The Electric Power system

RUSSIA

cigre
For power system expertise

Power system of COUNTRY

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Basic facts

- Area (km²): 17 125 191
- Population (mln): 146,7
- Number of electricity consumers: -
- Number of TSOs: 1 – PJSC FGC UES (88% of transmission grid)
- Number of DSOs: 1300 (approx.), the largest - Rosseti Group (74% of distribution grid)
- Peak load (GW):151,6
- Number of ISOs: 1 – System Operator of the United Power System
- Average interruption of electricity (h): 1,8

Global map of the grid and of its interconnections

- Interconnectors with:
  - Finland
  - Estonia
  - Latvia
  - Lithuania
  - Belorussia
  - Ukraine
  - Azerbaijan
  - Georgia
  - Kazakhstan
  - China
  - Mongolia

Grid facts and characteristics

- All power systems are interconnected by HV and UHV transmission lines 220–750 kV and operated in synchronous mode (in parallel), except IPS of the East.

Russian Power Grid (in general):

3,4 mln km of power transmission lines

686,2 thousand substations

Assets of Rosseti Group

88% of Russian transmission grids
74% of Russian distribution grids

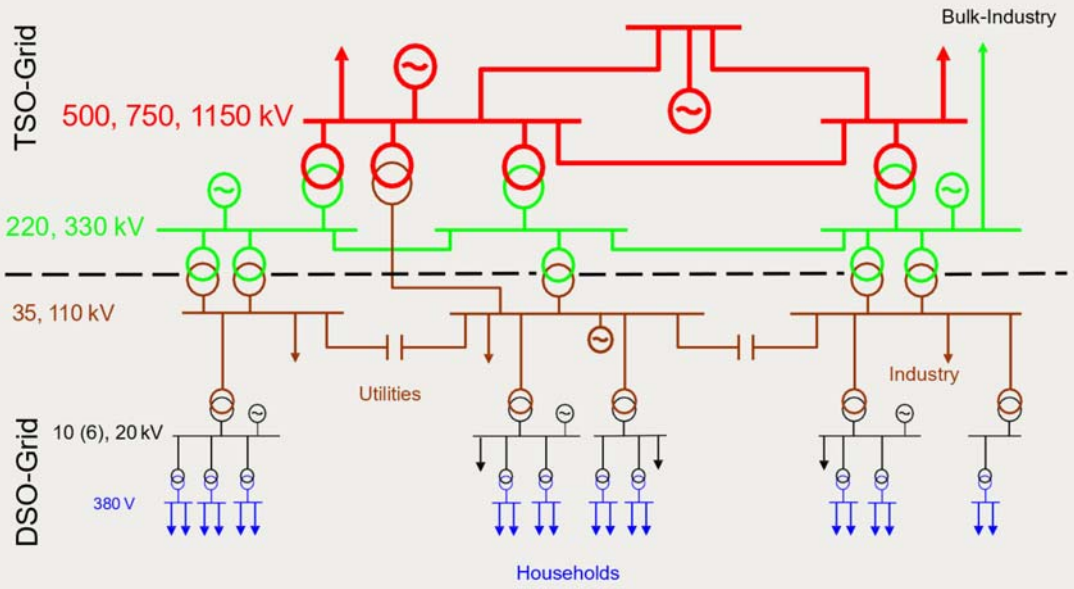
2,37 mln km of power transmission lines

517 thousand substations
802 GVA transformer capacity
8,57 % Network losses

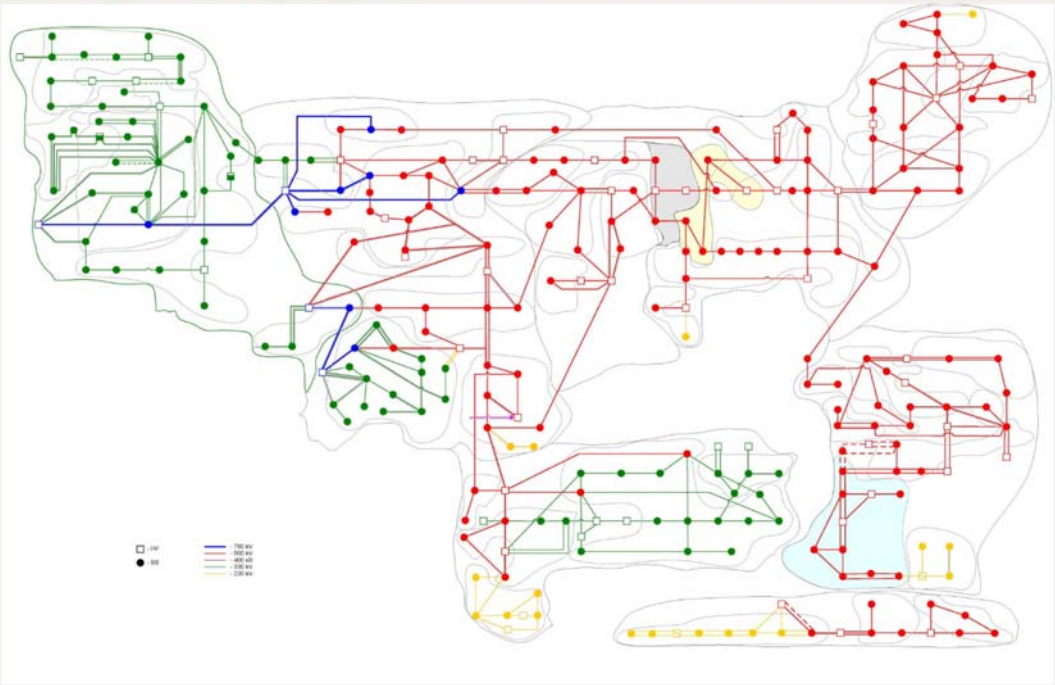
Distribution grid: 0.22,0.38,6,10,20,35,110 kV

Transmission grid: 220,330,500,750,1150 kV

Structure of electrical power system



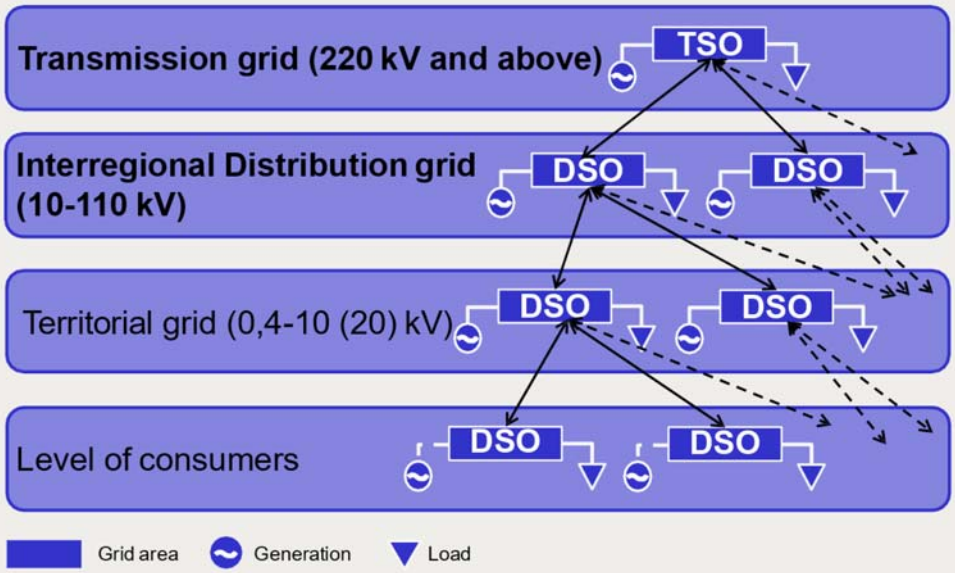
Map of the high voltage grid



Information on TSO(s)

- Name: PJSC “Federal Grid Company of the Unified Energy System” (the largest TSO)
- Network length (km): 148 265,66
- Served area (km²): 15,1 mln (approx.)
- Annual transmitted energy (TWh): 558,7
- website: https://www.fsk-ees.ru/eng/

Cooperation of TSO and DSOs



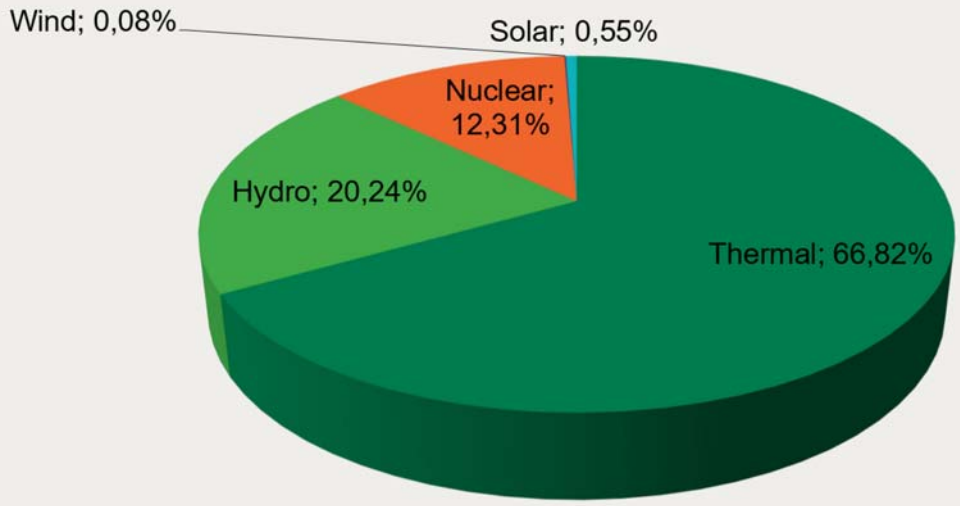
Responsibilities of TSO & DSOs

- TSO
- FGC UES managing the Unified National Energy Grid (UNEG)
- Providing electricity transmission services and connecting participants in the wholesale market to the electricity grid
- Investment activities in the UNEG development
- Engaging in the UNEG technical supervision of the UNEG grid facilities

- DSO
- Managing distribution grids
- Providing electricity transmission services and connecting consumers to the electricity grid

Power structure of the country / countries

Installed capacity of power plants (UPS of Russia, 01.01.2020)



Installed capacity with reference to primary resources

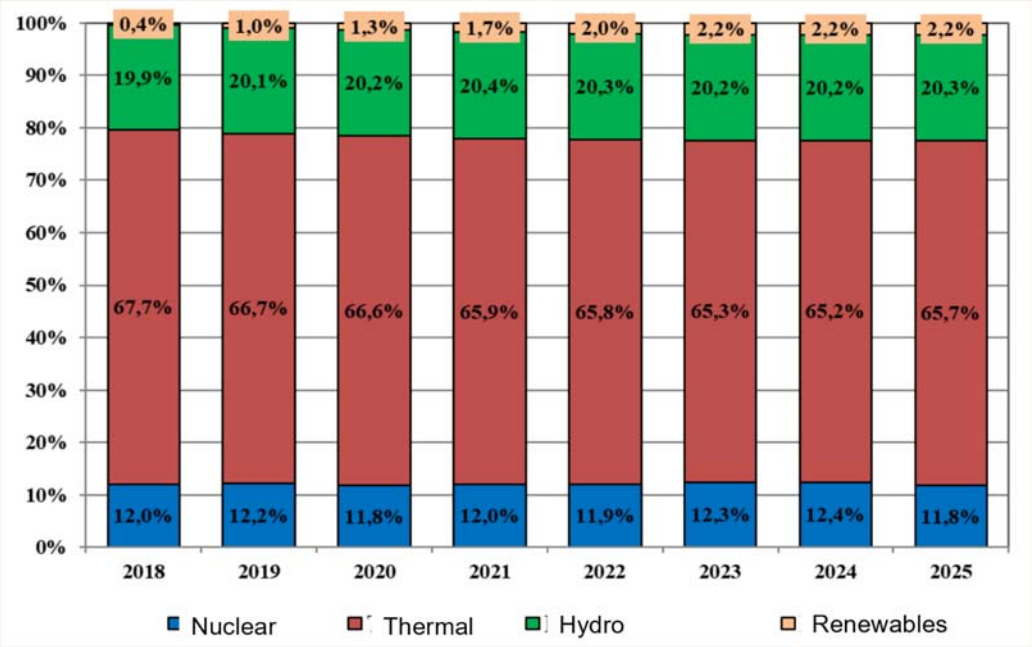
- Installed capacities (GW), total – 246,3 GW (01.01.2020)
  - Thermal – 164,6 GW
  - Hydro power – 49,9 GW
  - Nuclear – 30,3 GW
  - Solar power – 1,4 GW
  - Wind power – 0,2 GW

Energy production with reference to primary ressources

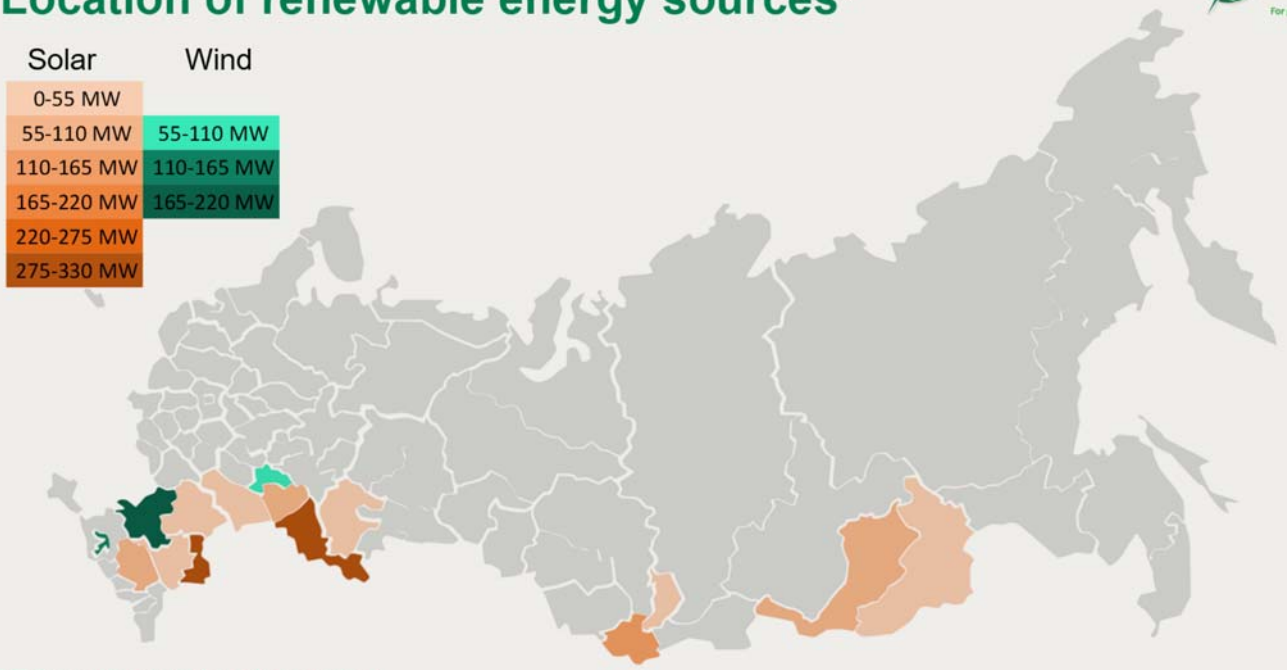
- Electricity generated (TWh), year
  - Thermal – 679,9
  - Hydro power – 190,3
  - Nuclear – 208,8
  - Solar power - 1,3
  - Wind power - 0,3

Development of generation capacity

Share of installed capacity of UPS or Russia

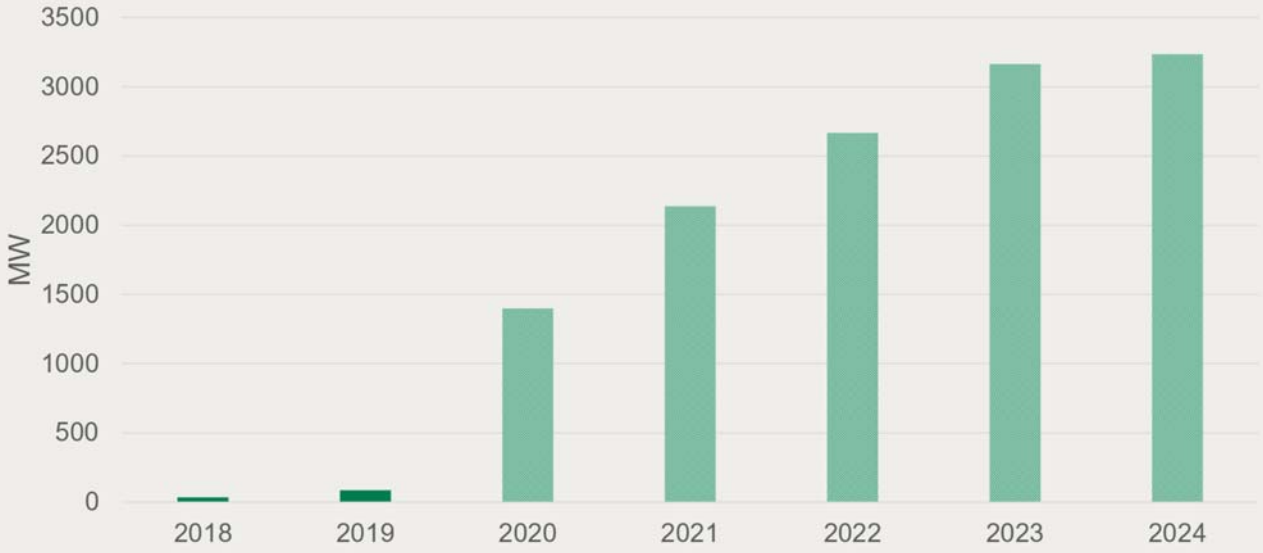


Location of renewable energy sources*

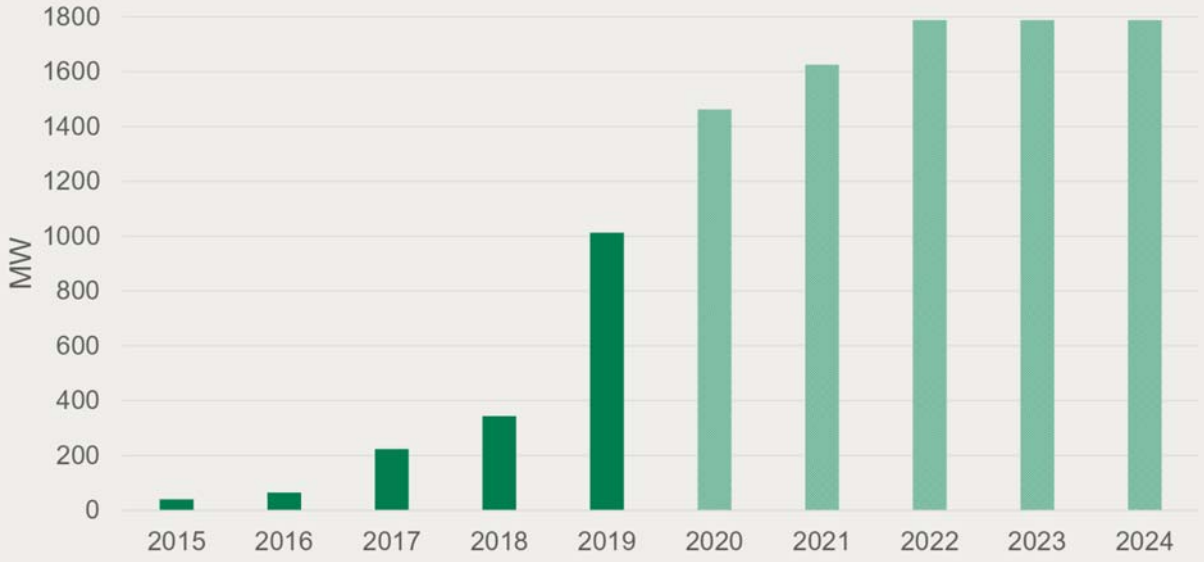


* RES on the wholesale market

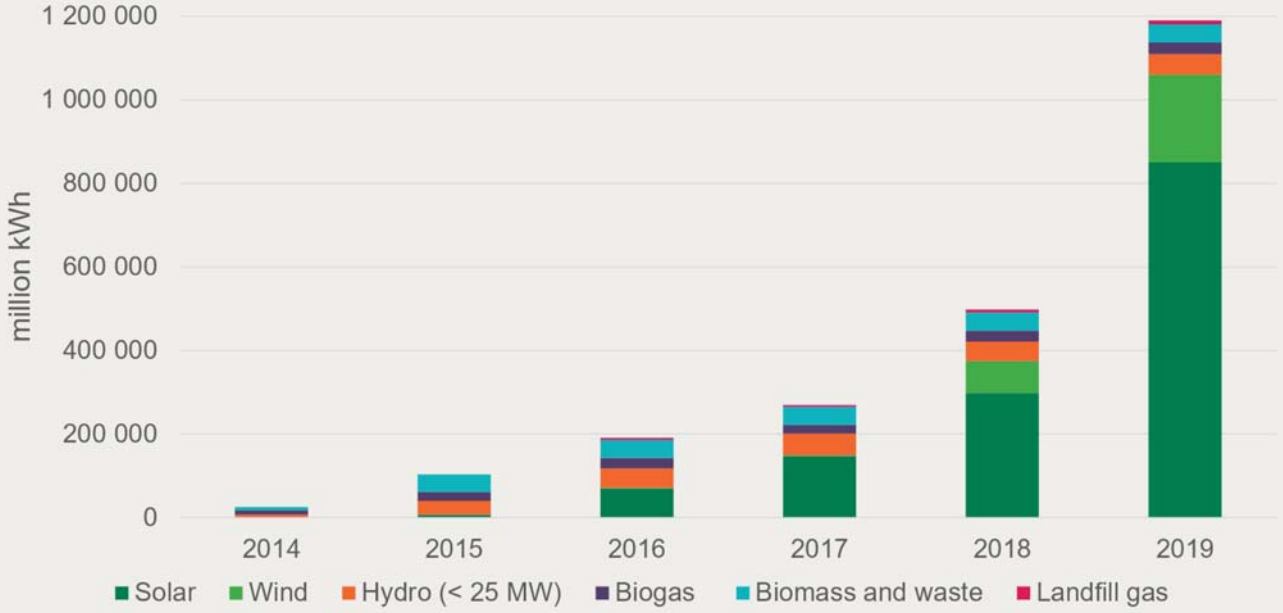
Development of wind power on the wholesale market



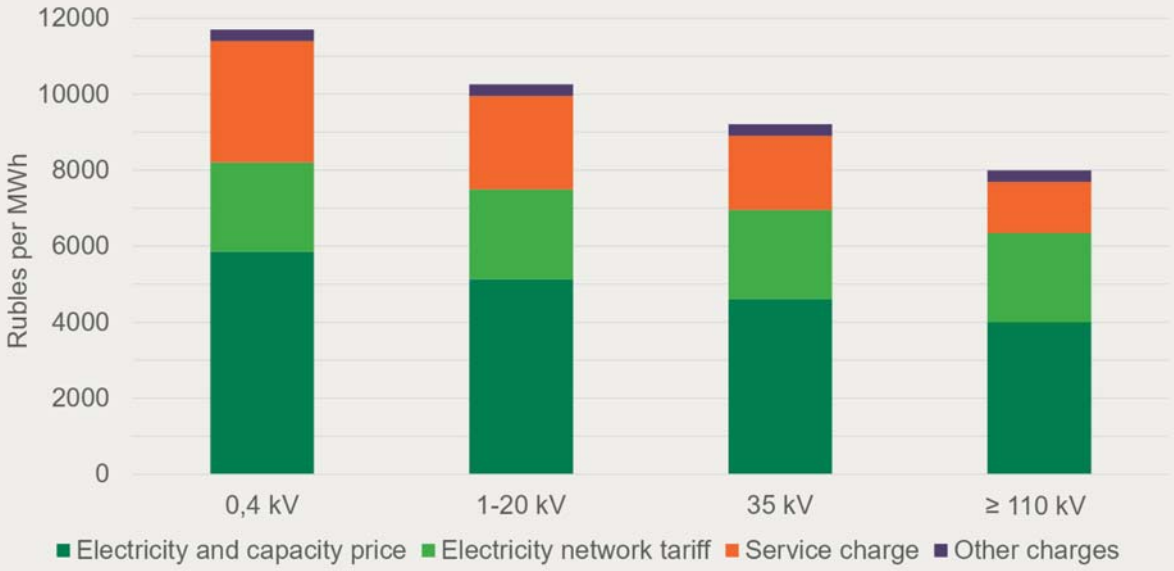
Development of photovoltaic power on the wholesale market



RES production per annum



Price development for industry consumers

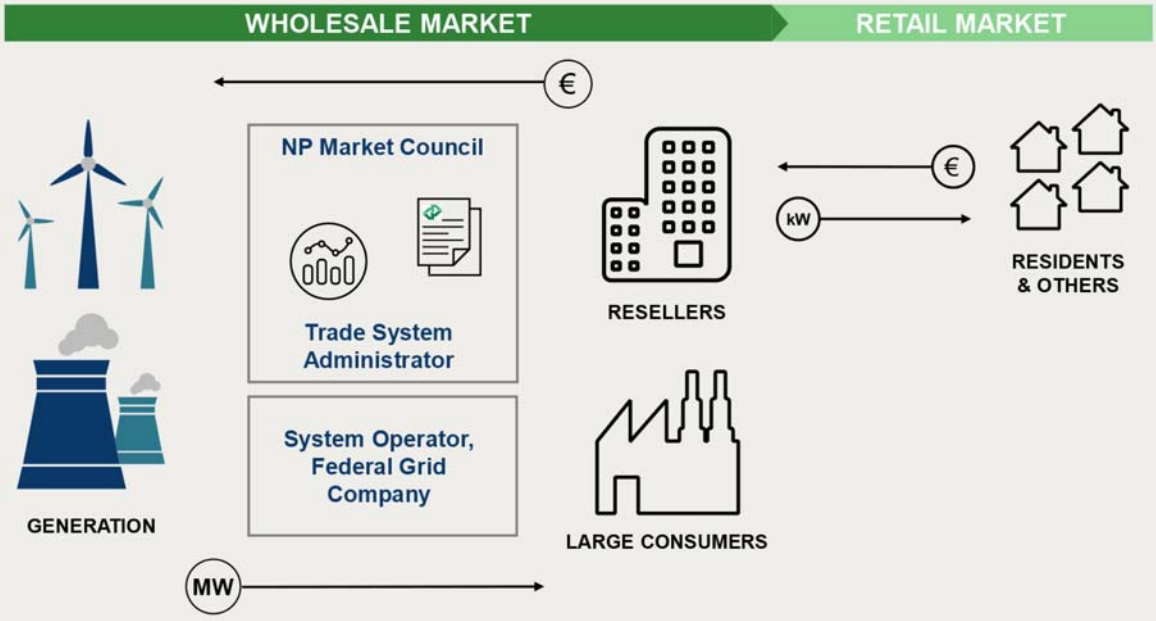


*The prices are shown for consumers in the 1st price zone of the wholesale market who are serviced by Guaranty Suppliers
** 1 EURO = 72,3187 RUB

Price development for households

- For residential consumers, electricity is purchased in the wholesale market by Guaranty Suppliers with special Regulated Contracts
- In 2019 the electricity price in the end-consumers bills of households in zones of centralized electricity supply equaled 3,31 rubles per kWh

Electricity and capacity market organisation

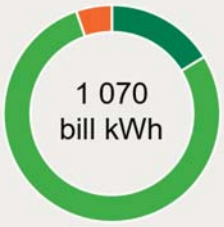


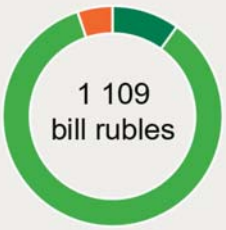
Power balance in 2018 / 2019

- Generation (TWh) – 1080,5 TWh (100,9% of 2018)
- Consumption (TWh) – 1059,4 TWh (100,4% of 2018)
- Net power flows (TWh) - -21,2 TWh
- Imports (TWh) – 5 121,982 / 1 602,609 (2018/2019)
- Exports (TWh) - 16 711,713 / 19 338,312 (2018/2019)

Energy exchanges in 2018 / 2019

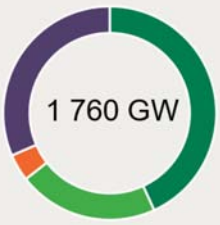
	Physical flows		Commercial flows	
	2018	2019	2018	2019
Electricity market	1068,17 bill kWh	1070,55 bill kWh	1088,26 bill rubles	1109,80 bill rubles
Capacity market	1698,521 GW	1760,39 GW	660,76 bill rubles	752,81 bill rubles





■ Regulated contracts ■ Day-Ahead Market ■ Balancing Market

*1 EURO = 72,3187 RUB



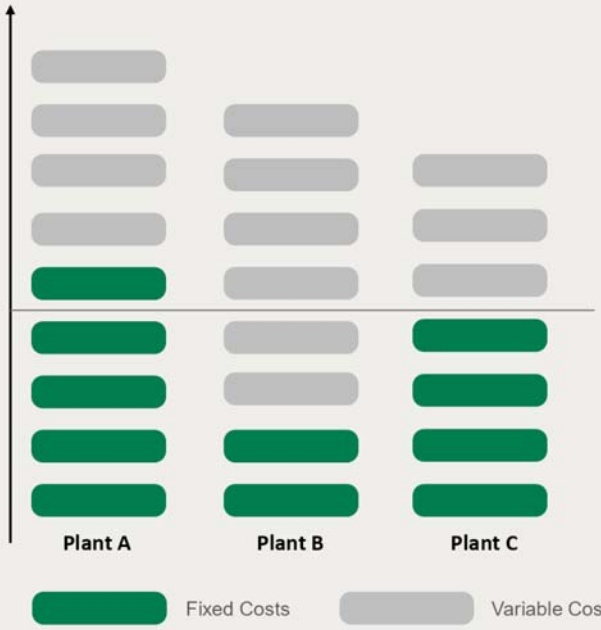
■ Reliability Pricing Model

■ Contracts of forced generation

■ Contracts for building new power plants

■ Regulated contracts

Specific aspects of the electricity market



Fixed Costs Variable Costs (fuel etc.)

Payments for electricity
the value of electricity sold through contracts, on the LMP-model Day Ahead Market and the Balancing Market

Unit Commitment	Day Ahead	Intraday
3 days	1 day	1 hour

Payments for capacity
the value of capacity sold through contracts or at market prices. Capacity sector also includes the contracts of new generation development and cross-subsidies transfers between regions

Long term capacity contracts	Reliability Pricing Model
15 years	6 years