# New condition for new Nuclear Energy in the World and in Russia

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#### International Symposium on Nuclear Nonproliferation and Peaceful Use on Nuclear Energy

Tokyo October, 4, 2007

# **Results of the 20th century**



In the beginning of the 21<sup>th</sup> century the main problem, fast energy rate growth, has visualized. 1990-2000 - 1.2% a year

2001-2005 - 2.3% a year!

Two reasons of energy consumption growth.

**1. Growth of the Earth population.** 

2. Alignment of energy consumption between developed and less developed countries.

1. Growth of the Earth population.



#### The most probable estimation in 2050 is that there 9 billions pupil will live on the Earth. Energy production must be increased in 1.5 times.

# 2.Alignment of energy consumption between developed and less developed countries.



#### Alignment of energy consumption will require to increase energy production in 3 times

# Balance of energy resources (the most optimistic)



■ Oil □ Gas ■ Coal ■ Hydro ■ Biomass and Was ■ Other Renewabl □ Nuclear ■ backlog demand

### Scale of the 21<sup>st</sup> century

By 2100 the population of the Earth will become about 12 bill.pupil



### **Energy resources price growth**



# **Electricity price**



#### The new economic situation increases nuclear energy attraction and widens its facilities

#### **Fuel Cycle of NE**

#### **Closed Fuel Cycle: Fast Burner Reactors (BR=0.1)**

Natural uranium consumption by 2100 – 29 million tons



#### **Fuel Cycle of NE**

**Closed Fuel Cycle: "High" Breeders (BR=1.6)** 

Natural uranium consumption by 2100 – 12 million tons



### **Basic Fuel Cycle Parameters for Various Scenarios OPC – Open Fuel Cycle, CPC- closed fuel cycle**





Maximum SWU, t/y



# Closed fuel cycle based on fast reactors with breeding solves the problem of natural uranium limitation

#### **Development of Thorium Fuel Cycle Since 2050**

#### Natural uranium consumption by 2100 – 11 million tons



Thorium fuel cycle expands resource base of nuclear energy in many times. It extends nuclear energy using also and for non-electric purposes.

# Nuclear energy risk potential for non-proliferation purposes in dependence on its structure.

#### **Fissile Material (Pu+U-235) Production in Nuclear Energy System**

**Burner** 

**BR=1.6** 

NES' weapon-grade material production capacity, t/y

#### NES' weapon-grade material production capacity, t/y





#### The capability of fissile materials producing, which could be used for military purposes, insignificantly depends on the nuclear power structure

### **International Nuclear Fuel Cycle Centers**





Production and trans-regional flows of fresh and irradiated nuclear fuel by 2050

t/year, N=2000 GW, "traditional" model

|                    | Developed | l countries | Developing countries |       |  |
|--------------------|-----------|-------------|----------------------|-------|--|
|                    | NF        | SNF         | NF                   | SNF   |  |
| Production in 2005 | 16 000    | 4 800       | 5 000                | 1 100 |  |
| Production in 2050 | 36 000    | 29 000      | 12 000               | 9 000 |  |
| Flows of 2005      | 11 000    | 9 000       | -                    | -     |  |

# Structure of Russia Electric Power Industry Electric capacities, GW

| Inc. Power           | system   | TPP       | Hydro    | NPP    |                           |
|----------------------|----------|-----------|----------|--------|---------------------------|
| Centre               |          | 34.6      | 2.3      | 11.8   |                           |
| Middle V             | olga     | 13.6      | 6.2      | 4.1    | ·                         |
| Ural                 |          | 39.8      | 1.8      | 0.6    |                           |
| North-we             | st       | 11.8      | 2.9      | 5.8    | s T                       |
| Northern C           | aucasus  | 9.7       | 5.4      | 1 👝    | 10 m m                    |
| Siberia              |          | 23.6      | 22.3     |        |                           |
| East                 |          | 8.2       | 3.9      | 0.05   |                           |
| Structu              | re of ft | rel consu | umption, | ¥<br>% |                           |
| Inc. Power<br>system | GA       | S         | OIL      | COAL   |                           |
| Centre               | 79       | )         | 9        | 12     |                           |
| Middle Volga         | 91       |           | 8        | 1      |                           |
| Ural                 | 76       | 5         | 7        | 17     | The main task - to reduce |
| North-west           | 56       | 5         | 25       | 19     | consumption of gas        |
| Northern Cauca       | asus 70  | )         | 10       | 20     |                           |
| Siberia              | 6        |           | 4        | 90     |                           |
| East                 | 5        |           | 9        | 86     |                           |

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#### Three stages of development of Russian NE



# I -restoration of the Industry, II- development of fast reactors and the closed fuel cycle, III- construction large-scale of NE.

