Russian Technology Platform Road Map «Environmentally Clean Thermal Power Generation of High Efficiency»

Director of the Technology Platform,
Deputy CEO of the Fund
«Energy beyond borders»
Prof., Dr. Sc. N. Rogalev

Expert meeting:

"Low Emission and High Efficiency Coal Fired Power Generation in Russia and Worldwide"

Development and Implementation of Coal Combustion Advanced Technologies

JSC «INTER RAO UES»
December 10, 2012

- About Technology Platform
- Main motivations and strategy
- Main targets till 2030 year in the field of coal-fired generation

The main goals of TP foundation

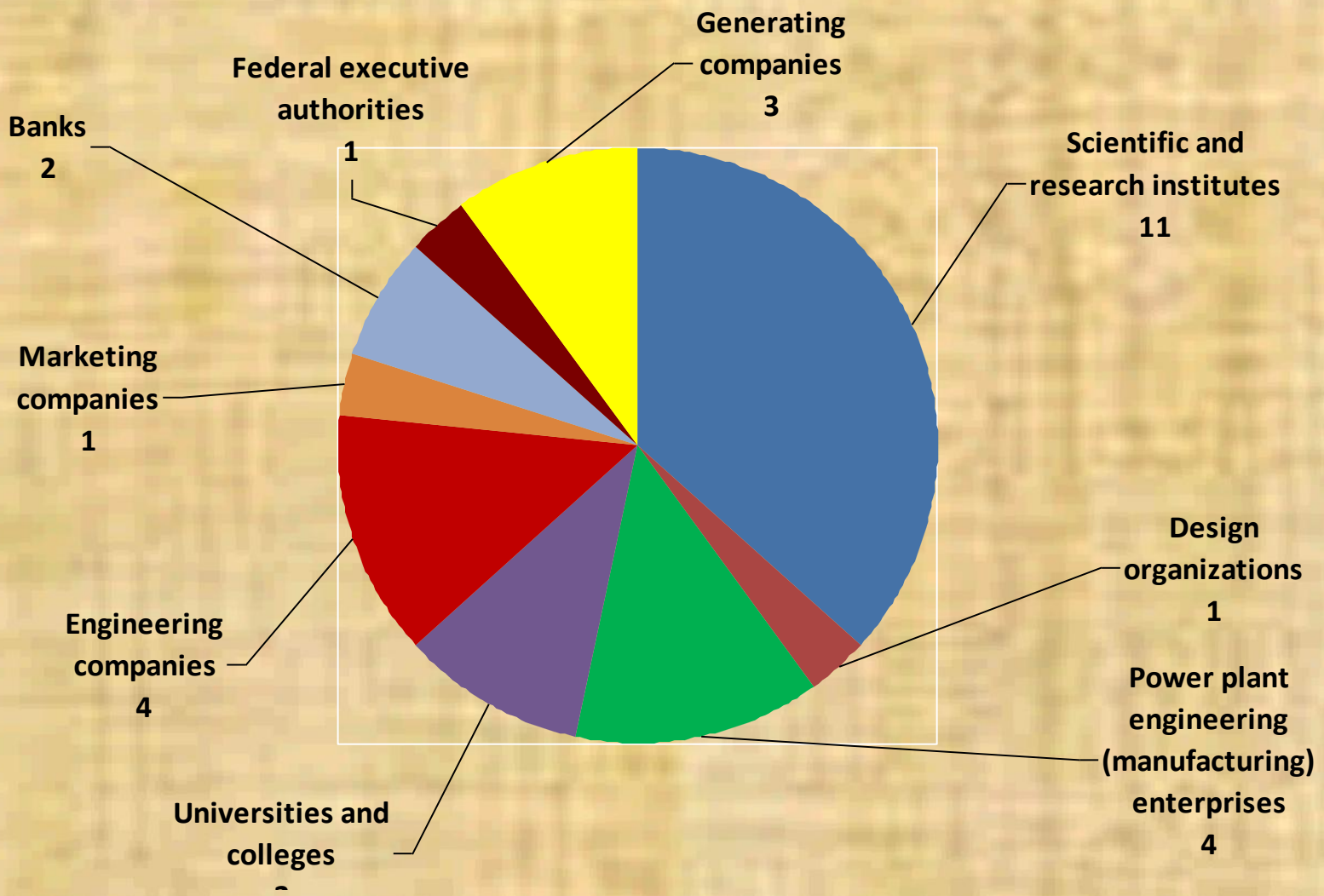
- Development and implementation of the advanced power technologies to modernize the power sector and to guarantee its sustainable upgrowth.
- Strengthening and development of competences in design and manufacturing of the advanced power generating equipment.
- Administration and coordination of efforts on research, development, deployment and wide dissemination of leading-edge energy technologies

TP Structure

Founding initiators	Russian Ministry of Energy
	JSC «INTER RAO UES»
Coordinator	JSC «All-Russian Thermal Power Engineering Institute»

The total number of participants	30
The number of authorities willing to join the TP	10

TP Participants



Implementation and financing of TP in 2012 г.

Financing was realized by:

- **Budget resorses:** contracts with Ministry of Education and Science, RFFR, grants and other sources,
  volume of financing – more than 550 mln. RUR;
- **Off-budget resorses :** JSC «INTER RAO UES», LLC «Gazprom energoholding» and other companies R&D program contract works,
  volume of financing – more than 300 mln. RUR;
- **Credit resorses :** within the frame of "Russian Fund of Technology Development" strategy partnership Memorandum the project CJSC «Unihimtek» is financing,
  volume of financing – 95 mln. RUR.

THE MAIN MOTIVATIONS AND STRATEGY

116 coal fired TPPs are in operation in Russia

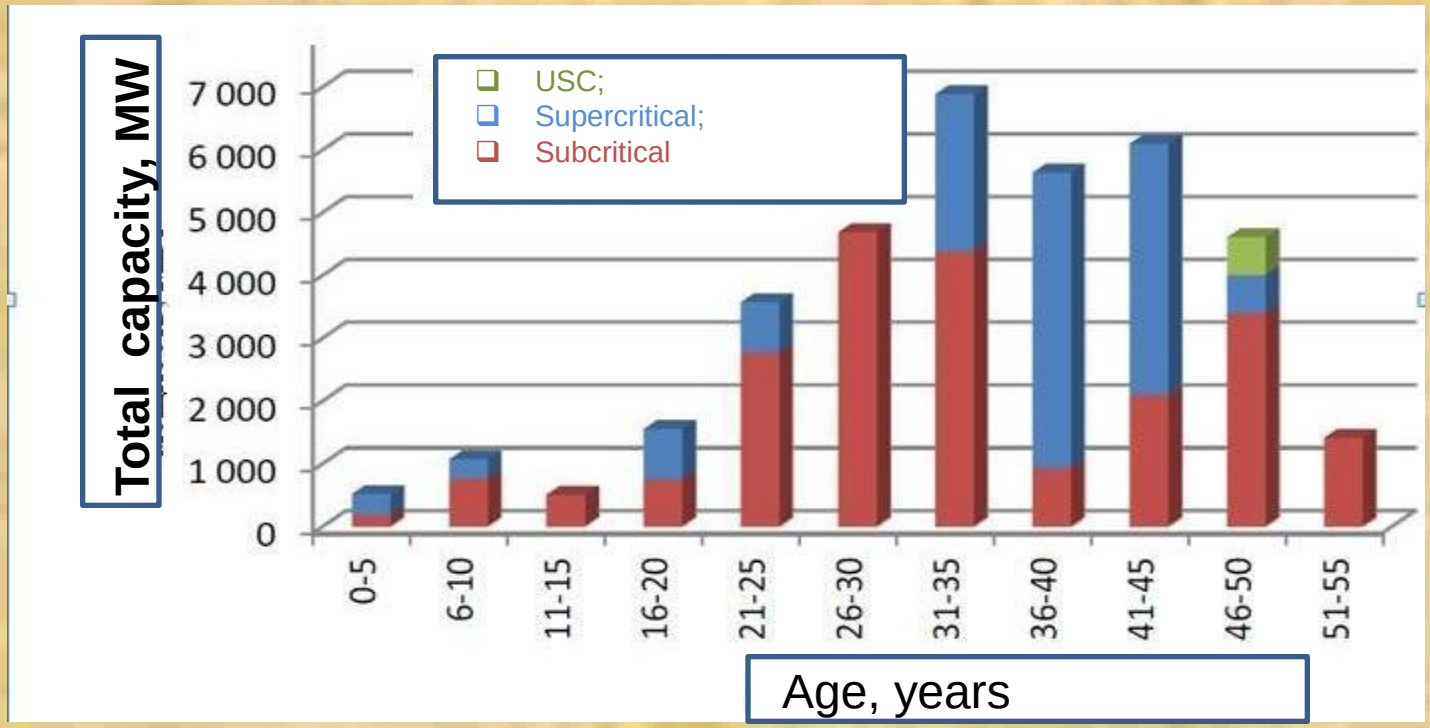
Coal fired power unit capacity (MW)	Number of units
800	2
500	7
300	28
200	35
150	28

Main part of them has been in operation for 35÷40 years:

- **low reliability indicators;**
- **electric efficiency – 30÷36%;**
- **low automation level;**
- **high NO_x, SO_2 and particles emissions;**
- **troubles with ash disposal areas.**

Coal fired TPP just in operation in Russia (IEA data)

- Almost 70% of coal fired TPP are subcritical .
- Producing electricity by subcritical plants plan to by stopped before 2050



Milestone: R&D

- Trade off between domestic development and purchasing license
  - Time to develop technology and cost of using existing technologies in the meantime
  - Cost of licenses and admin costs
- Materials
- Next step technologies
- Joint international R&D
- Private-state partnership
  - State policy

Milestone: State policy

- Goal: to stimulate R&D and achieve technology targets
- Stimulus
  - Future pollution control (target: industry, equipment manufacturers)
  - R&D grants
  - Advanced technology tax credits
  - Power purchasing agreement (to compensate higher electricity rates)
- Support policies
  - Demand side energy efficiency
  - Information

MAIN TARGETS TILL 2030 YEAR IN THE FIELD Of COAL FIRED POWER GENERATION

Technology directions

1. USC coal fired 330-66-800 MWt units with 44-46% efficiency; future A-USC (35 MPa, 700/720 °C) technologies, making possible to achieve 51-53 % efficiency; new generation 100-200-300 MWt coal fired CHP power plants, using different fuel combustion technologies.
2. 200-400 MWt, 50% efficiency IGCC (integrated gasification combined cycle) power units and advanced combine cycle Fuel Cells – GST technologies, promising till 70% efficiency.
3. Environmentally clean solid fuel combustion and flu gases cleaning technologies, providing low SO_2, NO_2, ash particles, etc. emission, including carbon capture and storage (CCS).

R&D strategic trends

- Development of modern high efficiency low emission technologies.
- Creation of new generation power equipment manufacturing.
- Increasing TPP efficiency by take-of the old low-effective equipment and substitute it by advanced, providing:
  - ✓ Radical electric and thermal power producing cost reduction;
  - ✓ Fuel consumption and employees coefficient reduction;
  - ✓ Emissions to environment lowering;
  - ✓ Maintenance costs reduction.

Missions

- Development of advanced high-efficient environmentally clean technologies for producing electric and thermal power;
- Replacement technologies of producing electric and thermal power still operating in Russia, under corresponding or exceeding world standard;
- Development unify equipment and typical projects for decreasing terms of modernization power generation and financial funds for its implementation;
- Conversion and implementation for demonstration advanced technologies;
- Providing innovation development of power generation and using ability of scientist-technical potential of domestic power industry machine building;
- Training of high-qualified employees;
- Increasing of employees qualification

Russian power industry coal technologies roadmaps

Project name	2013-2015	2016-2020	2021-2030	After 2030
Coal power units with Advanced and Ultra supercritical steam properties	Development and/or purchasing equipment for replacing capacities	Mastering in operation of 600÷1000 MW power units with steam temperature 600/620^{0}C , fuelled by brown and hard coals	Market deployment of 600÷1000 MW power units	Commercial power units with steam temperature of 700^{0}C , using flame combustion and CFB boilers(with CO_2 capture)
	Feasibility study	R&D, development of construction materials for power unit with steam temperature up to 700^{0}C	Construction of demonstration power unit with steam pressure up to 35 MPa and temperature up to 700-720^0	

Russian power industry coal technologies roadmaps

Project name	2013-2015	2016-2020	2021-2030
Coal power plants with combined heat and electricity generation	R&D: - Development of boilers with evaporation capacity of 400÷700t/h, using flame combustion and CFB for different kinds of fuels; - Design of heat-extracting (cogeneration) turbines of new generation; - Design of coal power unit with capacity of 100÷200÷300 MW	Market deployment of power units for TPPs R&D aimed at increasing economical and ecological properties	Market deployment of power units $\eta_{electric}$=41÷42%, $\eta_{кит}$ = 85÷90%, minimum content of SO_2, NO_x and ash particles

Key Technologies developed by TP

Project name	2013-2015	2016-2020	2021-2030	After 2030
Combined cycle unit with hard fuel gasification	Development of the demo unit with capacity of 25 MW	Validation of demo unit operation	Commercial operation of CCGT with gasification $N_{эл}$ = 200÷300 MW	Market deployment of CCGT with gasification $N_{эл}$ = 600-800 MW, and capital costs lower than at the combined cycle plant, $\eta_{эл}$=42÷45%, Emissions of hard particles <0,1 mg\m3, SO2 <10 mg\m3, NOx <10 mg\m3
		Design of a combined cycle plant with capacity of 200÷300 MW	Design of CCGT with gasification and capacity of 600÷800 МВт	
	R&D aimed at improving indicators of CCGT unit operation , development of high temperature syn-gas purification systems	R&D aimed at developing new equipment, including gas-generator, GTU, thermal diagram	R&D aimed at developing technologies for -CO2 capturing (within GTU cycle); Hydrogen application; Membrane air separation	

Platform Key Technologies

Project name	2013-2015	2016-2020	2021-2030	After 2030
Efficient gas purification systems, providing near zero emissions of SO_2, NO_X and ash particles	R&D aimed at development of - combined ash collectors; - two-stage nitrogen oxide reduction; - ammonia-sulphate desulphurization; - combined SO_2, NO_X and ash particles separation devices	Demo projects for validation of gas purification technologies	Commercial introduction of gas purification systems at coal power units (SO_2 ≤ 100 mg/m³, NO_X < 100 mg/m³, ash particles < 1 mg/m³)	Reduction of emissions at coal TPPs: SO_2 ≤ 30 mg/m³, NO_X < 50 mg/m³, ash particles < 1 mg/m³
		Development of gas purification systems for coal power units $N_{эл}$ = 600÷800 MW	R&D aimed at providing near zero emissions	

Thanks for your attention