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SCENARIO UNCERTAINTIES AND STRATEGIC PRIORITIES: THE FRAMEWORK FOR THE SCIENCE AND TECHNOLOGIC POLICY

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Forecasting the Future: the Crisis of Methods

Traditional approach to forecasting: experts forecast based on key trends and existing uncertainties; the scenarios are designed for uncertainties of the perspective period; quantitative estimates are derived

Advantages: «objectivity» of the revealed tendencies and variants regardless of analyst personality, but depending only on qualification; transparency of the way to form trends and scenarios; possibility to obtain quantitative estimates of the forecast parameters.

Disadvantages: real interests of business-process participants (as well as scientific and tehnologic process etc.) are indirectly taken into account. Taking into consideration resource deficit of the state, it leads to the risk of non-realization of scopes and objectives which the state sets itself, their transformation into "the set of welfare wishes";

Foresight: is implemented on the basis of Delphi-surveys of real participants of business or scientific and technologic processes. A joint view of the "agenda" is formulated which is, simultaneously, an element of the corresponding process management.

Advantages: the forecast is formulated by the participants of the process.

Disadvantages: there is a high risk of the "collective myths translation", which are currently popular in the examined community. For the long-term foresight the presence of the long-term vision of process participants is required (namely long-term vision of Russian business and science participants is a considerable problem). Otherwise at the end of the period a random result is obtained.

For this reason, scientific and technologic foresight is now ineffective. A "traditional" forecast with elements of surveying leaders in business and technology may be of more use.

1. Global Trends and Scenarios

Global Trends

Demographic stabilization

- Population growth is stabilizing at a global scale due to demographic transition in developing countries: a decrease in fertility will be global. In accordance to this, global population will stabilize as well.
- therefore "the cheap labor" will exist neither in the literal sense, nor in the sense of political economy (the formation of pensions systems, tax increase).

Hence, an important technologic trend of the prospective period is the formation of technologies that are not labor-intensive (robotization); technologies of treatment of "the elderly diseases".

Industrialization 4.0

- In the US and partially in the EU: reshoring on the basis of up-to-date technologies (pervasive ICT, robotics, biopharma,…) and cheap energy carriers
- In China there is industrialization-3, this time it is based on building a complete national innovative system (priorities – ICT, new energy, robotics)

Pecularities of the process: customization of mass-production; reliance even of medium technologic industries on high technologies (ICT, technical processes, materials, …); elimination of distinction between product-service and product-good. Production "at place".

Global integration and disintegration

- A trend of "big spaces" formation, which control competencies in finance, technologies, energy, security, building technologic chains
- A trend of "neo-globalization" connected with the formation of global trade-investment partnerships (TTIP, TTP) and technologic breakthrough in established leaders (US, EU)

In any case the demand for solutions, which provide energetic security, defense, global management and cybersecurity is going up

Technologic singularity? Yes and no, but the development of technologies is definitely accelerating (ICT!)

Global Trends: Technologies

Technological singularity?

- The world is facing a new technologic breakthrough. The most obvious directions are information and communication technologies (intensive development is taking place right now), biotechnologies (on the horizon of 2020-2030), robotics (2020-2030), new science of materials (nanotechnology and others), new energy, cognitive technologies
- It might lead to qualitative breakthrough in production (not labor-intensive individualized production; removal of energetic deficits), in business-models (global business without intermediaries), humanities (drastic life prolongation).
- For this reason, it is appropriate to speak about possibility of the "singularity" appearance that leads to a new social mode of life
- A change of the management format: self-organization (social networks, transient global consortia, blockchain-technologies) changes the format of initiative and project management

What can refute it?

- The possibility of lingering global economic crisis accompanied with a decrease in technology investment both from state (transition to the policy of budget deficits limitation under intensification of social load, the crisis of the long-term goal-setting) and private sources;
- The risk of premature "blowing out" of the bubble on high-tech markets with discredit of the concept of the rapid technological development
- The possibility of unsolving a row of fundamental scientific and technologic problems necessary for successful creation of the proper technologies (physics of plasma –thermonuclear reaction , quantum effects – new element base for ICT, brain map – neurointerface)

New technology	Developed technologies and activities
Modelling of human intellect, cognitive models of conscience and behavior	A wide range of "standardizes" analysis and forecast in business (including financial markets), meteorology. Medicine (up to "digital doctor"), education ("remote teacher"), military etc.
Evolution of the Internet («semantic web», «the Internet of things»)	The revolution in intellectual activity ("semantic Internet"). New standards de-facto for consumer and, probably, investment goods ("the Internet of things"), military production.
Dramatic transformation of ICT markets under changing of the component base technologies (cease of the Moore law operation, development of new materials, photonics etc.). Creation of breaking quantum technologies.	Obsolescence and "closing" of traditional ICT; change of "de-facto standards" in connected industries
Transition to personalized medicine, "health medicine". Dramatic increase in life expectancy. Management of human cognitive abilities	Crisis of traditional mass-oriented medicine. Decomposition of medicine into "traditional" medicine for the poor and "new" medicine for the well-off is possible. Crisis of traditional business-models targeted at mass production of drugs.
An increase in environmental requirements for production, transport, foodstuff, commodities, buildings. Individualization of consumptions	Новые стандарты де-факто, делающие рынки закрытыми для традиционных товаров New de-facto standards which close the markets for traditional goods
Technology of advanced 3D printing	Internal crisis of labor-intensive medium technological machine-building and metal-working industries Originating of new business-models in high-tech industries (qualitative outsourcing expansion including small and medium companies). Stimulation of production transportation in developed countries (levelling of low costs factor)
Development of new energy, systems of energy accumulation, management of power grids	Вытеснение с рынка углеводородов, «дорогих» по себестоимости добычи. Возникновение тренда к опережающему расширению рынка электромобилей и «гибридов». Exclusion of hydrocarbons, "expensive" in extraction cost, from the market. The trend of anticipatory expansion of the battery-cars and "hybrids" market
Development of robotic transport and armament	Exclusion of equipment, services etc. connected with execution of "standardized" problems (in railways etc.) from the market. Contraction of some markets of traditional military technics and armament
Development of flexible robotic production which allows to individualize output of mass-production	Internal crisis of some traditional industries: contraction of traditional labor-intensive production ("candidates" for new robotics leaders are motor-car industry, possibly production of mass electronic and electrotechnical goods). Expansion of possibilities to move the production

The Structure of the Global Socio-Economic Development Scenarios

	Acceleration of global scientific and technological development (probability – 80%)	Deceleration of global scientific and technological development (probability – 20%)
Regionalization of global economy, formation of interacting force centers system (70%)	Competition between force centers (probability – 55%)	«Slow world» (probability – 15%)
Restoration of the "technological monocentrism" in the global economy (30%)	Global technological pyramid (probability – 25%)	Unlikely (5%), out of consideration

2. Trends and Scenarios for Russia

Trends: the Agenda of the 2030s

The triangle of challenges:

- ***Demographic***: in the future it is possible to expect a decline in labor resources and an increase in load – both from the side of the elderly and (according to particular scenarios) the young

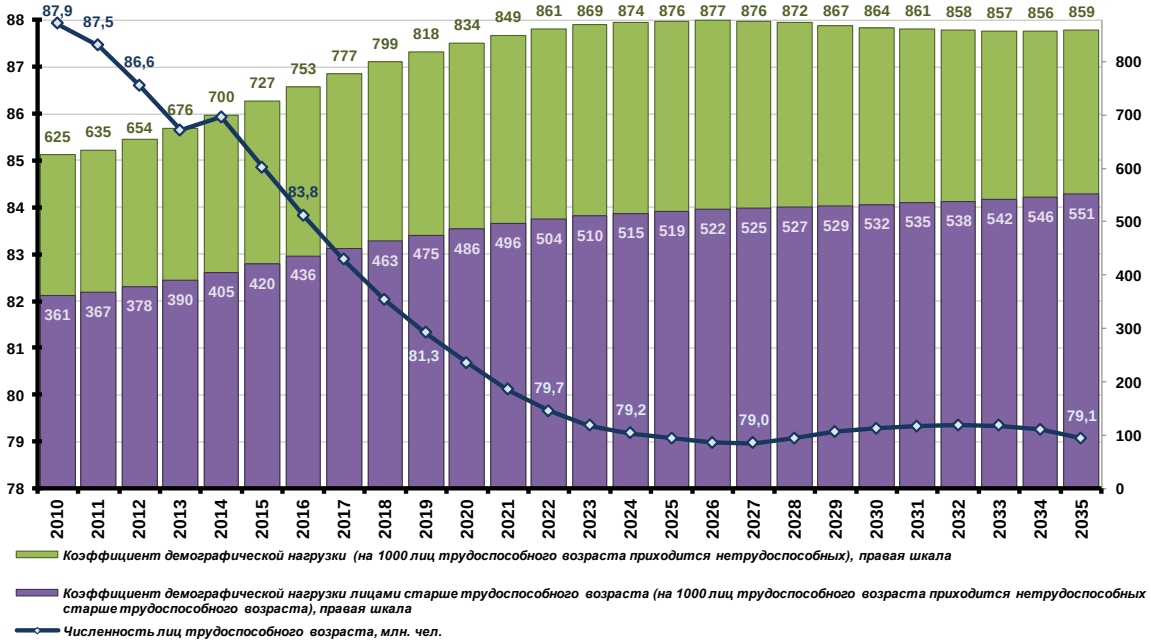
Therefore labor-intensive growth is impossible

- ***Financial***: an increase in pensionary load will require maintenance of high tax burden for business and will limit possibilities to grow for account of state (even if someone is willing to)

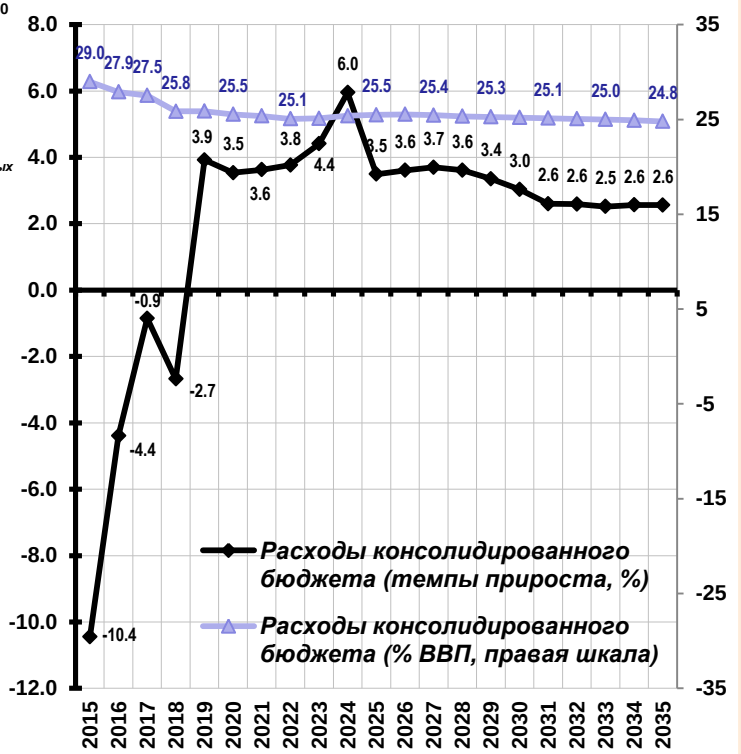
Therefore possibilities of capital-intensive growth are limited

- ***Technological***: incipient global technological (and industrial!) revolution changes greatly conditions and formats of business. Thus, **there is a high risk of decrease in demand for hydrocarbons. A row of "overlapping" technologies appear**

The Level of Demographic Load



Expenditures of Consolidated Budget



Scenarios for Russia

	Competition between force centers (55%)		Global technological pyramid (25%)	«Slow world» (15%)	Other scenarios (5%)
	Proper force center	Resource periphery	Imbedding in global chains	«Smart raw materials» scenario	Out of consideration
Institutional regime	Formation of institutions targeted at support of internal businesses including NTI. Formation of institutions providing interaction between state and private business regarding technological development (joint project realization sharing risks, foresight, purposeful export support etc.)	Innovative system targeted at the work with big corporations	Realization of breaking (including highly risky) projects in science and technology. Liberalization, support of FDI inflows and outsource projects. Intensive formation of institutions targeted at support of internal business, including NTI.	Intensive formation of institutions targeted at support of internal business, including NTI. Formation of institutions providing interaction between state and private business regarding technological development (joint project realization sharing risks, foresight, purposeful export support etc.)	
Probability of realization	**40% (three years ago - 20%)**	**15% (three years ago - 35%)**	**25%**	**15%**	**5%**

Structure of scenarios for science and technology development

	Proper force center	Mobilizationary	Punctual Specialization
Technological leadership	**Local leader in technology**	**Traditional specialization**	Import supplementing leadership
Catching-up development, following technological mainstream	Technological periphery	Following the leader in efficiency	**Accept of leading technologies**

Main Scenarios

Local technological leadership:

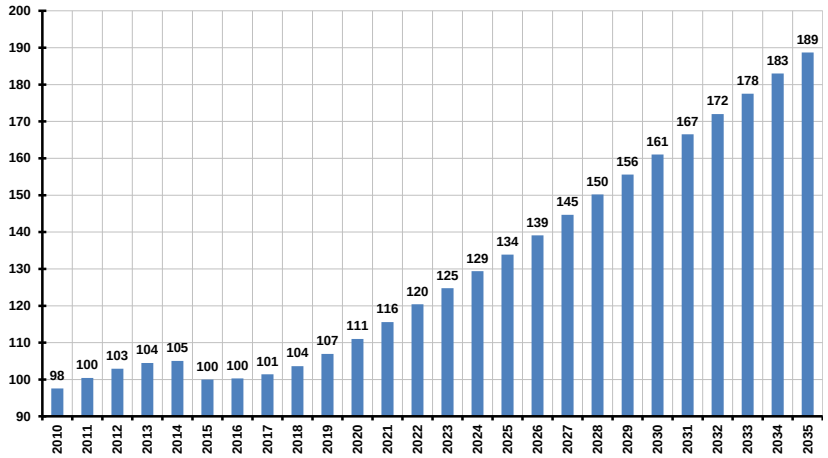
- to form and keep technological leadership in certain spheres (in the traditional ones: nuclear energy, military aircraft industry etc., and in the new ones, based on Prioritized directions of scientific and technological development and the National Technological Initiative implementations)
- to form a proper force center based on current and new competencies

Providing for dual balance between «projects and institutions»:

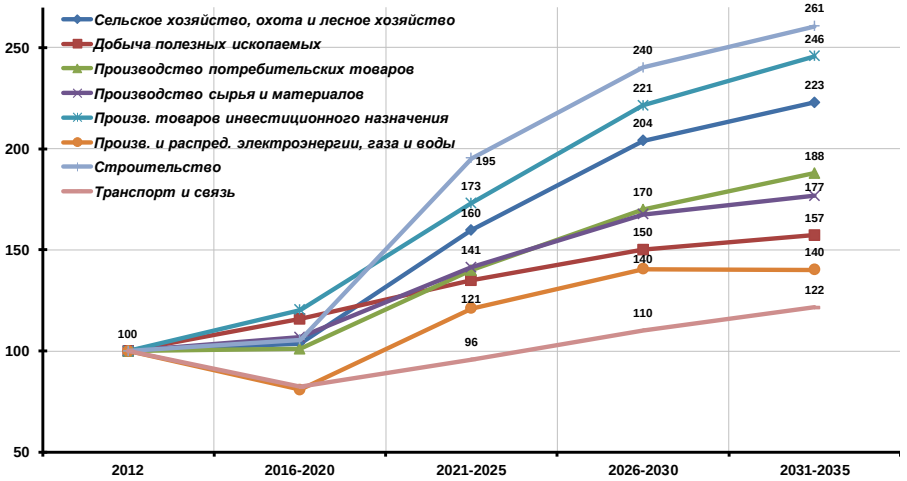
- technological breakthrough and creation of new production industries and markets / diffusion of developing technologies, support of innovation activities and mass-production modernization
- realization of projects / creation of ecosystems and institutions, which provide technological reproduction of resources and competencies.

«Price of Growth»: Labor Productivity and Employment Shifts

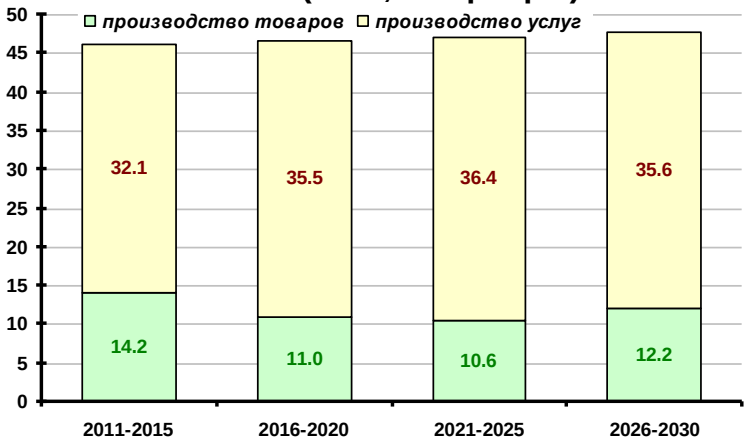
Labor productivity dynamics (by the number of the employed), 2015=100%



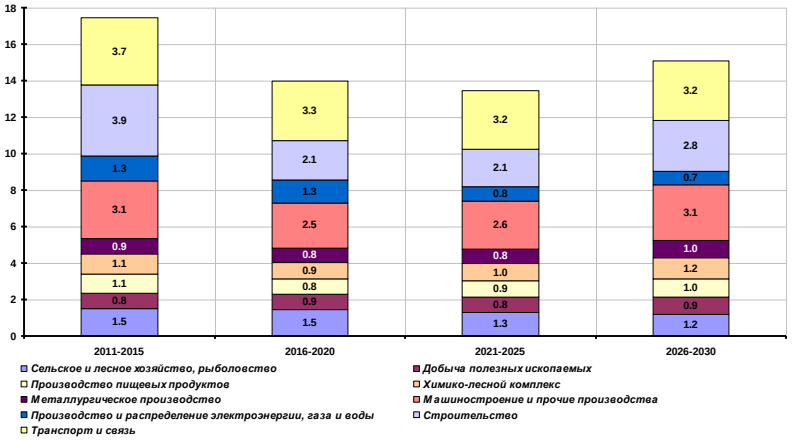
Investment requirement, by sector of economy, average over the period, 2012=100%



The number of the employed: from production to services (2030, mn. people)



The number of the employed by industry (2030, mn. people)



Estimates of PDDNT Realization Effect

	Increase in labor productivity	Decrease in unit costs	Increase in international export share	Decrease in import share on the local market	Increase in product price as a result of properties improvements	OVERALL
billion rub. (in prices of 2013 year)						
OVERALL	*15 082*	*9 876*	*1 518*	*5 350*	*1 319*	*33 144*
Safe and efficient energy	0	1 311	226	642	43	2 222
Biomedicine, bio-industry, bio-resources, and food safety	1 948	0	0	58	0	2 006
Information and communication technologies and systems	7 043	4 643	0	248	-1	11 934
Space means and systems	409	155	168	0	0	732
Transportation means and systems	215	941	0	0	181	1 337
Next-generation materials and production technologies	4 153	2 512	414	4 401	53	11 533
Rational environmental management and ecological safety	1 314	313	710	0	1 043	3 381
% of GDP (2013)						
OVERALL	28.2	18.5	2.8	10.0	2.5	62.1
Safe and efficient energy	0.00	2.46	0.42	1.20	0.08	4.2
Biomedicine, bio-industry, bio-resources, and food safety	3.65	0.00	0.00	0.11	0.00	3.8
Information and communication technologies and systems	13.19	8.70	0.00	0.47	0.00	22.4
Space tools and systems	0.77	0.29	0.32	0.00	0.00	1.4
Transportation tools and systems	0.40	1.76	0.00	0.00	0.34	2.5
Next-generation materials and production technologies	7.78	4.70	0.78	8.24	0.10	21.6
Rational environmental management and ecological safety	2.46	0.59	1.33	0.00	1.95	6.3

Towards a New Structure of Economy

Balance between «projects and institutions»

- defining key trends and find market breakthroughs;
- using limited resources (not only financial, but also human and management)
- ability to reach success both on «technocratic» and «financial» metrics;
- ability to delete obsolete elements from the system

Balance of the strong order (based on cooperation between business and government) **and strong «creative rhizome»**, which provides constant inflow of innovations from «below»

Ability to create an ecosystem for economic growth and the framework for communication of all stakeholders