New energy-efficiency technologies in electric power industry

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The structure of power resources of Russia

Primary power resources
(non-renewable power resources)

Renewable power resources

Primary power resources

electricity
heat
The structure of electric power industry in Russia

Total capacity of power plants (216 mln kW)

- hydro- and pump-storage; 44,9; 21%
- nuclear; 22,2; 10%
- others; 17,5; 8%
- thermal; 66,2; 31%
- condensing; 65,3; 30%
Nuclear power industry of Russia at the beginning of the 21-st century

<table>
<thead>
<tr>
<th>Region</th>
<th>Power, GW</th>
<th>Russia</th>
<th>World</th>
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<tbody>
<tr>
<td>North-West</td>
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<td>Kolskaya 1,8 GW</td>
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<td>Leningradskaya 4 GW</td>
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<td>Centre</td>
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<td>Smolenskaya 3 GW</td>
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<tr>
<td>Novoronezhskaya 1,8 GW</td>
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<tr>
<td>Kurskaya 4 GW</td>
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<tr>
<td>Kalininskaya 3 GW</td>
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<tr>
<td>South</td>
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<td>Volgodonskaya 1 GW</td>
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<td>Volga region</td>
<td>Balakovskaya 4GW</td>
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<td>Beloyarskaya 0.6 GW</td>
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Share, %: In power, 11.5% for Russia, 10% for the World; In output, 16.5% for Russia, 17% for the World.
TOTAL up to the year 2020

Total capacity  41 GW

Power production  ~300 TW/h

Input: 21,6 GW

Output: 3,7 GW
Hydropower resources in Russia

- Total output of electric power: 900 bln kWh
- Total capacity: 216 000 MW
The concept of national power industry development of USA up to the year 2030

Interconnection

Regional connections

Local connections
The concept of power industry development in Russia
(suggestion of GUP VEI)
The structure of electric power and heat production in Russia (bLn kWh)

- Boilers: 1300; 48%
- Thermal η; 560; 21%
- Nuclear; 120; 4%
- Hydro; 165; 6%
The structure of electric power and heat production in Moscow

Power production in Moscow in 2005 (bln kW*h)

- 25% 39 heat of boiler houses
- 45% 70 heat of thermal power plants
- 46.5 30 electric power

Total: 156 bln kW*h
VEI suggests the electrification of the existing boiler-houses by way of their interconnection with the gas turbine and creation of the single energetic complex on the basis of the boiler houses, which will allow to generate about 1 to 3 GW more thermal electric power.

The project does not suggest the installation of any additional boilers, which will allow to minimize the expenses and the area required for the gas-turbine thermal power plant.
Technologies of electric power production
Non-traditional sources of low-power

Ground solar photoconverters and photo-energetic systems based on multi-layered structures with concentrators.
- Efficiency > 30%
- Power output > 250 W/m²
- Service life > 25 years
- Reduction of electric power cost to 2 roubles (0.08$) for 1 kWh

Specific power rating of lithium-ion rechargeable batteries

Hydrogen-aerial battery of fuel-cell unit
Non-traditional storages of electric power

Flywheel storage (up to 25 kW/h)

Superconductive storage (up to 10 MJ)

Storage with circulating electrolyte

both real and reactive power into the WPS grid, responding independently as required at each site on the basis of local voltage conditions. ASC contended that D-SMES would provide an instantaneous voltage-control capability at a lower cost compared to traditional network stabilization solutions.
Development and creation of the series of highly reliable, compact and capsular low power nuclear stations (NSLP, 10-50MW, NIKIET-VEI project)

Innovational product allowing to solve the problem of electric and thermal power deficit.
Significantly increases the reliability of electric power supply system of the city.

Along with maintaining natural security in conditions of natural circulation the NSLP technologies provide:
- 25 years of operation without recharging of the core region and major repairs
- Long-term and stable work at any level of productivity within 20-100 % without the limitations of power changes;
- Automatic switch to hot reserve mode in case of any heat-consumption termination and absence of its own requirements.

1 - Reactor
2 – Active zone
3 – Pressure compensator
4 – Intermediate heat-exchanger
5 – Steam generator
6 – Heat-exchanger- vaporizer and the radiator of autonomous contour of power take-off
7 – Heat-exchanger- vaporizer and the radiator of autonomous contour of power take-off

I – First contour of natural circulation
II – Intermediate contour of natural circulation
III – Contour of thermal power consumers
IV – Autonomous contour of power take-off with natural circulation
V – Naturally circulating open-circuit air contour of reactor cooling
The system of integration of sources in power complex of the power supply facility

**The sources of DC-current:**
- Storages
- Photocells
- Fuel element

**The sources of AC-current:**
- Gas-turbine installations
- Mini water power plants and nuclear power plants
- Wind power plant

**Frequency converters**

**DC to AC converters**

**Converter of communication with external electric power network**

**The system of automatic complex control**

**AC network of power supply facility**
Principles of construction and diagram of sources interconnection
The development of technology and principles of construction of the integrated electric network with sources of small-scale power generation of different type.

The suggested power grid is built with the broad use of modern converters, providing high quality of voltage for consumers and high controllability of system mode. A cellular principle of power grid construction unites small power-producers owning power generation businesses into a common system of electric power consumers.
The diagram of power output of small nuclear power plants
Energy-efficient technologies of power industry
The structure of electric power consumption in Russia

- Electric drives: 60%
- Lighting: 14%
- Losses in networks: 13%
- Other: 13%
In 1980-ies for the first time ever in the world 1150kV power transmission line was put into operation and the equipment was made for such a line. These jobs were done under the supervision of VEI.

Super high voltages such as 1150 kV of AC-current and 1500 kV of DC-current allow to create the most effective power transmission lines.
VEI has a unique experience in construction of power UHV DC transmission line (Ekibastuz-centre)
The equipment designed by VEI is in operation at Vyborg back-to-back DC system
Valves based on photothyristors

Gated hall of 250 kV, 1000 A Moyle converting substation
FACTS device in electrical network
STATCOM voltage converters

- 2-level
- 3-level
STATCOM at Essex substation (USA)

Outdoors Equipment –
Transformers, Capacitors, Reactors,
Filters, Switchgear, Buswork

STATCOM Building –
Converters, Control, & Cooling
Units featuring controlled series compensation with thyristor control

- Р – disconnectors;
- ЗР – grounding disconnectors;
- П1, П2 – insulating platforms;
- КБн, КБр – capacitor banks;
- ОПНн, ОПНр – surge arresters;
- ТГ – thyristor group;
- Рк – reactor;
- ДУ – damping device;
- БУЗУн, БУЗУр – quick-response controlled protective device;
- ШВн, ШВр – shunting switch.

STATCOM-based units
180 MVAr, 330 kV magnetically controlled shunt reactor
VEI carries out a number of works developing power-efficient technologies and electrical equipment.

Controlled electric drive (CED)

HV CED

LV CED

The use of frequency-controlled electric drive for electric motors allows to save 15 to 50 percent of consumed power.

The higher the share of converted electric power, the higher the energy-efficiency of the country.
High-output plate ozonizer
(awarded gold medal at
“High technologies of the 21-st century” exhibition)

- Plate ozone generator
- Generator module for 3 kg of ozone per an hour

Ozonizer block of VEI mounted on the eastern water power supply of Moscow
VEI’s SHF lamp ("SVETON")

Based on pollution-free non-electrode SHF gas-discharge lamp “SVETON” light source of high intensity features quasi-solar radiation spectrum. Light-emitting SHF discharge is maintained in gas-filled quartz sphere of the lamp, placed in translucent resonator excited with a magnetron.

**Features:**
- More than 75% of optical energy radiation with normal colour-reproduction is in the visible spectrum.
- The lamp features a spot luminous element.
- Low level of UV and IR-radiation.
- Service life is 50000 hours.
Thank you for your attention