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RUSSIA'S WATER RESOURCES 2030: PLAUSIBLE SCENARIOS

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RUSSIA'S WATER RESOURCES 2030: PLAUSIBLE SCENARIOS[4]

The research presented in this paper focuses on the sustainable use of water resources in Russia based on a Foresight study with a 20-year time horizon. The study uses a scenario-planning method to develop four trajectories: economic depression, economic stagnation, visionary future, and national priority. These four trajectories offer significantly different yet plausible alternative futures. The current paper draws upon the earlier horizon scanning activity, which identified a set of trends, weak signals and wild cards, along with their implications for water resources in Russia. Based on this work, it identifies key factors and indicators, which may characterize future developments in the following domains: (i) the sustainability of water systems; (ii) water use by households and industry; and (iii) new water products and services. The evolution of variables and indicators will then be considered under the scenarios termed 'Nearly perfect future' (economic growth), 'Problem conservation' (economic stagnation), 'Losses and accidents' (economic depression), and 'National priority' trajectories. The paper concludes with a brief description of further research directions, including a discussion on the probability of the scenarios being implemented. Russian policy makers and water companies may use the scenarios to adapt (i.e. plan for timely responses), avert certain undesirable future developments, or approximate the visionary future of the sector.

JEL: H4, H5, H87, I30, M11, R20, R52, Q01, Q02, Q15, Q18, Q22, Q25, Q26, Q27, Q53, Q54, Q55

Keywords: water resources, sustainable water systems, water use, water goods and services, scenarios, Foresight, Russia.

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1. Introduction

In the course of the last 15 years, the Russian water supply and sanitation industry, as well as the utility sector, have undergone constant reforms. Unfortunately, the changes were not of a systematic character. As a result, up to the present time, there is no optimal balance between government regulation and economic incentives for water supply and sanitation companies. This uncertainty has led to an unsatisfactory technical condition of the infrastructure and the poor financial state of enterprises operating in the sector.

Several important factors make the water supply and sanitation sector highly susceptible to administrative regulation. Among these are (i) the high social sensitivity of the sector, water supply and sanitation being key housing service providers to urban dwellers; and (ii) the monopolistic market: centralised water supply and sanitation systems being typically operated by local (city) level monopolies; and as such, requiring some government regulation in order to prevent monopoly rents.

Therefore, the alternative future trajectories for water resources closely comply with government policy measures, which are, in turn, contingent upon the overall economic situation in the country. For instance, during the economic downturn, fee freezes were introduced as an additional social support measure for households. This affected the operation of business, infrastructure improvement schemes, and the provision of better quality products and services in the sector.

Currently the coverage of water supply services in urban Russia corresponds to the level seen in developed countries. Urban water supply and sanitation systems were built mainly in the period of mass urbanization in the 1960s and 1970s. Since then, a substantial part of the infrastructure has become obsolete, out-of-date, and is in need of an overhaul. In most cases, there has been neither modernization nor restoration of fixed assets. As a result, at present the water systems in Russia suffer from relatively low quality water, low process efficiency, and a high frequency of accidents. Meanwhile, water consumption has noticeably decreased. This decrease in water use, up to half the volume used a decade ago, is attributable to the introduction of water metering and the widespread installation of modern plumbing, and is not considered a result of reduced economic (industrial) activity. Consequently, almost all water supply systems have significant stand-by capacity.

Today privatization of water supply and sanitation systems is prohibited by legislation. The provision of water and sanitation services to the population is a legal privilege of local governments. However, most regulatory decisions are made at the state (regional and municipal) level, particularly regarding key issues such as the establishment of tariffs for consumers and norms of water consumption. There is a growing tendency not only towards administrative centralization, but also towards centralization of economic activity through the establishment of regional water supply and sanitation

companies. Presently, enterprises owned by municipal authorities operate the sector. The majority of these are unitary enterprises, which have special operation rights. At the same time, private sector companies cover about 25% of the market and operate on the lines of public-private partnership, concession, or lease agreements.

Over the last five years, expenditures exceeded revenues for most enterprises in the sector. In 2014, the water companies' losses amounted to 19 billion RUB. Generally, only the enterprises operating in cities (with over 200,000 inhabitants) showed positive accounting balances. This is due to political considerations that are behind the tariff policy. At the beginning of 2015, a cubic meter of water in the Russian water supply system cost, on an average, 24 rubles (less than 50 US cents). In other words, it was notably cheaper than in most European countries; about two times cheaper than half a litre of bottled or packaged water. Currently, the expenditure of an average Russian household on water supply and disposal (excluding water heating[5]) is less than 1% of household income. Low tariff levels and uncertainty regarding flexible tariff systems as well as privatization in the short to mid-term makes the sector less attractive to investors and creditors. Nevertheless, prospects may change over the long- term, and thus it may be worthwhile to explore and indicate alternatives in the form of various scenarios.

The development of scenarios that reflect alternative plausible developments in a particular sector of the economy is a common methodological approach used by researchers and policy-planners. Scenarios can suit well a variety of methodological approaches applied in studies and documents, including those related to water (Flörke et al., 2011; UNESCO, 2015; World Business Council for Sustainable Development, 2006). Therefore, the present study also adopts the scenario approach, which takes future trends and uncertainties into consideration, and builds the basis for strategic responses to future challenges that may play out in different directions.

The following sections of the paper first review scenario work undertaken by international organizations and other acclaimed players in the field. The analysis of publications and previously identified key global trends and issues (and their possible implications for the Russian water sector) provide a context for the scenarios developed in this paper. The section on methodology and scope describes the scenario approach adopted in this study and identifies a set of key variables and indicators, which constitute a background to the scenarios developed. Next, the paper delineates four possible future scenarios. Scenarios are then cross-referenced with each other to provide a background for discussing individual strategies. The conclusion highlights the probability of their implementation and possibilities for future research.

[5] Heating costs are, on the contrary, rather high due to the absence of heating meters in most apartment houses and low average annual temperatures in most Russia's regions.

2. International water scenarios

As a grand challenge, the topic of water resources has been high on the agenda of national governments, international organizations, and companies related to the water sector. A number of studies touch upon various aspects of the topic. Therefore, it is important to give a brief account of them for the sake of complementarity and consistency of scenarios developed in this work.

The future scenarios developed in this study take into account rapid socio-economic changes and uncertainties surrounding water resources that may arise in future. First, a review of existing scenarios that address different aspects relating to water is undertaken. In total, we review 10 sets of scenarios according to the following selection criteria:

1. Credibility of organizations: leading international and national institutions with globally acclaimed work such as the United Nations, OECD, and the European Commission. Moreover, we reviewed studies by ATKINS and ARUP - the two leading global design, engineering, and project management consultancies, who have done comprehensive work on the water sector.
2. Coverage of scenarios: the selected scenarios that provide a global context for those developed in the present study. The reviewed scenarios demonstrate a consensus on key trends and drivers shaping the water sector. We also reviewed key variations between scenarios that indicate potential future divergences.
3. Relevance to Russia: some of the selected scenarios involve Russia directly (such as the one developed by the Baltic Environmental Forum), whereas others (such as the ones developed by UNESCO) only refer to water related issues in Russia.
4. The timeframe of the study: the selected studies were published not earlier than 2009 and look at the period between 2030 and 2050.

Table 1 features water scenarios selected for review in this study.

Table 1. Selected water scenarios

Name of the study	Source & publication year	Time horizon	Country/region	No. of scenarios
Charting our water future	Water Resources Group (2009)	2030	Global	3
Support to the EU Blueprint to Safeguard Europe's Waters	European Commission (2012)	2030	Europe	9
Water and Energy Outlook	UNWATER (2014)	2035	Global	3
Meeting the Water Reform Challenge	OECD (2012)	2050	OECD countries	3
Growing Blue: Water in 2050	International Food Policy Research Institute (Veolia Water, 2011)	2050	Global	2
Global Water Futures 2050: Five stylized scenarios	UNESCO (2012)	2050	Global	5
The future of Urban Water: Scenarios for Urban Water Utilities in 2040	ARUP (2014)	2040	Australia	4
Future water scenarios for Eastern Baltic Region	Baltic Environmental Forum (BEF Latvia, 2011)	2050	Baltic region	4
Future Proofing: The UK Water Sector	ATKINS (2013)	2050	UK	4
Water footprint scenarios	UNESCO-IHE Institute for Water Education (2012)	2050	Global	4

Table 2 provides brief characteristics of these scenarios. The set of scenarios presented here do not cover all of the issues raised by the trends and drivers identified at the first stage of the present study. The scenarios for Russia developed in this study take into consideration key trends, described by international researchers. To these were appended more comprehensive factors that cover the three thematic areas identified (i.e. sustainable water systems; water use by households and industry; and new water products and services).

Table 2: Brief characteristics of selected water scenarios

Source	Water sector scenarios	Brief summary
2030 Water Resources Group (2009) Charting our water future. Economic framework to improve decision-making	Base-case scenario	Due to prevailing practice and low efficient policy measures most countries will not close the existing water supply-demand gap.
	Endogenous scenario: *Accelerated economic growth*	With a 15% shift in social and economic profile of the population and increase in water and energy consumption per person, the water supply-demand gap will increase by 186% in 2030. The measures taken and the existing supply infrastructure capacity would be insufficient to close the existing gaps (i.e. in South Africa) and will require introduction of innovative solutions.
	Exogenous scenario: *Climate change*	The climate change assumptions of this scenario will primarily influence the water requirements for agricultural production. The scenario implies a decline in crop yield, higher food prices, and growing childhood malnutrition. It also forecasts that the water gap will increase by 31% in 2030. The solution of existing problems will also require implementation of new measures.
A multi-criteria optimisation of scenarios for the protection of water resources in Europe. JRC Scientific and Policy Report. Support to the EU Blueprint to Safeguard Europe's Waters (2012)	'Water saving in households' scenario	Saving up to 25% in water consumption by simple measures, e.g., replacing showerheads, or using aerators, water saving and sensor devices for water taps.
	"Irrigation efficiency" scenario	Irrigation efficiency will be improved from 74-77% to 93% by a complete shift to drip irrigation. Additionally, the use of deep groundwater will be reduced by approximately 20%.
	Scenario "Water re-use in industry"	About half of water used by industries will be re-used, thus reducing freshwater withdrawal.

Source	Water sector scenarios	Brief summary
	'Leakage reduction scenario'	Effecting an improvement in public water supply systems by eliminating about half of current leakages (similar to the scenario applied in the COWI (2011) report).
	'Urban-greening 25% scenario'	Introduction of greening measures and infiltration devices in urban areas will lead to reduction of total river flow (UN, 2011)[6], water runoff from cities, flood peaks and potential flood damage.
	"N-fixing Scenario" and "Optimum Fertilization Scenario"	Reduction of nitrate and phosphate concentrations in regions significantly engaged in agriculture, which will reduce the eutrophication process.
	"Re-Meandering Scenario"	Increased river meandering will increase their sweep and gradually fill underground water reservoirs; lead to reduced flood peaks in all European regions, potential flood damage, and nitrate concentration.
	"Crop Practices Scenario"	Combined methods of improved crop practices will increase organic matter that, in turn, will reduce the risk of soil erosion and increase its capacity to retain water, thus reducing the potential of flood damage.
World Energy Outlook 2012 and United Nations World Water Development Report 2014 "Water and Energy" (Vol. 1)	Absence of new policies (i.e. the Baseline Scenario)	No possible or potential future policy actions.
	IEA's New Policies Scenario	The central scenario of the International Energy Agency's world energy model considers the broad range of present policy commitments and future plans to address energy-related challenges.
	The *450 Scenario*	In order to limit the global increase in average temperature to 2°C, concentration of CO_2-eq gases in the atmosphere will be limited to around 450 p.p.m.
OECD – Meeting the Water Reform Challenge	The resource efficiency scenario	The increase in global water demand by 2050 will be reduced from 55% to 15% by introducing alternative energy generation technologies which do not require water, improvements in irrigation efficiency and water use by households and industries.

[6] The overexploitation of aquifers in some regions is causing land surface levels to sink – increasing vulnerability to surfacewater flooding – and intrusion of unusable salt water. Therefore, there is an urgent need to normalize the level of groundwater.

Source	Water sector scenarios	Brief summary
	Nutrient Recycling and Reduction scenario	The discharge of nutrients in wastewater will be reduced by approximately 35% with their reuse in agriculture and by introduction of new measures, e.g., move to natural fertilizers.
	The Accelerated Access scenario	Calls for more ambitious goals than the ones set out by the MDGs: by 2050 to provide universal access to an improved water source and to basic sanitation. WHO characterizes the latter as 'the lowest-cost technology ensuring hygienic excreta and sullage, disposal and a clean and healthful living environment both at home and in the neighbourhood of users' meaning' [WHO, 2015].
Growing Blue: Water in 2050 - The future of water requires a sustainable, blue path	Business as usual	The level of water productivity is not sufficient to control risks and ensure sustainability. There will be moderate leakage reduction and increase in energy demand, especially in non-OECD countries (at 110%).
	Blue growth	High improvements in leakage reduction and water efficiency use, as well as high increase in energy demand. By 2030, the share of renewable energy sources will increase from 19% to 29%.
UNESCO – Global Water Futures 2050: Five stylized scenarios	Conventional world	Economic growth will resume. Dissemination of technological innovation will increase water use efficiency and sanitation deployment but may not be sufficient to cope with growing requirements
	Conflict-world	We will see a sporadic growth of global economy, characterized by instability, stagnation of technological innovation, increase in agrochemical pollution (in an effort to maximise crop yields), and more frequent water-related conflicts.
	Techno-world	There will be vigorous economic growth, characterized by the expansion of global markets, accelerated pace of technological innovation, and mitigation of climate change effects. Water resources will be used maximally, which will become the limiting factor to economic growth. Creating effective solutions will thus become the highest priority.
	Global consciousness	The global financial crisis will redesign priorities and polices, and effect a change of values. Focus of technological innovation will shift to sustainable solutions, including cutting greenhouse emissions. Pressure on water will diminish due to crisis-related and new eco-management tools. Global quality of life will reach a historically high level.
	Conventional world gone sour	We will see economic and technological innovation stagnation, expansion of agricultural lands, and considerable deterioration and transformation of the environment. Water will become only one among other major survival concerns.
ARUP – The future of Urban Water:	Incremental improvements	Slow economic growth characterized by limited concern for sustainability. Further, economic uncertainties will allow for only minor changes to existing assets.

Source	Water sector scenarios	Brief summary
Scenarios for Urban Water Utilities in 2040		
	Better together	Industry and water utilities will collaborate across a centralized system in a time of high economic growth driven by investments in clean technologies.
	Autonomous communities	A world in which households and industry will independently collect and use water, which could bring about issues of water-energy and water-food nexuses in a time of high economic growth.
	Survival of the fittest	The most negative scenario with increased global competition for limited resources due to prolonged period of recession and a lack of investments.
BEF Latvia - Future water scenarios for Eastern Baltic Region	Economy first	The economic development turns towards globalization and liberalisation, intensification of agriculture, slow adoption of water-efficient technologies, higher pollution level, preservation of water resources that have high social and economic importance.
	Policy rules	High energy costs will enable effective coordination of policies. There might be major effects of climate change and an increase in the demand for water.
	Fortress Europe	An unstable world marked by financial, energy, and climate crises, and increased threat of terrorism. We will see slow advancements in new technologies, and a shift from the EU Water Framework Directive to the Water Security Framework Directive to secure water supply.
	Sustainability eventually	There will be a transition from a market-oriented economy to environmental sustainability with a focus on quality of life. By 2050, water policies will be widespread, e.g. they will follow the Polluter Pays Principle, resulting in positive results, including a change in consumption patterns.
ATKINS – Future Proofing: The UK Water Sector	The Graphene Era	The economy will become innovative, high-tech, and green, and society will attribute high value to natural resources. People will be motivated to consume sustainably, and water quality will match water use.
	The Wood Economy	The future is characterized by high costs of imported energy and growing scarcity of domestic energy resources, which will force water companies to seek new self-sufficiency solutions to fight competition.
	The Concrete Jungle	Large scale investments in water and wastewater infrastructure are boosted by cheap energy costs and incentives to overcome resource scarcity.
	The Steel Squeeze	Economic stagnation with high energy prices put pressure on water companies to balance price regulations and rising costs. Due to this, water companies do not face high competition.
UNESCO-IHE: Water footprint scenarios	Global market	We will see high economic growth and liberalized international trade. Environmental policies will rely on economic instruments and will not be oriented towards long-term sustainability.

Source	Water sector scenarios	Brief summary
2050		Fossil fuel will remain the main energy source. Rapid technological development is expected.
	Regional markets	Economic growth will focus on regional and national boundaries. Environmental issues will not play an important role in decision making. New efficient technologies will be rapidly developed and adopted. Fossil fuels will remain the main energy source but the share of alternative energy sources will increase.
	Global sustainability	Slow economic growth with liberalized international trade will be characterized by more importance given to social and environmental values. Efficient and clean technologies will be developed. Reduced use of fertilizers and less polluting industrial activity is expected.
	Regional sustainability	Slow long-term economic growth with equity and environmental sustainability will be at the top of policy agendas. The use of biofuel as an energy source will increase significantly. Pollution in agricultural and industrial sectors will be lowered.

The conclusions derived from the scenarios reviewed indicate that the absence of policies tailored to change existing problems in the water sector will inevitably worsen the situation. Most of the authors foresee an increasing water demand leading to water scarcity unless policies aim at changing water use patterns, decreasing water intensity of the economy, and ensuring sustainable development of water companies. The majority of the sources (7 out of 10) also forecast a growing energy demand and acknowledge the importance of new solutions for the energy-water nexus, e.g. energy introduction from alternative and renewable sources. Some of the scenarios propose a dramatic expansion in agriculture in light of population growth across the world. An expansion in agriculture will increase use of water for irrigation and fertilizers, and consequently aggravate water pollution. An increase in industrial waste would also increase pollution. Suggested solutions vary from improvements in irrigation efficiency (such as shift to drip irrigation) and use of eco-fertilizers, to introduction of water-reuse systems and new water use technologies. Additionally, there is a negative influence of climate change upon the economy in general and the water sector in particular. Therefore, special measures are required to mitigate its effects. Not every scenario takes into consideration the social consequences of the sector's development, such as an increase in migration, higher influx of refugees, or possible acts of water terrorism. Several scenarios suggest that moving towards 'green growth' is the necessary condition for a high quality of life and future sustainable development. Sources that consider the link between global or national economic development and development of the water sector prove a strong connection between the two, characterized by change in water consumption and amount of investments in the sector, interrelation between water and adjacent sectors, including their willingness to cooperate. The main conclusions described in the scenarios reviewed correspond to the vision of the future deemed desirable by the paper 'Water Resources – an Analysis of Trends, Weak Signals and Wild Cards with Implications for Russia' (Saritas et al., 2015) and has been elaborated in greater detail in the present research.

The next section identifies the common assumptions and trends used in the analysis of the scenarios. These assumptions constitute a broader global context for the scenarios developed within the present study along with the trends, drivers, weak signals, and wild cards developed for Russia in the earlier phases of the study.

3. Methodology and scope of the study

The research described in this paper draws upon scenario-planning methods. Scenarios do not intend to provide a prognosis by mechanically extrapolating past trends in to the future. Instead, in the words of Schwartz (1991), scenarios are, '*tools for ordering one's perceptions about alternative future environments in which one's decisions might be played out'*.

The main assumption of scenarios is the uncertainty of the future with several external (independent) factors, which may affect the water sector. The aim is to explore

those multiple directions of development. Methodologically correct scenarios have the following distinctive features:

- Describe possible future changes in a particular ‘system’ (domain, environment, society)
- Involve imagination
- Indicate the causes and consequences of key developments
- Challenge our current images and conjectures about the future
- Help to create and evaluate alternative policies, strategies, and actions
- Are seen as relevant and an important element of the strategic decision/policy-making process.

Scenarios are used successfully to develop government or business strategies, as well as serve as an instrument to agree on future interests of a variety of stakeholders. They are typically built around trends, issues, and uncertainties in workshops with the participation of experts and stakeholders.

The development process of the water sector scenario in the present study involves a review phase, which includes an analysis of existing scenarios presented earlier. The analysis of trends, weak signals, and wild cards developed in the previous phase of the study through reviews and brainstorming session with experts constitute the backbone of the scenarios for Russia within the global context. A set of variables and indicators developed for all scenarios describe three thematic areas of the study (Saritas et al., 2015): (i) sustainability of water systems, (ii) water use by households and industry, and (iii) new water products and services (Table 3).

Table 3. Initial list of indicators developed for each of the thematic areas

Thematic areas	Main factors reviewed in each scenario	Indicators
Sustainable water systems	- Influence of climate change on water resources; - Surface and underground water sources and their condition; - Water resources management in hydrotechnical systems; - Transboundary problems of water resources management; - Water resources economy; - Recycling and water re-use: 'Micro' and 'Macro' water treatment; - Related cross-sectoral problems to water resources	- Water withdrawal from water resources (cubic m) - Volume of contaminated discharged water (cubic m) - Volume of recycled and reused water (cubic m) - Volume of contamination in discharged water (*10^6 kg)
Water use by households and industry	The demand and the volume of water supply and sanitation services	The dynamics in the volume of water consumption by households (litres per year) The number of installed water meters in multi-apartment houses and apartments (units) The number of particular measures taken to increase water use efficiency in households (number of households, applying these measures, monthly)
	Finance situation of water utilities sector	The financial result of the water sector (RUB / year) Tariffs (and their dynamics) for water supply and sanitation services for population and industry (RUB/month) The volume of private investments attracted to the sector (RUB/year)
	Technical condition of the water utilities' infrastructure and the quality of their services	Incidents (and their dynamics) in the water sector (number of incidents) The level of technical and commercial losses (percentage) The share of water companies complying by sanitation norms regarding water quality (percentage) The share of water companies observing norms regarding sewage treatment (percentage)

Thematic areas	Main factors reviewed in each scenario	Indicators
Water goods and services	- culture of water use; appearance of new technologies and new materials for water treatment; appearance of smart technologies, use of IT sensor information technologies in the water sector increasing consumer-oriented focus of water companies higher efficiency of energy technologies a progress in combo technologies, mainly in water-energy nexus, primarily in hydroenergy distribution of water companies costs for water purification and desalination the economic and diplomatic relations with countries from which water technologies are exported to Russia; economic and political crises	- Increased awareness of water scarcity among population (percentage) - The share of water saving and water efficient equipment in the total volume of equipment of industrial enterprises by sector (percentage) - Customized services of water companies for end users (persons), number of water companies that provide such services (units)) - Volume of investments in development and application of new technologies (RUB/year) - Volume of water companies costs (by region) for water desalination (RUB) - Cost relationship between operational and capital costs for water purification (percentage) - Development and application of new business models / new organizational solutions, including those in the ICT sphere, in water companies (number/share of such enterprises/year) - Intergovernmental agreements of the Russian Federation with countries from which water technologies are imported (number of agreements) - The volume of export and import pf water technologies in the Russian Federation (RUB/year)

Scenarios were supplemented with quantitative forecasts that included data such as economic growth, water use, and investment and expenditures for water services. Data for forecasts were based on analogies between recent economic and water development trends in Russia and their plausible projections in the future. The process of scenario development also involved brainstorming sessions to discuss intermediary results with experts in panels, interviews, and wider consultations.

4. Future scenarios for the water sector in Russia

The following are the most important external factors (variables) that describe uncertainties in the water sector, and shape the scenarios developed in this paper:

- Economic development
- Government policy and the ability of the water sector to attract investment
- International relations and trade
- Technological progress
- Public attitude towards water use

The following four scenarios were developed based on the plausible variations of the aforementioned drivers: i) 'Nearly perfect future (economic growth)'; ii) 'Problem conservation' (economic stagnation); iii) 'Losses and accidents' (economic depression); and, iv) 'National priority.' These are presented in the following sections.

Scenario 1: Nearly perfect future

This scenario implies stable economic development in Russia, partly due to an increase in the oil price [OECD/IEA, 2014], absence of substantial political or diplomatic tensions (that cause, inter alia, sanctions), economic diversification, better investment climate, and access to financial resources and new technologies in the international market that would ensure consistent technological development of the Russian water sector.

This development would be characterized by a steady GDP growth with increased investments in capital stock and 'green' technologies (environmental projects). Such economic development may lead to:

- increase in volume of construction of new industrial facilities based on modern technologies;
- application of efficient energy and water use technologies;
- modernization of existing enterprises through water recycling and reuse;
- the upgrade of existing wastewater treatment facilities.
- a decrease in the volume of water withdrawal and disposal
- a decrease in the volume of discharged water pollution
- significant improvement in the quality of water in water basins.

As a result, the annual volume of recycled and reused water will grow, the volume of water withdrawal will decrease, and the volume of discharged water contamination will diminish steadily. Global developments may affect Russia's import of water technologies.

Technology transfer from developed to developing countries will be heavily accelerated due to an increase in Chinese foreign investment [Wei, 2015]. In this case, the import of most of Russia's water technology will switch to Asian suppliers. These capacities have to be built in advance. For instance, it will become necessary to develop joint ventures with Chinese partners as early as possible to ensure both technology transfer to Russia as well as export of competitive Russian water goods and water technologies to Asia (i.e. biotechnologies) [the BRICS Post, 2015].

Russia will incorporate ideas of 'virtual water' within its export strategy and will concentrate on the water-constrained markets of Asia. Eurasian integration will provide extra options for the creation of agro-clusters in southern Siberia and will allow increased export of goods to Central Asia and western China.

Russian cities and regions located near the sea will make use of desalination and purification technologies, the costs of which would decrease drastically. In Russia (e.g. in Crimea) as in several other countries (e.g. Saudi Arabia), the active use of solar desalination technology, the switch from chlorine-based treatment to UV, and membrane treatment will be fast and widespread. For example, in Crimea where some trial solar stations already exist, there is a rising need for fresh water. In big seaports, the share of recycled water in domestic water use will exceed 30%.

Combo technologies in Russia will almost completely wipe out obsolete water and energy-intensive solutions for utilities. A synergy effect will become feasible for large enterprises (like electricity plants) and smaller ones. Recycling technologies of power stations using water (such as nuclear plants) will be widespread across the country. Automated pumping technologies and online stations for monitoring quantity and quality water supply, as well as centralized monitoring technologies, will be similar to those applied in the EU.

Due to the overall increase of the national public budget, there will be a growing volume of public investments for construction of new water reservoirs and the maintenance of existing ones. Water supply to the population, industrial enterprises, and agriculture will improve consistently. Further, there will be significant improvements in the water supply of Russia's arid zones.

Due to reduced unemployment and an increased average level of wages and pensions, there will be an opportunity to introduce mechanisms that combine effective tariff regulation for the population and new technologies that minimize household water consumption. Increased water use fees for industrial enterprises will encourage them to introduce water-saving technologies.

Due to higher personal income, the water tariffs might increase, and organizations that provide services in water management will have the opportunity to implement their investment programmes and reduce losses in water supply and energy consumption. Due considerations will be made regarding the affordability of utility services in general, and water supply and sanitation services in particular. Agreements between authorities and water companies will set a share of capital expenditures that may be exempt from 'tariff freezes', a provision that is especially important for old cities requiring renovation of a substantial share of their water infrastructure.

Although international financial institutions advise a maximum 4% of household income on water services (excluding water heating rates), the overall amount of housing service fees should be taken into consideration. In 2014, average expenditures of

households on water supply and sanitation were less than 1% of household income. Assessment of utility services accessibility could be undertaken using a programme that has been working successfully in Russia for the past 20 years. The programme aims to help low-income households pay for housing services. In 2009, 13% of households benefited from this programme; in 2014, this figure dropped to 8%, indicating that utility tariffs became significantly more affordable.

The sector's ability to draw investors will rely not only on an improved financial situation, but also on the long-term predictability of revenues. One important prerequisite for attracting investment is long-term tariff regulation, when the latter is determined for an entire investment cycle (5 to 10 years) and not just for one or two years. In this scenario, tariffs are determined not in absolute terms, but by a certain formula that allows for changes in external variables such as inflation, other monopolies' fares, and commitments to improve efficiency. Long-term tariffs will allow the water supply and sanitation enterprises to create quasi-competitive motivation as reduced inefficient expenditures may serve as a source of return on investment and generate additional profits.

The 'Nearly perfect future' scenario implies a competitive selection of engineering infrastructure management models. Based on the best international practices, the two basic models are the following:

- A joint venture, whereby the basic objects of engineering infrastructure are included in the authorized capital of an enterprise (this will require amendments to the law on water supply in order to allow privatization), and all shares (or a controlling stake) are owned by public authorities i.e. the local government (the German model);
- A public-private partnership (including, but not limited to concession agreements) is established.[7] Changes to the concession law will be necessary to grant winners of the competitions the right to form concession agreements (and other public-private partnership agreements) based on the best quotations (following the French model). Thus, this would bring into play the principle of competitive pricing for the right to enter urgently a competitive market.

The public body authorized to provide water supply and wastewater disposal services will be in charge of the selection of engineering infrastructure management models.

All necessary legal decisions related to the division of responsibility of the utility companies and consumers, particularly in apartment buildings, will be taken. These imply that multi-apartment houses (not individual apartments) will be the consumers. Moreover, entities that manage residential real estate (property management companies, homeowner associations) will be a party in contractual relations. They also preview necessary legal measures to ensure parties' payment discipline of counterparts. To ensure efficient

[7] Previously, municipal unitary enterprises dominated the water industry in Russia. As municipal unitary enterprises have for years been under the strong political influence of the state (unclear what public owner means – the state?), they may not be fully perceived as economic (market) actors. Today the political emphasis is on the mechanisms of public-private partnership (i.e. concessions) to attract private investments. However, experience has proven that for objective reasons private concessionaires do not manage to attract investments for municipal infrastructure. Currently, concession agreements are drawn up for 30 to 50 years, which is not only economically inefficient, but also signifies privatization of communal infrastructure (which is against the law). In the European Union, on the contrary, we observe the process of re-municipalization in public services, including water and sanitation.

operation of utilities, house-metering devices will become the property of the water companies (not apartment owners), which will allow online determination and optimization of water consumption balance. In the 'Nearly perfect future' scenario, these meters with flexible tariff rates will be electronic and will have real time connections with the utility companies and consumers, thus allowing flexibility, for instance, in different types of users and duration of use.

Water supply and sanitation services in Russia are mainly residential, and their objectives are set at the municipal level. Successful implementation of liberal reforms largely depends on the real transfer of water management responsibilities (including tariff policy and control over engineering infrastructure) to the municipal level. The objective of decentralization is linked closely with the regional nature of utilities' work, and aims to increase the efficiency through economies of scale. Decentralization also implies closer and horizontal inter-municipal linkages that allow for effective solutions to common problems.

The positive developments described in this scenario will reduce the administrative burden (barriers) on the sector. The sector will become more attractive to private investors scenarios and will not merely depend on public budgetary resources. This will lead to technological modernization of engineering systems, widespread introduction of smart information technologies, and consumer-orientation. This might improve the quality and reliability of services.

As environmental protection is a public good and its provision involves government funding and strict legal regulation, it may occupy a weak place in this scenario. The efficiency of environmental protection will rely on the quality of treatment and disposal of wastewater.

Scenario 2: Problem conservation

Economic stagnation implies an insignificant growth in Russia's GDP (i.e. around 0.1% per year). In such an event, most companies will shift their focus from development to minimization of losses. Due to high interest rates on bank loans, the number of investment projects - including those related to the introduction of new water saving technologies and modernization or construction of new wastewater treatment facilities – will reduce.

The technology transfer from developed to developing countries will not accelerate despite the rising role of Chinese foreign investments. Western multinational companies will not trade their know-how. Meanwhile, Crimea remains under a technology embargo from the EU and the US [Rapoza, 2015], and simultaneously faces significant water management challenges. These circumstances will enable Chinese penetration into the peninsula market. Furthermore, these companies will eventually enter other regions of Russia offering water services and hi-tech goods. They will subsequently monopolize high margin water segments, thereby further damaging the prospects of Russian companies that will continue rendering the unprofitable operating services.

The cost of desalination and purification technologies will continue to decrease in the international market [Water Reuse Association, 2012; Mohamed, 2015], but a substantial price drop will happen only due to economy of scale. Transmission from chlorine-based treatment to UV and membrane treatment will only be rapid and widespread in developed

countries, specifically in cities like New York, Tokyo, London, and Moscow. Combo technologies (especially in the water-energy nexus) will develop across the world rather intensively due to high demand in Asia and Africa. In Russia, these will be mainly limited to the bigger cities.

Driven by social policies, the government will use a special index (set below market price inflation) to calculate and set tariffs of services provided by water supply and sanitation enterprises. This will not allow water supply and sanitation organizations to implement investment programmes; thus, investment opportunities in the sector will remain extremely low.

Private businesses will be interested in managing water infrastructures only in big cities, but will lack funds for necessary upgrading. Such businesses will retain profits only by optimizing administrative activity, which ultimately would have little impact on the improvement of quality and reliability of services.

Over the next five years, the share of private business in the market will grow to 35-40% due to the implementation of private initiatives based on concession agreements. Such initiatives will be run by private businesses only in cities with more than 200,000 residents. Efforts to attract private businesses to manage unprofitable water supply and sanitation enterprises in small settlements will fail. In this case, the final transfer of administrative responsibility for water supply from the municipal to the regional level will become more popular.

The gradual deterioration of fixed assets will result in a continual decline in the quality of wastewater treatment. Even after economic recovery, the share of investments in environment protection programmes and green technologies in relation to the total volume of investments will remain rather low. Due to this, the volume of recycled and reused water will remain more or less unchanged.

Further, federal and regional budgets' capital expenditures on construction of new reservoirs for guaranteed water supply to the population and businesses the will be significantly reduced.

Companies will tend to complete existing investment projects and not plan new ones. As businesses would continue to operate with reduced production volumes, wastewater discharge will reduce insignificantly. Furthermore, the gradual deterioration of equipment at wastewater treatment plants will adversely affect the quality of wastewater treatment, and even lead to an increase in the volume of discharged pollutants. As a result, we will see deterioration in the water quality of water basins.

Information technologies (i.e. for metering) may be introduced in water utilities of some cities, but such implementation might not be systematic. Once sold to customers, water companies could lose access to the meters, required to ensure regular estimation of services supply.

As the public budget expenditures on water supply measures will face cuts, financing of new large infrastructure units (those in federal properties) may be made through the special federal programmes (targeted funding) such as the 'Development of the water sector of the Russian Federation in 2012 – 2020' federal programme (Government of Russia, 2012). Activities previewed in this programme have already been re-scheduled or cancelled. For instance, the construction of the Elista reservoir (originally scheduled for 2012-2014) has been rescheduled for 2016 (Elista city portal, 2014). The construction of Krasnodar reservoir (originally scheduled for 2012-2014) and the reservoir on the

‘Shurdera’ beam (Dagestan) are incomplete due to cuts in funding. Funding of certain activities may be re-allocated to the anti-crisis budget (i.e. construction of the water supply side flow path of the river Ufa in river Miass).

In this scenario, the institutional relations between the water supply services and individual consumers (flat owners) will be direct. This means that each resident will sign a contract as a short-term solution. However, this will mean increased paperwork and an even more complex system of service provision.

Summarizing the possible developments in this scenario, the quality of water services will deteriorate. The population will increasingly switch to using bottled water for drinking and cooking. The number of accidents in the water supply system will grow and may become exponential by 2019-2020 or even before 2018. Depending on the policy and economic developments in the country after 2019-2020, the economic stagnation scenario may transform into the ‘Nearly ideal future’ or ‘National priority’ scenario, described below.

Scenario 3: Losses and accidents

This scenario is characterized by negative GDP growth. As a result of economic depression many enterprises will close or reduce operations. Those remaining will seek to reduce costs that do not directly generate profits. Low solvency of the population will be a barrier for water supply and disposal organizations to implement their investment programmes.

Although the major global technology trends are expected to remain the same in this scenario, the scale of their implementation will be very limited compared to the ‘Nearly perfect future’ and “Problem conservation’ scenarios. If coupled with global economic depression [Allen, 2015], labour-intense and low-tech production in ASEAN and southern Asian countries will increase to cut costs [OECD, WTO, the World Bank, 2014], and this will hinder implementation of the best water solutions.

The strong economic pressure faced by Russia since 2014 will remain a constraint on modernizing the water sector. Federal water programmes that preview private capital (co-)financing will not achieve their objectives. Public and private firms will lack the necessary R&D funds, and imports of innovative products and solutions from East Asia will be the main source of new technologies.

Many industrial enterprises on the demand side will risk going bankrupt or shutting down, while others will require restructuring. Therefore, the level of industrial water consumption will plummet, resulting in the decrease of wastewater discharge volumes. Lack of funds for industrial water purification technologies may negatively affect the quality of wastewater treatment and increase the number of accidental discharges.

The economic recession in the country will also have negative consequences for ‘green growth.’ No significant environment friendly technologies would develop. Water reuse programmes for energy generation and the implementation of a ‘blue agenda’ to reduce inefficiency in water use at both domestic and industrial levels will suffer severe delays.

Likewise, in the ‘Losses and accidents’ scenario, the government will artificially restrain tariffs on utility services for households to protect welfare policies. The effectiveness of this tool is questionable as it focuses mainly on those who consume more

(non-poor households). Second, co-financing tariffs out of the national budget during a crisis will be difficult. Moreover, it will lead to a significant reduction in the real income base of water supply and sanitation companies, deterioration of fixed assets and quality of services, higher probability of accidents, withdrawal of private sector, and outflow of qualified personnel from the sector. Financial claims for losses linked to accidents will be served to the owners of infrastructure (local authorities, as these objects may not be privatized), and this will exacerbate the fiscal crisis.

The government may attempt to advance regionalization of the water sector, decentralizing decision making and costs to the regional level, while at the same time trying to level-off the situation through introducing cross-rates (that is, the population of relatively prosperous settlements will sponsor the population of 'problematic settlements'). This idea was already in circulation during the economic crises of the 1990s and 2000s.

The historical analogies of 1998-2002 show that this scenario may develop for a period of three to four years, after which the government will change its policy and take action.[8] With the situation reaching a boiling point, the government will assume a leading role in supplying the population with high-quality drinking water and improving the reliability of the water supply and sanitation engineering. This task will assume a national priority. Currently, developments in this scenario may be unlikely. Nevertheless, they may become plausible in the event of a full-blown economic crisis with serious social implications for Russia.

Scenario 4: National priority

The developments described above could become a continuation of the crisis scenario. The preconditions imply a poor performance of the economy and a rapid deterioration of the situation in the water sector. As it would be a subject of high national priority, it will inevitably lead to the adoption of unpopular decisions designed to achieve fundamental changes. The measures taken may ultimately lead to reforms in accordance with the 'Nearly perfect future' scenario. These may include steps such as improving the investment attractiveness of the sector, limiting non-economic grounds for tariff regulation, and boosting the financial status of water supply and sanitation enterprises.

At the same time, this scenario foresees other developments in the sector, which are markedly different from those in the 'Nearly perfect future' scenario. First, we will see no decentralization of governance in the sector. Instead, we will observe a trend towards centralization, whereby the authorities will formally be concentrated at the regional level, but in reality all major decisions will lie with the federal centre. A possible mechanism here could be the allocation of significant funds from the federal budget to upgrade the water supply and sanitation sector.

This scenario is contingent upon the speedy resolution of a selected number of the most burning issues. Therefore, it will not provide a comprehensive solution to the

[8] In Russia after the economic crisis in 1998 the government 'froze' the tariffs for utility services for 1999-2000. This has led to a sharp increase in accidents in the municipal sector, the outflow of skilled professionals, active discussion of 'entering the era of disasters in the housing sector.' This situation could not last longer. Since 2002, the tariffs for utility services began to rapidly grow (the effect of 'delayed' inflation). And in 2003 (during the cycle of the Federal election), the Federal government motivated large business owners to establish PPPs in order to split the risks of emergencies and fundamentally change the situation in the municipal sector.

problems existing between service providers and consumers. Thus, legal and financial problems between the sector's companies and consumers, especially those households living in apartment buildings, will remain. This, in turn, will prevent the introduction of new smart technologies, since it would require cooperation between parties.

Furthermore, this scenario does not leave room for competition between management models. The focus rests on the development of PPPs in the form of concessions. Ultimately, a few large business actors will emerge in the sector as operators, who will either be business people selected by the government or companies with state ownership.

These developments will provide solutions to the most urgent problems of the sector such as quality enhancement and reliable service provision. However, legal restrictions and lack of motivation will not allow the companies to address the pressing need for sustainable development of the sector based on new effective technologies, including ICTs, and organizational arrangements.

5. Discussion and conclusion

Table 4 below is intended to offer a better sense of the alternative futures presented in the four scenarios above. The table synthesizes and benchmarks the indicators and parameters of the scenarios that fall under the three thematic areas emphasized in the project.

Table 4: Benchmarking of scenarios based on key factors

Factors / Scenarios	Nearly perfect future	Problem conservation	Losses and accidents	National priority
Overall context				
Economic context	A stable and sound economy will promote a sustained growth Frequency of crises reduced, inancially strong government and companies overcome crises successfully without big losses Russian water industry grows together with the global water industry (global water industry will reach $980 bn by 2020). Decentralization of the water sector	Extended economic depression, periodical crises Conservation of existing problems of the water sector	Negative economic growth Many enterprises in the water industry go bankrupt High level of uncertainty	Continuous economic depression and stagnation Centralization of the water industry, ownership of water companies transferred from private/municipal level to the level of Russia's regions
Sustainability of water systems				
Recycling and reuse	A number of industries have adopted 'circular economy' and 'zero discharge' concepts Total amount of recycled and reused water – 300 per cent of fresh water consumption	Moderate improvements have been achieved Consumers are more aware of the importance of sustainability Some improvements have been achieved for recycling & reuse (270 per cent of fresh water consumption), but closed cycle still not fully adopted	Industries and urban areas continue to pollute the environment No incentive for building recycling and reusing infrastructure, as these are considered too costly Environment protection awareness is still limited Total amount of recycled and reused water – 200-220 per cent of fresh water consumption	The main concern is water provision for users. Recycling and reuse are not among priorities
Amount of	The amount of water consumption	No significant changes as users	Increase of water consumption	Water consumption is high;

Factors / Scenarios	Nearly perfect future	Problem conservation	Losses and accidents	National priority
water used (water consumption)	decreases (about 10 per cent of total fresh water consumption)	have no incentives to reduce water consumption	due to growing loses (about 15 per cent of total fresh water consumption)	some reduction is possible due to slow down of economic activity
Water use by households and industry				
The dynamics of water consumption in households and industry (water consumption)	Water consumption by households is reduced to 110-140 litres per person per day	No significant changes occur, water consumption stays at the level of 180-200 litres per person per day	Due to the low water tariffs, water consumption grows to 250-300 litres per person per day	Water consumption gradually declines after a sharp increase of water tariffs to about 150 litres per person per day
Use of water metering systems	100 % of multi-apartment buildings are equipped with water meters General meetings of apartment buildings owners are in charge of metering: either everybody installs meters, or no one does Water utilities calculate costs per apartment buildings, not per individual apartment owner Smart meter are widely installed Meters are owned by water utility companies, which gives an opportunity to better control water consumption and apply 'smart' tariffs	50% of multi-apartment buildings are equipped with water meters and this figure does not change 70% of apartments are equipped with meters The use of traditional (simple) water meters, characterized by low quality and measurement uncertainty Contractual relationships with apartment owners makes the installation of meters at the building level meaningless	20% of multi-apartment buildings and 30% of apartments are equipped with water meters Due to the low cost of water, meters become economically unsound, and they are predominantly broken or not checked	50% of multi-apartment buildings and 90% of apartments are equipped with water meters Meters installed under strong administrative pressure and the cost covered by the state budget. It is a complementary measure in relation to the increased tariffs Water meters do not have a significant impact on the level of water consumption
Measures to	Not less than three measures are	No measures are taken	No measures are taken	At least one measure is taken

Factors / Scenarios	Nearly perfect future	Problem conservation	Losses and accidents	National priority
increase water use efficiency by households Accidents and water losses	taken Efficient plumbing, compost-toilets, water-saving shower units, the widespread use of dishwashers and washing machines The use of spray nozzles and six-litre water closet supply tanks			Government-led application of simple and cheap water-saving solutions, such as spray nozzles on water taps
Annual financial result of water sector	The utility sector shows a positive financial result (has profit)	Losses of the water sector increase from RUB 19 billion to 30 billion per year	Losses of the water sector increase to RUB40-50 billion per year	At the beginning of this scenario, the losses amount to RUB 40-50 billion per year As the scenario develops, they are reduced due to growing tariffs
Dynamics of tariffs on water supply and sanitation services for households and other consumers	The tariff increase, taking into consideration the solvency of the population, increases on average by 50% (in 2015 prices) in the course of five years Flexible tariff regulation introduced	The existing system of tariff regulation remains Tariffs rise by 60-80% of the inflation rate, which is a decrease in absolute terms	Tightening of tariff regulation: 'freezing' of tariffs; rates do not change for 2-3 years, while inflation reaches 10%	Rapid increase in tariffs after their 'freezing' by 50% in 2-3 years
The volume of private investments attracted to the sector	By 2020 RUB 1.2 trillion per year, predominantly (70%) from external sources Sector's infrastructure is modernized	RUB 300 billion per year, generated mainly from tariff revenues, which does not provide for bare reproduction Sector's investment attractiveness does not change or may slightly worsen	RUB 150 billion per year, generated mainly from tariff revenues, which does not provide even for basic reproduction The sector remains unattractive to private investors due to low	RUB 500-600 billion per year for the duration of this scenario (2-3 years), which provides only for basic reproduction and steady development of the sector Investments in water resources are made mainly by state-owned

Factors / Scenarios	Nearly perfect future	Problem conservation	Losses and accidents	National priority
		The government and major banks provide a part of the necessary investments for upgrading infrastructure and water supply networks.	tariffs and long payback period	companies Private sector involvement remains low Several large companies operate in the sector
Accidents dynamics	Reduced number of reported accidents	Increased number of reported accidents	Increased number of reported accidents	Reduced number of reported accidents
The level of technical and commercial losses	The losses are reduced to 10-12% in the course of 5 years of this scenario	The water losses in pipe networks grow by 2-4% per year and may exceed 40% by 2020	The water losses in pipe networks grow by 4-6% per year and may exceed 50% by 2020	The water losses in pipe networks decrease after reaching the 40% peak
Meeting sanitary norms for water quality	The share of water that meets sanitary requirements reaches 90% in 5 years	The share of water that meets sanitary requirements reduced to 30% within 3 years	The share of water that meets sanitary requirements reduced to 20% within 3 years	The share of water that meets sanitary requirements reach 60% in 5 years
Meeting sanitary norms for the sewage treatment	The share of sewage water that meets sanitary requirements reach 70% in 5 years	The share of sewage water that meets sanitary requirements reduced to 30% in 3 years	The share of sewage water that meets sanitary requirements reduced to 15% in 3 years	The share of sewage water that meets sanitary requirements reaches 60% in 5 years
New water products and services				
International markets (including 'virtual water' trade)	Export of water in large tanks, by water pipelines and tankers Extensive volume of smart 'virtual water' export (water-intensive products) Water rights trade	Export of bottled water Growth of retail and wholesale trade of bottled water slow down from 6-6.5 % in 2013-2014 to 4-5% in 2020. Thus, the world trade of bottled water reach 393 030 mln litres per year	No export Growth of retail trade of bottled water slow down sharply from 6-6.5% in 2013-2014 to 2-3% in 2020. Thus, the world trade of bottled water reach 367 240 mln litres per year	No export Growth of retail trade of bottled water slow down sharply from 6-6.5% in 2013-2014 to 2-3% in 2020. Thus, the world trade of bottled water reach 367 240 mln litres per year

Factors / Scenarios	**Nearly perfect future**	**Problem conservation**	**Losses and accidents**	**National priority**
		Continued export of some 'virtual water' volume (water-intensive products)		
Production costs (desalination, operating vs. capital costs)	Economic efficiency of water export exceeds that of oil	Pioneer desalination units allowed to lower costs as compared with the best examples of 2010-2015 (\$0,35-0,55/m^3), average costs do not exceed \$1/m^3	Application of existing (ready) solutions only, which does not allow a decrease in desalination costs (they remain at \$0,3/m^3)	Application of existing (ready) solutions only, which does not decrease desalination costs (they remain at \$0,3/m^3)
New technologies (including those in the Water-Energy nexus)	Aquaculture including those integrated with electric power stations New water-saving energy technologies	No significant improvements observed Gradual awareness of water-energy solutions The market faces substantial institutional constraints at the intersection of water and energy sectors	Conventional technologies Increased water demand by energy and industry Energy and water sectors compete for water in certain Russian regions	Mainly conventional technologies, limited investments Increased water demand for energy and industry Energy and water sectors compete for water in certain Russian regions
Water use in agriculture and for irrigation	Use of new rain-imitating technologies Drop irrigation becomes widespread	Repair of existing irrigation systems	Further decline of old irrigation techniques	No particular improvements in the irrigation systems

The main advantage of the scenario approach is the ability to plan responses in advance of challenges at macro and micro levels. Table 4 demonstrates that each scenario will require a specific set of documents and response actions, as well as technological solutions for use by Russian companies and authorities.

The present trends in the water resource sector in Russia indicate that in the coming years the water supply and sanitation sector, and the utilities sector in general, will not be organized along market principles, or provide additional social security measures for the population. Therefore, the tariff policy may remain detached from the actual costs, and this may entail difficulties for the sector.

From 2015 onwards, the most likely scenarios are 'Problem conservation' and 'Losses and accidents'. However, their implementation will lead to considerable technological problems in the sector, and, consequently, to social discontent. There may be a substantial increase in the rate of accidents in the water supply and sanitation system by 2019-2020 (as in the 'Problem conservation' scenario), or even by as 2017-2019 (as in the 'Losses and accidents' scenario).

Following these developments, it is expected that the water sector will develop in line with the 'Nearly perfect future' scenario or the 'National priority' scenario, or a combination of the two. This development will depend on the social and economic situation at the time unpopular policy decisions will have to be adopted.

On the other hand, technological developments might offer great opportunities for the Russian water sector. These may range from new technologies for water purification, new materials and solutions for infrastructural developments, smart metering and monitoring systems, the use of more efficient (and less water intensive) equipment and production processes, as well as the development of new technologies for water recycling and re-use. By the year 2030, significant progress might happen in the circular water economy with both domestic and industrial zero-discharge. R&D activities at the national and corporate levels will pay off and will contribute economically and socially to the sustainable development of the water sector.

At regular time intervals, the scenarios would require a review and, if necessary, an update. Although the scenarios describe developments over the next 15-20 years, three of them, with the exception of 'Nearly perfect future', imply major changes in the sector, which will become obvious in the next two to five years.

Each of the four scenarios described in the paper will require different actions from the government and the water companies to mitigate negative impacts, and capitalize on 'windows of opportunity'. Future research needs to explore the possible state and corporate responses to the proposed scenarios.

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