



Future of S&T: Evaluation of the Prospects of Mature and Emerging Technologies

Alexander Chulok

XIII April international Academic Conference on
Economic and Social Development

Moscow, HSE,
4 April 2011



НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ
УНИВЕРСИТЕТ

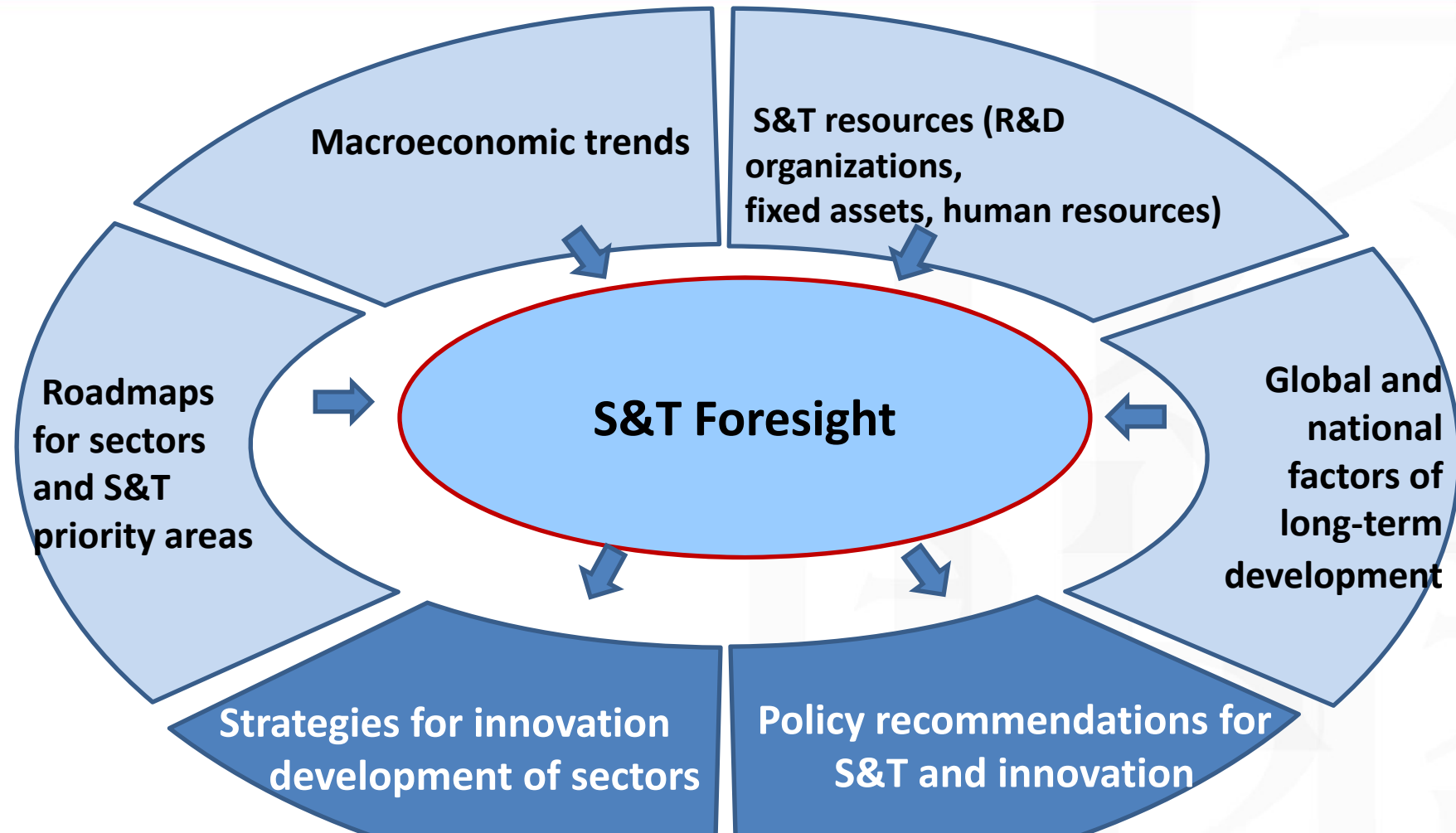
Contents

- **S&T Foresight:**
 - general framework
 - sources and databases
 - two groups of outcomes
 - networks of experts
- **First results:**
 - perspectives for Russia – evidence from research fronts
 - scientific areas of emerging technologies
 - “white spots” and breaking-through windows
 - challenges and windows of opportunities for mature technologies
- **S&T Foresight outcomes: possible ways of use**



НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ
УНИВЕРСИТЕТ

S&T Foresight: general framework





НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ
УНИВЕРСИТЕТ

S&T Foresight: sources and databases

➤ Global Challenges and Global Responses

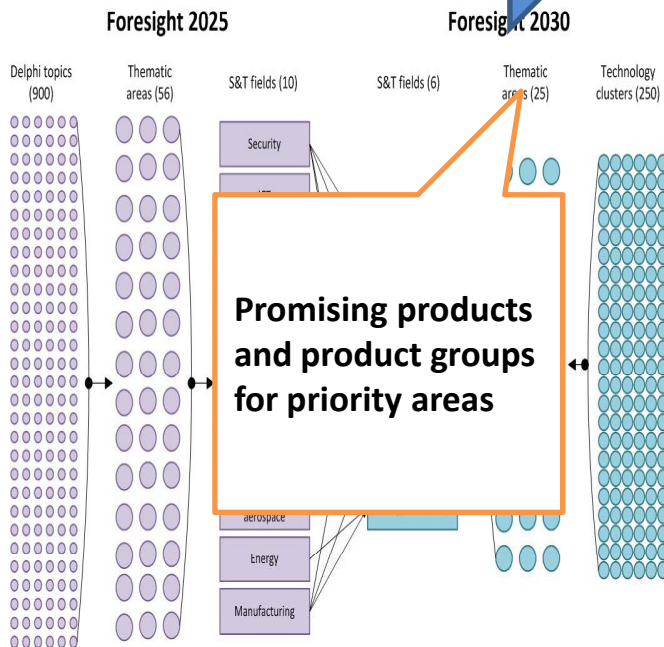
➤ Changing role of S&T Foresight in S&T and innovation policy

➤ New S&T instruments

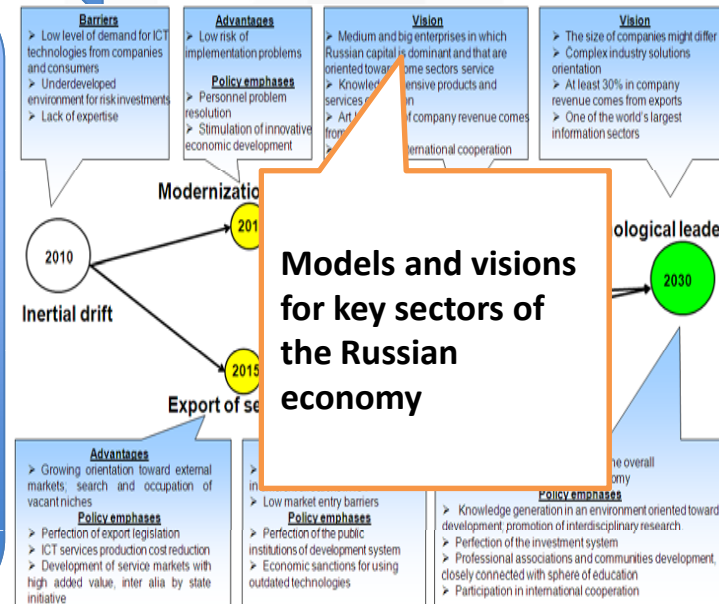
Results of previous S&T Foresight

3rd Cycle of S&T Foresight

Results of previous sectoral Foresight



- In-depth analysis
- Consideration of global challenges
- Three dimensions: What? How? Who?
- Detailed description of results: “first sprouts” and technology packages passports
- Identification of centres of excellence and gaps



- Results of the government S&T programs
 - Critical technologies' passports
- Industrial strategies, RF government programmes, etc.
 - Technology platforms and available roadmaps
- International systemic forecasts and framework documents (FP7, Japanese Delphi, etc.)



НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ
УНИВЕРСИТЕТ

S&T Foresight: two groups of outcomes

Priority areas

Key challenges until 2030

Technologies and technological solutions with a potential to contribute to dealing with key challenges

Description of technology packages

Energy and energy efficiency

Information and communication systems

Biotechnologies

Medicine and health

New materials and nanotechnology

Transport and space systems

Rational use of nature

Pull

Technology packages

Young sprouts

Push

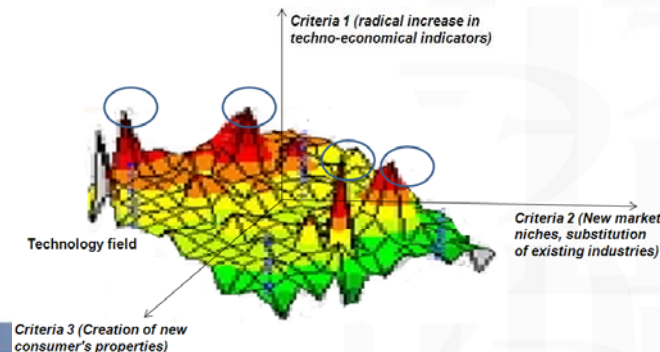
Key features

Groups of products and technologies with a potential to deal with critical problems and major challenges

Breakthrough technologies and product groups expected to be particularly important in 2020-2030

Description format

1. Leading countries, Russian teams
2. Management solutions (policies)
3. Time of emergence and application
4. Financial resources
5. Infrastructure solutions
6. Required competencies

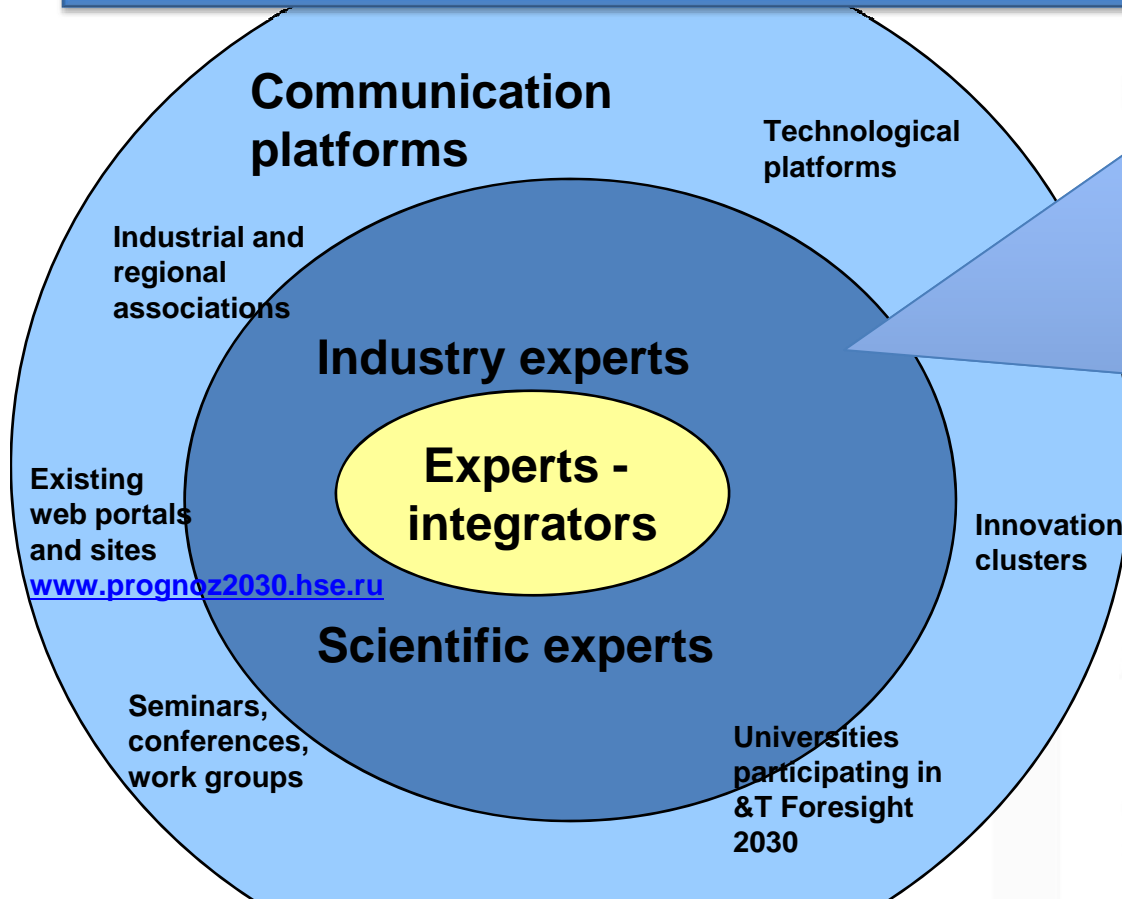




НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ
УНИВЕРСИТЕТ

S&T Foresight: networks of experts

Total number of involved experts: over 2000



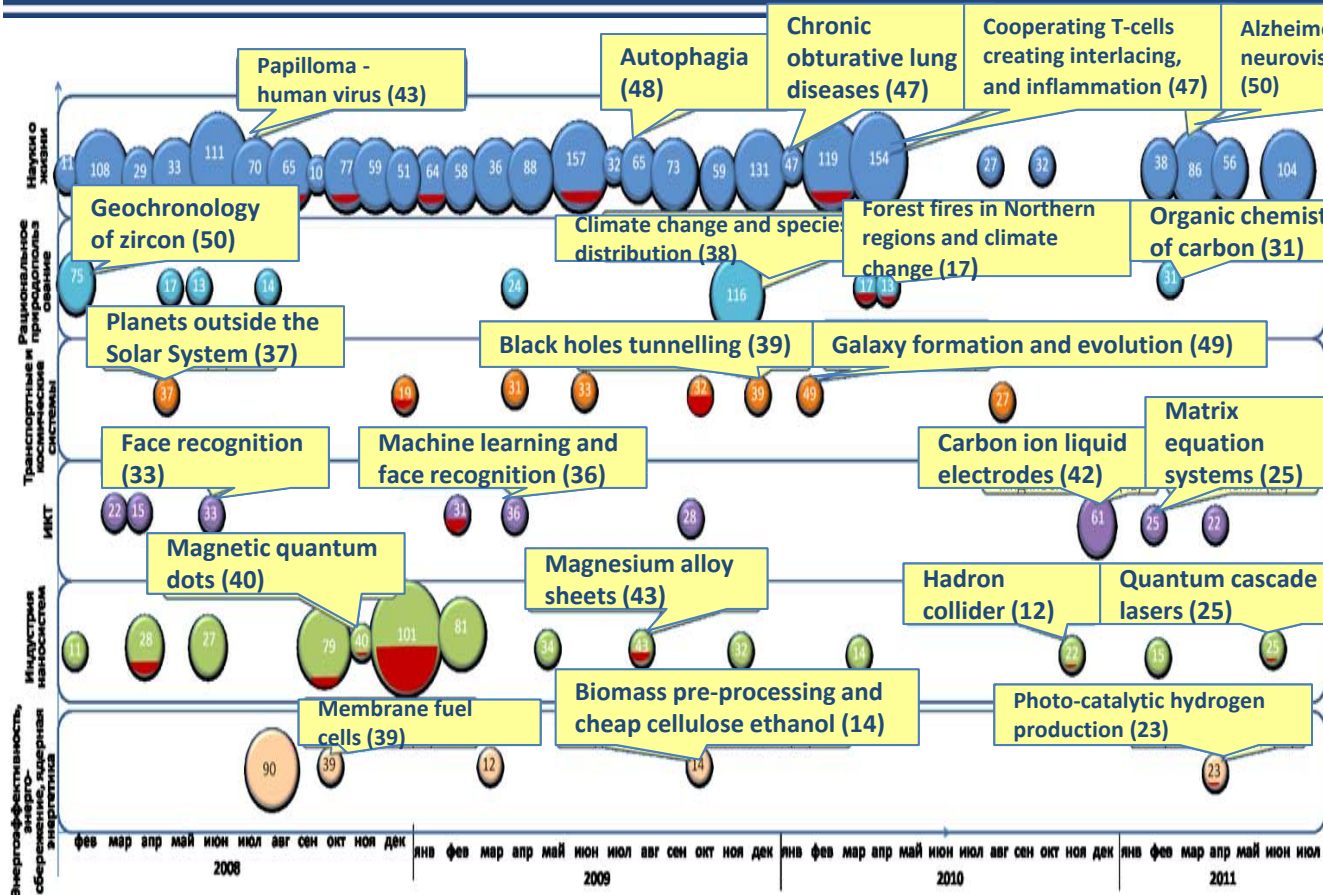
International Advisory Board on Foresight (HSE)

- ✓ Members of Government Academies of Science
- ✓ CEO of leading companies
- ✓ Members of High Technologies and Innovation Commission
- ✓ Members of industrial work groups and councils at relevant ministries
- ✓ Developers of industrial strategies
- ✓ Members of leading industrial and academic institutes
- ✓ Experts with the highest citation index



НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ
УНИВЕРСИТЕТ

First results: perspectives for Russia – evidence from research fronts



✓ Research front – highly cited publications identified through clustering

✓ Publications (co)authored by Russians are present in 15% of research fronts

✓ Share of Russian publications is 1%

✓ The highest contribution of Russian authors is in Life Sciences and Nanosystems Industry publications

✓ The biggest gaps are in Transport and Space Systems and Energy Saving areas

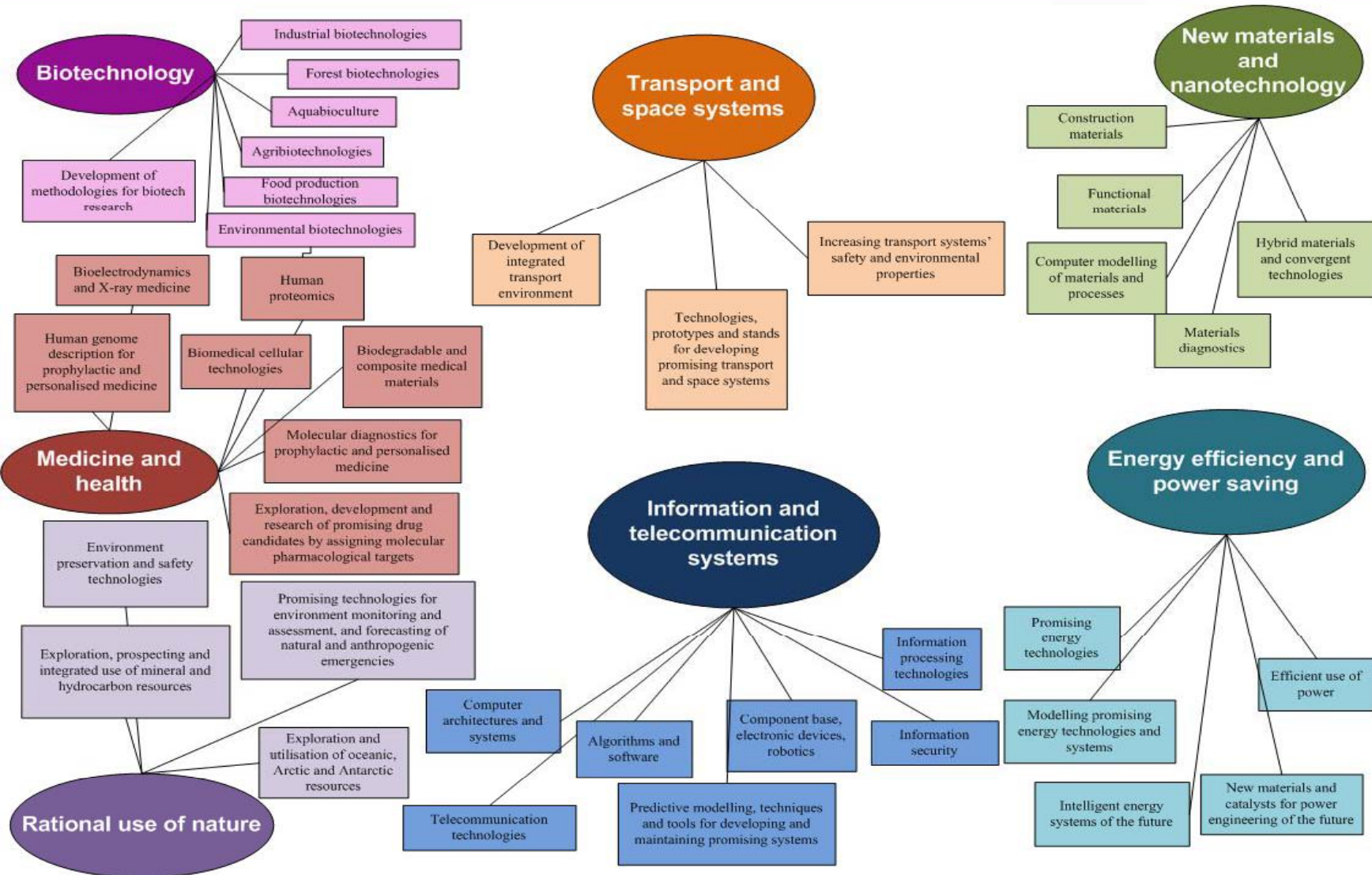
Legend: the oval area represents the number of fronts in each priority research (vertical axis); the number in the oval represents the total number of articles (by front) – (there may be 4 fronts with 2 articles on each and 1 with 8 articles); red indicates presence of articles by Russian authors; for each year, front names and maximum number of articles (in brackets) are indicated.

Source: ISSEK calculations based on Web of Science and Essential Science Indicators data (Thomson, Reuters).



НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ
УНИВЕРСИТЕТ

First results: scientific areas of emerging technologies





НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ
УНИВЕРСИТЕТ

Scientific areas: “white spots” and breaking-through windows (first results)

Technologies for mathematical modelling and optimisation of next-generation power generating and related installations' schemes and parameters

Functional structure composite materials for dental and maxillofacial implants

Human proteome profiling

High-temperature and durable turbine buckets

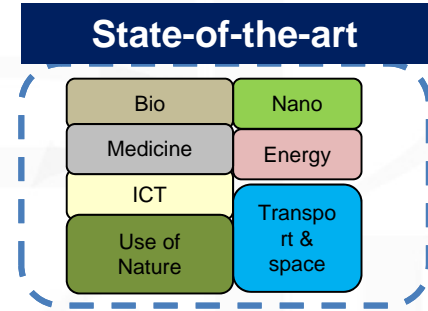
Climate and climate change modelling

World leader – opportunity to keep the leading position, or make a technological breakthrough

Parity - on a par with the world level or immediately below it; opportunities to join forces and increase efficiency

Certain achievements: opportunities to increase competencies to the world level

High-temperature superconductivity
Chemistry of solids
Nanosize catalysts and membranes for deep integrated processing of raw materials



- Technologies for separating and purifying gaseous mixtures and liquids
- Next-generation engineering systems for energy-efficient buildings
- Detoxication of air and water environments
- Wireless energy transfer
- Traffic flows' and transport systems' intelligent management systems' models
- Software systems' prototypes for real-time analysis of complex 3D images and videos
- Tissue equivalents and artificial live human organs
- Techniques to cultivate marine organisms' cell lines

- Biotechnological processes for producing industrial and medical bioproducts in plants and animals
- Bio-testing and bio-indication techniques offering increased sensitivity and selectivity
- Computational systems' component prototypes
- New distributed computing principles
- Materials diagnostics
- Technologies for deep processing of organic fuels

Significantly below the world level: “white spots”



НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ
УНИВЕРСИТЕТ

First results: challenges and windows of opportunities for mature technologies

Medicine and health

Transport systems

Energy

Global trends

- Increase of cancer rates
- Proliferation of city diseases
- Lack of organs and tissues for transplanting

- Stricter environmental requirements
- Increased energy saving requirements
- Safety on transport

- Increased global energy consumption
- Exhaustion of cheap conventional energy resources
- Vulnerability of power infrastructure

Russian challenges

- High mortality rate
- Small towns and villages do not have advanced medical facilities nearby
- Inefficient rehabilitation system

- Low energy efficiency and reliability of vehicles
- Inefficient monocentric radial structure of the transportation network

- Low oil recovery ratio at traditional oilfields
- Low efficiency of gas steam-turbine plants
- High energy waste in the grids

Potential technological response areas

- ✓ Gene and cell therapy
- ✓ Drug delivery and localisation systems
- ✓ Biocompatible non-degradable materials

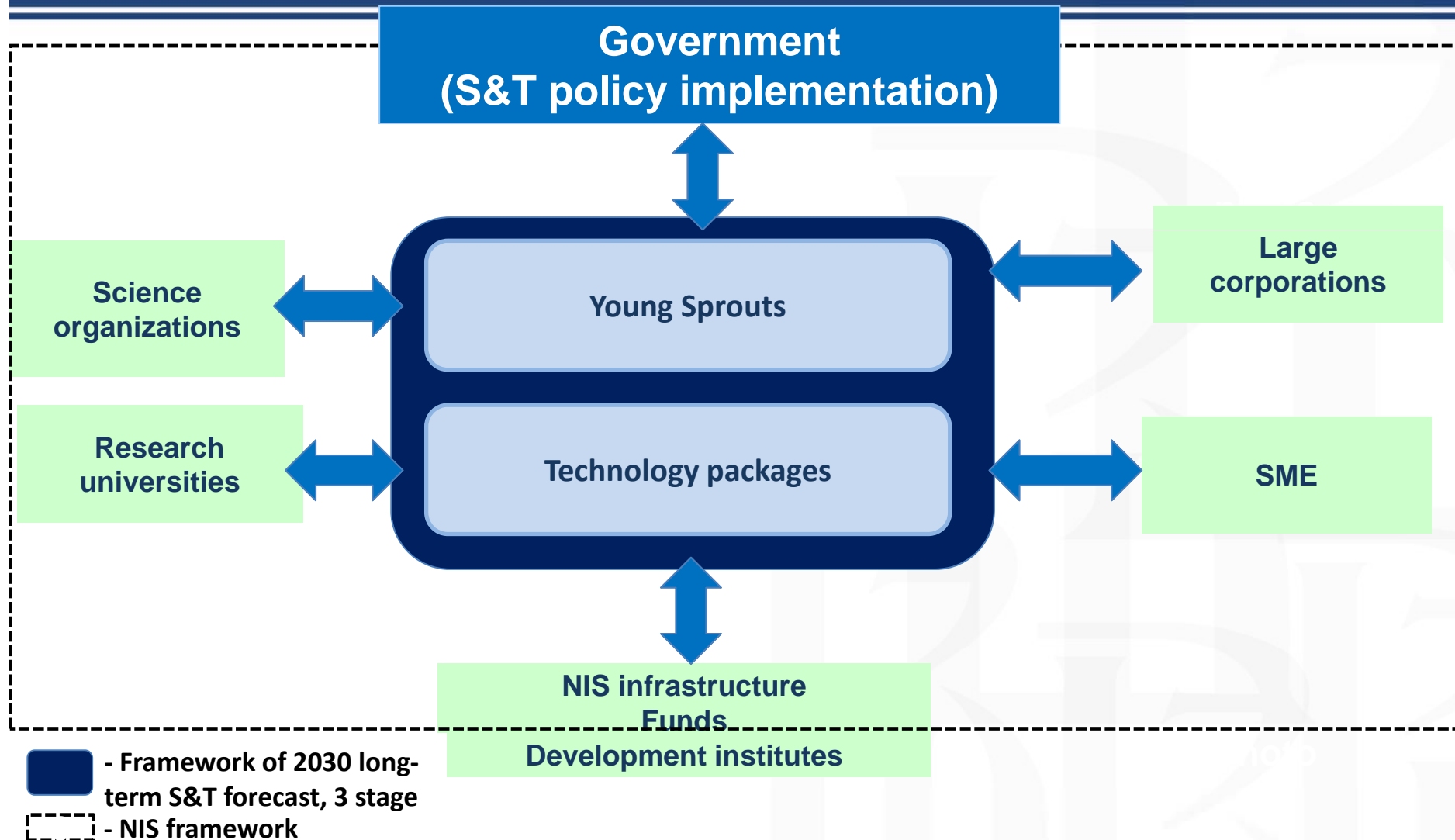
- ✓ Hybrid automobile engines
- ✓ Low-carbon sustainable vehicles
- ✓ Intelligent transport networks

- ✓ Highly efficient heat and power natural gas based plants
- ✓ New technologies for burning organic fuels
- ✓ New hydrogen production, storage and consumption technologies



НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ
УНИВЕРСИТЕТ

Two groups of S&T Foresight outcomes: possible ways of use





НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ
УНИВЕРСИТЕТ

**Thank you
for your attention!**

achulok@hse.ru