

LONG TERM NATIONAL CHALLENGES FACING LITHUANIA'S ECONOMY AND SOCIETY

*Background discussion paper to support
development of Smart Specialisation Strategy in
Lithuania*

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Independent Expert Group, MOSTA and Visionary
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3/27/2013

EXECUTIVE SUMMARY

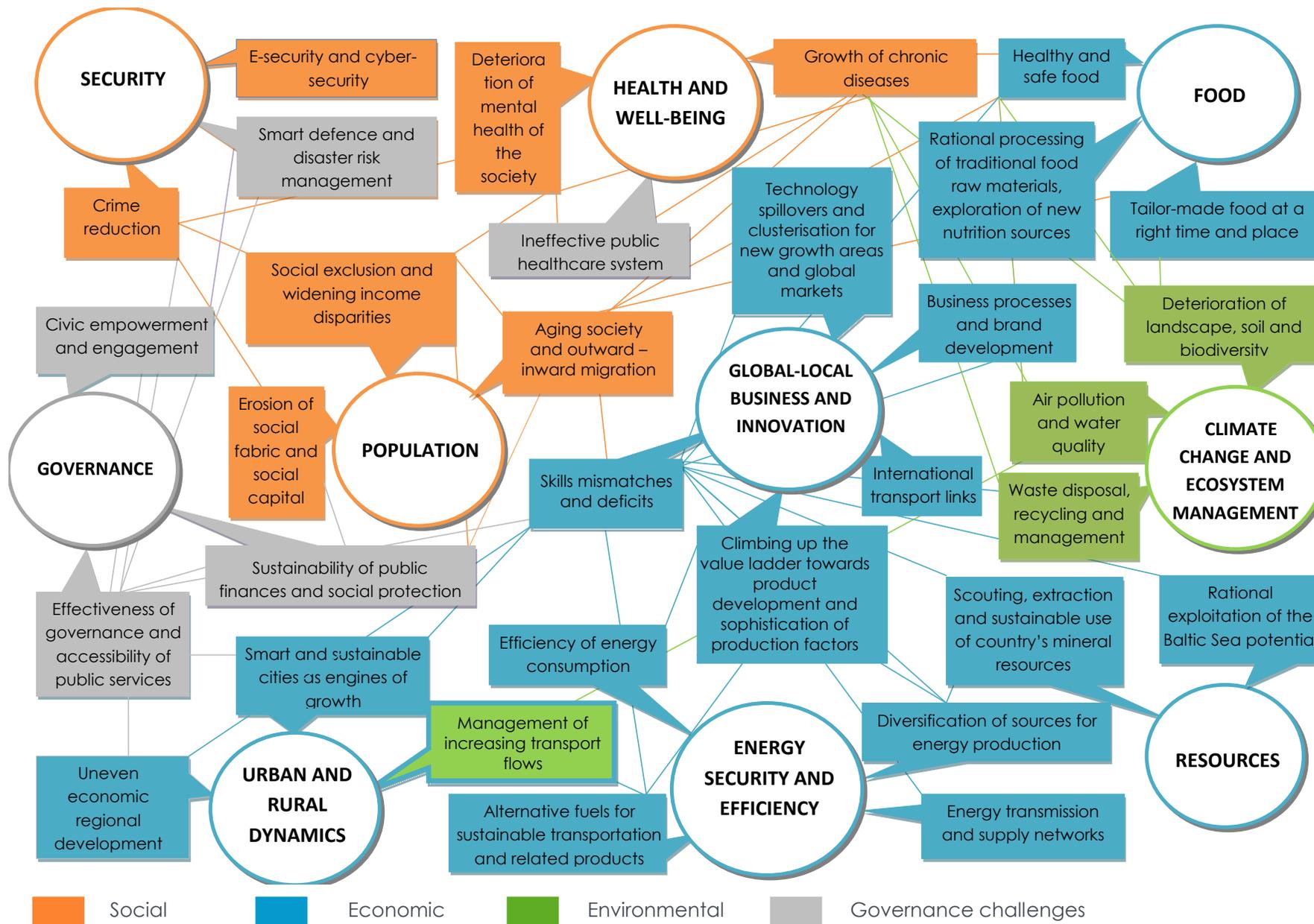
This paper presents the most significant national challenges that could influence Lithuania's long term development. The analysis was carried out on the basis of review of over 70 studies, expert reports, and national policy documents, in order to identify key national challenges before 2030 and the potential response. The national challenges that are important for Lithuania are divided into ten clusters. Each cluster's name is a common denominator for interlinked and interactive trends and challenges. The focus is on long term trends and current problems as the latter are the most frequently addressed by the policy documents and previous studies. Trends are also identified where the data was available in the documents. Below is a short summary of key challenges.

FIGURE 1. KEY LONG TERM CHALLENGES FOR LITHUANIA

Cluster	National challenges (threats and opportunities)
Health and well-being	Growth of chronic diseases Deterioration of mental health of the society Ineffective public healthcare services system
Energy security and efficiency	Efficiency of energy consumption Energy transmission and supply networks Diversification of sources for energy production Alternative fuels for sustainable transportation and related products
Population	Aging society and outward-inward migration Social exclusion and widening income disparities Erosion of social fabric and social capital
Urban and rural dynamics	Smart and sustainable cities as engines of growth Management of increasing transport flows Uneven economic regional development
Climate change and eco-system management	Water quality and air pollution Deterioration of landscape, soil and biodiversity Waste disposal, recycling and management
Global-local business and innovation	Technology spillovers and clusterisation for new growth areas and global markets Climbing up the value ladder towards product development and sophistication of production factors Business processes and brand development Skills mismatches and deficits International transport links
Food	Healthy and safe food Tailor-made food at a 'right' time and place Rational (minimized waste) processing of traditional food raw materials, exploration of new nutrition sources
Resources	Rational exploitation of Baltic Sea potential Searching, extraction and sustainable use of country's mineral resources
Security	Crime reduction E-security and cyber-security Smart defence and disaster risk management
Governance	Sustainability of public finances and social protection Effectiveness of governance and accessibility of public services Civic empowerment and engagement

Successful exploitation of current economic, R&D and innovation potential should be key factor in turning these challenges into opportunities and sources of prosperity. The above 32 challenges will be further discussed and mapped with the results of the analysis of international trends and the most significant European trends that could affect Lithuania's development in the following 15 years.

FIGURE 2. MAPPING THE SOCIAL, ECONOMIC, ENVIRONMENTAL AND GOVERNANCE CHALLENGES FOR LITHUANIA



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OBJECTIVES AND APPROACH

The analysis of the national challenges, trends and drivers was carried out in March 2013 on the basis of review of over 70 studies, expert reports previously carried out in Lithuania, and national policy documents. It seeks to identify key opportunities and threats for Lithuania until 2030 and the potential response. Each national challenge targets a high-level goal which, if achieved, would have a major and enduring benefit for wider Lithuanian society. This is motivated by an intention to move away from narrow fractional and sectoral interests.

The report also benefited from the International Independent Expert Group discussion that took place on 25th of March 2013.

FIGURE 3. KEY DEFINITIONS

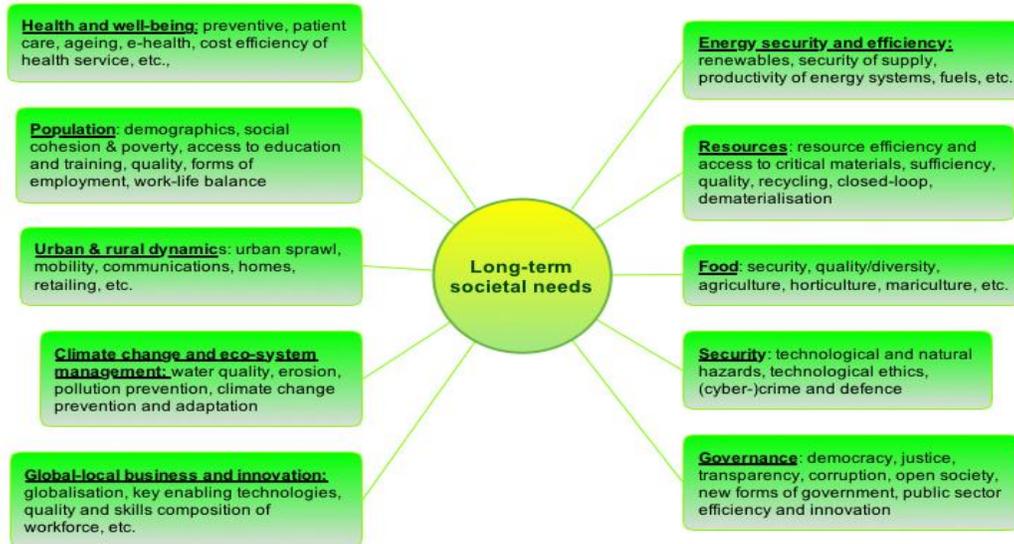
Challenges - specific critical opportunities or threats (barriers), which, if further developed or removed, would help solve an important problem with a high likelihood of global/national impact through widespread implementation.

Trends are those change factors that arise from broadly generalisable change and innovation. They are experienced by everyone and often in more or less the same contexts insofar as they create broad parameters for shifts in attitudes, policies and business focus over periods of several years that usually have global reach. What is interesting about trends is that normally most players, organisations or even nations cannot do much to change them – they are larger than the power of individual organisations and often nation states as well.

Drivers concern those forces, factors and uncertainties that are accessible by stakeholders and create or drive change within one's business or institutional environment. These tend to be more immediate and relevant and distinct to different types of stakeholders – and also they can be both adapted by and/or strongly impact stakeholders, sometimes rapidly.

Weak signals refer to the early signs of possible but not confirmed changes that may later become more significant indicators of critical forces for development, threats, business and technical innovation. They represent the first signs of paradigm shifts, or future trends, drivers or discontinuities.

The analysis of national challenges focuses on the ten key clusters of trends and drivers as presented in Figure 4. The same 10 topics have been used in a parallel exercise aimed at reviewing the international trends and views on future challenges for Lithuania. The two exercises have been run in parallel so as to build up a basis for assessments of interactions between global trends and 'local' challenges.

FIGURE 4. KEY CLUSTERS OF TRENDS AND CHALLENGES

Source: Technopolis Group, adapted from Loveridge (2009) and <http://iknowfutures.eu>

The analysis has a number of limitations. Firstly, the report was produced in a very short period of time. Second limitation is the quality of the studies and other documents produced in Lithuania. Hence some of the important challenges can be missing. Thirdly, this analysis focuses on past data. To reduce these limitations, the analysis will be matched with the review on key international trends, and discussed with experts in the later stages of the process on identifying the smart specialisation priorities for Lithuania.

1. HEALTH AND WELL-BEING

A scan of existing studies reveals several trends that will influence the future developments concerning health and well-being (preventive, patient care, e-health, cost efficiency of health service, etc.) in Lithuania: growth of lifestyle diseases, chronic and non-infectious diseases and the deteriorating health of the population, also due to the ageing of the society. The health indicators of the Lithuanian population, especially for men premature mortality, are among the worst in the EU. The standardized mortality rate for the Lithuanian population under 65 years old was almost 2 times higher than the EU-25 average in 2010ⁱ. According to the basic welfare indicator – the average life expectancy (73.1 years in 2009, according to the World Health Organisation data) - Lithuania is the last in the EU. Mortality, morbidity and disability indices suggest that the main health problems are associated with certain chronic and non-infectious diseasesⁱⁱ. Moreover, current system of public healthcare services provision does not meet the expectations of the society and discontent and distrust in the population is increasing.

1.1. Growth of chronic diseases

With the increased speed of living, unhealthy lifestyle, increased pollution and the ageing of the society, cardiovascular diseases and malignant tumours are the diseases with highest mortality in Lithuania (54.3% and 18.2% of deathsⁱⁱⁱ respectively)^{iv}. Digestive diseases (5.2%), endocrine system diseases and diabetes (0.8%) are also common. There is an upward trend in the incidence of these diseases: cardiovascular diseases - from 159 cases per 1,000 adults in 1996 to 305 cases in 2006; digestive diseases respectively from 72 to 165 cases^v. Investments into the prevention and treatment of these diseases in Lithuania would require significantly more resources than on average in the EU or in the new EU member states like the Czech Republic or Poland^{vi}.

Lifestyle-related diseases is an increasing threat in Lithuania, caused by excessive food consumption (especially saturated fat, salt, sugar^{vii}) along with decreased physical activity, increasing poverty and work related stress^{viii}. This situation raised the need for new foods that meet nutritional requirements for healthy (rational) nutritional value^{ix}, the need for new diagnostic systems and awareness-raising on the healthy lifestyle in the society. Lithuanian population's consciousness in relation to their health remains weak^x. Not enough attention is paid to a healthy lifestyle, although, according to Eurostat, in 2010 only 7% of the Lithuanian population claimed that their health was 'very good', hence Lithuania accounted for 26th place out of the 27 EU Member States according to this indicator^{xi}. The population lacks the motivation to take care of their health, public attitude towards a healthy lifestyle skills, maintenance and enhancement of health, is immature^{xii}.

Evaluation results on the individual health status are also directly dependent on the social characteristics. Persons with higher education live on average 11.3 years longer than less educated; city residents - 3 years longer than rural residents.

Mortality due to addictions (alcohol consumption and smoking) is larger among the Lithuanian population with lower social status^{xiii}. One of the most striking indicators - spread of tuberculosis, since this disease in industrialized countries is associated with poverty, social exclusion and lack of medical and social support for patients and people in the 'risk' zone. The rate of tuberculosis in Lithuania is almost 3 times higher than the EU-15 average and 6 times the EU-27 average^{xiv}. Moreover, the numbers of people with disability are increasing in Lithuania^{xv}.

A clean and safe environment is one of the most important determinants of human health. According to the European Agency for Safety and Health at Work study, 51% of employed persons in Lithuania refer to their working conditions as the main reason for the deterioration of health^{vi}. About 660,000 of the population (most of them live in rural areas) still uses groundwater from dug wells for water that is often contaminated and does not meet the drinking water requirements. There are numerous studies demonstrating the link between noise and heart attack risk^{vii}.

Climate change - more frequent heat waves, storms, warmer winters, sudden invasions of cold weather and daily fluctuations - will increasingly cause danger to human health. The sick, elderly and newborn are particularly sensitive to such changes; weather changes may even lead to increased morbidity or even mortality. The changes in ground water levels, tides effect on water quality can lead to higher risk of diseases related to drinking water quality. Air pollution and effects of climate change can cause new problems related to allergies^{viii}.

1.2. Deterioration of mental health of the society

Mental and behavioural disorders are among the most important health problems in terms of their economic and social burden to society^{xix}. Lithuania remains among the states, characterized by extremely poor mental health indicators: still a very high rate of suicides (31.5 per thousand population in 2010, i.e. 3 times more than the EU average^{xx}), murders and violent crimes (committed by juvenile individuals), high mortality related to alcohol consumption. Alcohol and illicit drug use by children and teenagers is increasing, new addictions and behavioural disorders are spreading. Surveys show that Lithuanian children are unhappiest in Europe, and bullying among children is the most widespread in Lithuania if compared to the rest of the EU^{xi}.

According to the European Commission, too little attention is paid to mental health in Lithuania: work-related stress problems are important for 15%, and psychological violence - only for 4% of employers^{xxii}. In 2011, Lithuania had 14 occupational physicians (0.007 per 1000 employees), thus occupying the last place among the European countries according to this indicator. Suicide rates in general, and especially among the working-age population group, are typically induced by unemployment and poverty^{xxiii}.

1.3. Ineffective public healthcare services system

Due to the ageing society, high negative impacts of diseases and deteriorating health of the population, the pressure on the health services provision is increasing. The

trend of increasing discontent and distrust of the system can be noticed among the population^{xxiv}.

Current healthcare services system does not meet the expectations of the society due to the lack of health care professionals, shortage of the diagnostic, therapeutic and laboratory equipment meeting modern standards^{xxv}. The accessibility of health services is decreasing due to the heavy and increasing workload on the medical personnel, which affects the quality of services^{xxvi}. Over the past decade, workload of family physicians increased by as much as 40% - a number of primary-level visit to the doctor on average increased from 3 visits to 4.2 visits per person per year. In 2011, there were 6.3 to 9.9 visits per capita per year in the 20 Lithuanian municipalities (including main cities)^{xxvii}.

80% of the managers of healthcare services institutions note the lack of medical personnel^{xxviii}. The numbers of family physicians are increasing, but there is still shortage of these practitioners. There is a clear trend of declining numbers of law medicine, pathology, laboratory medicine physicians, epidemiologists, dentists. There is a lack of internal medicine physicians, anaesthesiologists, intensive care physicians, traumathologists, surgeons^{xxix}.

There is also lack of effective cooperation and coordination between the healthcare sector and other policy sectors^{xxx}.

FIGURE 5. SUMMARY HEALTH AND WELL-BEING

Key challenges	Trends / Potential response ¹	Related economy sectors and/or science fields ²
Growth of chronic diseases	Healthy lifestyle: food, sports, awareness raising	Medicine, Bio-pharmaceutics and nanomedicine, nano-services. ICT and nanotechnology (imaging). Food technologies, agriculture, health care, social care, sports.
	Diagnostics, medical monitoring and preventive medicine	
	Regenerative medicine ^{xxx}	
	Environmentally friendly, 'green' technologies for industry	
Deterioration of mental health of the society	Technologies and social innovations for work and/or unemployment-related stress	Social sciences, psychology, medicine. Healthcare. Social care. ICT.
	Technologies and social innovations for treatment and prevention of dependencies	
	Technologies and social innovations to stop bullying and child abuse	
	Treatment of mental and behavioural disorders	

¹ Potential response can indicate response by providing scientific, technological, economic or policy solutions. This section can also indicate trends of developments in this field.

² **Important note:** the lists of sectors and science fields provided in summary tables are indefinite. These sectors and science fields were indicated in the literature sources reviewed. These lists will be further developed based on the analyses of the economic and scientific potential existing in Lithuania, the expert survey and expert discussions that are to take place in April 2013.

Key challenges	Trends / Potential response ¹	Related economy sectors and/or science fields ²
Ineffective public healthcare services system	<p>E-services and ICT for healthcare</p> <p>Social innovations for healthcare accessibility in rural areas</p> <p>Work organisation reform in the healthcare system</p> <p>Sufficiency and quality of medical personnel</p>	Medicine, ICT, healthcare, social care. Management sciences.

2. ENERGY SECURITY AND EFFICIENCY

A quick scan reveals several closely interlinked trends that influence the future developments concerning energy security and efficiency (renewables, security of supply, productivity of energy systems, fuels, etc.) in Lithuania: increasing country's dependence on imported energy after the closure of the Ignalina Nuclear Power Plant (NPP), drastically increasing imported energy prices, and the increasingly outdated energy infrastructure (especially the thermal heating systems). These bottlenecks could impede the determination to increase the country's energy independence, to reduce the influence of monopolies in electricity and gas^{xxxii}, and highlights the overall problem of national energy security^{xxxiii}. Moreover, rising energy prices pose a key challenge to the industry competitiveness, which still relies on low production costs. Focus on the new technologies for efficient energy consumption, energy extraction and supply / transmission, diversification of energy sources and increasing the share of green energy allow for developing solutions for these challenges. If Lithuania decides to remain a country with nuclear power, technologies for nuclear power, including nuclear waste storage security will also remain crucial.

2.1. Efficiency of energy consumption

Although energy consumption has decreased since 2000^{xxxiv} (according to other sources, it increased^{xxxv}), the rising costs of energy pose a major challenge to both the economy competitiveness and welfare of the citizens. A lot of energy is wasted due to inefficient infrastructure or lack of awareness of energy users. Over 60 % of the total potential for energy savings is in the area of residential and public buildings^{xxxvi}. Heating, ventilation and cooling, as well as lighting account for more than half of the final energy consumption. Worldwide about 20 % of the electricity is used for lighting^{xxxvii}.

Thermal energy and heat related fuel consumption comprises about 88% of final energy demand by households, services and industrial sectors^{xxxviii}. The main consumers are the households (citizens); hence this field is sensitive to the price changes and the need to regulate the heating system. Households is one the most promising areas for energy savings. The energy efficiency of the housing needs of Lithuania is about 1.8 times lower than in most EU countries^{xxxix}. Lithuanian thermal energy sector has a number of problems associated with the inefficient use of energy in buildings: a well-developed, but technically worn centralized heat distribution system, the inadequacy of existing technological capabilities, high dependence on imported fuel^{xl}.

The share of thermal energy is one of the largest in the final country's energy balance. Thus, the reliability of heat supply system, security and reduction of heat distribution losses is an important part of energy security^{xli}. Due to improper operation and poor construction quality, the heat supply networks are increasingly corroded^{xlii}. Due to a slow modernisation of centralized heat supply systems more

users may disconnect from it in the future and that would cause serious environmental, economic and social problems^{xliii}.

2.2. Energy transmission and supply networks

Another field of challenges relates to the *electricity transmission networks* and their reliability and security; future energy transmission/distribution technologies, and the supply crisis prevention.

Comparing the alternatives for gas supply, liquefied natural gas terminal in Klaipeda seen as a cost-effective and quickly implemented project^{xliiv}.

A big drawback is that the Lithuanian electricity system is still tightly integrated into the IPS / UPS and remains isolated from the Central and Western European energy systems^{xliv}. The lack of investments required to upgrade the electricity transmission network, can lead to major systemic threats or accidents^{xlvi}.

The solutions for the challenges related to the energy transmission networks (especially electricity) relate to the technologies for network reliability, efficient use of existing networks, development of the electricity networks, and automation^{xlvii}. For example, future energy technologies related to smart grids (intelligent networks) - digital technologies to upgrade networks - open up new possibilities for power grid operators, energy producers, suppliers and consumers, e.g.: integrated communication of data collection, storage and control; sensors and management technologies to get the correct and accurate information to ensure network integrity measurement, automatic scanning, measurement error elimination, blocking unauthorized scanning; new interfaces (human-computer interface) and control algorithms for treating large amounts of information about the state of the system and concentrated submitting data to the network operator^{xlviii}.

2.3. Diversification of sources for energy production

Lithuania has become heavily dependent on energy imports after the closure of the Ignalina NPP^{xlix}. The use of primary energy sources has shrunk and country's dependence on natural gas and oil has increased^l. Given the stringent environmental requirements natural gas remains one of the most promising fossil fuels in Lithuania, but because of the rising gas prices, its comparative economic attractiveness is declining^{li}. The strategic objective is that by 2020 the Lithuanian energy sector will be independent of the power supply from a single source^{lii}. Hence, diversification of energy production sources is one of the key challenges.

Future energy technologies relate to hydrogen energy and nuclear fusion. The traditional or 'old' energy technologies are also rapidly evolving; for example, coal development to liquid fuels, nuclear reactor technology advances to the fourth generation (Gen IV), the fourth-generation of biofuels^{liii}. The production of the nuclear power and the need for related research will depend on Lithuania's decision whether it will invest into a new nuclear power station and what type of power reactor will be selected^{liiv}. If Lithuania decides to remain a nuclear power state,

technologies for nuclear power, including nuclear waste storage security, will remain crucial.

A strong incentive for the development of renewable energy sources was given by introduction of key policy documents^{lv} at the national and EU levels^{lvi}. The main environmentally clean renewable energy sources for Lithuania are: geothermal energy, solar and wind energy^{lvii}, hydropower, biofuels, biomass (wood, logging waste, straw, energy crops, grasslands, and other biomass)^{lviii}. The use of fuel from wood accounts for over 80 % of renewable energy sources in Lithuania^{lix}.

Another problematic area of the energy sector is the reduction of pollution and ecological aspects^{lx}. Energy production and consumption in various sectors of the economy lead to key local, regional and global environmental problems (air pollution in urban areas, environmental acidification and eutrophication, climate change) and has very strong negative impacts on biological resources and human health^{lxi}.

2.4. Alternative fuels for sustainable transportation and related products

Increasing demand for fuel in the commercial vehicle sector poses another challenge for Lithuania. It was expected that by 2010 the truck fuel consumption will exceed passenger and private vehicle fuel consumption^{lxii}.

There is a trend of increasing interest in the production of alternative fuels, especially biofuels and biodiesel, also using vegetable and animal fats for the production of these fuels^{lxiii}. According to the Lithuanian Ministry of Agriculture, in 2010 the production of biodiesel and bioethanol exceeded by 26% the national targets set in the Biofuels production and promotion programme for 2004-2010^{lxiv}. However, production of biofuels is based on the fossil fuels. If the case of low crop yields (used as a raw material), fewer biofuels can be actually produced than fossil fuel consumed to produce it^{lxv}.

There is potential to provide renewable raw materials for industrial biotechnology. Potential to produce biomass is significantly higher than potential demand in domestic markets and relatively higher than in Western European countries on average. There is potential to process surplus biodiesel into other higher added value products: bio-oil, bio-plastics (liet. bioalyva, bioplastikliai)^{lxvi}.

FIGURE 6. SUMMARY ENERGY SECURITY AND EFFICIENCY

Key challenges	Trends / Potential response	Related economy sectors and/or science fields
Efficiency of energy consumption	Energy-efficient building materials and energy saving technologies for housing Energy saving technologies for industry Energy saving lighting systems, cooling and ventilation, air conditioning systems	Construction / renovation of private housing; engineering industry ^{lxvii} . Thermal energy industry (e.g. central heating radiators and pipes); architecture and civil engineering; cooling and ventilation, air conditioning

Key challenges	Trends / Potential response	Related economy sectors and/or science fields
	Efficient central heating systems	systems; steam generators; domestic electrical apparatus or appliances, non-electric domestic appliances; power transmission lines construction, air-conditioning equipment, other heating equipment, combustion process optimisation ^{lxviii} . Lighting systems: physics, engineering sciences (organic electronics and solar cells, semiconductor materials and devices for light technology) ^{lxix} . Other
Energy transmission and supply networks	<p>Intelligent network technologies (smart grids).</p> <p>Efficient use of existing networks</p> <p>Development of the electricity networks, including the development of regional/international networks for distribution of electricity</p> <p>Automatisation</p>	ICT, mathematics. Other.
Diversification of sources for energy production	<p>Technologies for energy waste storage and supply security</p> <p>Future energy extraction technologies</p> <p>Technologies for the development of renewable energy sources</p> <p>Technologies for reducing CO² emissions in energy extraction, production, transmission and storage</p>	Photovoltaics, hydrogen energy, nuclear energy, fusion, solid biofuels and biodiesel, bio-energy, hydropower, geothermal energy, fossil fuels (oil, peat, shale gas). Other.
Alternative fuels for sustainable transport	Technologies for alternative fuels in transportation	Biofuels, biodiesel and related products

3. POPULATION

A quick scan reveals several closely interlinked trends that influence the future developments concerning demography (demographics, social cohesion and poverty, access to education and training, its quality, forms of employment, work life balance etc.) in Lithuania: on-going population decrease, affecting labour force availability, relevant skills shortages and poverty. Decreasing birth rate and increasing emigration flows accelerate aging processes in Lithuanian society^{lxx}. It is expected that by 2060, the Lithuanian population will decline by 18% and life expectancy will continue to grow so that demographic challenges will be crucial for the society functioning^{lxxi}. The lack of labour force, especially skilled one, becomes central for economic development^{lxxii}.

3.1. Aging society and outward – inward migration

In 2010 the total fertility rate stood at 1.55 in Lithuania, while fertility level necessary for sustainable growth of population should be at least 2.1^{lxxiii}. The 'children' generation replaces only half of 'fathers' generation with the lowest net reproduction index of 0.6 in the EU27^{lxxiv}.

Moreover, net migration in Lithuania is the one of the highest in the EU being equal to 23.7 persons per thousand in 2010^{lxxv}. According to the official statistics, 447 thousand people emigrated from Lithuania over 1996-2010 (given the declared and undeclared departures)^{lxxvi}. The migration patterns of Lithuanians can be seen to have been reactive to large socio-economic and/or political changes; namely the fall of the Soviet Union, and the joining of the European Union, both triggering large waves of emigration. There are several socio-economic push factors that contribute to high emigration: low overall employment, high rates of youth unemployment, high numbers of minimum monthly wage earners a prevalent in-work poverty among low-educated single parents with dependent children, a low minimum income scheme, weak social safety nets and the accumulated experience of emigration^{lxxvii}. In 2004 Lithuanians entered the EU labour market, in particular in the UK and Ireland, in increasingly larger numbers, thus contributing to a rising legalisation of emigration. The financial and economic crises of 2008-2009 have led to further extensive flows of economic emigrants.

As a result of both population aging and emigration trends, until 2010 in Lithuania, the number of children under 14 years old dropped by 28%, but the number of individuals above 65 years old rose by more than 10%^{lxxviii}. The share of individuals older than 60 years already exceeds the share of children under 14 years^{lxxix}. Population decrease and consequent population aging induce labour force shrinkage and skilled labour force shortage in Lithuania^{lxxx}. Thus, it becomes a serious threat to the country's competitiveness^{lxxxi}. Lithuania is losing primarily young people and people of employable age. Every second emigrant is under 30 years old, so that Lithuanian emigrants are among the youngest and most educated in the EU^{lxxxii}. Most emigrants who have not declared their departure are low-skilled workers, mainly

having professional experience in the services sector^{lxxxiii}, but the percentages of high-skilled workers and emigrants with a higher education level are relatively high and rising.

The labour market policies should aim at reducing long-run unemployment and activating currently economically inactive individuals^{lxxxiv}. Moreover, population aging poses new challenges to labour market structure and availability of skills. Aged citizens constitute larger proportion of Lithuanian population, but the work and social environment do not respond fully to ongoing changes in population structure^{lxxxv}.

Immigration flows into Lithuania have been rather small throughout the years since independence; however, return migration has been steadily increasing and accounts for 70% of inward migration during the period 1991-2010^{lxxxvi}. Since 2004 an increase in numbers of immigrants from Turkey, China and Moldova has also been registered^{lxxxvii}. With the rising level of living standards, Lithuania can become a 'new' immigration destination.

3.2. Social exclusion and widening income disparities

In Lithuania, one third of population is at risk of poverty or it experiences material deprivation and belongs to households of low employment^{lxxxviii}. Unemployment and low level of remuneration are the driving forces of poverty in Lithuania^{lxxxix}. Those, who are at risk of poverty, incomes are at least 7-8 times smaller than the richest population quartile's incomes^{xc}. Around 20% of population is in poverty and that share has not changed drastically since 2005^{xcii}. Therefore, it is clear that short-run projects and economic measures do not bring desired results, as a holistic approach and social innovations are needed^{xcii}.

Even though the difference of poverty rate in rural and urban areas has reduced, it stills remains vital^{xciii}. Another essential poverty dimension is children less than 18 year's old living in poverty. They face higher risk of poverty than an average Lithuanian^{xciv}. Family structure has important impact on children being at risk of poverty, as one-parent families and large families fall more often into risk of poverty^{xcv}. Moreover, as energy prices increase, the new risk of being at 'energy' poverty arises in Lithuania^{xcvi}.

Furthermore, Lithuanian children and youth have unequal opportunities to participate in informal education. This is especially true in rural areas and smaller towns where variety and access to such education is particularly limited^{xcvii}. Moreover, rural areas population experiences 'cultural' exclusion as only 12% of rural population participate in cultural life^{xcviii}.

3.3. Erosion of social fabric and social capital

Lithuanian society suffers from weak social fabric – lack of social capital, increasing feelings of distrust and insecurity. Globalisation, development of new means of communication, increased mobility of people including economic migration pose new challenges related to tolerance to other cultures, but also the risk of losing the ethnic

and cultural identity of the nation^{xcix}, and the declining ability to cope with the commercial, mass culture^c. Urbanisation, unfavourable demographic processes in the rural areas, lifestyle changes, and concentration of culture in the major cities influence negatively the historical ethnographic culture of the regions^{ci}.

Lack of investments into culture and emigration of culture professionals' lead to further alienation of the society, loss of proper cultural education, as well as interest into cultural heritage and cultural values^{cii}. Insufficient attention to culture and creativity can lead to economy's and labour market's orientation towards low-skilled labour-intensive economy^{ciii}.

The role of communities and non-governmental organisations' is increasing, but the density of community NGOs and their impact on society is insufficient^{civ}. One of the recent trends however is that cultural entrepreneurs and artists started moving to live to rural areas (e.g. a community of 'used to be cityfolk' in the Marcinkonys village who established a cultural community of traditional cheese producers). This trend could be exploited to develop cultural industries in the villages and thus contribute to the development of rural areas.

FIGURE 7. SUMMARY POPULATION

Key challenges	Trends / Potential response	Related economy sectors and/or science fields
Aging society and outward-inward migration	Social innovations	Health care, social care, human resource management, education, labour market, industry, healthcare and wellness industries
	Inactive labour force inclusion in job market	
	Promotion of 2-children families	
	Increase of current workforce productivity	
	Products and services for ageing society, e.g. social care, healthcare and wellness products and services	
	Differentiated policies to foster return migration, especially for skilled labour	
	Rethinking immigrations policies, especially for skilled workers and researchers	
Youth employment policies		
Social exclusion and widening income disparities	Social innovation	Industry, education, labour market, cultural services, health care, social care, public administration, other
	Increasing levels of economic activity	
	Redesign of currently ineffective programmes	
	Increasing access to (particularly informal) education and cultural life in rural areas	
Erosion of social fabric and social capital	Social and cultural innovations	Culture, creative industries. Social sciences and humanities. Arts.

4. URBAN AND RURAL DYNAMICS

A scan of existing studies reveals several trends that will influence the future developments concerning urban and rural dynamics (urban sprawl, mobility, communications, homes, retailing, etc.) in Lithuania: decline of population, uneven regional development, uneven access to public services, and alienation of the society and loss of cultural and ethnic identity. Other challenges relate to the effective management of the increasing transport flows. Not only technological, but also social and cultural innovations can provide solutions for solving these challenges.

4.1. Uneven economic regional development

Population decline is the most typical and largest driver affecting territorial development – a phenomenon faced by all cities of the country, including the capital and most rural areas. During 2008-2012 the numbers of urban population has fallen by 10.8% (more than in the rural areas - 10.4%)^{cv}.

The flows of internal migration reflect the trends of regional polarisation and metropolisation. Internal migration is regionally differentiated. Suburban areas surrounding the biggest cities have been migration-gain areas, whereas peripheral areas undergoing long-term depopulation, particularly in the country's North-east, can be identified as migration-loss areas. These areas feature strong labour shortages, a low-skilled labour force, long-term unemployment and a high rate of dependency on state support^{cvi}.

Social and economic disparities between the regions of Lithuania remain relatively high. There are significant regional differences in the development and access to public infrastructure, access and quality of public services, especially after some recently carried out reforms in the public health, education and other sectors. This affects the attractiveness of some regions (especially the rural areas) to investors, but also to citizens^{cvi}. Regional development imbalances are caused not only by internal factors, such as geographical location, population composition or structure of the economy, but also by the chosen principles of sectoral investment, where thematic and territorial investment method has not been widely used. One of the core reasons behind the unattractive and less developed areas - abandoned, undeveloped or poorly developed public infrastructure^{cvi}.

4.2. Smart and sustainable cities as engines of growth

Lithuania's economic growth is limited by increasing disparities between the capital and other cities^{cx}. Vital means of city development (network of streets, public transportation, landfills, engineering communications, etc.) are not addressed adequately. One of the reasons for uneven urban development is an inefficient use of the cities' economic potential^{cx}. There is a lack of collaboration in dealing with urban development challenges; measures of urban planning, civil engineering, public administration, environmental protection, sociology, and commercial law have to be better coordinated. Clear strategy for urban development is not developed, social

and economic development plans have to be integrated with the urban master plans, and the latter are outdated in many cities^{cxix}. Undeveloped public transport does not allow for proper use of the existing economic potential of cities^{cxii}. Lack of the air transportation also limits the country's international attractiveness^{cxiii}.

There is potential in using the existing urban development resources in a more sustainable way. The urban structure in Lithuania has blurred since 1998 - the population density of urban areas amounted to just 39 residents/ha when the minimum population density of the urban structure is 30 residents/ha^{cxiv}. The current urban development does not use the resources in sustainable way - abandoned urban areas are not exploited (for example, brownfield re-use potential in Vilnius is about 500 hectares, of which 120 hectares are in the city centre^{cxv}).

New construction technologies allow for sustainable development of the cities. Production of building materials and manufactured products, the construction implementation process, demolishing of the buildings and operation of a building's life cycle consume large amounts of energy. CO2 emissions increase with the increasing energy consumption. Existing standards and construction requirements in many cases hinder innovation and use of new materials and products^{cxvi}.

4.3. Management of increasing transport flows

The number of private and commercial vehicles is growing as well as congestion on the roads. The main challenges related to the management of transport flows are: multimodal transport concepts and intellectual transport systems^{cxvii}, road safety, pollution, alternative fuels, traffic flow management; promotion of alternative, more efficient means of transport; transport machinery diagnostics^{cxviii}, energy efficiency in transport policy^{cxix}.

The Ministry of Transport of the Lithuanian Republic highlights the increasing losses due to congestion and the need to optimize traffic flow and find the optimal flow control algorithms. This is especially relevant in the major cities - Vilnius, Kaunas, Klaipėda. Development of the intelligent and multimodal transport concept is required for using different systems of transport in the inter-urban traffic and urban areas^{cxx}. Combined shipments / transport is increasingly relevant^{cxxi}.

FIGURE 8. SUMMARY URBAN AND RURAL DYNAMICS

Key challenges	Trends / Potential response	Related economy and/or science fields	sectors
Uneven economic regional development	<p>Rethinking economic development policies in the regions, e.g. grants, tax incentives and loans for businesses, FDI and local investment attraction</p> <p>Education, lifelong learning policies and reskilling</p> <p>Rethinking investment policies, e.g. infrastructure development, brownfields re-use, public ICT, etc.</p>	Public sector. Construction, other	sectors.

Key challenges	Trends / Potential response	Related economy sectors and/or science fields
	Governance issues (centralisation – decentralisation)	
Smart and sustainable cities as engines of growth	Brownfield re-use potential New materials, technologies and methods for sustainable construction Cross-sectorial strategies for urban development (master plans etc.)	Construction industry; architecture and civil engineering; engineering industry.
Management of increasing transport flows	Multimodal transport concepts and intellectual transport systems ^{cxii} Technologies and methods for traffic flow monitoring, optimisation and control	Sectors: transport and logistics, engineering industry, ICT R&D areas: transportation engineering, ICT, physics ^{cxiii}

5. CLIMATE CHANGE AND ECO-SYSTEM MANAGEMENT

Lithuania is on track to meet obligations imposed by the Kyoto protocol, however important challenges remain. Current economic infrastructure is unsustainable and worn out, based on inefficient use of resources and low technologies. Sectors that relate most to the adaptation to climate change and climate change mitigation policy are: transport, energy, industry, agriculture, waste management, spatial planning and regional policy, forestry, science, education and public awareness-raising^{cxxiv}.

5.1. Air pollution and water quality

Due to climate change effect on water resources, the quantity and quality of water resources can change in the future^{cxxv}. Flooding is more frequent also due to the growth of waterproof ground surface (effects of urbanisation)^{cxxvi}. The risk of flooding in the urban areas increases due to poor state of rain water management systems^{cxxvii}.

Most wastewater treatment plants are physically and morally outdated, so only about 70% of wastewater is treated to the prescribed standards. Most of the water supply and wastewater treatment infrastructure is inefficient or outdated. Most of the water pollution is caused by agricultural activities. There are still significant numbers of small area pollution spots (due to oil, pesticides and other substances)^{cxxviii}. The monitoring system on the pollution of public outdoor swimming / bathing places needs improvement^{cxxix}.

Transport sector is the largest source of air pollution. Pollution problems are caused by outdated or lacking infrastructure, traffic congestion^{cxix}, particularly in urban areas, lack of interaction between different types of transport, Europe's oldest car park and a large and increasing numbers of automobiles, both private and commercial. According to Eurostat's data of 2008, 90% of all journeys by land in Lithuania are taken by car. According to this dependence of Lithuania has the first place in the EU^{cxix}. The numbers of vehicles per capita is higher than the EU average and the current trend will grow in the future. A lot of vehicles are older than 10 years. The growth of automobile traffic, limited road capacity, complicated organisation of traffic, leading to traffic jams is increasing not only in the central parts of the cities, but also the major road arteries of the cities.

The use of most polluting transport (road transport) is growing fast, but the use of rail and inland water transport decreases. Population's motivation to use public transport is weak, its mobility habits are unfavourable to the environment. Most of the public transport infrastructure is morally and physically outdated, poorly developed; there is a lack of bicycle trails and multimodal urban transport system, so most of the city's central parts are more polluted than other parts^{cxix}. Freight transport by rail is inefficient; the probability of accidents increase due to poor rail technical parameters in terms of bandwidth (liet. pralaidumas); railway electrification rate is low^{cxix}. Electrification of passenger rail transport could have a positive effect on the reduction of polluted air emissions.

Total greenhouse gas emissions into the air increased by almost a third during the last decade (2000-2010 year) in Lithuania^{cxxxiv}. Relatively high levels of greenhouse gases and pollutants emitted into the atmosphere are caused by still very inefficient use of thermal energy, outdated heating systems, and the poor thermal properties of most residential houses. Due to the expected high growth of consumption and production, also the closure of the Ignalina NPP, more attention will be given to primary energy, fossil fuels; hence more pollutants and greenhouse gases will be emitted into the atmosphere^{cxxxv}. Another problem is air pollution in the metropolitan areas during the cold season and spring^{cxxxvi}.

Corporate social responsibility is still an unusual phenomenon in Lithuania, it is more evident within individual organisations and individual initiatives, but there is an increasing upward trend. Development and instalment of environmentally friendly and low carbon generating technologies into the activities of major sectors of economy (transport, industry, energy, agriculture, housing, tourism), integration of environmental concerns into their development strategies can contribute significantly to reducing the negative effect on the environment^{cxxxvii}. The adoption of sustainable industrial development measures (environmental management systems, eco product design, eco-labelling, sustainable industrial development reports) is encouraged by the existing Lithuanian policy documents^{cxxxviii}. The EU has also introduced a wide range of environmental conditions, and Lithuanian business is not yet prepared to meet these requirements^{cxxxix}.

5.2. Deterioration of landscape, soil and biodiversity

The condition of Lithuanian landscape is still stable, but some parts of landscape change as a result of renaturalisation and urbanisation^{cxl}. Various negative biotic and abiotic factors (pests' reproduction, spread of diseases, storms and other climate factors) may adversely affect the vitality, productivity, the protective and social functions of forests^{cxli}. Possible changes in climate (hot, dry summers) may increase the risk of fire. Ecological needs are met in terms of forest coverage of Lithuania. Areas of natural forests (33.2% of total land) are important due to the absorption of greenhouse gas emissions. The currently unused lands could be used for forestation^{cxlii}. Then country's forest cover would increase by 3%^{cxliii}. The logging waste can be used for biofuel production.

New species or atypical species can be spread in the Lithuanian forests due to climate change. Climate change can lead to better conditions for the spread, reproduction and survival of genetically modified organisms. Invasive non-native plant and animal species threaten current biological diversity and public health, high costs can be required to control or eradicate these new species^{cxliv}.

The share of value added produced by agriculture and related activities is declining, partly due to the soil erosion and degradation and therefore loss of crop. Soil degradation, loss of biodiversity, climate change and the increasing numbers of extreme weather events, as well as change of seasonal precipitation patterns and intensive activities (e.g. use of chemicals) by other industries have a negative impact

on crop yields, livestock management and production. Due to the rising temperatures and extreme weather events, greenhouse gas emissions from soil are increasing, and there is a decline of organic soil materials. All this suggests that soil degradation will continue, and perhaps faster^{cxlv}. Also, the surface soil layer in the cities, waste dumps and pesticide storage areas, industrial areas and highway roadsides remain polluted^{cxlvi}.

Climate warming and the increasing number of high risk weather events will have a direct impact on the health, growth and production, as well as reproduction of livestock. There will also be indirect effects through changes in the yield of pasture and forage crops, and distribution of animal diseases. There is a need to create crisis prevention and crisis management systems to monitor, manage and prevent these risks; to research, monitor and develop new plant species best adjusted to the new conditions^{cxlvii}.

5.3. Waste disposal, recycling and management

The rates of consumption are increasing, which leads to higher rates of waste. This aggravates the ecological status of the country. Since consumption growth is ahead of consumer awareness growth, even yearly improvements in waste management infrastructure in Lithuania are unable to cope with the increasing streams of waste. Cleanliness of public places is worse than 15-20 years ago. Green public procurement is not widespread in Lithuania, as the environmentally friendly products are more expensive^{cxlviii}. Hence, waste management is one of the most urgent problems in Lithuania.

Waste recovery and recycling is undeveloped in Lithuania. Most of waste (86% of municipal waste and 55% of industrial waste in 2010) is disposed in landfills, which is still the cheapest waste management option. Production of biodegradable waste is disposed in the landfills together with municipal waste. Medical waste management in health care facilities is ineffective / insufficient^{cxlix}. In recent years, Lithuania has rapidly implemented the green waste composting sites. However, collection and management of green waste makes up only a few percent of biodegradable waste generated by the municipal waste. Lithuania has great potential for reducing GHG emissions in the waste sector, by installing waste burning infrastructure, which could burn the unsuitable for recycling waste and could produce heat and electrical power. This would lead to the reduction of GHG emitting waste^{cli}. Due to the lack of capacity of existing devices for sludge treatment, the excess of sludge accumulated in the urban wastewater treatment plants leads to a negative impact on climate change^{cli}.

FIGURE 9. SUMMARY CLIMATE CHANGE AND ECO-SYSTEM MANAGEMENT

Key challenges	Trends / Potential response	Related economy sectors and/or science fields
Air pollution and water quality	Technologies and intelligence systems for wastewater management	Water supply, sewerage, waste management; industry, agriculture; ICT and mathematics; management
	Technologies and intelligence systems for management of floods	

Key challenges	Trends / Potential response	Related economy sectors and/or science fields
	Intelligent transport systems, multimodal transport Alternative means of transport (electric cars, etc.) Green technologies in industry, transport and agriculture Intelligence systems for monitoring, management and prevention of risks	sciences Transport and storage; industry and agriculture; energy. Transportation Engineering; Measurement Engineering, Mechanical engineering; ICT and mathematics; management sciences
Deterioration of landscape, soil and biodiversity	New better adjusted species of crops Eco-agriculture Intelligence systems for monitoring, management and prevention of risks Green technologies for industry and agriculture to reduce soil erosion and degradation	Agriculture, forestry and fishing. ICT and mathematics; management sciences; agricultural and related sciences
Waste disposal, recycling and management	Waste recovery and recycling Technologies and intelligence systems for waste management and waste treatment Consumer awareness raising and green public procurement	Waste recycling, recycling, sorting, storage. Public sector. ICT and mathematics; management sciences.

6. GLOBAL-LOCAL BUSINESS AND INNOVATION

A scan of existing studies reveals several challenges that will influence the future developments concerning global-local business and innovation (globalisation, key enabling technologies, quality and skills composition of workforce, value chains, etc.) in Lithuania.

6.1. Climbing up the value ladder towards product development and sophistication of production factors

Many companies of Lithuanian industry still operate within the least profitable parts of value chains. The focus is on simplistic production operations and functions, for example export of raw materials^{cliii}, provision of assembly or just selling the production capacity without any brand ownership^{cliv}. However, companies are starting to understand that focus on cost is a temporary solution when the overall standards of living in the country and there costs of production are rising, and the cheaper developing countries are becoming hard to compete with^{clv}. One way out is moving towards product development operations^{clvi}. The most distant and profitable point along this path is the development and design of own products. However, one can begin by taking smaller steps as well: instead of selling the existing general production capacity can start preparing and producing prototypes, system solutions and 'turn-key' projects or offering production development and testing services. Another opportunity is to use the knowledge and experience accumulated so far in order to move towards new, more valuable products and services: switch to a higher value chain. A new area of use can be found for the current raw materials or products. The transition can be made to a more complex product with a similar underlying or production technology^{clvii}.

Product development capabilities are closely related to business R&D and innovation capabilities. According to the Innovation Union Scoreboard (IUS), in 2013 Lithuania took 23rd place in EU-27 in terms of innovativeness (25th place in 2012)^{clviii}. Business investments into new innovations (especially R&D activities) are very low^{clix}. The share of business enterprise expenditure on R&D as percentage of GDP, as well as the innovative activities of enterprises, has increased over the last decade and even during the economic slowdown. However its level remains five times below the EU27 average (0.24% of GDP in 2011, when the estimated EU27 average was 1.26%). The low level of business R&D investments and weak innovative capabilities of the businesses give rise to poor innovation performance and therefore low competitiveness of the national economy. Knowledge and technology intensive sectors remain small and the extent of their development does not provide any grounds for speaking about convergence (for example, Lithuania lags well behind in terms of the knowledge-intensive services exports as % total service exports)^{clx}.

Certain barriers may explain this lower share of R&D and innovation investments. One explanation is shortage of capital. Utilisation of venture capital to support innovative businesses, start up and spin-off firms trying to commercialise research

outcomes remains one of the lowest among the European countries. Venture capital (especially seed and pre-seed capital) measures in this field were mainly missing until very recently. This situation could be improved by linked measures directed to innovative companies, start-ups and private equity investors, involving mentors and other business acceleration services. Another explanation is in the risk-averse entrepreneurial tradition and lack of markets for innovation. The Lithuanian innovation system relies mainly on supply side instruments and neglects the possibilities to link innovation demand with technology producing capacities. It is especially important for (i) supporting those research fields and industry sectors that are new, on the rise and outside the scope of policies, as well as (ii) using the existing research potential for tackling main social-economic challenges that are discussed in this Report. Despite several instruments addressing innovative enterprises there is a lack of more effective support for entrepreneurial culture and especially a culture for going global^{clxi}.

Low absorptive capacities in Lithuanian SMEs are seen as one of the factors hampering innovation. Here the gap is dual. Firstly, the challenge relates to the quality and renewal of labour market skills (see *Chapter 6.4*). The shortage of highly skilled labour is critical, especially for growth in high and medium technology sectors. The growth and share of PhD graduates, especially in the technological research fields, and the overall quality of studies goes hand in hand with poor results in technological advancement. Moreover, barriers to immigration may also endanger the attraction of skilled labour and foreign researchers. High unemployment in Lithuania may have a negative impact on the investments into skills renewal and learning in indigenous enterprises^{clxii}. Hence, sophistication of key production factors, such as technological advancement and labour, is one of the key national challenges.

6.2. Technology spillovers and clusterisation for new growth areas and global markets

The growth potential of current business areas of many of Lithuania's companies can soon be exhausted. First, the goal is to move towards global markets and international value chains^{clxiii}. The minimum target for successful industrial companies in the future would be becoming at least a technology partner in international value chains^{clxiv}. Second, new opportunities should also be sought among business areas with the greater growth potential, for which there are definite markets and market growth^{clxv}. Third, new markets and opportunities for restructuring are provided by the technology spillover possibilities. These are especially relevant for traditional sectors such as food, transport, energy. A significant part of future goods and services are as yet unknown, but the main driving force behind their development will be Key Enabling Technologies (KETs), such as nanotechnology, micro- and nanoelectronics including semiconductors, advanced materials, biotechnology and photonics^{clxvi}, also smart environment, diagnostic and measurement technology, renewable and bio fuel, etc. The collaboration between the high-tech sector and the traditional sectors of the economy in Lithuania is weak, and it is one of the main reasons why Lithuanian high-tech sectors do not grow. Lithuanian high-tech companies are not

integrated into the local economic system, therefore it limits their development prospects^{clxvii}. The research in the strategically important technological directions (info-bio-nano-cogno) gradually transferred to the Lithuanian traditional industry could transform the economy towards higher value-added products^{clxviii}.

ICT has the highest potential for technology spillovers in Lithuania. Lithuanian consumers are increasingly e-literate; and IT solutions are spread from electronic banking facilities, health care information, transportation systems management, education, to the application of interaction devices - such as smart electricity meters and electricity networks (smart grids), wireless heart monitors, emergency services, alarm systems, leisure and entertainment^{clxix}. The Economist Group selected Kaunas as one of the five top cities in the world with the highest quality of broadband connection, along with three Japanese cities and Seoul. In addition, an Oxford University study that analysed countries' readiness to meet future consumers' expectations for high quality and innovative services (called 'ready for tomorrow'), considered Lithuania along with the most advanced countries of the world, such as South Korea, Japan, and Sweden, and Lithuania was listed among the 14 countries providing the highest level of IT training^{clxx}.

As the international competition is sharpening and the prices of raw materials and labour are rapidly increasing, Lithuanian small and medium-sized enterprises are unable to individually address the business renewal or sector-wide restructuring issues^{clxxi}. According to the IUS 2011, indigenous enterprises have low-medium levels of co-operation arrangements and there is a strong decline (14%) in innovative SMEs collaborating with others. Thus SMEs may not be benefitting fully from positive externalities arising from proximity to other innovative (e.g. foreign) enterprises. There is a need to develop the skills and absorptive capacity of enterprises to adapt and exploit technologies and other external knowledge, whether developed in Lithuania or internationally. Lithuanian innovation system is fragmented^{clxxii}, the relations among different actors are weak^{clxxiii}. However, the recent trends indicate that the processes of collaboration, especially of business to business (value chains) are gaining acceleration^{clxxiv}. This is often the case with smaller companies that are unable to join the global value chains on their own due to limited production capacities.

6.3. Business processes and brand development

Another major bottleneck is the lack of high quality management capabilities^{clxxv}, including brand management and marketing^{clxxvi}, and effective business processes. One of the way for boosting the value added is moving towards design of own products and becoming a brand owner^{clxxvii}. Lithuania is lagging behind the advanced EU countries according to the export of own (especially high value-added) products and services. Too many Lithuanian companies are exporting raw materials or intermediate products. The future goal should be the creation of smart brands that are capable of crossing national borders. Mostly these can be niche brands aimed at specific target markets.

Moreover, despite the relatively lower labour costs, Lithuanian companies do not catch up with the productivity of countries characterized by higher standards of living. Productivity is hampered not only by lack of technological innovation in production, but also by the ineffective business processes, lack of management, marketing and branding skills and experience. Therefore, in order to create added value in all sectors of the economy, it is important to focus efforts on the current efficiency and the reduction of barriers to labour productivity: export and integration into international markets capabilities, business processes and technological capabilities.

6.4. Skills mismatches and deficits

Participation in secondary education and particularly higher education in Lithuania is considerably above the EU average^{clxxxviii}. However, the quality remains contested. In 2009 according to 65 countries survey, the highest reading level was reached by 0.1% of pupils (the survey average is 0.8 %) and the highest math level is achieved by 1.3% of pupils (the average is 3.1%)^{clxxxix}.

While lifelong learning is crucial for continuous development of competences, the proportion of adults engaged in learning remains considerably below EU average^{clxxx}. Indicators on creativity of population and climate for creativity are also well below EU averages^{clxxxix}.

Lithuanian businesses increasingly feel the lack of the qualified^{clxxxii} labour force^{clxxxiii}, especially of the technological and engineering professions^{clxxxiv}. Currently, business in Lithuania lacks engineers, working with product development. It is expected that demand for engineers and production managers will face supply shortage in the future. As well, the competence of active engineers does not satisfy employers^{clxxxv}. Labour productivity remains an important issue that could fuel further economic growth^{clxxxvi}.

According to the existing data, economic migration is not the main reason as a large proportion of the emigrated work force are from the low skills based services sectors (e.g. catering)^{clxxxvii}. Insufficient quantity of students at the relevant study fields and low popularity of the technological and engineering professions^{clxxxviii} are among the main reasons. Other reasons relate to insufficient quality of education^{clxxxix} (e.g. the education system does not foster creativity^{cx} and the ability to learn^{cxci} which is key in the context of the 'learning economy', where it is more important how one learns, not what she learns), and the overall effect of the ageing of society^{cxcii} as it puts pressure on the labour market, human resources management, labour force's learning progress and productivity, etc.

6.5. International transport links

The international competitiveness of Lithuania (especially in the transport and logistics sector) is to a large extent determined by its geographical position. With approximately 80% of freight which is transported through international transport corridors passing through Lithuania, the country has become the most important

transport centre in the European Union, linking the EU with the East, according to the market research company Datamonitor^{cxci}. The North-South highway, the railway route connecting Scandinavia with Central Europe, and the East-West route that connects vast Eastern markets with the rest of Europe - they all figure among the 10 principal freight routes in Europe^{cxci}. Sea motorways formed in the Baltic Sea to the north-south direction are among the strategic transport and economic interests of Lithuania^{cxci}. It is therefore necessary to develop and modernise the transport infrastructure links with the Trans-European transport network, timely response to the changes in the European and global logistics market and to keep up with the pace of innovation^{cxci}.

FIGURE 10. SUMMARY GLOBAL-LOCAL BUSINESS AND INNOVATION

Key challenges	Trends / Potential response	Related economy sectors and/or science fields
Technology spillovers and clusterisation for new growth areas and global markets	<ul style="list-style-type: none"> Innovation in application of technology in different contexts Cross-sectoral innovations Exporting and networking capabilities of firms 	Many sectors and science fields, especially nanotechnology, micro- and nanoelectronics including semiconductors, advanced materials, biotechnology and photonics. ICT. Smart environments, diagnostic and measurement technology, renewable and bio fuel, etc.
Climbing up the value ladder towards product development and sophistication of production factors	<ul style="list-style-type: none"> Own product development, R&D, innovation and IPR capabilities Risk capital and investment management Balancing innovation supply and demand policies R&D and knowledge management; open access centres and research infrastructures Entrepreneurship ecosystem development (startups, technology transfer, intellectual property (IPR) management) Sophistication of production factors (skills of labour force, production technologies, etc.) 	<ul style="list-style-type: none"> Industry. Management sciences. Public policies (government sector). Other fields.
Business processes and brand development	<ul style="list-style-type: none"> High quality management capabilities bus advancement of business processes Brand development capabilities 	<ul style="list-style-type: none"> Industry and services. Management sciences. Other fields.
Skills mismatches and deficits	<ul style="list-style-type: none"> Ensuring quality of education system Higher levels of technological and engineering competences Closer collaboration between universities and business Lifelong learning innovations, promotion of informal education Labour market innovations 	<ul style="list-style-type: none"> Education system, R&D, human resource management, public administration, ICT. Social sciences. Education sciences. Other fields.

Key challenges	Trends / Potential response	Related economy sectors and/or science fields
International transport links	More efficient transportation, distribution and storage	Sectors: transport and logistics, engineering industry, ICT R&D areas: transportation engineering, ICT, physics

7. FOOD

A scan of existing studies reveals several trends that will influence the future developments concerning food (security, quality/diversity, agriculture, horticulture, mariculture, etc.) in Lithuania. Significant changes in the country's demographic situation (women's employment growth, an aging population, and growing number of other ethnic groups) will have a significant impact on consumers' expectations for food preparation and consumption^{cxvii}. Focus on healthy (higher quality products with increased biological value that meet the principles of healthy nutrition) and safe food (safe food chain)^{cxviii} allow for developing solutions for these challenges.

7.1. Healthy and safe food

While in Lithuania food produced today is safe as ever, excessive food intake along with decreased physical activity results in the upward trend of lifestyle diseases (see Chapter 1)^{cxix}. People lifestyle and diet increases the risk of chronic non-infectious diseases and has an impact on life expectancy^{cc}. Studies conducted by the National Nutrition Centre note that the share of fats in the Lithuanian population diet exceeds by far the physiological fat targets. Consumption of dietary fibre is insufficient. This situation has raised demand for new food products that meet the nutritional value (healthy) requirements, and which quality meets consumers' nutritional needs^{cci}. Consumption of food products with unbalanced fatty acid composition, unsafe and/or unhealthy ingredients results in higher morbidity of the population, especially due to cardiovascular diseases, obesity, overweight, dental caries, osteoporosis, diabetes mellitus^{ccii}. In this context, special importance acquire food products, which in addition to the main functions - to provide the necessary regeneration of the body and energy components - also encourage human body recovery, boost the immune system and reduce chronic non-infectious diseases^{cciii}.

The overall incidence of infectious intestinal diseases transmitted through contaminated food, tends to increase among the Lithuanian population^{cciv}. Diseases caused by pathogenic micro-organisms in food and harmful chemicals remain an important public health problem as well as economic problem. Hence, another challenge - to ensure food safety and quality, primarily by providing high quality and safe raw materials, which can be achieved by introducing modern technologies in the primary food chain 'from farm to fork'. It is necessary not only to choose the plant and animal varieties most appropriate for particular agro-climatic conditions, but also to preserve their quality during growing / keeping and processing^{ccv}.

7.2. Rational (minimized waste) processing of traditional food raw materials, exploration of new nutrition sources

Demographic changes as well as the advent of personalized nutrition based on human genetic information will raise the new requirements for nutritional components with specified health benefits. Therefore, search and implementation of new sources of biologically valuable dietary components, comprehensive evaluation

of their health effects and benefits as well as technological and economic aspects of their commercialisation will be other important challenges and trends in the development of novel foods with improved functionality^{ccvi}.

In Lithuania, as well as around the world, organic food and organic farming trends are apparent. Studies note that less environmentally damaging farming (organic agriculture), with less mineral fertilizers and plant protection chemicals, nitrogen containing feed, would contribute positively to the environment and would ensure a more favourable rural development^{ccvii}. However, currently there is a clear lack of scientific evidence proving the benefits of organically grown crops and food produced thereof. Therefore, more comprehensive studies should be focussed on evaluations and comparisons of conventional and organic farming products by using both *in vitro* chemical and biochemical methods and particularly *in vivo* assays based on 'omics' approach.

A large fraction of agricultural resources and foods are still used not effectively, thousands of tons of valuable food grade materials are discarded as a waste. Therefore, the use of agro- and biorefinery concepts enabling to use raw materials in more rational ways also should be expanded. This should involve wider development and application of innovative tools - new food, bio, nano- and chemical engineering technologies, as well as their combinations leading to the 'no waste' processing and production of high value components, both for food and non-food applications^{ccviii}.

7.3. Tailor-made food at a 'right' time and place

Significant changes in the country's demographic situation (women's employment growth, an aging population, and growing number of other ethnic groups) will have a significant impact on consumers' expectations for food preparation and consumption^{ccix}.

Another future challenge for the Lithuanian food industry is to provide the consumer with a 'right' food at a 'right' place, on 'right' time. Increasingly it comes to food products tailor-made and delivered for each individual, with most focus on the consumers' age. In the forthcoming decades a significant part of the Lithuanian population will be over 65 years old. Therefore, this will undoubtedly put pressure on producing and providing specific food products of exceptional quality for this particular group of people^{ccx}.

FIGURE 11. SUMMARY FOOD

Key challenges	Trends / Potential response	Related economy sectors and/or science fields
Healthy and safe food	Healthy food: higher quality products with increased biological value that meet the principles of healthy nutrition Food safety: safe food chain Organic agriculture	Agriculture / organic agriculture; food industry; chemicals; packaging industry; healthcare. R&D: medicine, food science and technology, nanotechnology (packaging), biochemistry, biotechnology, information technology ^{ccxi} . Chemical engineering.

Key challenges	Trends / Potential response	Related economy sectors and/or science fields
Tailor-made food at a 'right' time and place	Tailor-made food for ageing society Transport and logistics of tailor-made food	Food industry, agriculture, transport and logistics, ICT. Medicine, food technologies. Management sciences.
Rational (minimized waste) processing of traditional food raw materials, exploration of new nutrition sources	Agro- and biorefinery of agricultural raw materials into high added value products for food and non-food applications Comprehensive evaluation of new origin sources for foods with high value nutritional profiles and specific healthy components	Food science and technology, chemical engineering, biomedicine, biotechnology, nanotechnology, management sciences

8. RESOURCES

A scan of existing studies reveals several trends that will influence the future developments concerning resources (resource efficiency and access to critical materials, sufficiency, quality, recycling, closed-loop, dematerialisation) in Lithuania.

8.1. Rational exploitation of the Baltic Sea potential

Apart from inland surface water, landscape, forests and biological diversity resources that are discussed in Chapter 5, the resources of the Baltic Sea provide national challenges (threats and opportunities) to be exploited. The Baltic Sea (BS) is a unique almost closed sea - a dynamic economic area, which is characterized by specific geographical conditions and natural resources. Different interested parties, such as boating industry, fishery, wind power parks etc. are increasingly competing with each other for extraction of limited useful resources in the BS area. In addition, the Baltic Sea is a fragile ecosystem and cross-sectoral activities need to be harmonized to manage climate change caused threats. Deliberate, proactive and rational exploitation of the marine resources could not only help to avoid conflicts, but can create synergies and be the basis for sustainable marine development.

Exploitation of the marine area and marine resources pose several challenges. Firstly, the safe, clean and efficient marine transportation^{ccxii} that involves sustainable shipping, maritime transport and efficient as well as secure international transport links (especially the east-west directions). One of the priority projects is the East-West 'Green' transport corridor, based on ICT solutions, aimed at increasing the efficiency of overall logistics chain. Equally important is the development of the marine highways in the region. The eastern coast of the Baltic Sea lacks of proper and modern infrastructure. The optical cable goes to Sweden through the Baltic Sea area. It is necessary to ensure development of the new communication corridors through the marine area.

Scouting, generation and sustainable use of the marine energy resources is related to the development of connections to the entire Baltic Sea region and the Pan-Baltic energy policy. It is necessary to identify the available natural resources of the sea and formulate preconditions for their sustainable use. This relates to search and probing for mineral resources as well as absorption of renewable energy resources in the sea.

A healthy marine environment is one of the essential conditions for ensuring the quality of natural resources, given the fact that the Baltic Sea is an especially sensitive ecosystem. Aquaculture and Fisheries are economy sectors, whose development is inseparable from the direct impact on the ecosystem and fish stocks. The largest concerns in terms of environmental sustainability challenges are: eutrophication, biodiversity challenges, pollution from ships and sea waste/trash, hazardous chemicals, climate change, and chemical stocks dumped in the sea during the First and Second World Wars.

8.2. Scouting, extraction and sustainable use of country's mineral resources

The biggest share of solid mineral resources extracted in Lithuania is used in construction and construction materials industry, production of cement and road building. The biggest share of mineral resources is comprised of peat/turf, gravel, sand, dolomite, and limestone. Lithuania has oil resources that are well researched; land oil reserves are a few hundred meters to 2.3 km below the surface. Retrieved oil is of very high-quality, low-sulphur, but the resources are relatively small; it would cover only a small part of our state's needs. Lithuania has oil reserves in the shelf of the Baltic Sea area as well.

The demand for solid mineral resources is increasing. Limestone is the most important building material of cement. It is also used for sand-lime brick, glass, paper, sugar industry. Expensive quartz sand deposits lie in Anykščiai district. This sand can be used for production of television tubes, and other modern technology.

Opportunities lie with the development of new technologies for scouting / searching for new mineral resources in Lithuania. Geologists suggest that the Lithuanian subterranean is rich in iron ore, salt, gypsum, and other important resources. The latest and much discussed example is scouting for shale gas resources in Lithuania.

Other opportunities also lie with the technologies and methods for extraction of the mineral resources. The process of extracting mineral resources involves digging them out and transporting them from the faces to the surface outside the mining excavation.

Finally, sustainable use of the mineral resources, processing of mineral resources, and production of new higher value added products have to be promoted. Opportunities lie with the use of Lithuanian peat (turf). At present only about 14-15% of extracted peat is consumed for the country's energy needs. The rest is used for production of fertilizers, various compost production, packaging materials, field turf, and yeast, used by the resort SPAs. Peat is a raw material for the chemical industry (ammonia, acetic acid, tar, wax, paraffin, bitumen and other products). Almost all the extracted peat is exported to foreign countries.

Some of the resources are already very limited (e.g. non-mineral quartz sand, Devonian age clay, oil), hence its extraction should be very rational. Recultivation of the damaged lands also needs solutions^{ccxiii}. Advanced technologies and techniques for recultivation of the damaged lands provide new opportunities. The use of sapropel resources for recreational purposes is another opportunity^{ccxiv}.

FIGURE 12. SUMMARY RESOURCES

Key challenges	Trends / Potential response	Related economy sectors and/or science fields
Rational exploitation of the Baltic Sea potential	Safe, clean and efficient marine transportation and trans-national transport links	Transport and logistics. ICT. Aquaculture and fisheries. Shipping. Ecology and environmental sciences.
	Monitoring, generation and sustainable use of the marine energy resources	
	Preserving a healthy ecosystem	
	Sustainable aquaculture and fisheries	
Searching, extraction and sustainable use of country's mineral resources	New technologies and methods for scouting / search for mineral resources	Construction industry. Mining. Chemicals industry. Tourism and recreation. Ecology and environmental sciences. Oil production. Other sectors.
	Technologies and methods for extraction and logistics of mineral resources	
	Processing and new higher value added products	
	Technologies and methods for sustainable use of mineral resources	

9. SECURITY

A scan of existing studies reveals several trends that will influence the future developments concerning security (technological and natural hazards, technological ethics, (cyber)-crime and defence) in Lithuania: increasing rates of violence and crime, distrust with law enforcement and lack of social capital in the society; growing rates of Internet and cyberspace threats. Not only technological, but also social and cultural innovations can provide solutions for solving these challenges.

9.1. Crime reduction

With the rising indicators of poverty and social inequality during the economic downturn, violence and destructive behaviour is spreading^{ccxv}. This poses one of the main national challenges. According to reported homicides per thousand residents Lithuania is among the first ten countries in the world. Other forms of violence are widespread (suicide, violence against children, violence against women, aggression at home, low levels of tolerance against other races and religions etc.). According to the scale of bullying at school Lithuania takes one of the worst places in Europe^{ccxvi}.

Moreover, distrust in the law enforcement is growing among the population^{ccxvii}. According to the survey of 'Baltijos tyrimai', 55% of citizens distrusted police in 2010^{ccxviii}. It should be noted that the Lithuanian population do not trust the Parliament, the Government and the courts equally or even more, but the lack of confidence in police has much larger social implications, because citizens encounter with police more frequently than those with other institutions. According to the State Police Department, the number of citizens who turn to police after crime incidents dropped by 10% the period of 2004-2007 (in 2004 – 19%, In 2007 – 9%). According to the same survey, 38% of citizens reported that they do not turn to police after facing the incident of crime. 62% of citizens, who turned to police, assessed the police work as 'bad' or 'very bad'. Therefore, people rarely turn to police, are dissatisfied with its work. Citizens' disappointment with law enforcement, sceptical approach towards prevention of crime and the effectiveness of the control policy matches the feelings of insecurity among the population^{ccxix}.

This situation calls for effective measures in researching and solving crimes, but also for cultural and social innovations dealing with the distrust, insecurity and the lack of social capital in the society.

9.2. E-security and cyber-security

With the growing use of ICT services, the number of information security incidents is also increasing. Internet security tools as well as effective prevention of crime in cyberspace have become an increasingly important area in the use of electronic communications services^{ccxx}.

According to Eurostat (data of 2010), about 80% of Internet users in Lithuania use data protection software (anti-virus software, spam blocking, general internal

network firewall protection. Nevertheless, nearly one third of consumer computers had been infected by viruses and suffered the loss of information or time. The most common e-security threats are viruses (49% of respondents) and spam (29% of respondents)^{ccxxi}. The most common network and information security incidents for companies were junk mail and computer viruses (data of 2010). Threat by junk, unwanted emails is increasing (increase of 8.7% since 2009)^{ccxxii}.

9.3. Smart defence and disaster risk management

The detailed data on the long term challenges in the field of State defence that would require immediate response by science and innovation are not made publicly available. The possible national challenges relate to international terrorism, and to the development and improvement of the intelligent surveillance systems for the monitoring of the international airspace, and other intelligence (monitoring, analysis) systems for smart State defence.

The recent discussions and progress in constructing several nuclear power plants near the Lithuanian border^{ccxxiii}, as well as the increasing effects of climate change on the frequency of floods in Lithuania, recent earthquake incidents in Poland^{ccxxiv} raise a question on how well is Lithuania prepared to protect the homeland security in the case of natural disasters and other major threats, e.g. nuclear threats. There is a need to rethink the strategies of civil protection in cases on natural disasters, bio-chemical and nuclear threats, and other threats to civil security.

Due to climate change effect on water resources, the quantity and quality of water resources can change in the future, hydraulic structures accidents can happen, floods become more frequent. Due to more frequent storms there is a need for a more effective risky events monitoring and warning system^{ccxxv}.

FIGURE 13. SUMMARY SECURITY

Key challenges	Trends / Potential response	Related economy sectors and/or science fields
Crime reduction	Technologies and methods for fighting crime (including organised crime) more effectively Cultural and social innovations to reduce violence in the society (against children, women, self-destruction, etc.) Intelligence on the state of crime, violence and distrust in the society	Public sector. Social sciences and humanities.
E-security and cyber-security	Advanced technologies and systems to ensure security of the personal and commercial data	ICT. Social sciences
Smart defence and disaster risk management	Intelligent surveillance systems, e.g. intelligence systems for airspace, fighting international terrorism, etc. Intelligent & durable risks surveillance systems	ICT, social sciences. State defence sector. Public sector (governance). Other sectors and fields

Key challenges	Trends / Potential response	Related sectors and/or fields	economy and/or science
	<p>Rethinking the strategies of civil protection in cases on natural disasters, bio-chemical and nuclear threats, and other threats to civil security.</p> <p>Strategies and technologies for protection of major infrastructure objects</p>		

10. GOVERNANCE

A scan of existing studies reveals several trends that will influence the future developments concerning governance (democracy, justice, transparency, corruption, open society, new forms of government, public sector efficiency and innovation) in Lithuania: a) capacity to fund provision of public services and sustainability of social protection system, b) effectiveness of governance and accessibility of public services, c) civic engagement and empowerment.

10.1. Sustainability of public finances and social protection

Economic and financial crisis of 2008-2009 has led to cuts in public spending and jump in public debt. Although debt to GDP ratio has recently improved (due to economic growth) the level of debt in absolute terms keeps rising^{ccxxvi}. This not only implies higher debt servicing costs and further exposure to future economic crisis, but also deterioration of quality of public services and unsustainable system of social protection. The latter already runs huge deficits and at the same time is frequently described as residual even in comparison to the most liberal developed countries. If demographic situation will further deteriorate as predicted (see Chapter 3) current system of social protection is likely to face bankruptcy in medium-long term. In addition to financial considerations this challenge also involves moral dilemmas. While labour is taxed at levels around 40 - 50 %, the capacity of Government to fund public services is sub-standard and current tax payers are effectively under (or un-) insured against future loss of income.

One of the main factors behind this long standing problem refers to low capacity of state to collect taxes. While the levels of taxes are comparable to those in other EU countries, since 2004 Lithuania is characterised by the lowest general government revenue to GDP ratio. In 2011 government revenues constituted 31.9 % of GDP (in comparison to 44.7 % in the EU-27).

With global markets, financial markets turbulences becoming a norm, there is a need for rethinking the public fiscal, economic and investment strategies in order to protect the public budget and national economy in times of economic and financial crises^{ccxxvii}.

10.2. Effectiveness of governance and accessibility of public services

During the past two decades Lithuania has successfully established workable public administration and has continuously reformed provision of public services. Nevertheless, several challenges remain. First, there is insufficient management by results and responsiveness to the needs of population, lack of quality standards in public sector delivery, insufficient institutional coordination and slack as well as unduly high administrative burden placed on citizens and organisations^{ccxxviii}. As a result, public sector is all too often considered as self-serving, inflexible^{ccxxix} and

ineffective in the use of public funds, including the EU structural funds. There is a lack of practices of 'good governance' and the State is criticised and being 'weak' in solving the main social and economic problems. Second, accessibility of public services remains uneven. Decline of population in rural areas has inspired optimisation efforts and as a result, the geographical distance between citizens in rural areas and providers of education, health care and other services has increased. E-Governance and adoption of various New Public Management (NPM) and post-NPM style reforms are the most frequently cited responses to the above problems.

10.3. Civic empowerment and engagement

The relationships between Government and citizens are increasingly facing several challenges. On the one hand, Government and providers of public services have distanced themselves from civil society. The venues for participation of citizens in public decision making are limited, public consultations are too formalised^{ccxxx} and engage a limited number of representatives, there are very few opportunities for communities to engage in provision of public services and solving relevant public problems at local level^{ccxxxi}. On the other hand, public trust in Government remains low^{ccxxxii}, perceived level of corruption is high^{ccxxxiii} and the level of participation in elections has decreased. As a result the governance mode in Lithuania is increasingly characterised as top-down centralised system with limited flow of ideas, responsibility and accountability between Government and citizens.

Changes in the mode of governance represent the strongest trend that could reverse the current unfavourable situation. Governance should shift from regulatory and allocating state to empowering state. This involves: a) delegation of decision making powers and resources to provide public services to local communities in line with the principle of subsidiarity; b) strengthening of civic society institutions through transparent involvement in national policy making and local problem solving^{ccxxxiv}; c) promotion of social dialogue on development and adoption of public sector innovations that could increase efficiency and effectiveness of Government.

FIGURE 14. SUMMARY GOVERNANCE

Key challenges	Trends / Potential response	Related economy sectors and/or science fields
Sustainability of public finances and social protection	Low capacity of state to collect taxes Dramatic economic upswings and downturns. Need to rethink the public fiscal, economic and investment strategies in order to protect social security in times of economic and financial crises Demographic trends	Social sciences
Effectiveness of governance and accessibility of public services	E-Governance Management by results Quality management	ICT, Management sciences
Civic empowerment	Empowerment of citizens Delegation of decision making and problem	ICT, Government and management sciences;

Key challenges	Trends / Potential response	Related economy sectors and/or science fields
and engagement	solving to local communities and civil society. Transparency and social dialogue	public sector economics; sociology, etc.

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