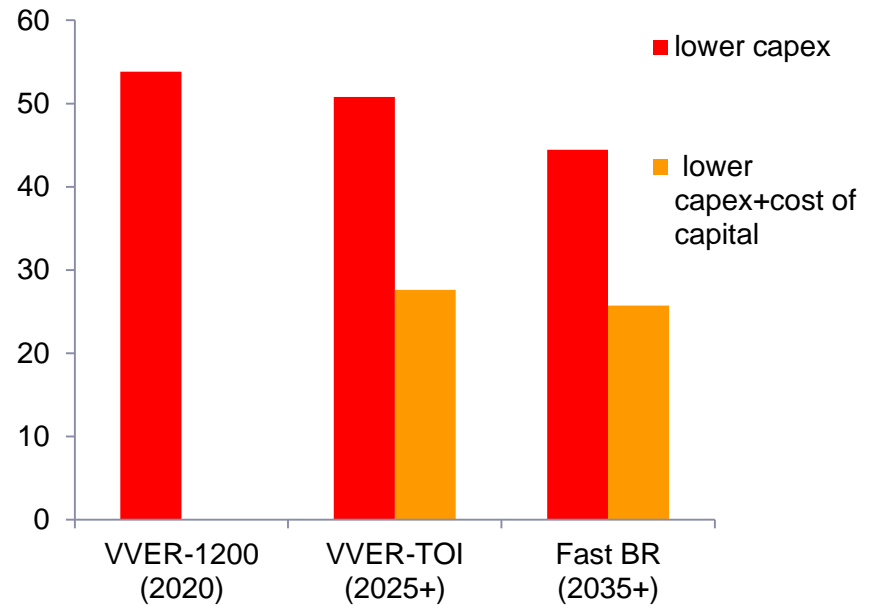
Impact of technological improvements on the NPP capex (local projects), \$/kW



Additional factors:

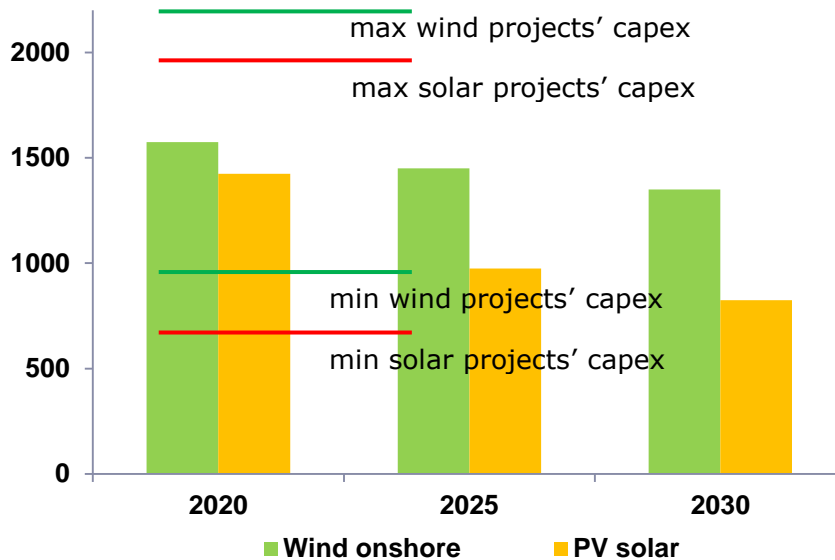
- Lower O&M costs
- Lower fuel costs
- Higher Capacity factor
- Lower cost of capital

Impact of lower NPP capex and cost of capital on the LCOE, \$/MWh (2018)



RES plants – rapid technological improvements will be accompanied by the high system integration costs

Impact of technological improvements on the wind and solar capex (local projects), \$/kW

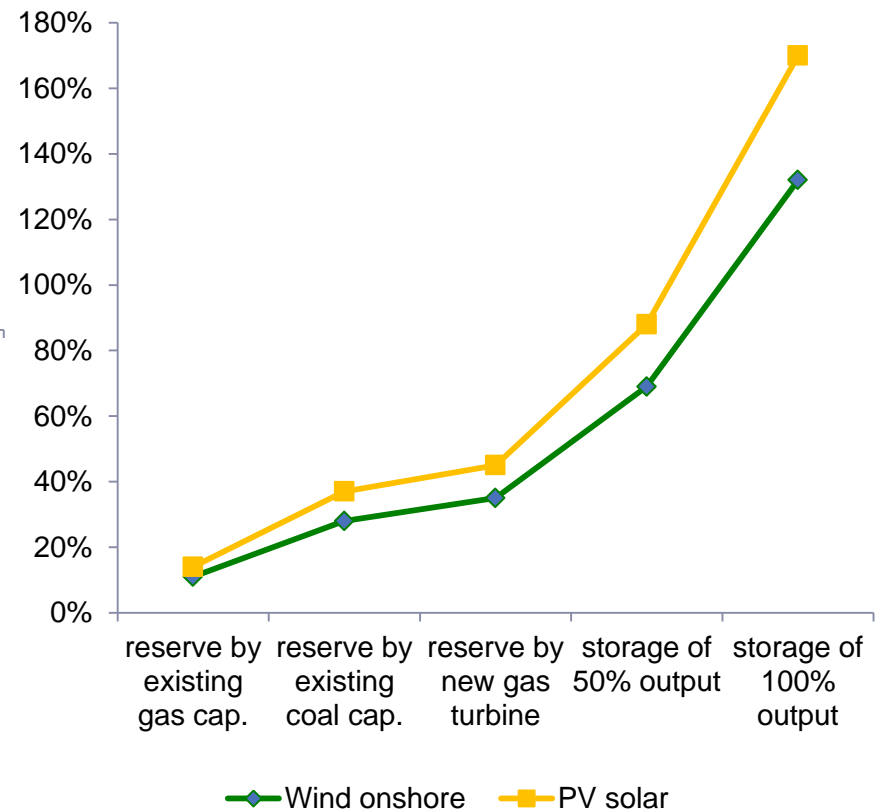


Wind and solar plants generate electricity stochastically, depending on the weather current conditions

For the proper screening analysis of ET it is important to take into account additional costs to enhance the availability of their capacity through:

- Maintaining of the additional reserves at existing of new thermal plants
- Their combination with storage capacities

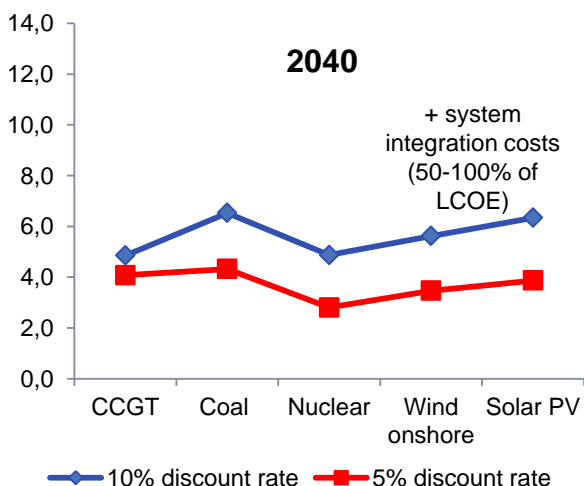
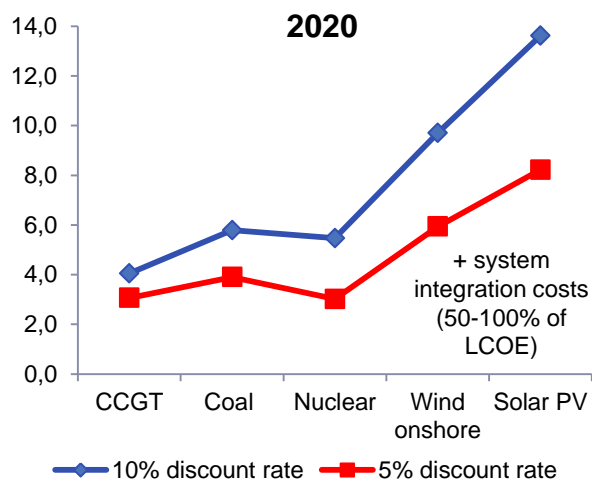
Impact of RES availability costs on the LCOE of RES plants (in % of RES LCOE)



Source: ERI RAS analysis

Cost-based analysis of non-carbon energy technologies and the role in the future capacity mix

LCOE of greenfield plants in the Central Russia, 0.01\$/kWh



Nuclear and modern gas plants will be the most important options for GHG emissions abatement in the Russian power sector

	2017	2040								
		1	2	3	4	5	6	7	8	9
Total capacity, GW.	239.8	289.2	289.6	288.9	297.0	289.6	294.9	291.0	298.1	258.2
Hydro	48.4	55.3	55.3	55.3	55.3	55.3	55.3	55.3	55.3	55.3
Wind and solar	0.7	6.1	6.1	6.1	13.8	6.6	13.0	7.4	15.3	6.1
Nuclear	27.9	65.0	61.3	60.5	70.1	62.5	51.6	70.5	72.9	53.9
Thermal	162.8	162.8	166.9	167.1	157.8	165.3	175.0	157.8	154.6	142.9
Total capacity, %	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Hydro	20.2	19.1	19.1	19.1	18.6	19.1	18.7	19.0	18.5	21.4
Wind and solar	0.3	2.1	2.1	2.1	4.6	2.3	4.4	2.5	5.1	2.4
Nuclear	11.6	22.5	21.2	20.9	23.6	21.6	17.5	24.2	24.5	20.9
Thermal	67.9	56.3	57.6	57.8	53.1	57.1	59.3	54.2	51.9	55.3
Total fuel demand, Mtce	274.6	278.1	285.2	291.2	261.2	284.0	302.6	259.9	250.0	254.7
Gas, % of total	71.4	62.8	69.4	68.5	62.0	63.0	64.0	69.2	70.9	63.9
Total CO ₂ emissions, MtCO ₂	545.8	583.0	574.4	589.5	550.3	594.6	629.6	524.1	498.8	530.4
In % to 2017 level		7%	5%	8%	1%	9%	15%	-4%	-9%	-3%

Source: ERI RAS analysis

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Thank you for attention!