The Electric Power System

- Russian Federation –
Basic facts

- **Area**: 17,125,407 km²
- **Population**: 146,267,288 (2015)
- **Number of TSOs**: 1 - Federal Grid Company of Unified System (95 %)
- **Number of DSOs**: 3500
- **Peak load**: 155 GW
- **9 time zone, 69 regional power systems forming 7 interconnected power systems (IPS).**
Grid facts and characteristics

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

**Distribution:** 0.22, 0.38, 6, 10, 35, 110 kV
- Lines – 2 200 000 km
- 480 000 substations
- total capacity 750 000 MVA

**Transmission:** 220, 330, 500, 750, 1150 kV
- total length lines 139 586 km
- 947 substations
- total capacity 382 788 MVA
Structure of electrical power system

Unified Energy System of Russia
Map of the high voltage grid
# Information on TSO(s)

## Federal Grid Company of Unified System

<table>
<thead>
<tr>
<th>Network length [km]</th>
<th>138 800</th>
</tr>
</thead>
<tbody>
<tr>
<td>Served area [km²]</td>
<td>151 000 000</td>
</tr>
<tr>
<td>Annual transmission [TWh]</td>
<td>518,09</td>
</tr>
<tr>
<td>Website</td>
<td><a href="http://www.fsk-ees.ru">http://www.fsk-ees.ru</a></td>
</tr>
</tbody>
</table>

## DSO including transmissions lines and substations 220-500 kV

<table>
<thead>
<tr>
<th>Name</th>
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<th>Served area [km²]</th>
<th>Annual transmission [TWh]</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bashkirian Power Grid Company</td>
<td>2 000</td>
<td>142 947</td>
<td>20,987</td>
<td><a href="http://bashes.ru">http://bashes.ru</a></td>
</tr>
<tr>
<td>Moscow United Electric Grid Company</td>
<td>1 503</td>
<td>46 900</td>
<td>71,884</td>
<td><a href="http://www.moesk.ru">http://www.moesk.ru</a></td>
</tr>
</tbody>
</table>
Cooperation of TSO and DSOs

- Transmission grid (up to 220 kV)
- Interregional Distribution grid (10-110 kV)
- Territorial grid (0,4-10 kV)
- Level of consumers

Grid area 🌍 Generation ⚡ Load 🔻
Installed capacity with reference to primary resources

- Installed capacities (%)
Electricity generation

Thermal power plant (TPP): 71% gas-fired, 24% coal-fired, 5% oil.
In 2014 it connected electricity grid companies 370 thousand new customers with an overall capacity of over 6 GW. And in just 3 years connected of more than 750 thousand of consumers with a connected load of 15 GW.
Location of renewable energy sources

- In July of this year the Russian Federation joined the International renewable energy Agency (IRENA).

- By 2035, in accordance with our new Energostrategia, electricity production based on renewable energy should be increased in 15 times.
Renewable energy sources

By 2020 the share of RES and NPPs in total amount of electricity generation is planned to be increased:

RES development will provide with energy the territories which are isolated from the Unified Energy System through the use of local fuel resources and renewable energy.

Structure of electricity generation by type of power plants, %

- RES: 16%
- NPPs: 1%
- Others: 83%

Putting into operation of new capacities by type of power plants, %

- RES: 84%
- NPPs: 12%
- Others: 4%
Development of photovoltaic power

Accumulated Capacity
(End of Year)

Development of Capacity

Unified Energy System of Russia
Price development

Price development for households

Price development for industry consumers
Power balance in 2014

- Generation 1 047,40 (TWh)
- Consumption 1 040,35 (TWh), including Losses 106,66 (TWh)
- Imports 12,7 (TWh)
- Exports 23,8 (TWh)

Federal State Statistics Service
Territory of the wholesale market:
1 – I price area – European Russia, Ural region
2 – II price area – Siberia
3 – tariff regulation areas (East region, Kaliningrad region, North-West region)
Energy market milestones

- **Regulated Market**
  - October 24, 2003
  - Government Decree of 24.10.2003 No. 643 on Wholesale electricity (capacity) market rules for the transition period
  - 01.09.2006
  - New wholesale electricity & capacity market launching
  - 01.11.2003
  - Free-trade sector set-up
  - 20.10.2005
  - Balancing market
  - 03.03.2010
  - Ancillary services market launching
  - 06.12.2007
  - SCUC technology launching
  - 01.07.2008
  - Capacity market

- **Competitive Market**
  - 01.01.2001
  - Government Decree of 11.06.2001 No. 526 on Main directions of the electric power industry reforming
  - March 26, 2003
  - Federal Law No. 35-FZ on Electric Power Industry
  - June 11, 2001
  - Government Decree of 11.06.2001 No. 526 on Main directions of the electric power industry reforming
  - 01.05.2014
  - New SCUC technology
  - 06.12.2007
  - SCUC technology launching
  - 01.01.2016
  - New Capacity market model
  - 01.01.2011
  - “Target model of the wholesale electricity & capacity market”
  - Government Decree of 27.10.2010 No. 1172 on Wholesale electricity & capacity market rules
  - 01.07.2014
  - New Capacity market model
Market System in the Electric Power Industry of Russia

**Capacity market** (Total value in 2014: ~ 4,16 bln. Euro)
- Provides long-term adequacy preventing generation supply shortage
- Forms economically effective generation structure (with the lowest total costs)
- Provides price signals for consumption development in the regions depending on sufficiency and cost of generation construction

**Ancillary Services Market** (Total value in 2014: ~19, 6 mln. Euro)
Ensures system reliability providing proper maintenance of equipment complementary characteristics and components

**Electricity Market** (Total value in 2014: ~ 12,52 bln. Euro)
- Provides short-term reliability and economic efficiency
- Form the most efficient existing generating resources load
- Provides electrical modes feasibility
- Provides price signals for energy efficient consumption
Market Regulators and Participants

**Regulators**

**Ministry of Energy of Russia** – a federal executive body responsible for drafting and implementing government policy and legal regulation in the fuel and energy sector.

**Federal Anti-Monopoly Service** – a federal executive body responsible for exercising control, supervision over the observance by the participants of anti-monopoly legislation and setting tariffs for infrastructural organizations and for the regulated forms of activities of the wholesale market participants.

**Infrastructure organizations**

**System Operator** – planning and control of the power system operation regime, technological support of electricity and capacity markets functioning.

**Commercial Operator** – financial estimates in the wholesale market.

**Federal Grid Company** – management of the Unified electricity transmission and grid system.

**Market participants**

Generating companies ~ 60, including:

- extraterritorial companies – OGK comprising large condensing power plants,
- territorial companies – TGK comprising cogeneration power plants,
- companies partially owned by the state comprising hydro power plants (JSC RusHydro) and nuclear power plants (RosAtom Group).

- Consumers ~ 220, guaranteeing suppliers
### Wholesale Electricity Market Scheme

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<tr>
<th>Suppliers selection</th>
<th>Monitoring of the actual equipment condition</th>
<th>Financial calculations on month results</th>
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<td><strong>Suppliers</strong></td>
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<tr>
<td>Price bid for CCS</td>
<td>Information on equipment condition</td>
<td>Invoice</td>
</tr>
<tr>
<td>Results of CCS: Volume &amp; price</td>
<td>Control of actual readiness of each generating equipment item to power output.</td>
<td>SO + CO</td>
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<td>Determination of the volumes of capacity purchase.</td>
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<td>Determination of capacity volumes supplied to wholesale market.</td>
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<td>Estimation of obligations and requirements of market participants.</td>
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<td><strong>Consumers</strong></td>
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<td>Competitive Capacity Selection (formation of monthly obligations on capacity supply)</td>
<td>Control of capacity consumption peak of each participant.</td>
<td>SO + CO</td>
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<td><strong>CO</strong></td>
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**Unified Energy System of Russia**
Capacity Market Scheme

**Mid-term planning** (X-2)

**Daily planning**
Day-ahead market (X-1)

**Intra-day planning**
Day (X)

**Financial calculations**
on monthly results

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**Suppliers**

- **SCUC**
  - Security Constrained Unit Commitment
  - 3 day ahead
  - (X, X+1, X+2)
  - SO

- **Day-ahead market**
  - Competitive selection
  - «day-ahead»
  - SO + CO

- **Balancing market**: Competitive selection execution + generation objects management

- **Invoice**

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**Consumers**

- **SO + CO**

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- **Price bid**
- **SCUC**
- **Price bid day-ahead market**
- **Results of the bids: volumes and prices**
- **Dispatch schedule**
- **Balancing price**
- **Invoice**

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- **Price bid day-ahead market**
- **Bids results: volumes and prices**
- **Balancing price**

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- **Determination of deviation volumes. Estimation of obligations and requirements of market participants.**

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